

Post oil and gas future urban sustainability and relevance of a compact urban form for Doha

Unlocking Doha's sustainable and resilient future

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Abstract

The discovery of oil and gas in Qatar has resulted into transformation of its capital Doha in just few decades from a small fishing and pearling town to an international city with diversified economy and Doha transformed from a compact, high-density and walkable traditional Arabic town of 1960s into an expansive car-dependent city with low-density sprawl all around. Qatar's population of 250k in 1981 grew to 2.4 million in 2015 with 2 million residing in the designated 'Metropolitan Doha' covering 1279sqkm area with a density of merely 16pph. Very high car-dependency and the policy of 'car-priority designs' on roads are rapidly diluting the 'concept of place', disconnecting the communities, reducing walkability, increasing carbon emissions and affecting public health. Consequentially, it is increasing infrastructure investments and maintenance costs with ever-expanding infrastructure networks that remain as 'over-provisions' disproportionate to the population density. Future consequences of these are detrimental to 'environmental and economic sustainability' and are deterrent to development of a compact-resilient city with cohesive communities. This paper is firstly assessing the current planning initiatives, secondly, re-evaluating Doha's urban morphological dynamics through a comparative assessment with four compact and high-density cities and finally suggesting strategies and policies to support a compact urban form.

Keywords

Metropolitan Doha, urban form, compact cities, high-density, post-oil-gas economy, urban sustainability

1. Introduction

This section incorporates the brief on the identified problems, the primary objectives, the structure of the study, background research, approach and methodology, and the limitations and the prospects.

1.1. The Problem and the Objectives

With prosperity from oil and gas, Doha, the capital of Qatar, a small fishing and pearling town has dramatically transformed within half a century into an international city with diversified economy. Though Qatar's first oil well was drilled in 1939 and oil exports started since 1949, however, largescale exploration and export started with the discovery of several large oil fields during 1960-70s and after establishment of Qatar Petroleum in 1974¹. Since then Doha started experiencing its transformation from a small, compact, high-density and walkable traditional Arabic town of 1960s into an expansive car-dependent city with low-density sprawl all around. Since the 1970s, new neighbourhoods, in a radio-

¹ Qatar Petroleum, 2021

concentric urban form expanded out of the old core following the 'A', 'B' and 'C' ring roads. The North Field with natural gas was discovered in 1971 and by mid 1980s it was recognized as the world's largest; Qatar has started exporting natural gas by the early 1990s² and thereafter, prosperity resulted from gas exports has been rapidly transforming Qatar. The new urban development and urban infrastructure projects are rapidly changing Doha's urban form; and the process received an additional impetus since 2010 when Qatar was awarded the right to host the FIFA World Cup 2022. West Bay, a new iconic business district with lofty towers rapidly emerged in reclaimed land three kilometres north of the historic core. A semi-circular seven-kilometre-long corniche from the one end of the historic core up to the end of West Bay has been developed as a massive public space. Southeast of the historic core, in a massive reclaimed land next to the old airport, the iconic Hamad International Airport (HIA), one of the largest and most modern in the region was constructed and in operation since 2014; the HIA currently possesses a large chunk of urban development potential land next to it. Three new towns, the Education City with campuses of international education and research institutes, the Pearl Qatar in reclaimed land north of West Bay and Lusail City further north are being developed rapidly. Two redevelopment projects, the walking zones of traditional Souq Waqif and Souq Wakra are completed and Msheireb Downtown, a mixed-use area is on the verge of completion. The completed first phase of the Metrorail project is in operation since 2019; an LRT system in Lusail and Tram systems in the Education City and Msheireb Downtown are currently under development. Several large-scale highway projects across the city and in its outer periphery have been taken up and many of these are now operational. The Hamad Port, a new sea port is currently under development in the southern edge of the city with three major economic zones being developed in its north.

Qatar's population, which was just 250k in 1981 grew to 2.4 million in 2015 and its lion's share, i.e. around 2 million reside in 'Metropolitan Doha', with a very low density of 16pph. If the large number of construction-labourers staying in the labour camps is excluded, density would fall further. The low-density sprawl in the sub-urban areas all along the major roads has been a trend in past few decades. With increasing prosperity, car ownership has increased unprecedentedly and society has increasingly become car-dependent; the number of registered motor vehicles in Qatar is reported at 1.66 million units in 2019 (with 1 million private cars)³ up from 0.77 million in 2010 (with 0.48 million private cars)⁴. As increasing number of motor vehicles have congested the roads, more and more wider roads and expressways are being built creating a vicious cycle with high car dependency, low density sprawl and demand for more and more road space. At the same time, adopting 'car-priority designs' (with 'highway design standards') on roads (so that traffic can move faster, decongest and reach the destinations faster) are rapidly diluting the 'concept of place', disconnecting the communities, reducing walkability in the urban centres and in the neighbourhoods, contributing to carbon emission and affecting public health. Moreover, at the same time, car-dependent-low-density suburban expansion consequentially is increasing infrastructure investments and maintenance costs demanded by the ever-expanding infrastructure networks, which remain as 'over-provisions' disproportionate to the population density. Future consequences of such a pattern of development are to be detrimental to 'environmental and economic sustainability' and to be deterrent to development of a compact-resilient city with cohesive communities. Yet, the problem has not been identified as serious; expansion of the roads with low-density sprawl is continuing without any conscious effort to assess it. Therefore, the objectives of the paper are to understand the severity of the problem, bring it to the notice of the intelligentsia and the policy/decision makers and to find out if there is any solution.

² Qatar Gas, 2021

³ PSA-Qatar, 2019

⁴ PSA-Qatar, 2012

1.2. The Structure of the Study

The paper firstly is assessing the current planning initiatives and secondly evaluating Doha's urban morphological characteristics and dynamics through a comparative assessment with four selected compact and high-density cities from Europe and Asia. Finally, it is attempting to find out the required strategies and policies and the amendments in the existing ones those could be beneficial for the city for achieving an urban form that is more compact, sustainable and resilient and would facilitate the city's progress in future during the post oil-gas economic transition period.

1.3. The Concepts and the Ideas: Background Research

'Urban form' refers to the physical characteristics that make up built-up areas of an urban area with its size, shape and configuration⁵. Urban form has been described as the 'morphological attributes of an urban area at all scales'⁶: from regional, to urban, neighbourhood, 'block' and street⁷. Therefore, how a city's urban form will be understood, structured, or analysed depends on scale⁸. At the broad city or regional scale, urban form has been defined as the spatial configuration of fixed elements⁹ including features such as urban settlement type, such as a market town, central business district or suburbs¹⁰. At a much-localized scale, the characteristics ranges from the features such as building materials, façades and fenestration, to housing type, street type and their spatial arrangement, or layout¹¹. An urban form not only relate to physical features, but also encompasses non-physical aspects such as population density, which is not just a physical, tangible element¹². Density is closely linked to a city's both physical and social environments. Physical properties of the built-environment is distinctly different between the areas of high and low population densities. At the same time, apartments of high-density housing and detached or semi-detached properties of the lower densities facilitate differential social interactive environments. Dempsey N. et al. highlight on the non-physical processes those are manifested in physical developments contributing to urban form¹³. Karl Kropf has highlighted four broad types of aspect and eleven logically distinct general aspects of urban form¹⁴. These under each broad category are:

1. Spatial relations of physical features: natural physical form and built physical form
2. Interrelations between humans and physical: features, social and economic context, use/function/activity, control, intention, construction, perception
3. Flows: natural and human
4. Change: formation/transformation/cyclical change

Dempsey N. et al. identify physical features and nonphysical characteristics that make up urban form of a city as size, shape, scale, density, land uses, building types, urban block layout and distribution of green space and categorise these under five broad and inter-related elements of layout, density, land use, housing/building type and transport infrastructure¹⁵. As we have mentioned earlier, the scales at which urban form can be considered or measured ranges from the individual buildings to a city and these levels of spatial disaggregation influence how urban form is measured, analysed and ultimately understood¹⁶.

⁵ Dempsey N. et al., 2010; Williams, K., 2014: 6; Živković J., 2019

⁶ Williams et al., 2000 in Dempsey N. et al., 2010

⁷ Williams, K., 2014: 6

⁸ Živković J., 2019

⁹ Anderson et al., 1996 in Dempsey N. et al., 2010

¹⁰ Dempsey N. et al., 2010

¹¹ Ibid.; Živković J., 2019

¹² Ibid.

¹³ Dempsey N. et al., 2010

¹⁴ Kropf K., 2009

¹⁵ Dempsey N. et al., 2010

¹⁶ Ibid.

'Sustainable development' was described by UNEP's Bruntland Commission Report (1987) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"¹⁷. Out of the seventeen 'Sustainable Development Goals' (SDGs), adopted by the UN in 2015, the 'Goal 11' is to make cities inclusive, safe, resilient and sustainable¹⁸. The UN specifies that half of humanity, i.e. 3.5 billion people lives in cities today, which is expected to be 5 billion by 2030 and cities occupying just 3 percent of the Earth's land account for 60-80 percent of energy consumption and 75 percent of carbon emissions. Many cities are vulnerable to climate change and natural disasters and therefore, building urban resilience is crucial to avoid human, social and economic losses¹⁹. Sustainable urban development requires a balance between the environmental, economic, and social goals of sustainability as an integrated process ultimately making a city greener, fairer, and more profitable for all stakeholders. But it cannot be achieved without significantly transforming the way cities are being built and the way urban spaces are being managed. Sustainable cities have been the leading paradigm of urbanism for more than three decades, but recently, much attention has focused on the relationship between urban form and sustainability, the suggestion being that the shape and density of cities can have implications for their future. Various concepts and models of sustainable urban forms such as the compact cities, eco-cities, green cities, new urbanism, landscape urbanism, and urban containment, etc. have been theorized and out of all these, compact cities are often advocated as more sustainable²⁰.

In urban planning literature, yet there is no definite definition of a 'compact city' per say; but most of the available definitions tend to share the 'core dimensions' of this model of sustainable urban form²¹. Burton defines it as "a high-density, mixed-use, and intensified city"²². According to other views, the compact city is characterized by high-density and mixed land use with no sprawl²³. In the early 1970s, Dantzig and Saaty in their 'extreme compact city model' discussed about three elements: the urban form, the space, and the social functions²⁴. In general, compact city is a high-density urban settlement with a vibrant core area with mixed-use developments and concentration of urban services and facilities, with low car-dependency and is a city that strategically controls greenfield developments in the outskirts (prevents or allows as per requirement, based on the policies and plan of the specific city). Compact city policies focus on optimising urban density and development starting from the centre or centres and from the core areas at a rate that is strategically evaluated and fixed based on the city's development potentials and carrying capacity (defined by available infrastructure and services, availability of land or built space under various land use categories, open space per capita, a city's available resources, etc.).

The idea of 'compact city' is related to 'centrism' evolved during the early 20th century. In the late 19th and the early 20th century, the modern discipline of urban planning started with the idea of 'decentrism' (decentralisation of urban activities and population) as the reaction to the urban malaise created by the industrial revolution²⁵. Ebenezer Howard's 'Garden city' concept in the late nineteenth century to Frank Lloyd Wright's extremely decentralised 'Broadacres City' in 1930s are the two classical urban planning models attempting to decongest the cities. On the other hand, Le Corbusier in 1930 proposed his 'Ville Radieuse' (Radiant City), with the same objectives, but unlike Wright, with the idea of 'centrism'; he proposed to increase urban densities with high-tower blocks to decongest the city centres, which would increase open spaces and improve circulation. In the 1950s, Ian Nairn, became extremely vocal against

¹⁷ UNEP, 1987: 2.1

¹⁸ UN, 2015

¹⁹ Ibid.

²⁰ Bibri S. E. et al., 2020: 2

²¹ Ibid.: 2-3

²² Burton E., 2002

²³ Refer Bibri S. E. et al., 2020: 2-3

²⁴ Dantzig, G. and T. L. Saaty, 1973 in Bibri S. E. et al., 2020: 3

²⁵ For details on 'centrism' and 'decentrism', refer Breheny M., 1996

low density urban sprawl; he wrote two influential papers against what he called 'Subtopia' (suburb+utopia, facilitating low-density sprawl) challenging the then planners in UK. In the 1960s, Jane Jacobs advocated high-densities in the cities on the grounds that density creates diversity and that diversity creates the richness of urban life. In 1971, 'Civilia: The End of Sub Urban Man', written by Ivor de Wolfe (pseudonym) disapproving sprawl and car use, proposed vision for a high-density city with the ideas such as urban regeneration and multi-centred city. In 1973, G. Dantzig and T. L. Saaty proposed a radical model for a 'compact city' aimed at reducing urban sprawl and preserving the open countryside²⁶.

However, only since late 1980s, the idea of 'compact city' gained much more popularity with growing concerns on environmental and urban challenges and with recognition of compact city form's potential role in achieving urban sustainability. In 1990, the Commission of the European Communities (CEC) published the 'Green Paper on the Urban Environment' and as the most sustainable approach to urbanism, advocated for many ideas related to the concept²⁷. Several European cities have taken up the policies of re-densification/ intensification of the existing cities, renewal of the historic cores, emphasized on public transportation and walkability and strictly controlled suburban sprawl.

Since around mid-1990s, critical research on the theory and practice of compact city form have increased manifold. According to several such studies, there are many perceived benefits of the compact city over urban sprawl²⁸. A compact city can promote sustainability by reducing the amount of travel and shortening commute time, by lowering down car-dependency thus lowering down emissions, by reducing energy consumption, by encouraging walking and cycling, by limiting the consumption of building and infrastructure materials, and by limiting the loss of agricultural and natural areas in a city's outskirts. Moreover, a compact city promotes regeneration of the city centres through the promotion of densely built dwellings, shops, businesses, and accessible infrastructure and facilities. It increases urban vitality, promotes re-use of infrastructure and previously developed land, reduces the requirement of per capita infrastructure provision and makes it cheaper due to compactness of the built-environment (lesser coverage, agglomeration and higher customer coverage per unit area). It promotes mixed-use developments, supports local services and businesses through population densities, i.e., providing a larger customer base for commercial activities. Compact city ensures better public transport services with increased overall accessibility, promotes transit-oriented development, decreases travel needs and costs and shortens commute times. It creates diversity of choice of employment, increases social contacts among residents, reduces crime and provides a feeling of safety through natural surveillance, etc. Scholars have also enlisted the benefits of agglomeration due to dense and diverse urban development²⁹. It is claimed that such qualities provide better economic output³⁰ and higher invention rates by providing fertile ground for knowledge spill over³¹, reduced energy use through employment density³², and alleviate social segregation³³. It is also argued that dense and diverse urban patterns are more resilient forms of urban structure, providing a redundancy of functions³⁴, networkability and response-diversity to disturbances³⁵. All in all, the compact city harnesses the advantages of agglomeration and taps into the tremendous variety of environmental, economic, and social benefits, which must be ensured through

²⁶ Dantzig, G. and Saaty T. L., 1973

²⁷ CEC, 1990

²⁸ Bibri S. E. et al., 2020: 4 – Table 4 for a comprehensive list.

²⁹ e.g. Glaeser E. L., 2011

³⁰ Quigley, 1998 in Lim, H. K. and Kain J., 2016

³¹ Carlino, Chatterjee, and Hunt, 2007; Glaeser, 2011 in Lim, H. K. and Kain J., 2016

³² Mindali, Raveh, and Salomon, 2004 in Lim, H. K. and Kain J., 2016

³³ Burton, 2001 in Lim, H. K. and Kain J., 2016

³⁴ Bettencourt and West, 2010 in Lim, H. K. and Kain J., 2016

³⁵ Bristow, 2010; Glaeser, 2011; Offenhuber and Ratti, 2014 in Lim, H. K. and Kain J., 2016

proper planning and development initiatives³⁶. Therefore, in recent years, city governments, planners, developers and policymakers have increasingly envisaged in designing a more compact city.

However, the compact city policies are also contested. Scholars argue that high-density might negatively impact on neighbourhood satisfaction³⁷, negatively impact on psychological health of the residents due to overcrowding³⁸ and reduce sense of attachment and quality of public utilities³⁹. Breheny concludes that people are not satisfied residing in high-dense dwellings⁴⁰ and Burton concludes that high-density areas corresponds to higher level of crime⁴¹. Another argument against is potential high noise pollution due to the proximity between dwellings, transport-lines, businesses, and services⁴². Several studies⁴³ argue that compact urban developments can increase property prices, cause traffic congestion, and create social exclusion. Moreover, the critics argue that compact city can increase ecological footprint due to higher consumption and larger income gaps⁴⁴, create unfavourable living conditions for low income groups by reducing living space and might limit accessibility to green space and nature areas⁴⁵. Another key point against the model is the possibility of loss of green spaces due to intensification and the critics also believe that ultimately sprawl is inevitable due to congestion inside the city⁴⁶.

