URBAN MORPHOLOGY AND HISTORIC LANDSCAPE MANAGEMENT: THE CASE OF KOLKATA

Mahbub Rashid

INTRODUCTION

Urban morphology is an area of geographical study that explores patterns of urban form and structure. For several decades now, urban morphological studies have used different cartographic and geometric concepts, methods and measures to describe the significance of urban landscape in relation to physical, functional, and social processes. "Town plan analysis" and "space syntax" are two important approaches in urban morphological studies. The focus of the first approach is on the visible urban form. It uses different cartographic techniques to describe and understand the nature and amounts of change in urban landscape viewed over long time spans, the agents involved in the process of change, and the issues related to the conservation and management of that change. In contrast, the focus of the second approach is on the invisible urban structure. It uses different topological and topo-metric properties of urban street networks to describe the historical, economic, sociological, psychological, and behavioral significance of urban landscape. Therefore, these two approaches could complement each other for a better understanding and management of historic urban landscape.

The purpose of this chapter is twofold – to briefly describe the concepts, methods and measures of town plan analysis and space syntax; and to apply some of these concepts, methods and measures to the historic core of Kolkata in West Bengal, India illustrating the usefulness of these approaches for the understanding and management of historic urban landscapes (HULs). Using town plan analysis, the study traces the historical development of the morphology of the city showing how the city had come into existence and changed over time, and how its various components are fitted together creating a historically significant morphology. Using space syntax, the study traces changes in the structures of street networks of the city over time, and the effects of these structural changes on the distribution of land use and landmarks in the city. The study concludes that urban morphological studies can be a useful way to explore the processes of formation and change of HULs and to formulate appropriate strategies for their management.

"Town Plan Analysis" and "Space Syntax": Two Urban Morphological Approaches

Town Plan Analysis

The "town plan analysis" is a morphological approach, first developed by M. R. G. Conzen, for geographical studies involving urban landscape. In his seminal work on Alnwick (Conzen 1960), Conzen defined town plan (also ground plan or urban layout), land uses, and building fabric as the three basic elements of urban landscape, and discussed their relative importance for urban morphological studies. He argued that urban morphological change is a complicated process due to differential rates at which town plan, buildings, and land use alter their character in keeping with ever-changing functional needs of society. In general, land and building use is subject to relatively rapid changes, while actual building structures are less so (though functional modifications will be frequent) and the urban layout, as defined by streets, open spaces and plots, proves usually to be the most resistant to change. Therefore, he considered the confinement of later developments within preexisting morphological conditions, primarily defined by urban layouts, as one of the fundamental laws in urban landscape studies.

In his work on Alnwick, Conzen introduced several morphological concepts, such as *urban fringe belt*, *burgage cycle*, *morphological frame*, *morphological region,* and *morphological period*. The fringe belt, in simple terms, is a zone of largely extensive land uses that is formed at the edge of an urban area during a pause in outward residential growth. With different shapes and sizes, fringe belts often follow field or rural property boundaries. They include considerably larger plots, less hard surfaces and fewer roads than normal residential developments. As a result, they are less permeable to traffic (Whitehand and Morton 2003, pp. 828-31). Fringe belts generally have many relatively open areas, often vegetated, such as parks, sports grounds, public utilities and land attached to various institutions.

Also called building intensity cycle (Conzen 1978), Conzen's concept of burgage cycle (a burgage being the landholding of enfranchised member of a medieval borough) consists of a phase of progressive infilling of a burgage, followed by a phase of clearing of buildings, and then by a phase of urban fallow that forms the initial stage of a succeeding redevelopment cycle. In studying burgages, Conzen used metrological analysis as an essential technique to reconstruct the histories of plots. For example, by analyzing the measurements of plot width of Alnwick , Conzen was able to infer the original widths of the plots and their subsequent subdivisions (Conzen 1960). Later, Slater (Slater 1981, 1990a), among others, used the technique in the English town of Ludlow to detect regularities in plot widths and patterns, and to speculate about the intentions of the medieval surveyor when the town was laid out.

