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THE SPATIAL ORGANISATION OF URBAN AGRICULTURE IN THE GLOBAL SOUTH

FOOD SECURITY AND SUSTAINABLE CITIES

Ada Górna

The Spatial Organisation of Urban Agriculture in the Global South

This book examines the role and position of urban agriculture in the spatial and functional structure of cities in the Global South.

In the face of dynamic urbanisation and negative consequences of climate change, one of the key challenges is not only how to provide food for the ever-growing urban population but also how to achieve urban sustainability and simultaneously reduce the negative impact of cities on the natural environment. These problems are particularly urgent in the metropolises of the Global South that are experiencing the greatest population growth while struggling with increasing social inequalities and the resulting uneven distribution of resources. Examining the role that urban agriculture can play in addressing these challenges, this book draws on three case study cities: Havana, Singapore and Kigali. The case studies, differing in socio-economic, spatial, political and environmental terms, exemplify diverse characteristics of urban agriculture in different geographical conditions. Drawing on fieldwork conducted in each city, this book also provides a unique perspective on the constraints in the development of urban agriculture and the use of its full potential for urban sustainability.

This book will appeal to students and scholars, as well as decision makers, interested in the issues of urban sustainability, food security, spatial development and alternative food systems.

Ada Górna is a senior assistant in the Faculty of Geography and Regional Studies at the University of Warsaw, Poland, where she lectures on urban studies and food systems. She holds a PhD in the field of social sciences in the discipline of socio-economic geography and spatial management from the University of Warsaw and has published in a range of journals, including *Land,* the *Journal of Baltic Studies, Planning Perspectives*, and *Miscellanea Geographica.*

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1 Introduction

According to the 2019 report of the United Nations Department of Economic and Social Affairs (UN DESA), city residents make up more than 55% of the current global population. By 2050, this percentage may increase to as much as 68% (UN DESA 2019). In the face of continuous, dynamic urbanisation and negative consequences of climate change, one of the key challenges becomes the issue of not only how to ensure the food security of ever-growing city population but also how to simultaneously implement the principles of sustainable development and limit the negative impact of cities on the natural environment.

Already in the 18th century, in *An Essay on the Principle of Population*, T. Malthus forecast inevitable exhaustion of Earth's natural resources (Malthus 1798). Those fears were reiterated in 1972 in the report on "The Limits of Growth", commissioned by the Club of Rome (Meadows et al. 2013). Although neither of those catastrophic visions ultimately came to pass, the debate on unequal distribution of good, resulting from social and economic disproportions, is becoming increasingly frequent in academic discourse. Excessive burden on ecosystems, increasing demand for energy and adverse climate change, which are largely attributable to the world's huge metropolises, demonstrate the need to revise the current approach to city development and to start building sustainable urban systems. According to the estimates of the United Nations Human Settlements Programme (UN-Habitat), cities are responsible for 75% of greenhouse gas emissions even though they only cover 2% of the world's surface. The total emissions take into account both the gases produced in the cities themselves (e.g. transport, heating and air conditioning of buildings, industry) and those produced outside cities in order to meet the cities' needs (e.g. power generation, as well as production of food and other goods) (UN-Habitat 2011). In view of the aforementioned challenges, there have been proposals for the development of compact cities as well as short-distance cities that make up a functional whole. In such a city, it would be possible to shorten the distance between the place of production and place of consumption, while the residents would be able to satisfy their basic needs without having to travel by car. What is more, the new green cities should make efficient use of natural resources, as well as increase their energy and food self-sufficiency (Fücks 2013). Such development would limit negative impact of large metropolises on the natural environment while simultaneously improving the well-being of the residents themselves.

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Currently, concepts such as smart city, green city, resilient city or soft city are gaining popularity. They all highlight – albeit in different ways – the need for thorough changes in the dominant paradigm of development of urban areas. Earth has become a planet of cities and it is cities that bear the great responsibility resulting from local processes taking place in them that have global, frequently catastrophic effects. The awareness of this fact as well as the effort to gradually transform urban systems are ingrained in the concept of intelligent and sustainable city development (Szymańska & Korolko 2015). While many aspect of city life require those changes, it is the issue of food production, distribution and consumption that is being more and more frequently tackled by scientists, planners and urban decision-makers.

