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Urban Morphology

An Introduction to the Study of the Physical Form of Cities

Second Edition

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To my parents—Maria Teresa Araújo and Manuel de Oliveira—my best friends.

To Cláudia, my wife, for sharing my life over the past two and half decades.

Foreword

Urban Morphology as a field of knowledge has grown substantially over the past two to three decades. This is evident not only in the major increase in the number of articles on this subject and the range of journals in which they appear but also in the increase in the number and size of conferences with urban morphological themes. Most of the major conferences, together with the initiation of the international journal *Urban Morphology*, have stemmed from the foundation in 1994 of the International Seminar on Urban Form (ISUF)—the first international organization of urban morphologists. This has also been the catalyst for the formation of numerous national and regional organizations devoted to this field.

There has not, however, been a commensurate growth in the number of books on urban morphology. Indeed it is hard to identify a single book in the English language that could readily be identified as an urban morphology textbook. This lacuna poses problems for students seeking a concise introduction to the field, as well as for researchers moving into urban morphology and seeking an economical review of its objects of investigation, concepts, and methods. This deficiency has now been rectified by Vítor Oliveira, who is one of the foremost current contributors internationally to urban morphological research, writing and editing, and also one of a group of academics who have done most to shape ISUF in the course of the second decade of its existence.

In assessing the recent flourishing of the study of urban form, it is important not to lose sight of the antiquity of the object of investigation—the urban area in all its physical manifestations, beginning with its fundamental place in the earliest civilizations. As a subject of study, these most intensively occupied areas of the earth's surface have very long histories, though, as in many other fields of knowledge, the appearance of this type of study in scholarly journals was rare until the end of the nineteenth century. The amount of the earth's surface covered by urban areas has in the meanwhile expanded enormously. Now occupied by over one-half of the world's population, it is no small task to encapsulate in a single short book a concise but wide-ranging account of the physical forms of these urban areas and their methods of study. But Oliveira achieves this by careful choice of examples, minimal use of technical terms, and effective use of maps, diagrams and photographs.

Integral to the forms of urban areas are the agents and agencies that create and transform them—for instance, the developers, architects, builders, planners, and politicians—and these too find a place in Oliveira's coverage. However, arguably one of the most important contributions of the book concerns its bringing together of material that all but established urban morphologists would find very time-consuming to assemble for themselves. The chapter on the different approaches to the study of urban form is a notable example. In addition to introducing 'classic' publications by major individual contributors to the field, summaries are provided of the historico-geographical approach, the process-typological approach, space syntax, and pertinent types of spatial analysis. This leads logically to consideration of comparative studies that have been undertaken of different approaches.

There is much here that is expressive of Oliveira's personal sensitivity to the relationship that urban morphology has with various disciplines—geography, architecture and urban planning to mention three of the more important. It is particularly evident in the links he discusses between the explanation of urban form and the ways in which this can be put into practice, not least in urban planning. The reader benefits from the author's personal experience of applying an appreciation of urban form to practical challenges. The scales considered range from individual plots and buildings to intra-urban regions and entire cities. There is also a reaching out to address social, economic, and environmental dimensions more widely, exploring urban morphology in relation to such matters as public health, social justice, heritage tourism, and energy.

This book is described by its author as a manual. In fact it is more than that. It is true that it does provide a systematic treatment of basic attributes of urban morphology, and in this respect it is unique among books in the English language. However, it has an important place in the literature in another way. It inspires as well as informs. It argues for an approach that is investigative and widely applicable, including in dealing with practical problems, but it is also integrative. And this approach is not only sensitive to history and culture but also amenable to systematic application. The varying identities of urban landscapes are viewed as central to both research and practice. In this and other respects, the gap is large between what is espoused here and the realities of planning practice as they have been uncovered in the real world of today. Underlying this problem, Oliveira argues, is the limited extent to which much that is currently being created in the urban landscape is informed by a sound grasp of urban morphology. Among its various merits, this book is a valuable step towards educating new and potential recruits to urban morphology in how they can help to rectify this serious defect.

January 2016

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Preface

The wide interest on 'Urban morphology, an introduction to the study of the physical form of cities' expressed after its publication, five years ago, led to the preparation of this second edition. This edition offers updated and more accurate knowledge on several morphological issues, presents expanded contents, and it has a more explicit didactic nature, including a set of exercises in the end of each chapter, that will help teachers and students in acquiring and consolidating their urban morphological knowledge. The edition is the result of my own continuous learning process developed over the last five years, including: new teaching experiences in Portugal (University of Minho), Spain (Valencia Polytechnic University), Brazil (Pontifical Catholic University of Paraná), and China (Nanjing University and Zhejiang University); new research projects at the Research Centre for Territory, Transports and Environment (CITTA) at the University of Porto; and debate in the two international scientific networks that, at the time of writing, I am heading—the International Seminar on Urban Form (ISUF) and the Portuguese-language Network of Urban Morphology (PNUM). This second edition of 'Urban morphology, an introduction to the study of the physical form of cities' has been prepared in the first half of 2021, working at home, in Porto, in the context of the COVID-19 pandemic. COVID-19 has changed our lives. The pandemic opened many debates of different nature and gave origin to new perspectives on extant and emergent issues. It brings to the centre of debate the physical form of cities, our places of residence, work, and leisure, as well as the spaces where we move through in cities.

This second edition has updated contents on 'The elements of urban form' and 'Relationships with other fields of knowledge' (Chaps. 2 and 8). Furthermore, it includes new sections on Chaps. 3–7. 'The agents and processes of urban transformation' comprises a new section devoted to informal settlements, and the chapter's review on the most influent plans in the nineteenth and twentieth centuries includes a brief insight on the Curitiba and Bogota plans prepared in the 1960s and 1990s. Chapter 4 has a new introductory section on the first houses and settlements, and it significantly increases the section devoted to early cities, including new material on the Egyptian, Harappan, Aztec, Maya, and Inca civilizations—complementing the information on the Sumerian and Chinese cities. Chapter 5 comprises a review

of urbanization processes after the mid-twentieth century, and it has a clear focus on megacities. In addition to New York, contained in the 2016 edition, the book analyses two other megacities—Tokyo (the largest megacity in the world) and Istanbul (a megacity with a unique urban history, as capital of Roman, Byzantine and Ottoman Empires). Both classics books ('A pattern language' and 'Fractal cities') and emerging perspectives on urban morphology deserve new attention in Chap. 6. Finally, 'From theory to practice' has a new introduction, and the section devoted to the relation between urban morphology and architecture includes three new case studies in Asia, Europe, and South America.

In the end of each chapter, there are two different kinds of exercise. One set of exercises is more individual, the other set has a collective nature. In the first, the reader is invited to test his morphological knowledge acquired in each chapter, through five questions of multiple choice covering the most important issues presented in the different sections. These exercises should give the reader an idea of his progression in this introduction to a new field of knowledge. The second group includes three interactive exercises, and it is more suited to the specific dynamics of the classroom (complemented by homework), proposing educators and students a more active way of teaching and learning. The design of this second set of exercises tries to balance the general morphological knowledge shared by different researchers in different parts of the world, with the 'particular' knowledge of the urban forms of the city where classes are taking place.

Late June, when concluding this second edition, and just before the 28th conference of ISUF, I was struck by the sudden death of Jeremy Whitehand. Right until the end we were working together on three different projects: the translation of 'Alnwick, Northumberland. a study in town-plan analysis' to Portuguese language; an ISUF Task Force on 'Teaching urban morphology'; and Jeremy's participation in the conference. It is my strong conviction that no one has done so much for our field, in the last decades, as Jeremy has done, both in an institutional—creating and developing research networks and editing the journal 'Urban Morphology'—and substantive way—proposing and refining a number of morphological theories, concepts, and methods. Jeremy has been, and will continue to be, my main influence in the field of urban morphology.

This second edition is dedicated to Jeremy.

Porto, Portugal
September 2021

Vítor Oliveira

Acknowledgments

Any work that summarizes thinking developed over a significant period owes much to other people. It is impossible to acknowledge all of them. I can do no more than indicate the major sources of inspiration, most of them fellow academics and researchers, whose paths crossed mines at various times.

Firstly, I would like to thank Jeremy Whitehand. The first scientific paper on urban morphology I have read, back in 2003 when I was starting my MSc thesis, was 'Recent developments in urban morphology' by Jeremy Whitehand, published in 'Urban Studies' in 1992. This paper gave me my first references in the field describing the work of M R G Conzen and of most members of the Urban Morphology Research Group (UMRG), of Michael Batty and Gianfranco Cannigia. Three years later, my first paper in a peer-reviewed journal, 'The morphological dimension of municipal plans', was published in 'Urban Morphology', the journal led by Jeremy Whitehand. Over the last years until his death in June 2021, in a direct (through personal conversations or through email correspondence) and indirect way (through his notable and extensive work), Jeremy Whitehand has been my main influence in the field of urban morphology. It is my strong conviction that no one has done so much for our field, in the last decades, as Jeremy Whitehand has done.

Writing this book was made possible by the *Centro de Investigação do Território Transportes e Ambiente* (CITTA) granting me considerable time for writing, in 2015, and revision, in 2021. I wish to express my deep gratitude to Paulo Pinho, the director of the research center and the supervisor of my MSc and PhD thesis concluded in 2004 and 2008, respectively. I would also like to thank another of my former professors, Alfredo Matos Ferreira. Back in the mid-1990s, in the *Faculdade de Arquitectura da Universidade do Porto*, Matos Ferreira has shifted my architectural focus from 'buildings' to 'cities'. Over the next 20 years, the passion on cities continued to be part of our conversations.

A number of colleagues in the International Seminar on Urban Form (ISUF) has influencied my morphological thought: Susan Whitehand, Michael P Conzen, Michael Barke, Peter Larkham, Kai Gu, Tolga Unlu, Ivor Samuels, Karl Kropf, Gian Luigi Maffei, Giancarlo Cataldi, Giuseppe Strappa, Attilio Petruccioli, Nicola Marzot, Marco Maretto, Paolo Carlotti, Paul Sanders, Sergio Porta, Anne Vernez

Moudon, and Wendy McClure. Thanks and appreciation are also due to my colleagues in the Portuguese-language Network of Urban Morphology (PNUM): Teresa Marat-Mendes, Jorge Correia (I also thank Jorge for his two photographs included in the book), David Viana, Manuel Teixeira and Teresa Heitor, in Portugal; and Stael Pereira Costa, Cristina Teixeira, Marieta Maciel, Manoela Netto, Frederico de Holanda, Luiz Amorim, Valério Medeiros, Renato Leão Rego, Karin Meneguetti, Gislaine Beloto, Silvio Soares, Eugenio Queiroga, Romulo Krafta, Eneida Mendonça, Evandro Monteiro, Bruno Zaitter, Mauricio Polidori, Renato Saboya, Vinicius Netto, Ana Cláudia Cardoso, Júlio Lima, Roberta Rodrigues, e Vera Tangari in Brazil. Bill Hillier, Julienne Hanson and Michael Batty have been major influences in space syntax and spatial analysis.

Finally, I would like to thank Bryan Woodhead, Cláudia Lira, Elisa Dainese, Filipa Neiva, Jan Reurink, Janto Marzuki, Sara Guedes, and Urszula Zdzieborska for their photographs included in the second chapter of the book. I would also like to thank Google Earth for the aerial views included in Chaps. 2, 4, 5, and 7.

Contents

Abbreviations

ABM	Agent-Based Models
CA	Cellular Automata
CAMUSS	Automata Modeling for Urban and Spatial Systems
CASA	Centre for Advanced Spatial Analysis
CISPUT	*Centro Internazionale per lo Studio dei Processi Urbani e Territoriali*
CITTA	*Centro de Investigação do Território Transportes e Ambiente*
COP	Conference of the Parties
DCP	Department of City Planning
ENPAS	*Ente Nazionale di Previdenza ed Assicurazione Sociale*
EUR	*Esposizione Universale Roma*
INA	*Istituto Nazionale delle Assicurazioni*
IPCC	International Panel on Climate Change
IPPUC	Instituto de Pesquisa e Planejamento Urbano de Curitiba
ISSS	International Space Syntax Symposium
ISUF	International Seminar on Urban Form
JOSS	The Journal of Space Syntax
LUBFS	Land Use and Built Form
LUTI	Land Use Transport Interaction
OECD	Organisation for Economic Co-operation and Development
PNUM	Portuguese-language Network of Urban Morphology
POS	*Plan d'Occupation des Sols*
UCL	University College London
UMRG	Urban Morphology Research Group
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization

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Chapter 1
Introduction

Keywords Cities · Disciplinary history · Manual · Urban form · Urban morphology

1.1 Motivation

Very few things give me as much pleasure as walking, for the first time, through the streets of a city. The moment, when I leave the hotel in the first morning, usually carrying a map, a sketchbook, and a camera, has an intense meaning for me, representing the beginning of the discovery of the city… this magnificent creation of mankind. That morning and the following days are of intense learning. I try to leave the hotel as early as I can, and to arrive as late as possible. In the numerous walking trips, I take some photographs, quick sketches, and brief written notes. Leaving a city is always sad, even knowing that my beloved city, Porto, will always be waiting for me. Sometimes, I return to the visited city earlier than expected. On these occasions, I always take the map that I have used in my first visit and continue to 'draw all the visited streets'. It is good to know that there are always new lines to be drawn…

As my passion for cities continued to grow, taking an increasingly central place in my academic and research work, I have realized, with some perplexity, that there were not many textbooks on the study of the physical form of cities. Initially, I thought that this was a lack of knowledge, but quickly, through my research work and contacts with Portuguese and foreign colleagues, I have acknowledged that there is indeed an absence of manuals on urban morphology.

The book has this specific goal, to be a manual… able to introduce the reader into the wonderful world of the study of physical form of cities. In this sense, the book is firstly directed to researchers, academics, and students of M.Sc. and Ph.D. courses where urban morphology is a fundamental theme, including geography, architecture, planning, engineering, and also history, archaeology, and sociology. It is also directed to professionals who, in a systematic way, deal with the physical

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form of cities: planners, urban designers, architects, engineers, and others. Finally, this book is for all those who are interested in cities, and who, like me, always want to learn something more about 'the most complex of human inventions' (Levi-Strauss, 1955). To achieve this goal, I have tried to make a simple and small book, using an easy language. This does not mean simplification of contents, but of how these are communicated—highlighting the essential and eliminating the superfluous elements.

My personal experience is reflected in the book: from my first training in architecture to my daily work in the *Centro de Investigação do Território Transportes e Ambiente* (CITTA), to the intense debate in the two morphological research networks in which I am most deeply involved—the International Seminar on Urban Form (ISUF) and the Portuguese-language Network of Urban Morphology (PNUM), and to the indispensable trips into the different cities that I had the pleasure to visit.

1.2 Object of the Book

This book is about urban morphology. It is hard to find shared definitions, by different morphological approaches, of 'urban morphology' and 'urban form'. The book draws on the basic definition that urban morphology means the study of urban forms, and the agents and processes responsible for their transformation; and that urban form refers to the main physical elements that structure and shape cities—streets (and squares), street blocks, plots, and common and singular buildings, to name the most important. The theme of the different elements of urban form will be developed in detail in the second chapter. In this book, the word 'city' is used in its wider sense, encompassing most human settlements.

The word morphology was first proposed by Johann Wolfgang Von Goethe (1749–1832), the famous German writer and thinker, who devoted part of his work to biology. Goethe used the word morphology to designate the 'science that deals with the essence of forms'. Although it was proposed as a branch of biology, the general and abstract nature of morphology enabled its application in many different fields. Table 1.1 shows a set of definitions of urban morphology proposed by different authors.

Despite the reduced number of manuals (the book 'Handbook of Urban Morphology', published one year after the 2016 edition, must be highlighted in this context—Kropf 2017), there are many texts on various aspects of urban morphology. Faced with the impossibility of bringing all these into the debate, I had to make some choices. This book is particularly informed by papers published in scientific peer-reviewed journals written in the English language. These papers have three fundamental advantages as a source of knowledge: updated information, scientific validation, and consideration of local issues under a wider framework. Yet, emphasizing these advantages does not mean that a significant disadvantage, underlined by authors such as Jeremy Whitehand or Michael Conzen, is ignored: it is easier for an English native speaker to prepare a text in this language. This leads to the existence, in these journals, of what the two authors describe as 'anglophone squint'

Table 1.1 Definitions of urban morphology (Marshall and Çalişkan 2011)

	Definition	Source
General	'The study of urban form'	Cowan (2005)
	'The science of form, or of various factors that govern and influence form'	Lozano (1990)
	'The study of the physical (or built) fabric of urban form, and the people and processes shaping it'	Urban Morphology Research Group (1990)
	'Morphology literally means form-lore, or knowledge of the form…what is the essence of that form; does certain logic in spatial composition apply, certain structuring principles?'	Mayer (2005)
Focus on the object of study (urban form)	'…an approach to conceptualising the complexity of physical form. Understanding the physical complexities of various scales, from individual buildings, plots, street-blocks, and the street patterns that make up the structure of towns helps us to understand the ways in which towns have grown and developed'	Larkham (2005)
	'Urban morphology…is not merely two dimensional in scope. On the contrary, it is through the special importance which the third dimension assumes in the urban scene that much of its distinctiveness and variety arise'	Smailes (1955)
Focus on the manner and purpose of study	'A method of analysis which is basic to find(ing) out principles or rules of urban design'	Gebauer e Samuels (1981)
	'…the study of the city as human habitat…Urban morphologists…analyse a city's evolution from its formative years to its subsequent transformations, identifying and dissecting its various components'	Moudon (1997)
	'First, there are studies that are aimed at providing explanations or developing explanatory frameworks or both (i.e. cognitive contributions); and secondly, there are studies aimed at determining the modalities according to which the city should be planned or built in the future (i.e. normative contributions)'	Gauthier e Gilliland (2006)

(Conzen 2011; Whitehand 2012). However, it also seems fair to say that in most scientific journals in this field of knowledge, a paper is not rejected by the lack of quality of English writing.

Books and unpublished doctoral thesis deserved special attention in the construction of this manual. In these cases, language proved to be a barrier: only texts in English, French, Italian, Portuguese, and Spanish were considered. Finally, communications in scientific conferences in this field of knowledge—such as the International Seminar on Urban Form, the International Space Syntax Symposium (ISSS), and the Portuguese-language Network of Urban Morphology—were considered and incorporated in the book.

1.3 Structure of the Book

The book is in nine chapters. After this brief introduction, the second chapter focuses on the different elements of urban form. The presentation of these elements follows an order of increasing the resolution of urban form. It starts with a description and explanation of different urban tissues that we can find in our cities. It then moves to the natural context and, increasing the resolution, to the system of public spaces that constitute each urban tissue, analysing both the spaces for circulation and permanence. The chapter moves then to plots which are, in most cases in our cities, the physical expression of individual property and, as such, distinct from the public or collective space. Once again, increasing the level of resolution, the chapter moves to buildings constituting the urban tissues of a city including not only singular buildings but also common buildings.

The third chapter focuses on the different agents and agencies responsible for, and the complex processes of, urban transformation. It analyses how each one of us takes part in the process of transformation of the urban landscape: as a promoter of an action of transformation of urban forms, as an architect responsible for the design of new physical forms, as a builder of these forms or, in a more indirect way, as a planner designing a city vision and guiding private activity in his day-to-day practice of development control, or as an elected politician defining a political strategy for the city. In addition, the chapter aims at understanding the processes of urban transformation: how do we organize ourselves as a society to build a balance between a comprehensive view of the city, usually a planned view, and a number of different contributions, eventually associated with a higher spontaneity. It is argued that this balance between unity and diversity is essential in a city that wants to be attractive, in morphological terms.

After introducing the main objects of study in urban morphology—the urban forms, agents, and processes of transformation—the fourth chapter analyses the evolution of cities over history. The structure of the chapter draws on seven historical periods that are relatively consensual for different researchers: (i) early cities, including Sumerian, Egyptian, Harappan, Chinese, Aztec, Mayan, and Inca, (ii)

Greek cities, (iii) Roman cities, (iv) Islamic cities, (v) Mediaeval cities, (vi) Renaissance cities, and finally, (vii) nineteenth-century cities. The main goal of the chapter is to understand how the main elements of urban form were combined in each of these periods, and what the main characteristics of these elements were.

The fifth chapter addresses contemporary cities, investigating the main city-building processes and including both inherited and emerging urban forms. It focuses on urbanization processes since the mid-twentieth century, exploring the progressive growth of urban population and its distribution by cities of different sizes. The chapter has a particular focus on megacities (cities with more than ten million inhabitants) and on three distinct examples, with different weaknesses and threats, and with specific strengths and opportunities: Istanbul, Tokyo, and New York. For more than 1500 years, Istanbul (Constantinople) was the capital of the Roman, Byzantine, and Ottoman Empires. After the partition of the Ottoman Empire, in 1923, a new country was established—Turkey—and Ankara became the new capital. Yet, Istanbul has never lost its fundamental role. From central Fathi to the peripheral districts of Sile (East) and Çatalca (West), the metropolitan area of Istanbul is inhabited by fifteen million inhabitants. At the end of the twelfth century, Tokyo (Edo) was established as a small castle town, occupying part of the area of present-day Imperial Palace. In the early seventeenth century, it had about one million residents, being one of the largest cities of the world, and in 1868, Tokyo became the capital of Japan, succeeding Kyoto. The city suffered major destruction in the mid-1920s, due to the earthquake, and in the mid-1940s, due to the Second World War. But in 1950 Tokyo was, together with New York, one of the two megacities in the world. Today, with almost 40 million inhabitants, Tokyo metropolitan area is the largest in the world. Founded in the early seventeenth century by Dutch settlers, New York has been continuously growing, in a remarkable process of urban evolution, marked by the 1811 plan (establishing its orthogonal layout), which culminated in today's magnificent city, structured in five main areas (Manhattan, Brooklyn, Queens, Bronx, and Staten Island), and a great metropolitan area that is the place of residence for more than eighteen million inhabitants. With more than one million people and with a remarkable urban history and built heritage as expressed by UNESCO classification, Marrakesh (one of the four imperial cities of Morocco) and Porto are the focus of the last part of the chapter.

After the first set of chapters that focus on the object (the city), the sixth chapter changes the emphasis to the researcher (the urban morphologist). The chapter is in three parts. The first part addresses a few works that are classics in urban morphology and urban studies. The first of these books was written in the late 1950s, five books were prepared in the 1960s, two were written in the late 1970s, one was prepared in the early 1980s, and the last one in the early 1990s. The ten books are *Studi per una operante storia urbana di Venezia* by Saverio Muratori; 'Alnwick Northumberland. A Study in Town Plan Analysis' by MRG Conzen; 'The Image of the City' by Kevin Lynch; 'Townscape' by Gordon Cullen; 'The Death and Life of Great American Cities' by Jane Jacobs; *L'architettura della cittá* by Aldo Rossi; *Formes urbaines: de l'îlot à la barre* by Jean Castex, Jean Charles Depaule and Philippe Panerai; 'A Pattern Language' by Christopher Alexander and his colleagues; 'The Social Logic of Space' by Bill Hillier and Julienne Hanson; and, finally, 'Fractal Cities' by

Michael Batty and Paul Longley. The second part of the chapter presents the main morphological approaches that have been developed over the last decades, from the historico-geographical approach (promoted by the Conzenian School) to the process typological approach (promoted by the Muratorian School), from space syntax to the various forms of spatial analysis (including cellular automata, agent-based models, and fractals), and also a number of emerging approaches. Finally, the last part of this chapter introduces a key topic—the need to develop comparative studies. The knowledge of the strengths and weaknesses of each approach will certainly enable those who want to develop a morphological study, to select the most appropriate options given the specific nature of the object under analysis.

The seventh chapter focuses on a fundamental issue for the field of urban morphology that has been receiving increased attention in the literature, the passage from description and explanation of the morphological phenomena to the definition of prescriptive guidelines to produce new urban forms. Two eminently practical activities that can benefit from morphological support are identified: urban planning (and urban design) and architecture. While the first is a potential receptor of morphological theories, concepts, and methods developed for the city scale, the second would be informed by morphological approaches developed for the building scale.

The eighth chapter addresses the contributions of urban morphology to fundamental dimensions of our collective life in cities, in particular the social, economic, and environmental dimensions. Bearing in mind the practical achievement of this purpose, five specific issues from these three generic dimensions are selected: public health, social justice, heritage tourism, climate change, and energy. The chapter discusses how to strengthen the channels of communication between each of these issues and the field of urban morphology.

Finally, the ninth chapter presents the main conclusions of the book, somehow bringing together the synthesis presented in each of the previous chapters and reflecting on the work as a whole. This chapter includes the identification of a few lines for future research within the science of urban form.

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Chapter 2
The Elements of Urban Form

Abstract This chapter focuses on the different elements of urban form. The presentation of these elements follows an order of increasing resolution of urban form. It starts with a description and explanation of the different urban tissues that we can find in our cities. It then increases the resolution and moves to the natural context and to the system of public spaces that constitutes each urban tissue, analysing both the spaces for circulation and permanence. The chapter moves then to plots which are, in our cities, the physical expression of individual property and, usually, distinct from the public or collective space. Once again increasing the level of resolution, the chapter moves to buildings, including both singular and common buildings.

Keywords Elements of urban form · Urban tissue · Streets · Street blocks · Plots · Buildings

The different elements that constitute the physical form to our cities is the theme of this chapter. Each of the main elements of urban form is isolated from its context, enabling a more effective analysis and understanding. This analytical exercise is not 'neutral' and it somehow implies the previous existence of reading instruments to organize and structure these elements. Yet, we have tried to minimize the role of the 'researcher' and to focus on the 'object', the city. The role of the 'researcher', and of its instruments for description, explanation and even for prescription, will be discussed in Chaps. 6 and 7, which will consider the different ways that distinct researchers use to deal with the same object, the city.

2.1 The Concept of Urban Tissue

Cities are, in morphological terms, extremely complex objects. In other words, cities are objects composed of different objects or distinct parts. It is possible to identify several relationships between these objects 'from the part to the whole' and to recognize a hierarchy in these relations. To deal with the complexity of cities, urban morphology uses this hierarchical view of the city, structured according to a set of fundamental physical elements.

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At a general level, the city is composed of urban tissues. Karl Kropf, in his paper 'Urban tissue and the character of towns', strongly influenced by the Italian tradition, defines urban tissue as an organic whole that can be seen according to different levels of resolution. These distinct levels correspond to different elements of urban form. The higher the level of resolution, the greater the detail of what is shown and the specificity of morphological description (see also Fig. 7.4 in Chap. 7). At a very low level, the urban tissue includes only streets and street blocks. At a high level of resolution, the tissue might include several details, such as construction materials of an open space or building (Kropf 1996).

In general, all cities and their tissues are constituted by a set of elements of urban form—streets (in a broad sense, including open spaces for circulation and permanence), street blocks, plots, and buildings. Yet, in each city these streets, street blocks, plots, and buildings are combined in a specific way, originating different types of tissues. Some of these tissues are clearly identifiable, offering their cities a unique character. Each of these urban phenomena is deepened by the 'time' factor, as many of our cities are the result of long processes of construction, developed over centuries, and where different layers are continuously overlapping without erasing the previous layer. The notion of 'palimpsest' is often used in urban morphology to explain this continuous construction over time (we will get back to the notion of palimpsest in Chap. 6 when presenting the work of Gustavo Giovannoni).

Figure 2.1 presents, approximately at the same scale, eight cities in four different continents, with some urban tissues that are clearly recognizable: Brasilia, with a relation between (or a percentage of) open space and built form clearly favorable to the former; Djenné, in Mali, with a central and very compact urban occupation in clear contrast with the periphery; Venice, with its exceptional geographical context marked by the strong presence of water and with an extremely compact urban fabric; New York, with an extremely regular pattern of streets and buildings alignment, and a wide range of buildings height (New York will be analysed in detail in Chap. 5); Barcelona, with its rigorous grid—forming octagonal open spaces in the street crossings—only broken by the large Diagonal, and with its homogeneous alignment of buildings; Paris, with the large radial streets conformed by built forms with uniform alignment and height; Rome, with a very dense layout of small street blocks interrupted by a number of monuments and squares that offer the city a high level of intelligibility; and finally, Sana'a, in Yemen, in clear contrast with the first urban tissue (Brasilia), with a relation between open space and building fabric that is clearly favourable to the latter.

The same way we can find different urban tissues in distinct cities, in different continents, we can also find distinct urban tissues within the same city. Figure 2.2 shows—once again, at the same scale—four different tissues within the apparently homogeneous fabric of New York. Indeed, these tissues are included in only one of the five boroughs of the city—Manhattan.

The first tissue is in the Downtown area around Wall Street. Wall Street takes its name from the seventeenth-century wall located in this street. Its current importance is due to its central role in the global financial markets. The surrounding area, with a very rich urban history, is characterized by a pattern of narrow streets, forming

Fig. 2.1 Urban tissues of eight different cities, approximately at the same scale: Brasilia, Djenné, Venice, New York, Barcelona, Paris, Rome, and Sana'a. *Source* Google Earth

street blocks of irregular shape and small size, including a few plots and buildings. These buildings correspond to very large volumes given by their large block-plans (footprints) and heights.

The second urban tissue is the Soho area around one of its most notable streets, Greene Street. This area is made of more regular street blocks, with larger areas than in the previous tissue, with a reasonable number of plots and buildings. The buildings

Fig. 2.2 Different urban tissues in New York city, approximately at the same scale: Downtown, Soho, Harlem, and Stuyvesant Town. *Source* Google Earth

height is similar to the streets width. A fundamental factor for the high quality of this built environment is the excellence of its iron buildings, erected between 1869 and 1895. Another factor that should be noted is the great mixture of uses, which contributes, in an undeniable way, to the urbanity of this area.

The third urban tissue is the famous black neighbourhood of Harlem, in particular the area around the 125th Street (Martin Luther King Boulevard). Unlike Soho, this part of New York is clearly marked by the residential use, except for the 125th Street which is a truly commercial street. The street blocks of Harlem are larger than those of Soho, and include a higher number of plots and buildings. Yet, there is a significant number of vacant plots which, somehow, contributes to a decrease in the urban quality of this neighborhood.

Finally, the fourth urban tissue is Stuyvesant Town, a private residential development located east of Gramercy Park. Contrary to the previous tissues, in 'Stuy Town' the open space prevails over the built fabric (although this dominance is not as expressive as in Brasilia), and the area does not have a plot structure. The number of street blocks and buildings is very low when compared with the previous tissues. It has large dimensions, comprised between the 14 and 20th streets, and a strong formal homogeneity.

2.2 The Natural Context

The natural context is the first condition for the establishment and organization of the different elements of urban form. The land relief, the quality and suitability of soil and subsoil, the climate, the solar and wind exposure, the type of natural landscape—all these factors influence how a settlement is established, from its foundation, from the first paths and streets (and, subsequently, from all the infrastructures that would be built in these streets) to the way land is sub-divided into a number of different parts, to the various buildings that are built in these plots, and even to the materials that, at least until recently, would give expression and surface to all these forms.

In each initial intention of human settlement, in different historical periods, topography has its own configuration and geometry influencing its location and form. Rosália Guerreiro's master and doctoral theses, 'O território e a edificação' and 'Urbanismo orgânico e a ordem implícita', synthesize a number of key elements on this influence of land relief in human settlements. These are summarized, very briefly, in the two following paragraphs (Guerreiro 2001, 2011).

Generally, the land relief can be divided into two categories. In addition to the basic forms of land relief or micro-relief (a hill, a promontory…) there is a number of composite forms, the macro-relief or the structural relief. The formation of these forms is associated with endogenous forces that originated the process of geomorphologic formation of the continents. The structuring lines of the territory are as follows: the ridge lines corresponding to imaginary lines connecting the maximum elevation points and dividing the flow of water in opposite slops; and the lines of thalweg, linking the lowest elevation points, promoting the natural drainage of water to downstream. Both ridge and thalweg lines are associated in branched hierarchical systems forming the orographic and hydrographic systems. The points where ridge lines and thalweg lines are ramified are the singular points of the territory, usually referred to as distribution centres and encounter centres. There is also a third system of territory lines—the contour curves, cutting perpendicularly the ridge and thalweg establishing the relationships between them.

In different human settlements, the definition of the first paths follows this natural structure of territory, strengthening its own configuration and geometry. Indeed, ridge, thalweg, and contour curves represent the lines where the effort to overcome the slope is smaller. As such, for centuries, these were the lines of movement. The place where these lines of movement get together—the notable points of the territory—became the central places (Fig. 2.3).

Figures 2.4 and 2.5 illustrate the importance of land relief to human settlements. It is impossible to imagine the urban forms of Machu Picchu (Peru), Masada (Israel), Saint-Michel (France) or Lhasa (Tibet) without considering the land relief. The city of Machu Picchu, built in the fifteenth century (and abandoned in the following century after the Spanish conquest) by the Inca civilization in the Andes, at almost 2,500 m above sea level, is one of the most remarkable examples of integration between human settlement and natural support. The city was structured in a set of terraces, ramps and stairs, around a central 'square' and included about 200 buildings distributed

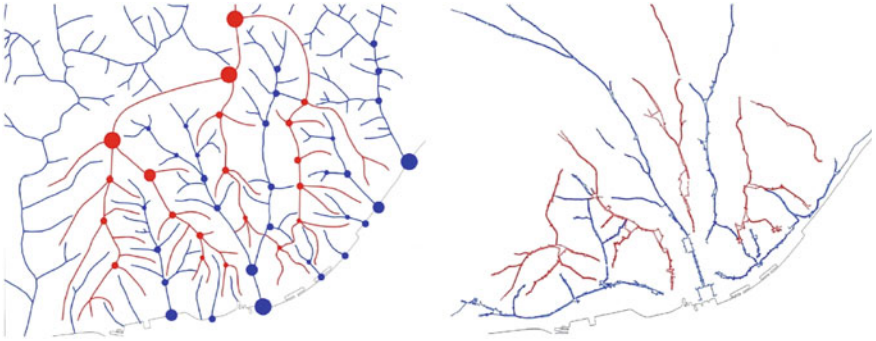

Fig. 2.3 Physiography of the physical support (ridges in red, thalwegs in blue; distribution centers in red and encounter centers in blue) and of the street system (ridge streets in red, thalweg streets in blue) of Lisbon. *Source* Guerreiro 2011

by religious, agricultural, industrial and residential areas. The second example is Masada, a fortified settlement built by the Jews in the Judean Desert near the Dead Sea at about 400 m altitude. Similar to Machu Picchu, Masada had a short period of occupation, being conquered by the Romans in the first century. A key element in the life of this settlement was a sophisticated water supply system.

The building complex made of the *Potala* Palace, *Jokhang* Temple, and *Norbulingka,* built by the Tibetan monks from the seventh century onwards on the Red Mountain at 3,700 m of altitude, is another notable example of the relationship between man and nature. Finally, the last example, linking Figs. 2.4 and 2.5, is Saint-Michael. Saint-Michael is a small settlement in Normandy, France, developed around a Benedictine abbey, built between the eleventh and sixteenth centuries. The uniqueness of this settlement is due not only to the dialogue with the land relief, as in the three previous cases, but also with water—when the water rises the settlement site becomes an island.

As in the previous cases, we cannot imagine Varanasi or Venice without their relation to water (Fig. 2.5). Indeed, the Italian city, founded in the fifth century, constituted by 120 small islands and a wide set of channels, is a singular case of relationship between human occupation and the lagoon where it is settled. The relationship between Varanasi and the Ganges River is also very intense. While the urban forms of this Indian city seem to touch the river, the life of its inhabitants is inseparable from the Ganges, using it in numerous actions including bath, laundry, and funeral services.

Depending on the concept of city (bounded, in a very simplistic way, between an organic model and a rational model), the influence of the natural context can have different degrees. This influence can also vary between different parts of the same city. Let us return to the example of Manhattan in New York. The establishment of a settlement on an island clearly influenced the way how, in the oldest part of city, faced with shortage of land, buildings height started to increase. However, if we move to another part of the island, for instance, a northern area where in the early nineteenth

Fig. 2.4 Relationships between urban forms and natural context—land relief: Machu Picchu, Masada, Lhasa and Saint-Michel. *Source* Photographs by Filipa Neiva (**a**), Urszula Zdzieborska (**b**), Jan Reurink (**c**), and Cláudia Lira (**d**)

Fig. 2.5 Relationships between urban forms and natural context–water: Venice and Varanasi. *Source* Photographs by Sara Guedes (**a**) and Jorge Correia (**b**)

century the regular grid started to be implemented, we can see that the rugged relief was not an obstacle for the construction of that grid. Furthermore, if we continue to move north, we arrive at the magnificent Central Park, where the 'apparently natural' physical support was, in fact, built by man.

2.3 The Streets System

It is through the streets system (in the generic sense, including avenues, boulevards …) that we travel, and start to know, a city. Streets define the different street blocks, distinguishing what is 'public', and is therefore accessible to all citizens, from what is private or semi-public. Streets are, in broad terms, the public and democratic space of the city, the place where we all met, with all our differences, and where we all interact in social terms.

All these possibilities of interaction are restricted when we move from the streets to the interior of buildings. Bill Hillier, the founder of Space Syntax, wrote, in a paper submitted to the International Space Syntax Symposium (ISSS), that social differences have no expression on streets. This British author argues that streets 'do not reflect the society' (or the most negative aspects of society), and that, on the contrary, streets can gather in space what society insists in dividing. In addition, Hillier argues that the livability of streets is probably the most relevant indicator of the presence of a strong civil society (Hillier 2009).

In morphological terms, and in a temporal perspective, streets are the most stable element of urban form. While the physical process of city building is something that 'takes time', involving permanent transformation, the streets system of a city is the one that offers greater resistance to this process of urban transformation, attaining a great temporal stability. The plots system has a lesser durability than the streets system, and the buildings system has a lower stability than these two.

There is a wide variety of streets, with different shapes and sizes, distinct ways of relation with surrounding streets, and different functions. The analysis of each of the main elements of urban form that we are developing in this chapter does not ignore that, for instance, the character of a street is influenced by other elements of urban form shaping it. This character is actually influenced by plots on one or both sides of the street; by buildings (by their height, and the relation between their height and the width of the street); by the way buildings are located on plots, sometimes near to the plot frontage, offering the street a higher sense of enclosure, sometimes far from the plot frontage, offering greater openness to the street; or by the ground-floor and the 'doors' these buildings open to the street. Another important issue when analysing the streets system, that will be developed in later chapters, is how in each street the space for pedestrians and vehicles (public or private, motorized, or non-motorized) is divided. 'Great streets', by Allan Jacobs, is an example of a notable book on the streets of our cities (Jacobs 1993).

Figure 2.6 presents a diverse set of streets in four different cities. The first photographs address the intersection of two of the most important streets of New York: the Broadway, which crosses the whole Manhattan island in the north–south direction, being the only street with an irregular pattern on the orthogonal grid of the city; and the 5th Avenue (with 10 km long and 30 m wide), which is perhaps the most famous of the eleven avenues of New York.

The two following photographs refer to the *Avenue des Champs Elysées* in Paris, one of the most important symbols of Baron Haussmann' s intervention in the French

Fig. 2.6 Different streets in different cities, approximately at the same scale: Broadway, intersection with the 5th Avenue, in New York; the Champs Elysées in Paris; the Via *Rinaldini* in Siena and the *Reguliersgracht* in Amsterdam. *Source* aerial views—Google Earth; photographs by the author

capital in the second half of the nineteenth century (see Chap. 3). This is an axis of 2 km long and 70 m wide (in its western part which is clearly more urban), conformed by a homogeneous set of buildings. Building height is clearly inferior to the street width, which gives *Champs Elysées* a strong sense of openness. It has a strong presence of trees, and very different uses including shops, cafes, and cinemas. This avenue is part of a longer axis with a fundamental importance in the city, linking *La Defense* and the *Louvre* Museum.

The third set of images refers to a small mediaeval street in Siena, Via *Rinaldini*. This street is directly linked with the famous square of the city, *Piazza del Campo*(that will be analysed in the following paragraphs). Via *Rinaldini* is less than 50 m length and 5 m width. Despite the clear differences in relation to the two previous streets, we should highlight that the cross-section of this street is somehow close to the cross-section of the 5th Avenue, where the building height is clearly higher than the street width.

Finally, the fourth set of photographs addresses the *Reguliersgracht*, one of the streets of Amsterdam, within the so-called 'ring of canals', an area that started to be built in the early seventeenth century. The built environment of Amsterdam—as well as of other Dutch cities—is marked by a sound presence of water. As such, the cross-section of the street (the street is about 30 m wide and 600 m long) is clearly different from the previous examples. Indeed, it includes the canal and on each of its sides a street with three different spaces: for pedestrians, vehicular traffic (distinguishing it from the urban environment in Venice where there is no vehicular traffic in the historical city), and car parking.

The public spaces system of a city includes not only the open spaces for movement, which we designate in a simplified way as streets, but also the open spaces for permanence, which we designate as squares and gardens. All this diversity of streets, described in the previous paragraphs, can also be found in squares.

Figure 2.7 presents four squares in three different continents. The first is Times Square, New York, located at the intersection of Broadway and 7th Avenue. While, in morphological terms, this square is no more than the intersection of the two streets, with no particular conditions inviting for a staying (somehow similar to Picadilly Circus, London), Times Square is full of people at any time of day or night. In terms of uses, the square is in the heart of the theater district and includes cultural and commercial activities contributing, not only to the dynamics of this space but also, to the consolidation of the image of the square through a significant number of attractive neon lights. Our collective imaginary is undoubtedly informed by the traditional party in the New Year's Eve, when a crystal ball falls from the top of the number 1 of Times Square.

The second square included in Fig. 2.7 is the *Place Georges Pompidou*, Paris, near the former market of *Les Halles*. This square is clearly different from the previous, both in morphological and functional terms. It has a clearly defined shape, a rectangle of about 175 m long and 70 m wide, and a slope upwards from the entrance in the *Centre Georges Pompidou*, that establishes its eastern limit, up to the buildings of the *Rue Saint-Martin,* that constitute its western boundary. This immense sloping surface is one of the fundamental characteristics of the square and it is a key element

Fig. 2.7 Different squares in different cities, approximately at the same scale: Times Square in New York, *Place Georges Pompidou* in Paris, *Piazza del Campo* in Siena and *Meidan Emam* in Isfahan. *Source* aerial views—Google Earth; photographs b, d and f by the author, photograph h by Jorge Correia

inviting people for different activities, from the simple lay down to various artistic performances. In terms of function, this square is clearly distinguishable from the first because it has a strong artistic dimension, due to the presence of the remarkable *Centre Georges Pompidou*, built in the late 1970s. As a complement, the *Place Igor Stravinsky* (south of *George Pompidou*, in Fig. 2.7) including a set of modern sculptures and the Stravinsky Fountain, should also be referred.

One of the most famous squares in the world, particularly among those studying the physical form of cities, is the *Piazza del Campo* in Siena. This Italian square, dating from the twelfth century, has a shell shape and it is delimitated by several notable buildings (*palazzi*) with different height (five to seven stories). Similar to the *Place Georges Pompidou*, this square has a wide sloping surface—following the city topography—with the lowest point in the northern part, in the entrance to the town hall, the *Palazzo Pubblico*. One of the most famous events taking place in the square is the *Palio*, a horse race which dates to Roman military exercises.

The last example included in Fig. 2.7 is the *Meidan Emam* in Isfahan, Iran. This large square, 520 m long and 160 m wide, has a rectangular shape (similar to *Place Georges Pompidou*) and it is delimitated by a continuous building complex, two stories, with a double colonnade. A few exceptional buildings stand out in this set—two notable mosques, classified by the United Nations Educational, Scientific and Cultural Organization (UNESCO), and a palace. The northern part of the square leads to the *Bazaar*. In addition to accommodating some exceptional functions, the square is intensively lived by local people for many different activities. Contrary to the three previous cases, there is not a strong presence of foreign tourists in Isfahan (mainly due to the international isolation of Iran).

As we can find substantially different urban tissues or streets in the same city (as we have seen in the example of New York), we can also find different squares with clearly distinct forms and functions in different parts of the same city. The following paragraphs, and Fig. 2.8, illustrate this phenomenon in Paris.

The first example included in Fig. 2.8 is the *Place Vendome*, in the *Tuileries* area. This square was built in the early eighteenth century (it is the latest example of this set). It has a rectangular shape (octagonal cut in the corners), 140 m long and 120 m wide; it is crossed by one street only—the *Rue de la Paix*, and it is made of a group of homogeneous buildings (architectural style and height). *Place Vendome* is the home of several fashionable shops.

The *Place des Vosges*, built in the early seventeenth century in the *Marais* area, is the second example. Slightly larger than *Place Vendome*, *Place des Vosges* is a 140 m square, configured by an extremely homogenous group of buildings comprising 36 houses (nine in each of the four sides) containing an arcade around the whole perimeter of the square. The centre of *Place des Vosges* is a green. The access to the square from the *Rue de Birague* is made through the arcade. As such, the square is delimitated by one important street only, the *Rue du Pas de la Mule*, at north.

The third example is the *Place des Victoires*, in the *Tuileries* area, nearby *Place Vendome*. This square, of circular shape, is smaller than the previous two—approximately 75 m diameter. As these two, it is defined by an homogeneous set of buildings, four and five storey. The square was built in the seventeenth century to frame the

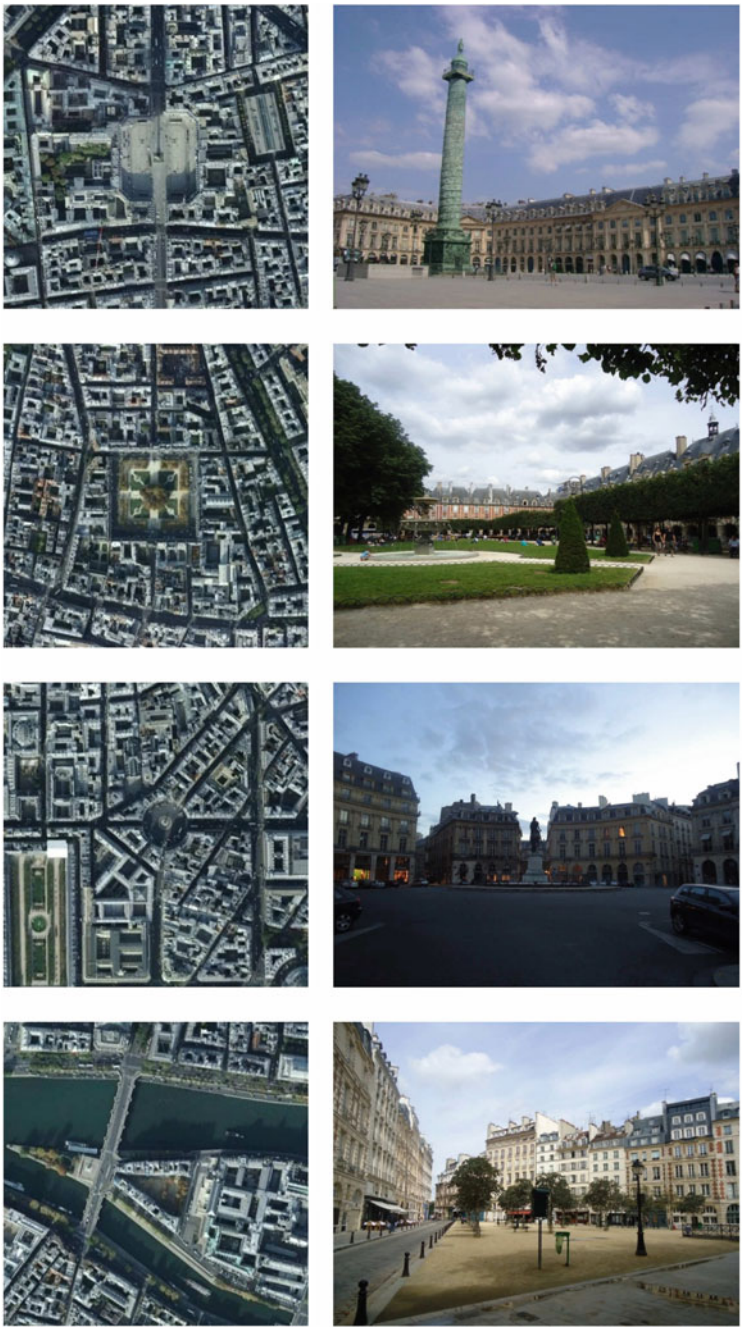

Fig. 2.8 Different squares in Paris, approximately at the same scale: *Place Vendome*, *Place des Vosges*, *Place des Victoires,* and *Place Dauphine*. *Source* aerial views—Google Earth; photographs by the author

statue of Louis XIV. Although it is a very interesting example in terms of urban form, hosting important fashion shops, the square is not much more than a roundabout.

The *Place Dauphine* is in the oldest part of the French capital, the *Ile de la Cité*. This last example is clearly different from the previous three cases: the square has a triangular shape (with an area that is larger than the Place des Victoires and smaller than the other two cases), and its buildings are more diverse than the previous ones, both in terms of height and architectural style, revealing the action of different agents.

The following paragraphs, and Fig. 2.9, illustrate the same phenomenon in Rome. As mentioned above, Rome is a city of a very dense layout made of small street blocks interrupted by several notable squares. Let us focus on four of these squares, *S. Pietro, Campidoglio, Navona,* and *Rotonda.* The *Piazza S. Pietro*, with a dominat religious nature, is located east of the *Tevere* River, within the Vatican territory. The square, the *basilica* and the colonnade (four columns deep) shaping it, were built in the sixteenth and seventeenth centuries. The square has a complex shape, composed of an ellipse (200 m long and 150 m wide) and a trapezoid (where the parallel sides have approximately 100 m and 115 m long and are distanced 100 m). The square is part of a wider composition, being the western limit of a strong axis defined by the Via *della Conciliazione*, which is bounded at east by the *Castel Sant'Angelo.* While the exact centre of the square is marked by an obelisk, two different fountains appear to be the two centres of the ellipse.

The second example included in Fig. 2.9 has a rather different nature, shape, and size. The *Piazza del Campidoglio* is in the historical kernel of Rome. The square and the three surrounding *palazzo* were built or restored in the sixteenth century, as a new civic centre for the city. It now gathers civic and museologic functions. The *Piazza del Campidoglio* has a trapezoidal shape. The bases of the trapezoid have approximately 55 m and 40 m and are distanced about 75 m (it is substantially smaller than *Piazza S. Pietro*). The square has a notable pavement with an oval geometric layout and, in the centre, an equestrian statue. Limited at east by the *Pallazo Senatorio*, the axial composition of this set includes, at west, a wide-ramped stair (the *cordonata*) connecting the square to the Via *del Teatro di Marcello.*

Contrary to the four Parisian squares presented above, the four Roman examples have a strong touristic dimension. That is the case of *Piazza Navona*, located north of *Corso Vittorio Emanuelle II,* which has an intense social life. The square as we know it was established in the seventeenth century. Its peculiar shape, a long rectangle of about 250 × 50 m with round ends (a proportion of about 5:1, where the largest dimension is higher than the largest dimension of *S. Pietro*), draws on the ruins of a stadium erected in the first century. Three notable fountains (*Nettuno*, *Quatro Fiumi,* and *Moro*, from north to south) have a central role in this remarkable baroque set. In addition to the numerous cafes, restaurants, and shops, *Navona* includes the church of *Sant'Agnese in Agone.*

The last example is *Piazza della Rotonda*, located 250 m east of *Navona.* The square was defined in the fifteenth century. Yet, the surrounding building fabric dates from earlier periods. That is the case of its main building, the Pantheon (the church of *Santa Maria Rotonda*, giving the name to the square), dating from the first century. As we can see in Fig. 2.9, the square is considerably smaller than the

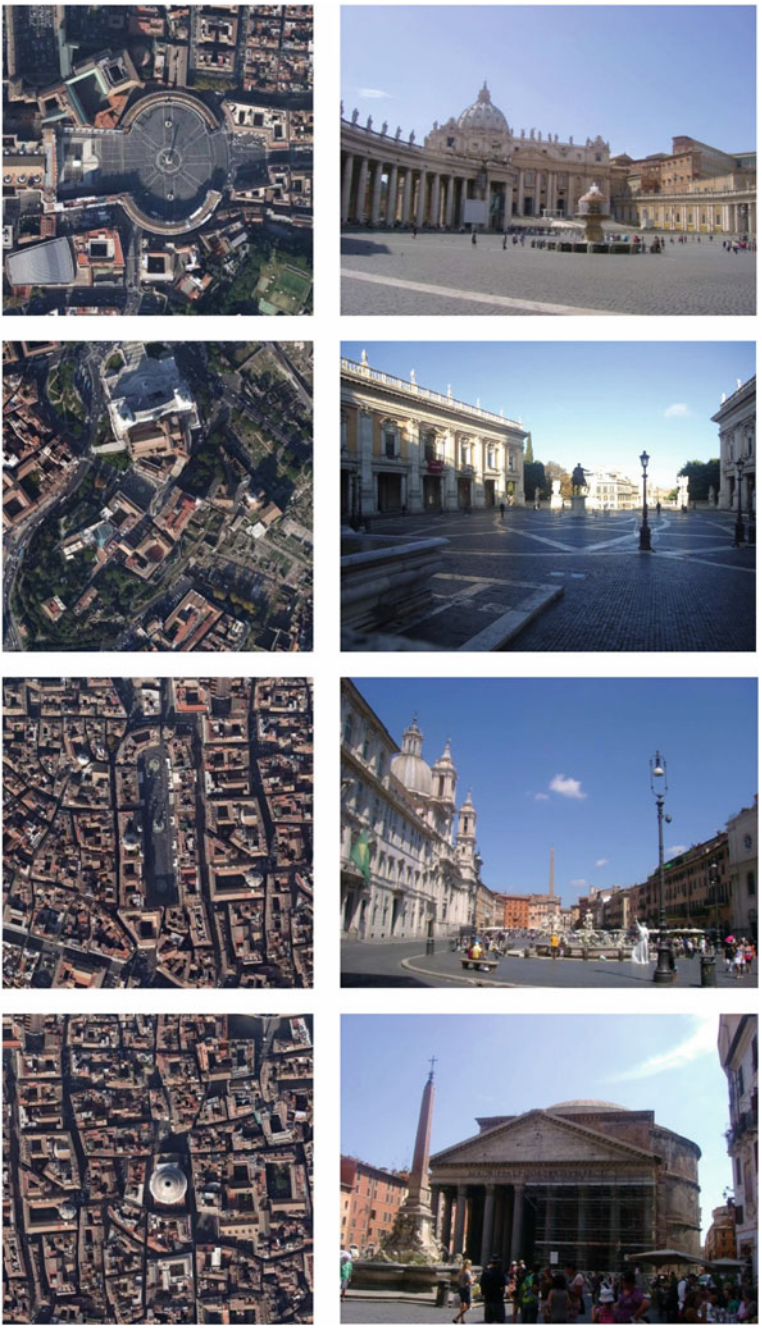

Fig. 2.9 Different squares in Rome, approximately at the same scale: *Piazza S. Pietro, Piazza del Campidoglio, Piazza Navona,* and *Piazza della Rotonda*. *Source* aerial views—Google Earth; photographs by the author

other three examples. It has an irregular shape near to a trapezoid. The bases of the trapezoid have approximately 45 m and 35 m and are distanced about 60 m. The square has a fountain with an obelisk in the centre. The square has many cafes and restaurants.

2.4 The Plots System

As mentioned above, the plots system of a city is one of the most important elements of urban form, separating the public and private domains (or the different private domains). Nevertheless, the role of this fundamental system is often neglected by the main agents and stakeholders in the process of city building, largely because of the, apparently, reduced urban visibility of plots.

The definition of the plots system in a territory is an essential element of its urbanization process and has considerable stability over time. The decision on what would be the new structure of private ownership in a particular territory might involve the subdivision of a set of large plots—for instance, plots of former rural use—or the proposal of a new land division. The subsequent stage of this urbanization process usually involves the precise definition of the different plots: (i) how is each plot related with the street? (what is the size of plot frontage? what is the orientation of the plot in relation to the orientation of the street?); (ii) what is the position of each plot within the plots system? (is it in the middle or in the edge of the street block? is it located in a long side or in a short side of the street block?); and (iii) what is the shape of the plot, and what are its dimensions and proportions? It is essential that we acknowledge that these definitions, taken when each plot is laid down, will condition the future options in terms of building types and, as such, have a significant impact on the urban landscape.

Although there are considerable differences between each specific context, in many cities the processes of plot subdivision and plot amalgamation are not very common. This means that the choices that we make, as agents, in very early stages of the urbanization process will condition, for long periods of time, the urban forms that in the future will be built in the city. It is also important to refer that, although the city suffers many kinds of disturbances over its 'life'—such as wars, fires, earthquakes, tsunamis, to name just a few—that could be used as a pretext to erase the pre-existing plots system (or parts of the plots system) and to create a new plot structure. Yet, in most of the cases, this does not happen, and the pre-existing plots system is maintained.

An important element in the description and explanation of the physical form of the city is the dimension of its street blocks and, within these, of its plots. In general, the dimension of street blocks and plots increases as we move from the historical centre to the peripheral parts of the city. Yet, there are some exceptions. These exceptions are not negligible, and they contribute to the identity of each city—in this regard, the concept of fringe belt will be presented later in Chap. 6. Another important element is the number of plots per street block, as it somehow expresses the greater or lesser diversity of agents and stakeholders—and of urban strategies—that are present in the

street block. Contrary to the size of street blocks, in general, the number of plots per street block decreases as we move from the historical centre to the peripheral parts of the city.

Figure 2.10 illustrates the plots system of central Pingyao. This plan is included in the paper 'Extending the compass of plan analysis: a Chinese exploration' by Jeremy Whitehand and Kai Gu (2007). Located nearly 500 km south-west of Beijing, Pingyao is a city that is notable for the survival of its traditional form. It is roughly a square-shaped walled city, with a significant number of planned streets and plots. Figure 2.10 presents the complex plots system of the city. Plots can be distinguished according to the extent to which they depart from a regular rectilinear form, as the result of modifications to the boundaries of plots since they were originally laid out. Figure 2.11 focuses on three different parts of the walled city, with different degrees of change. In the first part, characteristic of the central and southern areas of walled

Fig. 2.10 Plot boundaries in central Pingyao, in 2000 (Whitehand and Gu, 2007)

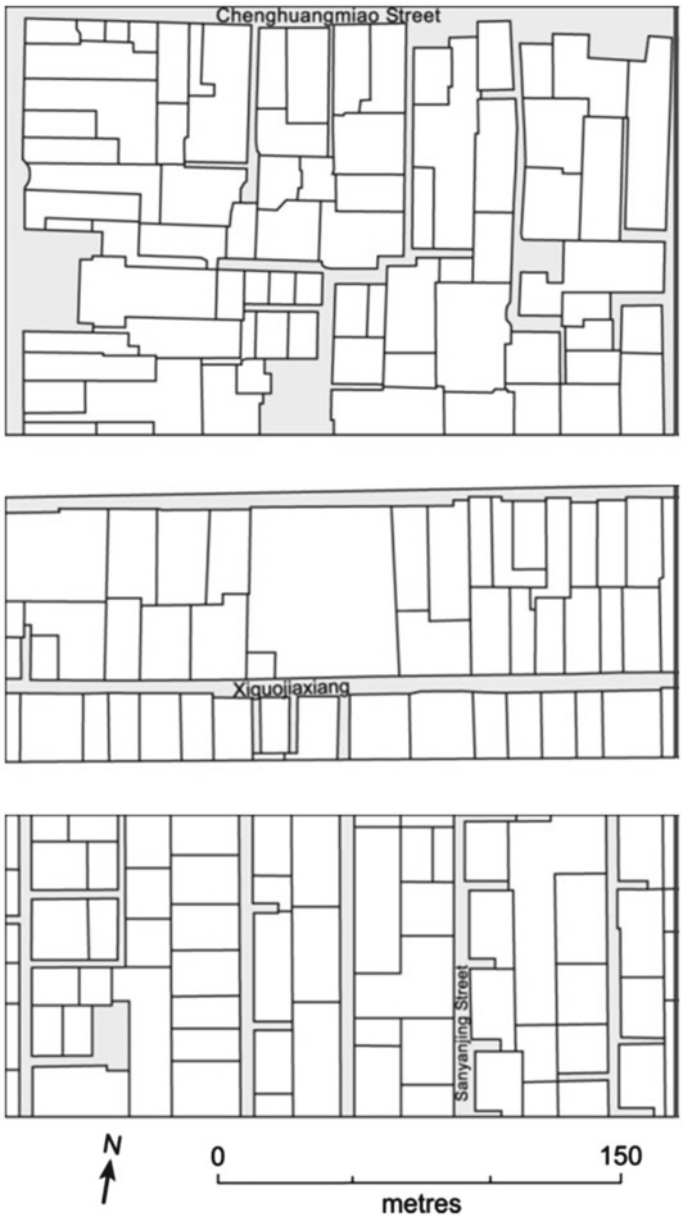

Fig. 2.11 Plot boundaries in central Pingyao—three different parts (Whitehand and Gu 2007)

Pingyao, the irregular shapes of plots reflect the very long time span over which they have been exposed to forces for change. In the second, characteristic of the former western and northern city limits (former city wall), the shapes of plots reflect the strong influence of more recent planned plot series. Finally, in the third part, characteristic of the current northern and western areas of walled Pingyao, there is a greater regularity of plots and street system.