Conzen's morphological frame corresponds to antecedent plan features or topographical outlines that exercise a morphological influence on subsequent urban developments. In contrast, Conzen's morphological region is an area with a particular form that provides a sense of unity and makes it distinguishable from surrounding areas. His morphological period is a timespan within which the morphology of a region remains relatively unchanged (Whitehand 2001).

It is important to note that significant developments and refinements of Conzen's concepts and methods have occurred over the last several decades, exploring his important concepts: fringe belts (Barke 1990, Whitehand 1975, Larkham 1995), morphological regions (Whitehand 2007), and morphological periods

(Whitehand and Carr 2001). Beyond these, at least three important lines of research have stemmed directly or indirectly from Conzen's ideas, which are concerned with (1) the nature and amounts of change in physical space viewed over long time spans, and thus generally focused on historic towns, (2) the agents involved in the process of change, and (3) the conservation and management of that change (Larkham 2006).

Through the historical analysis of medieval English towns, the studies of the first research line show that these towns often have complex town plans, composed of plan units reflecting separate periods or origins of development. These studies also show similarities in form and process between towns (Slater 1990b). Some of these studies also allow reinterpretation of problematic historical and archeological issues (Lilley 1994). While most of these studies have been done at the scale of individual towns and quarters, a few studies have also been done comparing settlement plan types (Roberts 1987) and morphogenesis at the regional scale (Lilley 1995, 1999).

Focusing on industrial-era cities, the studies of the second research line explore how and why landowners including the church and aristocratic families affect urban landscape (Lilley 1994, 2001, Slater 1978, 1987); landownership patterns affect the conversion of agricultural land to urban use (Hooper 1985); suburban developments vary in form and character over space and time (Beresford 1988, Cannadine 1982, Trowell 1985); and why and how economic, political and social history affect urban landscape (Rodger 2001, Youngson 1966). Several studies along this line of research also explore the complex decision-making processes involved in various developments (Freeman 1990, Whitehand and Whitehand 1984); and the role of specific types of agent in the development process (Larkham 1995, 1988).

Studies of the third line of research explore the use, adaptation, and conservation of commercial and residential areas (Whitehand and Carr 2001). These studies note that urban landscape has increasingly become controlled by large-scale developers, and legislative, planning, and other public bodies (for example, see (Bramley and Kirk 2005)). They also note that development control decisions taken by planning authorities or bodies have put less emphasis on the subtle historic qualities of urban landscape, and put more emphasis on building density and highways guidelines (Whitehand 1992).

In summary, Conzen's town plan analysis provides a comprehensive approach for analyzing the interplay between the historical, social and functional processes and urban landscape. However, in addition to being methodologically cumbersome, Conzen's morphological approach is unable to take into account how we may perceive, use and experience urban landscape. In this regard, space syntax can help, which I describe next.

SPACE SYNTAX

Space syntax refers to a body of theory, methods, techniques and measures that can be used in the morphological analysis of urban landscape focusing on its 'hidden' structures of perception, use and experience. Since the 1970s, a substantial body of research has used space syntax to study urban morphology and its effects of social and historical processes (Hillier [1996] 2007, Hillier and Hanson 1984). Space syntax often uses the phrase 'spatial configuration' referring to how individual spatial units are related to each other and to the whole in a spatial system. Among different spatial units space syntax uses, *axial lines* representing straight lines of movement and visibility and *segments* representing the parts of axial lines broken at the points of intersections with other lines have been used most frequently in

urban morphological studies. A configuration of axial lines or segments is important because humans tend to move in straight lines and along routes with few changes in directions to minimize effort and time and to maximize movement economy.