The supporters point out to that negative social problems related to density may be possibly due to the inherent characteristics of the studied urban areas where poverty is concentrated, rather than to be the consequence of the urban form itself⁴⁷. Increased consumption rates and larger income gaps might be related to the incidents of accumulation of both high- and low-income groups in the studied high-density urban areas, but possibly not because of urban form⁴⁸. Again, since crowding is a problem of perception of space, its occurrence might be a design problem not a result of urban compactness⁴⁹. Therefore, there is a risk that generic problems of urbanization are criticized as being problems of compact high-density cities⁵⁰. It is evident that the debate over compact city is a kind of the continued legacy between the debate between 'centrism' and 'decentrism'. The persistent lack of a clear definition of 'compact city' is sometimes attributed to such contradictory findings by the scholars for and against the concept.

Several recent UN-Habitat reports and policy papers argue that compact city form has positive effects on public health, economy, resource efficiency, social cohesion and cultural dynamics⁵¹ and that low population density is environmentally harmful in both mono-centric and polycentric urban structures⁵². Apart from making a similar line of argument⁵³, European Union further states that cultural, social and political dynamics are promoted by density, proximity and diverse choices available within compact cities⁵⁴. The OECD claims that compact city policies result in lowered CO2 emissions, reduce energy consumption in transportation, reduce of infrastructure cost, help in conservation of farmlands and

³⁶ Bibri S. E. et al., 2020: 1-2

³⁷ Bramley and Power, 2009 in Lim, H. K. and Kain J., 2016 and Bibri S. E. et al., 2020: 4

³⁸ Haigh, Ng Chok, and Harris, 2011 in Lim, H. K. and Kain J., 2016

³⁹ Dempsey, Brown, and Bramley, 2012 in Lim, H. K. and Kain J., 2016 and Bibri S. E. et al., 2020: 4

⁴⁰ Breheny 1997 in Bibri S. E. et al., 2020: 4

⁴¹ Burton, 2000 in Bibri S. E. et al., 2020: 4

⁴² De Roo, 2000 in Bibri S. E. et al., 2020: 4

⁴³ Breheny, 1992, 1997; Neuman, 2005 in Bibri S. E. et al., 2020: 4

⁴⁴ Heinonen and Junnila, 2011 in Lim, H. K. and Kain J., 2016 and Bibri S. E. et al., 2020: 4

⁴⁵ Burton, 2001 in Lim, H. K. and Kain J., 2016 and Bibri S. E. et al., 2020: 4

⁴⁶ Breheny, 1996 in Bibri S. E. et al., 2020: 5

⁴⁷ Bramley and Power, 2009 in Lim, H. K. and Kain J., 2016 and in Bibri S. E. et al., 2020: 5

⁴⁸ Glaeser, 2011 in Lim, H. K. and Kain J., 2016 and in Bibri S. E. et al., 2020: 5

⁴⁹ Kearney, 2006 in Lim, H. K. and Kain J., 2016 and in Bibri S. E. et al., 2020: 5

⁵⁰ Lim, H. K. and Kain J., 2016

⁵¹ UN Habitat, 2011, 2014a, 2015

⁵² UN Habitat, 2014b

⁵³ CEC, 2011

⁵⁴ CEC, 1990

biodiversity and increase labour productivity⁵⁵. Most of the scholars agree that as a desired form, the compact city indeed secures a development that is environmentally sound, economically viable, and socially beneficial⁵⁶, especially when the development is strategically planned and well-designed. It is important to focus on developing efficient planning approaches that can optimise the benefits of the good dimensions of a compact city, which would eventually attenuate the lacunas associated with it. Therefore, with all these understandings, the paper attempts to reach at the previously discussed objectives of finding relevance of a compact urban form for Doha.

Very few but increasing number of studies have been carried out covering Doha's urban development and planning. Khaled Adham provides a vivid narrative on Doha's urban transformations in the recent decades and on its aspirations to become a global city with unique urban development projects⁵⁷. Florian Wiedmann et al. analyse urban evolution in Doha based on the theory of production of space propagated by French sociologist Henri Lefebvre and pointed out that Doha has witnessed a rapid shift from a traditional to modern built-environment and currently going through a new transformation period with negative circumstances from the increasingly fragmented and segregated nature of its urban development⁵⁸. Agatino Rizzo analyses the urban planning initiatives in Qatar and discusses the nitty-gritties of plan implementation; he points out that there is an absence of a serious assessment of the ongoing mega-projects⁵⁹. Khaled Shaaban and Essam Radwan discuss about transition of Doha and the city's transportation projects⁶⁰. Simona Azzali analyses social segregation, physical fragmentation and environmental concerns as the consequences of Doha's rapid urbanisation and motorization. She concludes that to prevent physical and social fragmentation focus should shift from isolated projects to development of compact, mixed-used neighbourhoods and districts with integrated land-use and transport planning policies; she also emphasises on transport integration up to the level of cycling and walking⁶¹. Yasuyo Makido et al. assess the relationship between urban form and temperature moderation in Doha and conclude that to mediate temperatures to provide pedestrians greater access to outdoor spaces, 'reducing the amount of urban area' as the first step⁶². Shandas V. et al. examine the spatio-temporal urban growth of Doha using satellite data from 1987 to 2013 and find out that during this period, Doha expanded at the rate of 5.45 percent annually (with higher rates after 1998) and added 315sqkm of land area; they speculate that the pattern of suburbanization is demanding greater infrastructure investments and limited the possibility of using active transportation (e.g. biking, walking, transit, etc.) further impacting on public health and environment⁶³. Raffaello Furlan et al. 2019, attempt to study and develop a TOD based regeneration model around the West Bay South metro station with infill developments incorporating affordable housing⁶⁴. Soud K. Al-Thani et al. find that Doha's continuous growth and expansion as a polycentric and low-density city are impacting on sustainability and liveability of the city⁶⁵. They find that urban sprawl in the city impedes developing transport system for other modes as alternative to private cars and that low walkability is attributable to lack of pedestrian paths and lack of local amenities and services⁶⁶. To address the challenges related to low-density pattern in Doha, the authors suggest adopting new technologies from e-working, to autonomous vehicles, etc.⁶⁷

⁵⁵ OECD, 2012 in Lim, H. K. and Kain J., 2016

⁵⁶ Bibri S. E. et al., 2020: 1

⁵⁷ Adham K., 2011

⁵⁸ Wiedmann, F. et al., 2012

⁵⁹ Rizzo, A., 2014

⁶⁰ Shaaban, K. and E. Radwan 2014

⁶¹ Azzali, S. 2015

⁶² Makido, Y. et al., 2016

⁶³ Shandas V. et al., 2017

⁶⁴ Furlan R. et al., 2019

⁶⁵ Al-Thani et al., 2019

⁶⁶ Ibid.

⁶⁷ Ibid.

Most of these studies at varying degrees have highlighted the problems of urban sprawl and propagated though not exclusively, for a denser and compact form for Doha.

Since early 1970s, several urban plans covering various parts of the city has been taken up by the government to manage Doha's growth systematically⁶⁸. The plans became quickly obsolete due to the unprecedented growth Qatar then experienced. The Government of Qatar, understanding the changing dynamics adopted several policy initiatives such as the Qatar National Vision 2030 (QNV2030) and it's National Development Strategy for providing a long-term development framework to guide and manage Qatar's future growth. In 2014, Ministry of Municipality and Environment (MME) adopted the Qatar National Development Framework, QNDF as the spatial representation of the QNV2030 for sustainable development of Qatar until 2032. Following the QNV2030's stress on mitigating the impacts of climate change, the QNDF intends to support 'a more resource efficient urban development structure and way of life for the people of Qatar'⁶⁹. The QNDF brings in a spatial development strategy for Qatar with multiple hierarchical mixed-used centres and a greenbelt policy and designates the area of 'Metropolitan Doha'. The QNDF acknowledges the problem of urban sprawl and several of its policies and strategies conforms to those of compact city development (to be discussed in the section 2).

1.4. Approach and Methodology

A large sum of work on compact cities are currently available, many of these are 'city-case-studies', carried out with variety of approaches and covering diverse subjects such as benefit analysis, evaluating components, measuring compactness, formulating compact city policies through comparative assessment⁷⁰, etc. Several attempts are made to establish 'compact city' indexes; however, the heterogeneity of the concepts of density⁷¹, diversity⁷², and urban form⁷³, coupled with the prevalence of different indexes⁷⁴, these studies remained as problematic for policy implementation. Therefore, it is evident that each city should deal with its own urban specifications in response to its development agenda and form aspects, applying compact city discourse and implementing policies to improve the health of the city and the quality of life for the citizens⁷⁵.

Therefore, simplification of the approach that provides inferences leading to policy formulation is the need of the hour. The method adopted here is firstly, to carry out a brief assessment on the impact of the current policies and strategies on Metropolitan Doha's urban form (section 2). Secondly, it is to carry out a comparative assessment of selected spatial parameters related to Metropolitan Doha's urban form with the same of four selected cities from Europe and Asia (section 3). The assessment results into inferences finally leading to identifying policies and strategies. The parameters selected here are the size and shape of the cities, size and the characteristics of the core areas, overall density, developed area density and road length.

Four cities, Vienna, Madrid, Hong Kong and Tokyo (part of it) are selected for the comparative assessment. For Hong Kong, the entire territory has been considered. For Tokyo, the 23-Special Wards or 'Tokyo-23 Ku' (as it is mentioned hereafter), the 'central city' or the 'Old Tokyo City' of Tokyo Metropolitan Region is considered. Vienna and Madrid have been considered within their municipal boundaries. Hong Kong is only developed in limited areas (in multiple locations) with extreme density levels. 'Tokyo-23 Ku' is almost an entirely developed part of Tokyo with more or less flat high-density

⁶⁸ Adham K., 2011 – refer for details on history of urban development and urban planning initiatives.

⁶⁹ MME-Qatar, 2014: 20, point 2.2.6

⁷⁰ e.g. OECD 2012

⁷¹ Churchman, 1999; Berghauser Pont and Haupt, 2010; Manaugh and Kreider, 2013 in Bibri S. E. et al., 2020: 3

⁷² Manaugh and Kreider, 2013 in Bibri S. E. et al., 2020: 3

⁷³ Hillier, 1996; Marshall, 2005 in Bibri S. E. et al., 2020: 3

⁷⁴ Lee et al., 2015 in Bibri S. E. et al., 2020: 3

⁷⁵ Bibri S. E. et al., 2020: 3

development. Madrid and Vienna are two classical European cities with compact form and high-density development. While Vienna's population is almost equivalent to that of Metropolitan Doha, Madrid possesses little more than a million more population. Each of these four are compact and high-density urban areas but are with certain distinctively different characters (discussed in the section 3).

Despite having extremely high-level of densities, Hong Kong is one of the most liveable cities in the world; through better planning, design and management of the built-environment, Hong Kong demonstrates how a large population can be accommodated in a small area without impairing quality of life⁷⁶. In Tokyo, another city with high-quality-of-life, the city government since the mid-1990s is supporting redevelopment in the brownfield sites and in reclamation land in the central wards (a significantly high-density zone previously), which have resulted into re-densification⁷⁷. Vienna and Madrid, for maintaining compact forms particularly have been adopting the policy of revitalisation and intensification of the existing areas and restricting sub-urban sprawl. With such policies, beginning from mid-1990s, Vienna successfully added a substantial population in the core city (by 2005, which was a 10% increase) resulting into much colour, vibrancy and economic opportunities in the older areas⁷⁸. Though Madrid expanded outwardly in the 1990s, but since 2006, even after substantial increase in the city's population, outward expansion is almost stagnated⁷⁹ keeping Madrid's compact form intact.

Questions might arise on the selection of cities as 'Tokyo-23 Ku' or Hong Kong to compare with Doha. However, as far as comparative assessments are concerned, it has been found that though sometimes cities are evidently incompatible both in scale and in socio-cultural, political, and historical contexts, but the comparison can still be undertaken regarding the relative proportions of density and diversity across these urban areas⁸⁰. Moreover, each of these cities is a kind of benchmark portraying a 'particular status' with 'typical characteristics' those can be studied as valuable lessons in the backdrop of Doha's present and potential future development. However, it is not about transforming Metropolitan Doha into Madrid or Hong Kong, but about taking strategic decisions learning from these four cities and accepting benchmarks which are sustainable and resilient for transforming Metropolitan Doha's future based on its own qualities/potentials.

1.5. Limitations and Prospects

As this paper is an individual initiative, there are certain limitations related to time, technology and funds; and it is particularly reflected in acquiring and processing mapping related data. Therefore, the paper depends on the commonly available data from web portals such as Google Earth or Google Maps and from the web portals of various government and non-government organizations. Mapping and analysis are carried out synthesizing data from various sources using basic version of SketchUp, the drawing and 3D-making software. Moreover, a simpler form of comparative assessment is adopted here, for e.g. conclusions on burden of road infrastructure is simply based on the comparative assessment of road length per capita in the cities; it does not include the actual cost that varies from city to city or country to country and it does not consider type and quality of the roads (apart from the functional hierarchy of expressways and major roads). Another drawback is of unavailability of population data at 'city-division' level for one particular year; while it is available in Hong Kong for 2016, Vienna for 2019, Madrid for 2021, 'Tokyo-23 Ku' for 2019 and in Metropolitan Doha it is available only for 2015. There might be some changes in the density levels particularly in Metropolitan Doha and in Hong Kong. The density levels can be revalidated once the new data set is available for these cities; however, it is most likely that the trends reflected, and the conclusions made here would not change.

⁷⁶ Yeh, A. G. O., 2011

⁷⁷ Lützel R., 2008

⁷⁸ City of Vienna, 2005: 40

⁷⁹ Díaz-Pacheco J. and García-Palomares J. C., 2014

⁸⁰ Bibri S. E. et al., 2020: 3

In general, the approach adopted here certainly meets the objectives of the study. A robust study on the same is possible with more varieties of detailed data and adopting other methods of empirical assessment; but the results are not going to be different. It is believed that the outcome of the paper is sufficient for taking policy decisions. However, further studies testing effectiveness of the individual or a set of policy decisions is certainly possible, and this paper would provide a fundamental base for such studies.

2. Metropolitan Doha and the QNDF's Spatial Strategy

The key challenges identified in QNDF are the typical ones, where generally the 'compact city' policies perfectly fit into as the solution. Some of the key planning challenges identified in the QNDF are degrading quality of life; mega-projects targeting higher income groups creating low-density, spatially fragmented developments, only accessible by private car; lack of public transportation options, traffic congestion and degraded public realm; low-density fringe area development due to the nature of public housing demand; lack of affordable housing options for the non-Qatari workers; ageing population, limited local employment opportunities and lack of community facilities in smaller towns; increased greenhouse gas emissions; lack of mixed-land use provisions in zoning, etc⁸¹.

QNDF with its vision of "creating a role model for sustainable urban living and the most liveable towns and cities in the 21st century", proposes a multi-centred hierarchical urban spatial structure for Qatar. As per its 'Spatial Strategy for Qatar 2032' these are to be mixed-use and mixed-density urban centres under a hierarchical categorization of 'Capital City', 'Metropolitan' and 'Town Centres' in descending order⁸². These centres are proposed with a high-density core (200-300pph/50-75dph) with concentrated employment activities those merge with the surroundings with a medium density (60-200pph/15-50dph) with increasing housing and community facilities⁸³. The optimal land use range for these centres is identified to be 30-70% commercial, 40-60% residential and 5-15% community facilities. Apart from these centres, 'District' and 'Local' Centres with medium densities supporting 10-40% commercial, 50-80% residential and 10-15% public facilities are proposed within walkable distance of the catchment population to serve daily and weekly needs the communities.

The concentration of density and mixed-land-uses around the core is to ensure most residents and workers within a walking distance of 250m from public transit reducing vehicular trips and increase health benefits⁸⁴. QNDF points out that these centres are to reduce requirement of creating major new settlements outside the existing urban areas, optimise use of existing infrastructure, reduce urban footprint and impact on the natural environment, avoid further urban sprawl, improve liveability, help fostering urban regeneration and create economic growth by co-locating a mix of land uses and concentrating goods and services, etc.⁸⁵ It is also envisaged that the centres are to facilitate concentration of public transport, health, education, cultural and entertainment facilities which would to intensify community and social interactions, encourage multi-purpose trips and shorten travel distances reducing demand for private travel and encourage walking, cycling and use of public transport.⁸⁶ QNDF proposes that these mixed-use centers will be connected through a public transport system comprising Metro rail and bus transit and walkable streets with attractive public realm⁸⁷. Moreover, it proposed to develop new zoning regulations with hierarchical allocation of heights (or floor area ratio) to support

⁸¹ MME-Qatar, 2014: 21

⁸² Ibid.: 40-51

⁸³ Ibid.: 45

⁸⁴ Ibid.: 45

⁸⁵ Ibid.: 44, point 3.4.2

⁸⁶ Ibid.: 44, point 3.4.2

⁸⁷ Ibid.: 44, point 3.4.3

transit-oriented development (TOD)⁸⁸. It is envisaged that by 2032 these centres with TODs will facilitate expatriate population, comprising 80percent of the total and reduce their dependency on private cars⁸⁹.