Let´s now take a small part of a city. *Rua do Almada* is a fundamental street in the urban history of my city, Porto (Fig. 2.12). The construction of this street in the second half of the eighteenth century was promoted by the so-called *Junta das Obras Públicas*, a public agency responsible for urban planning and management. *Rua do Almada* is 800 m long and 10 m wide. It links two different squares, *Largo dos Loios*, at south (smaller), and *Praça da República*, at north (larger). As shown in Fig. 2.12, the street consists of ten street blocks and 214 plots. The largest street block of this set is located south of the *Praça da República*, including 58 plots. In a significant part of these 58 plots, frontage is about 5 m and depth ranges between 20 and 90 m. Over more than two centuries in the 'life' of these plots, buildings were conserved recurring to small maintenance works. Yet, eight buildings erected in the last decades of the twentieth century can be found in these 58 plots. However, even in this set of eight buildings, seven were built in the original plots of the eighteenth century, and only one building was erected on a plot resulting from plot amalgamation (of two different plots). In *Rua do Almada* the establishment of a particular type of plot, long and narrow, led to the emergence of a particular type of building. Due to the reduced dimension of the plot frontage, the building type had to adopt an in-depth organization, usually with more than 15 m depth. This in-depth organization of the building has led to the location, in each storey, of one (or two) room (s) near the two facades and of a staircase, and of one (or more) rooms in the interior of the building.

The German geographer MRG Conzen, whose work will be analysed in detail in Chap. 6, was one of the main promoters of the study of the plot to describe and explain the physical form of a city. One of the concepts proposed by Conzen is the burgage cycle. The burgage cycle is the progressive built occupation of the back of the plot culminating in a significant reduction of the open space, resulting in the need to release this space and in a period of urban fallow, preceding a new development cycle. The proposal of this concept was based on the study of Alnwick, in particular on the analysis of the plot belonging to Mr. Teasdale in six different periods of time between 1774 and 1956. Although this phenomenon was recognized in Alnwick, it occurs in many different contexts, including the plots of Porto. In the city of Porto, the burgage cycle conceptualizes a process of plot occupation and construction of working-class housing in the back of the *bourgeois* building facing the street, without changing the plot structure—the so-called *ilhas*, built in the nineteenth and twentieth centuries.

Fig. 2.12 Plots in *Rua do Almada*, Porto. *Source* Google Earth

2.5 The Buildings System

Although buildings do not have the stability in time that streets and plots have, they are one of the most important elements of urban form and the most visible of these elements. In general, the city is made of two different types of buildings, ordinary or common buildings and singular or exceptional buildings. The main characteristics that distinguish these two types are related to the building form and utilization. The former includes most buildings making the city. The similarities between buildings, within this type, are stronger than the differences between them. This type includes mostly buildings of residential utilization, but also commerce and services buildings. The second type includes only a few buildings of the city, those buildings that because of their shape and utilization are clearly distinguishable in the urban landscape. Within this second type there is a smaller set, a very special set of exceptional buildings whose form has become indistinguishable from the form of the city they are part of. This is the case, for instance, of the Opera House in Sydney.

The position of each building within its plot is of fundamental importance for the character of the urban landscape. In most cities, until the end of the nineteenth century, the continuous alignment of different buildings defined, in a very clear way, the street form. Yet, a number of city theories, developed over the twentieth century, have questioned this traditional alignment of buildings and led to the introduction of an increasing variation in the position of buildings within plots, questioning the traditional definition of 'street' and 'street block'.

Another important characteristic of buildings is their height, and particularly the relationship between their height and the width of street where they are located (Fig. 2.13). The variation of these two measures can introduce significant changes in the urban landscape. If the height of buildings is much less than the street width, we will have little sense of enclosure. Yet, if the height of buildings is greater than the street width, the sense of enclosure will increase. Other important characteristics of

Fig. 2.13 Relationship between buildings height and street width, New York. *Source* photographs by the author

buildings are the organization of the ground floor and the physical relation between exterior and interior, the façade design (important for the urban landscape) and, in the interior, the position of the staircase and the organization of dwellings.

Although in last decades there has been a powerful trend towards an increasing uniformity of buildings at the global scale, we can still find a great diversity of buildings across different countries and different continents. Figure 2.14 includes five photographs of different buildings in different cities and villages, in five different continents. The first is a photograph of Chicago taken from the Lake Michigan. This part of the city, around Lake Shore Drive, has a regular street system with a great diversity of buildings with very different heights. In the middle of the photograph, some skyscrapers seem to emerge within the set of tall buildings. Although there is also a great diversity in terms of building materials, the urban landscape is marked by the presence of steel and glass. The second photograph is in a rather different geographic and cultural context: Djenné, one of the oldest towns of sub-Saharan Africa, inhabited since 250 B.C. This area includes almost 2,000 traditional buildings that were built using earth as the main material. The architecture of Djenné, of its ordinary and exceptional buildings (such as the Mosque, in the photograph) is characterized by its homogeneity of materials and colors and by a strong sense of verticality. The third photograph shows a traditional building of the *Batak Toba* people, located in *Samosir* in the middle of Lake *Toba*, in Sumatra (Indonesia). This house, very different from the buildings in the upper photographs, has a boat shape and it is elevated from the ground. It is mainly built of wood, and it has intricately carved gables and upsweeping roof ridges. The fourth photograph presents a set of buildings in the *Stortorget*, a small public square in the *Gamla Stan*, the historical centre of Stockholm. Despite the similar height and alignment of buildings, there are some subtle differences between them like the different colors and the design of the upper stories and roofs. Finally, a traditional building of the Māori people located in Taumaranui, New Zealand, is included in the last photograph of Fig. 2.14. The design of the roof and the central column in the main façade (usually two other columns are in the interior of these buildings), and the sound presence of sculpture distinguishes this building from those in the previous photographs, contributing for the identity of the Māori architecture.

As we have seen when analysing other elements of urban form, we can also find very different buildings within the same city. In addition, it is possible to identify a kind of evolutionary path or a typological process, corresponding to a succession of building types in the same cultural area. Focusing on a particular part of my city, the *Rua de Costa Cabral*, Fig. 2.15 identifies the main residential types of the area and offers a reading of how these building types have evolved over time. The first column of photographs displays the transformation of single-family houses: from the terraced houses built in narrow frontage plots (a), in medium frontage plots (b) and in large frontage plots (d) to the semi-detached houses (f) and the detached houses (h). The second column of photographs presents the transformation of multi-family buildings: from terraced buildings erected on narrow and large plots (c and e) to semi-detached buildings (g) and detached buildings (i)—this will be developed in the last section of Chap. 6.

Fig. 2.14 Different buildings in different cities and villages, in five continents: Chicago, Djenné, Samosir, Stockholm and Taumaranui. *Source* photographs by the author (**a** and **d**), Elisa Dainese (**b**), Janto Marzuki (**c**) and Bryan Woodhead (**e**)

Fig. 2.15 Succession of building types in the same cultural area, Porto (Oliveira et al., 2015)

Exercises

A. Testing Your Knowledge

2.1 What are the main similarities and differences between the most representative tissues of Barcelona and New York?

i. They are similar in terms of streets, street blocks, plots and buildings; one major distintion between the two cities is the number of buildings erected after the mid-tweentieth century.
ii. Both cities have a regular pattern of streets and buildings (alignment and height); Barcelona is made of squared street blocks and New York is made of rectangular street blocks.
iii. Both cities have a regular pattern of streets and buildings alignment; the form of street blocks and plots, and particularly the height of buildings are different in Barcelona and New York.

2.2 What are the fundamental structuring lines of the territory, in terms of macro-relief?

i. Ridge lines (highest elevation), converging into distribution centres.
ii. Ridge lines, thalweg lines (lowest elevation) and contour curves (perpendicular to ridge and thalweg).
iii. Thalweg lines, linking the encounter centres and promoting the natural drainage of water.

2.3 What are the most persistent elements of urban form?

i. Buildings; and in particular, singular exceptional buildings.
ii. Streets, plots, buildings, and land uses.
iii. Streets, and the system of public open spaces.

2.4 Why is the frontage width a main characteristic of plots?

i. It allows the construction of buildings with larger frontages.
ii. It enables a higher control on the design of building facades.
iii. It enables increasing, or decreasing, the number of agents and urban strategies present in the street.

2.5 What has been the main change in buildings, taking place over the twentieth century?

i. The change in the position of buildings within plots.
ii. The increasing range of construction materials.
iii. The increasing range of architectural styles.

Solutions

2.1. iii
2.2. ii
2.3. iii
2.4. iii
2.5. i

Interactive Exercices

Exercise 2.1—The Game of Cities

'The game of cities' is an exercise that brings out the importance of both collective action and streets in the process of city-making (Oliveira and Perdicoulis 2014). 'The game of cities' is played in a computer aided design (CAD) environment, projected on the wall, with the players being coordinated by a moderator. The game is in two parts. There is a common process, but these parts are made of different contents. The first part of the game presents a site merely as a topographic relief—preferably of a real city, the city where the game is taking place (Fig. 2.16, left). The first player is called to play, while all the others watch, and is asked to draw one urban form element: streets (and also squares and green areas), street blocks, plots, and buildings (including common and singular buildings). If one player decides to design streets, street blocks or plots, the width and length of each of these elements is enough. If a player designs one or more buildings, then must also provide the height and the use (residence, commerce/services/offices, public equipment, industry). When the design of the first player is concluded, the second player is called to play. Contrary to the first player of the game, who finds a totally vacant terrain, the second player has to considerer not only topography, but also the elements of urban form designed

Fig. 2.16 Exercise 2.1—topography of the site (left), and topography and street system (3 km x 3 km, Boavista, Porto)

by the first player. One by one, all players are called to play. If the number of players is high (e.g. 15 or more), then each player should play only once. If the number of players is low, it would be interesting to go through a second round. The result of the game will be a small (part of a) city with different inputs from different agents, simulating what happens in real life.

The second part of the game goes one step further: the diagram of the site reveals not only topography, but also the existing street system (Fig. 2.16, right). The street patterns may turn the site familiar, and some players are likely to recognise it. The dynamics of the game in the second part are very similar to the first, yet the actions of each player are considerably conditioned by the street system. The players are expected to gradually understand the fact and the way that a street system will contribute to the organization of the urban form elements of the city.

The contribution of 'The game of cities' is towards the conscience that city-making is a collective work, achieved in successive steps of development by many agents, and a change of focus from buildings to streets.

Exercise 2.2—Your Urban Landscape

'Your Urban Landscape' is an exercise that explores the capacity of each student to describe a familiar urban landscape using a new language learned in this chapter, based on the main characteristics of the fundamental elements of urban form.

The starting point for the development of this exercise should be the house of the student. Starting from there, the student is asked to describe and explain, in morphological terms: i. the street where he lives, and the streets defining his street block; ii. the nearest square, iii. the plots of the street block; and, finally, iv. the buildings of the street block where he lives. Based on this homework request, each student should prepare a brief PowerPoint (5–10 min, 10 slides maximum) to be presented in classes. The student should use text and images (drawings and photographs), or any means that he thinks it is adequate. The realization of the exercise should involve one or more visits to the site under analysis.

The exercise highlights the benefits of fieldwork, notably of walking, of direct observation, of immersive experiences, and engagement in real-world urban landscapes (including the possibility of measurement of some physical characteristics).

Exercise 2.3—A Collection of Urban Tissues

The exercise 'A Collection of Urban Tissues' explores the idea that, despite the differences, all urban landscapes are structured by the same elements of urban form. What changes, from place to place, is the way these elements are combined in each specific setting. For instance, the combination of irregular streets, small street blocks, many plots per street block, small plots of irregular form, coincidence between plot and building frontages, and high building coverage, are characteristics of mediaeval urban landscapes. Yet, the basis for this morphological description of mediaeval landscapes are streets, plots and buildings – the main elements of all urban landscapes.

For this exercise, each student should select one city in his country. Different students should select different cities. Using a software for the interactive visualization of maps and satellite images (like Google Earth, Bing Maps or Baidu Maps),

and focusing on the two-dimensional view of the selected city, the student should try to identify different urban tissues. Each identified tissue should be formed by a particular combination of streets, plots, and buildings. Based on these results, each student should prepare a brief PowerPoint (5–10 min) to be presented in classes. The PowerPoint should contain three main slides for the whole urban tissues: i. one slide with plans of the tissues, approximately at the same scale (see also Fig. 2.2); ii. one slide with photographs of the tissues (street-views obtained from the referred software); and, finally, iii. one slide gathering the major characteristics of each tissue, in terms of streets, plots and buildings.

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Chapter 3
The Agents and Processes of Urban Transformation

Abstract The third chapter focuses on the different agents and agencies responsible for, and on the complex processes of, urban transformation. It analyses how each one of us takes part in changing the urban landscape: as a developer of an action of transformation of urban forms, as an architect responsible for the design of new physical forms, as the builder of these forms or, in a more indirect way, as a planning officer designing a city vision and guiding private activity in his day-to-day practice of development control, or as an elected politician defining a political strategy for the city. In addition, the chapter aims at understanding the processes of urban transformation: how do we organize ourselves as a society to build a balance between a comprehensive view of the city, usually a planned view, and a number of different contributions of higher spontaneity. It is argued that this balance between unity and diversity is essential in a city that wants to be attractive, in morphological terms.

Keywords Agents of change · Cities · Planning · Plans · Urban transformation

3.1 Agents of Change

This section focuses on developers, architects, and builders (as direct agents) and on planners and politicians (as indirect agents). It tries to understand how each of these agents pursues their own goals, what are the motives underlying his behaviour, and how several, sometimes conflictive, interactions between different agents take form in the built environment. Naturally, each of these groups is not homogeneous, and it is clearly bounded by a particular context. Yet, there are some common characteristics that can be found in each type of agent.

The number of studies addressing the agents of change is lesser than the number of works devoted to the physical characteristics of the urban landscape or even the processes of urban transformation. Yet, there are some research centres that, over the last years, have been developing consistent lines of research on the issue of agents. That is the case of the Urban Morphology Research Group (UMRG) in the University of Birmingham, and particularly of its Head, Jeremy Whitehand. This section draws on some of the main findings of the UMRG in their study of cities in the United Kingdom in the twentieth century. One paper was particularly relevant

V. M. Araújo de Oliveira, *Urban Morphology*, The Urban Book Series,
https://doi.org/10.1007/978-3-030-92454-6_3

for structuring this chapter, 'Recent Advances in Urban Morphology' by Jeremy Whitehand.

3.1.1 Developers

The occurrence of an action in the physical form of the city implies the existence of a developer (or initiator) who decides to make a change. The figure of the developer is somehow more heterogeneous than that of other agents analysed in this section, ranging from a property owner that promotes one single action (the 'owner–occupier') to an individual that devotes his professional life to the launching of new developments (the 'speculative developer'). Eventually, the 'developer' and the 'builder' can coincide in the same individual or organization. The nature and role of developers have changed significantly over history. The book 'Shapers of Urban Form', edited by Peter Larkham and Michael Conzen, addresses this changing nature of developers in different periods in urban history—pre-modern, early modern, industrial, late modern, and postmodern—analysing the action of kings, of the Church, and of industrial developers, to name just a few (Larkham and Conzen 2014a).

The decision to develop a particular action is influenced by many different factors. Economic factors—many of which are cyclical in character—are among the most important factors that are usually considered by developers. Yet, the influence of economic factors may vary according to the type of developer. Economic factors are more important to the speculative developer and are less important to the residential owner seeking to develop sites of which he intends to continue to occupy a part. These economic factors, in particular the land value has a key influence on the future building types and building density (Whitehand 1992).

Another important factor considered by developers is the timing of development. The success and character of proposals for change are influenced by the life cycle of fashions. In addition, there is always a time-lapse between attempts to bring about change and actual transformation. This time-lapse can be due to changes in economic conditions or to vagaries of the process of development control. In the latter, the length of the time-lapse is largely determined by the interaction between a direct agent (for instance, the developer or architect), and an indirect agent (like the planning officer working in the local planning authority). A consequence of these time-lapses is that developments sometimes take place in conditions markedly different from those in which they were conceived (Whitehand 1992).

The developer has also a crucial role in selecting a particular building type or density (which is influenced, as mentioned above, by land value). This selection can be quite polemic and debates on this issue can be frequently biased. Yet, it is important to acknowledge that a more frenetic activity does not necessarily entail more obtrusive development—for example, small, detached houses may be more obtrusive in the urban landscape than flats (Whitehand 1992).

One crucial characteristic in developers, and in other agents, is their provenance. Decisions made by local developers may result in different types and styles of alterations or additions to the building stock than decisions taken by developers based far from the site of the proposed change (Larkham 1988).

3.1.2 Architects

The first link between different agents of change is usually between a developer and an architect (when an architect is hired). After being engaged, the architect tends to act as an agent of the developer dealing with the local authority. He has also an influence in the selection of the builder and particularly of other agents who are not analysed in this book, such as engineers and consultants. Jeremy Whitehand and Susan Whitehand (1983) studied the relationships between developers and architects in two British towns for the period between First World War and the 1980s. They found that the locations of architects were closely related to those of developers (this proximity continued, although to a less extent, until the end of the period under analysis), and major differences of distribution can be recognized between the architects employed by developers from inside and outside the towns under analysis—in the latter, there was a strong tendency for the architect to be in the same city as the developer.

The role of architects has changed significantly over history. As Larkham and Conzen (2014b) remind us, until the late modern and postmodern periods, although the presence of architects has been implicit, their role was somewhat muted. After Renaissance, architects' identity and standing as a profession have grown in public awareness, and by the twentieth century an increasing number of architects started to enjoy broad celebrity status on a par with great writers, musicians, and painters, and the most creative have become icons in mass cultures.

One important aspect related to the architectural practice is that many more urban landscapes exist on paper than ever come into being on the ground. As Whitehand (1992) states, the main reasons for this seem to be the extensive use of design competitions (in the case of institutional and public areas) and the large number of unimplemented schemes attributable to the development control process (in the case of residential and commercial areas). In the former case, and in addition to the specific nature of design competitions (one proposal is selected while many projects remain on the paper), there is also the case of non-implementation of proposals due to the long time span over which some developments are undertaken. In the latter, the development control process—particularly in areas where local authorities exercise a strong restraining influence—can lead to several modifications and complete transformations of proposals, not always in the direction of improved solutions. In some cases, even when developments have begun to take shape on the ground, work can stop in an incomplete state and recommence some years later, giving rise to inconsistencies between the project of the architect and the erected building. It is important to acknowledge that the urban landscape results from interactions between a number of parties over a period during which the influences upon decision-making

are changing and is commonly different from that envisaged by any of the parties, including architects (Whitehand 1989).

3.1.3 Builders

After the developer has engaged an architect, subsequent links are sufficiently varied in type and in the direction of influence to make the notion of a single chain of decision-making inappropriate. While the location of a developer has a major influence on the selection of the architect, subsequent links are not necessarily in a set sequence, and the linkages between agents can be quite various (Whitehand and Whitehand 1983).

In relation to the provenance of builders, and according to the studies of the UMRG, there has been a long-term increase, over the twentieth century, in the role played by non-local builders. Yet, before the Second World War, in most areas, local firms were still predominant and external firms acted as innovation–diffusion agents. This means that the necessity for the prolonged presence of the builder and his workers on the site of the construction work was still a key factor. In their research on the inter-war period in England, Whitehand and Carr (2001) found that, despite the unprecedented amount of house building in this period, the geographical spheres of influence of builders (and architects) were highly localized. Unlike in the nineteenth century and contrasting with what was happening in North America, there is little evidence of speculative building having been undertaken by people whose livelihood was not primarily derived from house building or house selling. This situation of proximity between the building firms and their houses was gradually changed by the enlargement of the operational areas of firms associated with the tendency for the activity to be concentrated among fewer firms (Whitehand 1992).

3.1.4 Local Authority's Planning Officers

The fourth type of agent analysed in this chapter is the planning officer working in a local authority. The action of this agent is mainly of an indirect nature, although in some cases he can develop a direct action on the physical form of the city. Depending on each specific country (from systems based on the establishment of some general rules to systems based on case law and discretion in decision-making), the activity of the local authority can assume different characteristics. Yet, it has always two main functions, development control and planning.

As mentioned above, the interaction between different agents is sometimes conflictive. While this is true for the relations between direct agents or between indirect agents, it is particularly evident for the interactions between direct and indirect agents, reflecting a tension between the process of development and attempted development. As legislation increased over time, local authorities become more involved

and moved to the centre of the conflict. In the process of development control, planning officers act as mediators between different private interests, notably between developers and occupiers of sites in the vicinity. This can be seen as a wider conflict between the forces of preservation and change—including, for example, residents who own potential development sites and residents whose gardens are unsuitable for development (Whitehand 1992).

In the case of development control, the influence of planning officers is limited and indirect, particularly in that they are reacting to proposals. In the case of planning, two different situations can be identified. The first is the preparation of a plan. Contrary to development control, this is a proactive practice involving reflection on the conservation of existing urban forms and design of new streets, plots and buildings. Yet, it is also an indirect action on the urban forms as it depends on the future action of developers. The second is the design of a proposal—in most cases, an action on the street system—to be implemented by the local authority. Contrary to the former, this is a direct action on the physical form of the city.

One of the most common criticisms on the action of the local authorities over the last decades, both in planning and development control activities, is the exclusive focus on physical standards relating to building density, car parking, and highways. This means that local government control over development has paid little attention to the appearance of the built environment (Punter 1986). Another criticism is that attention is devoted principally to individual buildings, sites, and monuments, or small areas of special interest, while the historico-geographical structure of entire cities or sizeable parts of cities are largely ignored (Whitehand and Morton 2004).

3.1.5 Local Politicians

The last type of agent analysed in this chapter is the local politician. Except in cases of absolutist regimes, where the local politician can have the power to act as a direct developer, its role has an indirect nature and corresponds mainly to a contribution to the definition of a strategic vision for the city designed within the local authority and, eventually, to decision-making on major projects.

Yet, even this contribution can involve situations of conflict. The conflict between the local politician and other agents (as in the relations addressed before) happens not only in relation to direct agents but also in relation to the local authority planning officers. This can occur when planning officers adopt a technical perspective on a particular issue that would be different from the political point of view. In such a case, technical knowledge can be marginalized by politicians who can produce the knowledge that serves their purposes best. This tension can be framed within a wider conflict between rationality and power.

I have developed, with my colleagues Mafalda Silva and Ivor Samuels, an evaluation of a form-based plan prepared and implemented in my city, Porto (Oliveira et al. 2014). This evaluation included an analysis of the main agents of change. The preparation of this plan began in 2000 during a socialist administration. At the end of 2001,

a conservative administration was elected. Yet, this political change seems to have minimal effect: though it delayed the preparation and approval of the plan, the typological approach proposed was not questioned. In fact, wider built heritage concerns were introduced and development control in some tissues has become stricter. Nevertheless, in the subsequent years the political support (through political discourse and programmes) of planning practice was not constant. Moreover, it can be said that the potential of this plan, in urban form matters, was not fully understood by local politicians. Arguably the complexity of the typological approach made it difficult to communicate in an effective way to non-experts. But it could also be the case that local politicians were not fully committed to achieving the main goal of the plan—the maintenance of the character and the urban identity of Porto.

25 years ago, Ivor Samuels had developed a similar assessment of a plan (also based on a morphological approach) designed in the early 1990s for the French town of Asnières-sur-Oise (Samuels and Pattacini 1997). This evaluation stressed the need of gaining a political consensus for the plan to be acceptable by local politicians participating in its adoption and implementation. In Asnières-sur-Oise, the election of a new mayor has introduced a more significant change than the election in Porto, as it questioned the whole morphological approach.

3.2 Processes of Urban Transformation

After addressing the direct and indirect agents of change, this section focuses on the different processes of transformation of the physical form cities. It moves from 'unplanned' to 'planned' processes (using a somehow simplistic distinction), and within the latter, from plans to plan implementation and development control as regulatory activities framing different contributions.

3.2.1 Unplanned Processes

The evolution of a city over time is framed by very different processes. While some involve the construction of shared views, supported by technical knowledge and political consensus (as will be described in the next subsection), others are mainly driven by individual and uncoordinated actions. One of the most extreme examples of the latter are informal settlements, a particular type of urban area that emerges as an answer to the absence of adequate housing and services for the low-income population. Informal settlements are usually associated with the lack of access to improved water source and sanitation, sufficient living area, housing durability, and security in tenure leading to a constant threat of eviction.

Despite the progress in improving and preventing the formation of informal settlements, their numbers continue to grow. According to UN-Habitat, in 2018, almost one in three people living in cities was living in informal settlements, mainly in

the so-called Global South. The situation is particularly dramatic in Sub-Saharan Africa, where one in two people living in cities was living in informal settlements. In Central African Republica, South Sudan, Sudan, Chad, and São Tomé and Principe, the rate was higher than 80%. In Asia and the Pacific, one in four urban citizens was living in these settlements. In Asia, the highest rates were found in Afghanistan and Yemen, with more than 60%. In Latin America and the Caribbean, one in every five urban citizens was living in informal settlements. Haiti, Bolivia, and Nicaragua held the highest rates, all above 40%. In the Middle East, there was a strong variation from country to country. Finally, it is important to highlight that informal settlements are not exclusive of least developed countries or the Global South. For instance, in Europe, Moldova and Belarus had very high rates—about 60% and 30%, respectively.

In terms of urban form, informal settlements share a few aspects with historical cities. Their streets are irregular and narrow, street blocks are small, streets and buildings are strongly related with no significant setbacks, and building density is high. And yet, there are some important differences. One is location. While the location of many historical cities benefits from a deep understanding of the natural context, informal settlements are usually located in peripheral hazardous places. While the street systems of both share some similarities, there is a profound lack of infrastructure in informal settlements. In addition, the notions of public space and private property that we usually associate with streets and plots, respectively, can be controversial in these settlements, due to the complicated relationship that their inhabitants have with the land. Finally, buildings in informal settlements are small and made of poor materials (UN-Habitat 2016).

Living in informal settlements is a daily challenge, as their inhabitants experience deprivation, disadvantage, and discrimination. There is an urgent need to improve and upgrade these living conditions and to regularize informal settlements as effective parts of cities. But it is also crucial for research and practice on the urban landscape, in Global South and North, to understand the lessons that these people and settlements can give us, in terms of the social fabric and urban form.

3.2.2 Planned Processes

3.2.2.1 The Plan

Eventually, the most comprehensive views of cities are condensed in urban plans. Based on the analysis of the existing situation in a particular moment in time, the plan tries to prepare the future of the city in many different dimensions, from physical (including urban form, transports, and environment) to social and economic dimensions. Due to the nature of this book, a greater emphasis is given to the physical dimension.

The urban history of each city includes a combination of comprehensive and individual actions. How much of the physical form of a city is the result of planned or individual actions varies from place to place. In addition, we can say that there are

some plans which have a profound and lasting impact, while others have no impact at all.

Table 3.1 presents a list of 22 plans that had, and still have, a profound impact on 22 different cities in four different continents. The main purpose of this list is, not to offer an unequivocal selection of 22 plans but, to give an illustration of the main directions in plan making over the last two centuries.

We should highlight that, even in each of these cases, the plan is only one part of the process of city-making. In many cases, the plan focuses only on one part of the city, the other parts being formed under the framework of other plans or through a more unplanned manner. It is also important to acknowledge the diachronic nature of each process of city-making. The process of city formation is generally a combination of large plans and small interventions on streets, plots, and buildings.

The Nineteenth Century

The first six plans of the list were elaborated in the nineteenth century—the first for a North American city, all others for European cities. While the plans for New York, Barcelona, and Lisbon prepare new expansion areas in these cities for the subsequent

Table 3.1 A list of influent plans in planning history in the nineteenth and twentieth centuries

Year	Plan / city	Authors(s)
1811	New York	*The Commissioners*, John Randel
181 4	London (Regent Street)	John Nash
1853	Paris	Georges-Eugène Haussmann
1856	Vienna	Franz Joseph I
1859	Barcelona	Ildefonso Cerdá
1879	Lisbon	Ressano Garcia
190 3	Letchworth Garden City	Raymond Unwin, Barry Parker
191 2	New Delhi	Edwin Lutyens
191 2	Canberra	Walter Griffin
1913	Amesterdam (South)	Hendrik Petrus Berlage
192 0	Lyon (*Estats -Unis*)	Tony Garnier
1925	Frankfurt	Ernst May
1925	Berlin -Britz	Bruno Taut , Martin Wagner
1945	Le Havre	Auguste Perret
1948	Copenhagen	Regional Planning Office
1952	Chandigarh	Le Corbusier
1957	Brasília	Lúcio Costa
1965	Curitiba	IPPUC , Jaime Lerner
1967	Milton Keynes	Llewelyn -Davies
1969	Bologna	Pier Luigi Cervellati
1981	Seaside	Andres Duany, Elizabeth Plater-Zyberk
1998	Bogota	Enrique Penalosa

Note Dates in the left column correspond to the beginning of plan preparation

decades, the plans for London, Paris, and Vienna redesign a part of these cities (a more extended area in Paris and more contained areas in the English and Ostrich capitals). While the plans for New York and Lisbon have an exclusive focus on streets, street blocks, and plots, there is increasing attention to buildings as we move from these two documents to the plans for London, Paris, Vienna, and Barcelona. As it might be expected and reinforces the argument of the last section on the increasing role of architects in the twentieth century, only one of these six plans was designed by an architect, the London plan by John Nash. As we will see, this situation changes radically in the twentieth century.

Thirty years after America had achieved its independence from England, a visionary act was designed for New York. In a time when Manhattan (with less than 100,000 residents) was concentrated at the southern part of the island, Simeon De Witt, Gouverneur Morris, and John Rutherfurd—assisted by surveyor John Randel—proposed a new planning paradigm for the city. The New York plan designed a new layout for a new territory that was 20 times larger than the existing city. In this new territory, the plan designed a street system (a set of streets, from 14th Street to 155th Street, and twelve intersecting avenues), a plot structure for each street block, and rigorous guidance on building alignments. This plan will be presented in more detail in Chap. 5.

Almost simultaneously, John Nash started redesigning a new axis in central London, connecting a new royal park, the Regent's Park, and the Regent's home, Carlton House (which would be demolished in the late 1820s when George IV decided to move to the Buckingham Palace)—Fig. 3.1. Although it was the design of 'just' one axis, this was one of the most radical changes in the urban form of London. The plan included the design of the notable Regent´s Park, of the street including two circuses (Oxford and Piccadilly) and some notable variations of direction such as the Church of All Souls and the Quadrant, some remarkable residential buildings of classical façades (Cumberland Terrace, Chester Terrace, Park Square, and Park Crescent) and, finally, the renovation of the Buckingham Palace.

The other four plans were all prepared in the second half of the nineteenth century. The plan for Paris is somewhere in between the two former plans, proposing the redesign of a large area of the existing city. The plan designed by Baron Haussmann, the mayor of the city between 1853 and 1869, included a new radial layout of wide streets—as opposed to the narrow and irregular mediaeval streets—as a key element for maintaining law and order. It also promoted the construction of new buildings: exceptional buildings (schools, hospitals, markets…) erected by the local authority, and common buildings which were object of development control. This process regulated several issues, like the relation between building height and street width—a maximum ratio of 1:1 for streets larger than 20 m, and 1.5:1 for streets with less than 20 m.

With the dismantling of the defensive walls around Vienna during the mid-nineteenth century—as it happened in most European cities—a debate emerged on the future of the green 'ring' (*Ringstrasse*) that separated the historical city and the then new city. The plan promoted by Emperor Franz Joseph I proposed the construction of a 5 km long horseshoe-shaped boulevard, starting and ending at the Danube

Fig. 3.1 The plans for London and Barcelona (*Source* Public domain)

canal, including green areas, private buildings, and some notable administrative and public buildings. Two sets of administrative and public buildings should be highlighted: (i) the *Burgring*, with an expansion of the imperial palace and two remarkable museums; (ii) and the buildings around the *Rathaus* Park—the Parliament, the City Hall (*Rathaus*), and the *Burgtheater*.

The dismantling of the city walls in Barcelona was contemporary of the wall demolition in Vienna (Fig. 3.1). Yet, contrary to the Ostrich capital, Barcelona had no significant peripheral areas, except for some small autonomous settlements, like *Barceloneta* and *Gràcia*. Accordingly, what Ildefons Cerdá proposed in his plan, prepared in the late 1850s, was not the mere occupation of the area immediately around the city walls, but the expansion, or *ensanche*, towards a territory that was about 7 times larger than the existing city. The plan designed a new layout based on a regular pattern of streets of about 20 m width, street blocks of 110 m, and chamfered corners at 45°, interrupted only by a large diagonal street, like the Broadway in New York. The plan also included guidance on the design of buildings, proposing the first rupture in relation to the peripheral occupation of street blocks.

The main proposals of Ressano Garcia's plan for Lisbon were the provision of new green spaces and the definition of a new street system, the *Avenidas Novas*. The plan was not intended to support development control through specific building and land use controls. The *Avenidas Novas* were the structural support for the entire northern urban expansion of Lisbon, combining, at the same time, a rational design with strict respect for the natural environment and the built pre-existences. Ressano Garcia defined the structural axes for a new city covering an area equivalent to the existing one, along an east–west direction. The city would be modernized through a large peripheral expansion in contrast to Pombal's intervention carried out after the 1755 earthquake, when the historical kernel of the city was totally redesigned. A specific expropriation law allowing the constitution of a lateral strip of 50 m, on each side, reserved for development, supported the construction of the new system of avenues and streets.

The First Half of the Twentieth Century

The second set of plans was prepared in the first half of the twentieth century. Although this set is more heterogeneous than the six plans analysed above, three groups can be distinguished: the first group, composed of the plans for Letchworth, New Delhi, and Canberra, proposes the construction of new cities (despite the closeness between Old and New Delhi); the second group includes the documents for Amsterdam, Lyon, Frankfurt, Berlin-Britz, and Copenhagen, and concerns the expansion of an existing city, from the design of a new housing neighbourhood to the comprehensive planning of a whole metropolitan area; and, finally, the third group composed of the plan for Le Havre corresponds to the reconstruction of a whole city destroyed in the Second World War.

At the end of the nineteenth century, in a context of a wide debate on the problems of large cities, Ebenezar Howard published the influential 'Tomorrow: a Peaceful Path to Real Reform' proposing a new model of urban development, the garden city (Howard 1898). The garden city would adopt a satellite location, gathering the

benefits of city and country, be self-sufficient and constitute the most economical solution for the growth of a city, while eliminating private speculation on land and housing. Located 50 km from London, Letchworth was the first garden city built according to Howard's model. It was designed by Raymond Unwin and Barry Parker in 1903.

In the subsequent decade, Edwin Lutyens prepared the plan for a new city—New Delhi, the then new capital of the British administration in India. The plan combined a monumental scale (that would also be used in the plan for Canberra) expressed in a central mall connected to a number of diagonal avenues (as in the Paris plan) and in a number of exceptional buildings—notably the Viceroy's House—with a low-density pattern of residential buildings based on a series of hexagons separated by broad avenues with double lines of trees.

Almost simultaneously, the Australian Government promoted an international competition for the plan of a new capital, Canberra (Fig. 3.2). The selected plan, by Walter Griffin and Marion Mahony Griffin, rests on a careful reading of the natural context—both relief and water—and on the design of a set of diagonal axes, somehow similar to the ones in New Delhi. Two main axes emerge: a land axis, aligned with the summits of four local mountains, and a water axis (crossing the first at right angles) running along the river, which in the plan became a chain of ornamental basins. This set of axes frames the design of a large triangle which is the symbolic heart of the city. The Municipal Government, the Market Centre, and the Capitol (now the Parliament House) are in the vertices of the triangle.

Contrary to the former three plans (Letchworth, New Delhi, and Canberra), the purpose of Hendrik Petrus Berlage, in his 1913 plan, was not to design a new city but to establish a south expansion area of Amsterdam (Fig. 3.2). The plan is based on a complex street system combining different types of geometry, street blocks of about 100–200 m long and 50 m width, gardens within the blocks, and buildings of a sound uniformity both in terms of alignment and height—four storey. While having a progressive goal (the building of mass housing) and procedural means (public expropriation and long-term planning), the Berlage plan can be seen as traditional city planning, in clear harmony with the nineteenth-century Amsterdam.

The relation between the existing city and the planned expansions is quite different when we compare the plans for Amsterdam and Lyon. Based on the theoretical idea of an 'industrial city', Tony Garnier designs a set of proposals for Lyon. The most important is the *Estats-Unis* residential neighbourhood, representing a rupture with traditional city building, in terms of the main relations between streets and buildings. Curiously, the architecture of these buildings is closer to the classical tradition than the buildings that would be designed by the Amsterdam School for the south of Amsterdam.

The plan by Ernst May for the periphery of Frankfurt continues the line of planning developed in Lyon, the design of city fragments mainly composed of residential buildings, the *Siedlungen.* This modernist plan, and particularly some of the detailed plans developed for each *Siedlungen* (for instance, *Westhausen*, as opposed to *Romerstadt* which has a more traditional layout), has crucial importance in planning history, replacing the street block by a new type of urban landscape where buildings are

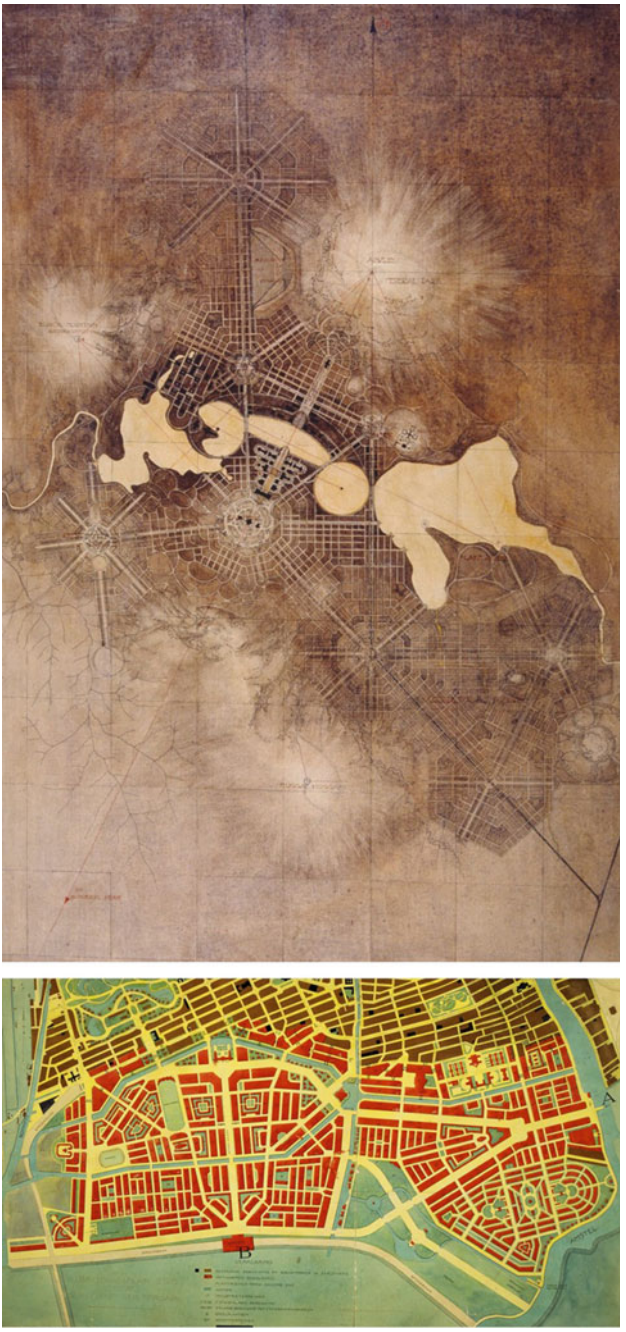

Fig. 3.2 The plans for Canberra and Amsterdam (*Source* Public domain)

completely disconnected from the street. The set of *Siedlungen*, comprising more than 15,000 dwellings, was conceived as housing districts—with only a minimum of facilities, meeting the most basic needs—of a large industrial city, being linked to the latter by a public transport network.

Similar to the two former cases, the Britz plan is focused on the design of a housing district, of about 1,000 dwellings, in the periphery of Berlin. Despite the rupture with the street block, Bruno Taut and Martin Wagner maintain a close relation between street and buildings, both in the main streets of the *Siedlungen—Fritz-Reuter-Allee*, containing the well-known 'horse-shoe' building, and *Parchimer Allee*—conformed by multifamily buildings and in secondary streets defined by single-family buildings (including about half of the dwellings of the neighbourhood). This relation is less evident in the south part of the neighbourhood.

The plan designed by August Perret for the French city of Le Havre is of a rather different nature, aiming at reconstructing the city centre that was destroyed in the Second World War. The plan for Le Havre is closer to the traditional city than the three former plans for Lyon, Frankfurt, and Berlin-Britz. In Le Havre, Perret designs a new layout of streets and street blocks based on a 100 m modulation very similar to the layout destroyed in the World War, and a set of buildings of a classical style based on modern prefabrication techniques.

The last plan of this set of documents prepared in the first half of the twentieth century is the 'finger plan' for Copenhagen coordinated by the city's Regional Planning Office. Although addressing the topic of city expansion, the 'finger plan' adopts a very different approach in relation to the set of plans prepared in the first half of the twentieth century and even to the series of plans elaborated in the nineteenth century. Indeed, it offers a comprehensive regional view. The plan resembled a hand, with Copenhagen at the centre (the palm) and five fingers spreading out in the direction of Køge, Roskilde, Ballerup, Farum, and Hillerød (from west to east), all within a maximum radius of 40 km. Instead of allowing Copenhagen to sprawl in all directions, the 'finger plan' aimed at supporting a structured urban growth along fingers, with the S-train network in the middle of each finger and green areas in between the fingers (farmland, forests, and recreational areas).

The Second Half of the Twentieth Century

This last set of documents includes four plans for new cities, designed according to modernist planning (Chandigarh, Brasilia, and Milton Keynes) and to the New Urbanism (Seaside); two plans for the restructuring and expansion of a city (Curitiba and Bogota); and one plan for the conservation of a city centre (Bologna).

After many theoretical proposals developed after the early 1920s, Le Corbusier had the first opportunity to design a whole new city in Chandigarh, the new capital of Punjab, India (Fig. 3.3). The plan of Chandigarh is composed of a regular grid of streets, rotated about 45 degrees in relation to the cardinal points, dividing the city into different sectors of about 1,200 × 800 m; the constant presence of green areas; a low building density—residential buildings of about two storey, and institutional or commercial buildings of about five storey; and the Capitol, in Sector 1, in the northeast part of the grid.

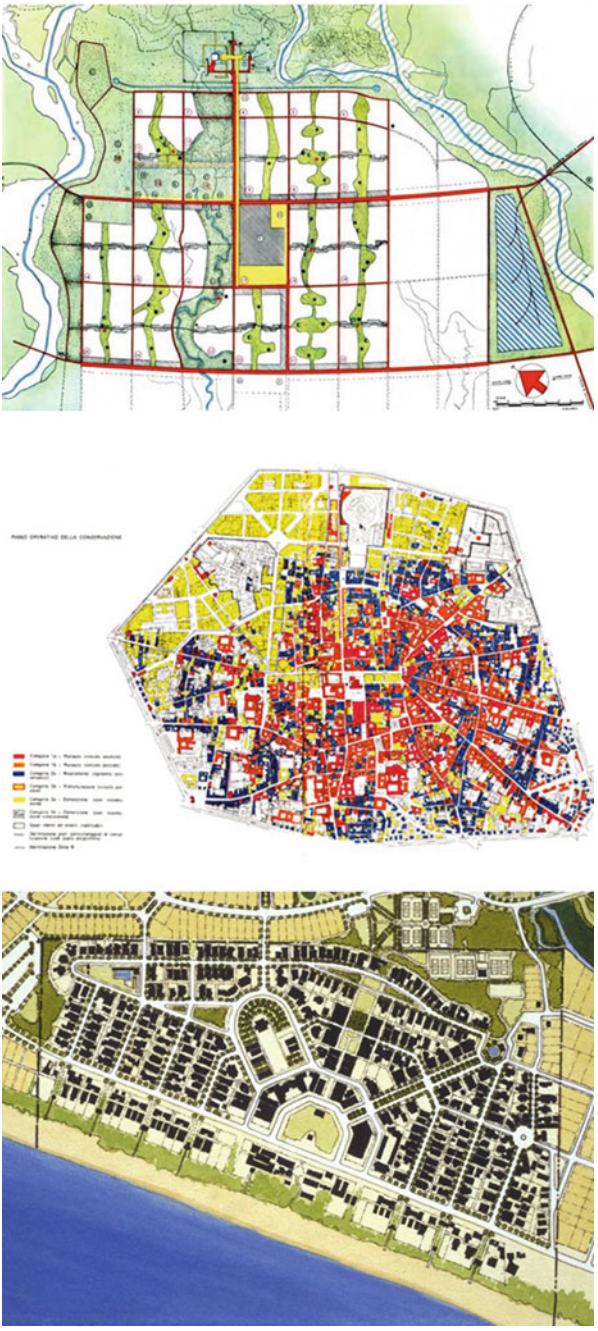

Fig. 3.3 The plans for Chandigarh, Bologna, and Seaside (*Source* Public domain)

In the mid-1950s, the Brazilian government decided to change the capital from Rio de Janeiro to a new city that would be built in the interior of the country, Brasilia. The Lucio Costa plan proposed a general organization of the city based on two crossed axes. The north–south axis, the *Eixo Residencial*, is a fast-circulation street supporting the location of residential areas, the superblocks, constituted by sets of six stories buildings on a continuous green space. Each set of four superblocks is a neighbourhood unit, including some non-residential buildings for commerce, services, and facilities. The east–west axis, the *Eixo Monumental*, includes (from east to west): the *Praça dos Três Poderes* gathering the executive, legislative and judicial powers; the *Esplanada dos Ministérios*, a wide rectangular green area surrounded by government buildings; the *Plataforma Rodóviaria*, in the junction of the north–south and east–west axes, gathering transport facilities, and commerce and services areas; and finally, the railway station.

Ten years after, the plan for Milton Keynes was elaborated as part of a programme launched in the 1950s (including Cumbernauld and Hook) promoting the construction of 'new towns' in England. The plan designs a city for about 250,000 inhabitants located 70 km from London, with two different circulation networks—one for pedestrians and one for vehicles. The layout of the town centre is developed in a symmetrical way in relation to the central station, the key element of composition. Like Chandigarh and Brasilia, Milton Keynes is a city that is completely different, in urban form matters, from a traditional city built until the end of the nineteenth century.

In the mid-1960s, a plan was prepared for Curitiba, framing a successful planning process that would be developed over the next decades. The plan and process, designed and implemented by the *Instituto de Pesquisa e Planejamento Urbano de Curitiba* (IPPUC), provides an effective integration of urban form, land uses, public transport system, and environmental concerns (water, sanitation, and garbage). One key agent in this process is Jaime Lerner, president of IPPUC in the late 1960s and city mayor in three mandates in the next three decades. This planning view promoted the city expansion along linear axes (somehow similar to the Copenhagen plan). Each axis is constituted by an exclusive lane for buses at the centre, flanked by two channels for private cars. In the surrounding area, building density is high in the proximity of the axis, and decreases as the distance from the axis increases.

At the end of the 1960s, a plan was prepared for the city of Bologna introducing a particular concern in the planning and architectural debate that was quite opposite from former plans (Fig. 3.3). The goal of the Cervellati plan was not to conceive a new city, or even to expand an existing settlement, but to conserve the existing city. One of the main ideas of the plan was that the historical identity of the city is not exclusive to the exceptional buildings erected in the sixteenth century, but it is present in the ordinary buildings erected in the seventeenth and eighteenth centuries. A typological approach was developed establishing four categories of building types all related in a unified urban landscape.

In 1980, after being gifted an 80-acre plot, Robert Davis appointed Andrés Duany and Elizabeth Plater-Zyberk to prepare a plan for a small town (2,000 people) in the coast of Florida, Seaside (Fig. 3.3). The plan for Seaside—a town that has become a

flagship of the New Urbanism movement—stands out as a reaction to the dominant model of urban development in the United States, proposing the return to the qualities of a small town (based on a reinterpretation of local vernacular) and a connected system of streets, which keeps pedestrians and traffic together but privilege pedestrians. The plan is complemented by a form-based code, notably condensed in one single sheet. After dividing the town into eight types of urban tissue, the code establishes the rules for transformation in each of these tissues offering guidance on the location and scale of yards and porches, outbuildings and parking, and building height.

Similar to what happened in Curitiba after the mid-1960s, the *Plan de Desarollo Económico, Social y de Obras Públicas* prepared in 1998 for Bogota, by mayor Enrique Peñalosa and his colleagues, inaugurated a new planning process for the Colombian capital. The new plan and process were supported by principles of inclusion (of low-income and informal workers and residents) and have been translated into fundamental proposals on the public space and transport system of Bogota. The former comprised the qualification of pedestrian paths and the improvement and expansion of bicycle routes. The latter included the promotion of public transport, namely the *TransMilenio* buses operating in exclusive lanes, and the restriction of private car use.

3.2.2.2 Plan Implementation and Development Control

While the set of 22 plans presented before had a high degree of implementation of their main proposals on the territory, this is not always the case. Indeed, the plan is one 'thing' and the planning process, including plan implementation, is a rather different 'thing'. Planning history includes many examples of plans with a low degree of implementation and plans that were never implemented at all.

While the process of plan making depends mostly on the planning team and the promoter of the plan (bounded by the specific planning system, the planning team interprets the fundamental needs and ambitions of the city, and prepares a coherent document, both in terms of its different parts and of the relation with other plans prepared for the same territory), the process of plan implementation depends on other important factors. One of the main factors influencing plan implementation is the commitment of human and financial resources. The emphasis placed on preparing a good plan should be followed by an equivalent effort for ensuring that the team and the financial means that are needed to support plan implementation are mobilized. The availability of resources over time, the type and diversity of resources that are available, and the relationship between planning practice and allocation of resources are crucial aspects. In financial terms, the most important elements for strengthening this link are municipal budgets, particularly the relationships between capital and running costs, and more specifically the relative weight of resources allocated to

planning issues. Also important is the way 'time', a valuable resource, is managed over the whole process of plan implementation.

Another important factor is plan utilization by politicians and professionals in decision-making. The success of plan implementation also depends on a clear identification by politicians and professionals and the document that frames the process of city building. There are some different levels on this issue: the influence of politicians in plan making; the effective use of the plan by politicians; and, finally, the use of the plan by professionals over plan implementation. The last aspect raises the issue of the composition of planning teams. It would be desirable that the local authorities would have qualified staff that could effectively internalize a significant part of the planning process, without denying the possibility of working together with academics and the private sector, and to explore innovative planning approaches. As such, the local authority's professionals could participate in a more continuous way in this process.

While plan making and implementation in the nineteenth century depended mainly on the power of a few agents, as time went by it started depending on the participation and involvement of many different agents. Despite some exceptions, particularly in the emerging economies, plans are not being designed and implemented through the isolated action of central or local governments. As we have seen, the processes of development control involve the interaction between indirect and direct agents of change. The framework for this interaction depends on the specific planning system: from contexts like the French system, where the plan is the main element defining the rules for this interaction to other contexts, to other contexts like the British system, where the plan is just one element of the process, offering in advance a structure for decision-making.

Exercises

A. Testing Your Knowledge

3.1 What are the main factors influencing developers when promoting an action on the urban landscape?

i. The opportunity to work with a specific group of architects and builders.
ii. Their professional relationships with the local authority's planning officers.
iii. Economic factors and the timing of development.

3.2 What is an informal settlement?

i. A settlement in the Global South.
ii. A settlement whose formation process has not been framed by a plan.
iii. A settlement without access to improved water source and sanitation, sufficient living area, housing durability, and security in tenure.

3.3 What is the main difference between the Frankfurt plan and plans prepared and implemented before the 1920s?

i. It represents a fragmented way of planning and promotes the absence of the street as a key element of urban form.
ii. It is the first expansion plan for a German city.
iii. The central role of residential neighbourhoods in the Frankfurt plan.

3.4 What was the major innovation of the Bologna plan?

i. The acknowledgement of conservation as the main goal for a whole urban area, and not just its singular buildings.
ii. It represents the territorial expression of left-wing planning policies.
iii. It rationalizes the chaotic road network of the city centre, linking it to the territorial road network.

3.5 What are the fundamental characteristics of the Curitiba and Bogota plans?

i. The focus on public transports and its relationships to urban form and land uses.
ii. The concern on the identity and character of the city.
iii. The proposal of typological zoning, regulating the transformation of urban form based on the main characteristics of exiting streets, plots, and buildings.

Solutions

3.1—iii.

3.2—iii.

3.3—i.

3.4—i.

3.5—i.

B. Interactive Exercises

Exercise 3.1—The Planner, the Developer, and the Architect

The main goal of 'The planner, the developer, and the architect' is to make explicit to students, some of the main interactions between different agents, taking place in the process of city building. The game should be played in the classroom, preferably in a CAD environment, involving simulation of action in a particular site in the city where the game occurs, and encompassing the interaction of three different groups of students in three consecutive moments.

Planners are the first group. The task of the planners, acting as one single team, is the definition of the rules of urban form transformation for 'that' site, bearing in mind the urban landscape where it fits in: i. what should be conserved (?); ii. what can be transformed (?); and iii. how can it be transformed (?). The second group is the developers. Bearing in mind the rules defined by the team of planners, the developers,

divided into two different teams, should establish the programme for new buildings to be erected on the site. The definition of this programme should bear in mind the main goal for developers—economic profit. The last group is the architects. Based on the inputs of the team of planners and the two teams of developers, four teams of architects (two for each team of developers) should briefly outline the plans and façades of the new buildings. At the end of the game, with four proposals for the site, the debate should reflect on the contribution of each team for the results.

Exercise 3.2—The Plan and the City

This exercise aims at exploring the impact of the physical form proposals of one plan in the urban history of a city. 'The plan and the city' should be developed as a homework exercise. Each student should select one plan from a list of plans of great relevance in his country's planning history, previously prepared by the teacher. The list of plans (similar to the list in Table 3.1) should be gathered considering the access of students to data.

The analysis of each plan should address three main aspects: i. the original urban form proposals of the plan (based on the plans' maps, written proposals, and regulations); ii. the proposals that have been implemented on the ground, distinguishing these from non-implemented proposals (based on a map of the city that has been prepared subsequently to plan implementation); and, finally, iii. how today's physical form of the city is still influenced by this plan (using software for the interactive visualization of maps and satellite images, like Google Earth, Bing Maps, or Baidu Maps).

Each student should prepare a brief PowerPoint presentation (5–10 min, 10 slides maximum) to be presented in the classroom. The student should use text and images (drawings and photographs), or any means that he thinks is adequate.

Exercise 3.3—The Greatest Grid

Considering one of the fundamental messages of this book, the recovery of key elements of urban form, such as streets, street blocks, and plots, the 1811 plan for New York stands out as a singular document in planning history. 'The Greatest Grid' should be developed as homework exercise. The development of the exercise draws on two notable websites (open-access material): 'The greatest grid' (https://thegreatestgrid.mcny.org/), devoted to the 1811 plan; and 'ZoLa—New York City's Zoning & Land Use Map', dedicated to zoning regulations (https://zola.planning.nyc.gov/).

This exercise addresses the permanence of streets, street blocks (first group of students), and plots (second group of students) defined by the 1811 plan. The first group of students should develop a comparison between the streets and street blocks proposed by the 1811 plan (https://thegreatestgrid.mcny.org/greatest-grid/the-1811-plan) and those of today (included in ZoLa). The second group of students should focus not on the whole Manhattan, but on two small parts of the island, comparing the plan proposals and today's plot structure: in Chelsea (https://thegreatestgrid.mcny.org/greatest-grid/selling-lots/89 and Fig. 5.4 in Chap. 5) and Union Square (https://thegreatestgrid.mcny.org/greatest-grid/square-parks-and-new-avenues/229 and Fig. 3.4). In both comparative exercises, students are

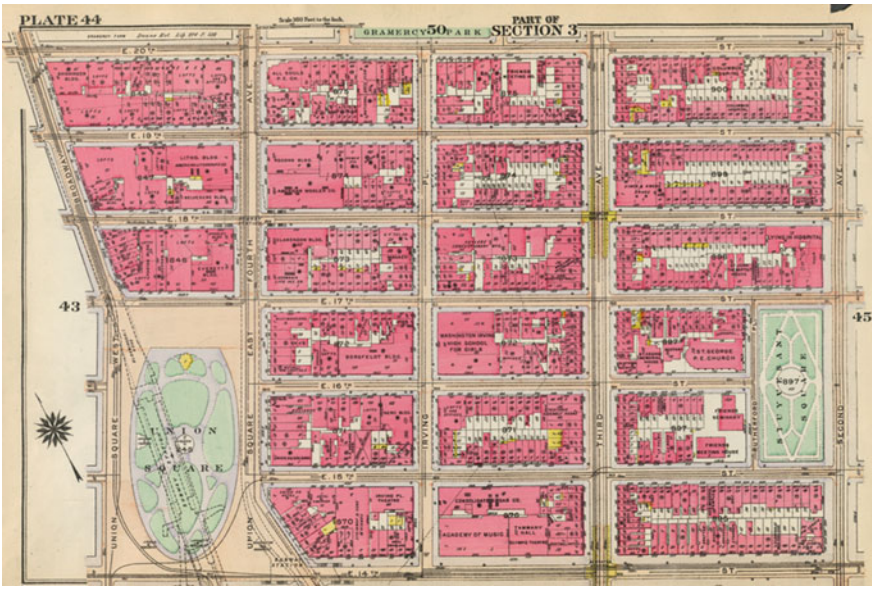

Fig. 3.4 Union Square area, 1916 (*Source* https://thegreatestgrid.mcny.org/greatest-grid/square-parks-and-new-avenues/229)

required to quantify what has persisted and what has changed. Each group of students should prepare a brief PowerPoint presentation (5–10 min, 10 slides maximum) to be presented in the classroom. Students should use text and images (drawings and photographs), or any means they think is adequate.