Space syntax provides rigorous techniques to represent a spatial system as configurations using axial lines and segments, which are called the axial map and the segment map of the system. It also provides techniques to analyze the intersecting patterns of the lines or segments using various graph-theoretic (or, syntactic) measures. Additionally, space syntax allows users to color the map based on the syntactic values of individual units. Using its methods, techniques, and measures, space syntax is able to study how different rigorously-defined elements of the spatial configurations of urban landscape are connected to each other at different scales, as well as how they are connected to social processes of long and short durations. Space syntax methods and measures have been applied to cities, districts, neighborhoods, and even to individual buildings to characterize their underlying syntactic structures. In several historical studies on urban morphology, space syntax has been used to describe and understand the relationships between the structures and the functions of urban landscape. For a review of some of these studies, see (Peponis and Wineman 2002, Rashid 2019, Rashid 2017).

Integration is the most important centrality measure of space syntax when applied to the axial or segment map analysis of space syntax. The integration value of an axial line has been defined based on the shortest routes between the line and all of the other lines in the network (defining "shortest" in terms of the fewest changes in direction) (Hillier [1996] 2007). *Choice* is another important centrality measure of space syntax. While integration is about closeness, choice is about betweenness. Unlike integration, choice gives the degree to which a line lies on simplest paths from one line to another line in the network (Turner 2007).

Relevant to the analysis of HULs is the fact that space syntax methods and measures can provide experientially relevant descriptions of various intangible qualities of urban landscape that are often inaccessible to historians. Using space syntax, many have studied the evolution of street networks within broad national and international historical contexts (Medeiros, de Holanda, and Trigueiro 2003, Medieros, de Holanda, and Barros 2009, Shpuza 2009); the changes in street networks in relation to movement and land use, often with a focus on historical urban areas (Azimzadeh and Bjur 2007, Karimi 2000, Rashid and Shateh 2012, Read 2000, Rashid and Bindajam 2015); and the extent to which street networks serves to materialize and mediate socio-economic differentiation and status in different historical periods (de Holanda 2000, Vaughan et al. 2005, Zhu 2004).

In summary, Conzen's town plan analysis and space syntax focus on different morphological properties of urban landscape. While the former uses metrical properties to study the street systems, building fabric, and land use patterns of urban landscape, the latter uses topological and topo-metric properties of street networks to study the experiential structure of the same. Complementing each other, they have the capacity to provide a much richer description of the history of changes in urban landscape. Therefore, in the rest of this chapter, these methods and measures will be used in a morphological study of the HUL of Kolkata in West Bengal, India to identify issues relevant to its heritage planning and management. Before that, Kolkata's history and built heritage are briefly described.

A Brief History of Kolkata and Its Built Heritage

The Indian City of Kolkata, the capital of West Bengal, is located in the eastern part of India, adjacent to the borders of Assam, Sikkim and Bangladesh (Bunting, Kundu, and Mukherjee 2002). Kolkata has been an important center for art, literature, architecture and cultural heritage in India for more than three centuries now. It was once the capital of British India, but in 1911 it lost that status to Delhi for political and geographical reasons. Despite its lost political status, with a population of approximately 14.11 million, Kolkata remains the third most populous city in India, 13th most populous, and 8th largest urban agglomeration city in the world (Office of the Registrar General & Census Commissioner 2011). Its population density has increased from 2,039 persons per sq. km in 1971 to 3,879 persons per sq. km in 2011 (Bunting, Kundu, and Mukherjee 2002).

Kolkata started as a trade settlement of the British East India Company in 1690 in and around the villages of Kalikata, Sutanuti and Govindapur on the eastern bank of the Hoogly River. By 1706, the settlement had a population of 22,000. At that time, there were two notable streets and at least eight permanent brick houses (also known as *Pucca* houses) and 8000 temporary mud houses with a thatched roof (also known as *Kutcha* houses). The early stage of urbanization of the city started seriously with the construction of Fort William in 1707, which was later replaced by another much larger fort located to its south with the same name. A wharf was added next to the old fort in 1710 (Ghosh 1996).