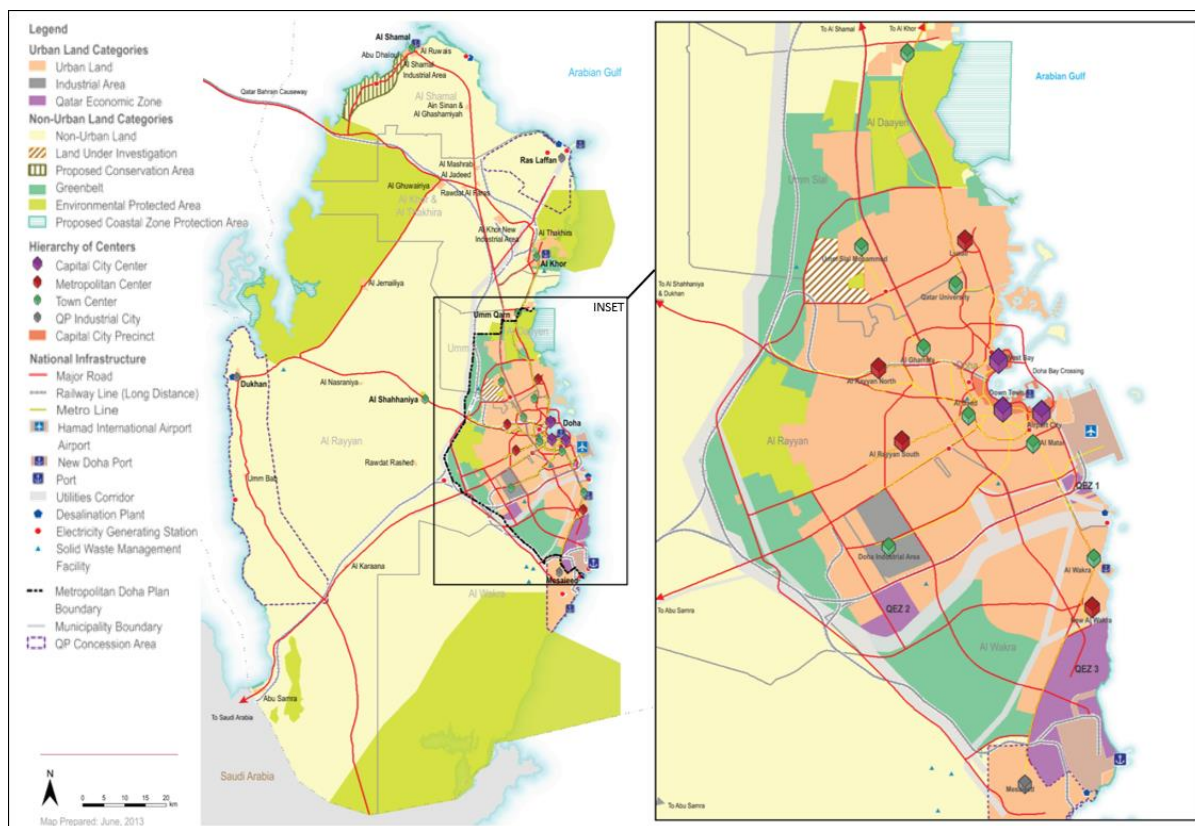


Figure 1: QNDF's National Spatial Strategy 2032. Source: MME-Qatar, 2014: 42-43

Apart from the centres, QNDF facilitates the basic framework for preparation of Municipal Spatial Development Plans in all the municipalities in Qatar along with zoning regulations. Another key recommendation of QNDF's spatial strategy is to enforce a greenbelt policy to contain urban expansion of Metropolitan Doha⁹⁰.

QNDF mentions that its strategic spatial framework is based on the estimations on Qatar's GDP, employment and population. Qatar's GDP is estimated to grow by QAR1054 billion with an employment of 1.7 million in 2032⁹¹. Population is projected at 2.5 million in 2017, which is envisaged to remain the same in 2032 with 1.9 million residing inside the Metropolitan Doha⁹². QNDF states that the size of Metropolitan Doha has been considered to accommodate 2.1 million, a 10 percent additional population on the estimate⁹³. It mentions that by 2017, Metropolitan Doha will be a city with a single urbanized form some 40km in extent from Lusail in the north, to the New Doha Port in the south and to be integrated by highways, metro rail, regional rail and feeder buses⁹⁴.

⁸⁸ Ibid.: 40, point 3.3.8

⁸⁹ Ibid.: 44, point 3.4.4

⁹⁰ Ibid.: 40, point 3.3.8

⁹¹ Ibid.: 24, Table 2.1

⁹² Ibid.: 25-27, Table 2.2

⁹³ Ibid.: 27

⁹⁴ Ibid.: 29, points 2.6.10 and 2.6.11

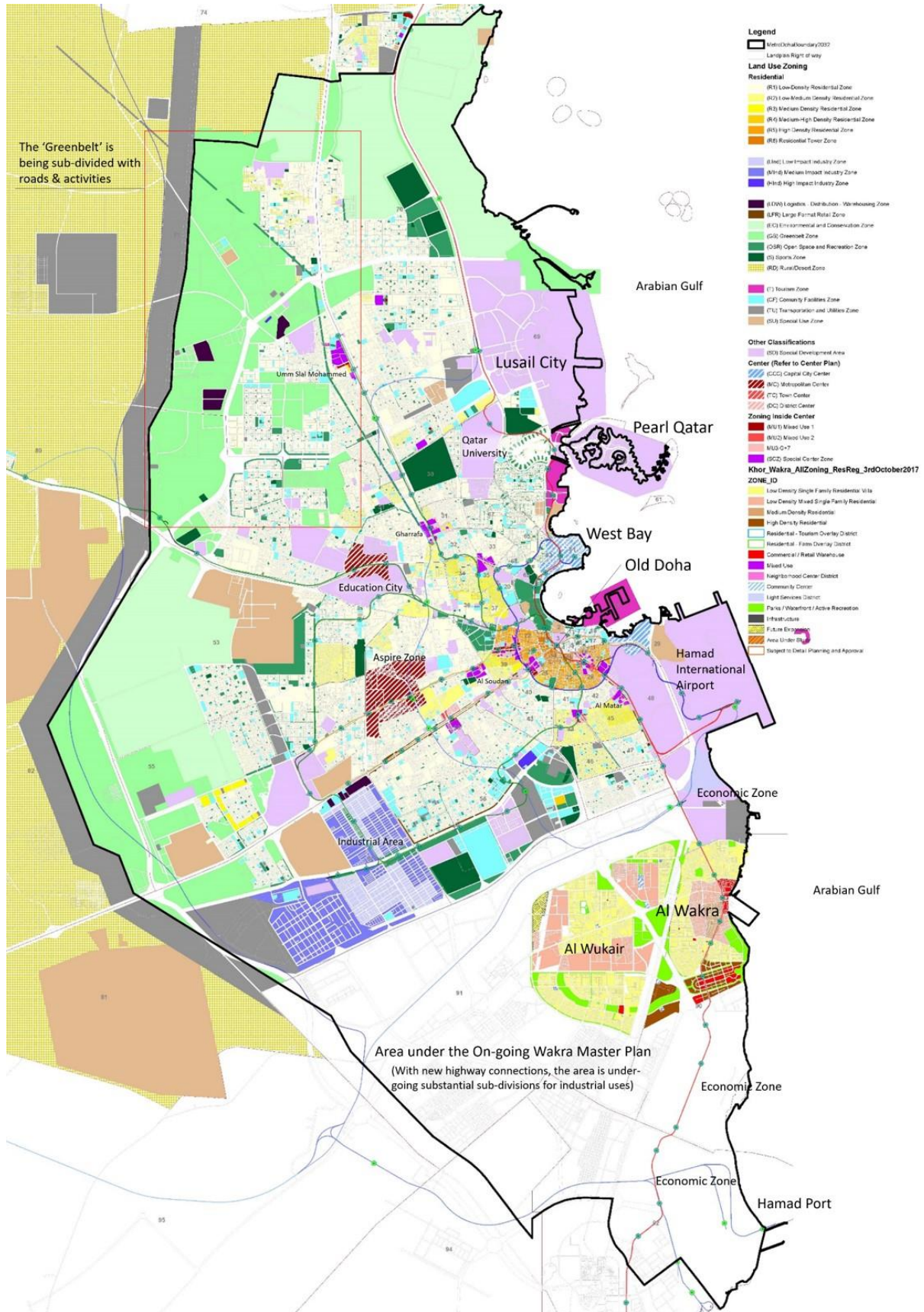


Figure 2. Metropolitan Doha's Land Use Plan. Source: MME

It is evident that QNDF's spatial strategy revolving around TOD-based mixed-use centres and the greenbelt policy conforms to the ideals of the compact city. Twenty-two out of these twenty-eight proposed centres (3 capital city centres, 3 metropolitan centres, 8 town centres and 14 district centres) are within the Metropolitan Doha and out of these twenty-two, MME has prepared 'centre plans' for 12 centres (4 town centres and 8 district centres). Although QNDF suggested a density range of 60-300pph (15-75dph) for the centres within Metropolitan Doha, interestingly, in the 12 centre plans, the estimated possible density (based on permitted GFA) averages to 431pph reaching up to 696pph with a maximum population capacity of 450k. Plans are under preparation for some of the remaining centres and 7 of these centres are being developed by private entities. The three proposed 'capital-city centres' in West Bay, Downtown Doha (the historic centre) and one near the Airport are currently undergoing the planning phase. The West Bay has become the iconic CBD of Doha with lofty skyscrapers; however, the area's current residential population is less than 12k with a density of only 15pph⁹⁵. Downtown Doha, the historic centre (a designated capital-city centre) possesses a population of 20k with a density of 64pph⁹⁶. The new iconic Msheireb Downtown within Downtown Doha proposes a tiny population of 2100 with a density of 68pph⁹⁷. One of the metropolitan centres, Lusail, developed by a private developer proposes a population of 200k with a density of 53pph⁹⁸. On the contrary, QNDF suggests residential densities in the 'capital' and 'metropolitan' centres at around 200-300pph (approx. 50-75 dwellings per hectare). Another new iconic private development, the Pearl Qatar, which is considered as a district centre in QNDF proposes a population of 45k with a density of around 80pph.



Figure 3. West Bay, the Iconic CBD of Doha with Residential Density as Low as 15pph. Source: Author.

It is evident that some of these centres have been planned with extreme level of densities that surpasses the QNDF's prescribed levels, while at the same time, some of the centres and areas within the centres, particularly developed by the private developers lag far behind in the density levels. The scenario will be much clearer when the plans for the 'capital-city centres' would be ready, which currently possesses extremely low level of residential densities.

Again, it seems that the size of Metropolitan Doha, which is 1279sqkm and the designation of urbanizable area within it have been kept at a very higher side, which have created a paradoxical situation encouraging low-density expansion. The Municipal Spatial Development Plans (MSDP) prepared within the Metropolitan Doha propose more than 95 percent Residential land use as low density (R1 and R2).⁹⁹

⁹⁵ PSA-Qatar, 2015

⁹⁶ Ibid.

⁹⁷ Msheireb Properties, 2021

⁹⁸ Lusail City, 2021

⁹⁹ MME-Qatar, 2021

Land use proposals in a large portion of Wakra municipality is yet not available, as its master plan is currently under preparation. It is evident from the MSDPs that the designated greenbelt within the city is not strictly enforced; roads and subdivisions are appearing in most of the areas in the zone rapidly filling up the entire Metropolitan Doha with low-intensity urban activities and low-densities.

3. Doha's Urban Form, a Comparative Assessment

In this section, Doha's urban form and its characteristics are compared with the four selected cities. Comparisons are made on size, shape and distances, characteristics of the core zones, city-level and city-division-level densities, spatial distribution of the gross developed areas, gross-developed area densities, characteristics of the road network and road network and gross developed area.

3.1. Size, Shape and Distances

Metropolitan Doha's size is the largest among all the selected cities. It is more than double than that of 'Tokyo-23 Ku' and of Madrid; while 'Tokyo-23 Ku' has 4.8 times and Madrid has 1.7 times larger population size. Vienna with almost equal population size is more than three times smaller than Metropolitan Doha. Hong Kong has 3.7 times larger population size than that of Metropolitan Doha, but its area is still a bit smaller.

Metropolitan Doha shaped like a 'half-moon' straddles for about 62km north-south (longest) and almost 35km east-west (widest). Its core area located in the eastern coast is about 22km from the northern and western, and about 30km from the southern periphery. Hong Kong comprises of an archipelago and a northern part, with Kowloon and the 'Northern Territories' in the mainland China. Hong Kong's north-south and northeast-southwest (longest) expanse is about 40km and 63km respectively. Its core is located towards south-east and is about 22km from its northern and 29km from its south-western (longest) peripheries. Vienna, Madrid and 'Tokyo-23 Ku' are 'circular shaped' with their core areas in the central locations. Vienna has a radius of around 8 to 10km; Madrid conforms to a similar size and shape, but the large district of Fuencarral-El Pardo, mostly comprising of undulating protected forested land bulges out towards the north-west. 'Tokyo-23 Ku' also has a radius of about 10km.

3.2. The Core Area City-Divisions

The 'core areas' of the cities are the 'urban activity hubs' with zones or wards or districts (as different city calls differently, here, 'city-divisions',) generally comprising of the historic centres and surrounding areas. These are the areas of employment generation with concentration of businesses, government functions, institutions, transportation nodes, etc. and are the 'tourist zones' with destinations, and concentration of hotels and restaurants. In most cases, the core incorporates high-density mixed-use areas and in some incorporates the new CBDs. Due to high concentration of the non-residential activities in most of the cases, the central 'city-divisions' in the very centre of a core might have a little lower density than the surrounding 'city-divisions', where the highest densities appear. The 'city-divisions' within the core are smaller in sizes than the ones outside the core.

Vienna and Madrid, the two European cities have distinctive core areas. In Vienna, the core comprises of ten municipal districts surrounding the old centre, the 'Innere Stadt'. Majority of these districts are located within a circle of three kilometres radius and the entire core is well within a circle of six kilometres radius on a central point in the Innere Stadt. In Madrid, like Vienna, the core of the city is extended from 'Centro', the historic centre to six surrounding districts. 'AZCA', in Tetuan in the northern part of the core is the emerging CBD of Madrid with high concentration of skyscrapers. The 'Centro' and 'AZCA' both can be covered within a circle of three kilometres radius if its centre is placed somewhere in between, in the district of Chamberi. The entire core area of Madrid is well within a circle of six kilometres of radius. In Hong Kong, the urban core is formed by the three districts of Hong Kong Island

and all five districts of Kowloon Region. The compact core formed by these distinctively small districts is divided in to two parts by the narrow Victoria Harbour.

‘Tokyo – 23 Ku’ is the urban core of the Tokyo Metropolitan Region; but as the original Tokyo city, the area has a distinct traditional core comprising of the districts of Chiyoda, Chuo and Minato located close to the Tokyo Bay area, characteristically following a circle of three kilometres radius with the centre the confluence of the boundaries of these three districts. However, currently the core functions and characteristics are shifting towards the inner districts with a larger area conforming to a circle of six kilometres radius with a centre deflected towards the boundary between the districts of Chiyoda and Shinjuku.

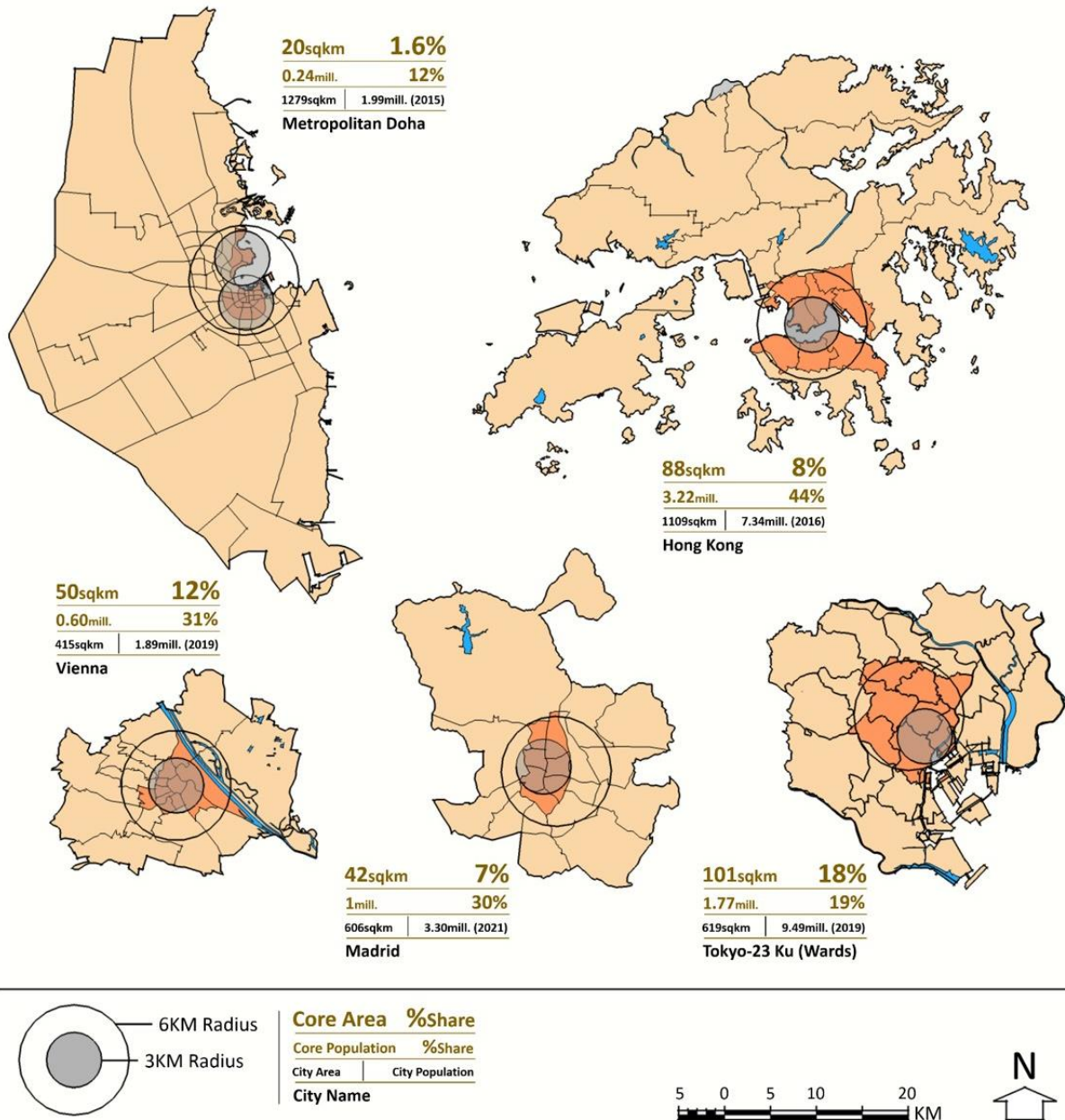


Figure 4. Location, Spatial Extent and Population of the Core Areas. Source: Author, prepared based on composite data from several sources¹⁰⁰.