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Chapter 4
Cities in History

Abstract This chapter analyses the evolution of cities over almost 6,000 years. After a brief introductory section, the structure of the chapter draws on seven historical periods that are relatively consensual for different researchers: (i) early cities, including Sumerian, Egyptian, Harappan, Chinese, Toltec and Aztec, Mayan, and Inca civilizations; (ii) Greek cities; (iii) Roman cities; (iv) Islamic cities; (v) Mediaeval cities; (vi) Renaissance cities; and finally, (vii) nineteenth-century cities. The main goal of the chapter is to understand, in each of these seven periods, what the main characteristics of the fundamental elements of urban form—streets, plots, and buildings—were, and how these elements were combined forming different urban landscapes.

Keywords Early cities · Greek cities · Roman cities · Islamic cities · Mediaeval cities · Renaissance cities · Nineteenth century cities

4.1 Humans, Houses, and Cities

Humans first evolved in East Africa about 2.5 million years ago. About 2 million years ago, some of these humans left their homeland starting a long journey that would lead them to settle in vast areas of North Africa, Europe, and Asia. According to some researchers, from 2 million years ago to about 10,000 years ago, the world was home to several human species living in different geographical settings. Around 10,000 years ago, Homo Sapiens were the only human species on Earth. Their main activities were hunting and gathering.

Throughout this very long period, humans started to produce their first houses, or what can be called pre-urban houses: from ephemeral or transient to temporal dwellings, and from these to permanent houses. Humans first built shelters, then these evolved into huts and, finally, to houses, mainly using the dominant materials of the region in which they lived, such as wood, earth, and stone (Cataldi 2015). The history of these pre-urban houses, particularly the first stages of this process of evolution, is very difficult to trace because most of these shelters were quite ephemeral. To deal with this issue, researchers have been studying some societies of today (and their spatial organization patterns) sharing certain similarities with

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these ancient groups of hunters and gatherers—from the Bushmen, in Africa, to the Tasaday, in Asia, or the Arunta, in Oceania.

The progressively increasing density of these houses, as well as of their inhabitants, has gradually given origin to small settlements and even pre-urban towns. Some researchers have established thresholds of houses and inhabitants and socioeconomic criteria to distinguish between these pre-urban towns or villages (including, for instance, Jericho in Palestine and Çatalhöyük in Anatolia, Turkey) from what would be the first cities.

4.2 Early Cities

Two factors were crucial for the birth of the earliest civilizations, the climate changes resulting from the last of the ice ages transforming the natural environment into a more favourable context and the development of settled agriculture allowing the production of food surplus.

These earliest civilizations, and the first cities, were probably developed in different time periods from 3,500 BC onwards in seven different places around the world—the Sumerian civilization in southern Mesopotamia (present-day Iraq), the Egyptian (in Egypt), the Harappan in the Indus Valley, the Chinese in the Yellow River, the Toltec and Aztec in the Valley of Mexico, the Maya in the jungles of Guatemala and Honduras and, finally, the Inca in the coastlands and highlands of Peru (Morris 1972)—see Fig. 4.1. The first three are the so-called 'dead' cultures

Fig. 4.1 The seven civilizations

out of which evolved the Greek, Roman, and Western European Christian civilizations. Mesopotamia is important not only because of that but also for its influence on the Arabian Peninsula where Islamic culture originated in the seventh century AD. The three American cultures are also 'dead', being destroyed by the Spanish conquerors in the sixteenth century (Aztec and Inca) or even before the conquest (Maya). The culture of Chinese civilization is an exception in these seven civilizations as it lasted from the late third millennium BC to the twentieth century without permanent interruption.

Most of the cities analysed in this section do not exist today as such. Accordingly, our knowledge is mainly based on data offered by notable archaeological works mostly developed in the twentieth century, namely the works coordinated by Leonard Woolley (Ur and Tell-el-Amarna), Flinders Petrie and Barry Kemp (Tell el-Amarna), John Williams (Mohenjo-daro), René Millon (Teotihuacan), William Coe (Tikal), and Hiram Bingham (Machu Picchu).

4.2.1 The Sumerian Civilization

The Sumerian civilization was established around 3,500 BC (although it included early stages of development related to primitive forms of agriculture starting from 5,000 BC) and its decline was around 500 BC. It is the earliest human civilization. It flourished in Mesopotamia, the fertile land between the navigable rivers Tigris and Euphrates, surrounded by the Zagros mountains in the east and by the Syrian and Arabian deserts in the west. The Sumerian civilization was structured in several city-states including Erbil, Eridu, Larsa, Lagash, Nippur, Uruk, and Ur—to be expanded in the next paragraphs.

The city of Ur had its most prosperous moments between 2,500 and 2,000 BC (Fig. 4.2). In one of these flourishing moments, it had a maximum population of 34,000 inhabitants and a population density of 370 inhabitants per hectare (Schoenauer 1981). Ur was in three different parts: the walled city, the *temenos* (a religious precinct), and the outer city. The walled city had an irregular oval shape, about 1,300 m long by 900 m wide. It stood on a mound formed by the ruins of the preceding buildings and it had a strong presence of water—the Euphrates and one canal. It contained two harbours in the north and west. The *temenos* occupied most of the north-western quarter of the city and it contained the only public spaces for permanence of the city (Morris, 1972).

The streets of the city within the walls were irregular and narrow. Yet, a basic hierarchy of streets could be detected; the main commercial streets were larger than the residential streets. The residential buildings had a strong sense of privacy, and their entrance was in the narrower streets—even in the case of houses located in the corner of two streets. These houses had one or two storeys and a ground plan built around a central court including a variable number of rooms (sometimes, more than ten rooms). In the case of two storey houses, a staircase located near the entrance would lead to the first floor. The archaeological remains indicate that sometimes

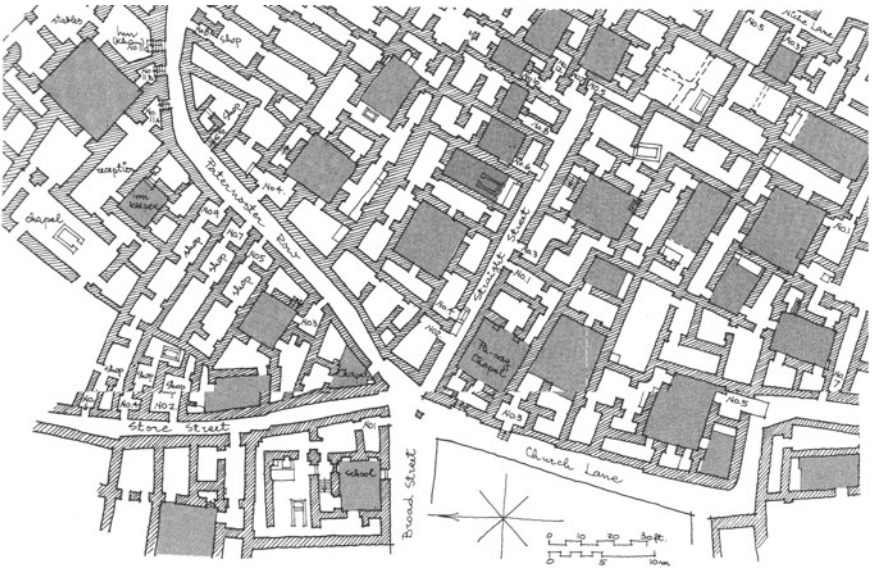

Fig. 4.2 The Sumerian cities: Ur—part of the city. *Source* Schoenauer (1981)

two houses were gathered making a larger house. These houses appear to have been occupied by the middle class rather than by the wealthy. The main characteristics of this type of house (with some variations) have been maintained for almost 6,000 years and can be found in the traditional houses of Baghdad.

One of the main contributions to the knowledge of Ur's urban history was given by archaeologist Leonard Woolley (Woolley 1929, 1963). One of the sectors excavated in Ur, by Woolley, revealed that along the main streets existed different chapels, a school with two different rooms, a large tavern, a restaurant, and cellars.

4.2.2 The Egyptian Civilization

The second of these seven civilizations is the Egyptian civilization, emerging in the third millennium BC in the fertile valley of the Nile (as the Sumerian in the Tigris and Euphrates rivers). While Sumeria was made of several strong city-states, Egypt was a robust unified state. It was made of different provinces. Unlike in Sumeria or in many other civilizations, Egyptian cities had an ephemeral nature, being usually associated with the construction of a temple—their religious and administrative functions were stronger than their economic role. Indeed, some cities could live for just a few decades. Therefore, most of them did not get to the present day.

Some of the most important cities were Amarna, Kahun, Memphis, and Thebes. We will focus on the first. Amarna, or Tell el-Amarna, was built by Pharaoh Akhenaten in about 1,347 BC and abandoned shortly after his death, 15 years later. The

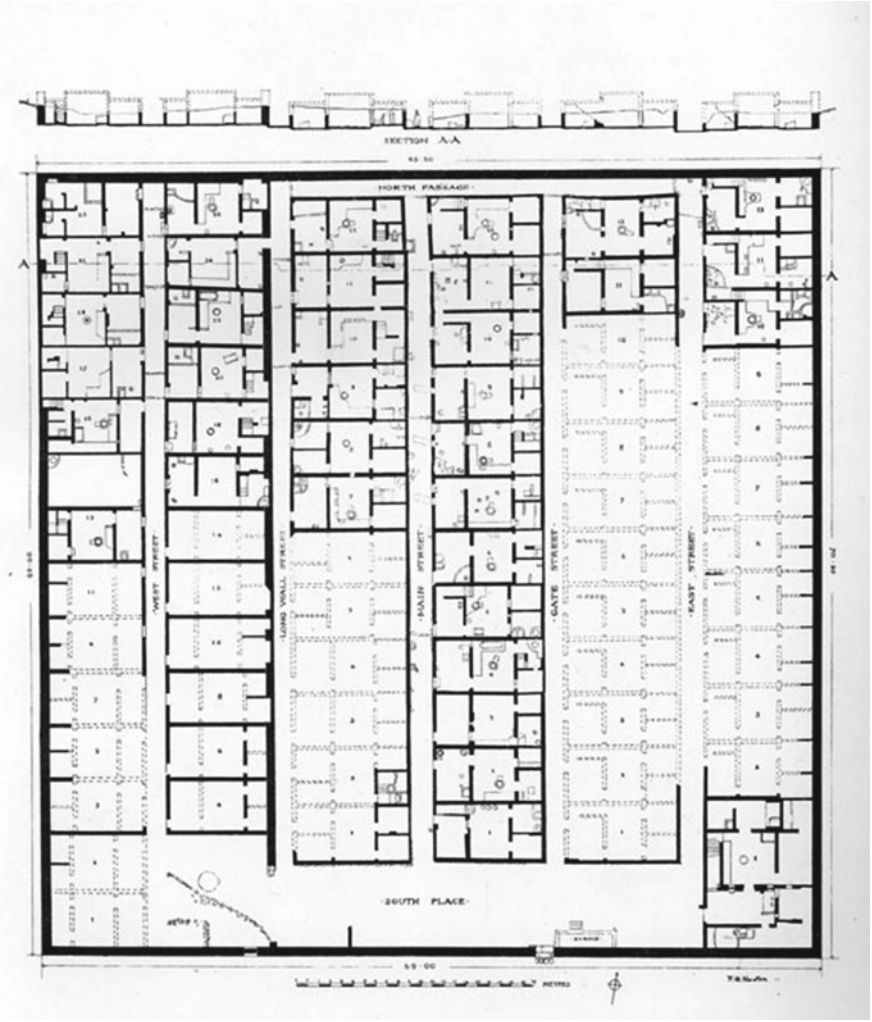

Fig. 4.3 The Egyptian cities: Amarna—plan of the workman's village. *Source* Petrie, public domain

city lies on the east bank of the Nile, halfway between Luxor and Cairo (300 km south of today's capital of Egypt). As in the case of Ur, the city of Amarna remained unknown for thousands of years. While archaeological excavations coordinated by Flinders Petrie and then by Leonard Wooley started in the late nineteenth century and continued in the first decades of the twentieth century, in the last 40 years the site has been object of continuous archaeological work—the 'Amarna Project', nowadays under the supervision of Barry Kemp (Petrie 1894; Kemp 1972).

The city of Amarna had a linear form alongside the Nile, with an overall length of about 7 km and a width of 800–1,500 m. Although the city was unfortified (as most

Egyptian cities), there were some walls, probably with a symbolic nature. The city included a central area (comprising the sun temples, the great palace, the pharaoh's residence, and the police and military barracks), north and south extensions, and a village for the necropolis workers, located about 1,000 m to the east. Both in central and extension areas, a street structure was laid down and subsequently occupied. This process of infilling seems to be a hierarchical one, starting from the wealthiest people, selecting the main streets and the best housing sites, moving then to the less wealthy.

The overall form of the workman's village is a 69 m square (see Fig. 4.3). It is surrounded by a wall with one gate at the south. The gate leads to an elongated square and from this open space to five north–south streets (the village also includes an east–west street, in its northern limit). The streets are very narrow, with less than 3 m width. The village includes 73 plots. These include 72 small houses and one larger house in the south-east corner, probably for the officer in charge. Plot and building frontages are coincident. Each of the 72 plots and houses was 5 m wide and 10 m long. Each building, with 50 m^2, was in three areas: a patio or hall, with many functions including spaces for working and for animals; a living room, the main space of the house (slightly larger than the two other areas); and a third area including the bedroom and kitchen. A staircase provided access to the roof.

4.2.3 The Harappan Civilization

As in the case of Sumerian and Egyptian, the Harappan (or Indian) civilization developed around two major river systems—the Indus, in the west, and the Ganges, in the east. The emergence of the first urban settlements occurred in the former, the Indus, in the third millennium BC, and then spread to the latter. The two main cities of this civilization were Mohenjo-daro and Harappa, both located in today's Pakistan, one in the province of Punjab, the other in the province of Sindh. Ancient Indian cities followed a common layout including a citadel, in the west, elevated and surrounded by a city wall, and a lower city, in the east, with a regular street system. These cities corresponded to ordered and settled societies, supported by agriculture and trade.

Mohenjo-daro was erected in 3,250 BC; it seems to have existed for 500 years and then it collapsed (Fig. 4.4). Mohenjo-daro should have had a population of 35,000 inhabitants. As in the case of Ur and Amarna, it was 'rediscovered' in the early twentieth century. Today, the archaeological ruins at Mohenjo-daro are the best-preserved urban settlement in South Asia dating back to the beginning of the third millennium BC. The book 'Mohenjo-daro and the Indus Civilization' is a key element for the knowledge on the city, describing the results of the first excavation works that took place between 1922 and 1927, under the coordination of John Williams (Marshall 1931).

Being an Indian city, Mohenjo-daro was in two parts, the citadel and the lower town. The citadel was elevated (ultimately, providing refuge for its inhabitants),

Fig. 4.4 The Harappan cities: Mohenjo-daro—part of the city plan. *Source* Wheeler (1968)

surrounded by a city wall, and included a number of buildings of civic and religious functions—comprising warehouses, administrative offices, and the Great Bath, a building for ritual bathing purposes.

The street system of the lower city was regular and mostly orthogonal, with north–south (main streets) and east–west axes. The main street was 9 m wide; the less important streets were 1–2 m wide. Streets were arranged at different heights to deal with flooding. The city had a sophisticated water and sewage system.

Contrary to Ur, and particularly to Amarna, Mohenjo-daro did not have special buildings. On the contrary, it emphasized the production of qualified basic buildings to its inhabitants. Each house had a courtyard (larger houses could have several courtyards). It also had a well, providing access to clean water, and a bathroom (connected with the street drainage system). Most of the houses, flat-roofed, had two storeys. The dimension of houses varied from small, with two rooms only, to very large dwellings, with many rooms. Figure 4.4 presents part of the city plan. It includes different houses. One of these is 25.5×29.5 m, fifteen times larger than the typical house in Tell el-Amarna. The main construction materials were bricks and wood. Shops (including a restaurant) have been identified in the street blocks along the main streets.

4.2.4 The Chinese Civilization

After many centuries of war between different states, the unification of China took place in the third century BC. The construction of the Great Wall started in 220 BC, and continued until the seventeenth century, using sections of earlier fortifications to form a united defence system against invasions from the north.

The Chinese city had a strong interrelation with the countryside. It was based on a strong hierarchy of three different parts of increasing dimension, the *hsien*, the *yi*, and the *tu*. The three parts—and the subdivision structure of the countryside—had a squared, or an almost squared, shape. This was based on the ancient belief that the Earth was squared, and the sky was circular. Another important aspect of the organization of the Chinese city is that it had a pre-established growth limit.

The Chinese city had a defensive wall and a north–south orientation. The street system was a regular grid, where the main streets lead to the city gates. There was a strong presence of commerce in many streets, particularly in larger cities. The residential areas were characterized by the presence of walls with a few openings.

The Chinese house was a residential complex, surrounded by a 3–4 m wall, comprising different buildings surrounding one central patio (in the case of families of higher status, the house could have two patios). The plan of this complex was symmetrically structured around a central axis. After entering the complex, and before moving to the patio, one would face the so-called 'wall of spirits' (the only exception in this symmetrical composition) preventing the entrance of demoniac spirits into the house. Buildings had one storey only and the Chinese would consider it presumptuous if someone intended to build a house higher than the city wall. The relation between buildings and patios in the Chinese house seems to be based on climatic issues, as patios in the north of the country were larger than those in the south. In addition, the roofs of buildings located in the south had a shape that offered further protection against sun exposure.

Each complex would correspond to one family, usually, a large family as the married sons would share the house with their parents. The building located closer to the street was the less important, containing the areas for servants and domestic tasks. The two perpendicular buildings were occupied by single and married sons. The most private areas of the complex were the most important and were occupied by the older members of the family. Some authors, like Durant (1954), argue that in this period the quality of life was higher in China than in Greece or Rome.

Figure 4.5 presents two different cities. The first is the capital city of Chang'an, in the Shaanxi province. Chang'an had an almost squared shape and a very large size—about 9,200 m by 8,500 m. The street system was an orthogonal grid with eleven north–south streets (five streets in the centre forming the main axis) and fourteen east–west streets. Among these, six main streets provided direct access to the main gates of the city while the rest were secondary streets. The street blocks had a rectangular shape, with the long axis pointing east–west. The Imperial Palace, facing south, and the Administrative City were built in the northern end of the central axis.

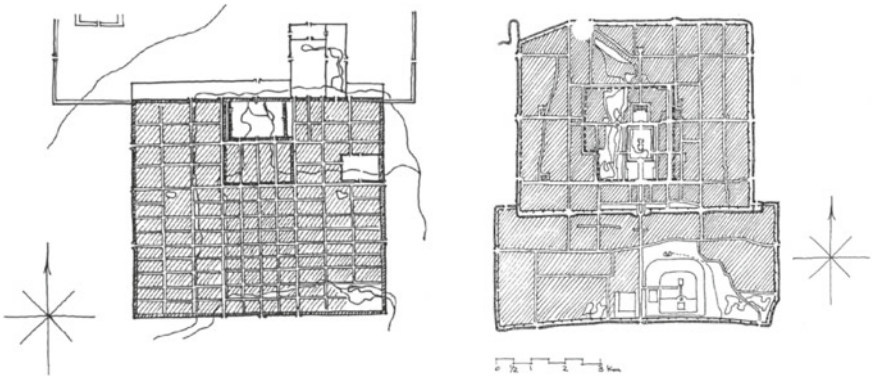

Fig. 4.5 The Chinese cities: Chang'an and Beijing. *Source* Schoenauer (1981)

The second city is Beijing. Beijing was structured in four different parts, each one surrounded by its own city wall: (i) at the south, the exterior city with a rectangular shape, ten gates and an area of 27.30 km^2, and a more informal character; (ii) at the north, the interior city with nine gates and an area of 30.25 km^2; (iii) within the interior city, the Imperial City, accessed by four gates and with an area of about 5.00 km^2; and, finally, (iv) within the Imperial City, the Forbidden City, with an area of 1.65 km^2.

4.2.5 The Toltec and Aztec Civilizations

For about fifteen to sixteen centuries, until the Spanish conquest in the 1520s, Central Mexico had been dominated by a series of pre-Columbian groups, from the 'Middle Cultures' to the Toltecs, and from these to the Aztecs. The earliest permanent village settlements in the Valley of Mexico (more than 2,000 m above the sea level, high mountain chains, and a great salt lake) seem to date from about 1,500 BC.

The city of Teotihuacan is located 50 km north-east of Mexico City. It seems to have been built in the first century AD (yet human occupation of the valley began before the Christian era) and to have collapsed in the seventh century. The reasons for the collapse are not clear but include a great fire. There is also no consensus about its population, although some authors argue that it could have had 100,000 or even 200,000 inhabitants (René Million argues that in 600 AD, Teotihuacan was the sixth largest city in the world). The population was occupied in handicrafts, trade, services, and government duties.

Archaeological work in Teotihuacan started at the end of the nineteenth century. It continued along the twentieth century, and it had a major moment with the production of a detailed archaeological and topographic map, by René Millon in the early 1970s (Fig. 4.6).

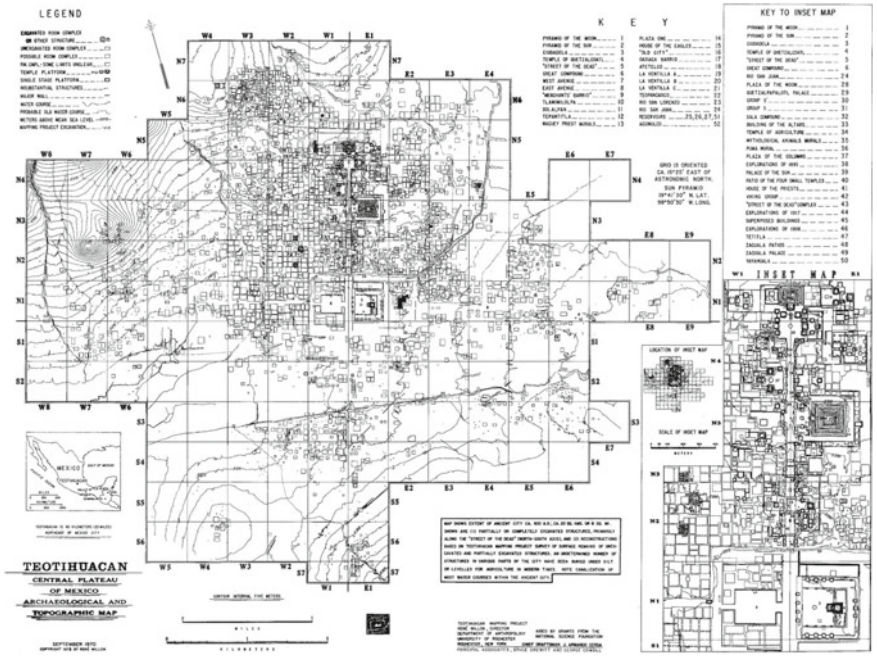

Fig. 4.6 The Toltec and Aztec cities: Teotihuacan. *Source* Million (1973)

Teotihuacan is structured by the main north–south axis, about 5,200 m long and 45 m wide, the Street of the Dead (Fig 4.6, reproduced larger in the bottom-right). The north limit of the axis is the Pyramid of the Moon and its *plaza* (square). This pyramid is truncated at the top to give space for a temple, and the ascending planes are broken to provide terraces. Two rows of buildings lead south, starting from the Moon square. In the east side of the Street of the Dead lies, from north to south, the Sun Pyramid (200 m square base, rising in four terraces to a height of over 60 m) and its *plaza*, the *Ciudadela* (Citadel), and the Pyramid of the Feathered Serpent (the Temple of Quetzalcoatl). On the west side of the axis lies, in the northern part, the Square of the Columns, and in the southern part, the Great Compound. At the south, a river offers a natural terminus to this composition.

The dominant housing in Teotihuacan was the apartment compound. In the archaeological site, there are over 2,000 apartment compounds, apparently built around 200 DC. Usually, these had one single door in their outer wall. The entrance lead to a central courtyard, which typically had a temple. Passages lead out from this to the single-storey apartments. These spacious apartments were usually structured by another small courtyard surrounded by rooms with porches. The walls were usually painted with bright colours. As in Mohenjo-daro, the quality of the houses might indicate that the level of social inequality was very low at Teotihuacan.

4.2.6 The Mayan Civilization

The Mayan civilization occupied the territories that are now Guatemala, Honduras, and southern Mexico (Yucatan) between about 1,500 BC and the Spanish Conquest in the 1520s. There is some consensus on dividing the history of this civilization into four periods: formative (1,500 BC–AD 150), proto-classic (AD 150–300), classic (the apogee of the civilization, between AD 300 and 900), and post-classic (from AD 900 to 1520). This means that contrary to the Aztecs, the Mayans were a 'dead culture' by the time of the Spanish invasion. Some of the main Mayan cities were Tikal (Guatemala)—to be amplified in the next paragraphs—Copan (Honduras), and Chichen Itza (Mexico).

Tikal, located in Guatemala's northern province of Petén, was probably the largest Mayan city. It was inhabited from the sixth century BC to the tenth century AD, and there is no consensus on its maximum population. The city could have had relationships with urban centres as far away as Teotihuacan and Calakmul in Mexico, Copan in Honduras, and Caracol in Belize. While abandoned Tikal did not attract the attention of Spanish conquers in the sixteenth century, it was only in the mid-nineteenth century that the site was 'rediscovered' and only in the mid-twentieth century that systematic archaeological explorations of the densely vegetated site began. The Tikal Project was developed for 13 years by the University of Pennsylvania, mostly under the coordination of William Coe (10 years). It brought to light about 4,000 built structures. The results of this notable project include a topographical map of an area of 16 km^2 (Fig. 4.7).

The central area of Tikal comprises several special buildings such as pyramidal temples (Temples I–V, 40 and 65 m height) and acropolis—see Fig. 4.7. In the centre of the urban set lies the Great *Plaza*, conformed by Temples I (Temple of the Great Jaguar) and II (Temple of the Masks, in the opposite side of the square), and the Central and North Acropolis, two ceremonial and residential complexes. Temples III (Temple of the Jaguar Priest) and IV, and the Plazas of the Lost World and the Seven Temples stand west of this set. Temple V is located south of the Great Plaza. Temple VI (Temple of the Inscriptions) is south-east of the centre.

Remains of dwellings, of different sizes and shapes (expressing also social differences, with a considerable range from rich to poor), are scattered throughout the central area and surrounding countryside. Most dwellings were grouped into small sets. These sets were structured, in a platform, around an open space conformed by a variable number of houses. Kitchens tended to be organized at the end of the house. The house had square or rectangular shapes, masonry walls, and plaster floors. These sets included some complementary structures such as burials and small temples.

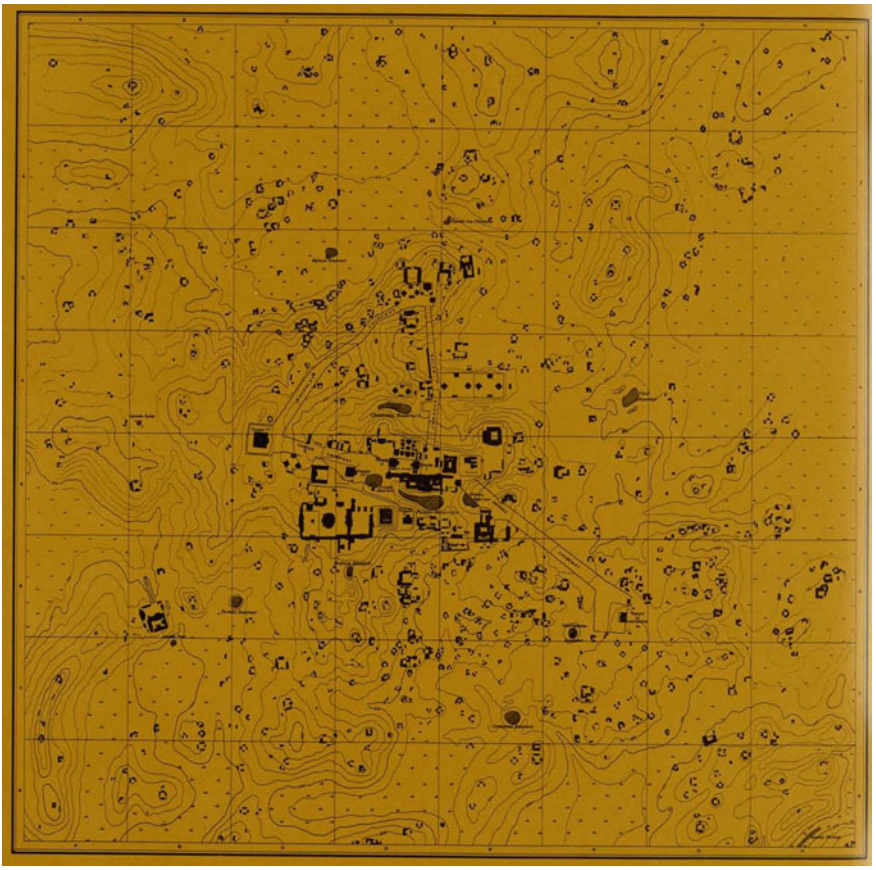

Fig. 4.7 The Mayan cities: Tikal. *Source* Haviland (1965)

4.2.7 The Inca Civilization

At its apogee, the Inca civilization occupied a linear territory of 4,000 km length, along South America's Pacific coastline, from present-day's Ecuador to Chile. This linear territory was made of some plain areas, but mainly of highlands in the Andes. There are many uncertainties about pre-Inca cultures in the first millennium AD. Inca cities include Cuzco, Chan Chan, and Machu Picchu. While the first was occupied by the Spanish, preserving part of the urban layout and erecting new buildings, the second (surrounded by an urban area) and third were abandoned and today are archaeological sites.

Machu Picchu was built in a later stage of the Inca civilization—erected in the fifteenth century and abandoned in the sixteenth century. Despite or because of that, it is perhaps its most notable legacy. Machu Picchu is located approximately at the centre of this empire, west of Cuzco. It stands 2,400 m above the sea level in the

middle of a tropical mountain forest. In 1911, an expedition led by Hiram Bingham, from Yale University, rediscovered Machu Picchu (Bingham 1948). In later years, he returned to Machu Picchu for further excavations.

Machu Picchu was not a large city as other pre-Columbian cities like Teotihuacan and Tikal. It was structured in a set of terraces, ramps, and stairs, and it was made of about 200 buildings. The city gate is located south. Entering the gate coming from the *Camino Inca* or from the *Carretera Hiram Bingham,* we access the first set of exceptional buildings including the Temple of the Sun, the Royal Tumbes, and the Royal Palace. Approximately in the centre of the settlement lies the main square (also called Sacred *Plaza*), an open space defined, at west, by exceptional buildings and structures (including the Temple of the Three Windows and the *Intihuatana*, or sun dial stone) and, at east, by a denser set of residential buildings. The northern part of the square is less defined but punctuated by the so-called sacred rock (in the direction of Huayna Picchu). An agricultural area mainly for crops of Indian corn and potatoes, in terraces, was developed south of this urban area.

As in Tikal, the residential area was divided into small groups of houses, belonging to different clans or families, with distinct architectural characteristics. These houses were one or two storeys, probably with steep roofs. One notable feature of all buildings is the use of stone without mortar or cement. One of the groups of houses is the so-called 'Three-Door Group', a large set of houses of rectangular plan and three entrances, located south of the central square (Fig. 4.8).

All seven civilizations analysed in this section emerged before the birth of Christ. In fact, the Sumerian, the Egyptian, and the Harappan have already disappeared by the *Anno Domini*. The emergence of these three and of the Chinese, the most resilient civilization, is deeply connected to the existence of, at least, one great river. Agricultural activity, in varied stages of development, was also fundamental to support

Fig. 4.8 The Inca cities: Machu Picchu. *Source* Hiram Bingham

these civilizations. The role of each of the cities presented in this section within the territory and civilization varied greatly, from ephemeral support to the construction of a temple, illustrated with Tell el-Amarna, to a strong city state, exemplified by Ur. In Ur, Tell el-Amarna, Mohenjo-daro, and Chang'an, streets had a fundamental role in structuring the physical form of cities. In the first case, these adopted an irregular layout, while in the other three, they formed a regular system. The irregularity or regularity of the plot system followed closely that of the street system. Despite some differences, in these cities, houses were organized around a courtyard. In pre-Colombian cities, another courtyard (or small square) was used to organize small groups of houses. Bearing in mind the goals of this book, the cases of Mohenjo-daro and Teotihuacan are particularly relevant. Not only do their elements of urban form hold strong similarities to those constituting many parts of today's cities but their social structure also seems to hold an unexpected balance.

4.3 The Greek Cities

The emergence of the Greek state-city occurred in the ninth century BC. The *polis*, the Greek state-city, was an urban–rural entity in which the city and its hinterland had a strong interdependence, in political, social, and economic terms. One important aspect of the *polis*, as the Chinese city, was that when the city reached a particular size, the process of urban growth would be constrained, and a new city would be founded. In a certain sense, the second city would be a colony of the first.

One of the key physical elements of the *polis* was the city wall, an element of irregular shape and variable dimension according to the city size (Fig. 4.9). Within the walls, in the highest part of the city, one would find another fundamental element of the *polis*, the acropolis, with a religious and defensive nature.

The Greek cities could have a regular or an irregular layout of streets. While Mileto and Priene illustrate the former, Athens is a remarkable example of the latter

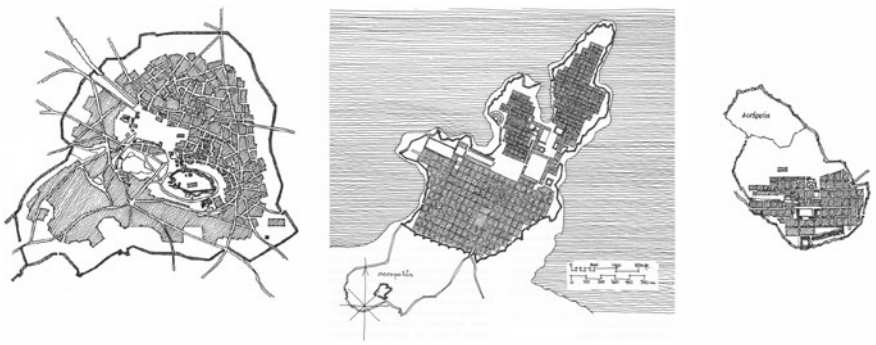

Fig. 4.9 The Greek cities: Athens, Mileto, and Priene, approximately at the same scale. *Source* Schoenauer (1981)

(Fig. 4.9). While both Athens and Mileto were destroyed by the Persians in the fifth century BC, they were an object of different processes of reconstruction: Athens followed the pre-existing pattern of streets, and Mileto designed a new layout. There were not many open spaces for permanence in the *polis*; the main exception was the *agora,* the place for gathering of the Greek citizens.

The street block was composed of residential plots—which could have similar, or different, sizes—offered by a particular process of land subdivision. Schoenauer (1981) describes in detail a particular street block in the city of Olynthus. This street block was composed of two rows of five houses each. The streets conforming to the block were different—narrower streets in the east–west direction and larger streets in the north–south direction. The street block was 91.5 m long and 36.5 m wide. An extremely narrow space—probably for drainage—separated the two rows of houses. Each of the houses had a squared shape of 18.2 m.

The singular buildings (cultural, civic, religious, and commercial uses) of Greek cities adopted strategic locations, independently of the street system, whether this was a regular or an irregular system. As such, these different buildings formed an 'organic' and asymmetrical composition, being related by a complex game of distances and empty spaces. This complex composition included several privileged paths, making use of relief, allowing the progressive discovery of singular buildings (Lamas 1993).

In clear contrast, the residential buildings followed closely the layout of streets. Despite some variations, Greek houses shared a set of fundamental characteristics. They were very simple with no ornamentation. As such, if seen from the street, a poor and a rich house would look very similar. On the contrary, the interior spaces would be very different. The houses, whether in a regular or an irregular street system, were structured by a central patio surrounded by a colonnade, the 'peristyle'. Houses could have one or two storeys; in the latter, the patio would continue to be surrounded by a colonnade on the upper floor.

4.4 The Roman Cities

The Roman cities had a strong sacred and symbolic sense. This was expressed both in the delimitation of the city perimeter and the definition of the two fundamental axes structuring the whole city, the *Decumanusmaximus* (east–west) and the *Cardusmaximus* (north–south). The crossing of these two streets, leading to different city gates, constituted the centre of the city. The *forum*, the privileged open space for permanence, was generally located in this intersection (Pompei, for instance, is an exception).

The percentage of Roman cities with a regular layout of streets—orthogonal or non-orthogonal—was higher than that of Greek cities. Regular layouts were more common in Roman colonies, like Timgad in modern Algeria, due to the specificity of land subdivision processes and the easiness of construction (Lamas 1993).

The Roman street block was mainly residential. It was divided into several plots—not so regular as streets—where the different residential buildings were erected. The

singular buildings seem to be more linked to this layout of street blocks than in the Greek case. The Roman cities included several equipment and public facilities (theatres, markets, and circuses), while the Roman territory was structured by many infrastructures, like bridges, aqueducts, and canals.

The Roman house, the *domus*, was influenced by the Greek peristyle-house and the Etruscan atrium-house (the Etruscans were the first civilization of the Italic peninsula). This one-storey house could have one to three open spaces. The larger houses would have two rectangular patios—the *atrium*, smaller, was the centre of the public area while the peristyle, larger, structured the private area of the house—and one small garden, usually in the back of the plot. Building coverage was very high. While the façade of the house, with a few doors and windows, and the relation between building and street was like the Greek house, the interior of the Roman house had a strong sense of ornamentation, being very different from the Greek house (Schoenhauer 1981). Another Roman building type was the *insulae*. This type was introduced due to the scarcity of space in cities like Rome and it could have six storeys.

Let us focus on one particular city, Pompeii (Fig. 4.10). Pompeii was founded in the sixth century BC, experiencing changes of overlord in the following centuries. In 89 BC, it was conquered by the Romans. In 79 AD, Pompeii was buried by the eruption of Vesuvius.

There is no consensus on the residents' number, but it could have had a maximum number of 25,000 people. Pompeii was roughly oval. It had about 1,300 m length and 650 m width, with an area of about 64.5 hectares enclosed by a double wall. There were eight gates into the city leading to well-paved main streets with sidewalks. One of these gates linked the city and the port. *Via di Mercurio*, in the northwest part of the city leading to the *forum* (located in the south-west part of the city and not in the crossing of the *Decumanusmaximus* and the *Cardusmaximus*), was the largest street—9.7 m wide and about 250 m long. Other main streets were about 8 m wide, while minor streets offering access to houses varied between 5.5 and 3.6 m wide. In Pompeii, the *Decumanusmaximus* was the *Via dell'Abbondanza*, linking two gates,

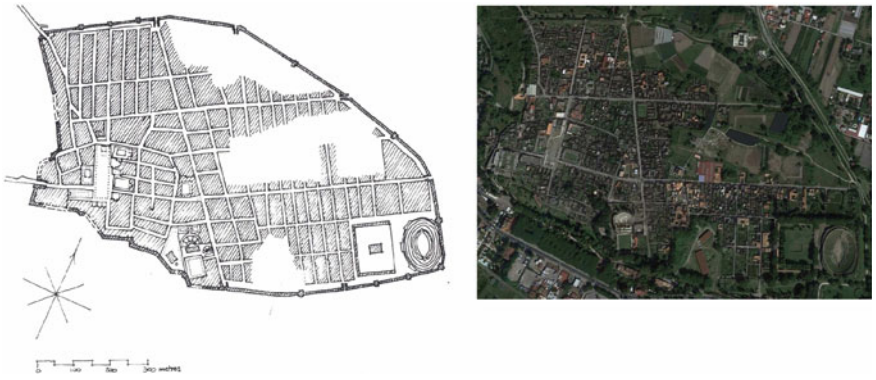

Fig. 4.10 The Roman city: Pompeii. *Source* drawing—Schoenauer (1981; aerial view—Google Earth)

Porta Marina and *Porta Sarno.* The *Cardusmaximus* was the *Via Stabiana,* linking *Porta Vesuvio* and *Porta Stabia.*

The street system, built in different time periods, defined street blocks of different sizes. The street blocks in the older part of the city, around the *forum,* were smaller and had irregular shapes. On the contrary, in the north-western part of the city, near *Porta Vesuvio* (in the so-called archaeological region 6), there are six street blocks of a regular elongated shape, about 140 m long and 35 m wide. At the south of these six blocks, another set of five rectangular blocks has the same width and shorter length (about 90 m). Two of these street blocks are occupied by two plots, and two buildings only, the House of Pansa and the House of Fauno. The House of Pansa had a set of 'shops' facing *Via delle Terme*. It had more than 50 rooms, and it was structured around the three open spaces of the Roman house, the *atrium*, the peristyle, and the garden. Similar to Sumerian and Greek houses, sometimes two or more houses were gathered to make a larger house.

Schoenauer (1981) presents a synthesis of the land use in Pompeii: 21 % of the land was occupied by public open spaces for circulation and permanence, 63 % by built-up area, and 16 % by private open space including *atria*, peristyles, and gardens.

To conclude, we can say that the Roman house shares with the former cases, in the so-called 'early cities' and Greece, two interrelated fundamental characteristics that cannot be found in subsequent cases in mediaeval Europe: the patio—offering favourable sun exposure and a particular microclimate—and a strong sense of privacy structuring the house in two different areas.

4.5 The Islamic Cities

Many Islamic cities are cultural descents of Sumerian cities of ancient Mesopotamia. Morris (1972) distinguishes between original—shared with these ancient cities—and later urban form determinants of Islamic cities. Original determinants include not only topography, climate, and construction materials (all three of a 'natural world' origin), but also the absence of orthogonal grids, of legislation in the sense of a formally codified civil law, of aggrandizement and considerations of civil aesthetics, and of social segregation. Later determinants comprise the urban guidelines contained in the *Qur'an* and the *Hadiths* (the sayings of the Prophet) that together form the basis of the *Shari'a*, the Islamic Holy Law which covers all aspects of the public and private, communal, and personal lives of the Muslims. Morris (1972) distinguishes three types of Islamic cities based on their origin: urban settlements of organic growth (exemplified by Erbil, ancient Arbela), cities of Graeco-Roman planned origins which were taken over by the Muslims as their empire expanded (for instance, Aleppo or Damascus), and third, new cities founded in conquered lands by the Muslim armies (for example, Baghdad or Tunis).

The defensive system of Islamic cities differed little from that of mediaeval European cities (pre-artillery), and included a relatively simple wall, strengthened by towers, with defensive additions at the gates. With few exceptions, the *Kasbah* (the

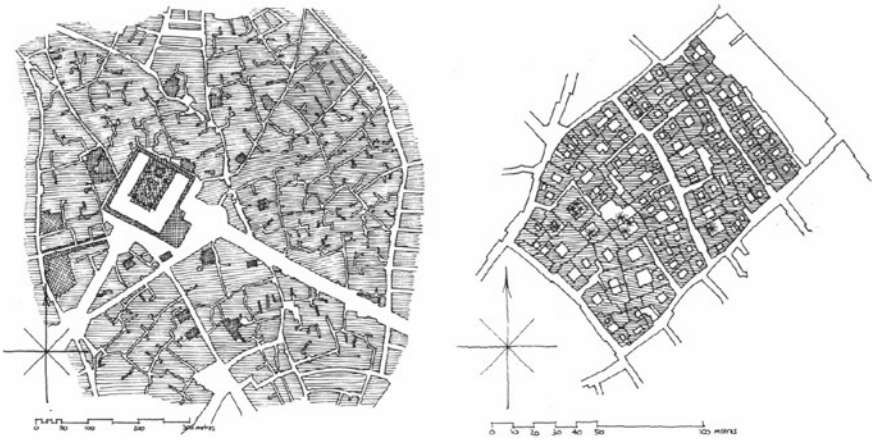

Fig. 4.11 The Islamic city: *Al-Kazimiyah* (near Baghdad), the medina, and part of the residential sector. *Source* Schoenauer (1981)

citadel of the ruling elite) was positioned against or astride the city wall, a characteristic seemingly inherited from ancient Mesopotamia, that was in direct contrast to Western European form where the citadel was at the centre.

All elements of urban form of the Islamic city were influenced by the *Shari'a.* The intricate street system, determined by the aggregation of residential buildings, was mainly composed of two types of streets: the thoroughfares, with a width of 7 cubits (ancient unit based on the forearm length), 3.23–3.50 m, allowing passage of two laden camels; and the *cul-de-sac*, with a width of about 4 cubits, 1.84–2.00 m, allowing passage for one laden camel. In this system of extremely narrow streets, the presence of a square, facing a mosque or including a market, would be an exceptional element (Fig. 4.11).

A key element was the *suq*, offering different goods and products. A location hierarchy, in relation to the Mosque, structured the *suq*. The individual shops composing the *suq* were small, ranging upwards from 1.5 m^2. These were arranged in different ways: as linear *suqs* on either side of a through street from a city gate to the Mosque; as area *suqs* where back-to-back rows face each other and where gates can be provided for overnight security; *suqs* where the shops were against the perimeter wall of special buildings (Morris 1972).

The fundamental building of the Islamic city was the Mosque. Its general arrangement consisted of a covered prayer hall along one side of a colonnaded courtyard. Sometimes, it had an open courtyard with one or more fountains for purification before prayer. It also included one or more minarets. There were a number of other building types related to the Mosque, including the *Hamman,* the public bath-houses used separately by men and women, and the *Madrasa*, a college for advanced study of Islamic law and sciences (Morris 1972).

Plots were very irregular both in terms of form and size. Except for a courtyard, building coverage was extremely high and each house would occupy the whole plot.

The house of the Islamic city was deeply rooted in the house of ancient Mesopotamia, promoting the privacy of the domestic domain. The house was structured by a courtyard, and it was divided into two parts, the *salamlik*, the public part, and the *haramlik*, reserved for the family. In larger houses, these parts were physically separated and structured around different courtyards, while in smaller houses they corresponded to different floors. The building façade was very simple, contrasting to the richness of the interior. The climatic comfort was one of the main concerns of the house, including a few measures to achieve that purpose. For instance, each room could change its function according to the time of the year (Schoenauer 1981).

4.6 The Mediaeval Cities

The fall of the Roman Empire—due to demographic decline, wars and plagues, and moral decadency—had a profound impact on Western Europe: the Roman urban heritage and its linkages to the former Oriental civilizations were lost, and the role and importance of cities changed dramatically as the Barbarians were mainly rural. Except for cases that were under the influence of the Eastern Roman Empire (like Constantinople, present-day Istanbul) and the Arabs (for instance, Cordoba or Palermo), cities were constantly destroyed by Barbarians. In some cities, the former settlements were significantly reduced and structured within singular constructions, like amphitheatres (Arles and Nimes) or palaces (*Spalato*, present-day Split) that were transformed into defensive elements.

In the tenth and eleventh centuries, the political stability and increase of commerce activity had a strong contribution to the resurgence of cities. According to Benevolo (1982), the population of Europe grew from about 22,000,000 in 950 to 55,000,000 in 1350. This process included diverse situations: (i) former Roman cities that were continuously occupied or that after being abandoned have been re-occupied; (ii) new settlements that emerged in the periphery of Roman cities (for instance, on the 'other' bank of the river); (iii) former Christian sanctuaries, located outside the Roman city, that have been developed into cities; (iv) rural villages that have grown; and, finally, (v) new cities, such as the French *bastides*, funded for commercial or military purposes, usually based on a rigorous geometrical plan (Lamas 1993).

The city walls reinforced their importance in the Middle Age, constituting a fundamental element of defence and separating the city from the countryside. In many cases, when the city achieved a maximum capacity, a new ring of walls was built outside the former offering new opportunities for growth.

The streets of a mediaeval city were very different from the streets of Roman, Greek, or of early cities that we have seen in this chapter. While the overall pattern can differ from, or resemble, the pattern of former cities, the relation between buildings and streets is very different. The mediaeval houses had a more direct relation with the street offering, in many cases, a commercial use on the ground floor. The building was in the front of the plot leaving its rear part empty. Buildings could have different heights and different façade design. The city square was also very different from

the *forum* or the *agora* having, in most cases, an irregular shape resulting from the gathering of different streets. The square was usually associated with the market which is the materialization of the idea of cities as places for commercial exchange.

The debate on the planned or spontaneous nature of the mediaeval city has attracted many researchers. For instance, while Sitte (1889) or Munford (1961) sustain the existence of planned proposals in the construction of cities in the Middle Ages, Morris (1972) argued for a more spontaneous nature.

Figure 4.12 presents two different mediaeval cities: Ragusa, present-day Dubrovnik in Croatia, and *Rothenburg ob der Tauber*, in Germany. Dubrovnik, situated on the Dalmatian coast, became an important Mediterranean Sea power from the thirteenth century onwards. It is structured by an east–west street, the *Placa ulica*, dividing the city into two different parts: a northern part with a more regular street layout, including narrow streets and stairs (due to the strong relief); and a southern part, at a lower level, with an older and more irregular street layout, and a higher building density. *Placa ulica* is 300 m long and has a variable width, from 11 to 18 m. It links the west gate and the port, in the east. It has a strong commercial use. The civic centre was near the port, and it was constituted by a few interconnected

Fig. 4.12 The mediaeval cities: Dubrovnik and *Rothenburg ob der Tauber*. *Source* drawings—Schoenauer (1981; aerial views—Google Earth)

squares gathering different monumental buildings. The Dubrovnik house was 6.8–9 m (30–35 *palmus*) width and 10–12.8 m (40–50 *palmus*) high. The buildings of the *Placa* had three storey: the ground floor was occupied by commerce and the access to the house (through perpendicular streets); the first floor contained the reception and living rooms; and the second floor included the dining room, kitchen, and bedrooms (Schoenauer 1981).

The city wall of *Rothenburg ob der Tauber* had five gates and more than 30 towers and bastions. The street system is very different from the Dubrovnik layout, constituting a radial system centred in the *Marktplatz*. The main streets of this system, linking the square market with different gates, were *Untere Shmiedgasse* (650 m long) in the south, *Hafengasse* (350 m long) and *Galgengasse* (400 m long) in the east, and *Klingengasse* (200 m long) in the north. The street blocks had irregular shapes and different sizes. Blocks around the market square, within the first city wall, were smaller and more irregular. Schoenauer (1981) analyses several buildings in the city and finds a particular building type with a patio. Yet, as he states, contrary to the Roman, Greek, and earlier examples, this house is mainly related with the street and the patio had merely a service function.

4.7 The Renaissance Cities

Although the term Renaissance is used in this section for the entire period, architectural history usually divides it into four different phases: Early Renaissance (fifteenth century); Late Renaissance (sixteenth century); Baroque (seventeenth century and early eighteenth century); and a more heterogeneous phase, including different styles such as Rococo and Neoclassical (in the mid- and late nineteenth century).

Morris (1972) identifies five different areas of Renaissance action on cities: fortification systems; regeneration of parts of cities through the creation of new squares and streets; restructuring of existing cities by the construction of new main-street systems which, extended as regional routes, frequently generated further growth; the addition of extensive new districts, normally for residential purposes; and the layout of a limited number of new towns (see Fig. 4.13 for Palma Nova and Neuf-Brisach).

The defensive strategy of Renaissance cities was based on a new type of fortification system, more complex, promoting larger distances between the city and the enemy lines (Fig. 4.13). This had a direct impact on the structure of the city. While the mediaeval wall could be substituted through successive concentric rings, the Renaissance fortification system was, due to its high cost and constructive complexity, more static. As such, it constituted an effective limit for the horizontal expansion of the city, leading to increasing building height and population density.

The street system of Renaissance cities included three fundamental elements. The first is the primary straight street. The construction of these streets was bounded by sound aesthetic concerns and they were an ‘architectural whole’. Perspective effects were emphasized by the location of terminal features, both architectural and sculptural, in the form of statues, fountains, and obelisks. The second is the regular

Fig. 4.13 The Renaissance cities: Palma Nova and Neuf-Brisach, approximately at the same scale. *Source* Google Earth

grid. Morris (1972) identifies three main uses for the regular grid: as the basis of residential districts added to existing urban areas; for the entire layout of a limited number of new towns; and, finally, in combination with a primary street system, for the layout of other new urban areas. The third element is the enclosed space. Based on their urban mobility functions, Morris groups Renaissance urban spaces under three broad headings: traffic space, forming part of the main urban route system and used by both pedestrians and horse-drawn vehicles; residential space, intended for local access traffic only and with a predominantly pedestrian recreational purpose; and, finally, pedestrian space, from which wheeled traffic was normally excluded.

The building façade becomes a crucial element in Renaissance cities, gaining an autonomous nature expressed by its careful design and organization. The Roman concern on the visual order of urban spaces (for instance, in the *forum* of Pompeii, through the use of a common arcade linking different buildings) is reintroduced, first in Sienna, in the regulation of the *Piazza del Campo*'s buildings after the conclusion of the city hall, and then in other Italian cities.

Figure 4.13 presents two new towns erected in the Renaissance, Palma Nova and Neuf-Brisach. Palma Nova was built in the turning from the sixteenth to the seventeenth century, as a fortified garrison outpost of Venice's defences. Its perimeter is a nine-sided polygon, and its central square is a regular hexagon (85 m side). These shapes are linked by a complex arrangement of radial streets. Six streets, 350 m long, lead out from the centre to an angle of the wall, or, alternatively, to the centre of one side of the polygon. Additionally, twelve radial streets start from the innermost ring of three concentric streets. A set of secondary squares are formed in the centres of house blocks. 45 street blocks, of different sizes and shapes, are defined. The main civic buildings are grouped around the central square.

The construction of Neuf-Brisach started one century after Palma Nova, as part of a few fortified buildings and sites along the eastern, northern, and western borders

of France. Despite the similar shape of the fortification, the street system of Neuf-Brisach is quite different from the one of the Italian city, adopting an orthogonal grid around a central square. The city layout is made of nine northwest–southeast streets and nine northeast–southwest streets. The central square, *Place d'Armes Général de Gaulle*, has the size of four street blocks. Another square, with the size of one street block, is located east of the main square. This system defines a set of 48 street blocks of similar size and almost squared shape (about 50 × 55 m).

4.8 The Nineteenth Century Cities

The nineteenth-century cities were different from their predecessors in terms of scale and the overall city form. The evolution of military strategy and the design of new types of weapons had significantly reduced the utility and effectiveness of city walls. As these become obsolete, the need for land due to the industrialization processes and the huge demographic growth was progressively fulfilled outside the wall. Later, the wall itself was destroyed being replaced by new elements of urban form (see the Vienna ring presented in Chap. 3). Without the definition of a perimeter, the built area expanded over the territory and suburbs have emerged. In suburbs, the traditional elements of urban form acquired new meanings and functions: the street was a simple path; the square was no longer a place for gathering and social interaction; the street block was progressively abandoned; and the single-family house, located within the plot, had no direct relation with the street—a wall or fence separated the public and private spaces (Lamas 1993).

Industrialization and the significant demographic growth caused severe problems: lack of housing, facilities, and infrastructures; deterioration of the built environment; lack of hygienic conditions and health problems; extreme poverty to name just a few. These problems would lead to a social reaction, mainly through the proposal of new communities based on a set of social and economic reforms. Due to the significant demographic growth in cities, there was an unbalance between housing supply and demand, leading to 'real estate speculation'. The processes of land subdivision and building construction started to be considered as instruments of investment.

In the late nineteenth century, London and New York were the largest cities in the world—the first with 4.2 million inhabitants, the later with 2.7 million inhabitants; yet, New York had a higher percentage of growth starting from about 100,000 inhabitants in 1812. In the first half of the nineteenth century, many of the rich residents of New York's Lower East Side began to move north, leaving their row houses. The arriving immigrants concentrated on that area, moving into the row houses that had been converted into multiple-apartment tenements (a similar process occurred by that time in many geographical contexts), or into new tenement housing built specifically for that purpose. A typical tenement would be erected on a 7.62 m (25 feet) wide and 30.48 m (100 feet) long plot—a plot defined according to the city regulations. The building would have six storeys. A stairway would lead to a hall serving four dwellings per floor. The three or four rooms within each dwelling would have an

in-depth organization (the 'railroad' tenement). Only one of the rooms would have daylight. Usually, each of these dwellings would accommodate more than one family. Another building type was the so-called 'dumbbell tenement' (the name came from its dumbbell shape). This building type was very similar to the former; yet, it was pinched in the middle, introducing long and narrow light shafts and the possibility of opening windows in more rooms.

Exercises

A. **Testing Your Knowledge**

4.1 What are the three 'dead cultures' out of which have evolved the Greek, Roman, and Western European civilizations?

i. Sumerian, Egyptian, and Carthaginian.
ii. Sumerian, Egyptian, and Harappan.
iii. Sumerian, Egyptian, and Persian.

4.2 What was the main similarity, in terms of urban form elements, between Mohenjo-daro and Teotihuacan?

i. The hierarchical (privileging some notable axes, like the Street of the Dead) and orthogonal street system.
ii. The high quality of singular religious buildings, notably their pyramids.
iii. The high quality of residential buildings, somehow expressing low levels of social inequality.

4.3 What are the main differences, in terms of singular buildings, between Greek and Roman cities?

i. While in Greek cities these buildings adopted strategic locations somehow independent from streets, in Roman cities they were linked to the street system.
ii. The higher percentage of cities with regular street systems, in Rome than in Greece, led to the construction of a higher number of singular buildings, promoting intelligibility of the urban layout.
iii. The higher percentage of cities with regular street systems, in Greece than in Rome, led to the construction of a higher number of singular buildings, promoting intelligibility of the urban layout.

4.4 Which of the following sentences offers a more accurate description of the elements of urban form in Islamic cities?

i. Irregular pattern of streets and plots, reduced number of singular building types (mosque, *salamlik*, *haramlik*), and one main residential type organized around a courtyard.

ii. Regular pattern of streets and plots, reduced number of singular building types (mosque, *salamlik*, *haramlik*), and one main residential type organized around a courtyard.
iii. Irregular patterns of streets and plots, reduced number of singular building types (mosque, *madrasa*, *hamman*), and one main residential type organized around a courtyard.

4.5 What is the main innovation of mediaeval cities, in terms of streets and buildings, in relation to former cities?

i. An irregular pattern of streets, the design of homogenous building façades, somehow recovering a Roman concern.
ii. A regular pattern of streets and the control of building height, somehow recovering a Roman concern.
iii. The street as a key element of urban form and a new residential type, closely related to the street and not to the courtyard.

Solutions

4.1 ii

4.2 iii

4.3 i
4.4 iii

4.5 iii

Interactive Exercises

Exercise 4.1—Our Common Heritage

This exercise aims at exploring the diversity of Humankind's built heritage—one of the main messages of the book. It benefits from the remarkable UNESCO website, particularly its section devoted to the World Heritage List (https://whc.unesco.org/en/list/) including open-access material. The website gathers more than 1100 sites in 165 countries. Based on the educator's presentation of the website, making evident the richness of the information gathered, 'Our common heritage' should be developed as a homework exercise.

The student should visit the website and, within the category 'cultural site', select one site. The site, located in any of the 165 countries, should correspond to one city or part of a city (including archaeological ruins) and not to one singular building or complex of buildings (monuments). The analysis of each site/city should address the historical (the most important time periods) and geographical framework of the city; the overall urban form (including city walls), streets (and squares), street blocks and plots, and singular (non-residential) and basic buildings (mainly residential buildings).

Each student should prepare a brief PowerPoint presentation to be presented in the classroom (5–10 minutes, 10 slides maximum). The student should use text and images (drawings and photographs), or any means that he thinks is adequate.