The subject of this book is urban agriculture, which – when properly managed – presents a chance for sustainable development of cities. The financial crisis of 2007–2009,[1] the COVID-19 pandemic announced by the World Health Organisation in 2020 and even the war in Ukraine, the effects of which included a serious increase in food prices, only aggravated the issue of limited access to food products, especially among the poorest city residents. This problem is particularly serious in metropolises of the Global South, which are the focus of the considerations contained in this book. It is those cities that are experiencing the biggest increase in population while simultaneously struggling with pollution, growing social inequality and the resulting uneven distribution of resources. Local food production can serve as a remedy to the aforementioned problems. It presents a chance for improved food security of the growing urban population, increase in their self-sufficiency as well as enhancement of urban ecosystems. The book tackles the role played by urban agriculture in the spatial and functional structure of three cities of the Global South – Havana, Singapore and Kigali.

1.1 Outline of the research subject matter

The subject matter of the research described in the book is urban agriculture, which has been growing in significance since the 1990s. It is currently an important topic in research on sustainable urban development. The very term "urban agriculture" may seem like an oxymoron. After all, agriculture is commonly considered an activity strictly associated with rural areas, while the urbanisation process in economic terms is measured precisely with the share of population employed outside this sector of the economy. Moreover, crop growing and animal breeding in cities are perceived as archaic, temporary and marginal activities, which at best can be symptoms of a new fad that play additional recreational roles or improve the aesthetic of the urban landscape. However, in reality, urban agriculture is a prominent economic activity, which plays a key role in the lives of hundreds of millions of people around the world (Smit et al. 2001). It is estimated that in the mid-1990s, the number of city residents engaged in agriculture exceeded 200 million, while 800 million people were dependent on supplies of food produced by those workers (Zezza & Tasciotti 2010). According to various sources, the share of urban

population engaged in agriculture at the time amounted to 40%–70% in Africa, 60% in Asia and 50% in Latin America (Bryld 2003; Zezza & Tasciotti 2010). Although those are merely estimates, they demonstrate the important role played by urban agriculture on a global scale, in particular in cities of the Global South. It is currently a rapidly developing sector, with growing significance for the food security of urban residents (in particular in the least developed cities) and a far-reaching economic, social and environmental impact.

Due to its comprehensive and complex nature, as well as a multitude of functions fulfilled in the city system, urban agriculture is the subject matter of research by representatives of many academic disciplines – agronomics, sociology, economics, urban studies, landscape architecture, spatial development as well as geography. The considerations contained in this book form a part of the contemporary trend of urban studies, research on sustainable development of cities as well as food security of their residents. Moreover, due to the comprehensive approach to urban agriculture and its place in the spatial and functional structure of the analysed cities, this study also contributes to research on urban food systems (Ingram 2011). This book combines three sub-disciplines of geography – socioeconomic geography, urban geography and agricultural geography. Apart from that, it contains spatial analyses that utilise the methodological apparatus of remote sensing and considerations that align with the research directions of political geography.

This book analyses four dimensions of urban agriculture: spatial, subjective, objective and functional. They were used here since they allow for a structured and exhaustive analysis of this comprehensive subject matter of research. The spatial dimension pertains to the location of urban agriculture within the analysed cities, the characteristics of its distribution and its spatial relations with other elements of the spatial and functional structure. Although the spatial aspect is particularly important, especially from the perspective of geographical research, it has been rarely tackled to date in available international literature. There also has been no comprehensive analysis of the spatial distribution of urban agriculture within the three selected cities. This book, which emphasises the spatial dimension of urban agriculture, seeks to fill the said gap in empirical research. Spatial analyses contained herein and the resulting cartographic studies present the distribution of agriculture within the space of the analysed cities, as well as the spatial organisation of individual urban gardens and farms and entire intra-urban agricultural areas. The three terms – urban gardens, urban farms and agricultural areas – are used in this book for a good reason. In each of the analysed cities, agriculture takes different forms that require different labels. In Havana's case, they are urban gardens (terminology will be discussed more broadly in Chapter 3), in the case of Singapore – urban farms (apart from a single instance of a community garden), and in the case of Kigali – agricultural areas (alternatively, crop fields or household gardens).

Other dimensions of urban agriculture analysed in the book are subjective and objective dimensions. The former takes into account the actors involved in urban agriculture, including producers, vendors, intermediaries, suppliers as well as consumers. The latter pertains to the products of urban agriculture and methods used

for their production. The final dimension – functional one – covers the benefits provided by urban agriculture, from economic through social to environmental ones, as well as its role in the spatial and functional structure of the analysed cities.