¹⁰⁰ MME-Qatar, 2021; PSA Qatar, 2015; LD Hong Kong, 2021; Population By-census 2016 Hong Kong, 2017; City of Vienna, 2021; City of Vienna, 2019; City of Madrid, 2021; Statistics of Tokyo, 2019; Google Earth and Google Maps.

Metropolitan Doha's core incorporates two central areas, the historic centre and the areas up to the C-Ring Road and West Bay, the new CBD, both located next to the coast and are separated by the Al Bidda Park and a sea-side promenade. The first part consists of twenty smaller 'zones' with the historic core and the high-density-mixed-use zones next to it developed during the 1960-80s. These zones conform to the traditional neighbourhoods and are redefined by the boundaries delineated based on the main circular and radial roads. The zones within the 'A' and the 'B' Ring Roads are smaller and those developed later between the 'B' and 'C' Ring Roads are comparatively larger; but all these zones are distinctive with mixed-use areas along the main streets. The second part of the core, West Bay consists of three zones and is the modern centre characterized by its iconic skyline with tall skyscrapers.

The core area of Metropolitan Doha accounts for a meagre 1.6 percent of the city's area and 12 percent of the city's population. In contrast, Hong Kong's core comprises of 8 percent of the city's area and 44 percent of the city's population, Vienna's core comprises of 12 percent area and 31 percent population, Madrid's 7 percent area and 30 percent population and the eight central wards of 'Tokyo-23 Ku' comprises of 18 percent of the area and 19 percent of the total population. It is evident that although Metropolitan Doha is the largest of all the five selected cities in size, but in contrast, its core is the smallest of all in size and is the weakest of all as far as its 'population-size-share' is concerned.

3.3. The City Level and City-division-wise Population Density

Out of these cities, overall city level population density is the highest in 'Tokyo-23 Ku' with a density of 153pph accommodating a massive population of 9.5 million. The overall city level densities of Hong Kong's 66pph, Madrid's 55pph and Vienna's 46pph are comparable; but their population varies greatly from Vienna's 1.9 million, Madrid's 3.3 million and to Hong Kong's 7.3 million. With the largest area, and population of 1.9 million, the Metropolitan Doha's overall city level density is only 16pph; it is 2.9 times less than that of Vienna, 3.4 times less than that of Madrid, 4.1 times less than that of Hong Kong and a huge 9.5 times less than that of 'Tokyo-23 Ku'.



Figure 5. Contrasting Built-environment, Madrid and 'Tokyo-23 Ku'. Source: Guzman¹⁰¹ and Schwarzkaefer¹⁰²

Spatial distribution of the city-division-wise density reveals that, in general the density in the core-area-city-divisions are distinctly higher; particularly, the difference is very high in all the cities except 'Tokyo-23 Ku'. The variation in 'Tokyo-23 Ku' is not prominent; in fact, densities of some of the western and north-western wards in the city are slightly higher than that of the core area wards. In Hong Kong, the highest densities are in the districts in Kowloon Region, with density reaching as high as 575pph in Kwun Tong; On the contrary, the density in the 'Island District' is as low as 9pph. In Madrid, density reaches up to 297pph in the district of Tetuan, where 'AZCA', the new CBD of the city is located; while the density in Fuencarral-El Pardo in the north-west is as low as 10pph. In Vienna, density reaches 275pph in Margareten located next to the historic centre; at the same time, it is as low as 14pph in Hietzing. In 'Tokyo-23 Ku', the highest density is in the ward of Toshima with 223pph, slightly higher than that of

¹⁰¹ "Madrid (2 de 2)" by Guzmán Lozano is licensed under CC BY 2.0

¹⁰² "Blue Hour over Tokyo" by Schwarzkaefer is licensed under CC BY 2.0

Tetuan in Madrid and Margareten in Vienna, but much lower than Kwun Tong of Hong Kong. Interestingly, the lowest density in the 'Tokyo-23 Ku' is from its historic central ward of Chiyoda, which is just 55pph. However, in all other wards of 'Tokyo-23 Ku', the overall density ranges between 120 and 223pph.

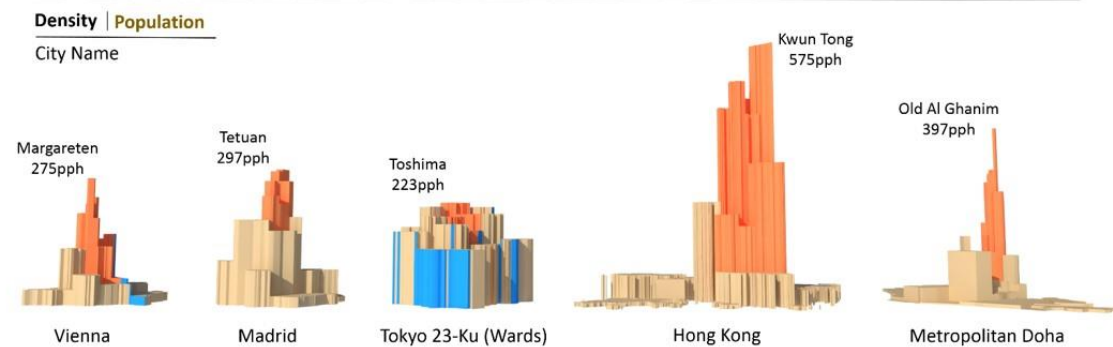
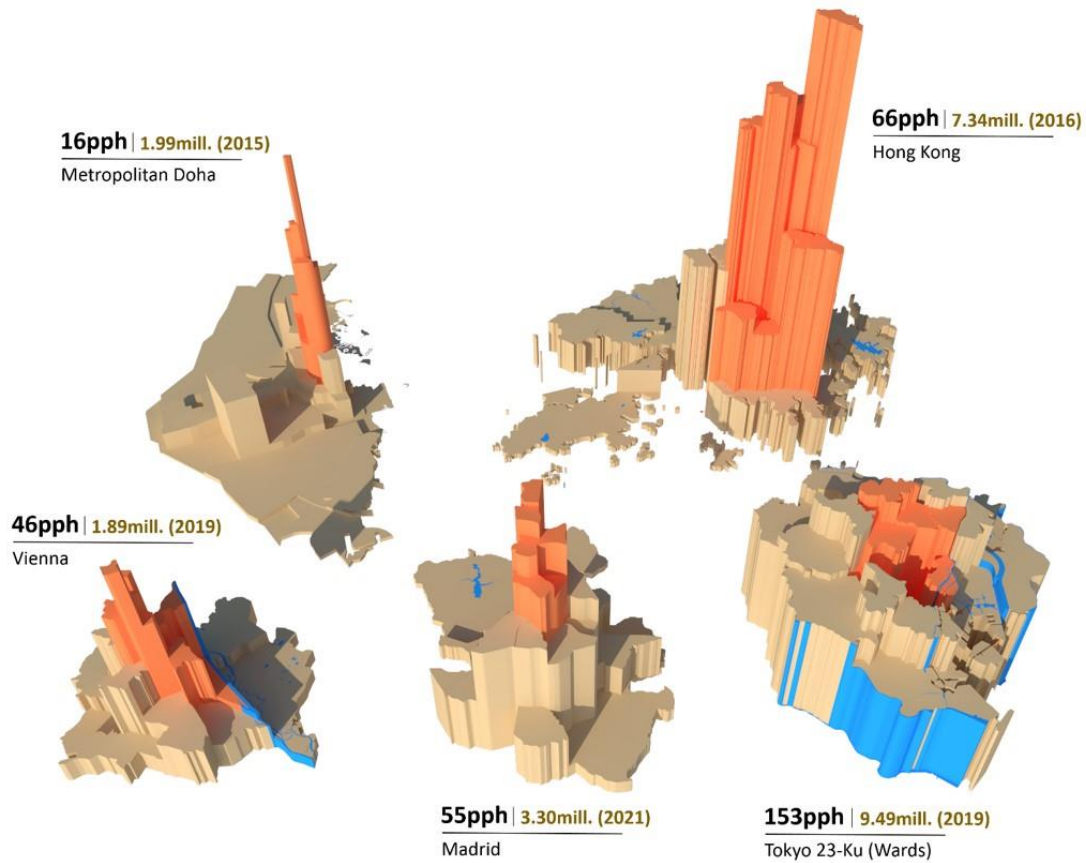


Figure 6. Comparison of City and City-division Level 'Overall Urban Density'. Source: Author, prepared based on composite information from several sources¹⁰³.

In Metropolitan Doha, though its overall city-density is just 16pph, the same in some of the zones in the Old Core is very high; interestingly, density in Old Al Ghanim (Zone 16) reaches as high as 397pph, which is considerably higher than that of Tetuan in Madrid, Margareten in Vienna and Toshima in 'Tokyo-23 Ku'. However, these high-density zones in the Old Doha are much smaller in size compared to the sizes of the

¹⁰³ Same as of Figure 4.

central city-divisions of the other cities, which is evident from the taller, but very thin representation of the Metropolitan Doha's zones in the Figure 5.

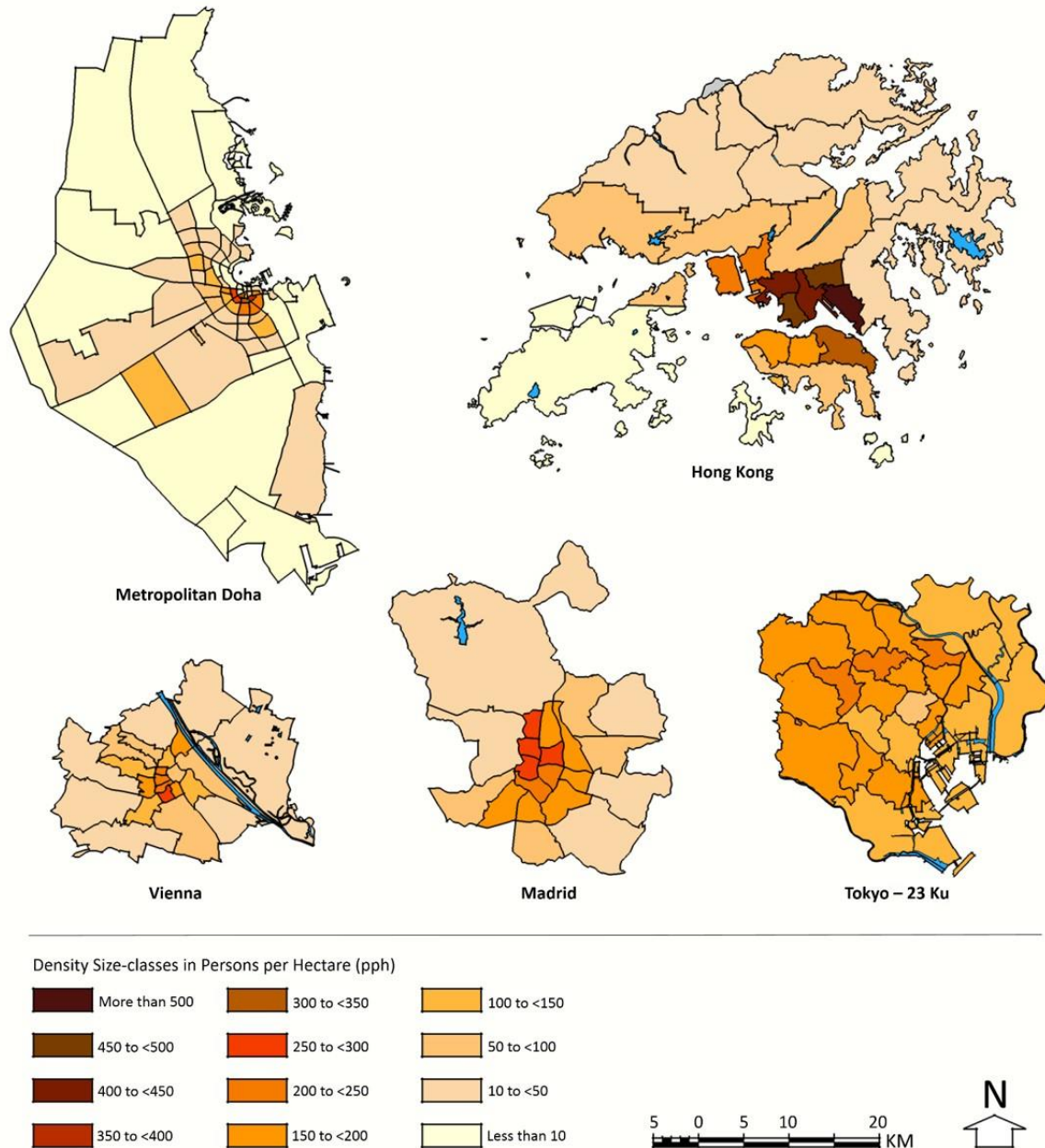


Figure 7. Spatial Distribution of City-division-wise Population Density Size-classes. Source: Author, prepared based on composite information from several sources¹⁰⁴.

The spatial distribution of the city-division-wise population densities in ‘density-size-classes’ reveals extremely high-density concentration in the districts in Kowloon Region of Hong Kong, moderately high-density distribution in the core areas of Madrid and Vienna and a skewed pattern with moderately high densities in ‘Tokyo-23 Ku’. Interestingly, with extremely high densities of 477pph, the five districts of the Kowloon Region in Hong Kong with a land area of just 47sqkm (3.7% of Metropolitan Doha) possesses 2.2 million population, which is larger than Metropolitan Doha’s total population. The seven central districts of Madrid with a land area of 42sqkm (3.3% of Metropolitan Doha) and a moderately high density of

¹⁰⁴ Same as of Figure 4.

239pph caters to a population of 1 million, equals half of Metropolitan Doha's population. Vienna's eleven districts in the core with a land area of 50sqkm (3.9% of Metropolitan Doha) contains roughly 600k population, equivalent to 30 percent of Metropolitan Doha's population. 'Tokyo-23 Ku's eight central districts with an area of 110sqkm (8.6% of Metropolitan Doha) with a density of 161pph, contains 1.8 million population, about 89 percent of Metropolitan Doha's population. Metropolitan Doha's high-density zones are tiny in comparison to rest of the selected cities and a huge 906sqkm of land area (71% of Metropolitan Doha) contains more than 500k population with a density less than 10pph (average only 2pph). Interestingly, another 306sqkm of land area (24% of Metropolitan Doha) caters to 700k population in the zones with a density size-class between 10 and less than 50pph (average 26pph). These low-density zones in both these categories together accounts for 95 percent of Metropolitan Doha's area that caters to more than half of its population making the city predominantly a very low-density city.

3.4. Gross Developed Area and Its Spatial Distribution

The Gross Developed Area (GDA) considered here is the urbanized land area in the selected cities that are developed for the urban activities. GDA is inclusive of all the building footprints, compounds, and all the roads within and around, but excludes the barren land, agricultural areas, forests, parks, gardens and other urban open spaces such as corniche. However, the land under the roads and highways in the excluded areas are not considered as part of GDA. GDA provides the extent of urban activities within the selected cities and portraying a more realistic spatial distribution of density provides inferences on the nature and character of the urban spatial spread shaping up the 'urban form'. The nature and character of the spatial distribution of GDA might be determined by varied factors such as topography, vegetation, agricultural areas, historical reasons, city government's policies and regulations, etc.