Exercise 4.2—Virtual Pompeii

This exercise aims at exploring the unique urban landscape of Pompeii, through the combined use of software for interactive visualization of maps and satellite images (Google Earth, Bing Maps, and Baidu Maps…), and the website 'Pompeii' (http://pompeiisites.org/en/)—open-access material. This should be developed as a homework exercise.

The student should start this virtual exploration of the city through its western entrance, the *Marina* Gate—see Fig. 4.14, down left corner. Exploration should continue through the *Decumanusmaximus—Via Marina/Via dell'Abbondanza,* until the *forum,* conformed by a set of singular buildings. The student should then head north into *Via della Fortuna.* At north-west, there is the archaeological region 6, where two of the most impressive houses of Pompeii are located, the House of Pansa and the House of Fauno. After visiting the two houses, the student should walk east into the *Cardusmaximus—Via Stabiana,* and then, move southeast returning to the *Decumanusmaximus.* From the intersection of the two main axes of the city, the student should move north-east into *Sarno* Gate. Before leaving the city, the student should visit the amphitheatre (about 125 m from the gate).

The morphological description of this visit should form a brief PowerPoint presentation (5–10 min, 10 slides maximum) to be presented in the classroom. The PowerPoint presentation can include text and images (drawings and photographs), or any other means.

Fig. 4.14 Virtual Pompeii. *Source* http://pompeiisites.org/

Exercise 4.3—Permanence and Change

This homework exercise aims at exploring permanence and change in the urban landscape, through a comparison of different time periods, using two different historical maps. The first step of the exercise is the definition of the case study area. The student should define a circle around his home; a radius of 500m is suggested (it can be adapted according to the specific characteristics of each area). The second step is the selection of two historical maps representing the study area. For that purpose, historical maps are usually available on the Internet. The search and collection of maps can involve different students. The selection of two different historical maps depends on the available data, but, if possible, it should address two periods with considerable morphological differences (for instance, prior to the nineteenth century and after 1800). The third step is the comparison of the two maps and the identification of permanence and change in the main elements of urban form—streets, street blocks, plots, and buildings.

Finally, results should be illustrated through selective zooms on the two maps and photographs of the study area. Each student should prepare a brief PowerPoint presentation (5–10 min, 10 slides maximum) to be presented in the classroom.

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Chapter 5
Contemporary Cities

Abstract The fifth chapter addresses our contemporary cities. It focuses on urbanization processes developed after the mid-twentieth century, exploring the growth of urban population and its distribution by cities of different sizes. The chapter then moves into a more detailed analysis of three 'megacities' and two 'medium cities'. For more than 1500, Istanbul (Constantinople) was the capital of the Roman, Byzantine, and Ottoman Empires. After the foundation of Turkey, in 1923, Ankara became the new capital, but Istanbul has never lost its central role. Today, it is inhabited by fifteen million people. In the twelfth century, Tokyo (Edo) was established as a small castle town. In the early seventeenth century, it was one of the largest cities in the world, becoming Japan's capital in 1868. Today, with almost 40 million inhabitants, Tokyo is the largest metropolitan area in the world. Founded in the early seventeenth century by the Dutch, New York has been continuously growing, in a process of urban evolution marked by the 1811 plan, culminating in today's metropolitan area that is the home of eighteen million people. With more than one million people and with a remarkable urban history and built heritage, expressed by UNESCO classification, Marrakesh and Porto are the focus of the last part of the chapter.

Keyword Megacities · Istanbul · Tokyo · New York · Marrakesh · Porto

5.1 Urbanization Processes (1950–2020)

Where does Humankind live in? Are we rural or urban? And what are the main transformations of the last decades? In which kind of cities do we live? Small or large? How small and how large? This section aims at answering these questions, mainly based on data offered by the United Nations and its Population Division of the Department of Economic and Social Affairs.

In the mid-twentieth century, two in three people on the planet were living and working in the countryside (Table 5.1). As such, the urban population in 1950 was 30% of the total population (2.5 billion people), being mostly concentrated in North America, Europe, and Asia (particularly Eastern and Southern Asia). Almost 2/3 of these urban dwellers lived in settlements with less than 300,000 inhabitants. In the

V. M. Araújo de Oliveira, *Urban Morphology*, The Urban Book Series,
https://doi.org/10.1007/978-3-030-92454-6_5

Table 5.1 Evolution of world population—rural and urban (%), 1950–2020

	Rural	Other urban < 300,000	Smallest cities 300,000–500,000	Small cities 500,000–1 M	Medium cities 1 M–5 M	Large cities 5 M–10 M	Megacities > 10 M
1950	*70.4*	17.7	2.0	2.6	5.1	1.3	0.9
1960	*66.3*	19.2	2.3	3.0	5.9	2.0	1.4
1970	*63.4*	19.7	2.4	3.5	6.5	2.9	1.5
1980	*60.7*	20.4	2.5	3.7	7.6	3.1	1.9
1990	*57.1*	21.7	3.0	3.8	8.6	3.0	2.9
2000	*53.4*	21.9	3.1	4.3	9.8	3.4	4.2
2010	*48.4*	23.1	3.4	4.9	10.7	4.1	5.3
2020	*43.8*	23.2	3.7	5.3	12.1	4.3	7.6

Source World Urbanization Prospects, The Economist

other 1/3 of the urban population, 'medium cities' (1 to 5 million) were predominant, being followed by 'small cities' (500,000 to 1 million) and 'smallest cities' (300,000 to 500,000), and then by 'large cities' (5 to 10 million) and 'megacities' (more than 10 million inhabitants). In the mid-twentieth century, there were only two megacities, New York and Tokyo, with 12 and 11 million inhabitants, respectively (Table 5.2).

Over the 1950s, the rural population continued to decrease to 66% at the end of the decade. In the urban population, the main increase took place in large cities and megacities. In 1960, the world had three megacities. The new megacity was Osaka, a former capital of the Japanese Empire in the seventh and eighth centuries (formerly called Naniwa), that at the end of the seventeenth century had a population of 350,000 inhabitants and a privileged commercial relationship with Tokyo. In 1960, Osaka was the home of 11 million people.

Table 5.2 Evolution of population in megacities established in the twentieth century (in millions), 1950–2020

	New York	Tokyo	Osaka	Mexico City	São Paulo	Mumbai	Kolkota	Los Angeles	Buenos Aires
1950	12.3	11.3	–	–	–	–	–	–	–
1960	14.2	16.7	10.6	–	–	–	–	–	–
1970	16.2	23.3	15.3	–	–	–	–	–	–
1980	15.6	28.5	17.0	13.0	12.0	–	–	–	–
1990	16.1	32.5	18.4	15.6	14.8	12.4	10.9	10.9	10.5
2000	17.8	34.5	18.7	18.5	17.0	16.4	13.1	11.8	12.4
2010	18.4	36.8	19.5	20.1	19.7	19.4	14.3	12.2	14.2
2020	18.8	38.3	20.5	21.9	22.1	22.8	15.7	12.5	15.9

Source World Urbanization Prospects, The Economist

The increase of urban population and the reduction of rural population continued throughout the 1960s. Within the 'urban', large cities had the highest growth rate. By the end of the 1960s, there were 15 large cities in the world, mostly located in North and South America, Europe, and Eastern and Southern Asia. There was one large city in Africa, Cairo. While the three megacities continued to grow, the Japanese capital held the highest rate. In 1970, Tokyo had 23 million inhabitants, meaning that in two decades it has doubled its population.

While the main dynamics of the former decades continued over the 1970s, the most expressive change took place in megacities, with the substantial growth of Tokyo and the emergence of two megacities in the Global South, Mexico City and São Paulo. Mexico City was founded as an Aztec city, called Tenochtitlan, in the fourteenth century and then destroyed and rebuilt by the Spanish as a capital city, in the sixteenth century. While it had 3.4 million people in 1950, three decades later, it had 13 million inhabitants. After having a minor role in three historical periods (early indigenous, Portuguese colonial, and imperial), it was in the republic, in the late nineteenth century, that São Paulo acquired a key position in the Brazilian urban system. São Paulo had a similar growth to Mexico City, from 2.3 to 12.1 million people in three decades, being a megacity in 1980 (Fig. 5.1).

The growth of megacities continued over the 1980s. In ten years, its number doubled from 5 to 10. In 1990, the new megacities were Mumbai and Kolkata in Southern Asia; Seoul in Eastern Asia (the South Korean capital would have a population decrease in the following decade); and Los Angeles and Buenos Aires in North and South America. As such, the 10 megacities were all located in America and Asia. The two Indian megacities, Mumbai and Kolkota, introduced, in a more explicit way, a new theme in the urban agenda, the poor conditions of living of a significant part of the urban population in the late twentieth century (as discussed in Chap. 3). On the other hand, Los Angeles is a notable example of the discussion between compact and sprawl.

In the 1990s, as in the previous decade, the change in megacities has been the most expressive within the percentage of the world population living in cities. In 2000, there were seven new megacities; for the first time, one was in Africa—Cairo, and one in Europe—Moscow (Fig. 5.2). The other five were Delhi, Dhaka, and Karachi in Southern Asia; Shangai (the first Chinese megacity) in Eastern Asia; and Rio de Janeiro in South America. In the turning from the twentieth to the twenty-first century, Tokyo, the largest megacity, had 35 million people.

In the following decade, there was a radical change. For the first time in Humankind history, more than half of the world population was living in cities. More specifically, in 2010, the world population was 6.9 billion and the urban population was 3.5 billion people. In 2010, more than 10% of the world population was living in medium cities, and 5% was living in 23 megacities. The seven new megacities were Beijing, Chongqing, and Shenzhen (all Chinese) in Eastern Asia; Manila in South-Eastern Asia; Istanbul in its singular location between Asia and Europe; Paris in Europe; and Lagos in Africa.

In 2020, settlements with less than 300,000 inhabitants represent 23% of the world population, medium cities represent 12%, and the 36 megacities (more than half is in

Fig. 5.1 São Paulo, *Praça da República. Source* photograph by the author

Asia) represent 8% of the world population. In 2020, seven megacities are above 20 million residents: Tokyo (38 million), Delhi (29), Shanghai (27), Beijing (24), São Paulo (22), Mexico City (22), and Osaka (20 million). Looking back, it is important to highlight that Tokyo has been the largest megacity since 1960. Finally, in this 70-years period, the highest growth rates have been in Tokyo, between 1950 and 1970, and in Dhaka, Karachi, Shanghai, and Delhi, between 2000 and 2020—all illustrating the rapid growth of population in Asia.

In 2020, the world population is 7.8 billion (3.4 rural and 4.4 urban), and it is estimated that, in 2050, it will be 9.8 billion (3.1 rural and 6.7 urban). While in North America, South America, Europe, and Oceania, most of the population lives in cities (all above 65%), in Asia there is a balance between urban and rural, and in Africa, most of the population is rural (around 40% of African people lives in cities). Looking at Africa, two of the four countries with megacities are mostly rural (Egypt and the Democratic Republic of the Congo), one is mostly urban (South

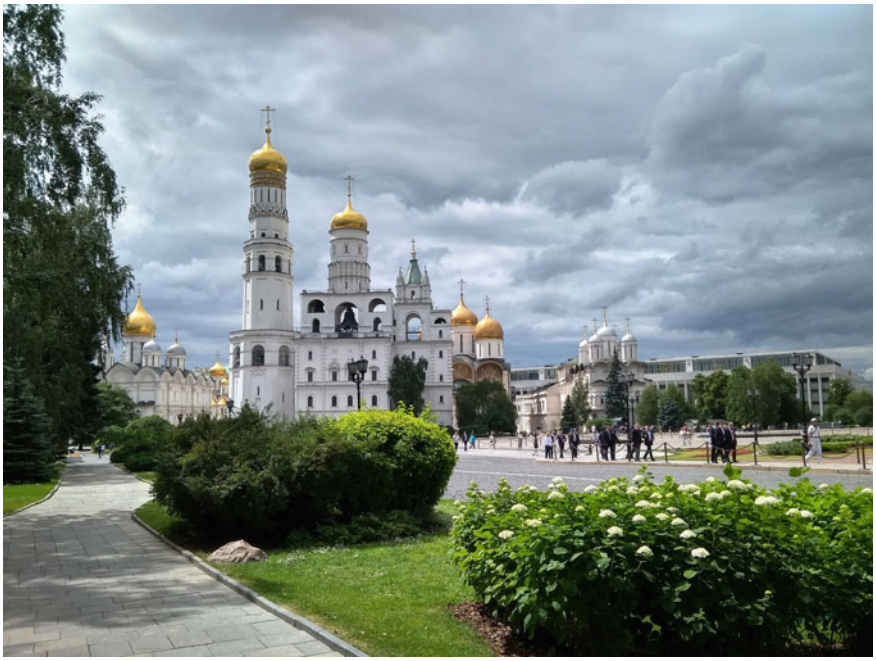

Fig. 5.2 Moscow, Kremlin. *Source* photograph by the author

Africa), and there is a rural/urban balance in one country (Nigeria). In Asia, four of the eight countries with megacities are mostly rural (India, Pakistan, Bangladesh, and the Philippines), three are mostly urban (China, Japan, and Indonesia), and there is a rural/urban balance in one (Thailand).

A look at the recent evolution of each country reveals common aspects, but also some singular features. Let us focus on three of these eight Asian countries, China, India, and Japan. In the mid-twentieth century, most of the Chinese and Indian population was rural (near 90% and 80%, respectively); while more than half of the Japanese population was urban. Nowadays, more than 90% of the Japanese population and 60% of the Chinese population are urban, while in India, only 35% of the population is urban. In 2050, it is expected that in the three countries, the most population will be urban.

The comparison of each of these three countries with its sub-continent and with Asia as a whole reveal other important aspects. In the mid-twentieth century, the urban population in China was lower than Eastern Asia and Asia averages; in India, it was close to the Southern Asia and Asia averages; and in Japan, it was considerably higher than the Eastern Asia and Asia averages. Nowadays, the urban population in China is higher than the Asian average but lower than the Eastern Asia average; in India, it is lower than the sub-continent and the continent averages; and in Japan, it is higher than the two averages. According to the United Nations' estimate, this tendency will continue in the next three decades.

Finally, a look at the urban population by size class of urban settlement reveals some additional aspects. In 1990, in China and India, most urban population was living in cities with less than 300,000 inhabitants; China did not have megacities and India had two. In China, in the last decades, the urban population has been growing, including now 105 medium cities and 6 megacities. In India, it includes 52 medium cities and 6 megacities. In Japan, in 1990 and in the present, most of the urban population is in two megacities, Tokyo and Osaka.

5.2 Megacities

5.2.1 Istanbul

This section addresses a city with a unique urban history—Istanbul, formerly named Byzantion and Constantinople. We start with a brief reflection on the natural site and the city of Byzantion, moving then to the urban history of Constantinople as Roman and Byzantine capital, and finally to Istanbul as Ottoman capital and major republican city after the foundation of Turkey. The last part focuses on Istanbul in the twenty-first century, addressing its different districts. This subsection draws on the notable book 'Istanbul, an urban history' by Doğan Kuban.

The natural site where Byzantion was established is unique. It lies between Asia and Europe (east and west), between the Marmora and the Black Sea (south and north), and in the convergence of two rivers, the Golden Horn (narrower) and the Bosphorus (larger)—Fig. 5.3. The settlement was established in the promontory on the tip of the peninsula, at the end of the Eastern Balkans, 50 m above the water level. This location offered many advantages, including a large harbour, sheltered from the south wind. One of the rivers, the Golden Horn, is about 300 m large. In its north bank, there was another early settlement, Sycae (present-day Galata, in Beyoğlu), facing Byzantion in the south. On the east side of the second river, the Bosphorus (30 km long, separating Europe from Asia), two other early settlements were formed, Chrysopolis (Üsküdar) and Chalcedon (Kadiköy). Finally, some settlements were established in a group of islands 20 km southeast of Byzantion (in present-day Adalar). All this area combines the Mediterranean, humid subtropical, and oceanic climate (according to Köppen climatic classification).

Byzantion was founded in 659 BC by the Megarans, a Greek group. With the expansion of the Romans in the second century BC, the city progressively lost its autonomy, and in 73 AD, it was finally incorporated by Rome. In 196 AD, Byzantion was destroyed by Septimus Severus, after the alliance of the city with one of his rivals. There are no relevant archaeological remains from the city before its destruction. As such, discussion about its size and shape is mainly based on the interpretation of ancient texts. For most scholars, the acropolis of the city should correspond to the Topkapi Palace (built in the Ottoman Empire). Due to its geopolitical importance,

Fig. 5.3 Istanbul site. *Source* Google Earth

Byzantion was later rebuilt and named Antoninia, by Severus. In the period of reconstruction, the walls of the city were rebuilt and extended (starting at present-day Eminönü Square and going south), and a key east–west street was built linking the agora and the main gate (at Çemberlitas).

After the first division into four parts, in the fourth century, the Roman Empire was divided into Western and Eastern, with capitals in Rome and Constantinople. As remarkable as the natural site of Byzantion, so was Constantine's decision of making it the capital of an empire centred in the Eastern Mediterranean (almost simultaneous to another major change in the empire—the recognition of Christianity). The transformation of the city started in 324, and it continued throughout the reign of Constantine's son. In terms of size, it significantly expanded Severus limits—the new city walls started now at Cibali, west of Ataturk bridge. Again, the Constantinian city was lost in the early Middle Ages, and most of what we know is based on later

literary descriptions. It was a 'Roman city', sharing common aspects with Rome or Timgad (Kuban 1996).

Constantinople was the capital of the Roman and Byzantine empires for one millennium. Part of this longevity was due to the Theodosian walls, the largest defensive system of Late Antiquity. Built in the first half of the fifth century, the walls were 19 km long and enclosed an area of about 1,400 hectares. Their layout was determined by topography and defensive requirements, and not by an increase in city population. In fact, the area between the Constantian and Theodosian walls was never fully developed, and the latter have remained the western limit of the city until the twentieth century (Kuban 1996).

The most prosperous period of Constantinople as East Roman capital was between its foundation and the end of Justinian reign in the mid-sixth century. After the so-called Nika revolt and destruction of many buildings in Constantinople, Justinian carried out a remarkable process of reconstruction of the city and the erection of notable monuments, like the basilica of St. Sophia (Fig. 5.4b). At the time, within walls, the urban space was mainly structured by one major east–west street, the Mese (present-day Divan Yolu). There is no relevant information about a secondary pattern of streets. Outside the walls, the three main settlements continued to flourish. Sycae was already part of the city (since Constantine I); it was physically linked with it through a stone bridge, and it was limited by a city wall erected by Justinian. The Bosphorus and a set of harbours provided relation with Chrysopolis and Chalcedon. In addition, a suburban landscape made of noble villas along the Bosphorus started to be created.

After the reign of Justinian, the city faced constant threats: external pressures from Islam, the neighbouring Balkan states, and the Catholics of the Western Mediterranean (eventually leading to the Crusaders occupation in the thirteenth century); internal religious struggles (like the iconoclasm); and a set of natural events (plagues, earthquakes, and fires). And yet, even in this period in history, the city had moments of glory, as in the case of the Macedonian and Comnenian dynasties. In the early eleventh century, the city had a population of 600,000 inhabitants. The urban landscape of Constantinople combined high-density residential areas and low-density religious areas (monasteries) with an expressive presence of green areas (see Fig. 5.5 for a representation of the city, some years before its fall).

In 1453, after a battle between the Theodosian defence system and modern artillery, Constantinople was captured by the Ottoman Empire. There is a strong symbolism in the fall of Constantinople for both civilizations. While some aspects of the Byzantine city would continue throughout the new period, in part due to the tolerance of Sultan Mehmed II, there would be some major changes in the following decades. The reconstruction of the new capital of the Ottoman Empire (succeeding Bursa and Erdine) and the attraction of a new population started shortly after the conquest. One of the most important transformations was the development outside the city walls, enabled by the strength and security offered by the Ottoman Empire. The new urban life was organized around the family and the mosque. The realm of the family was the *mahalles* (quarters). The physical form of the city was an organic accumulation of *mahalles,* in which houses were more important than streets. On

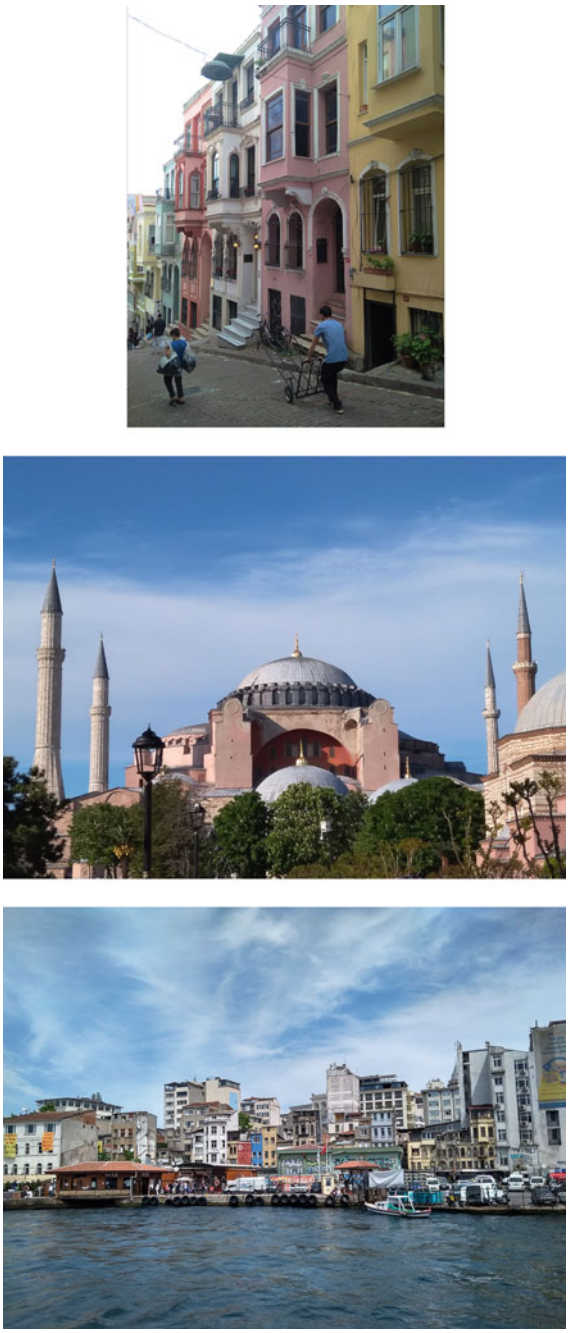

Fig. 5.4 Fatih (Sehsuvar Bey and St. Sophia) and Beyoğlu (Arap Cami). *Source* photographs by the author

Fig. 5.5 Representation of Constantinople by Cristoforo Buondelmonti, 1420. *Source* Public domain

the other hand, the mosque was not only a building, but a whole complex made of different constructions with distinct functions—the *kulliye.* In between the family and the mosque, there was the *bazaar* and the market, the *çarşi.* And above all these parts, there was the palace, the *saray.* The first palace was built in present-day Istanbul University, and a second one, the Topkapi Palace, in the acropolis of old Byzantion. One century after the conquest, the reign of Süleyman the Magnificent (1520–1566) represents the apogee of the Ottoman Empire. One of the most important contributors to the greatness of this period is Sinan, the chief architect of Süleyman. Probably their most impressive achievement is the Süleymaniye, a notable representation of the idea of the *külliye* as a socio-religious complex, and a key element of urban form,

clearly distinguishable from ordinary buildings and streets, due to the regularity of its composition (Kuban 1996).

The process of modernization and westernization of Istanbul started in the eighteenth century, with the 'tulip period', leading to a more extrovert lifestyle, and being strengthened in the mid-nineteenth century with the *tanzimat*, a period of structural reforms of the Ottoman society. In terms of city representation, this would include the preparation of the first map based on modern mapping techniques by François Kauffer (Fig. 5.6) and the drawings by Antoine Ignace Melling portraiting an urban landscape that would soon disappear. The modernization process started changing the perception of the city limits, with the increasing importance of districts and quarters outside the walled city and the acknowledgement of the Bosphorus as an integral part of a wider Istanbul (one of the key characteristics of today's urban landscape). It also initiated the transformation of the urban fabrics, in which public and private secular architecture would replace the religious constructions. But the fundamental changes would take place in the nineteenth century: in the street patterns, leading towards higher regularity, in clear confront with the traditional patterns created by the sum of buildings; in the scale of the building fabric, with increasing building footprints; and in development control of residential areas, aiming at regulating the construction of the many wooden single-family buildings that were the basis of the traditional urban landscape of Istanbul.

The First World War, the occupation of the city by western allies, the war of independence, the end of the Ottoman state in 1923, and the transfer of the capital to Ankara were a sequence of events that profoundly changed Istanbul. It was in this context that, in the 1930s, the first systematic attempts of planning started. While implementation of planning proposals was delayed due to the lack of resources

Fig. 5.6 Map of Istanbul by François Kauffer, 1776. *Source* Public domain

Table 5.3 Evolution of population in Istanbul, 1950–2020

Year	Metropolitan area population
1950	967,000
1960	1,453,000
1970	2,772,000
1980	4,397,000
1990	6,552,000
2000	8,744,000
2010	12,585,000
2020	15,190,000

Source World Urbanization Prospects

(needed for the construction of the new capital), after their beginning, the rhythm and depth of transformation of the city would continue to increase over the twentieth century. This includes the complete transformation of Istanbul urban forms: the destruction of parts of the city wall; the construction of a new street pattern planned for cars (see the examples of the Askaray and Beyazit squares); the loss of Ottoman residential architecture, within the historical centre and along the Bosphorus; and the establishment of the *gecekondu* (squatter settlements) due to the high rates of population growth, particularly after the mid-twentieth century.

According to the first official census, there were 690,000 people living in Istanbul in 1927 (against 1.2 million during the First World War). Over the last century, the population has been always growing, with the highest rates in the 1960s (population has almost doubled from 1960 to 1970—see Table 5.3). Over this period, the city started to be more homogeneous, with the steady increase of migrants from different regions in Turkey, of Muslims, and of Turkish speakers. In 2010, Istanbul had near 13 million people, becoming a megacity, and ten years after, it has 15 million people—almost 1/5 of the Turkish population (the country includes another city with more than 5 million people, the capital Ankara). In 2020, Istanbul has a perfect balance between females and males. It has a strong presence of young people, expressed by the following composition by age: 21.7% youth, 71.4% working age, and 6.9% elderly.

Istanbul is made of 39 districts—25 in Europe and 14 in Asia—and 782 neighbourhoods (Fig. 5.7). There are profound differences between the districts. The population varies from less than 20,000 to about 1 million inhabitants in Adalar and Esenyurt, respectively. Population density goes from less than 100 (Çatalca and Şile) to more than 40,000 inhabitants per km^2 (Gaziosmanpaşa), and the average value is 2,900 inhabitants per km^2. In terms of area, the size of districts varies from less than 10 km^2 (Bayrampaşa, Beyoğlu, and Güngören) to more than 1,000 km^2 (Çatalca). While almost 10 million people live in the European part and more than 5 million in the Asian part, population density is similar in both parts due to the larger size of the European part.

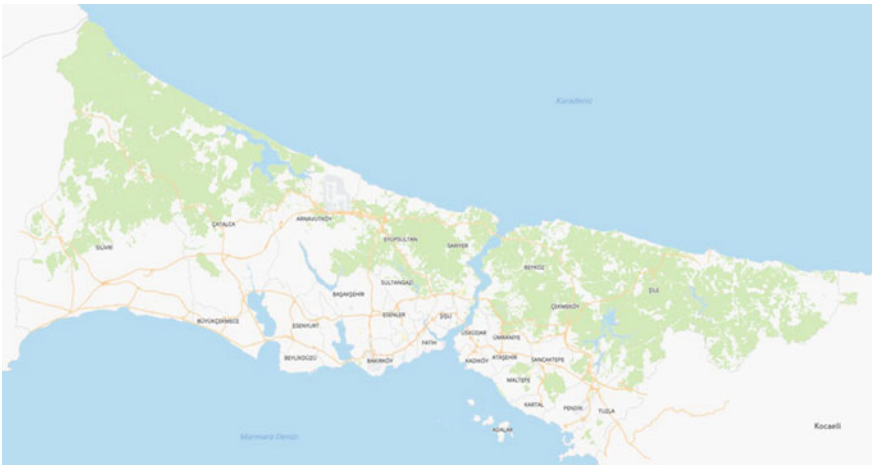

Fig. 5.7 Istanbul districts. *Source* Istanbul Büyüksehir Belediyesi

The next paragraphs focus on the five districts with the longest urban history: Fatih, Beyoğlu, Üsküdar, Kadıköy, and Adalar. Fatih corresponds to the imperial capital limited by the Theodosian walls, only partially intact. Despite the huge loss of built heritage in a unique city in Humankind history (particularly of Roman and Byzantine periods), Fatih has still a remarkable urban landscape. The district is the home of almost 450,000 people, distributed by about 60 neighbourhoods. Both the level of education and the socioeconomic status are lower in Fatih and Beyoğlu (near the city average) than in Üsküdar, Kadıköy, and Adalar. The size of the family is larger in Fatih, Beyoğlu, and Üsküdar than in Kadıköy and Adalar. While the western neighbourhoods of Fatih have the higher population numbers, the eastern ones (located within the Constantinian limits) have the lower population values. One of these eastern neighbourhoods is Sehsuvar Bey. The neighbourhood has a strong relief, ranging from the sea level at south to 40 m at north (Fig. 5.4a). The northern part of the neighbourhood is made of a regular pattern of streets and street blocks, composed of many plots, and with the high coincidence of plot and building frontages. On the contrary, the southern part is made of irregular streets and street blocks, with less plots per street block and a lower coincidence between plot and building frontages.

The second district, Beyoğlu, includes historical Sycae (Galata) and a larger area located northwest. It has about 230,000 inhabitants and a similar population density to Fatih. Smaller than Fatih, Beyoğlu is made of 45 neighbourhoods. The northwest neighbourhoods are more populated than the older southeast ones. One of the less populated neighbourhoods is Arap Cami, set between Ataturk and Galata bridges (Fig. 5.4c). The character of Arap Cami, as of Istanbul itself, is strongly determined by the presence of water. Topography varies from 0 to 20 m. The neighbourhood is made of a varied pattern of streets and street blocks, where most of the small street blocks are made of many plots and a continuous building frontage.

Fig. 5.8 Üsküdar, Kadıköy, and Adalar. *Source* Bing Maps

Fig. 5.9 Üsküdar, Kadıköy, and Adalar. *Source* photographs by the author

There are about 530,000 people living in Üsküdar (former Chrysopolis). Its area is two times higher than Fatih and four times higher than Beyoğlu. The district is made of more than 30 neighbourhoods. Although there is not a clear division as in the former districts, the neighbourhoods along the Bosphorus tend to be less populated. Figure 5.8a shows some of these neighbourhoods bordered by the Bosphorus. As in Arap Cami, the relation with water and the intense river traffic are fundamental characteristics of this urban landscape. Topography has great variations, between 0 and 60 m. While the patterns of streets and street blocks are more irregular than the two other cases, the most relevant difference is the lower number of plots per street block and the lower continuity of building frontages. While the building fabric is not as impressive as in Fatih and Beyoğlu, the vibrancy of urban life is quite similar.

About 480,000 people live in Kadıköy (former Chalcedon). Population density is lower than Fatih and Beyoğlu and higher than Üsküdar. The district is made of about 20 neighbourhoods. Figure 5.8b shows the Caferağa and Osmanağa neighbourhoods (complemented by Fig. 5.9b capturing a scene of the street life). The relation with the Bosphorus is a key characteristic. Relief varies between 0 and 30 m in the centre of this small 'peninsula'. A comparison with the Üsküdar neighbourhoods, included in Fig. 5.8a, reveals a more regular pattern of streets and street blocks, a higher density of plots, and a higher coincidence between plot and building frontages.

Adalar is an archipelago in the Sea of Marmora, also named the Princes' Islands. The archipelago is made of four larger islands, corresponding to five neighbourhoods, that are the home of 15,000 people. Figure 5.8c shows the Büyükada island, inhabited by almost 8,000 people. The urban landscape is made of an irregular pattern of streets and street blocks, the non-coincidence between plot and building frontages, and the strong presence of green areas. Most residential buildings, with a strong presence of wood, have a high architectural quality (Fig. 5.9c).

5.2.2 Tokyo

This subsection focuses on the world's largest megacity, Tokyo (formerly known as Edo). After a brief introduction to the natural site and the urban history of Japan, we move to the history of Edo between the twelfth and nineteenth centuries (with a particular focus on the second part of this period, the Tokugawa Shogunate), the urban growth of Tokyo in the last 150 years, and the development of its different wards in the last decades. This last part draws mainly on a notable morphological analysis of the Japanese capital carried out by Shigeru Satoh in 2003.

Japan is an archipelago in the Pacific Ocean made of almost 7,000 islands. It has no land borders with other countries. Japan's neighbours on the eastern edge of the Asian continent include the Republic of Korea, China, and Russia. The country is in a volcanic zone on the Pacific ring of fire exposing it to earthquakes, tsunami, and volcanoes. Tokyo is in the Kanto region in the eastern part of Honshu, one of the five main islands of Japan (the others being Hokkaido, Kyushu, Shikoku, and Okinawa). The settlement site is a remarkable interplay between water and land, the

Tokyo Bay, which is linked to the Pacific through the Uraga Channel (Fig. 5.10). Numerous rivers, notably the Arakawa, flow into Tokyo Bay. Throughout the years, land reclamation along the coast of Tokyo Bay has been constant. Tokyo has a humid subtropical climate.

The unification of Japan took place in the third century. In this period in history, the country did not have a strong urban culture. Each emperor would build his new imperial residence, moving it from place to place, as in the Egyptian civilization (presented in the last chapter). The idea of an imperial capital, the *miyako*, was imported from China in the mid-seventh century. The urban layout of Chang'an was the model for the spatial organization of Japanese capitals. Since 645 and over one and a half century, 14 capitals have been erected, from Naniwa (Osaka) to Heian (Kyoto). Contrary to these 150 years of constant change, the last one, Kyoto, was the capital of Japan for more than one millennium, until 1868, although in some periods it had only a symbolical nature due to the military power of the shogunates

Fig. 5.10 Tokyo site. *Source* Google Earth

(*bakufu*) after the twelfth century. In the late mediaeval period, Kyoto should have about 500,000 inhabitants (Masuda 1970).

Edo (originally named Edojuku) was established as a small castle town in the twelfth century, in the place of present-day Imperial Palace (Fig. 5.11). Farming and fishing were two central activities in this early settlement. The first castle was built by the governor of the Musashi province in the plain of the Kanto region. In this historical period, despite the unified state, each region was the stage for complex political and military tensions between different feudal lords, the *daimyo*. Despite its prosperity, the Edo castle did not have a significant size or role in Kanto. In the mid-fifteenth century (by the time of the fall of Constantinople, described in the last subsection), the castle was rebuilt and expanded by Ōta Dōkan. The new castle had a 5.5 km line of moats, three lines of defence, and 25 gates. Around the castle, there were several shrines and temples. Overall, the streets of Edo were parallel to the larger roads intersecting the town. As Edo did not achieve total dominance of the Kanto plain, it was exposed to the tensions of the region, and between the late fifteenth and late sixteenth centuries, the city experienced a certain decline (Morris, 1972; Yazaki 1968).

After the war in the late sixteenth century, Ieyasu Tokugawa was appointed as shogun, becoming the effective ruler of Japan in 1603. Edo, his selected residence, was now at the centre of the country life. This was the beginning of the Tokugawa Shogunate, which would rule Japan for two and a half centuries. Edo was gradually

Fig. 5.11 Chiyoda, Imperial Palace. *Source* photograph by the author

transformed, and in the mid-seventeenth century, it had the largest castle in the history of Japan, and it was probably the largest city in the world with more than one million people. One of the fundamental reasons for the substantial populational increase was the requirement for the feudal lords to be residents in Tokyo, at least in alternate years. The presence of feudal lords involved the presence of many people, including warriors. While the number of townsmen should be slightly higher than warriors, each of these should be above 500,000 people.

More than 2/3 of the city area was for the military class, while the other 1/3 was equally divided for townsmen and for temples/shrines. Different commercial and industrial activities were established in different specialized streets. By then, Edo was made of the following wards (*ku*) in present-day Tokyo: Chiyoda, Chuō, Shinjuku, Sumida (these four will be analysed in detail at the end of this subsection), Minato, Bunkyō, Taitō, Kōto, Shibuya, Toshima, Arakawa, and parts of Shinagawa, Kita, and Itabashi. In these areas, the districts of Nihonbashi, Kyobashi, Kanda, and Asakusa were the most important. The traditional house for the townsmen was a one- or two-storey building, erected in the plot frontage, made of mud-plastered walls and gabled roof and where the ground floor generally had an open front used for shop space. Another residential building was the *nagaya*, located on vacant plots in back streets, accommodating several families (tenants). As in the case of Istanbul in the Ottoman Empire, Edo in the Tokugawa Shogunate was subject to great disasters that destroyed a significant part of its urban form elements. One of these was the great fire of 1657 that caused the death of 50,000 people and affected streets in a total length of more than 80 km (in the reconstruction process, parts of these streets have been widened) (Yasaki 1968).

The policy of international isolation promoted by the Tokugawa Shogunate, the pressure of foreign countries towards open trade in Eastern Asia, internal social and economic problems, and a civil war between supporters of the shogunate and of the empire, led to the Meiji restoration of imperial rule in 1868. In that year, Edo was proclaimed imperial capital and renamed as Tokyo. In the following years, Tokyo was progressively transformed from a feudal city into the capital of an emerging modern state, including fundamental changes in institutions and administration (wards reorganization), in social stratification structures (increasing the rhythm of relocation of the *daimyo* and warriors, which started in the last years of the shogunate), and in industry and commerce. This modernization process promoted by the Meiji government shares some similarities with the *tanzimat* in Istanbul, described in the last subsection. Japanese census started in the 1870s. According to these, Tokyo's population was 520,000 in 1872, but in just two decades, between the late 1870s and late 1890s, it doubled from 670,000 to 1,330,000 people (see Fig. 5.12 for a map of the city in the second half of the nineteenth century). Life in this continuously growing city continued to be affected by devastating events. Firstly, in 1923, the Great Kanto Earthquake, and subsequent fires, destroyed almost half of the urban area of Tokyo. The city was subject to an intense reconstruction programme, and in 1930, all the destroyed area has been rebuilt, including processes of land readjustment. Secondly, the participation of Japan in World Word II (after invading Korea in 1910 and Manchuria in 1931) has brought enormous destruction to the country and

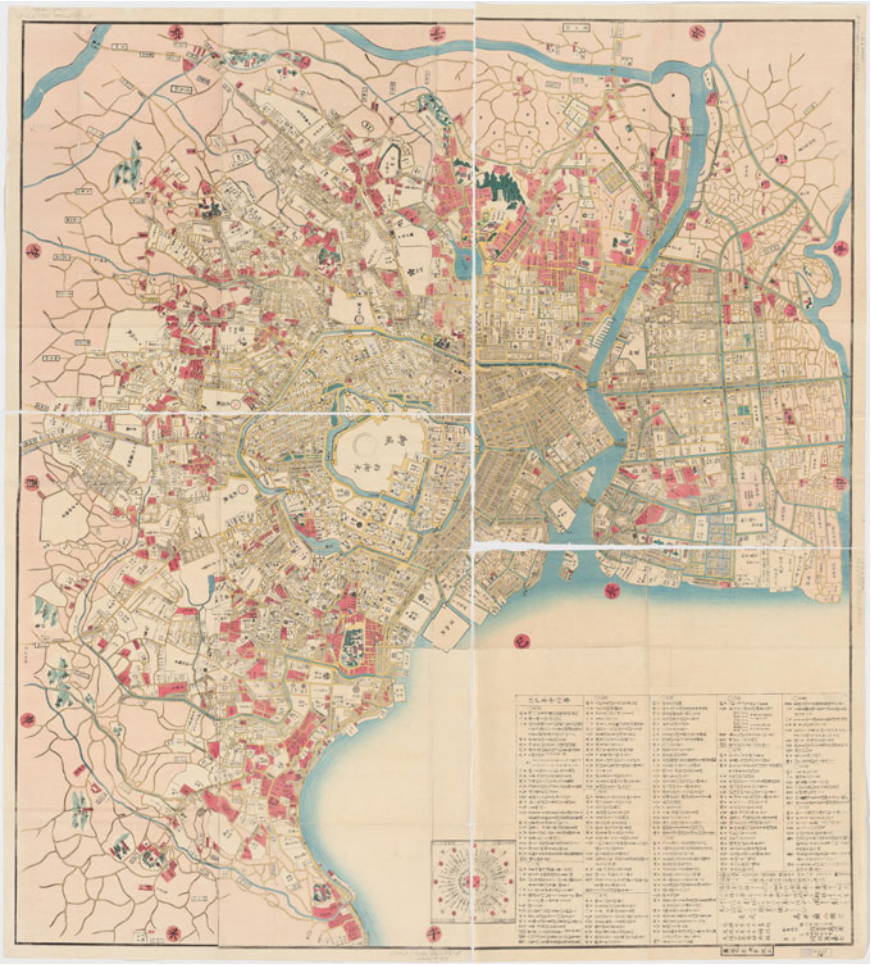

Fig. 5.12 Map of Tokyo by Takai Ranzan, 1859. *Source* Public domain

its capital. As in the case of the great earthquake and despite the extreme degree of destruction, recovery was fast.

The increase in population in the post-war period is remarkable. Table 5.4 portraits this evolution between 1950 and 2020, at three different scales: the metropolitan area (considering the metropolis and the three prefectures of Saitama, Chiba, and Kanagawa), the metropolis, and the city (made of 23 special wards, the *ku*). In general, there has been an increase in population throughout the seven decades at the three scales. In the first decade, there has been a substantial growth in the metropolitan area, the metropolis, and the city. Yet, after 1960, the demographic processes have been different: faster in the metropolitan area than in the metropolis, and of population loss in the city between 1970 and 2000. Almost one-third of the Japanese population

Table 5.4 Evolution of population in Tokyo, 1950–2020

	Population (in millions)		
Year	Metropolitan area	Metropolis (prefecture)	City
1950	11.3	6.3	5.4
1960	16.7	9.7	8.3
1970	23.3	11.4	8.8
1980	28.5	11.6	8.4
1990	32.5	11.9	8.2
2000	34.5	12.1	8.1
2010	36.8	13.2	8.9
2020	38.3	13.7	9.5

Source World Urbanization Prospects, Tokyo Metropolitan Government

lives in Tokyo Metropolitan Area; and if we consider the metropolitan areas of Tokyo and Osaka together (the latter including Kyoto), these represent almost half of the population of Japan. In 2020, there are 13.7 million people living in the Tokyo metropolis, corresponding to 6.9 million households, meaning about 2 persons per household (below the national average of 2.4). According to the Organisation for Economic Co-operation and Development (OECD), population density in the metropolitan area is 3,200 people per km^2, increasing to 4,700 in the core area. Tokyo has a strong presence of old population, as expressed by the following composition by age: 12.2% youth, 63.6% working age, and 24.2% elderly (elderly population is 3.5 times higher in Tokyo than Istanbul).

The next paragraphs focus on four central wards in Tokyo city—Chiyoda, Chuo, Sumida, and Shinjuku. This analysis of these *ku* is based on the remarkable morphological reading carried out by Shigeru Satoh and his collection of urban form patterns into 500 × 500 m boxes (Satoh, 2003). The Chiyoda ward is 11.7 km^2 and it is the home of 63,000 people (the ward with the lowest number for resident population). It includes the area of the Imperial Palace where the first castle town was erected in the twelfth century. As mentioned above, Chiyoda has suffered major destruction throughout the last centuries. One of the areas suffering the most profound changes is located between the Imperial Palace and Tokyo Station—Marunouchi (Figs. 5.13, 5.14 and 5.15). This urban landscape has a strong presence of water and vegetation. The street network of Marunouchi, built in the 1960s, is an orthogonal grid. Most street blocks have a rectangular shape and small size, around 10,000 km^2. Each street block corresponds to a very reduced number of plots (one to three) and each building has a very large footprint, occupying almost the whole area of the plot. Plot and building frontages are coincident, contributing to a close relationship between streets and buildings. The building fabric includes high- and medium-rise buildings, erected after the 1990s and mainly made of glass and steel. The main land uses are offices and commerce.

While Chuo and Chiyoda have similar sizes, the Chuo population (160,000) is 2.5 times higher. But, still, it is the second lowest of Tokyo city. The ward is located between Chiyoda and Sumida River / Tokyo Bay, and it had a key role in the urban history of Tokyo. Over the years, it has been the subject of significant transformation and land readjustment processes. Figures 5.13, 5.14 and 5.15 address one of its parts, Ningyocho. One of the most notable aspects of Ningyocho's urban landscape, common to other parts of Tokyo, is the remarkable dual network of flows and building stocks. On the one hand, there is a main regular network for faster flows of movement (complemented by a notable public transport system) framed by medium- and high-rise buildings. On the other hand, enclosed by the former, there is a secondary network for slower flows of movement, where silence prevails, framed by low-rise buildings and a strong sense of human scale—Fig. 5.15c. This complex pattern of organization of flows and stocks, which has been constantly improved over time and supported

Fig. 5.13 Shinjuku (Nishi), Chiyoda (Marunouchi), Chuo (Ningyocho), and Sumida (Mukoujima): streets, street blocks, and plots at the same scale. *Source* Satoh (2003)

Fig. 5.14 Shinjuku (Nishi), Chiyoda (Marunouchi), Chuo (Ningyocho), and Sumida (Mukoujima): block plans of buildings at the same scale. *Source* Satoh (2003)

by consecutive land readjustment processes, is one of the main lessons that Tokyo has to offer, in terms of its physical form. The aerial photograph in Fig. 5.16, taken from the Tokyo Metropolitan Government building looking west, complements this description. Street blocks are smaller in Ningyocho than in Marunouchi, and the number of plots per street block is significantly higher. While there are about 30 plots in the Marunouchi sample, there are almost 1,300 in the Ningyocho sample. In the latter, plots have between 50 and 300 m^2, and a common plot is 5 m width and 20 m depth. This means that the presence of different urban agents and strategies and as such of a more diversified urban landscape is significantly higher in Ningyocho. While office and commerce are more present in the main network, commerce and housing are dominant in the secondary network.

Sumida, located northeast of Chou, is larger and has a higher resident population (266,000) than Chiyoda and Chou. We focus on Mukoujima at the centre-north of the

Fig. 5.15 Shinjuku (Nishi), Chiyoda (Marunouchi), Chuo (Ningyocho), and Sumida (Mukoujima). *Source* photographs by the author

Fig. 5.16 The dual network of flows and stocks. *Source* photograph by the author

Sumida ward. The street network of Mukoujima is clearly different from the ones of the two former samples. It has an irregular pattern following paths of farming land, waterways, and old roads, being overlapped by a reduced number of regular streets. Yet, this irregular pattern should not be misunderstood with chaos, as it holds a hierarchy of three tiers of streets and has a strong human scale—as in Ningyocho. Considering the 500 × 500 m boxes in Figs. 5.13 and 5.14, it is in Mukoujima that the percentage of land for streets is lower—about 20% of the total, against 40% in Ningyocho and Nishi Shinjuku, and 50% in Marunouchi. Street blocks and plots are very different both in form and size. The density of plots in the Mukoujima sample is higher than in the Ningyocho sample—about 1,600 in the former and 1,300 in the latter. The most common plots have between 30 and 90 m^2 (some plots have been subdivided over time). Most of the building fabric is made of row-buildings, two-storey, for residential use, or combining residence with commerce or workshops on the ground floor. There are still some wooden houses that have survived the Great Earthquake and World War II.

Shinjuku ward is 18.2 km^2 and it is the home of 347,000 people (as Sumida, its population density is higher than the city average). Our focus within the ward is on Nishi Shinjuku, the area around the Tokyo Metropolitan Government building. The area was planned in the 1960s. It is structured by an orthogonal grid and a density of street blocks and plots like Marunouchi. The major difference between the two samples, with a significant impact on the urban landscape, is the position of each

building within each plot and the relation between buildings and streets. While in Marunouchi plot and building frontages are coincident, creating an urban landscape that is more friendly to pedestrians, in Nishi Shinjuku, most buildings setback. The sample includes 21 plots (mostly between 9,000 and 10,000 m^2) and 23 buildings mainly for offices (30–54 storeys) and commerce (20–30 storeys).

5.2.3 New York

This subsection focuses on one of the two oldest megacities—New York. After a brief introduction to the natural site and the first Manhattan settlements by the Dutch and British, we focus on the city after independence in the late eighteenth century. Contrary to Istanbul and Tokyo, the physical form of New York is strongly influenced by one notable plan, designed in 1811, that created the pattern of streets and avenues, street blocks, and plots that still frames the life of Manhattan. 'The greatest grid: the master plan of Manhattan 1811–2011', edited by Hilary Ballon, is a major reference for understanding plan preparation and implementation over time. Finally, we address the five boroughs of the city in the last decades.

New York is on the east coast of the United States. As shown in Fig. 5.17, the site is a complex interplay between water and land, the New York–New Jersey Harbour Estuary. The island of Manhattan, in the centre of the figure, is located between the US mainland at west (Hudson River) and Long Island at east (East River). At north, it is separated from the mainland (Bronx) by the Harlem River. The relationship of Manhattan with the Atlantic Ocean is mediated by the Upper Bay and the Lower Bay. As Tokyo, New York has a humid subtropical climate.

After being explored by Giovanni da Verrazano, for France in 1524, and by Henry Hudson, for the Netherlands in 1609, the area that would be named New Amsterdam (and renamed New York in 1664) was settled by the Dutch West India Company in 1625. In the next year, Peter Minuit, the first Director-General of New Netherland, bought Manhattan Island from a local tribe. Figure 5.18 presents a map of New Amsterdam at the end of the Dutch occupation in the mid-seventeenth century. New Amsterdam was a small settlement surrounded by water at east, south, and west, and by a wall (in what would be Wall Street) at north. The pattern of streets was very irregular. One main street emerged in this irregular set, the *Breede Wegh*—a pre-existence of the former indigenous occupation (the *Weekquaesgeek*). Later, it would be called Broadway. The map in Fig. 5.17 shows a set of 20 street blocks of irregular size and shape, with several plots of different sizes and shapes, and varying building densities (higher in the southern street blocks). Fort Amsterdam stands out as an exceptional built complex. Despite the construction of new streets, the street pattern of today's Lower Manhattan is very similar to the pattern of the seventeenth century.

In 1664, New Amsterdam was conquered by the British and renamed New York. Under the British Government, the city flourished and its population had a significant increase. From about 1,000 inhabitants in 1650, it grew to 20,000 inhabitants in its late

Fig. 5.17 New York site. *Source* Google Earth

colonial days. There was a moderate expansion of the urban area—the city was three times larger than New Amsterdam 100 years earlier—extending until the Commons (now the City Hall Park). On the other hand, a new pattern of orthogonal streets and street blocks, promoted by private initiatives, started to be built. This is the case of the areas between Broadway and Hudson River, in the west part of Manhattan, and to the east of Bowery Lane, in the eastern part of the island.

After the independence from Britain, this preference for a regular layout would have its greatest expression in the early nineteenth century. In 1807, the New York State Legislature appointed three commissioners—Gouverneur Morris, Simeon De Witt, and John Rutherfurd—to prepare the future of the city. They hired John Randel Jr as surveyor general. The 1807 Act sets some design guidelines, fixing the plan's baseline at the edge of the dense settlement at Houston St., anticipated squares and three types of streets, and established specific implementation procedures. The plan was based on an apparently futuristic growth scenario. At a time when the city

Fig. 5.18 Map of New Amsterdam by Jacques Cortelyou, 1665–1670. *Source* Public domain

(concentrated south of Canal Street) had 96,000 inhabitants, the plan envisioned it reaching 155th St and forecasted a population of 400,000 in 1860. The population of Manhattan in 1860 would be 813,500, doubling the Commissioners' projections for that year (Ballon 2012).

The plan proposed a division of the territory north of Houston St into a grid layout of 12 avenues and 155 streets. Figure 5.19 shows the pre-existent layout (grey shaded blocks) and the proposed grid—almost 2,000 new blocks. Although the grid looks uniform, it contains two primary patterns that create variety. The first is the streets' width: avenues are 30 m wide, the standard cross streets are 18 m, and the major cross

Fig. 5.19 Map of New York by William Bridges, 1811. *Source* Public domain

streets are 30 m (they exceed both the norms in Lower Manhattan and the minimum stipulated by the 1807 Act). The second is the street blocks' dimensions: all blocks are 60 m wide (north to south), but their lengths (east to west) vary, diminishing from the centre of the island to the shorelines. One key characteristic of the plan was that all streets and avenues were numbered, rather than named. Due to the high land values of Manhattan, the plan has restricted the number of squares and parks, believing that the Hudson and East rivers provided sufficient open space. The existing small and scattered parks were retained.

The plan did not dictate plot dimensions, but the blocks had a modular system, all are divisible by 6 and 7.5 m–20 and 25 feet (Fig. 5.20). A standard plot was 30 m deep (half of the street block depth) and 6 or 7.5 m wide. Regulation of buildings height was related to the streets' width: taller buildings in the avenues and lower-rise buildings in the side streets.

Plan implementation was a long process—it took about 60 years for the grid to be built up to 155th Street—including significant modifications: (i) the insertion of Broadway (which would become the counterpoint of the grid, particularly in its diagonal stretch from 10th to 72nd Street); (ii) the construction of two new avenues linking the northern and southern parts of the island (Lexington, between 3rd and 4th avenues, and Madison, between 4 and 5th avenues); (iii) the creation of new open

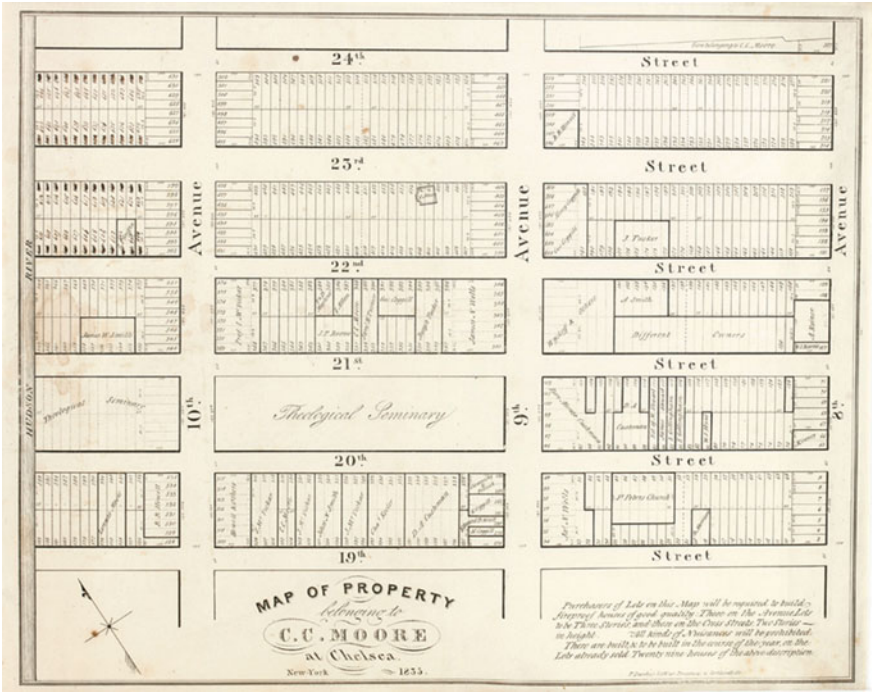

Fig. 5.20 'Map of property belonging to C. C. Moore at Chelsea', 1835. *Source* Public domain

spaces—neighbourhood parks and squares (from Union Square to Bryant Park), in a first stage, and Central Park in a second stage (covering an area of three street blocks wide and 51 blocks long, and promoting the role of the 5th Avenue as the meridian separating the east and the west sides); (iv) the enlargement of some axes (Park Avenue north of 47th Street, Lenon Avenue, Adam Clayton Powell Boulevard, and 17 of the east–west streets); and finally, (v) the removal of the military parade ground, the Observatory and most of the proposed squares.

Despite the levelling of hills and filling of valleys to produce a more horizontal surface, today's topography still has a striking resemblance to conditions in the early nineteenth century. Most streets of the plan ran through private property. To build these streets, the State Legislature defined the street opening system, an early form of eminent domain allowing the construction of streets and squares for the city and the financial compensation of the owners (Ballon 2012).

New York first expanded along the East Side. Its low and flat topography invited construction, unlike the West Side's rugged hills and valleys. In the 1830s, there was a housing boom, and at the end of the decade, the city had opened gridded roads up to 52nd Street. The improvement of the West Side began in the mid-1860s. The establishment of Morningside and St. Nicholas Parks and the undulating Riverside Drive are some examples of the presence of topography. Similarly, the planning of Upper Manhattan (north of 155th St), carried out more than 50 years after the 1811 plan, would give more preeminence to its rugged landscape (Ballon 2012). In the late nineteenth century, the Brooklyn Bridge linked Manhattan and Brooklyn. In 1898, these two, joined by the Bronx, Queens, and Staten Island, consolidated into the five-borough metropolis.

The technological advances of the twentieth century exaggerated the grid, as skyscrapers climbed higher with the help of steel skeletons and elevators. Before 1916, the grid could be extended straight up into the sky along the boundary lines of streets and plots. In 1916, the first zoning law was approved restricting the height of buildings, requiring them to setback as they rose to protect a measure of sunlight on the street and lower storeys. In 1961, a new zoning law was approved aiming to encourage builders to incorporate open space into their plots, allowing them to build taller towers (Ballon 2012).

In the twentieth century, there was an important change—the incorporation of superblocks into the grid, by erasing some street sections. While some were formed by monumental buildings and complexes, others were made of large housing projects. Although the housing superblocks fit neatly into the orthogonal street system, they changed the grain of the city and had no walkable character or mixed-use quality. In the last decades, the prevailing trend has been to recover the grid, as in the recent developments of Battery Park and Ground Zero (Ballon 2012).

In the mid-twentieth century, New York was, together with Tokyo, one of the two megacities in the world. Overall, at the metropolitan and city scales, there has been a growth of population from 1950 to 2020 (Table 5.5), reaching 18.8 and 8.3 million people, respectively, at the end of this period. While between 1980 and 2020 there, has been a growth for the two scales, from 1950 to 1980, these processes have been different—it has been more continuous at the metropolitan area (the 1970s were

Table 5.5 Evolution of population in New York, 1950–2020

Year	Population (in millions)	
	Metropolitan area	City
1950	12.3	7.9
1960	14.2	7.8
1970	16.2	7.9
1980	15.6	7.1
1990	16.1	7.3
2000	17.8	8.0
2010	18.4	8.2
2020	18.8	8.3

Source World Urbanization Prospects, New York City—Department of City Planning

the exception) and more discontinuous at the city. Today, the population of New York is 6% of the total population of the United States, a country that has another megacity, Los Angeles, and eight cities with more than 5 million people. According to the OECD, population density in the metropolitan area is 800 people per km^2, increasing to 1,500 in the core area. New York has the following composition by age: 17.9% youth, 66.4% working age, and 15.7% elderly.

Over the last three decades, there has been a growth of population in each of the five boroughs, with the highest percentual increase in Staten Island (Table 5.6). Today, the number of residents is higher in Brooklyn and Queens and lower in Staten Island. Population density is higher in Manhattan (the smallest borough, made of 12 districts) and lower in Staten Island (made of 3 districts). The highest densities in Manhattan can be found in the Upper West Side and Upper East Side (respectively, Community Districts 7 and 8). Figure 5.21 shows the ground plan of these two parts of Manhattan; their pattern of streets, street blocks, and plots constitutes the legacy of the 1811 plan to the city.