The aforementioned dimensions were taken from a study by W. Sroka (2014). The author also proposes a fifth dimension – dichotomous one, that is, juxtaposing urban and rural agriculture. Although the differences between the two will be pointed out in this book, its empirical part focuses primarily on urban agriculture, specifically intra-urban agriculture, so including the dichotomous dimension in the framework of the conducted research is not required.

Apart from the dimensions discussed above, the book also presents the institutional and legal framework of urban agriculture that plays a key role in shaping its internal features and the features of its distribution. This framework comprises the applicable legal regulations, in particular those pertaining to the land ownership system, as well as planning and strategic documents presenting the directions of the spatial development of the analysed cities. They are the result of the policy pursued by central and municipal authorities, whose competencies include assignment of the ownership rights, determination of terms of land lease and development of planning documents designating the areas where agricultural activity (i.e. growing plants or breeding animals) is possible or desirable. Legal regulations also have a direct impact on internal features of urban agriculture, such as selection of production methods and techniques. Using appropriate regulations, the authorities can, for example, prohibit the use of artificial fertilisers or pesticides and apply incentives addressed to farm and garden owners as well as individual farmers to convince them to use the specified production organisation models. Using the institutional and legal framework, the authorities therefore determine the features and functions of urban agriculture; however, they can only do it in a given environmental, socioeconomic and political context. This is why distribution of urban gardens and farms, even though it can be influenced by the authorities, primarily depends on access to natural resources such as land and water, as well as on terrain, soil quality and climate conditions. In order to paint a fuller picture of urban agriculture, this book also presents the broader context in which it operates in each analysed metropolis.

This publication analyses the role played by urban agriculture in the three selected cities of the Global South. Therefore, the book adopts a functional and structural approach since the analysis covers the role of the element (urban agriculture) in the functioning of the whole (city), as well as relationships between urban agriculture and other elements of the spatial and functional structure of selected cities. The presented study is primarily empirical and cognitive in nature. This book relies on three case studies and is meant to improve the state of knowledge on the features of urban agriculture and the role it plays in the spatial and functional structure of cities of the Global South. Nevertheless, the conducted research also has a methodological dimension. Its results allow for designation of methods that are suitable for analysis of urban agriculture functioning in different socioeconomic, political and environmental conditions.

1.2 Spatial coverage and temporal scope

The considerations included herein concern cities of the Global South. The subject matter of detailed research includes three selected cases – Havana (the capital city of Cuba), Singapore and Kigali (the capital city of Rwanda). There are many methods of dividing the world into two regions – Global North and Global South. However, the most frequently quoted division is the one along the so-called "Brandt Line", proposed in 1980 by the Independent Commission for International Developmental Issues, led by the former Federal Chancellor of the Federal Republic of Germany and Nobel Peace Prize laureate Willy Brandt. Due to its common application, this line has become one of the best-known and simultaneously influential spatial depictions of the global developmental division. However, it is also a source of numerous controversies (Solarz 2012, 2019). First of all, they arise from the erroneous assumption that the countries assigned to those two separate groups form coherent, homogenous wholes. Another important issue is the multitude of divisions of the world based on the level of socioeconomic development (Solarz 2012, 2014, 2019).

The Global South includes more than 100 countries, inhabited by more than three quarters of the world's population. Those countries are located on different continents and in different climate zones; they vary considerably in terms of access to resources, affluence of the residents, political regime, culture as well as international policy directions. Due to the differences between the countries of the region, the criteria of dichotomous division of the world are dubious. First and foremost, the assumption that one group (the Global North) only includes highly developed countries, while the other one (the Global South) – exclusively the poorly developed ones, is debatable.

On the basis of data contained in the Human Development Report 2021–2022, published in 2022 by the United Nations Development Programme (UNDP), countries which are commonly assigned to the latter group belong to all categories of countries distinguished on the basis of the Human Development Index (HDI) – with low, medium, high and very high level of development (UNDP 2022). Although countries classified as the Global South are indeed the most numerous group among countries with low and medium levels of social development, they also make up 81.3% and 33.3%, respectively, among countries with high and very high levels of development. Examples of countries from the Global South which are characterised by very high level of social development include Singapore, Israel, South Korea, United Arab Emirates, Saudi Arabia, Bahrain, Chile, Qatar, Argentina, Brunei and Uruguay.