Hong Kong predominantly has a hilly and rugged terrain, a highly crenulated coastline and more than two-hundred islands and around 443sqkm (40% of total land) of land in Hong Kong is protected under the Country Parks Ordinance of 1976.¹⁰⁵ Moreover, there are three ecological important habitats and several marine parks with stringent controls.¹⁰⁶ Hong Kong's Town Planning Ordinance also supports zoning of ecologically sensitive areas with development restrictions.¹⁰⁷ With such restrictions, careful considerations on urban development and due to the topographic deterrents in general, Hong Kong's GDA follows narrow coastal strips or narrow valleys of the rivulets. Based on the study of the Google Earth images, Hong Kong's GDA currently is estimated to be about 299sqkm of land area, only twenty-seven percent of total land. Hong Kong's GDA is fragmented but are compact within mostly narrow and linear smaller regions. In contrast, in 'Tokyo-23 Ku', with flat developable land all around and due to the high pressure of urban development in the region (that already expanded outside 'Tokyo-23 Ku' in Tokyo Metropolitan Region), GDA comprises of a very high, 577sqkm of area, a ninety-three percent of total land. Madrid's GDA is estimated to be about 213sqkm, which is thirty-five percent of the total land area; the percentage share is lower due to the presence of the largely undeveloped (90%) district of Fuencarral-El Pardo (with 40% of Madrid's area) in the northwest. However, Madrid's spatial distribution of GDA indicates a compact form with most development concentrating in the central districts or in the adjoining areas of the surrounding districts. Vienna's north-western and western parts consist of hilly terrain with woodlands and parks. At the same time, its southern, south-eastern, eastern and north-eastern areas contain extensive agricultural land. Excluding these, Vienna's GDA is estimated to be about 212sqkm, which is fifty-one percent of the total land area. The GDA is compact all around the old core districts particularly in the western part of the city (west of the Danube River) but is a bit more fragmented and scattered in the agricultural areas of the southeast and extreme northeast part of the city. Interestingly, Vienna's GDA is almost equivalent to that of Madrid's, however, unlike Madrid (and all

¹⁰⁵ Environment Bureau, Hong Kong, 2016: 12

¹⁰⁶ Ibid.

¹⁰⁷ Ibid.: 15

other selected cities), the airport of Vienna is located outside its city limit and is excluded from the GDA estimations.

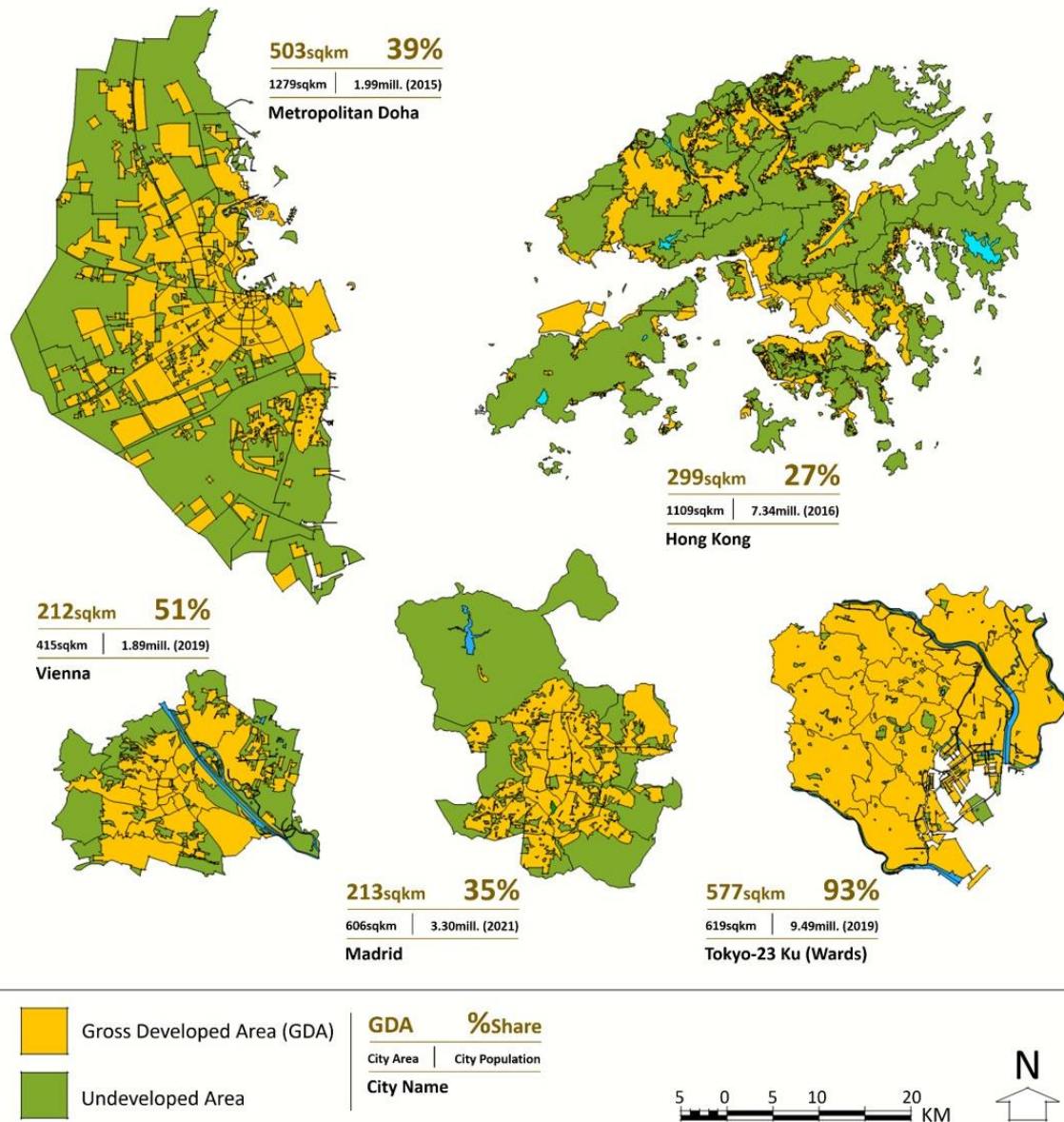


Figure 8. Comparative Assessment of the ‘Gross Developed Area’ (GDA) and ‘Undeveloped’ Areas. Source: Author, prepared based on composite data from several sources¹⁰⁸.

On the other hand, as we have discussed earlier, presence of largely undeveloped district of Fuencarral-El Pardo in Madrid has contributed to its lower GDA share against the total area in comparison to that of Vienna. Interestingly, though with much larger population base, Hong Kong’s GDA is only marginally larger, by 86sqkm than the same of Madrid and Vienna.

Metropolitan Doha portrays a contrasting picture; with flat barren land all around the city, GDA has expanded all the directions along the highways and gradually becoming fragmented in the sub-urban areas. Metropolitan Doha’s current GDA is estimated to be around a huge 503sqkm of land area which is 87 percent of Tokyo-23 Ku’s GDA and 2.4 times larger than that of Madrid and Vienna and 1.7 times larger than that of Hong Kong.

¹⁰⁸ For city divisions and population as in Figure 4 and for the ‘developed’ and ‘undeveloped’ areas from Google Map and Google Earth.

3.5. Comparison of Gross Developed Area Population Density (GDAD)

The Gross Developed Area Density (GDAD), ‘the population density of the urbanized area excluding the city’s undeveloped areas’, provide us with a better and clearer perspective on the intensity of urban spatial expansion. GDAD confirms the actual population load that is being absorbed by a particular land area with developed structures, necessary infrastructure and facilities and amenities.

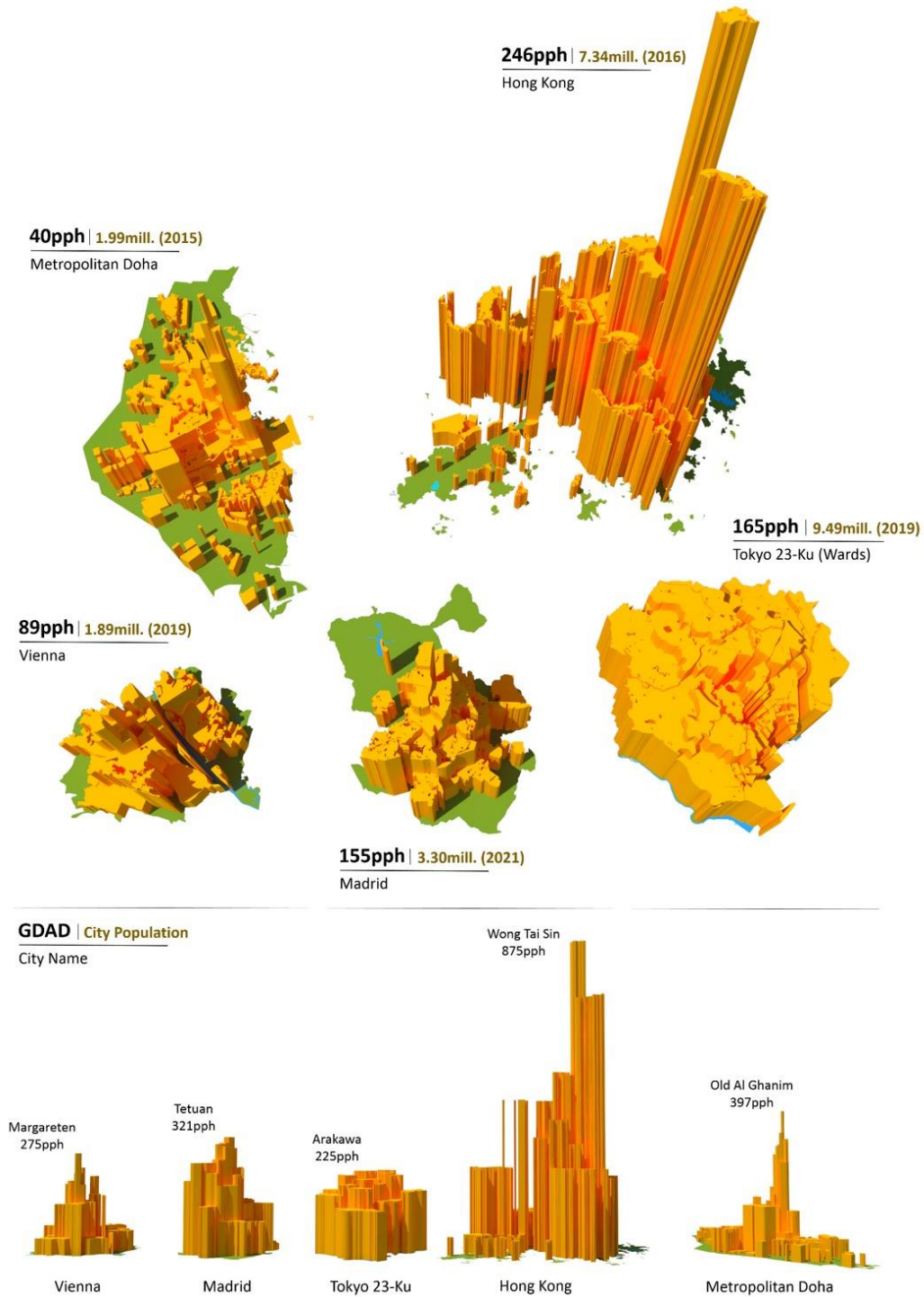


Figure 9. Comparison of ‘Gross Developed Area Densities’ (GDAD). Source: Author, prepared based on composite information from several sources¹⁰⁹.

¹⁰⁹ Same as of Figure 8.

Against Hong Kong's overall density of 66pph, with only 27 percent of developed land (GDA), its GDAD reaches to 246pph, which is the highest amongst all the five cities. On the contrary, with expansive GDA (93% of the total), 'Tokyo-23 Ku's' GDAD of 165pph is only marginally higher than its overall density of 153pph. The GDAD of Madrid reaches to 155pph (overall density 55pph); interestingly, Madrid's GDAD is now comparable to that of 'Tokyo-23 Ku' and that reveals its compactness. Similarly, though not at par with Madrid's, Vienna's GDAD reaches to 89pph (overall density 46pph). On the other hand, with extensive urban sprawl, Metropolitan Doha's GDAD is the lowest of all at 40pph, which is less than half of that of Vienna's, four times less than that of Madrid and of 'Tokyo-23 Ku' and six times less than that of Hong Kong's.

Analysis of city-division-wise GDAD reveals massive fluctuations particularly in Hong Kong; GDAD in the district of Wong Tai Sin in Kowloon Region reaches as high as 875pph. GDAD in the core city-divisions of Madrid is marginally higher than the overall densities with the highest in the district of Tetuan at 321pph. On the other hand, GDAD in the core areas of 'Tokyo-23 Ku', Vienna and Metropolitan Doha remain similar to the overall densities as these areas are more or less fully developed.

Due to various natural and policy based restrictive conditions, extensive future urban sprawl in the undeveloped land is unlikely in Hong Kong, Madrid and Vienna. In 'Tokyo-23 Ku' high-density development has already taken place in its 93 percent of the land area. However, Metropolitan Doha as its current state is experiencing a rapid low-density sprawl all around.

Assessment of spatial distribution of GDAD size-classes at city-division level clearly provides the emerging patterns of spatial development in the selected cities. Hong Kong's GDAD is extremely high in the core areas. The narrow northern coastal strip of Hong Kong Island's GDAD ranges from 301pph in Wan Chai to more than 703pph in the Eastern district. The same in Kowloon is considerably high in a range from 418pph in Kowloon City to more than 875pph in Wong Tai Sin. The next size-classes of GDAD emerges in the districts of Kwai Tsing (320pph), Tsuen Wan (425pph) and Sha Tin (358pph) located in proximity to the core area and thereafter the GDAD decreases in progression in the peripheral districts, lowest appearing in the 'Island District'. Tokyo's GDAD distribution closely resembles to its overall density distribution due to high proportion of gross developed area (GDA) in all the wards. Madrid's spatial distribution of GDAD revalidates its relative compact character; GDAD is more than 300pph in the central districts of Tetuan (321pph), Chamberi (305pph) and in Centro (301pph). High GDAD in the district of Centro, which is the historic centre of Madrid reflects its strong character as a 'mixed use' zone, which is not evident in the historic centres of the other selected cities apart from Hong Kong. Madrid's low GDAD appears only in the district of Barajas, which is predominantly occupied by its international airport. Vienna's comparatively higher GDAD in the size-classes between 200 to 300pph emerge in the districts of Margareten (275pph), Mariahilf (219pph), Neubau (201pph) and Josefstadt (234pph) located in the immediate west and southwest of the Innere Stadt. Another district with more than 200pph is Brigittenau (209pph) north of Innere Stadt. Vienna's lower level of GDAD appears particularly in the southern districts. In Metropolitan Doha, low-density expansion is evident all around. Leaving a small area in the old core, in general, GDAD is low across all the zones of the city. However, comparatively a slightly higher size-classes between 50 to 100pph appear in the zones such as Madinat Khalifa northwest of the core area and towards southeast in the northern part of the Salwa Road, the Industrial Area and in Al Wakra in the south. Rest of the areas have expanded fragmentarily all around with GDAD less than 50pph (with an average of only 19pph).