The diversity of the different neighbourhoods of New York is one of its most important characteristics. The brief description that follows moves from south to north in Manhattan, and from there to the Bronx, Queens, Brooklyn, and Staten Island. The built environment of Lower Manhattan is marked by the pattern of streets

Table 5.6 Evolution of population in New York City's five boroughs, 1990–2019

	Bronx	Brooklyn	Manhattan	Queens	Staten Island	**New York City**
1990	1,203,789	2,300,664	1,487,536	1,951,598	378,977	**7,322,564**
2000	1,332,650	2,465,326	1,537,195	2 229,379	443,728	**8,008,278**
2010	1,358,108	2,504,700	1,585,873	2 230,722	468,730	**8,175,133**
2019	1,418,207	2,559,903	1,628,706	2,253,858	476,143	**8,336,817**

Source New York City—Department of City Planning

Fig. 5.21 Manhattan—Upper West Side and Upper East Side: streets, streets blocks, and plots. *Source* New York City—Department of City Planning

of both Dutch and English settlements (Fig. 5.22b). It was the site of the first capital of the United States and, after 1792, of the financial capital of the world. It includes the Ground Zero that, after the terrorist attacks in September 2001, has emerged in the area showing the strength of the city. At northeast of Lower Manhattan, we will find the Seaport and the Civic Center. This was mainly developed after independence. It has a strong linkage with the water and in its northeast part relates to the Brooklyn Bridge. Lower East Side, located south of the 1811 grid, is the traditional gathering point for newly arrived immigrants of many cultures. Little Italy and Chinatown are the most visible examples of the presence of these communities. Soho and Tribeca are two of the trendiest (and most expensive in which to live) neighbourhoods of New York, with an intense artistic life, full of galleries, cafés, and shops. Soho is also widely known due to its remarkable architecture, one of the world's most significant set of buildings in wrought iron (Fig. 5.22d).

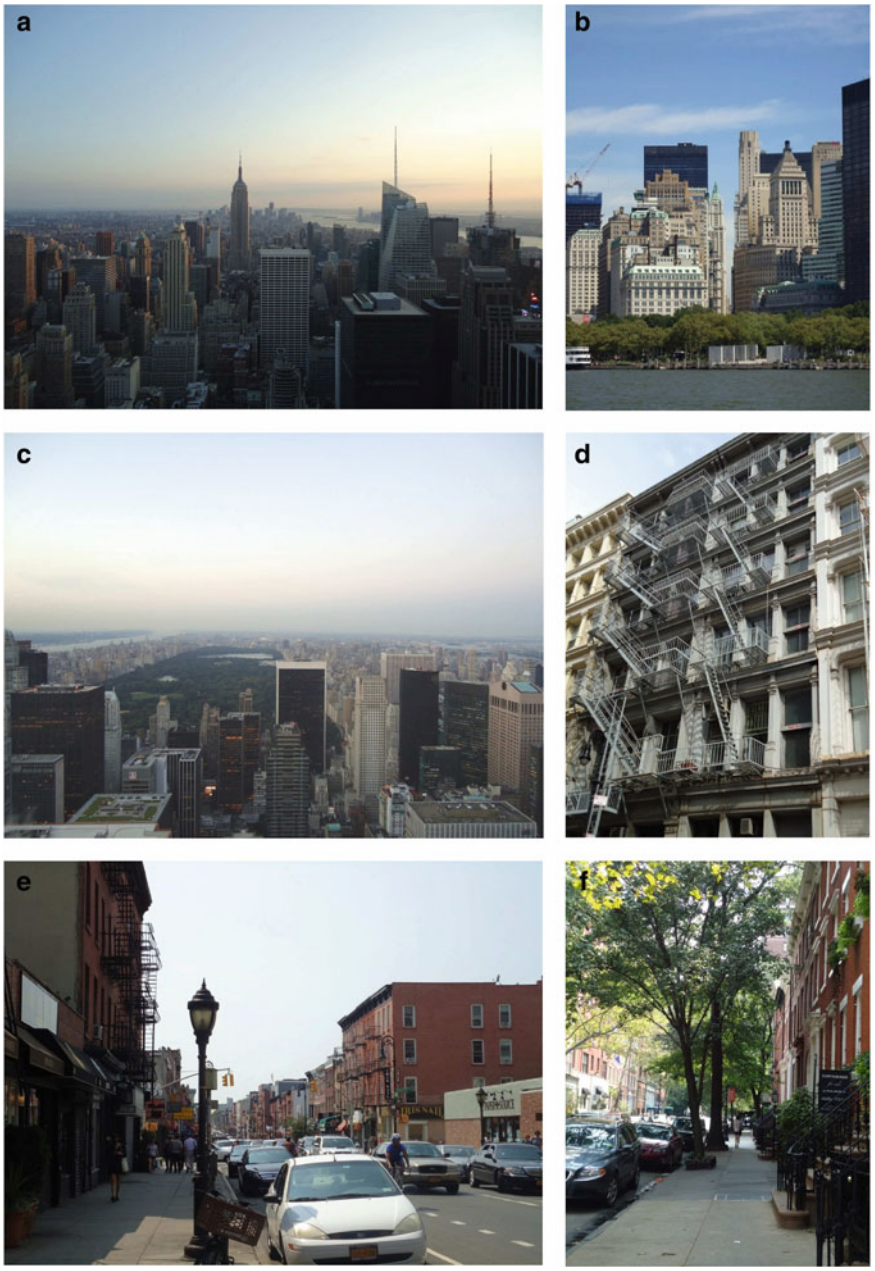

Fig. 5.22 New York: **a** the southern part of Manhattan, **b** Lower Manhattan, **c** the northern part of Manhattan, **d** Soho, **e** Brooklyn, and **f** Greenwich Village. *Source* photographs by the author

Let's move north of Houston Street. Greenwich Village combines the south-western part of the 1811 grid, around the vibrant Washington Square, with a more irregular pattern of streets, around Sheridan Square (Fig. 5.22f). Gramercy and Flat-iron are dominated by the pattern of streets defined by the 1811 plan. While Gramercy is mainly a residential area structured around the park built in the 1830s, the area around the Flatiron Building and Madison Square has a mixture of uses. South of Central Park, we find the Theater District. The Theater District first began to attract theatres and restaurants to the neighbourhood after the Metropolitan Opera House moved there in 1883. The district includes some of the most important build-ings (Rockefeller Center), squares, and parks (Times Square, Bryant Park) of New York. At the east of the Theater District, we find Midtown. This is an area with many skyscrapers and some fundamental museums. It is clearly marked by the pres-ence of the 5th Avenue, and it is inhabited by a high-income population. This high-income population has lived in the Upper East Side since the turning of the twentieth century. Today, it is gathered in the 5th and Park avenues. Madison Avenue holds several shops and galleries. The area gathers some important museums. Despite its latter occupation, after the construction of the elevated trains, several buildings have been progressively built in Broadway and Central Park West. Today, the Upper West Side is a very diverse place from the high-income population in Riverside Drive and Central Park West to mid- and low-income in Amsterdam Avenue. It is also the place of fundamental cultural buildings, like the Lincoln Center. The northern part of the island is Harlem, the vibrant centre of African American culture. The neighbourhood is structured by the 125th Street (Martin Luther King Jr Boulevard), including key buildings of the culture of the city, like the Apollo Theater.

The Bronx is almost two times larger than Manhattan. Its pattern of streets is clearly different from Manhattan, more fragmented and structured by main undulated streets. It holds some singular buildings and open spaces such as the Yankee Stadium, the Botanical Garden, and the Bronx Zoo. Queens has the largest area and the second-highest population of the five boroughs. One of its more dynamic areas is Long Island City, connected to Manhattan by the Queensboro Bridge, or 59th Street Bridge. One of the major expressions of the artistic life of Queens is the PS1 MoMA, a part of the Museum of Modern Art. Brooklyn (Fig. 5.22e) is the largest borough of New York in terms of population (it would be the fourth largest city of the United States if it was a city by itself) and the second largest in terms of area. It is probably the area with the soundest ethnic diversity. Three of the most important areas of the borough are Downtown Brooklyn, Brooklyn Heights, and Park Slope, near the remarkable Prospect Park. Both Brooklyn and Queens have a pattern of streets somehow close to the dominant pattern of Manhattan. Finally, Staten Island has a street system more fragmented than the Bronx street system. It is a borough with an area larger than the Bronx and about 475,000 inhabitants.

5.3 Medium Cities

5.3.1 Marrakesh

Marrakesh is a 'medium city' and one of the four imperial capitals of Morroco. Its medina has been classified by UNESCO as part of the World Heritage List. The urban history of Marrakesh over five dynasties, from the Almoravid (starting in the mid-eleventh century) to the Alawite, as well as the four decades of the French protectorate, and the years after independence in 1956, is described in the next paragraphs.

Marrakesh is in the north part of Morroco, in Northern Africa. The country faces the Mediterranean Sea at north and the Atlantic Ocean at west. It has land borders with Algeria at east and Mauritania at south. Marrakesh is in the Transit River valley (the river running east–west, north of the city—in the top of Fig. 5.23), located north of the Atlas Mountains (running east–west—in the bottom of Fig. 5.23) separating it from the Sahara Desert, and about 150 km east of the Atlantic coast. Both the Atlas and Sahara have a strong influence on the character of the city. Marrakesh has a hot semi-arid climate.

Marrakesh is one of the four imperial cities, together with Fes, Meknes, and Rabat. The city, which gave its name to the Moroccan Empire, was founded in the mid-eleventh century by the Almoravids, a Berber dynasty (an ethnic group indigenous of North Africa) established in 1056 that lasted until 1147. The city became the capital of these conquering nomads who would succeed in stretching their empire from the Sahara to Spain and from the Atlantic to Algeria. The original layout of the medina dates to the Almoravid period, which included the construction of the city walls (built in 1126–27), a large palace (destroyed), a mosque, and the *khettaras*, a sophisticated system of subterranean channels for irrigation that is still in use. Youssef ben Tâchfine and, particularly his son, Ali ben Youssef were the main promoters of the urban development of the city in this dynasty.

In 1147, the Red City was taken by the Almohads (1147–1269). While most of the existing monuments—palaces and mosques—were destroyed by the conquerors, Marrakesh was maintained as the capital and has experienced unprecedented prosperity. The magnificent Koutoubia Mosque was built in this period upon the ruins of the Almoravid foundations. The Almohads built new quarters extending the city wall, the Kasbah (1185–90) which was a prolongation of the city to the south with its own ramparts and gates (Bab Agnaou, Bab Robb), its mosque, palace, market, hospital, parade ground, and gardens (UNESCO, 2009). Contrary to the Almoravid buildings, constructions erected by the Almohads were very simple with no decoration.

After the Almoravid and Almohad dynasties, the city has gone through different cycles of decline or stagnation, and prosperity. The first period of decline came with the Merinid dynasty that ruled the empire for more than two centuries and established Fez as the main city. The last years of this dynasty were marked by famine and ruin in Marrakesh.

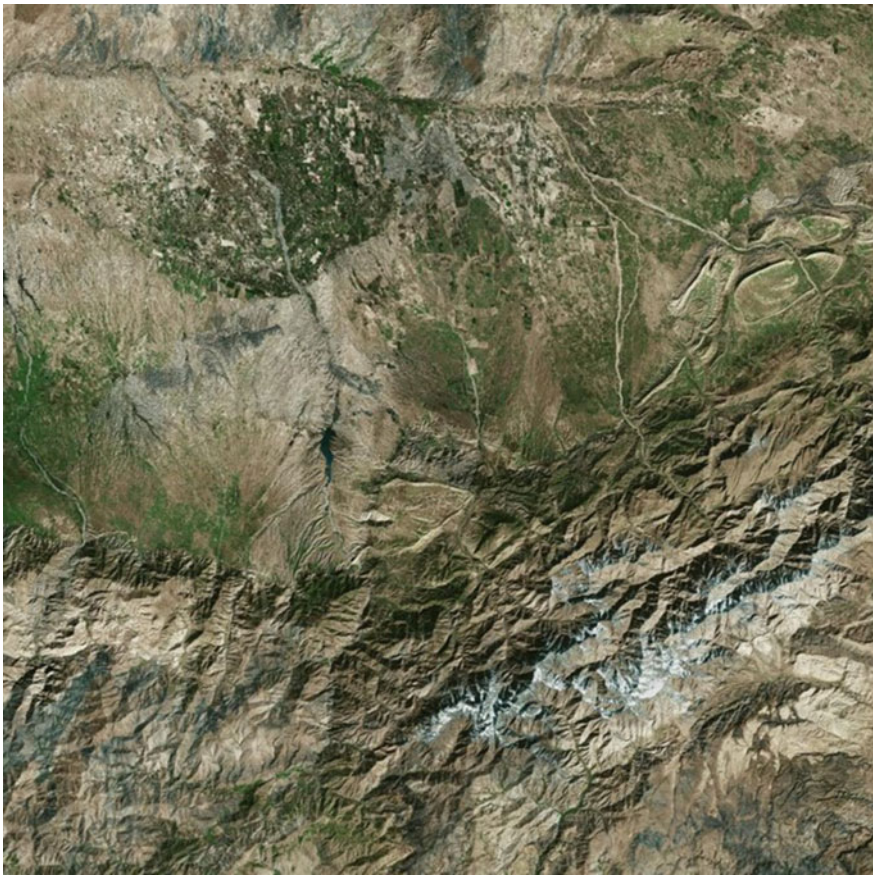

Fig. 5.23 Marrakesh site. *Source* Google Earth

The Saadians conquered the city in 1522. The new dynasty has given the city a period of great prosperity, including some major works, namely: the reconstruction of the notable Ben Youssef *Madrasa* in the northern part of the Medina; the construction of the *El Badi* Palace, in an abandoned Almohad garden northeast of the Kasbah, inspired in the Alhambra (Granada); and the erection of the Saadian Tombs, whose precious architecture is isolated from the rest of the Kasbah. The *Mellah*, or Jewish quarter, was built in the late sixteenth century for the largest Jewish population in Morocco. It is one of three main areas of the traditional city, together with the medina and Kasbah (Gottreich 2007; Métalsi et al. 1999). Figure 5.24 shows what is probably the first cartographic representation of the city in the second part of the sixteenth century.

A period of stagnation came in 1688 with the Alawite dynasty (which is still the ruling house of Morocco) favouring, first, the city of Fes, then Meknes, and finally Rabat. Nevertheless, some sultans of this dynasty have developed important works,

Fig. 5.24 Marrakesh map by Antonio da Conceição, 1549–1589. *Source* Public domain

giving the city a new mosque, *madrasas*, palaces, and residences harmoniously integrated into the homogeneous unit of the old town, which was surrounded by 10 km of clay and lime and beaten-cob ramparts. The great traditional areas of greenery—the palm groves, the *Menara,* and, to the south, the *Agdal* gardens—were located beyond the walls (UNESCO 2009). In the late nineteenth century, the *Al-Bahia* Palace was erected, northeast of the *El Badi*. The nineteenth century is also marked by internal fights encouraged by different European countries.

In the first half of the twentieth century, under the umbrella of the French protectorate, a new city northwest of the medina was designed. The *Guéliz* neighbourhood was conceived by Marshall Lyautey, Captain Landais, and the planner Henri Prost. Figure 5.25 shows the plan of the city after the construction of the *Guéliz* neighbourhood linked with the medina by the *Doukkala* gate.

Marrakesh has always been growing since the mid-twentieth century, when it had about 200,000 inhabitants, presenting higher rates of growth in the 1980s and 1990s (Table 5.7). Nowadays, Marrakesh is a vibrant city of about one million inhabitants. It is the fifth most populated city in Morocco (a country with a population of 36 million people, 62,5% of which are urban), after Casablanca, Rabat, Fes, and Tanger—all medium cities (one to five million people).

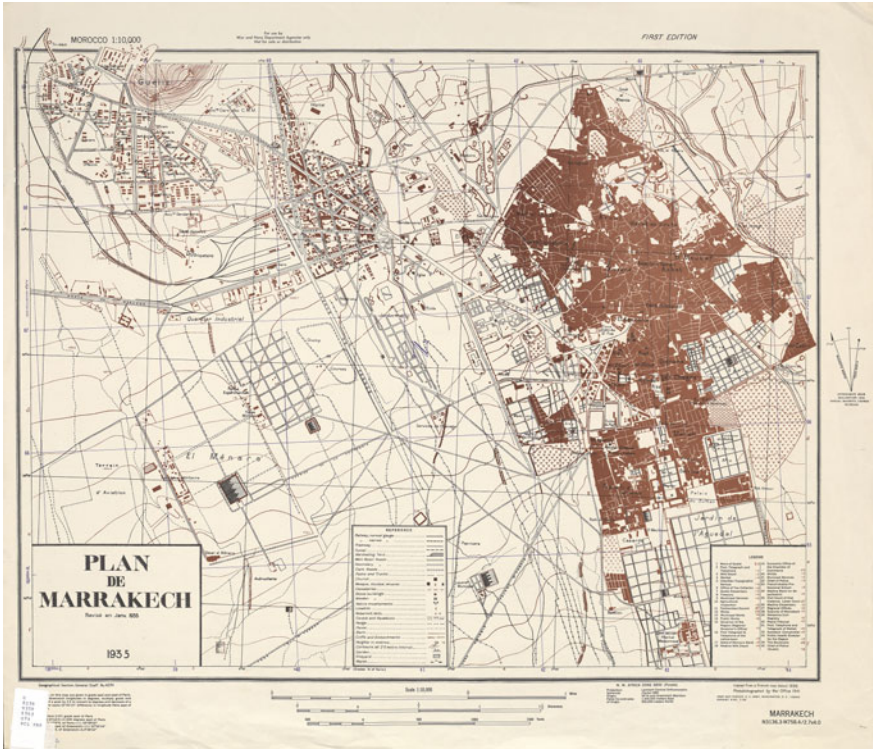

Fig. 5.25 Marrakech map, 1935. *Source* Public domain

Table 5.7 Evolution of population in Marrakesh, 1950–2020

Year	Population
1950	209,000
1960	243,000
1970	323,000
1980	416,000
1990	578,000
2000	751,000
2010	880,000
2020	1,003,000

Source World Urbanization Prospects

Marrakesh is an extremely sensorial city with intense colours and odours. The patterns of streets, plots, and buildings within and outside the medina are significantly different (Fig. 5.25). The elements of urban form within the medina are a remarkable example of an Islamic City as described in Chap. 4. The medina of Marrakesh is surrounded by the city wall, a notable structure of irregular shape with 10 km length, 6 to 9 m high, and 1.5 to 2 m wide. Ten monumental gates establish the connections between the medina and the immediate surroundings.

The exterior open spaces within the medina are mainly composed of two rather different elements, the intricate pattern of narrow streets and the large *Jemaa-el-Fna* Square—see Fig. 5.26 for an aerial view and Fig. 5.27 for some daily life photographs. The medina is a notable example of the liveability of open spaces. The relation between built space and exterior space is clearly favourable to the first, in a proportion that distinguishes the interior of the medina from both western cities and the 'city' outside the medina, namely the *Guéliz* and the *Hivernage* neighbourhoods. *Jemaa-el-Fna* is a rather unusual square. It has a very irregular shape, with more than 250 m in its largest axis, and it is configured by rather ordinary buildings. Yet, as Times Square in New York, it is always crowded both by residents and tourists at any time of the day. Activities in the square change during the day, from the market in the morning to musical and cultural performances in the evening.

One type of street, as described in the previous chapter, is the *suq*, composed of a large number of individual shops and organized according to the products for sale (Fig. 5.27f). The *suqs* of Marrakesh with their narrow streets are located north and east of Jemaa-el-Fna. The most ancient areas of the *suqs* are located between *Suq Smarine*, in the south, and the Ben Youssef Mosque, in the north, and include the *Rahba Kedima*, the 'old square' (a former slave market that is a centre for different types of healers).

Contrary to other imperial cities, in Marrakesh, the *Kasbah* and the medina are strongly connected. Except for the palace, the streets of the *Kasbah* are very similar to those of the Medina. This is also the case of the *Mellah* that has lost its original population becoming very similar to the other areas within the Medina.

Fig. 5.26 Marrakesh: the intricate pattern of narrow streets and the large *Jemaa-el-Fna* Square. *Source* Google Earth

The Ben Youssef area is one of the most important cultural and spiritual areas within the Medina. Three singular buildings are predominant in this area, the Marrakesh Museum, the Ben Youssef Mosque, and the Ben Youssef *Madrasa* (Fig. 5.27e). The *Madrasa* is one of the most remarkable buildings of the city. It has a squared shape and two storeys. It is organized around a symmetrical axe including the central patio with a rectangular pool, the prayer room, and the *mihrâb*. Two galleries of student cells, both on the ground floor and first floor, are structured around this axis.

The *Bab Doukkala* connects, literally, two different worlds, the Medina and the *Guéliz* neighbourhood. Indeed, the radial patterns of streets—built around the 16 November Square and the Mohammed V Avenue—and the relation between open space and the built fabric are significantly different outside and inside the medina. The built environment of the *Guèliz* (and *Hivernage*) is less adapted to the climatic conditions than the one of the medinas. Despite the intense transformation of the building stock in *Guèliz* for the production of office buildings and multifamily residential buildings that occurred in the last decades, it is possible to find some modernist single-family buildings surrounded by gardens erected in the early twentieth century (Fig. 5.27c).

The high-income *Hivernage* neighbourhood extends the *Guèliz* south. Although it presents a similar pattern of streets, plots tend to be larger, and building coverage is lower. Despite the qualification of streets (for instance, with trees), many of these are configured by high walls with no visual contact between the street and the different

Fig. 5.27 Marrakesh: **a** *Jemaa-el-Fna* Square; **b** and **d** street in the Medina; **c** street in the *Gueliz* neighbourhood; **e** Ben Youssef *Madrasa*; and **f** the *suqs*. *Source* photographs by the author

plots and buildings. In addition to the luxury houses, the *Hivernage* includes hotels, clubs, theatres, and casinos. At west of the neighbourhood, and 2 km of the *Bab Jdid*, the *Ménara* gardens, with the large reservoir built in the twelfth century and the green-roof palace erected in the nineteenth century, constitute a remarkable piece of landscape design.

5.3.2 Porto

Starting from a small castle town in the sixth century, Porto has been significantly expanded, firstly, in the fourteenth century, through the construction of a new city wall, and then in the eighteenth century, through the opening of a set of planned streets outside the wall. Since the early nineteenth century, the city and Portugal itself faced fundamental political changes, from Absolutist to Constitutional Monarchy, from the First Republic to Dictatorship, and from that to Democracy, in 1974.

Porto is on the coast of the Iberian Peninsula, the western limit of Eurasia. The city and metropolitan area are in the North, the largest and most populated region of Portugal. The metropolitan area is limited by the Atlantic Ocean and its natural landscape is framed by the *Douro* River (Fig. 5.28). The river had always fundamental importance to Porto connecting the city with the *Alto Douro* region where the notable Port Wine is produced. The historical kernel of Porto and the region are two sites classified by UNESCO as part of the World Heritage List. Two other important rivers in the metropolitan area are the *Ave* and *Leça* (north of *Douro*). Porto has a warm-summer Mediterranean climate.

Despite some previous forms of human occupation developed since the eighth century BC, the history of Porto as a town began in 1123 with the attribution of the so-called *foral*. The town in the twelfth century was a small settlement, of 3.5 hectares (in a high position, 60 m above the Douro River). By then, it was mainly constituted by a small castle town surrounded by a Romanesque city wall with four gates. The city walls was probably built in the sixth century, including a cathedral, a residential building for the clergy, a small market, and a number of small houses. Outside the wall, the land had mainly agricultural uses. One of the most important streets within the Romanesque wall was *Rua D. Hugo*. It is a small and very irregular street, not only in terms of the plan but also in terms of the topographical differences. The form of its 20 plots is also very irregular, including frontages from 3.5 m to 70 m. The diversity of its buildings is also substantial: building coverage is very high, and building height goes from one to four storey (although most buildings are two storey).

In the fourteenth century, a new city wall with 16 gates was built, including an overall area that was twelve times superior to the former. The new walled area included the Ribeira, the main port of the city. The increasing port activity in the early sixteenth century, mainly based on the Port wine trade with Britain, led to the introduction of some changes in the mediaeval city—the construction of new streets and some improvements in the city wall. One of these streets was *Rua das*

Fig. 5.28 Porto site. *Source* Google Earth

Flores. In morphological terms, it was substantially different from *Rua D. Hugo*. The construction of *Rua das Flores* started in 1521 linking two existing squares, one of these containing one city gate. The street is 350 m long and 9 m in width, and it has 100 plots. The permanence of its plot structure over time is remarkable. In 500 years of urban history, all (but one) plots kept their original form. Plot frontages are considerably less diverse than in *Rua D. Hugo*. The variety of building types is lower than in *Rua D. Hugo*. Height is, as it might be expected, higher than within the Romanesque wall, ranging from two to six storey.

In the early eighteenth century, the economic development of the city, supported by Brazilian gold and diamonds, allowed the construction of a set of Baroque buildings. Throughout the century, there was a significant increase in population, from less than 20,000 to about 30,000 inhabitants. Therefore, Porto local authority asked for the intervention of the Crown, and in 1758, the *Junta das Obras Públicas* was established as the public agency responsible for urban planning and management. It focussed

on two different areas, the historical kernel and the territory outside the city wall. Supported by favourable legislation on land and building expropriation, the *Junta* designed not only the street itself but also a street facade for the different buildings. It also provided land subdivision processes into regular plots with standard width (5–6 m) and variable depth. These plots are very different from the ones that can be found within the first and the second city walls. In 1784, the vision and the main guidelines of the *Junta* were gathered in a plan, the *Plano de Melhoramentos*. The work developed by this agency over eight decades is one of the most interesting periods in the urban history of Porto. A symbolic street of this period is *Rua do Almada* (already mentioned in Chap. 2) which has the name of the first president of the *Junta*, *João de Almada e Melo*. The street was built in 1764. With more than 800 m long, linking the walled city to a new square at the north, it is far longer than *Rua das Flores* and *Rua D. Hugo*. The average width of the street is similar to *Flores*. *Rua do Almada* includes ten street blocks and 215 plots. A significant part of these plots is 5 m wide and 20–90 m deep. This type of plot led to the emergence of a particular type of building. Due to the small size of the plot frontage, the building had to be developed 'in depth' – more than 15 m.

Despite some references to two different maps from the eighteenth century, the first map of Porto, encompassing what was then the whole city, was prepared in the early nineteenth century, in 1813, by George Balck—the so-called *Planta Redonda* (Fig. 5.29). Eight decades later, the map of 1892, designed by Telles Ferreira, would be a milestone in Portuguese cartography (Fig. 5.30).

The history of Porto in the first half of the nineteenth century was framed by two military events, the second Napoleonic invasions in 1809 (Portugal was invaded by the French three times between 1807 and 1813) and the civil war between conservatives and liberals from 1826 to 1833. The civil war and the victory of the liberals led to the establishment of a Constitutional Monarchy in Portugal and to the extinguishment of the *Junta* in 1833.

In the expansion of Porto outside the second city wall, after the opening of the first streets designed by the *Junta*, the new streets were planned and built on a territory structured by five roads leading to different cities in the north of Portugal. The urban landscape was marked by the development of industrial activities and the emergence of a new housing type, the *ilhas*. This residential solution for the working class consisted in rows of houses built on narrow and long plots connected to the street through strips of open private space and located on the back of larger *bourgeois* houses facing the street.

In 1892, the northern and western expansions of the city were supported by two main axes, *Avenida da Boavista* and *Rua da Constituição*. The construction of these axes took a long period of time. The first map of Porto, the *Planta Redonda*, already represented the eastern part of the Boavista axis (Fig. 5.29). This street linked the *Praça da República* with one of the five gateway roads to some of the most important nearby cities in the north of Portugal. In 1813, Boavista was 500 m long, 11 m wide, and 80 per cent of it had already been occupied with buildings. More than 150 years later, in 1978, the street length was 13 times higher. Although the early stages of the construction of *Rua da Constituição* can be traced to 1843, the first map to

Fig. 5.29 Porto map by George Balck, 1813. *Source* Public domain

include this street was the 1892 map (Fig. 5.29). Despite its apparent unitary form, *Constituição* had been built in three moments. The percentage of building façade has been growing in a regular rhythm, from 20% by the late nineteenth century to 58% by the late 1970s.

The urban landscape of Porto, in the first half of the twentieth century, is marked by the construction of the first social housing blocks, trying to eradicate the *ilhas*. In the first phase, these interventions corresponded to single-family houses, one to two storey, in peripheral parts of the city. The first multifamily housing building promoted by the Porto City Council was built in 1940. In the 1950s, there was a massive public investment on housing. Part of this investment corresponded to an important housing programme designed for the city, the *Plano de Melhoramentos*, which lead to the

Fig. 5.30 Porto map by Telles Ferreira, 1892. *Source* Public domain

construction of 6,000 dwellings in sixteen separate neighbourhoods. This second phase of housing promotion continued throughout the next two decades, including large neighbourhoods made of several apartment blocks, four storeys, clearly separated from the street. These dwellings were always very small and had a standard interior layout.

Since 1864, the year of the first census in Portugal, Porto population has always been growing until 1960. After a period of two decades with inconsistent trends, since 1980 the city has been losing population to its metropolitan area (made of 9 municipalities) and great metropolitan area (constituted by 17 municipalities, formally established in 2003) – Table 5.8. This has been most evident in the surrounding cities of *Maia*, *Valongo*, *Matosinhos,* and *Vila Nova de Gaia.* In 2020, Porto has 217,000 inhabitants and its great metropolitan area has 1.7 million inhabitants, which is a rather unusual proportion between a city and its metropolitan area (1:8). Porto and Lisbon taken together represent almost half of the Portuguese population. According to the OECD, population density in the metropolitan area is 1,300 people per km^2, increasing to 1,600 in the core area. Porto has the following composition by age: 13.5% youth, 66.8% working age, and 19.7% elderly. If we look at the data of the last census, we can see that Porto population (45.5% men and 54.5% women) were aggregated in 101,000 families, meaning that the average number of persons per family is 2.4. The city had 138,000 dwellings in 44,000 buildings, meaning 3.1 dwellings per building, expressing a sound presence of single-family housing and small-dimension multifamily housing.

The following paragraphs describe the main parts of the city. The historical centre corresponds to the area once contained within the fourteenth-century wall (Fig. 5.31a). Its streets and plots are very irregular, and the building density is high. Buildings are narrow, usually three storeys (some have five storeys). Although building and plot frontage are coincident, building coverage is very high. This is a part of the city where change has been, and should continue to be, slow. *Mouzinho da*

Fig. 5.31 Porto: **a** and **b** historical centre; **c**, **d**, and **e** *Baixa*; and **f** Boavista. *Source* photographs by the author

Table 5.8 Evolution of population in Porto, 1950–2020

Year	Population		
	Great Metropolitan Area	Metropolitan Area	City
1950	–	730,000	285,000
1960	1,145,000	840,000	310,000
1970	–	924,000	302,000
1980	1,516,000	1,104,000	327,000
1990	–	1,164,000	302,000
2000	1,731,000	1,254,000	263,000
2010	1,760,000	1,285,000	238,000
2020	1,728,000	1,313,000	217,000

Source World Urbanization Prospects, Instituto Nacional de Estatistica, AMPorto

Silveira, in the late nineteenth century, and *D. Afonso Henriques*, in the mid-twentieth century, were the last streets to be built in the area (Table 5.8).

The *Baixa* (Downtown) is located north of the historical centre in the immediate surroundings of the demolished wall. It was partly built according to plans prepared in the late eighteenth century and includes buildings dating from then to the early twentieth century. Streets and street blocks are regular, and plots have a rectangular shape. Most buildings have commercial use on the ground floor. The *Baixa* includes the civic centre that was built in the early twentieth century after the demolition of several street blocks (Fig. 5.31c). It also includes some small- and medium-size gardens, like the *Palácio de Cristal* (Fig. 5.31e).

Steadily after the 1960s—and the construction of a new bridge linking this area with the city of *Gaia* in the south bank of the *Douro*—the *Boavista* area emerged as the main financial and services centre of the city. The area is structured around the *Rotunda*, a large green roundabout with a diameter of more than 200 m, gathering eight different streets with a sound variety of plots and buildings. In the last years, some exceptional buildings such as the *Casa da Música* were erected in this area reinforcing an image of modernity (Fig. 5.31f).

Traditionally, the residents of the western part of the city hold higher incomes than the inhabitants of the eastern part of Porto. The size of a dwelling is also larger in the western part. The western part of the city combines, from north to south, the city park—linked to the seaside, a regular grid built after the late nineteenth century, and the *Foz Velha* with an irregular pattern of streets, plots, and buildings very similar to that of the historical centre.

Exercises

A. Testing Your Knowledge

5.1 Today, where does humankind live in?

i. 56% of the world population lives in urban settlements and 44% is rural. Most of the urban population lives in medium cities (1 to 5 million people).
ii. 56% of the world population lives in urban settlements and 44% is rural. Most of the urban population lives in settlements with less than 300,000 people.
iii. 44% of the world population lives in urban settlements and 56% is rural.

5.2 What have been the fundamental changes in world population distribution over the last seven decades?

i. The change of predominance in the rural/urban dichotomy and the growth of large cities (5 to 10 million people).
ii. The change of predominance in the rural/urban dichotomy and the growth of megacities (more than 10 million).
iii. The change of predominance in the rural/urban dichotomy and the growth of medium cities (1 to 5 million).

5.3 What makes the uniqueness of Istanbul urban landscape?

i. Its geographical setting (between Asia and Europe, between the Marmora and the Black Sea) and the patterns of streets, plots, and buildings inherited from the Roman Empire.
ii. Its urban history (capital of Roman, Byzantine, and Ottoman Empires for more than 1,500 years) and present political role (capital of Turkey).
iii. Its geographical setting (between Asia and Europe, between the Marmora and the Black Sea) and urban history (capital of Roman, Byzantine, and Ottoman Empires for more than 1,500 years).

5.4 From the list below, select the most relevant characteristic of Tokyo's physical form and structure.

i. A dual network of flows and built stocks: a main regular network for faster flows framed by medium- and high-rise buildings; and a secondary network for slower flows, framed by low-rise buildings.
ii. A pattern of streets, plots, and buildings (both singular and common) inherited from the twelfth century.
iii. The high-rise buildings dominant in the urban landscapes of some central wards.

5.5 Looking at New York's process of urban development what has been the most important, and long-lasting, action on the physical form of the city?

i. The construction of the Dutch wall (at present-day Wall Street), encompassing a set of 20 street blocks.

ii. The implementation of the new pattern of streets, street blocks, and plots proposed by the 1811 plan.
iii. The construction of major road infrastructures in the mid-twentieth century.

Solutions

5.1 ii.

5.2 ii.

5.3 iii.

5.4 i.

5.5 ii.

Interactive Exercises

Exercise 5.1—Where do we live?

'Where do we live?' aims at offering students a first insight into the main population dynamics of their countries and continents. It draws on data collected and offered by the United Nations (UN), and its Population Division of the Department of Economic and Social Affairs.

Students should start their investigation at https://population.un.org/wup/DataQuery/. Each student should select one country from the continent where the exercise is taking place. The first step is looking at the country's urban population distribution in 2020, identifying the different cities that fit in each of the five types defined by the UN: smallest cities, small cities, medium cities, large cities, and megacities (see the last row of Table 5.9 for the example of Spain, in Southern Europe). The second step is looking at these cities' evolution over time (drawing on the set identified in the last row), focussing on three historical periods: 2000, 1980, and 1960. The final step is identifying periods of population increase and decrease for each of these cities, as well as the highest positive and negative rates. The results of the exercise should be gathered in a table similar to Table 5.9. The exercise can take place in classes or as homework.

Exercise 5.2—Physical and socioeconomic reading

'Physical and socioeconomic reading' is an exercise that explores the capacity of each student to gather physical characteristics and socioeconomic indicators, as exemplified in Chap. 5. The exercise, framed by the contents taught and learned in the last chapter (particularly in the analysis of Istanbul, Tokyo, New York, Marrakesh, and Porto), should be as follows.

Firstly, each student is given a city from an initial list, gathering the main cities of the country where the exercise is being developed. Secondly, the analysis of each city should make evident: i. a brief geographical and historical context; ii. the present urban form (streets, street blocks, plots, and buildings) of a particular part of the city

Table 5.9 Evolution of urban population according to city size, 1960–2020

	Smallest cities 300,000 – 500,000	Small cities 500,000 – 1M	Medium cities 1M – 5M	Large cities 5M – 10M	Mega. > 10M
1960	Malaga 300,000 Sevilla 439,000 Zaragoza 323,000	Valencia 505,000	Barcelona 2,468,000 Madrid 2,392,000	–	–
1980	Bilbao 432,000 Las Palmas 361,000 Malaga 494,000 Valladolid 323,000	Sevilla 646,000 Valencia 745,000 Zaragoza 583,000	Barcelona 3,837,000	Madrid 4,253,000	–
2000	Bilbao 353,000 Cordoba 308,000 Las Palmas 356,000 Murcia 367,000 Palma 331,000 Valladolid 320,000	Malaga 526,000 Sevilla 687,000 Valencia 743,000 Zaragoza 616,000	Barcelona 4,355,000	Madrid 5,014,000	–
2020	Alicante 370,000 Bilbao 350,000 Cordoba 344,000 Las Palmas 402,000 Palma 467,000 Valladolid 305,000 Vigo 307,000	Malaga 590,000 Murcia 500,000 Sevilla 704,000 Valencia 834,000 Zaragoza 731,000	–	Barcelona 5,586,000 Madrid 6,618,000	–

Source World Urbanization Prospects

selected by the student, using a software for the interactive visualization of maps and satellite images (like Google Earth, Bing Maps, or Baidu Maps); and iii. a small set of demographic, social, and economic indicators for that same part of the city, usually available at each country's national statistics.

Each student should prepare a brief PowerPoint (5–10 min, 10 slides maximum) to be presented to the classroom. The student should use text and images (drawings and photographs) or any means that he thinks is adequate.

Exercise 5.3—Urbanized

'Urbanized' is a notable documentary directed by Gary Hustwit in 2011 (available at https://www.hustwit.com/urbanized). It offers the framework for this exercise: a debate on the main strengths, weaknesses, opportunities, and threats for several cities all around the world.

In addition to the visualization of the full documentary (in the classroom or at home), two or three cities and topics should be selected for discussion (for instance, Brasilia, as a city, and density, as a topic). For each of these cities and topics, two small groups of students should be created, for a debate framed by a dialectical method. The first group should develop a thesis and build a set of arguments to support it (for instance, defending the low density of Brasilia, based on the symbolic nature of the monumental axis, and the strong presence of green areas in the residential axis). The second group should formulate an anti-thesis and present its fundamental argumentation (for example, contesting that the low density of the Brazilian capital, not only within but also outside the so-called 'Plano Piloto', based on social justice and environmental sustainability). In the end, the two groups should collectively build a synthesis, in a process where each student should be able to appreciate the arguments of their colleagues.

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Chapter 6
The Study of Urban Form: Different Approaches

Abstract While previous chapters focused on urban forms, the sixth chapter focuses on those studying these forms. The chapter is in three parts. The first part addresses some classics in urban morphology and urban studies. The first of these books was written in the late 1950s, five books were prepared in the 1960s, two were written in the late 1970s, one was prepared in the early 1980s, and the last one in the early 1990s. The second part of this chapter presents the main morphological approaches that have been developed over the last decades, from the historico-geographical approach (promoted by the Conzenian School) to the process typological approach (promoted by the Muratorian School), from space syntax to the various forms of spatial analysis (including cellular automata, agent-based models, and fractals). This part is complemented by an overview of some emerging approaches. Finally, the last part of this chapter introduces a key topic—against a background of different theories, concepts, and methods—the need to develop comparative studies. The knowledge of the strengths and weaknesses of each approach will certainly enable those who want to develop a morphological study, to select the most appropriate options given the specific nature of the object under analysis.

Keywords Classics in urban morphology · Comparative studies · Historico-geographical approach · Process typological approach · Space syntax · Spatial analysis

6.1 Classics in Urban Morphology and in Urban Studies

6.1.1 'Studi per una operante storia urbana di Venezia'

Studi per una operante storia urbana di Venezia by Saverio Muratori was first published in 1959 and then in 1960. The book closes a 10-year cycle of architectural research, historical study, and cultural and didactic campaign that goes back to 1952 when Muratori was called to the professorship of Distributive Characteristics of Buildings at the *Istituto Universitario di Architettura di Venezia.* He would then leave to the University of Rome, as Professor of Architectural Composition, in the end of 1954. In 1950, Muratori had to define the programme for this course. One of

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the main ideas was that the urban and architectural crisis of the mid-twentieth century was mainly due to the modernist assumption that an analysis of the city dividing it according to its main elements, isolating them from their context, would lead to a more effective planning practice. Another key idea was its definition as a course of history of buildings, including exceptional and ordinary buildings.

After reflection on several theoretical and methodological issues, the book analyses the city of Venice dividing it into eight main areas. Particular attention is given to the system of parishes constituting the *Area Realtina*, from *Quartiere di S. Bartolomeo* to *Quartieri di S. Giovanni Crisostomo* (Fig. 6.1) and from these to *Quartiere di S. Sofia e S. Caterina*. One of the fundamental elements of this comprehensive study is a set of plans at the scales of 1:10,000 and 1:4,000. The plans refer not only to the existing situation in Venice in the late 1950s, but go back to the eleventh, twelfth (and thirteen), and sixteenth centuries. In addition to this set of plans of the city and its different *quartieri* (an element of urban form of crucial importance and with a high autonomy), the book includes several plans, elevations, and sections of some Venetian buildings types at the scale of 1:500.

Muratori argues that the initial settlement could be reconstructed as a strongly rational archipelago of parishes. In face of this, the gothic Venice somehow expressed a crisis in planning while the Renaissance Venice was a remarkable synthesis of a continuous and polycentric city.

Muratori investigates the rationality of history through the reconstruction of the process of derivation of both architectural and urban forms, from previously built structures to more recent complex configurations. The process of derivation retains the traces of a form's inception in simple original arrangements by updating them over the centuries (Marzot 2002).

A set of fundamental urban concepts are defined in the book—type, urban tissue, organism, and operative history. According to Muratori, a certain type could not be identified except within a particular application, in the urban tissue. The urban tissue could not be identified except in its involving context, in the urban organism. The urban organism would only become real in its historical dimension, as part of a temporal construction that is always grounded on the conditions suggested by the past. This led to the argument of a strong relation between history and planning/architecture.

Following the publication of *Studi per una operante storia urbana di Venezia* two other important texts were published in subsequent years. The first was *L' edilizia gotica Veneziana* by Paolo Maretto in 1960, published as a complementary book of the operative history of Venice and constituting a systematic survey of the historical buildings of this Italian city (Maretto 1960). The second is *Studi per una operante storia urbana di Roma* by Muratori, Renato Bollati, Sergio Bollati, and Guido Marinucci, completed in 1963 and constituting a comprehensive atlas of the Italian capital (Muratori 1963).

Fig. 6.1 *Studi per una operante storia urbana di Venezia–Quartieiri di S. Giovanni Crisostomo*, from the eleventh century to the 1950s. *Source* Muratori (1959)

6.1.2 *Alnwick, Northumberland—A Study in Town-Plan Analysis*

'Alnwick, Northumberland—A study in town-plan analysis' by M R G Conzen was first published in 1960 and then again in 1969. Its perspective and contents were clearly influenced by Conzen's training and early research in Berlin, during the late 1920s and early 1930s (see the next section of this chapter). The second edition of the book, as Conzen states, has provided him an opportunity for revision of concepts and terminology, reinterpretation of some earlier plan units, and for introducing a glossary of technical terms (118 items) which may be regarded as a concise formulation of morphological theory (Conzen 1969). The book has been recently translated into Chinese, Italian, and Portuguese.

The book is an attempt to fill a gap in urban morphology. It is driven by the problems of how the plan of an old-established town has acquired its geographical complexity, what concepts can be deduced from such an inquiry to help in the analysis of town plans in general, and what contribution the development of a plan makes to the regional structure of a town. It is an attempt to explain the present structure of a town plan by examining its development (Conzen 1960).

The book is in three parts. The first part discusses the aim, scope, and method of town-plan analysis. It introduces the tripartite division of the urban landscape—one of the fundamental elements of Conzen's theory—focussing particularly on the town plan. The town plan is defined as the topographical arrangement of an urban built-up area in all its man-made features, containing three distinct complexes of plan elements: (i) streets and their arrangement in a street system; (ii) plots and their aggregation in street blocks; and (iii) block plans of buildings.

The second part analyses the growth of Alnwick's built-up area according to five morphological periods (expressing the way on how each period leaves its distinctive material residues in the landscape): (i) Anglian, (ii) Norman to Early Modern, (iii) Later Georgian and Early Victorian, (iv) Mid- and Late Victorian and, finally, (v) Modern. This analysis of the physical growth of Alnwick from Anglian times to the 1950s is informed by a number of key concepts, some new, like the burgage cycle (the life cycle of a plot held by a burgess), others constituting developments of existing ideas, such as the fringe belt (an element formed at the urban fringe of a town or city during a period when the built-up area was either not growing or growing only very slowly).

The third part of the book analyses the existing town plan of Alnwick. This detailed study identifies 14 major types of plan units and 49 subtypes (Fig. 6.2). The major types are as follows (the roman numbers are in the key of Fig. 6.2): (i) Mediaeval High Street Layout, with triangular market; (ii) Mediaeval *Suburbium*; (iii) Simple High Street Layout; (iv) Extramural Borough Street, with special siting; (v) Closed Fringe Belt, with consequent ring-road; (vi) Traditional Arterial Ribbons; (vii) Later Alterations of Old Town; (viii) Pre-Victorian Frame Roads; (ix) Late Georgian and Early Victorian Residential Accretions; (x) Mid and Late Victorian Residential Accretions; (xi) Modern Residential Accretions; (xii) Composite Ribbons without Traditional

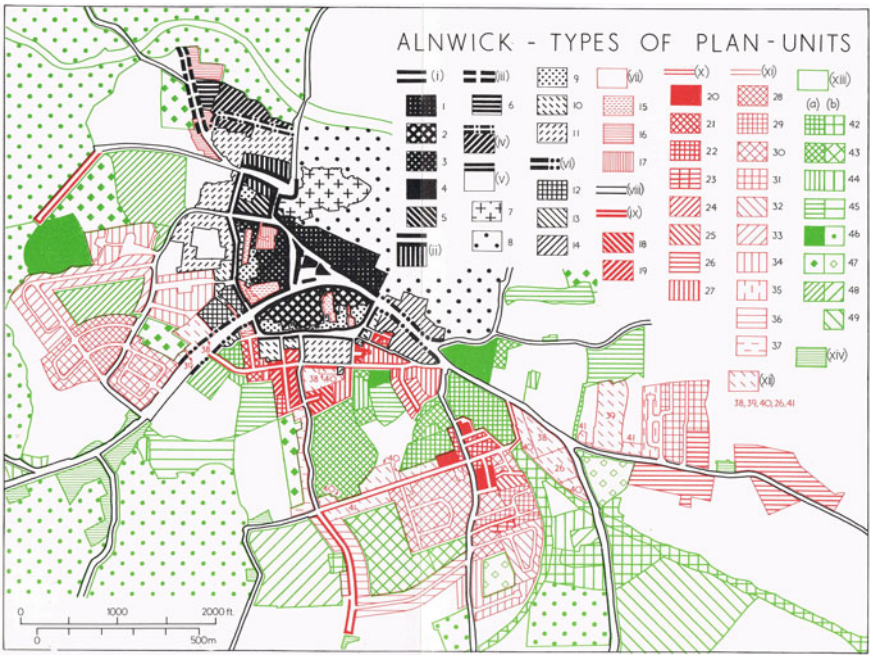

Fig. 6.2 Alnwick, Northumberland—A study in town-plan analysis—types of plan units. *Source* Conzen (1960)

Plots; (xiii) Intermediate and Outer Fringe Belts; and, finally, (xiv) Farmsteads and Other Agricultural Buildings. Drawing on this division—and as such on the three elements of the ground plan—Conzen proposes a geographical structure based on a set of plan divisions grouped into four orders. The three parts of the book comprise 21 maps, including four fold-out maps, three in colour.

Two features distinguish the book from the previous and subsequent studies on the physical structure of urban areas: the extent to which processes were conceptualized, and the meticulous way in which terms used to describe them were researched (Whitehand 2009a). The essential message of the book is that the numerous morphological features of urban places at all scales can be reduced to a logical system of explanation, which can lead to an incisive and nuanced understanding of the relationship between urban communities and the physical fabric they create and recreate around them as social needs change over time (Conzen 2009a).

In the 'Conclusion', Conzen opens two lines of research that he would develop in the subsequent years: the need for this theory of plan analysis to be connected with a full investigation of the associated patterns of land use and building types to produce a complete interpretation of the townscape; and the need to extended the theory to cover different functional types of towns, and towns of different cultural areas.

6.1.3 The Image of the City

'The image of the city' by Kevin Lynch was first published in 1960. Contrarily to the two former cases on Venice and Alnwick, this is not an urban morphological book in the strict and narrow sense of these words. Yet, the work of Lynch, like that of Cullen and Jacobs (to be presented in this section), is a questioning of the modernist conventional wisdom as realized in the post-war clearance and rebuilding programmes. The three works contributed to a paradigm change in urban design that begins to recognize the virtues of our inherited urban fabric (Samuels 2009).

'The image of the city' is about the look of cities, the importance of this look, and the possibilities of changing it. Lynch argues that giving visual form to the city was, then, a new and special kind of design problem. In the course of examining this problem, the author looks at three American cities—Boston, Jersey City, and Los Angeles—proposing a new method to deal with the visual form at the urban scale and offering some principles of city design.

The book is in five parts. The first part introduces the reader to the main issues on the image of the environment. The visual quality of the American city is considered by studying the mental image of the city which is held by its citizens. One central visual quality is particularly explored in the book, 'legibility' (also called 'imageability') meaning the ease with which the different parts of the city can be recognized and organized into a coherent pattern. A distinctive and ordered environment helps the resident to orient himself, to place parts of the city into coherent categories, and to acquire a sense of security that he can relate to the surrounding urban world.

The second part of the book focuses on three case studies. Lynch studies the central areas of Boston, Jersey, and Los Angeles, talking with their inhabitants, trying to understand the role of environmental images in our urban lives. Two basic analyses are carried out: a systematic field reconnaissance of the area on foot by a trained observer, mapping a number of different elements; and a lengthy interview with a small sample of city residents (60 persons for the three cities) to evoke their own images of the physical environment.

A five-element classification of the contents of the city images that are related to physical forms is offered in the third part: (i) paths, the channels along which people move throughout the city; (ii) edges, the boundaries and breaks in continuity, such as rivers and train tracks; (iii) districts, the areas characterized by common characteristics; (iv) nodes, the strategic focus points for orientation, like squares and junctions; and finally, (v) landmarks, the external points of orientation, usually easily identifiable physical objects in the urban landscape, such as distinctive buildings, statues or landscape features. Figure 6.3 presents a reading of the visual form of Boston, Jersey City, and Los Angeles structured according to these five elements.

The design of these five elements (with a particular focus on the paths) in an interrelated way, the form qualities (from singularity to names and meanings), the sense of the whole, the metropolitan form, and the process of design are the main issues of the fourth part. This process of design includes what might be called a visual plan for the city and the metropolitan region—a set of recommendations and

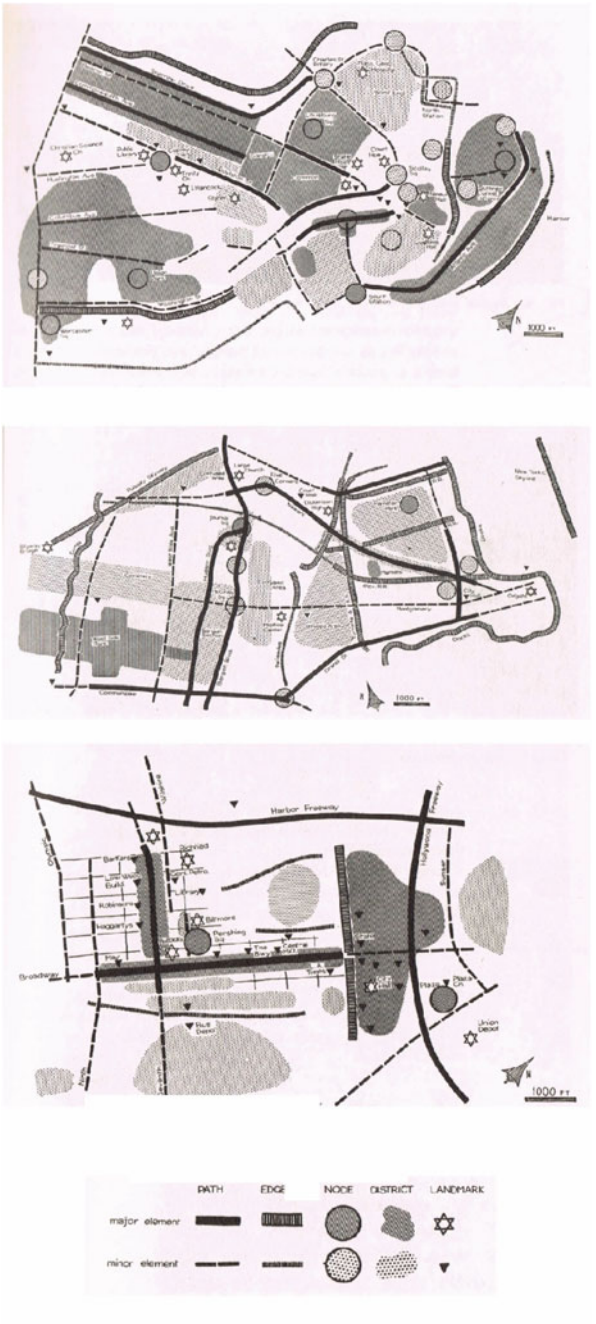

Fig. 6.3 The image of the city—the visual form of Boston, Jersey City, and Los Angeles (paths, edges, nodes, districts, and landmarks) as seen in the field. *Source* Lynch (1960)

controls on urban form. The fifth part of the book offers a synthesis of the new vision and scale.

In synthesis, two fundamental questions prompted this book: what does the city's form actually mean to its residents (?) and what can the city planner do to make the city's image more vivid and memorable to the city dweller (?). To answer those questions Lynch formulated a new criterion, legibility, and made evident its potential value as a guide for the building and rebuilding of cities. Twenty years later, Lynch would publish the 'Good City Form' where he adresses other dimensions of the city's performance, significantly decreasing his emphasis on legibility (Lynch 1981).

6.1.4 Townscape

'Townscape' by Gordon Cullen was first published in 1961 and then again in 1971, with a new introduction, reinforcing the main arguments that were presented in the early 1960s.

The book—profusely illustrated with drawings and photographs—begins by describing the basic ingredients of townscape, continues by showing these ingredients as assembled in the wider context of the town scene, and finishes by revealing the full 'poetry' of townscape, first in studies of existing towns, and then in proposals for new projects. One of Cullen's main goals is to be able to manipulate the elements of the town so that an impact on the emotions of its users is achieved. Indeed, the purpose is not to dictate the shape of the town or environment, but simply to manipulate it within established tolerances.

The book proposes an art of relationship aiming at taking all elements that create the environment (buildings, trees, nature, traffic, advertisements, to name just a few) and weave them together in such a way that 'drama is realized'. This art of relationship depends on three fundamental concepts, serial vision, place, and content. The serial vision is strongly related to optics and motion, and to the movement of a person through different parts of the city. Figure 6.4 illustrates this concept: walking from one end of the town plan to another, even at a uniform pace, a sequence of revelations is provided. This is suggested in the serial drawings opposite (each arrow represents a drawing), reading from left to right. This serial view can be divided into two different elements: the existing view and the emerging view.

The concept of place (or position) concerns our reactions to the position of our body in the environment, dealing with a range of experiences stemming from the major impacts of exposure and enclosure. Cullen argues that if we would design our towns from the point of view of the moving person, the whole city would become a plastic experience, a journey through pressures and vacuums, a sequence of exposures and enclosures.

The concept of content refers to the specific fabric of towns—colour, texture, scale, style, character, personality, and uniqueness. As most towns are of old foundation, their fabric shows evidence of different periods in its architectural styles and the various patterns of the layout.

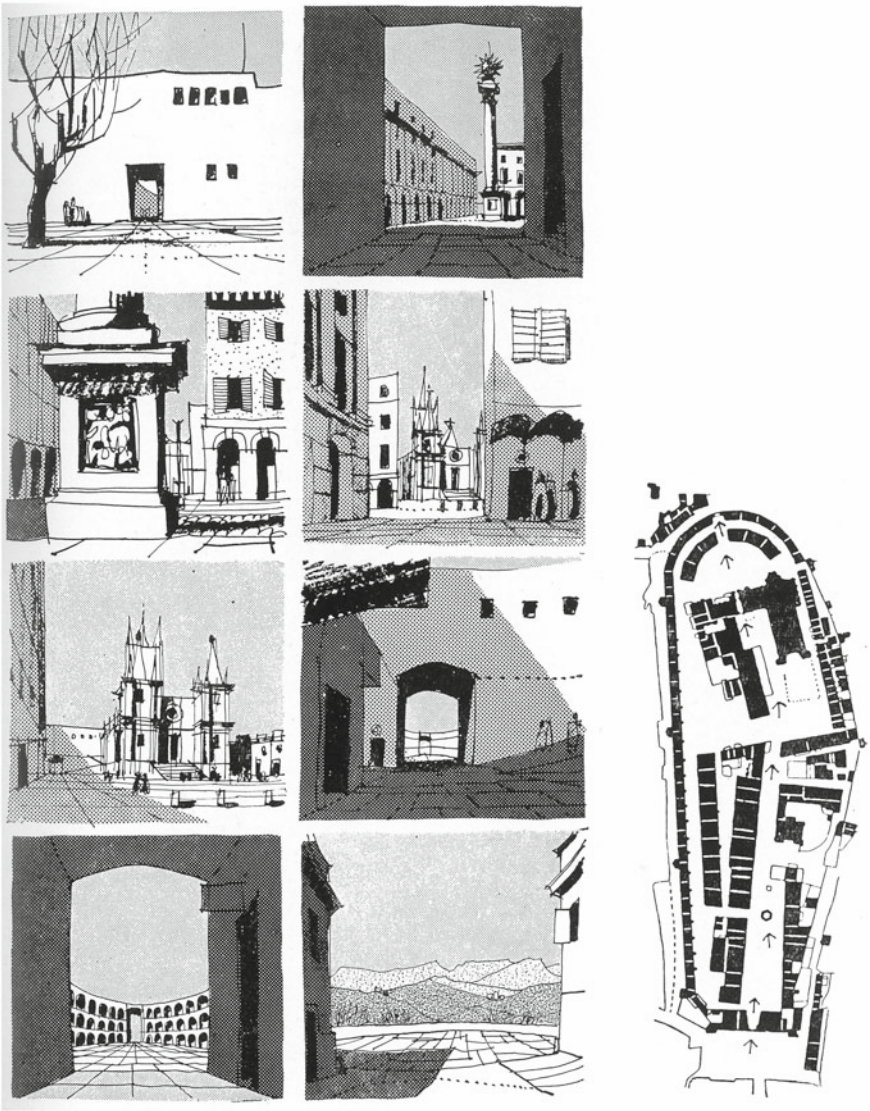

Fig. 6.4 Townscape—serial vision. *Source* Cullen (1961)

As in the case of Lynch—and contrarily to Muratori and Conzen—Cullen offers a normative approach. As in 'The image of the city', 'Townscape' is grounded on the individual capacity of visual perception, in such a way that the town is approached as an object of perception of its inhabitants.