Apart from the socioeconomic criterion, measured using the aforementioned HDI, another determinant of the division into the Global North and Global South is the scope of political rights and civic freedoms (Solarz 2012, 2019). It is measured using, among others, the "Freedom in the World" index, according to which the non-governmental organisation Freedom House classifies countries of the world in three categories: free country, partly free country and not free country. According to the 2023 report (Freedom House 2023), countries of the Global South which are

considered free include, for instance, Brazil, Chile, Uruguay, Argentina, Panama, Botswana, Namibia, Ghana and South Korea. In turn, partly free countries are, among others, Peru, Bolivia, Haiti, Senegal, Nigeria, Tunisia, Tanzania, Kenya, India, Indonesia and Malaysia. The last group – countries which are completely not free – include Cuba, Venezuela, Zimbabwe, Uganda, Rwanda, Ethiopia, Thailand, Vietnam and Singapore. Therefore, countries of the Global South have been classified in all three categories, which means that the region is also highly diversified in terms of the scope of political rights and civic freedoms. The fact that Cuba, Rwanda and Singapore are considered not free indicates that all three cases should be included in the region of Global South. The level of socioeconomic development is, after all, not the only criterion that should be taken into account in the division into countries of the Global North and Global South. This is particularly important in the case of Singapore, as its presence in the latter group may give rise to doubts due it its very high HDI.

The division into Global North and Global South, which has replaced the previous differentiation into First, Second and Third World countries as well as developed and developing countries is frequently criticised; however, it should be considered partially useful. It helps us understand, explain and structure the surrounding world to a certain extent. For this reason, it is commonly used in academic, political and media discourse (Solarz 2012).

Despite socioeconomic and political differences between the countries and cities of the Global South, there is no doubt that they also share a number of features. On a global scale, the metropolises of the region exhibit the fastest growth. The list of the largest cities in the world – the so-called megacities, whose population has exceeded ten million people – primarily includes those classified as cities of the Global South. According to the latest report of the UN DESA, published in 2019, 28 out of 33 megacities are metropolises of the Global South. Those megacities are, in descending order: Tokyo, Delhi, Shanghai, São Paulo, Mexico City, Mumbai, Beijing, Dhaka, Karachi, Buenos Aires, Chongqing, Istanbul, Kolkata, Manila, Lagos, Lima, Tianjin, Kinshasa, Canton, Shenzhen, Lahore, Bangalore, Bogotá, Jakarta, Chennai, and Bangkok (UN DESA 2019). Another characteristic feature of settlement systems in many countries of the region is the primate city phenomenon, which is a consequence of population concentration in large cities. Primate city is a term used to describe a leader in terms of size, dominating in the given country's settlement network. The phenomenon means concentration of the population in a given city in relation to the total population of a given country or a given city's population accounting for an overwhelming percentage of total urban population. In the report of the United Nations Department of Economic and Social Affairs (UN DESA 2019), the term "primate city" refers to settlement units inhabited by at least 40% of the country's total urban population. According to the document, as many as 20 of 27 primate cities are classified as belonging to the Global South. These are Hong Kong, Singapore, Asunción, Kuwait, Panama, Brazzaville, Monrovia, Montevideo, Lomé, Phnom Penh, Tel Aviv, Nouakchott, Kigali, Cairo, Beirut, Ouagadougou, Kabul, Port-au-Prince, Santiago and Lima (UN DESA 2019). Therefore, they include two of the cities analysed in this book – Kigali and Singapore.

Due to the pressure of the global market, metropolises of the region are unable to develop a spatial structure that would meet the needs and aspirations of their residents. Problems and challenges typical of the majority of cities of the Global South struggling with continuous population growth primarily include social stratification and the related spatial segregation, as well as establishment of marginal districts. Another typical feature of those metropolises is the important role played by the informal sector (in both construction and commerce). Nevertheless, cities of the region are more and more frequently undergoing processes that are also typical of highly developed countries. They include, in particular, urban sprawl and spread of housing estates inhabited by urban elites into suburban areas, as well as gentrification in the central districts (Czerny 2012). Despite the aforementioned similarities between metropolises of the Global South, it is important not to treat them in an arbitrary manner. Traits of individual cities comprise a number of socioeconomic and political conditions as well as global factors, as demonstrated by the research contained in this book.

It should be emphasised that the Global South is not treated here as a homogenous region, consisting of countries with a similar (low) development and wealth level. On the contrary, one of the assumptions of this study is to present yet another domain in which the Global South is internally diverse. Demonstrating the comprehensive and complex nature of urban agriculture itself is yet another proof of comprehensive and complex nature of the entire region.