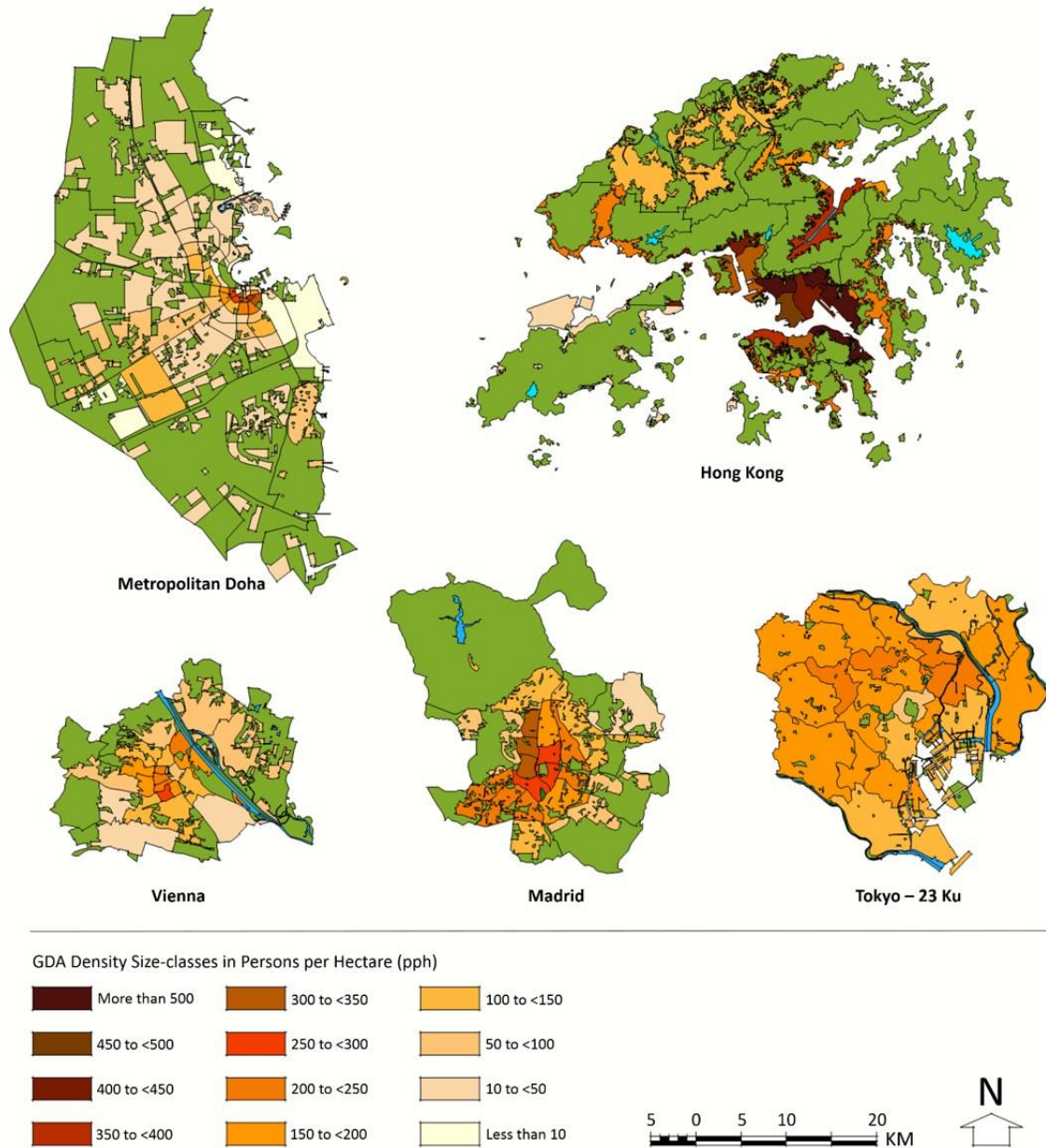


Figure 10. City-division-wise Spatial Distribution of Gross Developed Area Density (GDAD) Size-classes. Source: Author, prepared based on composite information from several sources¹¹⁰.

We have previously stated that currently, Metropolitan Doha’s Gross Developed Area (GDA) is estimated to be around 503sqkm, which is one of the largest among the selected cities. If Metropolitan Doha’s Gross Developed Area Requirement is estimated based on its population and GDAD of the other four selected cities, it reduces to more than six times to only 81sqkm at the rate of Hong Kong’s, to about four times at the rate of Madrid’s and ‘Tokyo-23 Ku’ to 129 and 121sqkm respectively and reduces to more than double to 223sqkm at the rate of Vienna’s (Figure 11).

¹¹⁰ Same as of Figure 8.

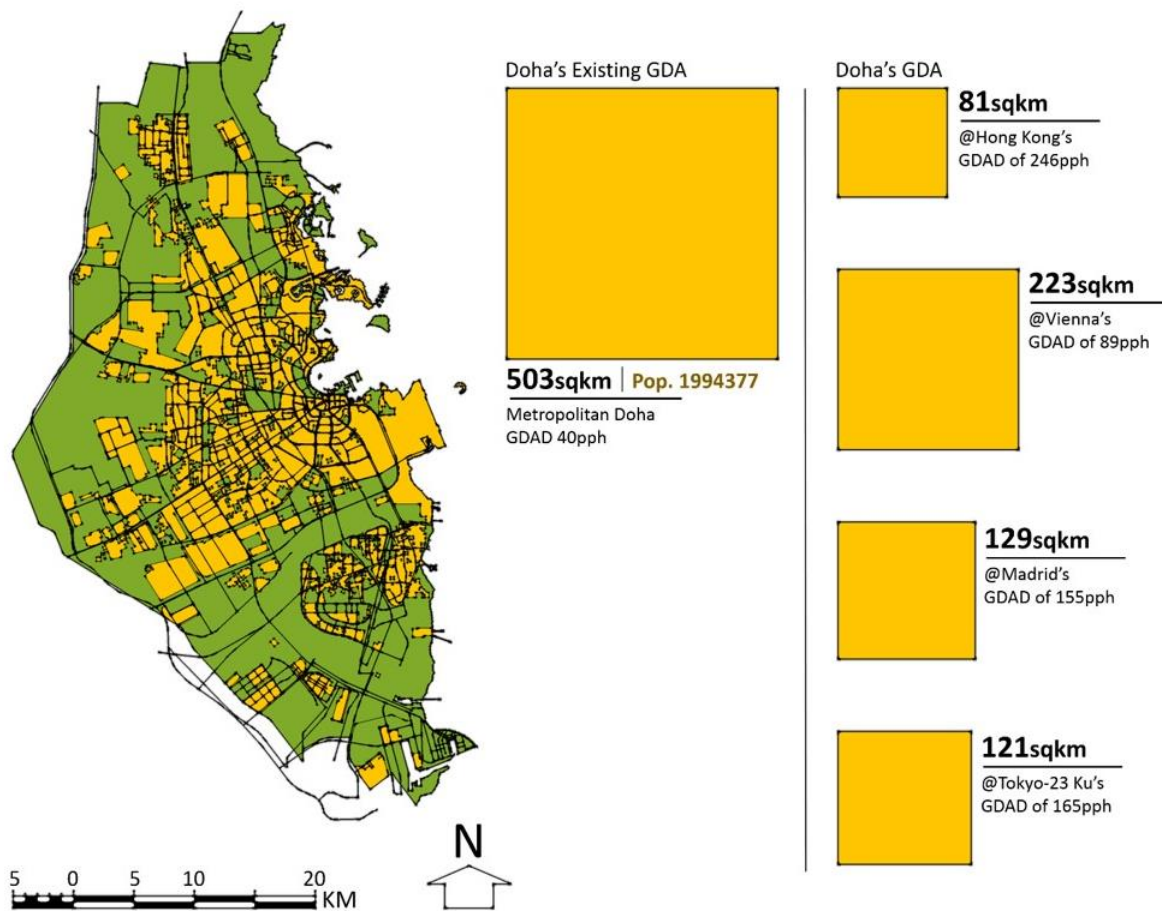


Figure 11. Metropolitan Doha's GDA with GDAD of Other Cities. Source: Author, prepared based on composite information from several sources¹¹¹.

This clearly reveals Metropolitan Doha's excessive area under GDA, which is a result of low-density urban sprawl all around and of an evidently weak core area.

3.6. Comparison of the Road Networks

The pattern of road network within a city is directly related to its form; either it supports a typical form and takes shape or reversely if developed earlier it guides an urban form to be evolved around it. Sometimes, excessive provisions of roads can lead to low-density sprawl and can create a highly car-dependent society, which we believe Metropolitan Doha is currently experiencing. Therefore, it is worth carrying out a comparative assessment of the nature and character of the road networks of the selected cities and to find out where Metropolitan Doha exactly is positioned in comparison to these compact and high-density cities.

For the assessment, the expressways and the major urban roads (EWMR) up to the neighbourhood level (excluding the lowest order local streets) have been considered. Interestingly, the assessment has revealed that about a total of 1450km long EWMR in Metropolitan Doha serving a population of 2million is 166km longer than that of Hong Kong's that serves 7.3 million people. Again, the Metropolitan Doha's EWMR network is almost seventy percent of the same of 'Tokyo-23 Ku' that serves 9.4 million population. Similarly, it is 1.8 times more than that of Madrid's that serves 3.3 million population and more than double than that of Vienna's serving almost a similar population size of Metropolitan Doha.

¹¹¹ Same as of Figure 8.

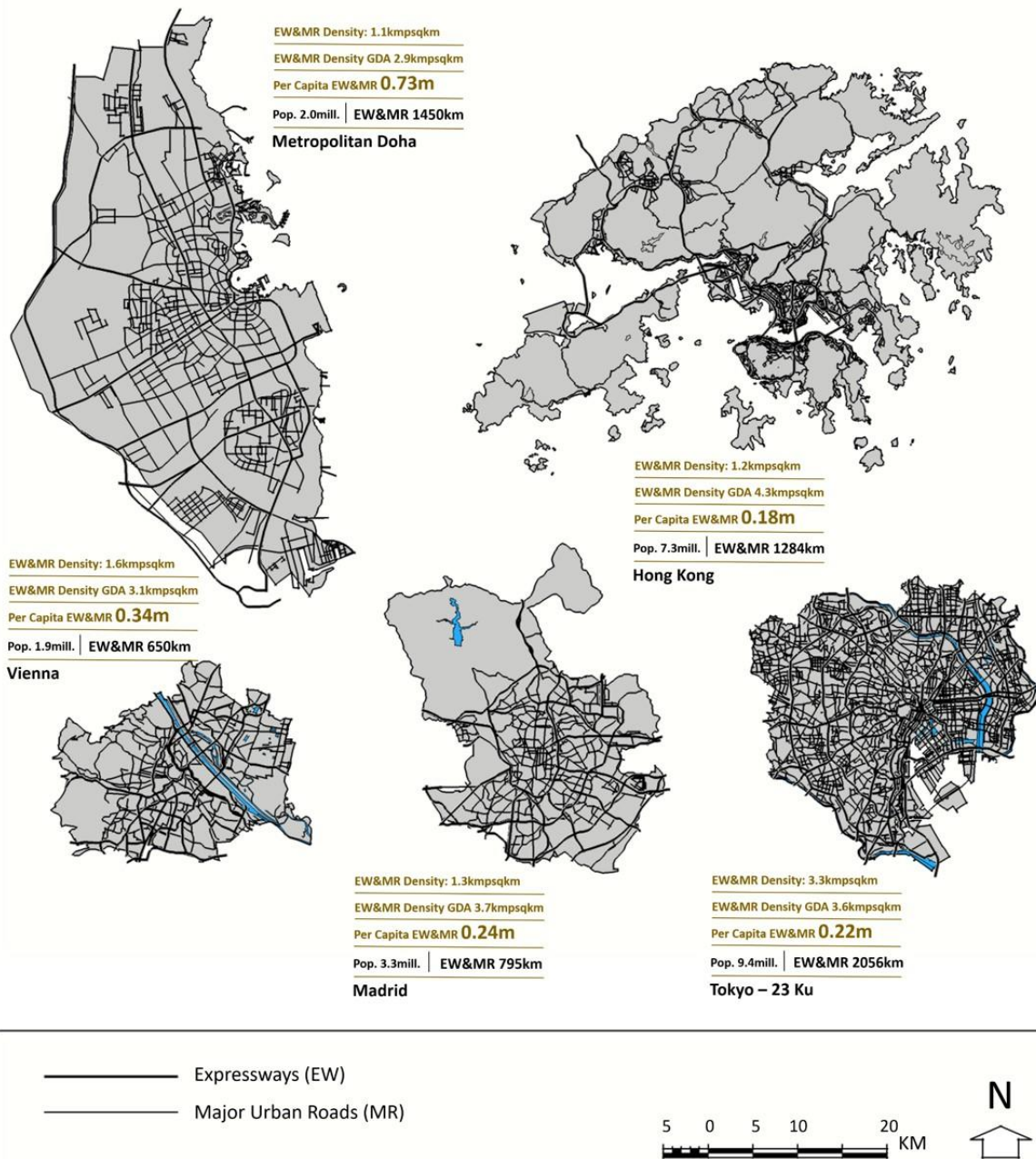


Figure 12. Comparative Assessment of the Expressways and Major Urban Roads. Source: Author, prepared based on composite information from several sources¹¹².

At the same time, Metropolitan Doha’s EWMR network is more loosely developed, spread out with larger in between blocks of land and gaps and the EWMR density is the lowest. The ‘EWMR density in kilometre per square kilometre of land’ (kmps/qkm) is closer between Metropolitan Doha (1.1kmps/qkm), Vienna (1.6kmps/qkm), Madrid (1.3kmps/qkm) and Hong Kong (1.2kmps/qkm) due to the presence of a large share of undeveloped area (with minimum roads) in these three cities. On the other hand, as it is fully developed and as it is smaller in size, the EWMR network of ‘Tokyo-23 Ku’ is three times denser than that of Metropolitan Doha. However, a more realistic picture emerges when ‘EWMR density in GDA’ is compared among these cities; Metropolitan Doha’s EWMR density in GDA is the lowest at 2.9kmps/qkm against Vienna’s 3.1, Madrid’s 3.7, ‘Tokyo-23 Ku’s 3.6 and Hong Kong’s 4.3kmps/qkm.

¹¹² For city boundaries as in Figure 4 and the roads from Google Map and Google Earth.

'Road length per capita' can be a measure of development, where in general, higher the value would indicate an area to be 'more developed'; however, sometimes, the same measure can also indicate 'over provisions' and 'burden' to a city's population. It can also correlate to very high car-dependency. Metropolitan Doha's 'EWMR length per capita' at 0.73m is more than four times higher than that of Hong Kong (0.18m), more than 3 times higher than that of Madrid (0.24m) and 'Tokyo-23 Ku' (0.22m) and more than double than that of Vienna (0.34m). If we hypothetically assume that EWMR construction and maintenance cost is same in all the selected cities (which is off course not true), per capita EWMR construction and maintenance cost in Metropolitan Doha will be higher than all these cities. It indicates proportionately a very heavy burden of constructing and maintaining such an EWMR network in Metropolitan Doha with such a low-density level and that might unnecessarily account for a large portion of future budget of the city. Moreover, other civic infrastructure networks of power, telecommunication, water and waste water systems, solid waste provisions, etc. increase proportionately to the length of road network, which indicates that cost of provision and maintenance of these infrastructure systems are most likely also costlier in Metropolitan Doha in comparison to the other selected cities.

When we observe that EWMR in the cities such as 'Tokyo-23 Ku', Hong Kong, Vienna and Madrid is sufficiently supporting urban activities and the population of the respective cities confirming good quality of life, we can certainly identify Metropolitan Doha's EWMR network to be a 'over provision' and a 'burden' for the city's population with a number of negative consequences.

3.7. Road Networks and the Gross Developed Areas (GDA)

In Hong Kong, Madrid and Vienna, apart from a few expressway connections, the major portion of the EWMR network closely follows the GDA. We have already discussed that the undeveloped areas in these cities are either comprised of unfavourable topographic conditions or are controlled stringently; it is evident that due to these reasons, the undeveloped areas in these cities remain comparatively 'road free'. 'Tokyo-23 Ku' is completely covered by its EWMR network as is a fully developed part of city with ninety-three percent of its area under GDA.



Figure 13. A Recently Built Expressway in Metropolitan Doha. Source: Ashghal.¹¹³

Doha's EWMR network is still evolving based on various proposed and ongoing projects across the city. A closer look reveals that many expressways and major roads are being built outside the existing GDA rapidly facilitating further expansion of GDA. It is evident that the loose, extended and expansive network

¹¹³ Ashghal (PWA), 2019 <https://twitter.com/AshghalQatar/status/1173228092787220481/photo/1>

of roads in Metropolitan Doha is directly proportional to low density urban sprawl and is evidently related to very high vehicular dependency in the city.

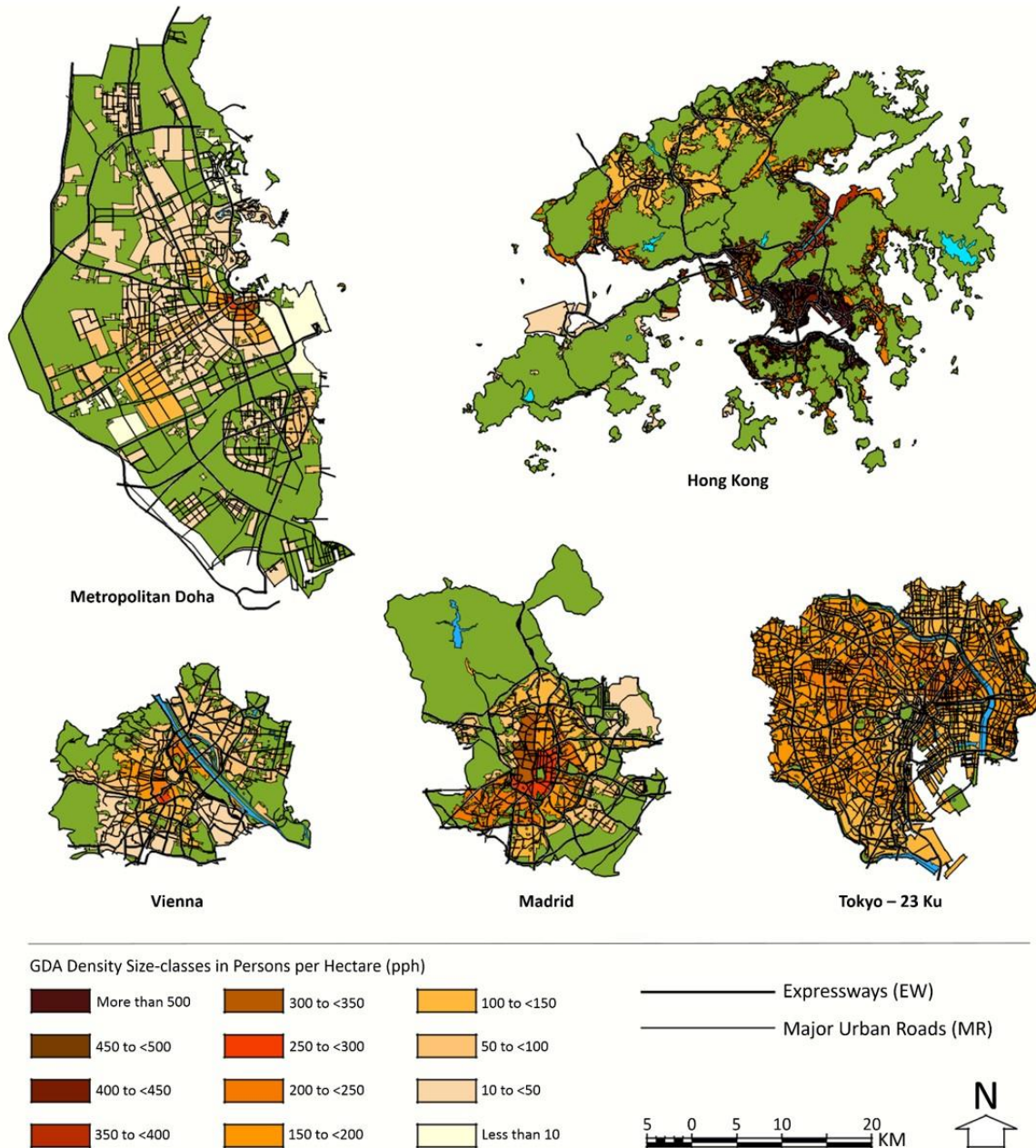


Figure 14. Comparative Assessment of Expressways and Major Urban Roads (EWMR) with GDA in the Selected Cities. Source: Author, prepared based on composite information from several sources¹¹⁴.