6.1.5 The Death and Life of Great American Cities

'The death and life of great American cities' by Jane Jacobs was first published in 1961. Similar to Lynch's and Cullen's books, 'The death and life of great American cities' is a classic in urban studies, addressing the physical, social, and economic dimensions of cities. The book is an attack to the theory and practice of city planning of the late 1950s and early 1960s. It is also an attempt to introduce new principles of city planning. In setting forth these principles, Jacobs writes about ordinary things of cities, such as the kind of streets that are safe and unsafe, or why some slums stay slums and other slums regenerate themselves even against financial and official opposition. The book is an attempt to understand how cities work in real life, because that would be the only way to learn what principles of planning could promote social and economic vitality in cities. Jacobs argues that cities should be the laboratory in which city planning should have been learning, forming and testing its theories. On the contrary, practitioners and academics were ignoring the study of success and failure of their approaches in real life.

After an introductory section, including a brief review of the most influential ideas on modern city planning and architectural design, the book is in four different parts. The first part is about the social behaviour of people in cities. This analysis has a focus on public spaces, particularly on streets. Jacobs establishes three main qualities for a safe street: (i) there must be a clear demarcation between public and private space; (ii) there must be eyes upon the street, eyes belonging to the natural proprietors of the street; and (iii) the sidewalks must have users, both to add the number of effective eyes on the street and to induce people in buildings to watch the sidewalks.

The economic behaviour of cities is the theme of the second, the most important, part of the book. This part of the book addresses diversity, discussing some of its main generators (or conditions for diversity): (i) mixed primary uses, ensuring the presence of people who go outdoors on different schedules and are in the place for different purposes, but who are able to use many facilities in common; (ii) small street blocks, ensuring frequent opportunities to turn corners; (iii) buildings that vary in age and condition, including a good proportion of old ones so that they vary in the economic yield they must produce; and finally, (iv) dense concentration of people, for whatever purposes they may be there.

The third part focuses on some aspects of decay and regeneration in the light of how cities are used, and how they and their citizens behave in real life. The analysis focuses on some powerful forces that can influence, positively or negatively, the growth of diversity and vitality in cities.

Finally, the last part suggests several changes in housing, traffic, design, planning, and administrative practices, and discusses the 'kind' of problem that, according to Jacobs, cities pose—a problem in handling organized complexity. Jacobs argues that for understanding cities, we must: (i) think about processes and contexts; (ii) work inductively, reasoning from particulars to the general; and (iii) seek 'unaverage' clues involving very small quantities, which reveal the way larger and more 'average' quantities are operating.

6.1.6 *L' architettura della cittá*

L' architettura della cittá by Aldo Rossi was first published in 1966. The theoretical and methodological framework for this book started to be designed a decade earlier when Rossi joined the influential journal *Casabella-Continuitá*, directed by Ernesto Nathan Rogers. This framework was then consolidated in the first half of the 1960s, in his research and teaching activity, in Arezzo and Venice (where he was teaching assistant of Carlo Aymonino), and in his early architectural practice. Subsequent translations (for instance, the American, German, or Portuguese editions) contained new elements supporting the main arguments of the book.

The main purpose of the book is the foundation of urban science within the context of human sciences. In this urban science, the city—or the construction of the city over time—is understood as architecture. While receiving contributions of different fields of knowledge, from geography (particularly French geography) to history, one of the fundamental purposes of the book is establishing the boundaries and the specific contents of the body of architectural studies that are part of this urban science. The book itself is seen as a project of the architecture of the city. The contrast between particular and general and between individual and collective constitutes one of the main points of views for the study of the city that are proposed in the book. This contrast is expressed in many different aspects: in the relations between public and private realm, in the contrast between the rational project of the urban architecture and the contextual values of the *locus*, and between public and private buildings.

The book also proposes an analytical methodology, balancing quantitative and qualitative approaches, framed by a theory of urban artefacts, by the identification of the city as an artefact, and by the division of the city into different parts, mainly primary elements and residential areas. Yet, it is sustained that the whole is more important than each of the different parts.

L' architettura della cittá is in four main parts. In the first part, Rossi focuses on the topics of description and classification, addressing, as such, the fundamental issue of building typology as a fundamental basis for the architectural project. For Rossi, the type is the 'idea' of architecture itself, which is nearest to its essence. In this debate, it is argued that, contrary to the then-dominant architectural thought, form is autonomous from function (in the Portuguese translation, this is remarkably illustrated with the case of Split, the palace which changed function to a city, as we have seen in Chap. 4). In this part of the book, Rossi has a brief reference to one of the other 'classics' presented in this section, 'The image of the city' by Lynch, addressing the way people are oriented in the city and the formation and evolution of their sense of space.

The second part of the book is on the different parts of the city structure, with a particular focus on the primary elements and the residential areas. The architecture of the city and of the place where it is developed, and the city as history are the main themes of the third part. Finally, the book addresses the issues of urban dynamics and policy options, including the history of ideal cities and urban utopias.

6.1.7 A Pattern Language

'A pattern language: towns, buildings and construction' written by Christopher Alexander, Sara Ishikawa, Murray Silverstein, Max Jacobson, Ingrid Fiksdahl-King, and Shlomo Angel (based at the Centre for Environmental Structure at the University of California, Berkeley) was published in 1977. It was the second book of a trilogy developed over the 1970s including 'The timeless way of building' and 'The Oregon experiment' (Alexander et al. 1975, 1977; Alexander 1979). Conceived as an alternative to mainstream practice, the first book proposes a new theory of planning and architecture centred on a timeless way of building developed by ordinary people. The second book, 'A pattern language', makes explicit how people can design their own houses, streets, and communities—as they have done in the past.

The book proposes one possible language, made of interrelated entities that are called patterns. Each pattern helps to complete the larger patterns which are above it, and it is itself completed by the smaller patterns that are below it (Alexander et al. 1977). Each pattern corresponds to one design problem in the urban landscape and to a solution to that problem. In the book, each pattern is presented in the same format: i. a picture, exemplifying the design problem; ii. an introductory paragraph, setting the context for the pattern and explaining how it helps to complete larger patterns; iii. the body of the problem; and iv. the solution (capturing, with varying certainty, an invariant property). Alexander and his colleagues see each pattern as something alive and evolving, as a scientific hypothesis, and they invite the reader to improve each pattern.

'A pattern language' is in three parts, reflecting the way how patterns are ordered and their most relevant connections. The first part is on towns, communities, and neighbourhoods, on patterns that should be designed and built through piecemeal growth. The second part is on buildings (groups and individual) and on the space between buildings, on patterns that can be designed and built by individuals or small groups of individuals. The last part is on construction, explaining in considerable detail how to erect a building, based on the organization of spaces defined in the second part. The book is made of 250 patterns (about 100 patterns for towns and buildings each, and 50 for construction), starting from the large scale addressing 'independent regions', 'the distribution of towns', 'city country fingers' and ending in the small scale addressing 'different chairs', 'pools of light' and 'things from your life'.

The planning process proposed at 'The timeless way of building' and 'The pattern language' was implemented in the design of the master plan for the University of Oregon, in Eugene. 'The Oregon experience' offers a concrete example of this theory in practice, describing implementation according to six fundamental principles: organic order, participation, piecemeal growth, patterns, diagnosis, and coordination.

6.1.8 *Formes Urbaines: de l'îlot à la barre*

Formes urbaines: de l'îlot à la barre by Jean Castex, Jean-Charles Depaule and Philippe Panerai was first published in 1977. The three authors were then based on the recently created *Ecole d' Architecture de Versailles* and had close links with the Italian morphological tradition (Darin 1998). Over the years, *Formes urbaines: de l'îlot à la barre* was translated to different languages, including Italian, Spanish, Dutch, German, and Serbo-Croat. In 2004, an English version with a new chapter on the Anglo-American context (focussing on four case studies) and some additional texts written by Ivor Samuels and Philippe Panerai was published (Panerai et al. 2004).

The book is about the erosion and disappearance of a well-defined spatial organization—the street block, typical of classical European cities. For the authors, the street block is not an a priori form but a resulting system, capable of organizing parts of the urban territory. It is a part of the urban area 'isolated' from the neighbouring parts by streets. Thus, the block is not an architectural form, but a group of plots and buildings. It has a proper meaning only when it is in a dialectical relationship with the street network. The street block of the traditional city is rarely homogeneous and the buildings of its perimeter obey some rules, especially those of that economic logic that has shaped the surrounding streets (Panerai et al. 2004).

The book tries to understand how streets have lost importance and how buildings have progressively distanced themselves from the city. The book also proposes a new scale of architectural analysis, an intermediate scale corresponding to the local organization of urban tissues, different from the scale of the grand layouts and monuments and from the scale of domestic details.

Formes urbaines: de l'îlot à la barre is in two parts. The first part, structured in five chapters, offers a detailed analysis of five major case studies in city planning (three of these were presented in Chap. 3), making evident the first stage of transformation of the street block, in the nineteenth century, and a second stage where it progressively opens up until it disappears, in the twentieth century: (i) the Haussmannien Paris (1853–82); (ii) the garden cities of Welwyn and Hampstead (1905–25); (iii) the extension of Amsterdam (1913–34); (iv) the *siedlungen* of new Frankfurt (1925–39), from *Romerstadt* with a more traditional layout to *Westhausen* clearly based on isolated buildings; and, finally, (v) the *cité radieuse* and the *unités d' habitation.* Figure 6.5 contains a schematic sequence of this process of transformation. The second part of the book is a discussion on the metamorphosis of the street block, the practice of space, and the development and diffusion of architectural models.

The appeal of the authors in favour of the closed street block was taken up three years later in their study of Versailles, which divides the history of the city into several periods, each of which is examined through the development of urban form and housing types (Castex et al. 1980). The authors highlight that this town developed not as a whole but as a collection of urban fragments.

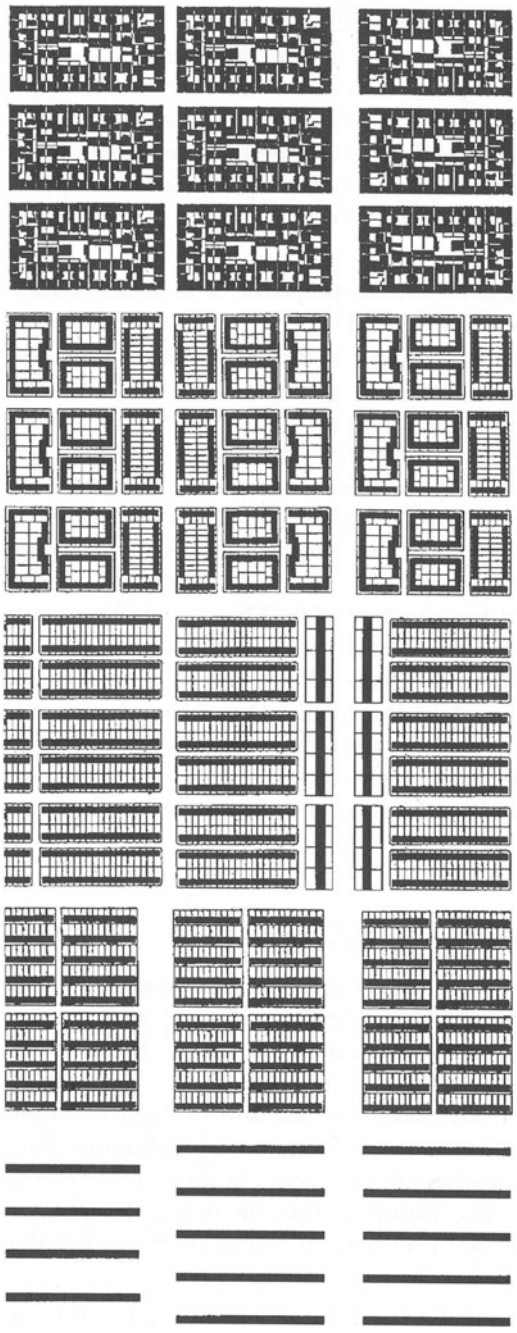

Fig. 6.5 *Formes urbaines: de l'îlot à la barre*—hommage to Ernst May. *Source* Panerai et al. (2004)

6.1.9 *The Social Logic of Space*

'The social logic of space' by Bill Hillier and Julienne Hanson was published in 1984. The book synthesizes a line of research that started in the Unit of Architectural Studies at University College London, in the 1970s, with the main purpose of understanding the influence of architectural design on the existing social problems in many housing estates that were being built in the United Kingdom.

The main goal of 'The social logic of space' is to outline a new theory, and new methods, for the investigation of the relation between society and space. It attempts to build a conceptual model for the investigation of this relationship based on the social content of spatial patterning and the spatial content of social patterning. It establishes a fundamental descriptive theory of pattern types and then a method of analysis. These are applied first to settlements and then to building interiors. On this basis, it establishes a descriptive theory of how spatial pattern carries social information and content (Hillier and Hanson 1984).

The book is in eight chapters. The first chapter establishes a framework for the redefinition of the problem of space, bearing in mind the construction of a broad theory of the social logic of space and the spatial logic of society. 'The logic of space' (Chap. 2) introduces a new concept of order in space, as restrictions on a process that would otherwise be random. The third chapter proposes a new method to deal with the physical structure of a settlement without losing sight of its local structure and to describe space in a way that makes its social origins and consequences a part of that description. The axial map and some syntactical measures are introduced in this chapter (see Fig. 6.5 for the application in *Gassin* and Barnsbury). 'Buildings and their genotypes' moves the discussion from settlements to buildings, adapting the analytic

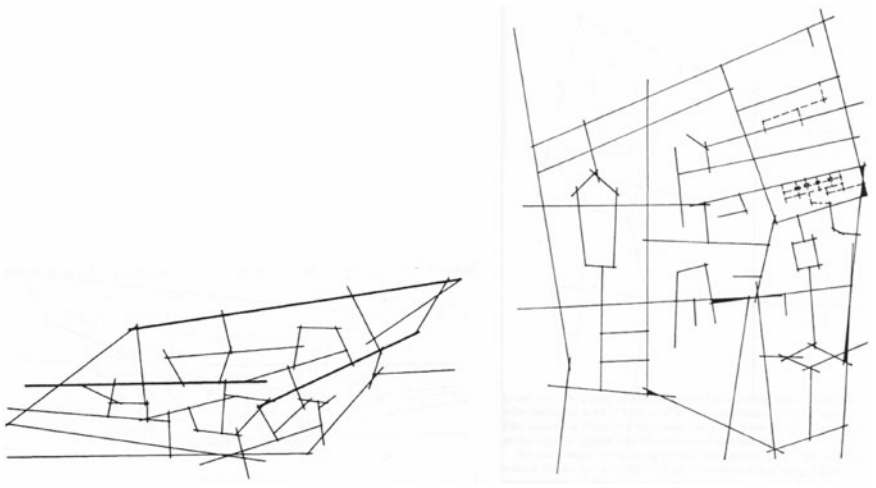

Fig. 6.6 The social logic of space—the axial maps of *Gassin* and Barnsbury. *Source* Hillier and Hanson (1984)

method to building interiors. The method shows how buildings can be analyzed and compared in terms of how categories are arranged and related to each other, and how a building works to interface the relation between the occupants and those who enter as visitors. The fifth chapter outlines a general theory of buildings in terms of their spatial form by considering the elementary building and its social relations, and by examining some cases as they evolve from the basic form to different types of complexity. A general framework of relating different kinds of order is established in the sixth chapter. It deals with both material and conceptual components of the spatial arrangement, and with randomness and order. 'The social logic of encounters' shows how certain fundamental social ideas may be given a kind of spatial interpretation through the notion of differential solidarity. The authors argue that societies are never one single form of solidarity but relations between different forms of solidarity, and that space is always a function of these differential solidarities. Finally, the last chapter proposes a general theory of the different spatial pathways required by different types of social groups. In synthesis, the book aims at providing a coherent model for linking together and making sense of the different phenomena of contemporary space, phenomena which were normally given a simple functionalist or economic explanation.

The theory of society and space outlined in 'The social logic of space' would be developed in two notable books published in the 1990s, 'Space is the machine' by Hillier and 'Decoding homes and houses' by Hanson (Hanson 1998; Hillier 1996). The former offers a configuration theory of architecture and urbanism. The latter examines the evolution of domestic space organization and family structure in Britain.

6.1.10 Fractal Cities

'Fractal cities: a geometry of form and function' by Michael Batty and Paul Longley was published in 1994. The book continues a line of research initiated by Benoit Mandelbrot in the 1950s and expands the collaboration between Batty and Longley, developed mainly after the mid-1980s in the University of Wales, Cardiff (in the mid-1990s Batty was based at Buffalo and Longley at Bristol). The book proposes the application of fractal geometry to cities. The authors argue that cities are fractal in form, and that much of the pre-existing urban theory is a theory of the fractal city.

One crucial idea supporting the book is that the world is apparently chaotic, discontinuous, and irregular in its superficial physical form, but underneath this first visual impression, there is an order which is regular and complex. A framework for capturing this regularity (beneath irregularity) and complexity, being focussed on the geometry of the real world rather than on its abstraction by Euclidean mathematics, is offered by the authors. Fractals have a central role in this framework. Fractals are objects of any kind whose spatial form is not smooth, therefore, termed irregular, and whose irregularity repeats itself geometrically across many scales. This self-similarity and repetition of geometry at many levels or scales shows the existence of a stable process (or set of processes) operating to achieve these forms (Batty and Longley 1994; Mandelbrot 1982).

The book is in ten chapters divided into two main parts. The early chapters, from 'the shape of cities' to 'laboratories for visualizing urban form', present the basics of fractal geometry and discuss how it can be considered in the understanding of the physical form of cities. The next chapters, from 'urban boundaries and edges' to 'extending the geometry of systems to fractal cities', propose a new geometry for the measurement and simulation of fractal cities (it has a predominant two-dimensional nature).

The book proposes fractal geometry to link form and function (socio-economic dynamics)—two aspects that, according to the authors, have been addressed mostly in isolation throughout the second half of the twentieth century. It offers a new way to think about cities and suggests that it can be adapted to specific contexts. Yet, it also states one limitation of fractal methods: these are more adequate to the generic city than to real cities, being mainly expository rather than applicable.

6.2 Different Morphological Approaches

The second part of this chapter presents the main morphological approaches that have been developed over the last decades: the historico-geographical approach consolidated after the seminal work of M R G Conzen, the process typological approach structured around the work of another seminal figure—Saverio Muratori, space syntax, and the various forms of 'spatial analysis' (using Kropf, 2009 designation) including isovists, cellular automata, and agent-based models. This part of the book is complemented by an overview on some emerging approaches.

6.2.1 Historico-Geographical Approach

This sub-section is in three different parts. After considering the early influences of German human geography (Whitehand 1981), attention is given to the view and concepts that Conzen has developed, including the fringe belt, morphological region, and burgage cycle. The developments and characteristics of the school of urban morphological thought that is grounded in the work of Conzen, with a particular focus on the Urban Morphology Research Group and the central role of Jeremy Whitehand, are presented in the third part of the sub-section.

6.2.1.1 German Human Geography

The German human geography of the late nineteenth century has two fundamental texts (Table 6.1). In 1894, the historian (the only disciplinary exception in a context dominated by geographers) Johannes Fritz published *Deutsche Stadtanlagen*, a comparative study of more than 300 German cities. Key innovations of this study are

Table 6.1 German human geography, 1890–1939

Decade	Year of publication	Author (Institution)	Studies on cities
1890–99	1894	Johannes Fritz (Strasbourg)	*Deutsche Stadtanlagen* German city layouts
	1899	Otto Schlüter (Halle)	*Über den Grundriβ der Städte* On the ground plan of cities
1900–09	1903	Friedrich Ratzel (Leipzig)	*Die Geographische Lage der groβen Städte* The geographical location of large cities
1910–19	1916	Hugo Hassinger (Vienna)	*Kunsthistorischer Atlas von Wien* Art-historical Atlas of Vienna
	1918	Walter Geisler (Halle)	*Danzig: ein siedlungsgeographischer Versuch* Gdansk: an essay on the settlement geography
1920–29	1924	Walter Geisler (Halle)	*Die Deutsche Stadt: ein Beitrage zur Morphologie der Kulturlandschaft* The German town: a contribution to the morphology of the cultural landscape
	1925	Hans Dörries (Goettingen)	*Die Städte im oberen Leinetal,Göttingen, Northeim und Einbeck* The cities of Leinetal, Goettingen, Northeim and Einbeck
	1927	Hans Bobek (Vienna)	*Grundfragen der Stadtgeographie* Basic questions of urban geography
	1928	Rudolf Martiny –	*Die Grundriβgestaltung der deutschen Siedlungen* The layout of the German settlements
1930–39	1932	M. R. G. Conzen (Berlin)	*Die Havelstädte* The Havel cities
	1936	Herbert Louis (Berlin)	*Die geographische Gliederung von Gross-Berlin* The geographical structure of Great Berlin

the use of the town plan and cartography as a primary source of information for urban history. One of the relevant outputs is a classification of cities based on the type of plan. Five years later, and clearly influenced by Fritz text, Otto Schlüter published *Über den Grundriβ der Städte*. The paper develops the line of research on the town plan, including the identification of the different parts that constitute the city centre. Whitehand (2007) argues that this work was a pioneer of what would be designated, years later, as the morphogenetic approach. Another important aspect in Schlüter's work is the conviction that the study of the city necessarily involves the analysis of a wider territory.

In the first decade of the twentieth century, *Die Geographische Lage der großen Städte* by Friedrich Ratzel continues that line of research. One of the major contributes of this 1903 text, is the fact that it focuses not only on the location of cities, but also on the reasons and characteristics that lead to the selection of the original site for the foundation of human settlements.

In the following decade, two texts were published adding new dimensions to the study of location and genetic issues. Each of these texts studies in considerable detail one single city, Vienna and Danzig (present-day Gdańsk). In 1916, Hugo Hassinger published an art-historical atlas of Vienna, where he identifies, in the town plan, the architectural styles and the age of the buildings, using colour. The result of this analysis is a set of plans that constitutes a fundamental element for the conservation of the built heritage of Vienna. Like his colleagues, Hassinger argues that a plan could show a whole range of aspects than a text, a table, or a diagram. Two years later, a former student of Schlüter, Walter Geisler, published one of the most important texts of this period (Geisler 1918). Paradoxically, Geisler refers to the work of all authors described above, except for Hassinger. The book on Danzig is in two main parts, divided into 17 chapters. The first part addresses the physical, geographic, demographic, and economic conditions of Danzig. The second part focuses on the spatial organization and structure of the city. In addition to a wide set of tables and photographs of Danzig, the book contains a fundamental innovation, a few plans drawn by the author including the identification of land and building utilization, and the number of stories of residential buildings in the central area of the city (Fig. 6.7).

In 1924, Geisler published a new and influential book on German cities, *Die Deutsche Stadt*. The book proposes a classification of these cities based on the sites selected for their foundation, the ground floor, and the types of buildings. In 1925, Hans Dörries recovered the line of research developed by Hassinger and Geisler in the previous decade, identifying in the plan of a number of historic cities the age and the architectural styles of their buildings. In 1928, after a series of preliminary studies on cities of the Westphalia region, Rudolf Martiny published a text on the structure of German settlements. Like Geisler, four years earlier, Martiny aimed at defining a set of generic elements on German cities. Almost simultaneously, Hans Bobek published a paper on basic issues in urban geography. Hofmeister (2004) argues that this paper has laid the foundations for a change of direction in one of the dominant lines of German human geography. In general, from that date until the late twentieth century, the theme of urban functions gained predominance in relation to urban form matters.

Yet, two texts with a fundamental role in the origins of the historico-geographical approach and urban morphology itself were prepared in the 1930s. The first was Conzen's thesis completed in 1932 (one year before his migration to England), where he analyses the plan and building fabric of 12 cities located northwest of Berlin (the first and second elements of its tripartite division of the urban landscape). As Geisler, Conzen uses different colours to represent the number of storeys and the different building types of these cities. The second is the text by Herbert Louis (one of Conzen' s mentors) on the geographical structure of Great Berlin. In this book chapter, Louis introduces the concept of *Stadtrandzone* (fringe belt), an element of urban form

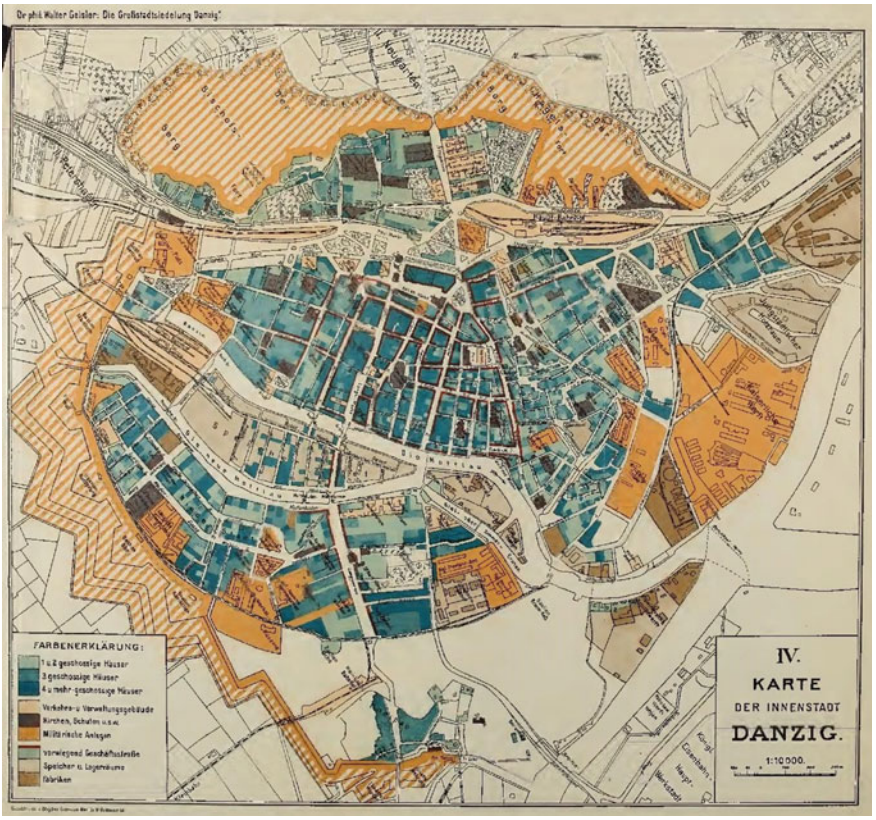

Fig. 6.7 The plan of *Danzig*. *Source* Geisler (1918)

composed of plots with a wide variety in terms of geometry and dimension, and whose formation at the edge of a built-up area is associated with a period of stagnation or of slow growth of this area and to how, some years later, that same area restarts its process of growth.

The work of German geographers in the early twentieth century had a crucial importance for the establishment of urban morphology as a science that studies the physical form of cities, as well as the agents and processes shaping it. This work had a strong influence not only in Germany (although a later influence) but also in other countries. In a review based on a number of national syntheses published in the journal 'Urban Morphology', under the designation 'The study of urban form in ...', I have identified a strong influence of these German authors on urban morphological studies developed in Poland, Ireland and England (Oliveira 2013). It is in England that this influence gained its utmost expression in the work of MRG Conzen. While after the 1930s, the morphogenetic approach would lose weight in German human geography, it would gain a new vitality in the following decades in the work that the geographer German, then emigrated, would develop in England.

6.2.1.2 The Ideas of MRG Conzen

MRG Conzen was born in 1907 in Berlin. Between 1926 and 1932 he studied geography, history, and philosophy at the University of Berlin. Among his teachers were Albrecht Penck and Herbert Louis. After the rise of the Nazi Party in 1933, Conzen emigrated to Great Britain. Between 1934 and 1936 he studied Town and Country Planning at the Victoria University of Manchester. He then started a consultancy activity in regional and town planning in Macclesfield, Cheshire. Simultaneously, he engaged in postgraduate research in historical geography at the Victoria University of Manchester. The beginning of the Second World War introduced profound changes in the life of Conzen, who was a German émigré living in England. In this period, Conzen lost his work in planning and eventually went back to geography, teaching first in the University of Manchester (1940–46), then in the University of Durham (1946–61), and finally in the University of Newcastle upon Tyne (1961–72). Conzen died in Newcastle upon Tyne in 2000.

Conzen has published few, but quite important, texts (Conzen 1958, 1962, 1988, 2004). Among these, 'Alnwick, Northumberland—a study in town-plan analysis', presented in the previous section, stands as one of the most important books on urban morphology published so far. Conzen's work offers a comprehensive framework for the study and design of the physical form of cities.

One of the key aspects of this framework is the tripartite division of the urban landscape, including the town plan (or ground plan), the building fabric, and land and building utilization. As mentioned above, the town plan is defined as the topographical arrangement of an urban built-up area in all its man-made features, containing three distinct complexes of plan elements: (i) streets and their arrangement in a street system; (ii) plots and their aggregation in street blocks; and (iii) block plans of buildings.

Another crucial aspect is the development of concepts on the process of urban development. In this book, we will focus on three of these concepts: fringe belt, morphological region, and burgage cycle. As mentioned above, the fringe-belt concept was first recognized in Berlin, in 1936, by Louis, but was developed to a far greater degree of sophistication by Conzen in his studies on Alnwick and Newcastle upon Tyne.

The fringe-belt concept draws on the acknowledgement that the outward growth of an urban area is very uneven in its progress. Indeed, the growth of a city is made up of a series of outward expansions of the residential area separated by marked pauses. A fringe belt tends to form at the urban fringe during a period when the built-up area is either not growing or growing only very slowly. It includes within it many relatively open areas, often vegetated, such as parks, sports grounds, public utilities, and land attached to various institutions (Whitehand 2007).

In Alnwick, Conzen identified three distinct belts: an inner and a middle fringe belt, embedded within the built-up area, and an outer fringe belt at the present edge of the town (in Fig. 6.8, these are in black, red, and green, respectively). The Inner Fringe Belt developed around the 'fixation line' (another concept developed by Conzen)

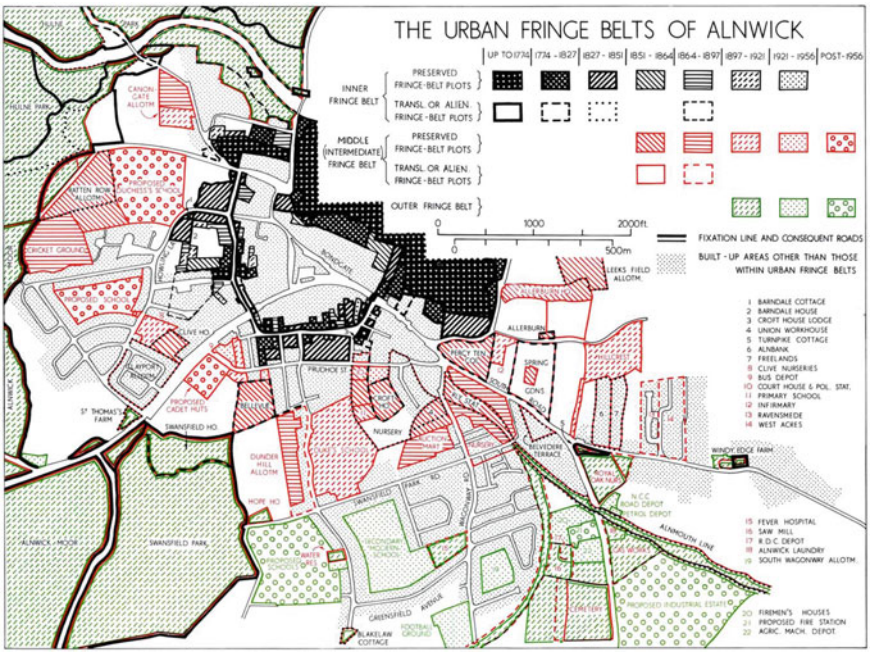

Fig. 6.8 The urban fringe belts of Alnwick. *Source* Conzen (1960)

of the mediaeval town wall. Conzen's fundamental contribution was to incorporate fringe-belt patterns within the city into an elaborated morphological theory of interactions between formative and transformative spatial processes of all kinds as evidenced in the detailed cartographic record of a city's physical evolution. As part of this, he developed an intricate classification of processes in fringe-belt formation and subsequent modification in Alnwick and, later, in Newcastle upon Tyne. Conzen continued to apply the concept in other places including Ludlow, Conway, and metropolitan Manchester (Conzen 2009b).

For Conzen, the climax of the exploration of the physical development of an urban area was the division of that area into morphological regions (Whitehand 2001). A morphological region is an area that has a unit in respect of its form that distinguishes it from surrounding areas. Between the late 1950s and the late 1980s, Conzen demonstrated in traditional British cities how the way in which the urban landscape is traditionally stratified, reflecting the distinctive residues of last periods and giving rise to a hierarchy of morphological regions—that can be represented in a composite map including regions of a different order. While in Alnwick, Conzen has identified a four-tier hierarchy of regions mainly based on the town plan (Conzen's main focus in the analysis of that market town), in Ludlow, he identified a five-tier hierarchy based not only on the town plan, but also on the building fabric, and land and building utilization. Table 6.2 synthesizes the contribution of different morphological attributes to urban landscape characterization.

Table 6.2 The contribution of different morphological attributes to urban landscape characterization. Adapted from Whitehand (2007b)

Attribute	Persistence	Contribution to hierarchy (rank)
Ground Plan	High	Mainly high and intermediate
Building Fabric	Variable, but often considerable	Mainly intermediate and low
Land Utilization	Low	Mainly low and intermediate

One of the distinctive characteristics of Conzen' s work is the detail of analysis. In this context, the relationship between plots and the block plans of buildings assumed a fundamental role. This relationship was conceptualized in the 'burgage cycle': the burgage being the landholding of an enfranchised member of a mediaeval borough; the cycle consisting of the progressive filling-in with buildings of the backland of burgages, terminating in the clearing of buildings and in a period of urban fallow prior to the initiation of a redevelopment cycle. In Alnwick, the burgage cycle is illustrated by the evolution of the Teasdale's Yard, in Fenkle Street, between 1774 and 1956. This cycle is a particular variant of a more general phenomenon of building repletion, where plots are subject to increasing pressure, often associated with changed functional requirements, in a growing urban area (Whitehand 2007a).

6.2.1.3 JWR Whitehand and The Urban Morphology Research Group

It was JWR Whitehand who effectively structured a new school of urban morphological thought grounded on the seminal work of MRG Conzen. Over half a century, Whitehand has been a key contributor to the definition of urban morphology as a field of knowledge and, within it, to the establishment of the historico-geographical approach, proposing and refining some morphological theories, concepts, and methods (Conzen and Oliveira 2021; Oliveira 2019). He founded the UMRG at the University of Birmingham, in 1974. The group is the principal centre in the United Kingdom for the study of historico-geographical aspects of urban form, having a significant set of international linkages, and playing a major role in the organization and development of the 'International Seminar on Urban Form', including its annual conferences and its journal 'Urban Morphology'.

The next paragraphs describe the development of the three concepts presented in the last sub-section, fringe belt, morphological region, and burgage cycle. It is inevitable to refer Whitehand's role in the development of the fringe-belt concept in such a way that his contribution is as important as that of Louis and Conzen. Not only he has explored new aspects of its spatial dimension, from city to conurbation and from static to dynamic (Whitehand 1967), as he added it an economic (Whitehand 1972a, b), an agency, and a planning perspective (Whitehand and Morton 2003, 2004), confirmed its validity in different geographical contexts (Whitehand et al.

2011; Conzen et al. 2012) and explored its ecological significance (Whitehand 2019). While Michael Barke has significantly extended the dynamic understanding of the concept, addressing plot changes, and the economic perspective (Barke 1974, 1990), Michael Hopkins had explored the ecological characteristics of fringe belts with a focus on habitat patches (Hopkins 2012). In 2009, M P Conzen published a comparative assessment of the concept's performance in the different cultural settings in which it has been applied, reflecting on the efficacy and limits of the concept itself to identify and account for variations in the texture of urban form across urban areas in these diverse cultural contexts (Conzen 2009b)—Fig. 6.9 offers an outlook on fringe belts in different European metropolitan areas. Finally, in 2013, Tolga Unlu offered a state of the art on this concept highlighting the distinctive characteristics of four types of emphasis—spatial, economic, social, and planning (Unlu 2013).

In the last decades, there have been applications and adaptations of the concept of morphological region and the method of morphological regionalization in all continents, and demonstrations of their potential in conservation and heritage planning. One important study was developed by Nigel Baker and Terry Slater in the beginning of the 1990s (Baker and Slater 1992). Taking the core of Worcester as a case study, Baker and Slater provide evidence for interpreting some plan units as planned extensions created within a short period and others as products of piecemeal development. The level of detail in explaining the application of the method is rather unusual. The first application of the method to a large city was developed by Barrett (1996). Focussing on the city-centre conservation areas of Birmingham and Bristol, Barrett developed the methodological procedure, paying particular attention to how the different maps of units of each of the form complexes are elaborated and then combined into a composite map. Bienstman (2007) offered what is perhaps the most comprehensive discussion of the concept and method, addressing important issues such as the production of the composite map and the detail of regionalization. It was the first comparative regionalization study between cities in different countries. Whitehand and Gu (2007) applied the Conzenian approach in Pingyao—the first comprehensive application in Asia. They defined the components and stages of the plan layout using Conzen's method of plan analysis (Conzen 2018). Although the boundaries of plan units are not identified, several components are recognized for the delimitation of such units. In the last years, two comprehensive reviews on the concept have been published (Whitehand 2009; Oliveira and Yaygin 2020). They state the need for stronger linkage between each regionalization and the historico-geographical body of knowledge, greater clarity in the methods of characterizing and delimitating these units, and wider appreciation of their role in planning (the plan for Barnt Green, by Jeremy and Susan Whitehand, stands out as a notable example of this potential of application).

Terry Slater continued the line of research on plots—particularly on the boundaries and dimensions of plots—showing how metrological analysis can be used to reconstruct the histories of plot boundaries. By analyzing measurements of plot widths in Ludlow, Slater was able to speculate about what was in the mind of the mediaeval surveyor when the area was first laid out for development and infer both the original plot widths and how they were subsequently subdivided (Slater 1990).

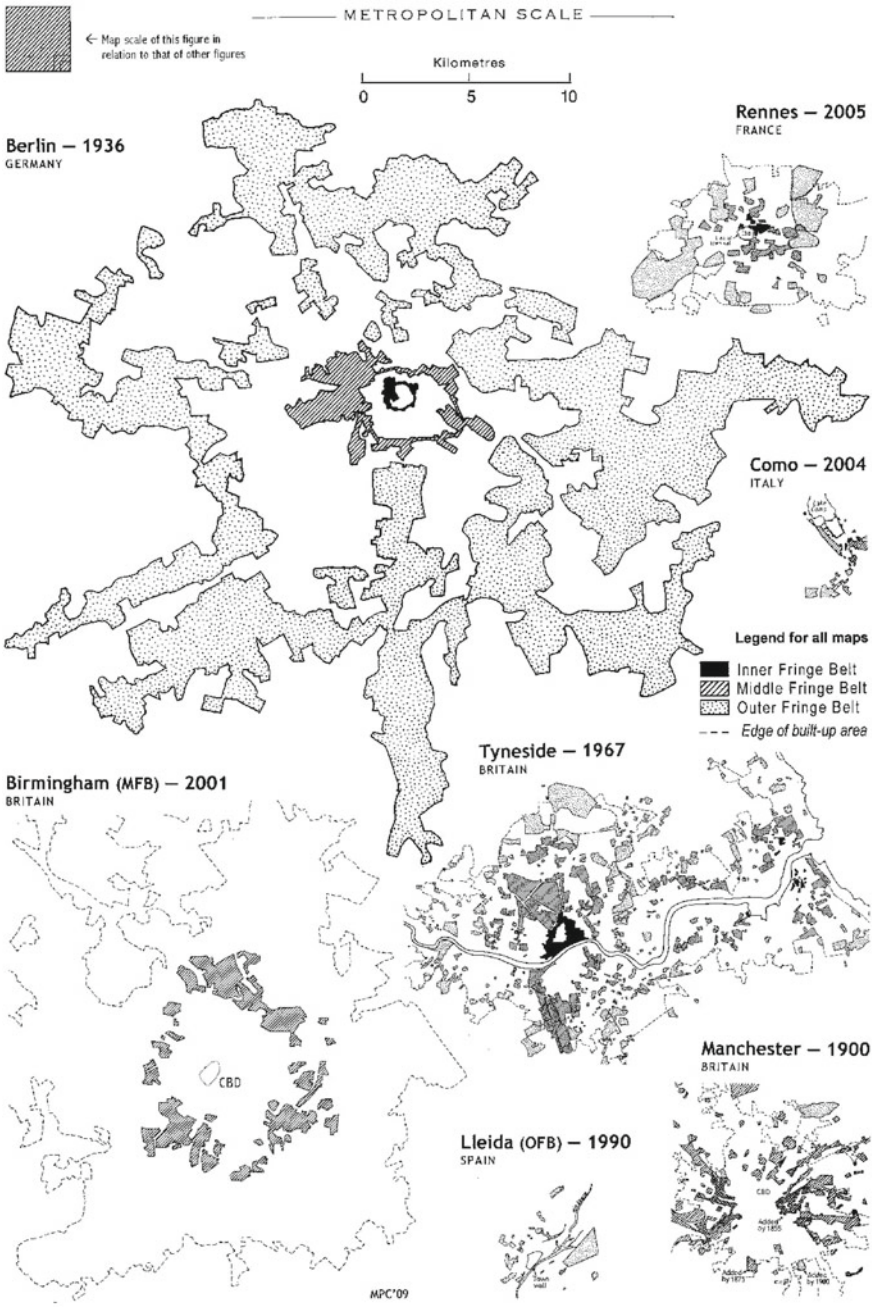

Fig. 6.9 Fringe belts at the metropolitan scale: European cases. *Source* Conzen (2009b)

6.2.2 Process Typological Approach

This sub-section is in three parts. The first and second parts are on the seminal works of Saverio Muratori and Gianfranco Caniggia analyzing their activity, in terms of research, teaching, and architectural practice. The recent developments of the approach, including a second and third generation of researchers, are described in the last part of the sub-section.

6.2.2.1 Saverio Muratori and His Antecedents

Saverio Muratori was born in 1910 in Modena. Between 1928 and 1933, he studied architecture at the *Regia Scuola Superiore di Architettura* at *Valle Giulia*, Rome. Among his teachers were Arnaldo Foschini, Enrico Calandra, and Gustavo Giovannoni. In the second half of the 1930s, he started a collaboration with Ludovico Quaroni and Francesco Fariello, developing several plans and projects on his own. During the years of post-war reconstruction, Muratori was deeply involved in the housing plans of the *Istituto Nazionale della Assicurazioni* (INA)—a programme coordinated by Foschini. In 1952, he was called to teach in Venice, returning to Rome two years later. The years in Venice were fundamental for the theory and practice of Muratori—the *Studi per una operante storia urbana di Venezia*, presented in the previous section, and the competition for Barene di S. Giuliano, that will be described in the next chapter, are part of this most fecund period. As Muratori's ideas and work were radically removed from fashionable trends, he was confronted by students and colleagues leading to his increasing isolation. Muratori died in Rome in 1973.

As mentioned above, Gustavo Giovannoni was one of Muratori's teachers. Giovannoni's most important work, *Vecchie cittá ed edilizia nuova*, is a treatise of urban design. Starting from a historical framework, it deals with the principles of urban growth and transformation as they emerge from an analysis of different geographical situations over a long-time span. Giovannoni argued that tradition and modernity could cooperate within a concept of organicity in which the historical centres were sites for acts of contextualism and the new expansions could be realized through satellite quarters. The main problem would become the investigation of the seam between the new quarters and the old urban structure—as it happened in the past. By analyzing specific case studies, he formulated the ideas of permanence of the planimetric pattern and of the city plan as a palimpsest, where the dense stratification of different layers would reveal the progressive, partial accretions, and erosions of the initial implantation (Marzot 2002).

In his paper *Saverio Muratori: il debito e l'eredità*, included in the book *Saverio Muratori Architetto*, Giancarlo Cataldi (one of the main proponents of the process typological approach) divides the activity of Muratori in five different periods corresponding to five different decades (Cataldi 2013). The first period (1930–40) designated as 'professional experimentation' includes the first years after Muratori received his degree. In this period, he prepared a series of articles for the journal

Architettura on the most recent architectural projects in Europe. His planning and architectural practice over this decade included the plans for *Aprilia* and the mining town of *Cortoghiana*, and a set of projects demonstrating his interest in the composition of Italian squares, as major urban themes, in which the surrounding environment supports the design of the square.

The second period, in the 1940s, corresponds to the development of a theoretical and operational perspective. In this period, Muratori wrote several essays where the ideas of towns as living organisms and collective works of art, and of planning new buildings in continuity with the building culture of the place seem to emerge. Simultaneously, Muratori had his first teaching experience as an assistant of Foschini and Calandra, his former teachers at *Valle Giulia*. The INA-Casa programme, including some Roman districts like *Tuscolano*, is launched in the late 1940s. By then, the church of *S. Giovanni al Gatano*, in Pisa, is erected. The building tries to capture the fundamental characteristics of Romanesque architecture.

The city is the main theme of the third period of Muratori's activity. In this period, Muratori designs two major public buildings, the *Ente Nazionale di Previdenza ed Assicurazione Sociale* (ENPAS), in Bologona, and the headquarters of the Christian Democratic Party at the *Esposizione Universale Roma* (EUR) district. As in the church in Pisa, these projects embrace two of the most significant periods in the history of Italian architecture—the Gothic and Renaissance, respectively. After an initial stage where a conceptual gap between these complex and original buildings and the plans for entire quarters could be found, at the end of the 1950s, and notably at the competition for *Barene di S. Giuliano*, a strong link between research and both architectural and planning practice is established. The plan comprised the recreation in a modern version, on the sides of the lagoon, of three particularly significant moments of Venice's urban history (we will get back to this plan in Chap. 7). After the first experience in Venice as a professor of Distributive Characteristics of Buildings, in the beginning of the decade, Muratori returned to Rome, in 1954, to replace Foschini as professor of Architectural Composition.

Territory and civilization are the fundamental themes developed by Muratori in the 1960s. Drawing on the Venice experience, *Studi per una operante storia urbana di Roma*, published in 1963, is a comprehensive atlas of the Italian capital (Fig. 6.10). By then, Muratori started to concentrate his philosophical reflections on wider issues outside the disciplinary field of architecture. *Achitettura e civilità in crisi*, analyzing the processes of self-awareness, and *Civilitá e territorio*, sustaining the idea of the architectural crisis as an expression of a more general crisis, are two examples of this wider line of thought (Muratori, 1963, 1967). For Muratori, the only way to solve the crisis lay in the capacity of human beings to establish, on a global scale, a balanced relationship with their territories (Cataldi et al. 2002).

In his last years, Muratori devoted himself to teaching and research, in a rather difficult context. This final stage of his teaching activity was strongly based on synoptic charts and diagrams. In research, in the unconcluded projects of *Atlante territorial* and *Tabelloni,* Muratori was trying to establish a universal classification of man-made structures.

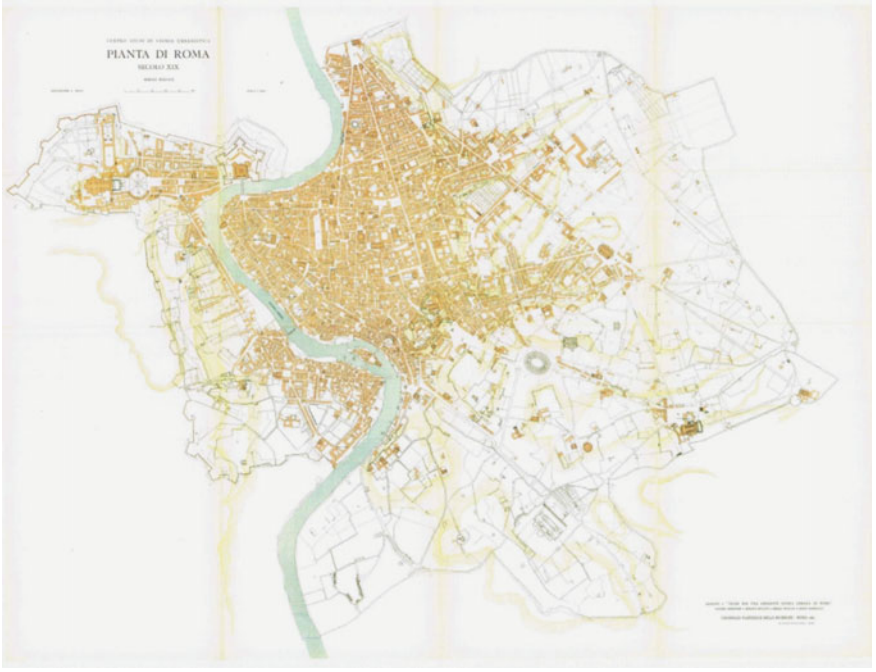

Fig. 6.10 *Studi per una operante storia urbana di Roma*. *Source* Muratori et al. (1963)

6.2.2.2 Gianfranco Caniggia

In the early 1960s, in Rome, Muratori's team of assistants began to form. One of these assistants was Gianfranco Caniggia. Caniggia was born in 1933 in Rome, having enrolled in the faculty of architecture at *Valle Giulia* in the early 1950s where he had Muratori as a teacher. At the time, the main Italian architects, including professors like Muratori, were fully committed in developing the *Istituto Nazionale delle Assicurazioni* (INA)-Casa housing scheme.

In 1963, after his first architectural works with his father Emanuele (the residential building in *Via della Trinità dei Pellegrine* in Rome and the elementary schools and hospital in Isola Liri) and with Adelaide Regazzoni (the residential and commercial building in Albiolo, Como), Caniggia concluded *Lettura di una città: Como* (supervised by Muratori), his first major contribution to urban morphology and building typology (Caniggia, 1963). The 'switchback' interpretation of the process of urban development enabled him to grasp in face of Roman row houses, the persistence of the *domus* as a type of substratum (Cataldi et al. 2002). This was a fundamental intuition that opened a line of research on the formation procedures of mediaeval courtyard houses in European historic cities, which would be explored in the book *Strutture dello spazio antropico* published in the subsequent decade (Caniggia 1976). As an assistant of Muratori in the 1960s, Caniggia started to work on urban tissues (as

Renato Bolatti and Sergio Bolatti), while Paolo Maretto on aspects of architectural language and Alessandro Giannini on the territorial scale.

In the 1970s, Caniggia had to leave Rome, and teach in Reggio Calabria (1970), Genoa (1971–78), and Florence (1979–81). Yet, this long trip would be one of the reasons for the diffusion of the process typological approach all over Italy. In Genoa and Florence, Caniggia developed a methodology for the interpretation of cities and their components. He progressively managed to accumulate sound teaching experience, forming the material for the preparation of *Composizione architettonica e tipologia edilizia*, written with Gian Luigi Maffei, and divided into two volumes. The first volume, on the interpretation of basic buildings, was published in the late 1970s (Caniggia and Maffei 1979). The book structure is based on the different geographical scales: it starts at the building scale (the historical development of building types), moves to aggregations of buildings, entire settlements, and finally to relationships between settlements, especially the routeways linking distinct settlements.

Cannigia returned to the faculty of architecture of Rome in 1982. Two years after, he published the second volume of *Composizione architettonica e tipologia edilizia*, on the design of basic buildings (Caniggia and Maffei 1984). Caniggia developed one of his fundamental architectural projects in the 1980s—the Quinto quarter in Genoa, where he applied what he had learnt about the peculiar characteristics of the Genoese urban environment.

One of the main concerns of Cannigia was to communicate Muratori's ideas in architectural terms. Caniggia simplified and reduced the theoretical system, highlighting its more directly operative aspects. In this sense, the significance lies in the use and importance in his writings of the terms and concepts of type, building fabric, and basic building—the formative matrix of the specialized building (Cataldi et al. 2002).

Table 6.3 identifies some differences between the work of Muratori and Caniggia. Muratori deductively aimed at conceiving a philosophical system capable of interpreting the history of civilization process-wise through architecture. Caniggia, in contrast, inductively set up a typological method capable of interpreting human environmental transformations in terms of design for architectural purposes (Cataldi 2003).

Table 6.3 Basic distinctions between Muratori and Caniggia

Muratori	Caniggia
Theory	Method
Organism	Structure
Organic	Serial
Architectural organism	Building type
Architecture	Building
Territory	Town

Source Cataldi (2003)

Cataldi (2003) identifies six major contributions of Caniggia to the process typological approach: (i) the examination and development of Muratori's concepts of type, typology, structure, tissue, series, and seriality; (ii) the establishment of the method of processual typology; (iii) the discovery and recognition of the Roman *domus* courtyard substratum as the matrix of all subsequent basic types; (iv) the distinction between basic and specialized building; (v) the theory of medievalization regarding the spontaneous utilization procedures of planned structures; and,finally, (vi) the method of interpretation by phases of a city's history in connection with basic typological processes.

Gianfranco Caniggia died prematurely in 1987. His last writings, mainly unpublished, were collected by Gian Luigi Maffei in the posthumous volume *Ragionamenti di tiplogia* published one decade later (Maffei 1997).

6.2.2.3 Recent Developments

As it happened with Caniggia, in the beginning of the 1970s, the other assistants of Muratori had to leave Rome. The reform in architectural studies in 1970 created new faculties and, as such, new opportunities for teaching. Luigi Vagnetti, a colleague of Muratori, had a fundamental role in this process, inviting in a first moment, Paolo Maretto (and Caniggia) to Reggio Calabria; and, in a second moment, Alessandro Giannini and the Bollati brothers to Genoa and Florence. The work of Maretto had two clear interests, the organization of the typological studies according to the four fundamental interrelated scales of man's context and linguistic experimentation. The city of Venice had, since his student days, a key role in his research (Fig. 6.11)

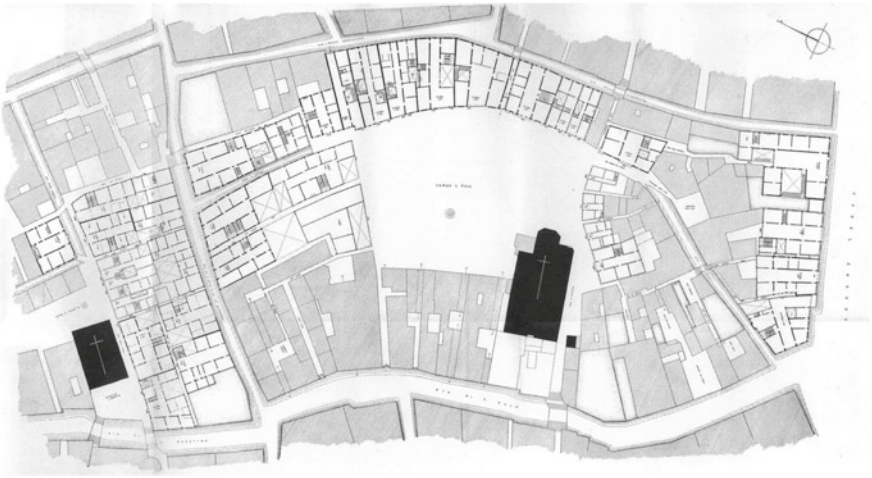

Fig. 6.11 *L' edilizia gotica Veneziana. Source* Maretto (1960)

(Maretto, 1960, 1986). The reading of the territorial scale was the main theme developed by Alessandro Giannini, including research on Ethiopia and Italy (*Liguria* and *Ostia Antica*). Renato and Sergio Bollati focussed on urban tissues, with systematic research and architectural practice in Rome, Venice, and a few Calabrian and Sicilian cities.

Recent developments of the process typological approach were framed by two different organizations, the *Centro Internazionale per lo Studio dei Processi Urbani e Territoriali* (CISPUT) and ISUF Italia, a regional network of ISUF. CISPUT was founded in Pienza, in 1981, by Giancarlo Cataldi and a few Italian and American colleagues. The aim was to offer a stage for architects and architectural historians to meet for comparative analysis and to explore the robustness of Muratori's framework (Cataldi et al. 2002). CISPUT was very active over almost three decades, organizing more than 20 conferences in different Italian cities, from Pienza to Modena. After the first foundation in 2007, in Rome, *ISUF Italia* was refunded in 2014 at a conference in the Italian capital. The re-foundation of *ISUF Italia*—under the presidency of Giuseppe Strappa—coincided with the beginning of the preparation of ISUF 2015 Rome, and the launching of a new journal, 'U+D Urbanform and Design', devoted to the relationship between urban morphology and architecture.

The origins and development of CISPUT and ISUF Italia are framed by two Italian researchers, Giancarlo Cataldi (ISUF president between 2013 and 2017) and Giuseppe Strappa. Giancarlo Cataldi, a former student of Muratori based in Florence, has played a leading role in the promotion of the process typological approach over the last three decades, devoting a significant part of his work to reconstructing its disciplinary history. His main research interests include territorial interpretation and typological processes, comprising the theme of primitive architecture. Three recent papers on Rome, Florence, and Valencia illustrate the former (Cataldi 2016, 2017; Cataldi and Lorens 2018). In all these, Cataldi makes evident the role of *substratum* permanent structures ensuring continuity in the transition between different historical periods. The development of the medievalization theory proposed by Caniggia is most evident in the Rome paper. The notable book 'Primitive dwellings' expresses Cataldi's interest in the evolutionary process of building types in the world. The book offers a typological reading of shelters, tents, huts, and houses in different geographical areas based on their dominant materials—wood, earth, and stone (Cataldi 2015). Finally, it should be highlighted the central role of Pienza in Cataldi's work—see, for example, *Pienza Forma Urbis* (Cataldi and Formichi 2007).

Giuseppe Strappa, based in Rome (after an experience in Bari), has also been developing some of the main ideas of the process typological approach. One major distinction in relation to Cataldi's work is the explicit concern on the relation between the analysis of the urban landscape (based on the concepts of routes, poles, basic buildings, and specialized buildings) and its design (Strappa 2018). This has been illustrated in a recent book on small towns of the Lazio region (Strappa et al. 2016). Another core concepts in Strappa work are organism and process—see, for instance, *L'architettura come processo* (Strappa 2014).

Another researcher with a crucial role in this second generation is Gian Luigi Maffei. As mentioned above, Maffei has integrated and published Caniggia's unfinished studies after his death. Continuing the line of research he had inaugurated with Caniggia in the late 1970s, and developed in the mid-1980s, he has published *Lettura dell' edilizia speciale* (Maffei and Maffei 2011). The main contribution of the book is extending the concept of typological process by explicitly applying it to specialized buildings. In addition, Maffei has published two books on Florentine and Roman (co-authored with Paolo Carlotti and Lucian Bascià) houses that analyse the evolution of the residential buildings against the background of the evolution of these two cities (Maffei, 1990; Bascià 2000).