The main part of this book comprises three case studies of urban agriculture in Havana, Singapore and Kigali. Their choice merits an explanation, since it was not accidental and resulted from a number of both substantive and practical motives. Cuba, Singapore and Rwanda exhibit different levels of socioeconomic development. According to the HDI ranking from 2022, among the 191 countries included in the ranking, Singapore is on the 12th place – in a group of countries with a very high level of development, Cuba on the 83rd place – in the group of countries with a high level of development, while Rwanda is on the 165th position – in the group of countries with a low level of development (UNDP 2022). These three countries are also characterised by different political systems – Rwanda is a republic, Cuba – a socialist republic, while Singapore – a republic with a semi-authoritarian system. Nevertheless, according to the division into the Global North and Global South, in the majority of academic studies, all three countries are classified in the latter group (among others, by Boniface 2003; Boyd & Comenetz 2007; Solarz 2012, 2014; Nouschi 2016; Solarz 2019). The city selection was based, among others, on the geographical location. They are situated in three different regions of the Global South – Havana in Latin America, Singapore in Southeast Asia and Kigali in Sub-Saharan Africa. This fact enabled an analysis of urban agriculture in diametrically different conditions and presentation of a broad spectrum of its features and the factors shaping it. The three cities differ not only in terms of the level of development and the political regime but also features of the spatial and functional structure itself. Their choice has enabled, on the one hand, specification of differences in the features of urban agriculture operating in diverse socioeconomic and political conditions, while, on the other hand, of universal attributes of

urban agriculture, present regardless of different local conditions. In order to ensure comparability of the conducted research, capital cities with a similar area were chosen (Havana – 728.3 km², Singapore – 734.3 km², Kigali – 730 km²). Due to the prestige associated with the role they play, capital cities are typically characterised by more dynamic urban processes, as well as more intense competition for space between various actors, including those engaged in urban agriculture. Capital cities are typically where important administrative buildings are located – ministries and embassies, as well as banks, hotels, universities or headquarters of international corporations. Choosing three capital cities allowed for an analysis of the role of urban agriculture amongst intensified competition for urban space.

The selection of those cities also resulted from certain individual conditions, separate for each of the analysed cases. Each analysed city is unique in its region in terms of urban agriculture, which was one of the basic criteria of their selection. The first case study is Havana, the capital of Cuba and one of the largest metropolises in the Caribbean. Dynamic development of urban agriculture in that city only began in the 1990s as a result of the economic crisis caused by the downfall of the Eastern Bloc, which led to a serious reduction of food product supplies to the island, mainly from the USSR. Due to the ubiquity of urban gardens within the city space as well as the role they play in supplying the residents with food, Havana is one of the most interesting subjects of studies on urban agriculture in all of Latin America. Its choice offers an opportunity to examine the history of an alternative food system, based on organic production methods and developing in an environment with limited resources.

The second case study is Singapore, one of the fastest developing metropolises in the world, considered a representative example of a smart city. The ICT solutions implemented there are meant to improve the well-being of the residents, ensure sustainable use of natural resources as well as improve the quality of the natural environment. However, Singapore is facing a major challenge due to its nearly complete dependency on food imports from abroad. Therefore, the authorities of this Asian city-state have begun to see urban agriculture as a chance for improving food self-sufficiency. Nevertheless, due to the limited spatial resources, growing building pressure and increasing land prices, agriculture in Singapore has to take forms that allow for highly efficient use of space and, at the same time, bring economic profits sufficient for it to remain on the market. Therefore, this city should be, on the one hand, considered a laboratory of modern agriculture based on advanced technologies (whose experience is used by other cities in the region, such as Hong Kong, Shanghai, Kuala Lumpur, Taipei, Tokyo or Macau); on the other hand, it is a city where more traditional urban agriculture is losing its significance. Contrary to Havana, the choice of Singapore allows for the role of local food production to be analysed amongst nearly unlimited economic resources and dynamic development typical of metropolises of the region.