4. Summary of Inferences

The summary of inferences from the sections 2 and 3 are enlisted below:

1. MME's QNDF-based centre plans facilitate development of a multi-centred compact and high-density city; some of the planned centres proposes densities surpassing the level prescribed in the QNDF. But the privately developed centres (and areas) lags far behind in densities than the prescribed limit.

¹¹⁴ As in Figure 8 and 12.

2. The size of Metropolitan Doha (1279sqkm) and the designated urbanizable area within it are wastefully large contradicting the compact city policies. Moreover, the designated green belt area is being encroached indicating that the entire Metropolitan Doha to become a further low-density city.
3. Metropolitan Doha is the largest among the selected cities; but its core area is the smallest in size and weakest in population coverage. The sizes of urban core in other cities ranges between 7 to 18 percent (average 11%) of the total areas; the same of Metropolitan Doha is just 1.6 percent. In the other cities, core areas comprise of 19 to 44 percent (average 31%) of the population, while the same in Metropolitan Doha is 12 percent.
4. With the largest area, and population of just 1.9 million, the Metropolitan Doha's overall city level density is only 16pph; it is 2.9 times less than that of Vienna, 3.4 times less than that of Madrid, 4.1 times less than that of Hong Kong and a huge 9.6 times less than that of 'Tokyo-23 Ku'.
5. With very low overall density, Metropolitan Doha comprises of certain core area zones with very high densities; density in Old Al Ghanim (Zone 16), which is 397pph is considerably higher than the city-divisions with highest densities in 'Tokyo-23 Ku', Madrid and Vienna. But high-density zones in Metropolitan Doha are much smaller in size.
6. Metropolitan Doha's entire population can fit into the five districts of Hong Kong's Kowloon Region with just 47sqkm (3.7% of Metropolitan Doha) of area that caters to 2.2 million population (density 477pph). Madrid's seven core districts with just 42sqkm (3.3% of Metropolitan Doha) of area, with a density of 239pph caters to half of Metropolitan Doha's population. Vienna's eleven core districts with 50sqkm (3.9% of Metropolitan Doha) of area contains roughly 30 percent of Metropolitan Doha's population. 'Tokyo-23 Ku's eight central districts with 110sqkm (8.6% of Metropolitan Doha) of area (density of 161pph), contains about 89 percent of Metropolitan Doha's population.
7. Metropolitan Doha's high-density zones are tiny in comparison to rest of the selected cities; a huge 71 percent of land in the city possesses a little more than 500k population with a density less than 10pph (with average 2pph). Another 24 percent of land in Metropolitan Doha caters to 700k population in the zones with a density size-class between 10 and less than 50pph (with average 26pph). These two low-density areas together account for 95% of Metropolitan Doha's area and more than half of its population making the city predominantly a very low-density city.
8. Leaving 'Tokyo-23 Ku', all other cities possess a large proportion of undeveloped land. Hong Kong's Gross Developed Area (GDA) accounts for only 27 percent of its area, Madrid's 35 percent, Vienna's 51 percent and Metropolitan Doha's GDA accounts for 37 percent. The undeveloped area in Hong Kong (73% of total), Madrid (65% of total) and Vienna (49% of total) are under stringent control that prevents sprawl. On the contrary, in Metropolitan Doha, with flat barren land all around and due to conflicting policies, GDA expands in all directions in fragmented form. Metropolitan Doha's current GDA is estimated to be around a huge 503sqkm of land area, which is as large as 87 percent of 'Tokyo-23 Ku's' GDA and 2.4 times larger than that of Madrid and Vienna and 1.7 times larger than that of Hong Kong.
9. With extensive urban sprawl, Metropolitan Doha's Gross Developed Area Density (GDAD) is the lowest of all at 40pph, which is less than half of that of Vienna's, four times less than that of Madrid and of 'Tokyo-23 Ku' and six times less than that of Hong Kong's.
10. Due to limited GDA, GDAD in Hong Kong's core districts is very high (e.g. 875pph in Wong Tai Sin). GDAD in Madrid's core city-divisions is marginally higher than the overall densities (highest in Tetuan at 321pph). On the other hand, GDAD in the core areas of 'Tokyo-23 Ku', Vienna and Metropolitan Doha remain similar to the overall densities as these areas are more or less fully developed.
11. In Metropolitan Doha, leaving a small area in the core, GDAD is low across all the zones. However, comparatively a slightly higher size-classes of GDAD between 50 to 100pph appear in the zones such as Madinat Khalifa (northwest of the core) and towards southeast in the northern part of the Salwa Road, the Industrial Area and in Al Wakra in the south. Rest of the areas have expanded fragmentarily all around with GDAD less than 50pph (with an average of only 19pph).

12. Metropolitan Doha's Gross Developed Area (GDA) of 503sqkm is one of the largest among the selected cities and if its GDA is estimated with its population and GDAD of the other four selected cities, the hypothetical GDA reduces to more than six times to only 81sqkm at the rate of Hong Kong's, to four times at the rate of Madrid's and 'Tokyo-23 Ku' to 129 and 121sqkm respectively and reduces to more than double to 223sqkm at the rate of Vienna's; it clearly reveals Metropolitan Doha's excessive area under GDA as a result of low-density sprawl and a weak core area.
13. About 1450km long 'expressways and major urban roads' (EWMR) in Metropolitan Doha serving a 2 million people is 166km longer than that of Hong Kong's serving 7.3 million people. Again, the Metropolitan Doha's EWMR network is almost seventy percent of the same of 'Tokyo-23 Ku' that serves 9.4 million people. Similarly, it is 1.8 times more than that of Madrid's that serves 3.3 million people and more than double than that of Vienna's serving almost a similar population size.
14. Metropolitan Doha's EWMR network is loosely developed and the EWMR density, i.e. roads in 'kilometre per square kilometre of land' (kmpsokm) is the lowest. However, the EWMR density is closer between Metropolitan Doha (1.1kmpsokm), Vienna (1.6kmpsokm), Madrid (1.3kmpsokm) and Hong Kong (1.2kmpsokm) due to the large proportion of undeveloped area (with minimum roads) in Vienna, Madrid and Hong Kong. On the contrary, the EWMR network of 'Tokyo-23 Ku' is three times denser than that of Metropolitan Doha as 'Tokyo-23 Ku' is fully developed and smaller in size. A more realistic picture emerges when 'EWMR density' in GDA is compared; Metropolitan Doha's EWMR density in GDA is the lowest at 2.9kmpsokm against Vienna's 3.1, Madrid's 3.7, 'Tokyo-23 Ku's 3.6 and Hong Kong's 4.3kmpsokm.
15. Metropolitan Doha's 'EWMR length per capita' at 0.73m is more than four times higher than that of Hong Kong (0.18m), more than 3 times higher than that of Madrid (0.24m) and 'Tokyo-23 Ku' (0.22m) and more than double than that of Vienna (0.34m). Hypothetically if EWMR construction and maintenance cost is considered same in all the selected cities, per capita EWMR construction and maintenance cost in Metropolitan Doha will be higher than all these cities indicating heavy burden on city's exchequer due to low-density levels. Moreover, other civic infrastructure networks of power, telecommunication, water and waste water systems, solid waste provisions, etc. increase proportionately along with the length of road network; indicating higher cost of these provisions and maintenance as well. As EWMR in the cities such as 'Tokyo-23 Ku', Hong Kong, Vienna and Madrid is sufficiently supporting urban activities and good quality of life; therefore, we can identify Metropolitan Doha's EWMR network to be a 'over provision' and a 'burden'.
16. In Hong Kong, Madrid and Vienna, apart from a few expressway connections, the major portion of the EWMR network closely follows the GDA and avoids undeveloped areas. 'Tokyo-23 Ku' is completely covered by its EWMR network as it is fully developed. Doha's EWMR network is still evolving based on various proposed and ongoing projects across the city; many expressways and major roads are being built outside the existing GDA rapidly facilitating further expansion of GDA. It is evident that the loose, extended and expansive network of roads in Metropolitan Doha is directly proportional to low density urban sprawl and is evidently related to very high vehicular dependency in the city.

5. Conclusions: Required Policy Initiatives

It is evident that QNDF, its spatial strategy and other ongoing projects in Metropolitan Doha have created a paradoxical situation by promoting both compact urban centres and low-density sub-urban growth. It is clear from the comparative analysis that the situation is leading to rapid 'urbanization at a rural scale' all around; it is disintegrating the city and making it expensive and unsustainable. QNDF's horizon year of 2032 is approaching and it is now an appropriate time for revising the spatial growth strategies for Metropolitan Doha and look beyond 2032, most reasonably to the horizon years of 2042 and 2052. Worldwide, urbanity is rapidly changing with development of knowledge-based economy, global

competitions, technological changes and from the awareness on requirements of sustainable and resilient development. So, the society, societal behaviour and aspirations are changing with it; it is highly possible that the way citizens of Doha 'changed' and 'adopted' a car-dependent lifestyle in past three decades, the new generation would 'abandon' their cars in coming decades for supporting a more sustainable lifestyle and would prefer a denser and compact Doha. At the same time, recent advancements in technologies from autonomous vehicles to drones and jet packs are going to bring sea change in future urban mobility.

For meeting the challenges of the post-oil-gas economy, a sustainable and resilient urban future is undoubtedly important for Metropolitan Doha. Sustainable economic development ensuring good quality life of the citizens and at the same time, reaching the goals of environmental sustainability currently demand strategizing a compact urban form for Metropolitan Doha. To support that, while on one hand, it is important to take up policies for strengthening the core and on the other, to take up serious control measures for restricting and discouraging further low-density, low-intensity sub-urban growth. It is envisaged that by 2042, with changing circumstances, more and more young people would start preferring to live in the core areas of the city for its vibrancy, attractiveness and quality of services. Therefore, based on the inferences from the section 4, the paper proposes the following:

1. To achieve a compact form (drawing from the comparative study), it is envisaged that by 2042, the population share of Metropolitan Doha's core area should increase from current 12 percent to about 40 to 50 percent of the total. At the same time, assuming a population of 1.5 million and maintaining a core area density of 200pph, the size of the high-density core should increase as well from current 1.6 percent to about 4 to 5 percent (about 60 to 75sqkm) of the current area of the Metropolitan Doha. However, it will be important to fine tune these figures with a detailed study on the possible core area taking in to consideration of various aspects of urban development at the local context.
2. Based on the location of Doha's existing core areas, the current growth pattern, the facilities and amenities, the coast-line and the potentials, it is envisaged that the future high-density core should linearly expand out of the existing one, principally along the metro-red line from Lusail to Wakra. A linear high-density corridor (walkable along the breadth at a range of 300-500m both side of the metro line, possibly with higher intensity surrounding the stations) should be the best suitable and sustainable compact core urban form for the city reducing car-dependency, and increasing public transportation use, walkability and cycling possibilities. The core area can expand in phased manner corresponding to population growth.
3. As a high-density area, the proposed core should be 'residential heavy' as far as use-mixes are concerned. Any new planning regulation should facilitate, and permission system should stringently ensure the required 'minimum residential built-space' in each of the new projects.
4. Current population density in the one of the proposed capital city centres, West Bay, which is the iconic modern CBD of Doha with large concentration of skyscrapers is surprisingly only 15pph. This indicates a disproportionate amount of built-space under the uses other than 'residential'. It is important to reassess the potential residential density and use-mixes in the existing core area and strategically allow conversion of spaces currently under other uses to residential.
5. From the section 2, it is evident that revalidating the centres proposed in QNDF is an urgent requirement; the metropolitan centres such Al Rayyan North and South should be degraded to mere 'facility hubs' as the QNDF's proposed density for a metropolitan centre cannot be achieved in these due to their typical characteristics. At the same time revalidating QNDF's town and district centres proposed within the Metropolitan Doha is important with respect to their location, size, land uses and proposed density levels. The centres and centre plans in the potential core area require readjustments with the core area development strategies and plans.

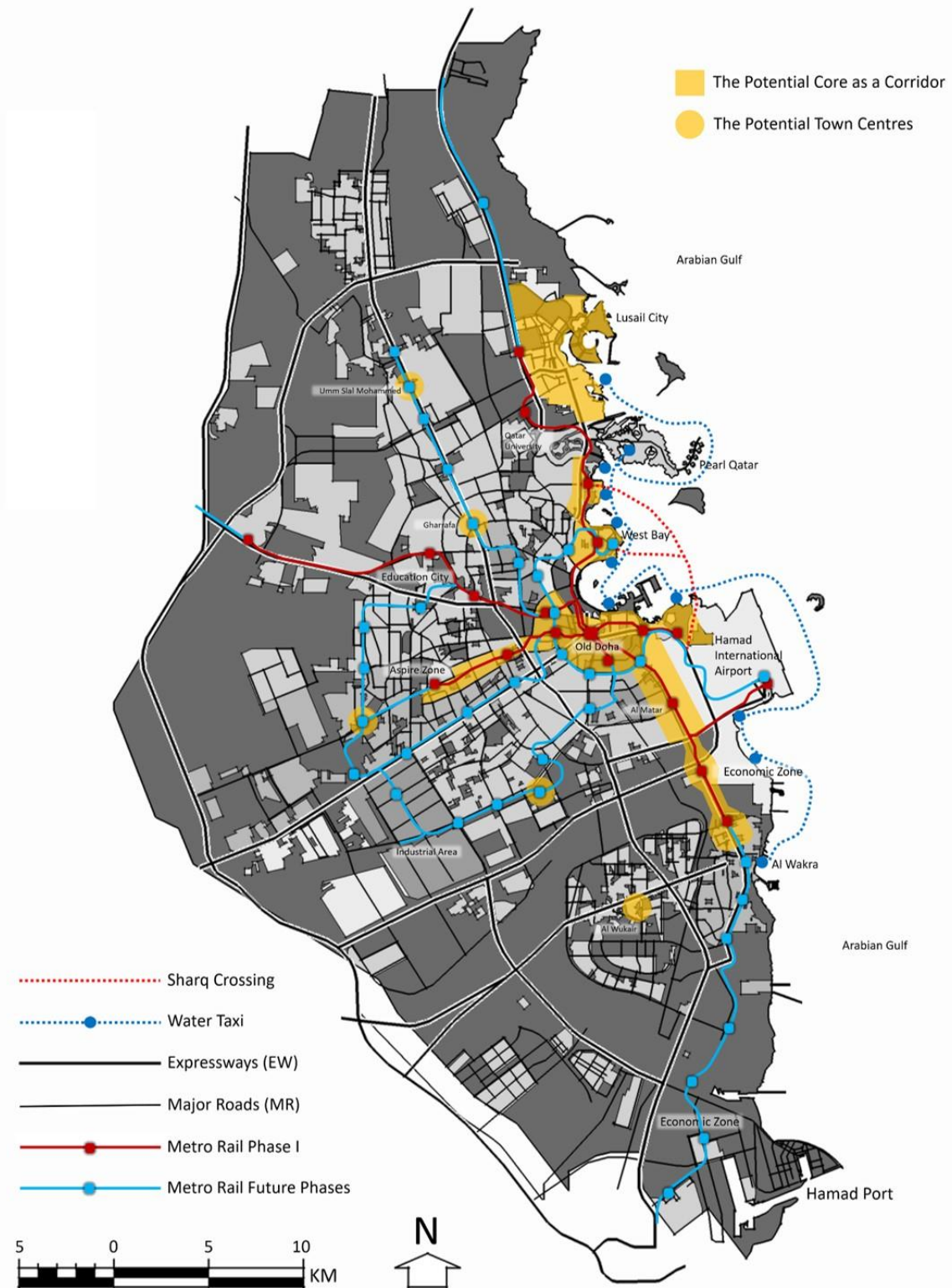


Figure 15. Conceptual Spatial Strategy for Metropolitan Doha 2042 with a High-density ‘Compact Core as Corridors’ Following the Metro Rail. Source: Author, with Metro Rail data from MME-GIS (not all stations are shown).