Finally, it is possible to distinguish the third generation of researchers of the process typological approach who did not work directly with Muratori or Caniggia. Two of the most important are Nicola Marzot and Marco Maretto, the son of Paolo Maretto. As in the case of Cataldi, Strappa, and Maffei, they both continue to promote different aspects of the work of Muratori and Caniggia. Marzot has been contextualizing the process typological against other Italian approaches, namely: the theory developed by Aldo Rossi that was analyzed in the previous section (see for example, 'The study of urban form in Italy' – Marzot, 2002). Two important books published by Maretto are 'Saverio Muratori—a legacy in urban design' and 'London squares'. The former explores the architectural practice of Muratori at an urban scale, analyzing some plans, from *Aprilia* to *Barene di San Giuliano*. The latter addresses one element of urban form—squares (Maretto, 2013). In addition to this reading of the work of Muratori and Caniggia, both Marzot and Maretto have been exploring the theme of sustainability, the relation between the historico-geographical and the process typological approaches, and the relation between research and practice.

6.2.3 Space Syntax

This sub-section is in two parts. It starts by describing the origins of space syntax and the seminal texts by Bill Hillier and Julienne Hanson, moving then to the main characteristics and fundamental developments of this configurational approach over the last decades.

6.2.3.1 Bill Hillier, Julienne Hanson, and the Origins of space syntax

While the core of a more quantitative approach to urban form analysis was, in the 1960s, in the centre of 'Land Use and Built Form' (LUBFS), at Cambridge University, directed by Leslie Martin and Lionel March, at the mid-1970s, it gained a new impetus with the creation of the 'Unit for Architectural Studies', at University College London (UCL), directed by Bill Hillier. Space syntax research began in this unit, aiming at understanding the influence of architectural design on social problems in many housing estates that were being built in the United Kingdom.

In addition to an interesting set of seminal papers published in the 1970s during the first years of this research programme (Hillier 1973; Hillier et al. 1976), three books by Bill Hillier and Julienne Hanson must be highlighted, 'The social logic of space' (Hillier and Hanson 1984), 'Space is the machine' (Hillier 1996b) and 'Decoding homes and houses' (Hanson 1998). The first was already presented in the previous sub-section. The second book, 'Space is the machine', is a synthesis of the developments of space syntax throughout the 1980s and early 1990s, highlighting the configurational and analytical (and opposed to normative) dimensions of this theory. The book is in four parts. The first part, 'Theoretical preliminaries', deals with the most basic questions which architectural theory tries to answer: what is architecture and what are theories (?). The second part, 'Non-discursive regularities', sets out a number of studies in which regularities in the relation between spatial configuration and the functioning of built environments have been established using 'non-discursive techniques' of analysis to control the architectural variables. The third part, 'The laws of the field', uses these regularities to reconsider a fundamental question in architectural theory: how is the field of possible spatial complexes constrained to create those that are actually found as buildings (?). Finally, the last part of the book, 'Theoretical syntheses', draws together some of the questions raised in the first part, the regularities shown in the second, and the laws proposed in the third part, to suggest how two central problems in architectural theory—the form-function problem and the form-meaning problem—can be reconceptualized. In synthesis, the book is concerned with what buildings and cities are like, why they are as they are, how they work, how they come about through design, and how they might be different.

The third book, published two years after 'Space is the machine', examines the evolution of domestic space organization and family structure in Britain through many accounts of historic houses, examples of speculative homes, and innovative, contemporary domestic architecture. 'Decoding homes and houses' shows how domestic space provides a shared framework for everyday life, how social meanings are created in homes and houses, and how different sub-groups in society differentiate themselves through their patterns of domestic space and lifestyles.

6.2.3.2 Main Characteristics and Developments

The focus on space and the relationships between space and movement are two fundamental aspects of space syntax. In seminal texts, like 'The social logic of space', this focus has emphasized the boundaries between space syntax and other theories. Hillier and Hanson believed that most of these theories were discussing space in terms of its defining surfaces. Others were debating space on its own and not the relationships within buildings and urban areas, which was the purpose of space syntax. Hillier and Hanson argue that a descriptive autonomy for space can be established, enabling the consideration of a wider morphological variety to reflect the different relationships between space and society. A new view of architecture and city is proposed, emphasizing those urban spaces where people move through

and where social and economic activities are carried out. Spatial configuration is a key concept in this approach, meaning the relationships between two spaces within a system considering their relationships with all other spaces in that system (Hillier et al. 1987). Spatial configuration is thus a more complex concept than 'spatial relationship' that considers only two spaces.

Space syntax offered a new perspective on the relationships between space and movement, either pedestrian or vehicular. Contradicting theories that pointed to the existence of flows to and from attractor land uses as the main explanation for these relationships, space syntax suggested that the configuration of the urban layout itself is the main generator of movement patterns. Hillier et al. (1993) designate the movement generated by the layout configuration as natural movement. They sustain that movement has a morphological dimension or, in other words, it is a functional product of the intrinsic nature of the layout. As such, movement, and space use in general, cannot be separated from urban form.

The way spatial relationships in a building or an urban area are represented is another distinctive element of space syntax. This representation can be translated into different maps. For many years, the dominant representation in space syntax was the axial map, which is constituted by the least set of axial lines covering the whole system, in a way that any convex space is crossed by one of these lines (Hillier and Hanson 1984)—Fig. 6.12. The axial line is the longest line that can be drawn through an arbitrary point in the spatial configuration. The axial map can be translated into a graph, which is a finite set of nodes, called vertices, connected by links, called edges.

Several topological measures can be extracted from that graph to quantify the characteristics of the spatial configuration. Global integration (radius n), local integration (a small radius, usually 3), and choice are some of the topological measures used in axial analysis. Global integration measures the relative depth of each axial line to all other lines of the system. Local integration calculates the accessibility of each line up to some (usually three) steps away. Choice measures the potential of each line to be part of the shortest path routes of the system. Two types of movement are addressed by these measures: integration focuses on the 'to-movement', and choice is centred on the 'through-movement'. The first is associated with centrality, the second is related to hierarchy. One key aspect of space syntax is the possibility to verify the movement potential represented in these maps through in loco measurement of real patterns of movement (procedure guidelines are gathered by Vaughan 2001).

The axial map has been one recurrent theme in space syntax literature since the millennium. A key issue in the definition and generation of the axial map has been the passage from handmade to computer-aided drawings. Some authors have criticized this passage allegedly because it did not bring higher objectivity to the production of axial maps, and it still allowed different users to obtain distinct maps based on the same cartographic representation. The key contributions to the improvement of axial maps came from some leading proponents of space syntax, such as Carvalho and Penn (2004) and Turner et al. (2005). Carvalho and Penn (2004) sustained the idea of scale invariance in a range of line lengths composing a sample of different maps. Culminating a two-decade process to translate the definition of the axial map

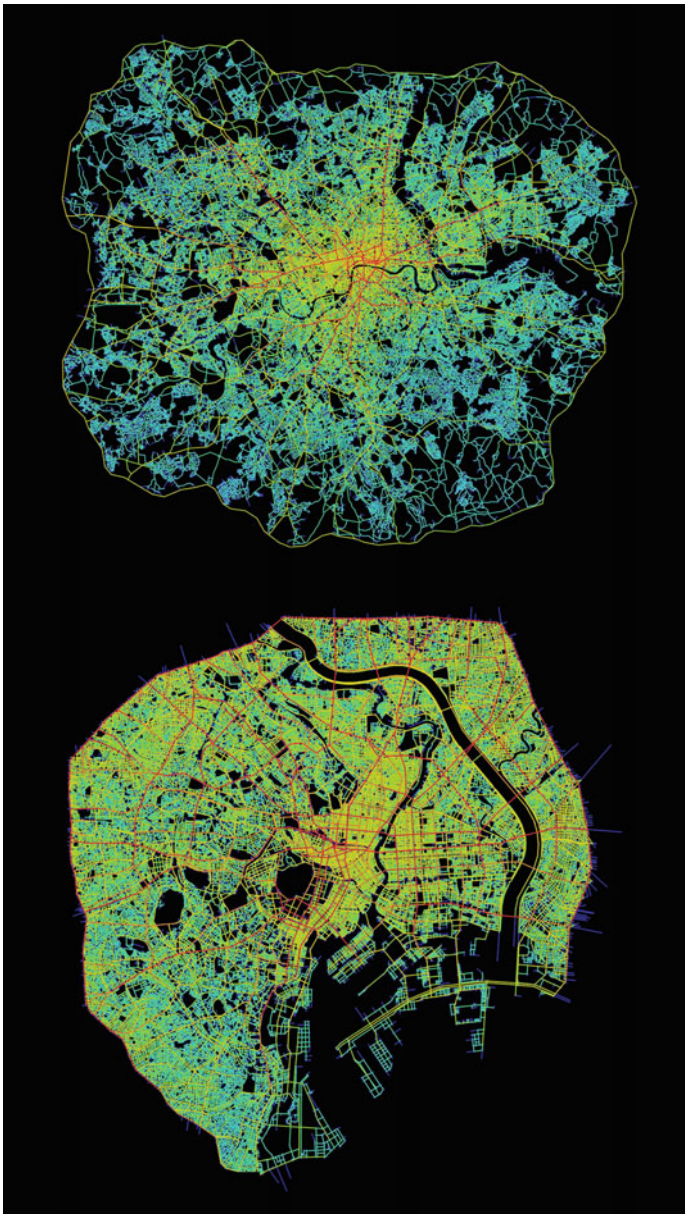

Fig. 6.12 The axial maps of London and Tokyo. *Source* Hillier (2014)

in mathematical terms, Turner et al. (2005) offered an algorithm for the construction of the axial map.

In the last decade, segment analysis has been progressively utilized by an increasing number of researchers. A significant part of the impetus for this increase came from the use of DepthMap software. The basic element in segment analysis is the street segment between intersections. DepthMap generates the segment map automatically from the least line or axial map, or from road centre line data. It allows three definitions of the distance between each segment and each of its neighbours: (i) metric, that is the distance in metres between the centre of a segment and a neighbouring segment; (ii) topological, assigning a value of 1 if there is a change of direction between a segment and a neighbouring segment, and 0 if not; and finally, (iii) geometric, assigning the degree of the angular change of direction between a segment and a neighbour, so straight connected are 0-valued and a line is a sequence of 0-valued connections, so that the linear structure of cities is captured. It then uses these three concepts of distance to calculate two kinds of measure: syntactic integration, or mathematical closeness, which measures how close each segment is to all others under each definition of distance; and syntactic choice or mathematical betweenness, which calculates how many distance-minimising paths between every pair of segments each segment lies on under different definitions of distance. Using the metric definition of distance, we find the system of shortest path maps for integration and choice, with the topological definition, we find the system of fewest turns maps, and with the geometrical definition, we find the system of least angle change maps (Hillier 2009).

Both axial and segment analysis allow addressing the street system at very different scales, from the detailed description of one public space to the comprehensive understanding of a whole city, region or even a country (Serra and Pinho 2013; Serra and Hillier 2019). The construction of these analytical models to describe and explain the present, or past, street systems (Pinho and Oliveira 2009), also allow the evaluation of different alternatives for the future transformation of these systems. Space syntax does not 'draw' new proposals; proposals are drawn by architects or planners, and then evaluated using spatial syntax. Space syntax is neither ideological nor normative; the evaluation of new proposals is based on how these are related to the existing city.

Two other forms of representation should be referred, isovists and visibility graph analysis. An isovist is the set of all points visible from a given vantage point in space and with respect to an environment. The shape and size of an isovist changes when moving through space (Benedikt 1979). Visibility graph analysis integrates all isovist fields of a given space, measuring the intervisibility connections of the urban space. It is a raster-based method, that has replaced convex space analysis, calculating how each cell relates to all other cells of the grid covering space (Turner et al. 2001; van Nes and Yamu 2021).

Over the last decades, space syntax has made evident that the street system of a city is a dual network. On the one hand, there is a foreground network, which represents the main structure of the city, consisting of a reduced number of longer streets, attracting mainly non-residential uses, and being related to micro-economy.

On the other hand, there is a background network, corresponding to a network of greater proximity, composed of many shorter streets, attracting mostly residential uses, and being related to sociocultural factors.

One key issue of debate has been the edge-effect (Eisenberg 2007; Ratti 2004). Drawing on the analysis of an ideal urban system in two distinct situations—self-contained, and in communication with another system—Ratti (2004) argues that space syntax results are influenced by the size of the area of the city under consideration. Over the years, a number of approaches have been proposed to deal with this issue: extending the network model for analysis with a 'catchment area of the catchment area' around the area of interest (Hillier et al. 1993); using a radius of analysis working as a moving boundary to calculate local measures (Penn et al. 1998; Hillier and Penn 2004; Turner 2007); or a specific 'radius radius' based on the mean depth of the most integrated line in the system (Hillier 1996). More recently, Gil (2016) has demonstrated that some measures are affected differently by the edge-effect, and that the same measure is affected differently depending on the type of distance used.

The incorporation of three-dimensional information in space syntax's graphic representation is another theme of the debate (see for example Hillier and Penn 2004; Ratti 2004a, 2005; Wang et al. 2007; Kim et al. 2019). On the one hand, one of the major purposes of space syntax is to understand the influences of spatial configurations on social life. As such, its main proponents have been opposed to the introduction of other variables in the spatial model. On the other hand, some authors believe that the absence of tri-dimensional information, namely, building heights, weakens the research results, particularly at the level of movement patterns. Based on their study on five London areas, Penn et al. (1998) contend that pedestrian movement is influenced by building height, the level of the area, and pavement width at the level of the individual road segment. Nevertheless, the study shows that both variables have a minor influence when compared with configurational variables.

In general, the original applications of space syntax separate spatial and land use analysis—another theme of debate. Hillier and Penn (2004) contend that this separation has been particularly productive in studying the impact of configuration and movement on land uses (Hillier 1996b) and the generation of centres and sub-centres (Hillier 1999), and in analyzing the spatial dimension of a process by which spatial configurations first shape, and then are shaped by, land uses (Hillier 2002).

There are two main arenas for debate within the space syntax community. The first is the biennial 'International Space Syntax Symposium' (ISSS). These symposia were launched in 1997, in London, and in the last two decades, they have taken place in three different continents: America (North and South America), Asia, and Europe. The second arena is 'The Journal of Space Syntax' (JOSS), a biannual journal launched in 2010, edited first by Julienne Hanson, then by Sophia Psarra, and finally by Daniel Koch. Yet, in the last three years, since 2017, the journal appears to be inactive.

6.2.4 Spatial Analysis

This sub-section includes three forms of spatial analysis—cellular automata, agent-based models, and fractals—each one corresponding to a different part of this text. Yet, the three forms of spatial analysis are not mutually exclusive and may be used in a complementary way. It is important to acknowledge that spatial analysis is more heterogeneous than the three approaches already presented in this section.

6.2.4.1 The Work of Michael Batty

As in the case of Whitehand, Cataldi, and Hillier, we can identify one fundamental researcher in the development and promotion of this approach—Michael Batty. Between 1962 and 1966, Batty studied Urban and Rural Planning at the University of Manchester. In 1983, he concluded his PhD, on Urban and Rural Planning, at the University of Wales. Since 1985, he has been editor of the journal 'Environment and Planning B', one of the main stages for debate on spatial analysis. Over the last two decades, after having taught in five different institutions (Manchester, Reading, Waterloo, Cardiff, and Buffalo), Batty has been based at the Centre for Advanced Spatial Analysis (CASA) at UCL.

Using a diversified set of concepts, methods, and models, Batty seeks to understand the spatial structure and dynamics (flows and networks) of cities as complex, emergent phenomena, in which the global structure develops from local processes (Fig. 6.13 shows the London local centres). He sees the city as a problem of organized complexity and applies the concepts of emergence and evolution for understanding it. These models have a loose correlation with the scale of the phenomenon modelled. They might represent city regions or areas within a city. Cells in a model might represent plots or a unit of census tracts or of other administrative aggregations (Batty 2005, 2013).

Considering the evolution of spatial models, Batty (2008, 2012) states that, in general, there has been a change from aggregate cross-sectional comparative static models of spatial systems to models that are disaggregate and dynamic. This has marked the transition from Land Use Transportation Interaction models (LUTI) to Cellular Automata (CA) and Agent-Based Models (ABM). This has also represented a change in scale and focus. CA models shift the focus from socio-economic processes to physical land development. ABM models are more generic, but in terms of urban modelling, most applications are at the fine spatial scale at the level of pedestrians and local movement. And yet, even with this comprehensive set of theories, concepts, methods, and models, Batty argues for the unpredictability of cities based on his understanding of these as complex systems, evolving in a process where many individual actions of different agents converge (Batty 2018).

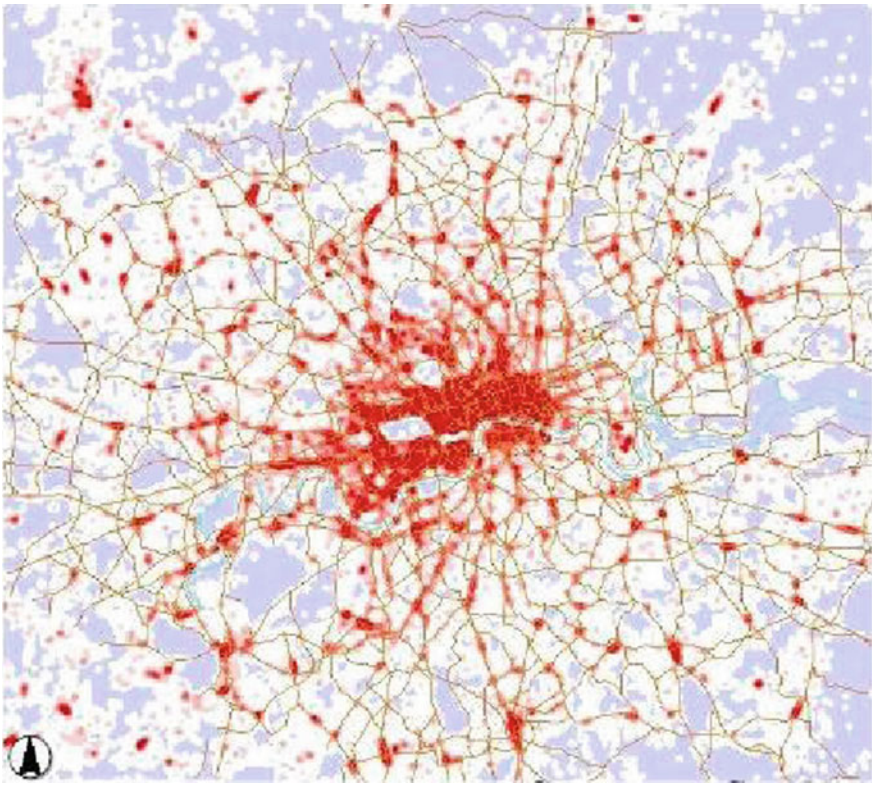

Fig. 6.13 The map of London centres by Michael Batty. *Source* Hillier (2009)

6.2.4.2 Cellular Automata

The history of CA goes back to John von Neumann's theory of self-reproducing automata and his cooperation with Stanislaw Ulam at the time when they were working with concepts of artificial life and idealizations of biological systems. The theory of self-replicating automata describes conceptual principles of a machine that was able to self-replicate. Alan Turing was already working with automata in the 1930s when he defined a simple abstract computer later known as the Turing machine where the idea of the automaton comes close to what we today consider as CA (Iltanen 2012).

CA models are a tool for the dynamic modelling of urban phenomena that try to capture the complexity of spatial phenomena. CA models have an extremely simple formulation that makes its perception of the area of urban studies very easy. There are five basic components: (i) cells, (ii) the states of the cells (on or off), (iii) neighbourhoods (the adjacent cells), (iv) transition rules (such as the number of neighbours required for turning the cell on), and finally (v) time. Cells are partitions of space in which some phenomena occur—for instance, territorial administrative

units. In each instant, each cell has a state from a finite set of possible cell states—different land utilizations. The neighbourhood establishes the extent to which spatial interactions between cells, considering their states (for instance, the interactions between different land uses), are accounted for. The usual neighbourhood is defined as the Moore neighbourhood which means that all cells at the eight compass points around the cell in question, or as the von Neumann neighbourhood which are the four cells north, south, east, and west of the central cell. Transition rules change the cell's states over time, simulating territorial dynamics. Time offers these models a dynamic character. The combination of these components allows modelling form—through cells and neighbourhood— and function— with cell states and transition rules (Pinto 2013).

The designation 'cellular' contributes to the spatial structure of the concept. The designation 'automaton' indicates the ability to process this code (the states of the cell) according to a set of transition rules. A model in which space is constituted by different cells is a cellular automata model. CA models had a very intense research in different areas of physics and mathematics, benefiting from the development of computing from the 1950s to the 1970s. Wolfram's work compiled in his fundamental book 'A new kind of science' (Wolfram 2002) and John Conway's 'Game of Life' (first published by Martin Gardner 1970 in the journal 'Scientific American') are two notable examples. The 'Game of life' consists of randomly planting a series of cells that are alive on a lattice and determining how they grow and survive dependent on those cells around them. If a cell is alive, then it stays alive if two or three cells in its neighbourhood are alive (survival). It dies if there are less than two cells (isolation) or more than three (overcrowding, congestion) in its neighbourhood. A cell comes alive if there are exactly three cells in its neighbourhood already alive (reproduction). The popularity of the 'Game of life' rests on the outstanding variation of behaviour and in the patterns it can produce with these simple rules.

Despite some experiences in the 1950s and 1960s (Hagerstand, 1952; Lathrop and Hamburg, 1965), CA were first applied in urban studies by Waldo Tobler in his work 'Cellular Geography' (1979). Tobler proposes a new geographical model receiving inputs from the 'Game of life' and from von Neumann's concept of neighbourhood. After this work, several authors started to implement CA models in the simulation of urban phenomena, particularly after the mid-1980s, when microcomputing widened the use of computational calculation: Helen Couclelis (1985) argued for the combination of CA and system theories to study urban systems; White and Engelen (1993) published the first constrained model, combining micro and macro scale mechanisms in cell state transition rules. Couclelis (1997) lists a few key issues (concerning space and its modelling, neighbourhoods and their definition, and transitional rules and their universality) for CA models to be more realistic in how they deal with space and how they capture the dynamics of spatial phenomena—how they can be more useful to urban studies and planning practice. Stevens and Dragicevic (2007) and Pinto et al. (2017) explore the use of irregular cells representing plots, offering CA a more accurate description of the urban landscape.

6.2.4.3 Agent-Based Models

Throughout the twentieth century, geography has incorporated ideas and theories from other disciplines. These ideas have strengthened the significance of both modelling and understanding the impact of individual agents and the heterogeneity of geographical systems at different spatial and temporal scales. ABM models allow the simulation of individual actions of diverse agents, and the measuring of the resulting system behaviour and outcomes over time. The development of automata approaches has been essential to the progression of ABM. As mentioned above, an automaton is a processing mechanism with characteristics that change over time based on its internal characteristics, rules, and external inputs. Automata process information inputs from their surroundings, and their characteristics are altered according to rules that govern their reaction to these inputs. Two classes of automata tools have dominated literature—CA (that we have been presenting in the last paragraphs) and ABM (Crooks and Heppenstall 2012).

While there is no precise definition of the term 'agent', there are some features that are common to most of them: agents are autonomous, heterogeneous, and active. Agents can be representations of any type of autonomous entity—people, buildings, plots, to name just a few. Each of these inanimate and animate agents possesses rules that will affect its behaviour and relationships with other agents and, or with, its surrounding environment. This environment defines the space in which agents operate, supporting their interaction with the environment itself and with other agents (Crooks and Heppenstall 2012).

ABM models have many characteristics of CA models, except that the environment and population sides of the system are kept apart. The population sector contains agents whose behaviour is specified in considerable detail. Agents tend to be mobile in a spatial sense and even if they do not physically move in space, they can be associated with different spaces and their change over time can reflect an implicit process of movement. In this sense, the environment is treated more passively than the population with the population driving any change in the environment, although in principle there is no priority for one or the other. The idea of an agent having a specific behavioural profile and acting on this purposively is central to the definition of ABM. In terms of aggregation and scale, ABMs tend to be at smaller scales than the region or the metropolis, although some land cover models based on ABM are predicated at these larger scales. They tend not to be constrained in terms of conserving any key quantity although they may be structured to generate or conserve a certain level of population, especially if the focus is on movement in a fixed space as in pedestrian models. Their dynamics and relationships to the wider environment are similar to CA and they tend to be highly disaggregated down to the point where individuals constitute their basic units (Batty 2012).

6.2.4.4 Fractals

Euclidean geometry is dominated by the concept of things as one, two, or three-dimensional. A line has one dimension—length; a plane has two dimensions—length and width; and a cube has three dimensions—length, width, and height. In the early 1950s, the mathematician Benoit Mandelbrot launched a line of research that would challenge this vision leading to two important essays in the mid-1970s that would acquire a final form in the book 'The fractal geometry of nature' (Mandelbrot 1982). In this seminal book, Mandelbrot argues that many patterns of nature are so irregular and fragmented that, compared with Euclidian geometry, nature exhibits not only a higher degree but a rather different level of complexity. Mandelbrot proposes a new geometry of nature—arguing for its use in different fields— based on the concept of 'fractal'. The title of his 1977 essay 'Fractals: form, chance, and dimension' reveals what would be the nature of the main characteristics of this concept: (i) the form of a fractal is irregular, having a broken appearance; (ii) most fractals are associated to chance and their irregularities are statistical; their shapes tend to be 'scaling'—the degree of their irregularity and/or fragmentation is identical at all scales; and, finally, (iii) the fractal dimension is not an integer value: while in Euclidean geometry (as we have seen), lines, squares, and cubes have an integral dimension, fractal patterns falling in the plane have a dimension between 1 and 2, whereas the 'fractal dimension' of fractals in space is between 2 and 3.

In the next decades, fractal geometry has been progressively applied to the built environment. Two fundamental books on fractals were published in 1994. 'Fractal cities: a geometry of form and function', by Batty and Longley is, as we have seen, an initial attempt to apply fractal geometry to cities. Figure 6.14 offers an image of employment densities in a fractal London. At the same time, Pierre Frankhauser published *La fractalité des structures urbaines.* Frankhauser (1994) sustains the existence of self-organizing processes, or interior order principles, promoting the development of 'irregular' urban patterns. As Batty and Longley, Frankhauser proposes the use of fractals to measure and characterize these irregular structures.

Another line of research has focussed on indigenous cities and settlements. In the end of the 1990s, in the book 'African fractals: modern computing and indigenous design', Ron Eglash has shown how fractal patterns, calculation, and theory are expressed in African cultures. He does it by moving along a spectrum of the presence of mathematics in culture from unintentional to self-conscious, corresponding to examples of abstract theory in these indigenous knowledge systems (Eglash 1999). Four years later, Clifford Brown and Walter Witschey have demonstrated that Ancient Maya settlement patterns exhibit fractal geometry both within communities and across regions (Brown and Witschey 2003).

'Fractal geometry in architecture and design', by Carl Bovill was published in 1996, focussing not on cities, but on built structures. Bovill (1996) investigates the use of fractal dimension both in evaluating buildings and as potential design generators. This line of research has been further extended in the last two decades—Joye (2011) offers a review on the different ways in which fractal geometry has been used to analyze and create architectural forms.

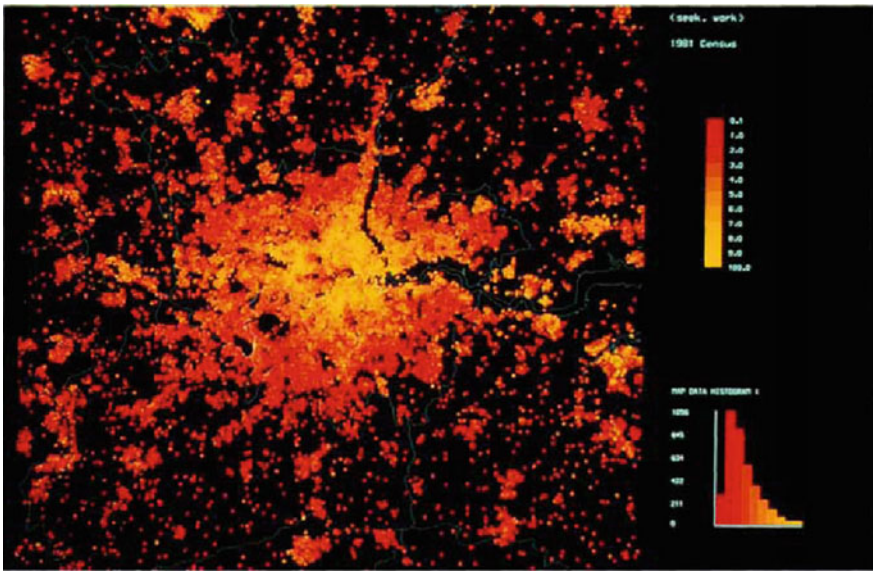

Fig. 6.14 Fractal London: employment densities. *Source* Batty and Longley (1994)

Finally, fractals have been used to analyse the characteristics of streetscapes. This has been mainly developed by Jon Cooper over the last two decades. Cooper started using fractal analysis to assess the complexity of urban and natural skylines, moving then to an examination of fractal properties of street edges, and finally to an analysis of street vistas linking the calculation of fractal dimension to the perception of levels of visual variety present in everyday urban streets (Cooper and Oskrochi 2008).

6.2.5 New Perspectives

This sub-section gathers a set of perspectives on urban morphology that, although sharing a common ground with the four dominant approaches presented above, have several innovative and distinctive features. The network analysis of urban streets has been a key topic of debate over the last decades. One of the most systematic views on this topic, distinct from space syntax, has been developed by Sergio Porta. In a set of papers written with Paolo Crucitti and Vito Latora in the mid-2000s, Porta explores the use of centrality as structural property, that can be measured in different ways, to understand complex networks (Porta et al. 2006). Porta and Ombretta Romice are the leaders of the Urban Design Studies Unit (UDSU) at the University of Strathclyde. Porta, Romice, and their colleagues have been developing two fundamental lines of research aiming at supporting planning practice. The first is urban morphometrics, a quantitative way of measuring and classifying urban form. This line of research has

been exploring urban form evolution over time, as well as unsupervised methods to address the present physical form of cities (Dibble et al. 2019; Fleischmann et al. 2020). The second line of research is the relationship between resilience and urban form (Feliciotti et al. 2016; Romici et al. 2020).

Another key research group is the Spatial Morphology Group (SMoG) at Chalmers University of Technology. The group gathers researchers that have been developing important investigations over the last two decades. One innovative perspective, developed by Lars Marcus (co-leader of SMoG), is centred on the concept of spatial capital, related to the accessible diversity of a given area, and on its measurement through Place Syntax, a method that adds space syntax the ability to include the contents of plots defining each street (Marcus 2010). A second perspective is offered by Meta Berhauser Pont (the other co-leader of SMoG), developing a comprehensive understanding of the relationship between density and urban form and proposing a tool to measure it—spacematrix (Pont 2009). Finally, Jorge Gil has explored the use of data mining in the discovery of urban typologies (Gil et al. 2012). Recent research of SMoG, gathering these different contributions and with evident similarities to UDSU, has been focussing on the identification of urban typologies based on streets, plots, and buildings, and on a detailed understanding of one of these urban form elements—plots (Bobkova et al. 2019; Pont et al. 2019).

These new perspectives range from the comprehensive understanding of different elements of urban form to detailed studies of one element. Stephen Marshall, as Porta in the first decade of the millennium, focuses on streets. He explores how streets, and their main patterns, are linked to the structure of the urban system and how they can contribute to the creation of better places while being functional— relating the fields of urban design and transports (Marshall 2005). He then complements this reading of the urban structure with an analysis of processes of formation over time, incorporating concepts such as complexity, emergence, and evolution (Marshall 2009).

Finally, I should refer to the Morpho methodology, that I have designed and developed with some colleagues at the University of Porto (Oliveira 2013; Oliveira et al. 2020). Morpho offers a structural analysis of the main elements of urban form (streets, plots, street blocks, and buildings) and how these are combined into different patterns in the urban landscape. The core of the analysis is the town-plan elements, with a focus on accessibility, density, and physical continuity. Depending on the scale (neighbourhoods and streets) and nature of the territory (areas with important built heritage), building fabric, and land and building utilization can be considered in the analysis.

6.3 Comparative Studies of Urban Form

As we have seen in the two last sections, the diversity and complexity of the physical form of cities is somehow reflected in the variety of morphological approaches to describe and explain it. The formulation and development of new theories, concepts,

and methods is a positive characteristic. Yet, it has a fundamental weakness: the debate in urban morphology has not been able to offer a comparative meta-framework allowing academics and practitioners to understand: (i) which approaches to use in face of the specific nature of a particular case study; (ii) if it is possible to combine different approaches; and (iii) in which moments, or under which circumstances, should one particular approach be used.

The need to develop comparative studies between these approaches has been raised on different occasions, notably by Jeremy Whitehand in his recent papers and editorials in the journal 'Urban Morphology' and in some ISUF conferences (Whitehand 2009c, 2012, 2015). In 2014, I had the pleasure of coordinating the 21st ISUF conference in Porto. One of the most interesting parts of the conference was a plenary session on the 'Different approaches in the study of urban form'. The session gathered at the same table the main proponents of the historico-geographical, process typological, and space syntax approaches—Jeremy Whitehand, Giancarlo Cataldi, and Bill Hillier—and Jurgen Lafrenz, representing a german morphogenetic tradition (Fig. 6.15). After four individual presentations, the four researchers joined a roundtable moderated by Pierre Gauthier. The debate addressed several key issues for the development of comparative studies, such as the existence of urban morphology as a discipline gathering different approaches, the specificities of each approach, the potential common ground, and the ways of establishing a consistent process of building bridges.

Fig. 6.15 International Seminar on Urban Form 2014: Different approaches in the study of urban form. *Source* photograph by the author

In addressing the need to develop comparative studies of urban form, research has focussed on the utilization of one morphological approach, or one concept or method, in distinct urban areas in different parts of the world. Whitehand (2009b) and Oliveira and Yaygin (2020) describe the utilization of the morphological regionalization method for identifying and mapping urban landscape units in different geographical contexts. Conzen (2009b) offers a comparative assessment of the performance of the fringe-belt concept in the different cultural settings in which it has been applied. Hillier (2002) presents the use of axial analysis in the description of 60 cities in three different continents, explaining geometrical differences between cities based on sociocultural factors and similarities based on microeconomic reasons.

Other authors have explored the utilization of different approaches in the same case study. Framed by ISUF itself, which results from the bridging between the historico-geographical and process typological approaches, Whitehand (2001) and Maffei and Whitehand (2001) started debating the relation between morphological periods and typological processes. Whitehand et al (2014) apply the two concepts in the British context and then in the Chinese context—morphological periods are characterized by different types, and connections between those types are identified. The relation between the historico-geographical approach and space syntax has also deserved the attention of some researchers. Griffiths et al. (2010) use these approaches in three suburbs in Greater London to identify the historical grain of built forms and understand the main aspects of socio-economic activity. Li and Zhang (2021) make explicit the relationships between the concepts of plan unit and street configuration—with a focus on the measures of integration and choice, and on segment analysis. In another line of research, Ye and Nes (2014) combine space syntax, spacematrix, and one mixed-use index—with their focus on integration, density, and land use mixture—in the classification of urban areas in four towns in the Netherlands.

One of the most influential papers on comparative studies of different approaches is 'Aspects of urban form' by Karl Kropf. Kropf (2009) starts with a critical analysis of relevant publications of the four dominant approaches that we have been debating in this chapter. He then identifies the range of phenomena that are object of urban morphological enquiry and one aspect that is common to all approaches and, as such, can be used as a reference to coordinate the different views in a rigorous way—urban form. Finally, he outlines a composite view in which the different approaches support each other to provide a better understanding of human settlements. Yet, while drawing this view, the paper does not advance into how we can effectively combine and coordinate these approaches (it does not offer any application or illustration).

That second step is given by the paper 'A comparative study of urban form' (Oliveira et al. 2015). Contrarily to Kropf, the authors do not address each approach as a whole, but rather focus on one key concept in each of these: morphological region (historico-geographical approach), typological process (process typological approach), spatial configuration (space syntax), and cell (spatial analysis). The four concepts are then applied to a single case study in the city of Porto. The application reveals the main points of contact between the four concepts: elements of urban form (the most important class), levels of resolution, and time. The analysis of existing relations between concepts, based on these points of contact, suggests that

the morphological region may have the necessary characteristics to provide a framework to combine and coordinate the different concepts. Based on the nature of each concept and the results that it offers, a sequential application is suggested: (i) morphological region, (ii) spatial configuration, (iii) typological process, and (iv) cell. Yet, despite these advances, the proposal does not offer an integrated methodology.

A third step is given by Cláudia Monteiro and Paulo Pinho. Monteiro and Pinho (2021a) effectively integrate the historico-geographical, process typological, and configurational approaches (through the concepts of morphological regionalization, typological process, and angular segment analysis), into one methodology for Morphological Analysis and Prescription—MAP. The methodology is in six stages (three concerned with analysis and three related to prescription): i. delimitation and characterization of morphological units; ii. identification of the typological process of each unit; iii. development of angular segment analysis; vi. regulation of the street system (based on angular segment analysis); v. definition of guidelines for urban form transformation (based on morphological regionalization and typological process); and finally vi. contribution to the zoning map and regulation. MAP has been applied to Porto and its proposed zoning map and regulation have been compared to those of the municipal plan in force in the city (Monteiro and Pinho 2021b).

Exercises

A. Testing Your Knowledge

6.1 **Formes urbaines: de l'îlot à la barre was published in 1977. What is the main message of the book written by Castex, Depaule and Panerai?**

i. The emergence and consolidation of the street block as key element of urban form, in the twentieth century.
ii. The loss of the street block, as an architectural form, in the twentieth century.
iii. The loss of the street block, as an element of urban form made of plots and buildings, in the twentieth century.

6.2 **What is the tripartite division of the urban landscape?**

i. A view of the urban landscape based on history, geography, and architecture.
ii. A framework for describing and explaining urban landscapes based on streets, plots, and buildings.
iii. A framework for understanding urban landscapes based on town plan, building fabric, and land and building utilization.

6.3 **What is the fundamental concern of the process typological approach?**

i. Strenghtening the rupture between existing and new urban landscapes.
ii. Re-establishing continuity between extant and future urban landscapes, through an emphasis on architectural style.
iii. Re-establishing continuity between extant and new urban landscapes, through a focus on type and process.

6.4 **Space syntax proposes a set of tools to model and measure the urban space. What do these measures address?**

i. The movement potential, based on the configuration of the street system.
ii. The real pattern of movement.
iii. The movement potential, based on the density of residents, workers, and visitors.

6.5 **What are the basic components of cellular automata models?**

i. Cells, states of cells (on or off), neighbourhood (the adjacent cells), and time.
ii. Cells, states of cells (on or off), transition rules (such as the number of neighbours required for turning the cell on), and time.
iii. Cells, states of cells, neighbourhood, transition rules, and time.

Solutions

6.1 iii
6.2 iii
6.3 iii
6.4 i
6.5 iii

Interactive Exercices

Exercise 6.1—Morphological Regions

This exercise addresses one of the most important concepts of the historico-geographical approach—the morphological region, as an area that has a unit in respect of its form that distinguishes it from surrounding areas (presented in the

Table 6.4 Exercise 6.1—Morphological regions

	Town plan (streets, plots, buildings)	Building fabric	Land and building utilization
First-order morphological regions			
MR1.1			
MR1.2			
MR1.n			
Second-order morphological regions			
MR2.1			
MR2.2			
MR2.n			

sub-section 'The Ideas of M.R.G Conzen'). The first step of the exercise is the definition of the case study area. The student should define a circle around his home. A radius of 1,000 m is suggested. Yet, the size of the study area should be adjusted to the complexity and variety of the urban landscape. The second step is the identification of first-order regions, mainly determined by the town plan. As such, each region should have a singular pattern of combination of streets, plots, and buildings. After producing a map of first-order regions, the student should select one of these regions for further development. Within the selected first-order region, the student should continue to explore the existence of morphological differences. These differences should be mainly based on the town plan and building fabric. The third step is the presentation of results, including: the two maps of regions (first-order regions and second-order regions); photographs illustrating each map (one for each region); and one table, describing for each first-order regions and second-order regions, the main physical characteristics (see the example of Table 6.4). The student should prepare a brief powerpoint to be presented at classes (around 10 minutes for each presentation).

Exercise 6.2—Typological Process

The typological process is one of the main concepts in the morphological approach developed by Muratori, Caniggia and their colleagues. It is a succession of types in the same cultural area—diachronic changes—or in several cultural areas in the same space of time–synchronic changes. The exercise starts (as in the former case) with the definition of the case study area. The student should define a circle around his home (the suggested radius is 250 m, although it can be adapted). The student should focus on the buildings of the study area. Based on field work, cartography, and software for the interactive visualization of maps and satellite images, the student

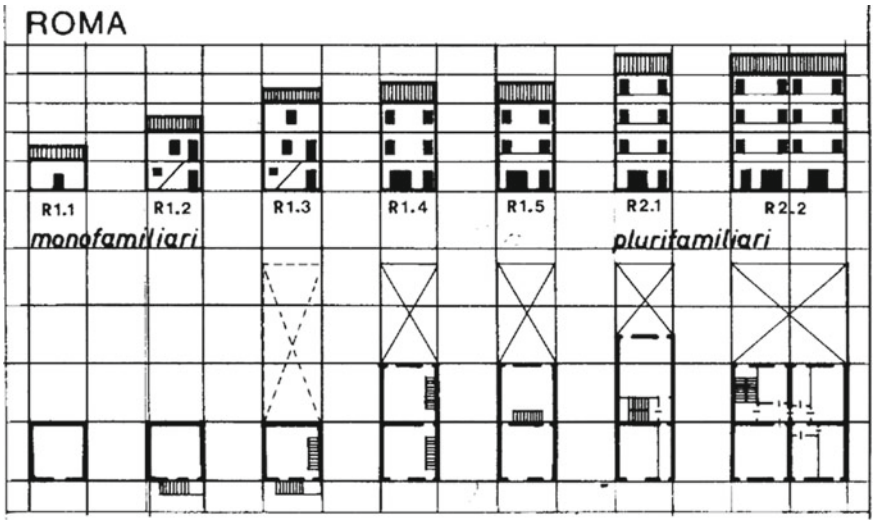

Fig. 6.16 Typological process. *Source* Caniggia and Maffei (1979)

should be able to identify the main building types. While it would not be feasible to have access to the building plans (interior organization of rooms), the goal of the exercise is to characterize a simplified typological process of the case study area. After identifying the building types, the student should be able to define a typological process, gathering all building types in a line of evolution through time. Finally, the student should be able to present the results of the exercise in a powerpoint (5 to 10 minutes), including a typological process' table, with building facades or simple plans (see Fig. 6.16 for an example by Caniggia and Maffei); and a sequence of photographs (one for each type).

Exercise 6.3—Axial Map

The main goal of this exercise is to expose the student to the Depthmap software used by the Space Syntax community (open access, available at https://varoudis.github.io/depthmapX/), and to perform a simple task, the design of an axial map and the calculation of some simple measures.

First, the student should define the case study area, through a circle around his home (suggested radius: 1.000m—it can, then, progress into a larger radius). Then, the student should design the axial lines, using a computer-aided design software (such as Autocad). The basis for this step should be the map of streets of the case study area. Starting from any given point of the study area, the student should design the visibility/movement lines of all streets, in a way that the whole system is covered by the least set of lines. All lines should be connected (a slight overlap of the end of each pair of lines is recommended) and the map should be saved in .dxf format.

Moving from Autocad into Depthmap, the next step is importing and converting the map into an axial map:

Map—Import

Map—Convert drawing map—Axial map

The produced axial map has two measures—connectivity and line length.

The following step is the calculation of global integration (radius n) and choice, and then, of local integration (radius 3, as one of the most used radii in space syntax).

Tools—Axial/convex/pesh—Run graph analysis—Axial analysis options: radius n, include choice

Tools—Axial/convex/pesh—Run graph analysis—Axial analysis options: radius 3

Finally, the maps should be extracted:

Edit—Export screen

For more details see the space syntax online platform at https://www.spacesyntax.online/.

Each student should prepare a brief powerpoint to be presented in classes (around 10 minutes for each presentation). The student should use text and images (drawings and photographs), or any means that he thinks it is adequate.

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Chapter 7
From Theory to Practice

Abstract This chapter focuses on a fundamental issue for the field of urban morphology that has been receiving increased attention in literature: the passage from description and explanation of the morphological phenomena to the definition of prescriptive guidelines for the design of new urban forms or transformation of extant forms. Two eminently practical activities that can benefit from morphological support are identified: urban planning (and urban design) and architecture. While the first is a potential receptor of morphological theories, concepts and methods developed at larger scales, the second would be informed by morphological approaches developed at the building scale.

Keywords Research and practice · Urban morphology · Building typology · Planning · Urban design · Architecture

Recently, I have explored the relation between research and practice in different fields of knowledge (Oliveira 2021a). A survey on health (psychology), education, law, and economics (business, management, and accounting) made evident a gap between science and professional practice. It also highlighted the similarity of the problem faced by these fields in relation to urban morphology. This can be illustrated with, for instance, some statements in the field of psychology. In the mid-1980s, Alan Ross concluded that behaviour therapy was at risk of losing its momentum due to an excessive preoccupation with theoretical developments and technical refinements (Ross 1985). Ross' call for bridging the gap was taken forward by Linda Sobell. She considered that if scientists were to have an impact on clinical practice, they would have to learn a new way of doing business (Sobell 1996). In an overview paper published 20 years later, Shannon Stirman and her colleagues stated that most clinics were not using research evidence to inform care and that evidence-based treatments were not being delivered in routine care settings (Stirman et al. 2016).

While this survey shows that the gap between science and practice is not exclusive of the urban landscape fields, an analysis of the disciplinary history of urban morphology—including the historico-geographical (Whitehand 2021) and the process typological approaches (Cataldi et al. 2002) with roots in the early twentieth century—shows that the gap is not new.

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As we have seen throughout this book, urban morphology is a consolidated body of knowledge with several theories, concepts, methods, and techniques to address the physical form of cities. It can rigorously describe the elements of urban form and their patterns of combination at distinct levels of resolution. It focuses on different urban landscapes, from historical kernels to peripheral areas, from planned to informal settlements. In addition, it can explain how these elements are shaped over time by different agents and processes of transformation. Urban morphology can evaluate the impact of change in urban form, framed not only by urban landscape criteria but also by environmental, social, and economic criteria.

Characterizing practice is more difficult than offering a picture of research, as it is more heterogeneous. There are major differences between planning and architectural practice. While planning takes place under legislative/political frameworks, addressing the fundamental dimensions of life in cities and aiming at prescribing the rules for their transformation, architecture occurs largely under a business framework, focusing on the design of buildings. Urban design is somewhere between these two activities. In most countries it is closer to urban planning, but in a few countries it can be closer to architecture, or it may not exist. A major consideration is the legal systems framing practice—from mandatory to discretionary systems, from systems closer to the 'urbanism' French tradition to those closer to the 'town planning' British tradition. Nevertheless, practice in relation to the urban landscape is well established. It includes several processes and procedures aiming at producing policies, plans, and projects for the transformation or conservation of the physical form of cities. A continuous and detailed understanding of what practice is should involve investigation within that professional environment.

What can urban morphology offer to professional practice? And how can practice be improved using research? Urban morphology describes and explains the dynamics of urban form and can offer recommendations for prescription and design. Furthermore, the impact of each proposed action on urban form, framed by a policy, plan, or project, can be rigorously evaluated. Urban morphology offers planning practice knowledge of urban form that it tends to lack. The physical form of cities has been losing prominence in planning, often being confused with land use. Research can offer practice a detached perspective on processes and procedures, a view with different time constraints from professional routines. On the other hand, practice offers research new frameworks for thinking about urban form, including political, legislative, and business aspects and awareness of wider settings in which the physical form of cities must demonstrate its relevance. Simultaneously, it encourages research, most of which is undertaken by academics, to be practice oriented.

7.1 Urban Morphology, Planning, and Urban Design

Over the last years the relationship between urban morphological research and planning practice has attained an important role in the debate on urban form. Among other events and developments, this relationship attracted the attention of a special issue

of the journal 'Built Environment' in 2011, a number of 'viewpoints' in the journal 'Urban Morphology', an ISUF Task Force (Samuels 2013), and a book (Oliveira 2021b).

And yet, despite the recent interest, as above mentioned, this is an issue with a long tradition within the different morphological approaches. In the process typological approach (Cataldi et al. 2002), one of the most notable cases was developed by Muratori in the late 1950s. In 1959, Muratori applied the results of his research on the urban history of Venice (the three fundamental historical tissues of this unique Italian city) in the competition for *Barene di San Giuliano*. The result was a set of proposals in a clear continuity with the urban history of the city (this case will be developed in the next section).

Within the historico-geographical approach, two concepts have been consistently applied. The concept of 'morphological region' has been used, for instance, in a plan for Barnt Green (Whitehand 2009) and in a study for a residential area in Stratford-on-Avon (Larkham et al. 2005). Based on similar principles, the 'urban tissue' has been applied in a number of plans for French cities—including Saint-Gervais-les-Bains (Samuels 1999) and Rennes—and in a series of design guides and 'supplementary planning guidance' for some English cities including Stratford-on-Avon and Rotherham. The application of the morphological region and the urban tissue concepts demonstrated the advantages of building a zoning proposal based on form and not on land use, as it happens in most cases where this planning tool is used. The second concept explored in professional practice is the 'fringe belt'. Kropf (2001) describes its application in the design guide for Stratford-on-Avon. This application demonstrated the importance, for the planning process, of the conservation of key elements of the geographical and historical structure of a city. In addition, Hall (2008) presents the contribution of urban morphology for day-to-day development control, and to the set of incremental decisions that shape urban areas, in the English town of Chelmsford.

This section aims at realizing the potential contribution of urban morphology to planning practice. The reflection draws on the analysis of three cases presented in the following subsections. We have selected a set of diverse cases in terms of approach (from process typological to space syntax), time period (from the 1950s onwards), and planning system (more or less flexible, more or less discretionary). The selected cases are the plan for *Barene di San Giuliano* (Venice, Italy) by Saverio Muratori, framed by the process typological approach, developed in the late 1950; the plan for *Asnieres-sur-Oise* (France), by Ivor Samuels and Karl Kropf, framed by the historico-geographical approach, prepared in the early 1990; and the plans for Jeddah (Saudi Arabia), by Space Syntax Limited (project directed by Kayvan Karimi), framed by the space syntax, developed over the last two decades.

7.1.1 *The Plan for Barene Di San Giuliano—Saverio Muratori*

In the year of publication of the seminal book *Studi per una operante storia urbana di Venezia*, Muratori had the opportunity to apply the results of his morphological research in a planning competition for an area located northeast of historical Venice, between the lagoon and mainland settlements—the area of *San Giuliano* (Fig. 7.1). The competition programme defined the creation of a new city for about 40,000 inhabitants, including a set of functions that are characteristic of contemporary cities but were difficult to locate within the historical centre of Venice.

In this competition, Muratori applied the 'designing in stages' methodology (for its detailed description see Cataldi 1998 and Maretto 2013). He prepared, not one single final proposal but, as many proposals as there are stages of urban growth constituting the history of Venice—three stages and therefore three proposals. Each of the three proposals adopted the designation of *Estuario* (Estuary), and it was a structural re-interpretation (not a copy or a 'pastiche' of past architectural language, as many postmodern architects would do some years later) of the tenth and eleventh century Venice, the Gothic period, and the Renaissance period, respectively. Muratori won the competition with *Estuario III* and received an honorable mention with *Estuario I*. The second prize was given to Ludovico Quaroni, with whom Muratori had worked back in the 1930s.

Fig. 7.1 *Barene di San Giuliano* **a** and 'historical Venice' **b**. *Source* Google Earth

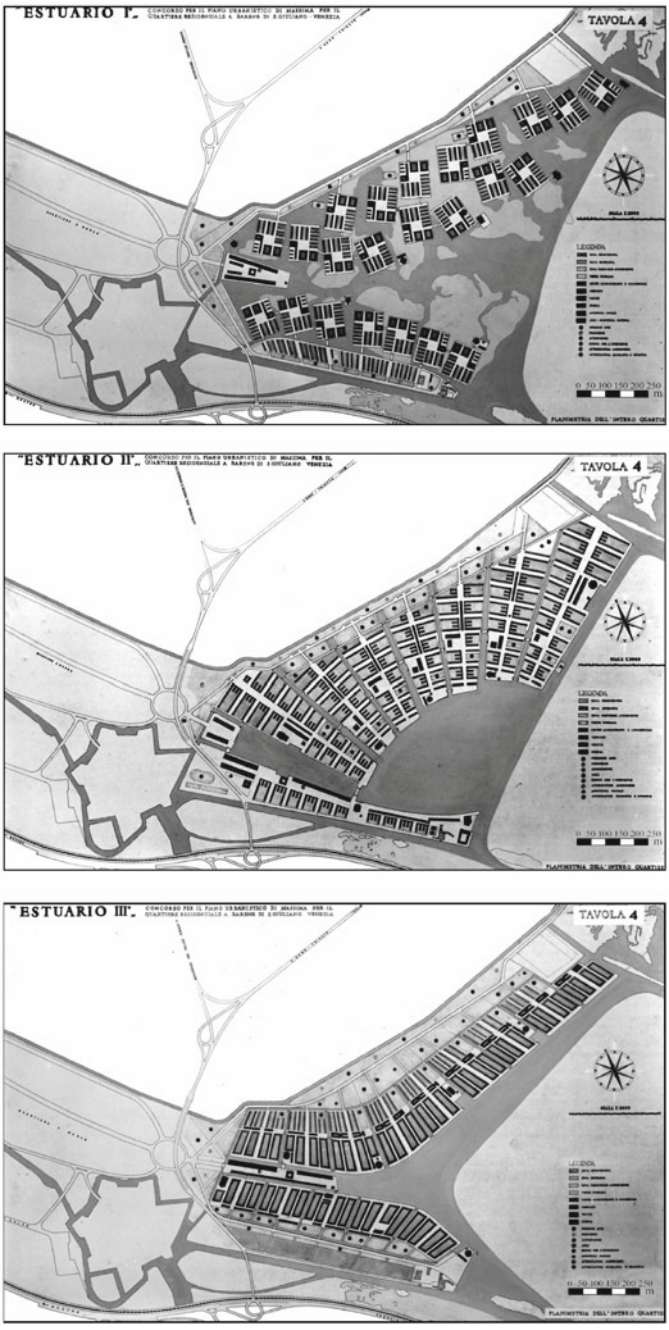

Fig. 7.2 The *Barene di San Giuliano* in Venice: Estuaries I, II and III. *Source* Maretto (2013)

Estuary I (Fig. 7.2) is an interpretation of Venice in the tenth and eleventh centuries, at a time when the dominant urban layout included a square centrally located within a group of islands, with a clear predominance of waterways over land routes. The city is structured into several neighborhoods constituted by islands linked to one another and to mainland by bridges, in a set of self-contained units laid out along both banks of the *San Giuliano* estuary. Each island nucleus was a residential unit of about 33,000 m^2.

Estuary II is an interpretation of Gothic Venice with an urban organization in a comb-shape and with a balance between canals and vehicular axes laid out in parallel. It proposes a set of self-sufficient neighborhoods comprised of peninsulas, for about 10,000 inhabitants each, laid out around the lagoon basin with their axis converging. The plan consists of building units with courtyards orthogonal to their peninsula axes. It is composed of a single residential building type, with three stories and an arcade ground floor.

Finally, Estuary III, the winning proposal, is an interpretation of Renaissance Venice with a predominance of vehicular axes over the canals, and with a built occupation of the boundaries along the canals, thereby releasing the inner space for land routes. It proposes an estuarine city laid out along two strips parallel to the two banks of the estuary, gradually opening toward the lagoon, with a view of Venice. A double pattern of canals, longitudinal and transverse, formed two series of flanking islands, somehow realating the main features of the other proposals: the island and the peninsular systems. In addition, the presence of effective longitudinal links offers unity and continuity (Maretto 2013). Despite its quality, the plan was not implemented and the area of the *Barene di San Giuliano* had no significant intervention until nowadays, as we can see in Fig. 7.1.

7.1.2 The Plan for Asnières-Sur-Oise—Ivor Samuels and Karl Kropf

In the early 1990s, Ivor Samuels coordinated an academic work of the Joint Centre for Urban Design, of the Oxford Polytechnic, in *Asnières-sur-Oise* (Fig. 7.3), a small French commune with a population of about 2,400 inhabitants, located 35 km from Paris. One of the participants in this study was Karl Kropf whom in 1986 had completed his master thesis under the orientation of Samuels and in 1993 would conclude a doctoral thesis under the supervision of Jeremy Whitehand. In both theses, Kropf proposes a simplification of the Conzenian concept of 'morphological region' (as an area that has a unity in respect of its plan, building fabric and land utilization that distinguishes it from surrounding areas), and explores its relationships with the work developed by Caniggia. For Kropf (1993) the 'urban tissue' (close to the concept of morphological region) is an organic whole whose form can be described at different 'levels of resolution' (Fig. 7.4). The levels of resolution correspond to

Fig. 7.3 *Asniéres-sur-Oise*. *Source* Google Earth

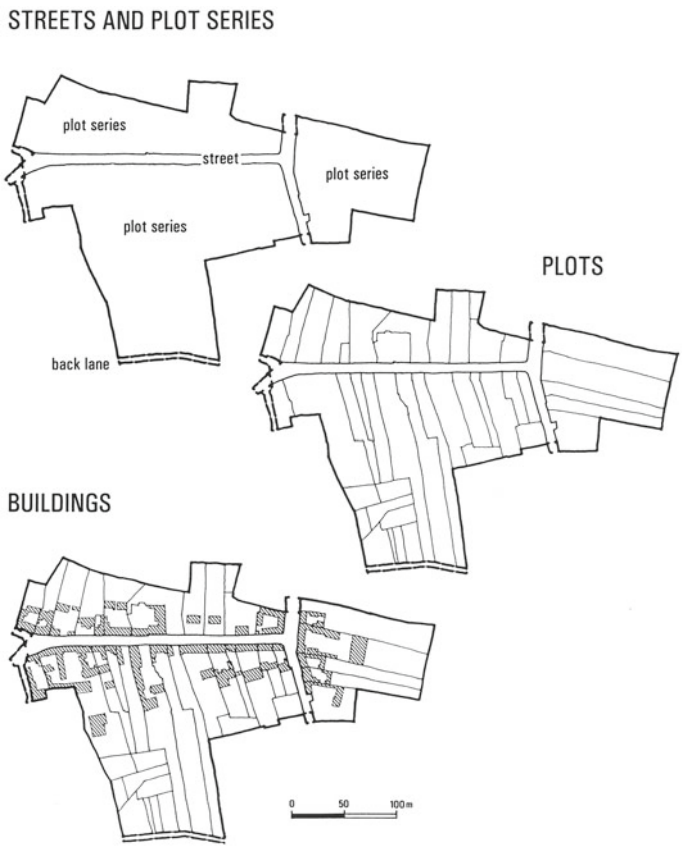

Fig. 7.4 An urban tissue shown at increasing levels of resolution. *Source* Kropf (1996)

the different moments when the different elements of urban form can be identified in a typo-morphological analysis—the streets and street blocks, the plots, the buildings, the different types of rooms and spaces, the structures and, finally, the materials. These different elements are interrelated in a hierarchy, where elements of a lower scale combine to form elements of a higher scale. Using this hierarchy as a framework structure, urban tissues can be defined in a systematic way with different degrees of specificity, describing the elements that constitute them at different levels of resolution. Three specific characteristics can be used to describe each element—its 'position', 'outline' (shape, size, and proportions of the external boundaries of the element), and 'internal arrangement' (type of component parts, number of parts, and relative positions).