The last selected city is Kigali, the capital of Rwanda, which is representative of other metropolises of Sub-Saharan Africa in terms of distribution of urban agriculture. Similar to Bissau, Brazzaville, Yaoundé or Kampala, agriculture in Kigali is also concentrated in vast bottoms of valleys and occupies a high share of space,

reflecting the nutritional needs, especially of the poorest social groups (Górna & Górny 2020). However, it should be noted that despite the fact that the capital of Rwanda is still struggling with a number of issues typical of other metropolises of the region, such as poverty, economic disproportions and expansion of marginal districts, it is also an example of a city whose authorities, like those in Singapore, are striving to increase the attractiveness of investments and simultaneously promote so-called green initiatives. The Rwandan capital is a unique example, since the research carried out there allowed for the role of urban agriculture to be outlined in a city on the verge of dynamic socioeconomic development. It created a chance to "capture" its features and functions on the "eve" of the upcoming changes resulting from the growing building pressure as well as spatial policy of the authorities (included in planning and strategic documents, such as the Kigali Master Plan, published in 2020), aimed at "structuring" the urban tissue.

On the basis of the three selected instances, it was possible to describe the role of urban agriculture in metropolises that exhibit different rates of changes taking place in their spatial and functional structure. Havana should be considered a stagnant city, where spatial expansion and intensive increase in building density is not observed – with the exception of the *Miramar* district, where new luxurious hotels have been constructed since Cuba opened up to tourists. However, undeveloped or abandoned parcels still remain within the district's space, which demonstrates the slow pace of increasing building density. In Singapore, "gaps" in space have already been filled as a result of dynamic development. Currently, due to a serious space deficit, this Asian city-state is using even the most peripheral areas for construction. It is also building artificial islands. On the other hand, Kigali exemplifies a city with remaining undeveloped land within its space. However, due to numerous investments in infrastructure, this land will likely be used for construction in the near future.

Since this book is based on comprehensive field research, the accessibility of the cities was also an important factor in their selection. It was necessary to choose locations where the planned research could be carried out. All three cities were and still remain sufficiently safe so that the fieldwork was successfully carried out even in marginal districts and none of the assumed activities presented any risk.

Taking into account the fact that the detailed research described in the book covers primarily intra-urban farming, that is, agriculture located in a densely developed urban area, it was necessary to limit the research area for two of the selected cases – Havana and Kigali. The administrative borders of both cities include vast nearby rural areas, which were excluded from this study. In the case of Singapore, whose administrative borders nearly completely overlap with the island's borders (the study only excluded several uninhabited islands, which are undeveloped or fulfil exclusively industrial or recreational functions) and whose densely developed area is not surrounded by rural areas, it was not necessary to reduce the spatial coverage of research.

The detailed analysis contained in this book covers predominantly the situation observed during the field research conducted in May 2018 in Havana, at the turn of January and February 2019 in Singapore and in July 2019 in Kigali. This

book is therefore a snapshot of urban agriculture at a given point in time. Regardless of the foregoing, the considerations contained herein cover a much broader time range than the dates of the field visits. The characterisation of the spatial and functional structure of the selected cities, preceding each description of urban agriculture in a given city, always covers the time of their founding and even the first settlements in the current location, sometimes expanding the temporal perspective by several centuries (Havana was founded in 1519, Singapore in 1819 and Kigali in 1907). Moreover, the following statistical analysis of distribution of urban agriculture was broadened using elements of dynamic analysis. In Havana's case, this analysis dates back to 2000 (the date of the oldest available satellite image) in Singapore – to 1974 (the date of founding of the oldest analysed farm), and in Kigali – to 2019 (the date of field research). The date ending the considerations included in the book was in all cases the year 2022, from which the latest available satellite images or information published on official websites of urban farms and gardens come.

1.3 Research objectives, questions and hypotheses

For the purposes of this book, one main objective and five detailed objectives were formulated. They are presented below along with auxiliary research questions. Moreover, threeresearch hypotheses were also developed – they are verified in the final chapter.

The main objective of this book is to determine the characteristics of distribution, internal features and functions of urban agriculture within the spatial and functional structure of selected cities of the Global South. It was assumed that the internal (endogenous) features were the structural and production as well as organisational and technical features of individual urban gardens, urban farms and agricultural areas, while their external (exogenous) features were the environmental, socioeconomic and political conditions in which a given garden, farm or agricultural area operated. The characterisation of the external features will serve as the basis for explaining the causes affecting the internal features of the agriculture itself as well as the functions it fulfils. Differentiating between endogenous and exogenous features is particularly important in order to avoid erroneous identification of causes and effects.

Due to the complexity of the research subject matter tackled, for all three analysed cases, the following **detailed objectives** were formulated, whose achievement will allow for answering the research questions written in italics:

1 Indicating the locations and features of distribution of urban agriculture

- Where are individual urban gardens/farms, agricultural areas located?
- What land do they occupy (next to houses, public, urban wasteland zones, flat terrain, inclines [slopes] and valleys)?
- Is urban agriculture dispersed or concentrated in particular parts of cities?