- The existing greenbelt policy is required to be restudied, and stringent measures are required to be taken to prevent urbanization in the greenbelt zone; at this context, consensus building and increasing co-ordination between various government agencies is equally important.

7. Suburban housing demand (including Qatari housing) and housing policies are required to be realistically assessed and essential measures are required to be taken up restricting further low-density expansion of the residential neighbourhoods.
8. Integrating the existing special zones and the industrial areas with the proposed high-density core through public transportation system is important.
9. Within the core area, walkability and cycling possibility are required to be increased by degrading the highways into 'streets', reclaiming the road-spaces (carriage-way) and by strengthening the public realm. It is possible to convert some of the major roads to one-way, narrowing down the 'carriage-ways', lowering down speed and increasing space under the footpaths, cycle tracks and street plantation. The measures to reduce car-dependency such as application of 'maximum parking standards' to limit parking spaces in the central areas, introduction of autonomous electric passenger carriers, introduction of a water taxi system along the coast connecting all the major nodes, introduction of low-cost tram systems connecting the low-density neighbourhoods to the core areas etc. should be considered.
10. It is also important to deviate 'through-traffic' from the central areas by implementing transportation projects such as the Sharq Crossing while limiting traffic capacities on the roads in the urban centres.
11. Limit further expansion of the expressways and highway network outside Metropolitan Doha's GDA.
12. The core areas should be the 'priority areas' for future investments in employment generation activities, residential real estate and civic infrastructure.

6. Further Research Possibilities

It is envisaged that this paper, as a base work, is to encourage further studies covering various aspects those could assist in transforming Metropolitan Doha into a compact city. Some of these could be:

1. Studies on core area development strategies with its spatial limits and density, transportation and infrastructure strategies,
2. Studies on core Doha's proposed compact form and transit-oriented development (TOD),
3. Studies on neighbourhood planning strategies for the inner neighbourhoods in the core area,
4. Detailed studies on social, economic and environmental benefits of developing Metropolitan Doha as a compact city,
5. Studies on the sub-urban areas and possibility of various forms of public transport,
6. Studies on impact of special zones and industrial areas on Metropolitan Doha's urban form,
7. Socio-psychological studies on younger generations' preferences in living in high-density core areas,
8. Studies on social housing strategies with respect to urban form, etc.

It is believed that the paper has brought forward the critical issues related to Metropolitan Doha's spatial growth, current strategies and urban form, and have provided sufficient justifications for adopting a 'compact city' model to transform the city in to a sustainable and resilient one during the post-oil-gas economy in the future. The paper is intended for conveying 'the message' to the researchers, planners and decision makers for taking up of further studies, and planning and policy initiatives in this direction.

7. References

Adham K. (2011) 'Rediscovering the island: Doha's urbanity from pearls to spectacle' in Elsheshtawy Y. (ed.) The evolving Arab city, tradition, modernity and urban development. First paperback edition. Routledge, Oxfordshire and New York: 218-257

Al Muftah H. (2016) 'Demographic policies and human capital challenges' in Tok M., Alkhater L., Pal L. (eds.) Policy-making in a transformative state. Palgrave Macmillan, London. Available at:

https://doi.org/10.1057/978-1-137-46639-6_10 (Accessed: 01-09-2021)

Al-Thani, S. K., Amato, A. Koç, M. and Al-Ghamdi, S. G. (2019) 'Urban sustainability and livability: an analysis of Doha's urban-form and possible mitigation strategies', *Sustainability* 2019, 11, 786; doi:10.3390/su11030786 (Accessed: 03-09-2021)

Azzali S. (2015) 'The impact of rapid motorization and urban growth: an analysis of the city of Doha, Qatar', *The Arab World Geographer / Le Géographe du monde arabe* Vol 18, no 4 (2015) 299-309. Available at:

http://meridian.allenpress.com/awg/article-pdf/18/4/299/1449197/1480-6800_18_4_299.pdf (Accessed: 28-05-2021)

Bibri S. E., Krogstie, J. and Karrholm, M. (2020) 'Compact city planning and development: Emerging practices and strategies for achieving the goals of sustainability', *Developments in the Built Environment* 4 (2020) 100021. Available at: <https://doi.org/10.1016/j.dibe.2020.100021> (Accessed: 29-05-2021)

Breheny, M. (1996) 'Centrists, decentrists and compromisers: views on the future of urban form' in Elizabeth Burton, Mike Jenks, Katie Williams (eds.), 'the Compact City A Sustainable Urban Form? E & FN Spon.

Statistics of Tokyo (2019) 'Households and population based on the Basic Resident Register 2019 / First year of Reiwa', Bureau of General Affairs Department of Statistics, Tokyo Metropolitan Government Available at: <https://www.toukei.metro.tokyo.lg.jp/juukim/2019/jm19010000.htm> (Accessed: 18-08-2021)

Burton E. (2002) 'Measuring urban compactness in UK towns and cities', *Environment and Planning B: Planning and Design* 2002, volume 29: 219-250. DOI:10.1068/b2713 Available at:

<https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.456.9918&rep=rep1&type=pdf> (Accessed: 23-08-2021)

CEC (1990) 'Green paper on the urban environment', Communication from the Commission to the Council and Parliament, European Union, Brussels. Available at:

<https://op.europa.eu/en/publication-detail/-/publication/0e4b169c-91b8-4de0-9fed-ea286a4efb7/language-en> (Accessed: 27-08-2021)

CEC (2011) 'Cities of tomorrow: challenges, visions, ways forward'. Luxembourg: Publications Office of the European Office, Commission of the European Communities. Available at:

https://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/citiesoftomorrow/citiesoftomorrow_final.pdf (Accessed: 28-08-2021)

City of Madrid (2021) 'Population by district and neighbourhood' in Data Bank, Statistical Information Areas, originally from Municipal Register of Inhabitants (Provisional Data), Available at: <http://www-2.munimadrid.es/TSE6/control/seleccionDatosBarrio> (Accessed: 16-07-2021)

City of Vienna (2005) 'Urban development plan Vienna 2005' Short Report. Available at: <https://www.wien.gv.at/stadtentwicklung/strategien/step/step05/download/pdf/step05kurz-en.pdf>

(Accessed: 12-07-2021)

City of Vienna (2019) 'Population and surface of Vienna's municipal districts 2019' originally from Statistics Austria, Available at: <https://www.wien.gv.at/english/administration/statistics/population-district.html> (Accessed: 12-07-2021)

City of Vienna (2021) 'City map' in ViennaGIS, Available at: <https://www.wien.gv.at/stadtplan/en/> (Accessed: 12-07-2021)

Dantzig, G. and Saaty, T. L. (1973) 'Compact city: a plan for a liveable urban environment', W.H. Freeman and Co., San Francisco.

Dempsey, N., Brown C., Raman S., Porta S., Jenks M., Jones C., Bramley G. (2010) 'Elements of urban form', in Jenks M. and Jones C. (eds.) Dimensions of the Sustainable Cities, Springer, London, 21-51.

Díaz-Pacheco J. and García-Palomares, J. C. (2014) 'Urban sprawl in the Mediterranean urban regions in Europe and the crisis effect on the urban land development: Madrid as study case', Urban Studies Research Volume 2014. Available at: <http://dx.doi.org/10.1155/2014/807381> (Accessed: 28-08-2021)

EAC-Hong Kong (2019) '2019 district council constituency boundaries index map', Plan No. DCCA/R/2019/Index, 1. Index Map in District Council Ordinary Election Constituency Boundaries. Electoral Affairs Commission, the Government of the Hong Kong Special Administrative Region, Available at: https://www.eac.hk/en/distco/2019dc_elect_map.htm (Accessed: 14-07-2021)

Environment Bureau, Hong Kong (2016) 'Hong Kong biodiversity strategy action plan 2016-2021'. Environment Bureau, the Government of the Hong Kong Special Administrative Region. Available at: http://www.afcd.gov.hk/english/conservation/Con_hkbsap/files/HKBSAP_ENG_2.pdf (Accessed: 24-08-2021)

Furlan R., Petruccioli A., Major M. D., Zaina S., Zaina Sa., Al Saeed M. and Saleh D. (2019) 'The urban regeneration of West Bay, business district of Doha (State of Qatar): A transit-oriented development enhancing livability', Journal of Urban Management, 8 (2019): 126-144. Available at: <https://doi.org/10.1016/j.jum.2018.10.001> (Accessed: 03-09-2021)

Glaeser, E. L. (2011) 'The triumph of the city: How our greatest invention makes us richer, smarter, greener, healthier, and happier'. New York: Penguin Press.

Jenks, M. and Williams K., and Burton E., (1996) 'A sustainable future through the compact city? Urban intensification in the United Kingdom'. Environments by Design. 1. 5-20. Available at: <https://www.researchgate.net/publication/293314926> (Accessed: 27-08-2021)

Kropf K. (2009) 'Aspects of urban form', Urban Morphology, 13 (2), 105-20 © International Seminar on Urban Form, 2009 ISSN 1027-4278 Available at: http://www.urbanform.org/online_unlimited/pdf2009/200913_105.pdf (Accessed: 29-08-2021)

LD-Hong Kong (2021) 'Hong Kong geographic data (include area by district council)' in Resources, Mapping Information as of October 2020, Lands Department, the Government of the Hong Kong Special Administrative Region Available at: <https://www.landsd.gov.hk/en/resources/mapping-information/hk-geographic-data.html> (Accessed: 02-08-2021)

Lim, H. K. and Kain J. (2016) 'Compact cities are complex, intense and diverse but: can we design such emergent urban properties?' Urban Planning (ISSN: 2183-7635) 2016, Volume 1, Issue 1, Pages 95-113 Doi: 10.17645/up.v1i1.535 (Accessed: 28-08-2021)

Lusail City (2021) 'The city of a lifetime', Available at: <https://www.lusail.com/the-city-of-a-lifetime/> (Accessed: 05-08-2021)

Lützel R. (2008) 'Population increase and "new-build gentrification" in central Tōkyō', Erdkunde, December 2008 DOI: 10.3112/erdkunde.2008.04.02 (Accessed: 13-08-2021)

Makido Y., Shandas V., Ferwati S. and Sailor D. (2016) 'Daytime variation of urban heat islands: the case study of Doha, Qatar', Climate 2016, 4, 32. Available at: doi:10.3390/cli4020032 (Accessed: 03-09-2021)

MME-Qatar (2014) 'Qatar national development framework' (QNDF). Ministry of Municipality and Environment, Qatar

MME-Qatar (2021), 'Boundary of Metropolitan Doha and zones within' QNMP GIS'. Ministry of Municipality and Environment, Qatar

Msheireb Properties, (2021) 'About Msheireb Downtown Doha, Master Plan', Available at: <https://www.msheireb.com/msheireb-downtown-doha/about-msheireb-downtown-doha/master-plan/> (Accessed: 05-08-2021)

OECD (2012) 'Compact city policies: a comparative assessment, OECD Green Growth Studies'. OECD Publishing, Paris, France.

PSA-Qatar (2012) 'Registered vehicles and motor cycles by type of license 2008-2012' Table 348 in Annual Statistical Abstract 2012 Issue, Planning and Statistical Authority, Qatar. Available at: <https://www.psa.gov.qa/en/statistics1/StatisticsSite/Pages/StatisticalAbstract.aspx> (Accessed: 27-08-2021)

PSA-Qatar (2015) 'Population Chapter 2015' in Statistics: Population Archive, Planning and Statistics Authority, Qatar. Available at: <https://www.psa.gov.qa/en/statistics1/pages/topicslisting.aspx?parent=population&child=population> (Accessed: 01-08-2021)

PSA-Qatar (2019) 'Registered vehicles and motor cycles by type of license 2015-2019' Table 79 in Annual Statistical Abstract 2019, Issue 39th: 546, Planning and Statistical Authority, Qatar. Available at: <https://www.psa.gov.qa/en/statistics1/StatisticsSite/Pages/StatisticalAbstract.aspx> (Accessed: 27-08-2021)

Population By-census 2016 HK (2017) 'Table No. A201a, Population by district council district and year', By-census Results, Main Tables, Release date 27-02-2017, the Government of the Hong Kong Special Administrative Region. Available at: <https://www.bycensus2016.gov.hk/en/bc-mt.html> (Accessed: 02-08-2021)

Qatar Gas (2021) 'About us, history'. Available at: <https://www.qatargas.com/english/aboutus/history> (Accessed: 26-08-2021)

Qatar Petroleum, (2021) 'About QP, QP history'. Available at: <https://qp.com.qa/en/AboutQP/pages/qphistory.aspx> (Accessed: 26-08-2021)

Rizzo, A. (2014) 'Rapid urban development and national master planning in Arab Gulf countries', Qatar as a case study, Cities, Vol. 39: 50-57, Available at: <http://dx.doi.org/10.1016/j.cities.2014.02.005> (Accessed: 28-05-2021)

Shaaban, K. and Radwan E. (2014) 'Rebuilding the transportation system in the city of Doha', Journal of Traffic and Logistics Engineering Vol. 2, No. 3, September 2014. Available at: doi: 10.12720/jtle.2.3.241-247 (Accessed: 28-05-2021)

Shandas, V., Makido Y., and Ferwati S. (2017) 'Rapid urban growth and land use patterns in Doha, Qatar: Opportunities for Sustainability?' European Journal of Sustainable Development Research, 1(2), 11. doi: 10.20897/ejosdr.201711 (Accessed: 28-05-2021)

UN (2015) 'Goal 11: Make cities inclusive, safe, resilient and sustainable' in Sustainable Development Goals. United Nations. Available at: <https://www.un.org/sustainabledevelopment/cities/> (Accessed: 29-08-2021)

UNEP (1987) 'Our common future report of the world commission on environment and development'. United Nations Environment Programme. Available at: <https://digitallibrary.un.org/record/133790?ln=en> (Accessed: 29-08-2021)

UN Habitat (2011) 'The economic role of cities'. United Nations Human Settlements Programme, Nairobi. Available at: <https://unhabitat.org/economic-role-of-cities> (Accessed 27-08-2021)

UN Habitat (2012) 'Leveraging density: urban patterns for a green economy', United Nations Human Settlements Programme, Nairobi. Available at:

<https://unhabitat.org/leveraging-density-urban-patterns-for-a-green-economy> (Accessed: 28-08-2021)

UN Habitat (2014a) 'A new strategy of sustainable neighbourhood planning: five principles' Discussion Note 3, Urban Planning, United Nations Human Settlements Programme, Nairobi. Available at:

<https://unhabitat.org/a-new-strategy-of-sustainable-neighbourhood-planning-five-principles-0>
(Accessed: 28-08-2021)

UN Habitat (2014b) 'The economics of urban form: a literature review', United Nations Human Settlements Programme, Nairobi. Available at:

<https://unhabitat.org/the-economics-of-urban-form> (Accessed: 28-08-2021)

UN Habitat (2015) 'Issue paper on urban and spatial planning and design'. Nairobi, Kenya: United Nations Human Settlements Programme 2015. Available at: https://uploads.habitat3.org/hb3/Habitat-III-Issue-Paper-8_Urban-and-Spatial-Planning-and-Design-2.0.pdf (Accessed: 27-08-2021)

Wiedmann, F., Salama A. M., Thierstein A. (2012) 'Urban evolution of the city of Doha: an investigation into the impact of economic transformations on urban structures', METU Journal of the Faculty of Architecture, Volume 29 Issue 2: 35-61. DOI: 10.4305/METU.JFA.2012.2.2 Available at:

https://pure.strath.ac.uk/ws/portalfiles/portal/38618741/Urban_evolution_of_the_city_of_Doha_Wiedmann_Salama_Thierstein_35_61_8_.pdf (Accessed: 03-09-2021)

Williams, K. (2014) 'Urban form and infrastructure: a morphological review', future of cities: working paper, review commissioned as part of the UK Government's Foresight Future of Cities Project, Government Office for Science. Available at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/324161/14-808-urban-form-and-infrastructure-1.pdf (Accessed: 29-08-2021)

Yeh, A. G. O. (2011) 'High-density living in Hong Kong', Essays, Urban Age, November 2011. Available at: <https://urbanage.lsecities.net/essays/high-density-living-in-hong-kong> (Accessed: 27-08-2021)

Živković, J. (2019) 'Urban form and function' in Leal F. W., Azeiteiro U., Azul A., Brandli L., Özuyar P., Wall T. (eds.) Climate Action. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-71063-1_78-1