After concluding the academic work, the team coordinated by Samuels was invited by the mayor to prepare a new *Plan d' Occupation des Sols* (POS) to replace the 1987 POS. The main goal of the new POS was the maintenance of local identity, avoiding the suburbanization processes that were occurring in the neighboring municipalities around Paris (*Mairie d'Asnieres-sur-Oise* et al. 1992). The other objectives of the POS were to regenerate the older districts and to reinforce the traditional shopping; to revitalize the abandoned industrial areas, with a mix of trade, services, industrial, and residential uses; and to integrate the new residential estates with the rest of the settlement (Samuels 1993). In terms of material content, the POS is made of regulations, a zoning plan, and a report. It is important to highlight that, compared with Saverio Muratori plan, the POS has a stronger intention towards permanence than innovation.

Using the concepts of 'urban tissue' and 'levels of resolution' the team divided the urban form of *Asnières* into six levels of resolution—the whole commune, districts, streets and street blocks, plots, building form and elements of construction—which are the basis for both description / explanation and prescription. This means that the references for the new urban forms in each part of *Asnières* are the existing forms in that specific part.

The approach involved a typo-morphological zoning—instead of the traditional functional separation—that lead to the identification of seven areas: four types of urban areas and three types of natural areas. For each zone, acceptable and unacceptable urban forms are illustrated—a tradition of the British design guides. There is a more restricted range of choice at the lower levels of resolution than at the higher levels, meaning a wider choice of plot size and building arrangement than window detail.

Figure 7.5 includes a set of drawings on the historical area known as *Le Village*. For this area of *Asnières*, the plan identifies four possible situations based on the 'position' of the plot within the street block: (i) in the front area of the block, (ii) in the lateral area of the block, (iii) in the corners of the block, and, finally, (iv) in a set of exceptional corners identified by the plan. An analysis of the first case—plots located in the front area of the street block as illustrated in Fig. 7.5—show that the new plots will have a rectangular shape with the narrow part of the rectangle in contact with the street, and containing the access to the interior of the plot. The plan indicates that the minimum dimensions of the new plots should be 7 × 25 m, defines a construction

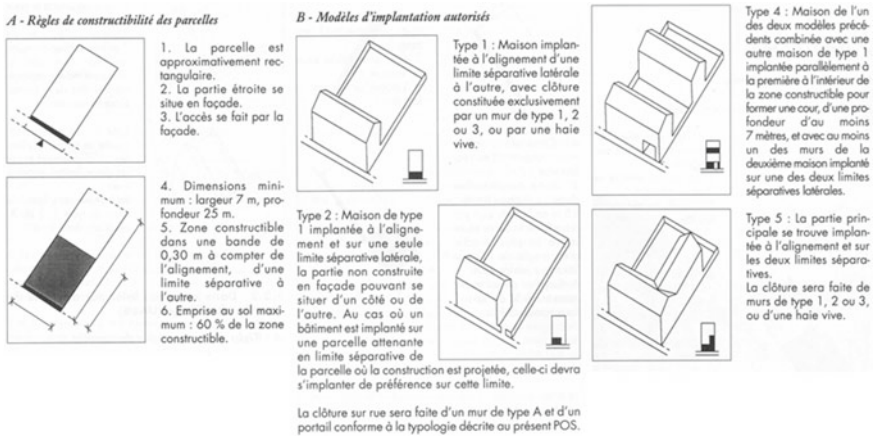

Fig. 7.5 The *Plan d' Occupation des Sols* of *Asniéres-sur-Oise*: *Le Village*. *Source* Mairie d'Asnières-sur-Oise et al. (1992)

area from the front alignment occupying the whole width of the plot, and defines a maximum building coverage of 60%. The POS allows four different positions of the building in the plot: (i) in the plot frontage occupying the whole plot width; (ii) in the plot frontage occupying more than half the plot width, while a wall delimitates the rest of the plot frontage; (iii) one building in the plot frontage occupying the whole plot width, allowing a passage in the ground floor, and one building (parallel to the first) in the interior of the plot occupying the whole plot width; and, finally, (iv) one L shape building with one of its parts in the plot frontage occupying the whole plot width. Samuels (1993) highlights that the POS does not propose a model, but rather a series of choices at each level of resolution—a set of possible parts with instructions for their assemblage. The purpose of the plan is to promote a variety of responses in the levels of resolution where this should happen, ensuring the formal diversity of Asnières.

Five years after concluding the plan preparation, Samuels returned to *Asnières-sur-Oise* for an assessment of the plan implementation process (an unusual, but crucial, procedure in planning practice). Based on a number of interviews to the main agents involved in this process, Samuels discusses a number of fundamental issues such as the need to build a stronger political consensus to support a morphological approach, to ensure the presence of a qualified team for plan preparation and implementation, and to realize the degree of design control that is adequate to each specific situation (Samuels and Pattacini 1997).

7.1.3 The Plans for Jeddah—Space Syntax Limited

The issue of informal settlements (clearly different from the problems addressed in the plans prepared by Muratori and by Samuels and Kropf) is a key challenge for planning in an increasing number of cities worldwide. Over the last years, space syntax has been developing research in this area demonstrating that the spatial configuration has a significant role in the gradual and endogenous improvement of informal settlements (Hillier et al. 2000; Karimi et al. 2007). Accordingly, space syntax has been proposing an approach that is based on the identification of the most integrated areas of these settlements and on the subsequent recommendation of a small number of physical interventions in these areas that would favor their articulation with the overall structure of the city, improving not only their own integration but also of surrounding areas.

In the last decade, Space Syntax Limited was hired by the municipality of Jeddah, Saudi Arabia, to design a strategic planning framework for the city, including a Strategic Plan, a Sub-Regional Plan, a Structural Plan, and a set of Local Plans. Jeddah is a city of more than 3 million inhabitants and population is expected to double in the next two decades. It is located between the holy cities of Makkah and Medina, acting as an important commercial hub for the entire Red Sea region. There are around 50 informal settlements in Jeddah with an estimated population of 1 million inhabitants.

The intervention of Space Syntax Limited began with a diagnosis of the city, using axial analysis to understand how the city evolution over time has led to current patterns of density, land use, and the main socioeconomic characteristics. Then, the spatial reasons that seem to support the main barriers to the development of an effective social cohesion were identified. It was found that unplanned areas come out as areas with high measures of local choice while the citywide super-grid, underlined by higher values of global integration, run outside these areas, even the areas in the most central parts of the city. In sharp contrast, these areas develop a very distinct local structure, which is captured by syntactic analysis at a lower metric radius, but this structure does not fit into the spatial structure beyond the boundaries of the unplanned settlement (Karimi and Parham 2012).

Finally, Space Syntax Limited's proposal includes three urban scenarios and recommends a set of intervention areas comprising the historical centre (about 1 Km^2), a number of informal settlements (with a significant size in the city and with a key role separating the historical centre from the rest of the city), a set of central areas, a former area of the airport, and a waterfront (Fig. 7.6). The urban space (streets and squares, in the broad sense of these words) is used as a mechanism to minimize the segregation of a part of the population that is extremely poor.

One of the key aspects of space syntax is that it constitutes a theory and an analytical methodology, but it does not impose an urban layout. On the contrary, it helps to enhance the qualities of the specific layout of each city, to create a higher spatial accessibility and, therefore, a higher social interaction. As such, the proposal

Fig. 7.6 Jeddah: **a** historical centre, **b** informal settlements, **c** former area of the airport, and **d** waterfront. *Source* Google Earth

for the informal settlements tried to identify the most integrated axes of the local structure and to enhance its articulation with the overall structure of the city (Fig. 7.7).

7.1.4 Towards Integration

As we have seen in the three previous subsections there is, indeed, a link between research on urban morphology and professional planning practice. This relationship exists in different morphological approaches, in different time periods and in different planning systems. However, this relationship is marginal to mainstream planning practice. There is a long way to go towards a wider utilization of theories, concepts, and methods of the science of urban form into day-to-day planning practice and development control.

This gap between theory and practice does not differ much of what goes on in social sciences and humanities. Although it should be that urban morphology is one of the disciplines feeding planning, in practice urban morphology and mainstream planning exist in largely separate worlds. This is somehow institutionalized, and it is expressed in a context marked by organizations that are almost exclusively dedicated to research and education, and organizations that are almost exclusively dedicated to practice, in public or private sectors. In addition, it seems evident that the different approaches and models provided by planning theory in recent decades,

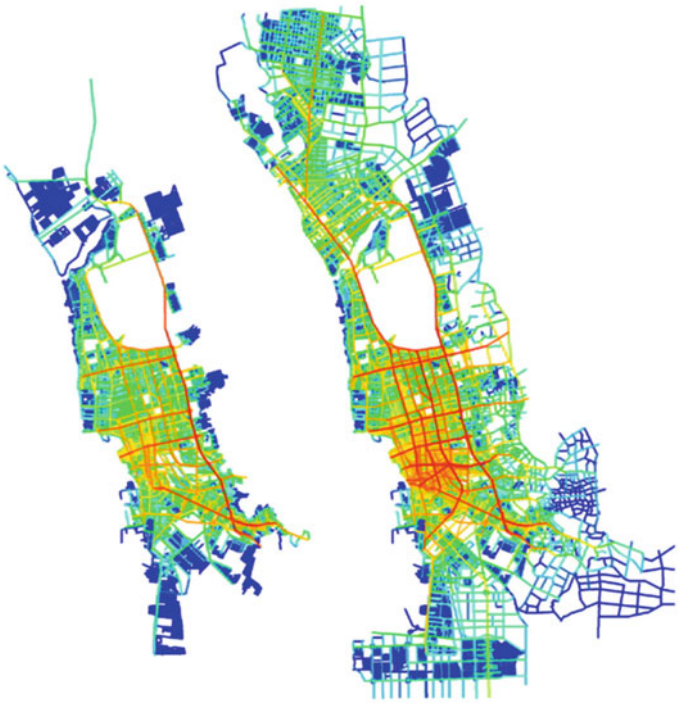

Fig. 7.7 The axial map of Jeddah: alternative scenarios. *Source* Karimi (2012)

despite their usefulness in relation to other professional issues, have not helped in coping with the physical dimension of cities. This means that the reduced channel of communication between the two activities, urban morphology and planning, and the reduced support effectively offered by urban morphology, were not balanced by planning theory inputs.

Another element that weakens this relationship is the tendency of knowledge towards specialization, something that is common in many disciplines. In a very compartmentalized knowledge structure, the ability to identify relationships with both practice and other research areas is significantly reduced. Four aspects help to explain this phenomenon: a lesser dominance of the English language in urban morphology compared with the physical sciences, making more difficult a global communication; the tendency for researchers to investigate urban form within their own country, usually going along with the tendency for these individual studies to be weakly connected with one another; the fact that researchers do not properly explore the existing channels of communication to present the results of their investigation demonstrating their relevance to contemporary cities and societies; and, finally, the fact that the different disciplines converging in urban morphology do not prepare their students to build bridges between different areas of knowledge (Whitehand 2010). Against this background, the fundamental challenge is to find a balance between two

different poles that will always exist—integration and specialization. It is important to remember that science focuses, primarily, on what is invariant in the universe, and that its purpose is necessarily specialized, rather than worrying on how the different phenomena taking place on the surface of the Earth are related to each other to create the different urban environments where people live in (Whitehand 2006).

This relationship is also weakened by the fact that different morphological approaches are, apparently, scientific in analysis but not in prescription. The rigorous morphological description and explanation can provide prescriptive guidelines and recommendations. However, there will always be a particular moment in this passage from explanation to prescription in which our own values, as professionals or politicians, will influence the decision-making and the selection for a particular alternative of urban form transformation.

The issue of resources, not only human and financial resources, but also the time factor, is also very relevant. The specific nature of research and planning practice leads, almost inevitably, to a divergence in the focus of these two activities; the extent of this divergence depends on the specific institutions involved. For instance, it is not likely that a particular planning department within a local authority would change its priorities and start devoting more resources to the design and development of a new analytical technique on urban morphology than to those that are allocated to the appraisal of licensing projects as part of the development control activity. As such, it is important to try to make the two activities more compatible. After evaluating the preparation and implementation of the *Asnières* plan, Ivor Samuels has designed a new method of morphological analysis and prescription that was far less consumer of human and financial resources, applying it in *Saint-Gervais-les-Bains* and Oxford (Samuels 1999, 2021).

One final important aspect is the transferability of morphological knowledge. The way how urban morphology has been influencing planning practice does not necessarily conform to the wishes and priorities of those developing research on urban form. The diffusion process of morphological knowledge is slow and takes place in a non-systematic way. Although this is an issue needing careful consideration, it does not differ much from other social sciences or from the relationship between planning theory and planning practice. In this sense, researchers should continue to develop their efforts building bridges between research and practice, developing systematic assessments, trying to understand the needs and aspirations of planning professionals, and constantly testing the relevance and the dissemination potential of their research results.

7.2 Urban Morphology and Architecture

This section aims at realizing the potential contribution of urban morphology to architectural practice. The reflection draws on the analysis of three cases. Again, we have selected a set of diverse cases in terms of approach (from process typological to space syntax), time period (from the 1980s onwards), and geographical location

(from Latin America to Eastern Asia). The selected cases are the Terni cemetery (Italy) by Giuseppe Strappa, framed by the process typological approach, designed in the late 1980s; a house in Brasilia (Brazil), by Frederico de Holanda, framed by space syntax, prepared in the late 1990s; and a set of houses in the Huangzhuang village (China) by Wowo Ding, with a more eclectic approach, designed in 2017.

7.2.1 The Terni Cemetery—Giuseppe Strappa

The design of the Terni Cemetery started with a national competition in 1986 won by Giuseppe Strappa and his colleagues. The elaboration of the project was extended over a decade. Its construction has been in three stages: the first concluded in 2011, the second completed in 2018, and the third stage that will begin in 2021 (Fig. 7.8). The cemetery is an illustration of Strappa view on the relation between research and practice: the architectural project deriving from the reading of the urban landscape, from the analysis of formation processes and building types. According to that, the architect's contribution would be the design of a building that is part of a particular typological process.

Strappa addresses the cemetery as a theme analogous to the city itself. As such, the Terni Cemetery would be made of i. routes, formed by arcades on two levels, and external paths, that are part of a hierarchy according to the enclosure logic; ii. base buildings, consisting of the tombs lining up along the paths; iii. special serial buildings, consisting of family chapels; iv. special nodal buildings, consisting of the tower for the congregations, the crematorium, and the chapel at the new entrance of the cemetery (to be built in the coming years); v. nodes, consisting mainly of stair towers interpreted as vertical routes that intersect with horizontal; and finally, vi. poles, consisting of the intersections at a larger scale (Strappa 2021). In addition to this interpretation of the cemetery according to the main formal elements of the process typological approach, there is also a strong presence of time, as the design of the building started 35 years ago, and its construction has been developed over the last decades.

The use of what Strappa labels as 'plastic-masonry' structures—closer to issues of architectural language—is based on two main reasons. The first is the notion of 'cultural area'. All buildings in the Umbrian area, where Terni is located, have strong stone features constituting one of the most vital factors in the cultural continuity of this territory. The second is the organic character inherent to the use of this material, the nedeed continuity that is established inside the masonry walls and one that regulates the position of the elements in a stable way (Strappa 2021).

Fig. 7.8 The Terni Cemetery. *Source* Oliveira (2021)

7.2.2 A House in Brasilia—Frederico de Holanda

Frederico de Holanda's house designed and erected in the late 1990s (he is the architect and owner of the building) is in *Sobradinho*, a satellite city of Brasilia. The house is in a 20 × 60 m plot located in a gated communited in the *Grande Colorado* borough. Building coverage is about 30%. The house is made of different volumes, painted with primary colours, structured around a 50 m^2 atrium (Fig. 7.9).

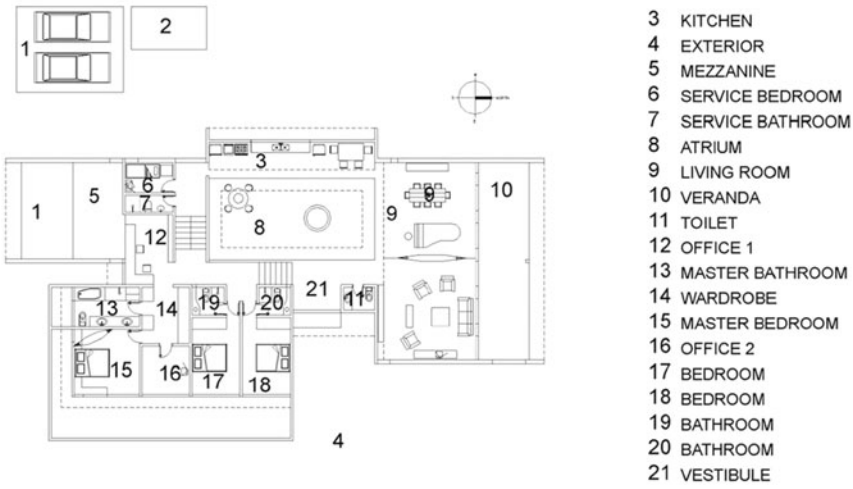

Fig. 7.9 A House in Brasilia. *Source* Oliveira (2021)

The house, and particularly the interior organization of rooms, is strongly influenced by Holanda research on space syntax and by his visits to some notable places around the world like Teotihuacan, Alhambra, and Pompeii. There are two structural elements in the organization of rooms. The first is the atrium. The atrium is open to the sky and to the surrounding spaces, through sliding glass doors—the exception is the southern limit, including a panel of decorative tiles. The second structural element is the long north–south visual axis close to the atrium. The axis goes through the

house from the backyard lawn (north) to the street (south), passing by the balcony, living/dinning room, entrance, circulation spaces, and one office. Ideally, all these spaces should turn into the atrium and axis.

The interior organization of the house is an expression of Holanda morphological view, offering openness in the non-restricted domain (rooms in which people may interact for purposes which do not involve intimacy) and the possibility of reclusion in the restricted domain (rooms for intimacy), and a balance between co-presence/co-awareness and isolation. The strongest peculiarity of the house are enhanced relations of visibility/accessibility among diverse categories of spaces—inner/inner spaces or inner/outer spaces. Comparative analysis, based on space syntax tools, reveals both similarities and differences between this house and the current production of buildings, including both professional and non-professional/social, as follows: (i) in terms of average integration, the house is closer to 'social knowledge' than 'professional knowledge'; (ii) integration rank order differs from both 'social' and 'professional' knowledge, in terms of middle-class houses; (iii) the shallowness of the 'private sector' is unique, at least concerning Brazilian domestic space; (iv) spatial openness is not unique to this house, but it is in the top of most open schemes; and, finally, v. inexistence of a formal living room distinguishes it from common middle-class houses in Brazil (Holanda 2021).

7.2.3 Houses in Huangzhuang—Wowo Ding

The profund changes taking place in China over the last four decades led to the loss of numerous villages. Against this background, a rural revitalization strategy has been designed involving many plans and projects to restore the traditional forms of villages. One of these cases is Huangzhuang, in the Jiangsu province. The Huangzhuang project has been coordinated by Wowo Ding, starting in 2017 and being completed in 2019.

Huangzhuang has the typical form of a village in the region—the strip-shaped villages or *Zhuangtai*. This is a village built on a high platform, formed by two rows of houses with a waterway in the middle (water is the centre of daily life). The front and back of the two rows are farmlands. This regular arrangement is a particular structure of the region, and the village form is closely related to the landscape and the way of living in a farming society. The village has about 170 households and 750 residents (1/3 of the houses are occupied all year, 1/3 are temporary residences, and 1/3 are not occupied). The farmers' houses are based on a simple building type, with three or four rooms connected by a corridor. The middle room, the *tangwu*, is the most important. Most of the houses are one storey. There is no bathroom or kitchen in the main building. The kitchen is a small hut in the south side of the house, while the toilet is just a shed placed behind the house.

Wowo Ding morphological view, translated into the proposal, makes explicit the mechanism of formation of this strip village. The proposal involves the drainage of the waterway and cleaning of its banks, allowing the canal to be once again at the centre

Fig. 7.10 Houses in Huangzhuang by Wowo Ding. *Source* Oliveira (2021)

of residents' lives. It also includes the strengthening of infrastructure systems, and construction of micro sewerage facilities, connecting every household—responding the needs of a more diverse population. Action on the village buildings started with four houses. The main goal of this first stage was to demonstrate how an existing house could be adapted to modern life through simple modifications. To address the needs of various groups of people for short-term or long-term housing, while maintaining the same basic type (grounded on a typological analysis), Ding and her colleagues proposed the following changes for each house: i. the addition of a bathroom, outside the main building—in the back or side-by-side; ii. the maintenance and reorganization of the *tangwu,* including the long table; iii. the connection of kitchen and main building, through a simple wooden corridor; and iv. the reorganization of the exterior space in the plot (Ding 2021) (Fig. 7.10).

7.2.4 Towards Integration

In architectural design the frame of references combines internal and external elements. While the former is part of 'that' specific urban landscape, the latter integrate the designer knowledge and values. In architecture, more than in planning and urban design, the frame of references is usually dominated by external references. That approach is fed by architectural schools, architectural prizes and magazines, and the media. The wide acknowledgment of 'creativity' as a fundamental characteristic of architectural practice is in line with the broad celebrity status that architects have acquired in the tweentieth century. Here, we argue for an alternative approach, aiming at achieving a more balanced frame of references. The specific nature of these references should be established in each case by morphological analysis. The internal references of an urban landscape suggested by research can be more structural, and less visible (as in the Terni cemetery) or have a high level of detail, including particular built forms and materials (as in the Huangzhuang houses).

While there is not a definite answer to the question of how to integrate a new building into an extant landscape, these examples, particularly the latter offers interesting perspectives for debate. The Huangzhuang village is an exceptional settlement built on a delicate balance between water and land. The building fabric is made of less than 200 buildings for housing and agricultural activities. Morphological and typological analysis have revealed the structural characteristics of this landscape: the central role of the canal surrounded by two rows of houses, small plots each including one main building and other complementary buildings for kitchen and bathroom, a tripartite division of the main building, and the central role of the *tangwu.* The project conserves all these structural elements as well as the building forms and construction materials (bricks and wood) and offers effective answers to contemporary needs of residents—a crucial aspect of built heritage debate. The project gives a more permanent character to complementary buildings, provides 'light' connections between buildings, and offers the main buildings new utilizations through space and material qualification.

Finally, the three projects, of different scales and programmes, share a certain simplicity, that is expressed in different ways. The organization of the Terni cemetery is a typological interpretation of the city itself, in its most fundamental physical elements. The different rooms of the house in Brasilia is organized in a simple spatial configuration around an atrium and a longitudinal axis. The rehabilitation of the Chinese village is based on a small number of actions in each plot aiming at maintaining the delicate balance between nature and built forms, and between past and present.

Exercises

A. Testing Your Knowledge

7.1 **How Can the Research-Practice Gap in the Urban Landscape Fields Be Characterized?**

i. The gap is new and it is exclusive of the urban landscape fields.
ii. The gap is not new, but it is exclusive of the urban landscape fields.
iii. The gap is neither new nor exclusive of the urban landscape fields.

7.2 **What Can Morphological Research Offer to Professional Practice?**

i. Scientific prescription and design.
ii. Scientific explanation and description of urban form dynamics to support prescription and design
iii. A number of morphological theories, concepts and methods.

7.3 **What Can Professional Practice Offer to Morphological Research?**

i. Rigid and established routines.
ii. New frameworks for thinking about urban form and wider settings where urban morphology must demonstrate its relevance.
iii. A prescriptive and design purpose.

7.4 **How Did Muratori's Research on the Urban History of Venice Supported His Proposal for *Barene Di San Giuliano*?**

i. Based on the urban history of Venice, Muratori proposes the recovery of its fundamental architectural styles.
ii. Based on the identification of three main periods in the urban history of Venice, and their structural elements, Muratori designs three proposals.
iii. Based on the identification of three main periods in the urban history of Venice, Muratori designs one proposal combining the main structural elements of the three periods.

7.5 **How is the Tension Between Conservation and Change Expressed in the *Huangzhuang* Project?**

i. The project aimed at transforming the urban landscape of the *Huangzhuang* village.
ii. The project aimed at conserving the relation between natural landscape and built forms, and the main characteristics of houses while introducing some changes to accommodate contemporary needs.
iii. The project aimed at conserving all urban form elements of the *Huangzhuang* village as they were before 2017.

Solutions

6.1 iii.
6.2 ii.
6.3 ii.
6.4 ii.
6.5 ii.

B. Interactive Exercises

Exercise 7.1—Policy

The purpose of this exercise is the development of critical thinking on urban form and its transformation over time. The student (or a reduced number of students) should start by identifying and reflecting on the main strengths and weaknesses of the physical form of his city. He should then select one of these weaknesses for further reflection. Subsequent thinking should aim at moving from 'scientifical knowledge' to 'professional action'—from the acknowledgment of this weakness to the definition of one policy to address it. This policy should be then translated into one goal and a few objectives (placed at a lower rank than the goal). Each objective should contribute to the achievement of the goal, and it must be clearly distinguishable from the other objectives. If possible, the achievement of each objective should be measurable. The exercise can be developed in classes, involving the preparation of simple diagrams and its presentation and subsequent debate.

Exercise 7.2—Plan

The purpose of this exercise is the definition of a set of guidelines for the future transformation of a particular urban area. As such, the territorial dimension is more explicit than in exercise 7.2. The starting point for the development of this exercise should be the house of the student. He should identify and map the urban tissue where his house fits in and offer a brief characterization of the tissue, considering its streets, plots, and block-plans of buildings (drawing on the ability developed in Exercise 2.3). Based on this characterization the student should develop a reflection on what should be conserved and what may be transformed in this tissue over the next years. This reflection should then be translated into the definition of a set of rules addressing the main elements of urban form, simulating a plan regulation. The exercise should be

developed as homework, involving the preparation of a PowerPoint presentation (5 to 10 min maximum), including one map, one table (urban tissue) and a small text (prescription rules).

Exercise 7.3—Project

While the former 'Policy' and 'Plan' are related to planning practice, this exercise aims at simulating architectural practice. The purpose is the design of a new building into an extant urban landscape. Starting from his house, the student should first identify an empty plot in the surrounding streets. He should map and characterize the urban tissue (streets, plots, and block-plans of buildings) where the plot fits in. Based on the characterization of the plot structure the student should decide to maintain the plot as it is, or to divide it into smaller plots (in that case, only one plot should be considered for the next step of the exercise). The student should design a new building (volume and main facade) for that plot bearing in mind the main characteristics of its urban tissue. The exercise should be developed as homework, involving the preparation of a PowerPoint presentation with one map, one table (urban tissue) and some sketches and photographs (new building and urban tissue).

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Chapter 8
Relationships with Other Fields of Knowledge

Abstract The eighth chapter addresses the contributions of urban morphology to fundamental dimensions of our collective life in cities, in particular the social, economic, and environmental dimensions. Bearing in mind the practical achievement of this purpose, five specific issues from these three generic dimensions are selected: public health, social justice, heritage tourism, climate change, and energy. The chapter discusses how to strengthen the channels of communication between each of these issues and the field of urban morphology.

Keywords Climate change · Energy · Heritage tourism · Social justice · Public health

One major challenge for urban morphology, in the next years, is to be able to identify its most important and morphologically specific contributions to contemporary cities and societies. It is urgent to strengthen the morphological dimension of debate and practice on cities. As such, urban morphology should pay less attention to criticizing, modifying, and transforming the wealth of its already sophisticated concepts, methods, and techniques, and pay more attention to potentiate the conditions for the application of its contributions in our daily lives. This process will necessarily involve some simplification, but it does not have to mean a loss in the fundamental contents of the discipline.

There is a need for developing key cross-disciplinary links between urban morphology and the different bodies of knowledge studying cities, promoting effective integrated research. Despite the potential advantages of transferring morphological knowledge to these different disciplines, its occurrence is quite limited. In urban morphology, and more generally in the social sciences and humanities, the ability to identify and build cross-disciplinary links, and the awareness of relevant work in other disciplines, are not very common (Whitehand 2010). The fundamental, and realistic, challenge is to find a balance between two distinct poles: integration and specialization. The identification and construction of specific links should involve the participation of academics, practitioners, and citizens. The development of each linkage presupposes the capacity of researchers to gather and synthesize broad perspectives, knowledge, and skills. Because most researchers, even in urban morphology, are trained in traditional disciplines, they must learn to appreciate differing perspectives

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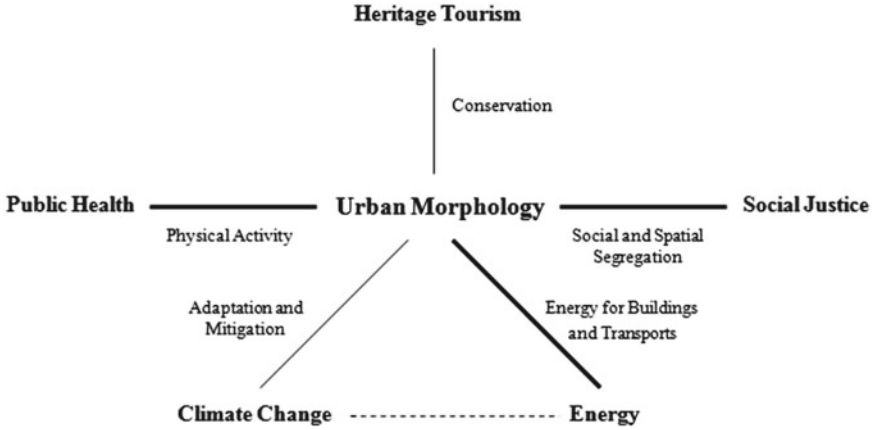

Fig. 8.1 Contributions of urban morphology to our collective life in cities

and methodologies. A breakthrough would be the provision of a sound morphological dimension to other fields. This could, for many research projects, provide the desired added value and, ultimately, enable further advances in our shared knowledge about cities.

The next three sections explore the potential contribution of urban morphology to five specific issues: public health, social justice, heritage tourism, climate change and, somehow interrelated with the former, energy. These are five selected examples (others could have been chosen) of specific issues of daily life where urban morphology could offer a sound contribution. Figure 8.1 offers a synthesis of these linkages—while the thick lines represent the most consistent linkages, the thin lines represent the most embryonic relations.

8.1 Urban Morphology and Society

The first section of this chapter focuses on two crucial issues in our societies where urban morphology can offer a sound contribution, public health, and social justice. Some of the key words in these processes of integration of different areas of knowledge are physical activity and walkability, in the first case, and social and spatial segregation, in the second case.

8.1.1 Public Health

Physical inactivity is a global pandemic, responsible for more than 5 million deaths per year through its effects on multiple non-communicable diseases (Sallis et al.

2016). Several studies in public health suggest that significant benefits can be achieved through the accumulation of moderate physical activity, like walking and bicycling, in regular short bouts (Karmeniemi et al. 2018). The health benefits of daily, moderate physical activity have the potential to be more effective than more structured, vigorous forms of exercise, like jogging or aerobics, because of increased levels of adherence to these activities. Indeed, research indicates that people may be more willing and able to adopt moderate physical activities and, once such activities are begun, to maintain them overtime, as compared with forms of vigorous physical activity. An increasing body of research argues that there is an effective influence of urban form on this type of physical activity and, as such, on public health. Investigation also shows the reverse—how urban form can discourage physical activity. Low levels of physical activity threaten our health, both directly and indirectly. A sedentary lifestyle is a well-established risk factor for cardiovascular disease, stroke, and all-cause mortality. In addition, the lack of physical activity is also a risk factor for being overweight and obese (Frumkin 2002).

One of the most consistent lines of research in this issue, over the last two decades, has been developed by Lawrence Frank and his colleagues, first in the Georgia Institute of Technology, then in the University of British Columbia, and finally in the University of California San Diego. Frank and Engelke (2001) distinguish between two types of barriers to physical activity: personal barriers, which are subjective considerations restricting an individual's motivation or ability to exercise; and environmental barriers, which are real-world conditions that place restrictions on physical activity. It is important to acknowledge that the latter may have disproportionate impacts on different subgroups, most especially on vulnerable groups, like elderly persons or children.

So, how do different elements of urban form impact walkability and cycling? Well-connected street networks and small street blocks (two interrelated aspects) offer more intersections and, as such: more direct movement between activities, the reduction of the distance between trip origins and destinations, the provision of alternative pathways of movement, and the limitation of vehicular travel speed through the closer spacing of intersections (Sallis et al. 2016). The characteristics of the specific parts of a street are also very important for promoting walkability and cycling. Streets with ample sidewalks, bike lanes, and crosswalks on which pedestrians and cyclists can travel will be perceived as safer—the perception of safety is also influenced by faster or slower automobile travel along the street—and have a positive impact on these soft modes of transport (Moudon et al. 1997; Frank and Engelke 2001). The number of parks is also an important attribute to consider (Sallis et al. 2016).

Not only streets are important, but also buildings. The density of buildings is a key characteristic (Sallis et al. 2016). Their age is another fundamental aspect. In general, the average distance one needs to travel for recreational purposes seems to decrease with the age of buildings and neighborhoods, implying that persons who live in older neighborhoods have better access to recreational facilities (Handy 1996). Another important characteristic seems to be the position of buildings within plots. While buildings oriented toward and situated next to streets have a favourable impact on

walkability, buildings considerably set back from streets and often oriented toward parking lots seem to discourage walkability (Moudon et al. 1997). Finally, research also made evident that people living in mixed use neighbourhoods are more likely to be active enough to achieve health benefits (Frank et al. 2005). Modest changes in the walkability of an urban landscape can be translated into important, health-enhancing population-level increases of activity.

8.1.2 Social Justice

There is a robust body of research on the social justice's dimension of the city. David Harvey and Susan Fainstein are two notable examples within this line of research. The work of the latter, around the concept of the just city, has a clear focus on the physical form of cities. An even more explicit link between social justice and urban form has been developed by Laura Vaughan, at the University College London, under the topic of social segregation. Over the last two decades, after her MSc and Ph.D. theses, Vaughan has been showing a consistent correspondence between social and spatial segregation, distinguishing, in the city, the existence of poor, spatially segregated areas and streets and more prosperous, spatially integrated areas and streets.

Research into poverty areas suggests that despite the many attempts to improve housing quality over the twentieth century, these interventions have failed to substantially alter the geography of poverty (Orford et al. 2002). Lupton (2003) states that physical characteristics, through their impact on population mix, lead neighbourhoods to acquire other characteristics, such as services and facilities, reputation, social order, and patterns of social interaction, as people and place interact. While disadvantaged individuals in an isolated area will form one set of social relations (exacerbating the disadvantages of these poor individuals), disadvantaged individuals in a well-connected area may form another set of social relations. Poverty can, for instance, lead to unequal access to jobs and thus to high rates of unemployment in a particular area. In addition to these findings Vaughan suggests that i) the persistence of poverty areas over time can be explained by a number of aspects including the combination of some spatial factors; and ii) when these areas are located close to economically active, well integrated streets, such spatial patterning can serve as a necessary mechanism for the social integration of minorities and it is frequently part of a natural process of acculturation and integration in the urban environment (Vaughan 2007).

The analysis of poverty areas usually reveals a sound presence of immigrants. It is the location and the spatial segregation of each of these areas which make them more likely to be settled by poorer immigrants. The process of formation of immigrant quarters is a critical stage in the integration of immigrants into society. Research into cases of supposed 'ghettoization' has questioned the simplistic notion of the immigrant residential quarter cutting its inhabitants off from society. In fact,

depending on the location and the way in which the street network is utilized, clustering can enable the intensification of communal activity, socialization, networking, and self-support. Analysis has shown that clustering of immigrants during initial stages of settlement, and sometimes beyond the first generation, is part of a process of acculturation and integration. It also shows that for immigrants, the existence of settlements in locations enabling economic activity is a necessary step in the process. Frequently, entrepreneurship in ethnically concentrated neighbourhoods not only results in processes of mixed-embeddedness and economic integration but strengthens social networks and reciprocity (Vaughan and Penn 2006; Vaughan 2007; Vaughan and Arbaci 2011). On the contrary, long term minority clustering can have a negative effect, impeding social mobility, limiting access to work, enabling criminal behaviour, or hampering school achievement.

Another fundamental line of research on the linkage between urban form and social justice has been developed by Emily Talen since the late 1990s, mostly at the University of Illinois, the Arizona State University, and the University of Chicago. Talen started exploring this link by focusing on social equity and spatial accessibility to public facilities, like schools, parks, or playgrounds, using the then emerging GIS for measurement (Talen and Anselin 1998). Throughout the 2000s, her emphasis has changed to diversity and to some key social characteristics, like income, age, family structure, and ethnicity. Underlying this emphasis was the idea that the most successful communities are often those that are the most diverse (Talen 2012). A third focus in this systematic line of research has been the neighbourhood as a spatial unit that people relate to a localized, place-based, delimited urban area that has relevance, meaning, and some level of personal influence (Talen 2018).

8.2 Urban Morphology and Economy

This section addresses the relationship between urban form and economy, with an emphasis on heritage tourism. Most research on the relationship between urban form and economy adopts a macro scale of analysis. A good example is a recent report, published by UN-Habitat within the framework of the United Nations Human Settlements Programme, offering a literature review on the economics of urban form (UN-Habitat 2015). The report addresses two major characteristics of urban form at the macro scale, density and centrality (comparing extreme situations of high and low density and mono- and poly-centricity) and relate both to size (measured by population). In relation to density and centrality, the report sustains that high-density forms, including both monocentric and polycentric, offer the best balance of low transport and infrastructure costs, low environmental impact, and high income-generation abilities. Furthermore, the economic costs of moving towards lower densities include increased transportation costs, increased greenhouse gas emissions per capita (a theme of the next section), and rising obesity rates, in conjunction with decreasing productivity. On the contrary, costs associated with high-density levels include congestion and high land prices. Ultimately, more economic benefits than

costs seem to be present in high-density areas. In relation to city size, the report argues that this characteristic is interdependent with both density and centrality. Increases in city size seem to correlate with higher wages, higher proportions of educated citizens, and higher productivity. These result from economies of agglomeration, which are reliant upon increased proximity and scale afforded by larger cities. The report argues that there is no optimal city size, but efficiency in city size is dependent upon local features and constraints (a view supported by Batty 2008). In a similar way, Gordon and Richardson (who, in the 1990s, have authored an influential paper on the debate between compact and sprawl) argue that urban form matters to economic growth, explaining the logic behind how entrepreneurs and others can be spatially prepared to succeed (Gordon and Richardson 2012).

8.2.1 Heritage Tourism

At the end of the Second World War, tourism began to flourish and spread to all corners of the world, due to high levels of affluence, advances in transports and telecommunications technology, and enhanced international relations. Since then, tourism has become one the most powerful economic forces in the world. It affects every nation and community, directly or indirectly, and influences decision making, even at national and supranational levels. Due to the global significance of tourism, communities throughout the world have welcomed it as an instrument for economic development. As part of this trend, tourism become compartmentalised into different types, somehow recognising that it is not a homogeneous or undifferentiated phenomena. One of the most significant types is heritage tourism. Visitors to historic places and their spending in the areas of lodging, food, admission fees and shopping, contribute billions of dollars every year to the global economy and employ millions of people directly and indirectly (Timothy and Boyd 2006).

Heritage tourism entails visits to historical sites, including built environments and urban areas, ancient monuments and dwellings, rural and agricultural landscapes, locations where historic events occurred and places where interesting and significant cultures stand out. The range of resources that function as attractions in heritage tourism is extensive and the types and dimensions are manifold. Most research adresses the ‘supply’ side, focusing largely on interpretation, conservation (on a wide and non-orthodox sense, being one of the keywords for designing a link between heritage tourism and urban morphology), and other elements of resource management, as well as the support services that exist for visitors at historical locations. While research on ‘demand’ has a less developed expression, it has shown that visitors to heritage sites are better educated, bigger spenders, travel in groups, and have average or high incomes (Timothy and Boyd 2006).

Urban conservation is an idea of modern times, developed after the French Revolution. Over the nineteenth and twentieth centuries, with variations in different geographical contexts, historic monuments were the focus of conservation. While promoting the preservation of these special buildings, this conservation approach

allowed, and in some cases supported, the destruction of significant parts of urban landscapes based, for instance, on health, security, and aesthetic considerations. In parallel to this dominant approach, new perspectives on conservation emphasizing the role of the urban landscape started to emerge in the early twentieth century. In the 1960s and 1970s, there were important advances, including the preparation of the Venice Charter, the creation of the International Council on Monuments and Sites/ICOMOS (and the subsequent realization of the 'Convention concerning the protection of world cultural and natural heritage' and establishment of the 'World Heritage List') and the making of the first planning documents centred on conservation—notably, the Bologna plan coordinated by Cervelatti (presented in Chap. 3). Present debate on urban conservation includes the tension between narrow architectural perspectives (including facadism and pastiche) and a comprehensive understanding of heritage (Bold et al. 2017; Roders and Bandarin 2019), the synergies and tensions with planning, and the contradiction between places that were areas of production in the past and are centres of consumption in the present, to name some of the most important.

While, for urban morphologists, it is widely accepted that cities must change, one of the key problems is how to cope with change while retaining older areas and structures in which past generations have invested so heavily. Within the science of urban form, one of the most consistent lines of investigation on the conservation of urban areas has been developed, for more than two decades, by Peter Larkham, first at the University of Birmingham and then at the Birmingham City University. In the book 'Conservation and the city', Larkham (1996) tries to understand how is change initiated and implemented, what effects has it on conserved areas, and how might it be better managed in the future. In doing so he addresses some of the fundamental questions of conservation: (i) what is to be preserved? (and who identifies the preservation-worthy buildings and areas, and whether this identification meets with the approval of the population living, working and recreating in these areas); (ii) to what extent do those influencing development and those affected by it have consistent views about the area in which development is proposed?; (iii) how is conservation/preservation to be carried out: are the buildings and areas identified in any way removed from the natural life-cycle of construction, use, obsolescence, decay and demolition?; and, finally, (iv) what is the nature and scale of changes proposed and carried out to the physical urban fabric? One important aspect of Larkham's research is the focus on those involved directly and indirectly with change, under the topic of 'agents of change' (this topic was addressed in the third chapter).

Conciliating heritage tourism and urban form conservation, through key inputs of urban morphology, is a challenging task. Close to Nasser (2003) we highlight the need to protect heritage as a natural resource that if overexploited will be degraded, the acceptance of change and development to ensure continuity, and the need to consider equitable access to heritage resources by the local community and visitors. Finally, it should be said, as Fig. 8.1 shows, that until now the input from urban morphology in heritage tourism was not as consistent as in the previous cases of public health and social justice.

8.3 Urban Morphology and Environment

This section, on the contribution of urban morphology to fundamental environmental challenges, focuses on two interrelated issues, climate change, and energy. The debate on the former, somehow, frames the discussion on the later.

8.3.1 Climate Change

The science of climate change is well established. The delivery of the 2007 Nobel Peace Prize to the International Panel on Climate Change (IPCC) marked the end of debate on whether climate change is human induced and real. Attention has then moved to what we have to do about climate change. At the Paris Climate Conference (officially known as the 21st Conference of the Parties, COP21), in the end of 2015, an agreement between 196 parties was reached. The agreement provides a pathway, and a mechanism, to limit temperature rise to below 2 degrees (maybe even 1.5). COP21 also sent a signal to markets that it is time to invest in the low emission economy.

Predicted weather-related events like sea level rise, increased storm events, and extreme heat waves imply an urgent need for new approaches to settlement design to enable human and non-human species to adapt to these increased risks. Adaptation and mitigation are emerging as some of the most pressing issues nations and cities face. While mitigation works to reduce current and future greenhouse gas emissions, including emissions that are generated through built environment and transports sectors, adaptation seeks to adjust the built and social environment to minimize the negative outcomes of now-unavoidable climate change. Whilst adaptation and mitigation can be seen as methods to achieve the intermediate objective of reducing vulnerability and the risks associated with climate change, resilient communities are the overarching goal (Hamin and Gurran 2009).

Blanco et al. (2011) argue that the way the main elements of urban form and infrastructure systems are organized can contribute to the emission of greenhouse gases and amplify climate change impacts. The structure, orientation, and condition of buildings and streets can increase the need for cooling and heating buildings, which are associated with the level of energy use (this will be expanded in the next subsection) and can account for a significant proportion of greenhouse gas emissions in a city. The extent of streetscape and the impervious surface of structures can intensify flooding and are direct determinants of the urban heat island effect (Yin et al. 2018).

8.3.2 Energy

Energy plays a fundamental role in today's world. The way urban areas are built has a great influence on the present and future demand for energy. The influence on transport demand is mainly expressed in trip generation and on built structures, in terms of end uses like heating, cooling, and lighting.

While urban morphology focuses on the physical stocks of cities and the processes and agents shaping them, sometimes ignoring the issue of urban flows, research on energy sometimes adopts sectoral visions of the problem, and has not been able to deal effectively with the spatial dimension of cities embracing all scales. Most literature on energy has been addressing one of two scales of analysis. At the city scale, research has been exploring the dichotomy between compact and diffuse patterns of urban development, the variations of density, and the land-use patterns, connecting these aspects with transports—including systems management and construction of infrastructures. At the building scale, recent research tends to cluster around three main lines of investigation: the establishment of different frameworks for classifying built forms (from an urban energy perspective); the design of innovative methods for estimating the energy consumption of buildings; and finally, the analysis of the potential of buildings for improvement. Despite the remarkable advances at both scales of analysis, there is a gap between the two communities of researchers.

In the last years, some studies started to address an intermediate scale of analysis (between the city, taken as a whole, and the building, seen as a self-defined entity) that has been previously ignored, possibly due to the complexity of environmental processes and lack of data. Osmond (2010) proposes the urban structural unit, a descriptive and explanatory framework that considers both the stocks and flows (energy, information, and materials) of the city. Ratti et al. (2005) use digital elevation models and the lighting and thermal simulation tool to analyse the effects of urban texture on building energy consumption. Ratti and his colleagues consider the following parameters: built volume and built surface, passive and non-passive zones, façade orientation, urban horizon angle, and obstruction of sky view. Following a similar line of research, Salat (2009) uses several environmental metrics—such as building shape and passive volume—to explore energy consumption in different parts of the city. Both papers include applications in large European cities. Shi et al (2021) address the efficiency of district cooling systems in high-density cities, considering the effects of the street layout, building density (floor area), and land uses, and assessing it according to five cost indicators. An additional step is taken by Silva et al (2017) considering not only heating and cooling in buildings (the focus of previous studies), but also travel. The methodology applies GIS to provide the analysis with a spatially explicit character, and neural networks to model energy demand based on a set of relevant urban form indicators.

The development of new approaches, theories, concepts, and methods should offer greater understanding of the interrelationships between urban form and the level of energy being used to maintain contemporary urban systems—considering both the quantity and quality of energy sources. It should also inform debate on current

urban development strategies, promoting the sustainable use of resources, land, and energy as key ingredients for long-term prosperity. Among the different issues of contemporary debate on cities, energy is certainly one of the most important. Rising energy prices, the urgent need to reduce emissions and mitigate climatic change (the theme of the last subsection), and the large investments that will be needed to make installations and infrastructures fit for the future, make urban energy a key challenge for the next years.

Exercises

A. Testing Your Knowledge

8.1 How does urban form relate to public health?

i. Urban form can influence vigorous physical activity, and this can have significant health benefits, avoiding cardiovascular disease and stroke.
ii. Urban form can influence moderate physical activity, and this can have significant health benefits.
iii. Urban form can influence vigorous physical activity, and this can have significant health benefits.

8.2 What impact can urban form have in the promotion of social justice in cities?

i. Recovering the architectural styles of the past can remedy many aspects of social injustice promoted by the modernist paradigm.
ii. The main elements of urban form, and their patterns of combination, can contribute to the social integration of the city's residents and workers.
iii. Strong planning proposals leading to profound transformations in the city's fabric can reduce the gap between the richer and the poorer residents.

8.3 How can urban morphological knowledge inform the debate between conservation and transformation led by heritage tourism?

i. Urban morphology can prevent the transformation of historical areas.
ii. Urban morphology can be a tool against tourism.
iii. Urban morphology can offer a comprehensive framework to understand, in each situation, what to change and what to conserve.

8.4 How can urban morphology inform adaptation and mitigation strategies?

i. Urban morphology offers a scientific description and explanation of urban phenomena, enabling the evaluation of different scenarios aiming at adusting the urban landscape (adaptation) and reducing emissions (mitigation).
ii. Urban morphology has no significant role in addressing climate change, including both adaptation and mitigation strategies.

iii. Urban morphology can contribute to reduce current and future greenhouse gas emissions, including emissions that are generated through the built environment and transportation sectors.

8.5 How does urban form influence energy demand in cities?

i. Industry is the most relevant sector responsible for energy demand. Urban form does not have a significant influence.
ii. The most relevant influence of urban form is through the street network on transport demand, and it is mainly expressed in trip generation.
iii. The influence is mainly twofold: of street network on transport demand, mainly expressed in trip generation; and of buildings in terms of end uses such as heating, cooling, and lighting.

Solutions

2.1—ii

2.2—ii

2.3—iii

2.4—i

2.5—iii

B. Interactive Exercices

Exercise 8.1—Urban Form and Health

This exercise addresses the relation between the main characteristics of urban form and the promotion of public health, through moderate physical activity, as framed by Sect. 8.1. The starting point, as in some previous exercises, is the student's house. The student should identify and map an area around his house holding the structural physical conditions (including high density of street intersections, street blocks, plots; coincidence of building and plot frontages) to have a positive impact on walking (as moderate physical activity) and, as such, on public health. This area is likely to have an irregular geometry. The student should then think of, and map, an expansion of this 'friendly walking area' (preferably in its physical continuity), bearing in mind the development of some non-structural changes on urban form—like the promotion of active ground floors, the presence of trees, and the redistribution of street space for pedestrian and cars, to name just a few. The exercise should be prepared as homework and presented in classes. The PowerPoint presentation (5–10 min) should include the two maps (original area and extended area), supported by photographs of both areas, and by the list of extant characteristics and proposed changes on urban form.

Exercise 8.2—Urban Form and Social Justice

This exercise is an exploratory analysis of the relationships between urban form and social justice, as framed by Sect. 8.1. The student should start by identifying

two segregated areas of his city—this identification should be based on his knowledge of the city. The areas should have different geographical locations. Firstly, the student should offer a brief social characterisation of these two areas, based on a few selected social indicators usually available at national statistics—for instance, education, employment, and income. The performance of these areas for each indicator should be then compared to the city average, offering a benchmarking. Secondly, the student should develop a physical characterisation of the two areas, focusing on streets, street blocks, plots, and buildings. The social and physical characterizations should be compared. While the exercise is just an exploratory analysis, it should be able to motivate students to reflect on the relation between spatial and social integration. The exercise should be prepared as homework and presented in classes. The PowerPoint presentation (5–10 min) should include the characterisation of the two areas, supported by text, drawings, and photographs.

Exercise 8.3—Urban Morphology and Heritage Tourism

This last exercise addresses the relation between urban morphology and heritage tourism, focusing on the conservation of urban form. The student should concentrate on the historical centre of his city, as this is usually the area under the greatest pressure of heritage tourism. The exercise is in two parts. In the first part, the student should reflect on the heritage tourism's pressure on his city. He should then offer a physical characterisation (streets, street blocks, plots, and buildings) of the historical kernel, identifying the main strengths, weaknesses, opportunities, and threats raised by heritage tourism. In the second part, the student should briefly outline a conservation policy, defining what should be preserved and what can be transformed (as explored in previous exercises), bearing in mind the goal of offering tourists an authentic experience, while at the same time assuring the needs and aspirations of residents and workers. The exercise should be prepared as homework and presented in classes. The PowerPoint presentation (5–10 min) should include the characterisation of the historical area and the main aspects of the conservation policy. The PowerPoint presentation can be supported by text, drawings, and photographs.

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Chapter 9
Conclusions

Abstract The ninth chapter presents the main conclusions of the book, bringing together the different synthesis presented in each of the previous chapters and reflecting on the produced work as a whole. This chapter includes the identification of some lines for future research within the science of urban form.

Keyword Cities · Urban morphology · Urban form · Manual

There is a gap in the literature on the study of urban form. Despite the existence of many excellent books on many different aspects on the physical form of cities, there are no manuals on this field of knowledge. This book addresses this gap and intends to be a manual on urban morphology. Indeed, it offers the reader an overview on a reduced, but essential, set of issues in this field of knowledge. The organization of the book is based on my personal experience, teaching urban morphology to students in the last year of an architectural degree, in a discipline structured in 15 lessons over one semester. As an introductory book, it 'stands on the shoulders of giants'. As such, it identifies the fundamental texts the reader should examine if he, or she, wants to further explore each of the main themes of the manual. Perhaps the most obvious examples, in the wide set of references included in the manual, would be the ten classics in urban morphology and urban studies listed in Chap. 6, or the two notable books on the history of urban form by AEJ Morris and Norbert Schoenauer included in Chap. 4.

The book is in two different parts. While the first part (Chaps. 2–5) focuses on the physical form of cities, the second part (Chaps. 6–8) is centred on urban morphologists and practitioners. This distinction between object and researcher/practitioner is crucial for the presentation of the book's contents. In the first part, we have tried to understand what are the main elements that structure the physical dimension of cities; how these elements have been created (who designs them and how each idea is effectively implemented on the ground); and how these different elements have been organized in each period of our collective urban history. After understanding the object, we have focused on the researcher and the practitioner. In the second part, we have addressed the main approaches that urban morphologists have been developing to understand the physical form of cities; the passage from scientific description and explanation to professional practice; and the contributions that urban morphology

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can give to other fields of knowledge focusing, as we urban morphologists, on the city.

Each of the next paragraphs includes one fundamental idea of the book. All cities, and all different parts of a city, are constituted by a limited set of elements of urban form—streets, street blocks, plots, and buildings, to name the most important. While these elements are the same from city to city, what varies is their characteristics and the way they are combined in different patterns originating different urban tissues. It is our strong believe that the capacity for effectively analysing existing urban forms or designing new ones depends on a correct understanding of the characteristics of each of these elements and of how these can be combined. Over the twentieth century, streets, street blocks, and plots have progressively lost their importance, in the processes of analysis and design, in favour of buildings—in particular, of exceptional buildings. We argue for a change of focus, addressing the different elements of urban form in a balanced way.

The second fundamental idea of the book is that our cities are made of a great variety of contributions of different agents (with distinct and, sometimes, conflictive interests) and through various processes of transformation. Developers, architects, builders, planning officers, and politicians all interact in different ways in the complex processes of city building. Furthermore, our societies tend to organize in different ways to balance comprehensive views of the city, usually planned views, and several contributions, eventually associated with a higher spontaneity. These complex processes should be considered in our analysis of, and action on, cities.

The analysis of our urban history reveals a clear permanence of the elements of urban form that have been used in the different processes of city building. On the contrary, the characteristics of each of these elements and how they have been combined over almost six millennia had moments of rupture and periods of permanence. Indeed, we can find similarities between the different cities. If we assume a simplified view, we can say that all city layouts built up over 6,000 years of history could be classified as 'regular' or 'irregular'. On the one hand, we can find regular layouts in Chinese, Egyptian, Greek, Roman, and Renaissance cities, although in the case of Greece and Rome we can also identify some cases of irregular layouts—Athens and Rome are, perhaps, the most notable examples. On the other hand, we can find irregular layouts in the Sumerian, Inca, Islamic, and Mediaeval cities, although in the case of Mediaeval Europe we can also find examples of regular layouts—such as the French *bastides*. But we can also find change, as the characteristics of the different elements have been transformed over time. While in the early cities of Mesopotamia and China and, although to a lesser extent, in Greek cities, streets were only the 'space between buildings', their importance increased in the Roman cities, becoming perhaps the most important element of urban form in Mediaeval cities. One of the most profound changes in the different physical elements occurred in the mediaeval era where some exceptional buildings and infrastructures have been literally converted into cities. This has been the case of the amphitheatres of Arles and Nimes or of the palace of Split. Another major change in urban form elements has been the disappearance of the courtyard house in Mediaeval Europe. While this had been the main residential building type from early cities to Roman cities, it was

substituted by a new type of house in mediaeval times—a house facing the street, with a clearly urban façade, many times with a commercial use in the ground floor, and with an exterior space in the back of the plot. Only in Islamic cities the courtyard house—a residential type with three millennia of history—continued to be a key element of urban form.

We have inherited urban landscapes of great diversity and richness. This diversity of formal characteristics and patterns of combination expresses the geographical, cultural, and economic diversity of the societies that have created and transformed them over time. Each urban landscape is the the product of a complex process where many agents converge. A portrait of the world population in 2020 reveals that more than half of us lives in cities, almost ¼ lives in settlements with less than 300.000 habitants, and almost 10% of us live in 35 megacities. It is a complex mosaic. Yet, complexity and diversity are confronted with globalization and homogeneity trends. In the urban landscape these trends are expressed by the production of spectacular buildings with no relation to their surroundings (but to other spectacular buildings in different parts of the planet), by more exclusive processes that promote a dicothomy between extremes (planned or informal), and by the reduction of the diversity of agents that can participate in these urban dynamics. While holding, perhaps, the most fascinating urban history of the five cities presented in Chap. 5, Istanbul is a notable example of a progressive loss of diversity after the mid-twentieth century. Against that background, one of the main messages of the book is that it is our shared responsibility to acknowledge and protect this diversity of our cultural and built heritage.

Urban morphology is a science with more than one century of history. Over this period, it has been consolidating a solid theoretical and methodological body and a wide set of concepts and techniques for understanding the dynamics of urban form. The current debate includes different morphological approaches shared by an increasing number of researchers in different parts of the world. In this manual we have analyzed four of these approaches—historico-geographical, process typological, space syntax, and spatial analysis. While the debate on urban form tends to emphasize the differences between approaches, this book proposes the opposite, working together, drawing on our common ground—the physical form of cities. In this context, it is argued that the topic of comparative studies of urban form should be part of the morphological agenda for the next years.

In this book, when analysing the relationship between theory/research and practice, we have distinguished two different links: one to planning practice and urban design and another one to architectural practice. We have made evident the existence of a more consistent link to planning and urban design, than to architecture. Yet, we have argued that mainstream planning practice is not informed by urban morphology. Neither is it influenced by planning theory. In fact, it does lack a sound theoretical and methodological body to deal with the physical form of cities. So, how could this relationship, between urban morphological research and mainstream planning practice, be reinforced? Close to Ivor Samuels, I would argue for the need to (i) communicate in a simple and direct way, to planning professionals, what urban morphology has to offer to practice; (ii) gather an on-going collection of case studies

of how and where urban morphology is being used successfully; (iii) prepare effective manuals on urban morphology; and, finally, (iv) (thinking in future planning practitioners) understand what morphological contents are being taught in higher education institutions, what contents should be introduced, and what contents that are now being taught should be improved.

It is not obvious to common citizens, neither to most academics, what the contribution of urban morphology to our daily lives in cities is. And yet, Chap. 8 has identified some essential dimensions where this input might be of fundamental importance, notably public health, social justice, and urban energy. As we have argued before, one major challenge for urban morphology in the next years is to identify and communicate, in a systematic way, its most important and morphologically specific contributions to contemporary cities and societies. This will certainly lead to the establishment of key cross-disciplinary links with the different bodies of knowledge studying the city, promoting effective integrated research.

This is a book on cities; on their physical form and on how we, urban morphologists and practitioners, describe, explain, and act on this physical from. It is also an introduction to a remarkable body of knowledge with one century of life. As such, it should be able to lead the reader to many notable books that were written since the birth of urban morphology in Central Europe in the turning from the nineteenth to the twentieth century. It should also encourage the reader to contribute to make his city a better city and to visit and enjoy other cities in different parts of the world.