2 Determining the factors affecting the distribution of agriculture

- What are the reasons for urban agriculture being located in individual parts of the city (e.g. supply of land resources, low land prices, presence of waste-land zones, proximity of the market)?
- What are the causes of concentration/dispersion of urban agriculture?

3 Indicating the characteristics of urban agriculture, including

a Structural and production characteristics:

- What is the structure of plant production?
- Which plant species are grown?
- Do food, industrial or fodder crops dominate?
- What is the estimated volume of plant production?
- What is the structure of animal production?

b Organisational and technical characteristics:

- Which production methods techniques are used?
- Are artificial fertilisers used?
- Is compost produced?
- What methods of protection against pests are used: natural/artificial?
- How many people are employed and on what terms?
- Is it a private or state-owned enterprise?

4 Describing the paths of the products from the place of production to the place of distribution/consumption

- Are the products sold or intended to meet the producers' own needs?
- Where are the products sold?
- Where are they transported to?
- What route do the products take?
- What is the distance between the place of production and place of distribution/consumption of the products?
- Are the products intended as the producers' own supply?

5 Determining the functions fulfilled by urban agriculture

- Does agriculture fulfil exclusively nutritional functions?
- Is agriculture multifunctional and, apart from nutritional function, does it also play social, environmental, educational and tourist roles?

With regard to the foregoing detailed objectives and research questions, the following three **research hypotheses** were formulated:

H1. Factors affecting the location of urban agriculture are not universal, but in each analysed case, they are the resultant of local socioeconomic, political and environmental conditions.

H2. Urban agriculture in the analysed cities operates within a shortened supply chain, both in spatial terms, understood as the distance between the place of production and place of distribution/consumption, as well as subjective, understood as the number of actors along the products' route.

H3. In each analysed case, urban agriculture fulfils different functions, depending on the socioeconomic and political conditions.

1.4 Research methods applied

The research procedure in this book was divided into three main stages: analysis and preparation (I), field work (II) and comparison and summary (III). These stages were carried out with respect to all three selected case studies – Havana, Singapore and Kigali. They are characterised below, along with the methods used during the implementation of each stage.

- Stage I (analysis and preparation)

Stage I included analysis of international academic literature, planning documents and online sources, allowing for selection of the case studies and detailed characterisation of their spatial and functional structure, as well as analysis of generally available satellite and aerial images, which enabled preliminary location of urban agriculture within the city space. Moreover, stage I included substantive and organisational preparation for the field research. It consisted in outlining the routes along which agriculture was mapped in each city, preparing questionnaire forms for data collection in the field and preparing a list of issues to be touched upon during semi-structured interviews.

The options of using remote sensing for urban agriculture research are very limited. This is mainly due to the insufficient spatial resolution of publicly available satellite images as well as the attributes of urban agriculture itself. First of all, a typical feature of the structure of crops located within cities is high heterogeneity of species. Various plant species are frequently grown in a single garden, farm, crop field or even plant bed. Second, due to the fact that the objective of urban agriculture is to ensure continuous food supplies, plants grown next to each other can be at different stages of development. In both cases, plants within a single pixel have therefore different spectral characteristics, which rules out the application of automated remote sensing tools. Third, agriculture very frequently occupies small spaces, up to about a dozen square metres. Therefore, the publicly available (and free) satellite images obtained by satellites like Sentinel and Landsat are characterised by spatial resolution (measured by pixel length, i.e. the smallest distinguishable digital unit in a given image) insufficient to identify urban agriculture and specify its characteristics with the assistance of automated methods. For example, spatial resolution of Sentinel-2 images is up to 10 m, which means that the smallest crop field recognisable in them (assuming that it has uniform land coverage) must occupy at least 100 m^2. For that reason, use of automated remote sensing

methods was omitted in this book. Instead, the chosen method was manual analysis of the images available in Google Earth Pro, an application which has been successfully used in similar research carried out by other authors in Hanoi (Forster, Buehler & Kellenberger 2009), Chicago (Taylor & Lovell 2014), Rome (Pulighe & Lupia 2016) or in Nakhon Ratchasima in Thailand (Jantakat et al. 2019). The resolution of the orthophotomap (developed on the basis of satellite and aerial images) is up to 30 cm, thanks to which its use in analysis of small fields with diverse spectral characteristics has proven effective. On the basis of the images available in the programme, densely developed research areas were selected (for Havana and Kigali). Within those areas, manual and visual interpretation was carried out, which allowed for identification of the polygons occupied by urban agriculture. Account was taken of direct identifying features, such as shape, size, structure and colour, as well as indirect features, such as the shade cast by facilities within the analysed polygons, their location, as well as associations with other landscape features. The margin of error was set at 5%, which is typical of research in social sciences. During the analysis, the polygon tool was also used to mark the identified gardens, urban farms and crop fields as well as to measure the area taken up by them. Moreover, every site was also assigned an ID number. The data of the sites from Google Earth Pro (containing the coordinates of the polygons identified as urban agriculture and designated routes) in the .kmz format were input in the MAPS.ME application, which was subsequently used to collect data in the field. MAPS.ME is a mobile application that shares maps from the OpenStreetMap portal and features a GPS tool, allowing for one's location to be determined in the field. Its major advantage is the fact that it can be used offline. Internet access in the visited cities (especially in Havana and Kigali) was limited, so the application became an important work tool, allowing for the identified sites to be easily found in the field.

- Stage II (fieldwork)

Stage II covered field research carried out in the three selected cities (in Havana in May 2018, in Singapore at the turn of January and February 2019 and in Kigali in July 2019). It involved mapping of urban agriculture within the previously designated research areas. During the field research, semi-structured interviews with actors involved in urban agriculture were conducted, including interviews with farm/garden owners, crop fieldworkers and vendors at local markets, as well as decision-makers in urban agriculture management. A particularly important element of the fieldwork was standardised field observation of the agricultural areas or urban farms and gardens as well as their immediate vicinity and the accompanying collection of photographic documentation. Stage II also included substantive consultations with representatives of local academic units dealing with urban agriculture. Thus, academic contact was established with representatives of the university in Havana (*Universidad de la Habana*) and the Kigali Independent University. The field research allowed for verification of the results and effectiveness of research methods applied at stage I.

The following is a detailed description of the research methods applied at stage II:

- Mapping of urban agriculture – it was carried out according to the routes designated during stage I. The sites previously identified in Google Earth Pro and entered in the mobile application MAPS.ME were located in the field using a GPS tool (available offline in the application).
- Standardised field observations – they were carried out according to the previously prepared questionnaire form (paper or electronic one). During those observations, particular attention was paid to the structure of production (plant or animal), production methods and techniques used within the analysed facility, as well as features of the surrounding environment (land use; height, type and functions of the buildings). The field observations were accompanied by detailed photographic documentation, thanks to which at stage III, it was possible to prepare exact diagrams of spatial development of individual sites.
- Semi-structured interviews, conducted with actors involved in urban agriculture, including with farm and garden owners, crop fieldworkers and vendors at local markets. They were carried out on the basis of the list of issues prepared during stage I. The semi-structured interview method allows for modification of the chronology of the questions asked, as well as for new issues to be raised both by the respondent and by the researcher (Longhurst 2003), thanks to which the scope of the information obtained was much broader than previously assumed. The conducted interviews allowed for collection of comprehensive information on the structural and production as well as organisational and technical characteristics of the analysed agricultural areas, urban farms and gardens. The interviews were not recorded and the collected information was entered in the questionnaire form either during the interviews or immediately after their completion.
- In-depth interviews with people in charge of managing urban agriculture in the selected cities – they were conducted with a representative of the Agri-Food and Veterinary Authority of Singapore, as well as a representative of the Kigali City Hall in charge of implementing the Kigali Master Plan 2013. The interviews provided information on the local and central authorities' policy towards the presence of urban agriculture within the space of selected cities as well as the related problems. Apart from that, in Kigali, an interview was conducted with Professor Rufus Jeyakumar, PhD, Dean of the School of Economics and Business Studies, Kigali Independent University. In Havana, conducting an interview with decision-makers in charge of urban agriculture management proved impossible. Instead, consultations were held with Professor Angelina Herrera Sorzano, a geographer working at the Faculty of Geography of the University of Havana (*Universidad de la Habana*), whose academic work is dedicated to urban agriculture in Cuba.

• Stage III (comparison and summary)

This stage consisted in analysis and synthesis of data collected during stages I and II and comparison of features and functions of urban agriculture in the analysed cities. It also included verification of the formulated research hypotheses as well