To satisfy the ever-expanding needs, the Company bought another thirty-eight villages from the Zamindars in 1717. Of these, five were on the other side of the river (in Howrah), while the rest were contiguous to the three previously acquired villages. As the settlement increased in size, it became clearly divided into two parts: the white or English areas developed based on a mercantile economy, and the black or native areas developed based on a more traditional Indian bazaar economy. By 1756, the number of *Pucca* houses increased to 498 and *Kutcha* houses to 14,450, and there were no less than 27 major streets and 52 minor streets. The British dug a canal, called Maratha Ditch, in 1742 to protect Kolkata. Eleven km in circumference, it defined the boundary of Kolkata at the time (Ghosh 1996, Cotton 1907). (**Figures 1a & b**)

The city experienced its first town planning development, as Lord Clive laid the foundation of the new Fort William in the village of Gobindapur in August 1757, after the British rule in Bengal was established. The new fort, built between 1758 and 1773, was the largest British citadel in South Asia. With increased safety and security, soon Kolkata became the principal *entrepôt* of trade between the Gangetic Plain, Britain, and Canton. By the end of the eighteenth century, some £5,000,000 worth of exports were flowing through the port (Marshall 1985/2012). In recognition of the city's new-found importance, Kolkata replaced Madras in 1773 as the political capital of British India. It retained this position until the transfer of government to Delhi in 1911, which was noted earlier.

Throughout the nineteenth century, migrants from the rest of the subcontinent and native Bengalis settled in Kolkata for the irresistible economic promises provided by its factories, banks, brokerages, agency businesses, and trades in such goods as grains, seeds, tobacco, perfumery, joss-sticks, cloth, jute, bullion, and silver. By the end of the 18th century, the population of the city had risen to 140,000. In 1837, with a population of 229,714, Kolkata was the most populous city in India. In 1850, the population of the city was 413,182. By the end of 19th century, the population had increased to 949,144 (Hornsby 1997).

In the nineteenth century Kolkata, the settlement pattern that emerged followed the lines of religion, caste, ethnicity and nationalities. In contrast to the earlier period, when Kolkata was divided into the white and native areas, the nineteenth century Kolkata saw the development of grey areas between these zones, which were occupied by ethnic groups like Parsis, various other non-Indian Asian immigrants, and mixed-blood Eurasians who occupied socioeconomic status between the British rulers and the ruled Indian masses (Kosambi and Brush 1988a).

Nevertheless, during this period of unprecedented population growth, Kolkata never had more than few thousand European inhabitants. In a nineteenth century map of the city (**Figure 1c**), the English zone in the center is shown as having spacious grace and splendor – laid out as a great capital should be, with authority. Next to the English zone, densely built native areas with irregular networks of narrow streets are shown on the north and east sides. On the western side of the city remains the Hooghly River. On the southern side, the map shows open lands, which were later developed as suburban areas. Around the whole city Mahratta Ditch, which later became Circular Road, is shown. Beyond the Ditch lay low-lying marsh lands (**Figure 1c**). By the mid twentieth century, however, the city had grown far beyond its 19th century boundaries adding mostly residential and industrial areas around its peripheries on both sides of the river (**Figure 1d**).

As shown in the maps (**Figure 2a**), the central area of the English zone of the city contains a huge open space, called the Maidan, with Fort William at its south-east corner. Completed in 1780, the Maidan provided an opportunity for the city to express its newfound status in more visible forms rivalling the status of any contemporary city (Davies 1985, Roy 1970, Sen 1960). Besides its long riverside promenade, meandering pathways, gardens, and statues, the Maidan would soon include the Victoria Memorial Hall, the St. Paul's Cathedral, the Ochterlony Monument, a race course, and a cricket field, as a comparison between the 1857 and 1957 maps of the area shows.

Another set of map shows the Esplanade, which includes most of the great public colonial buildings of the city, in the northern part of its central business district (**Figure 2b**). In this area, very little change is observed from 1857 to 1957.

Side by side with its many imposing public buildings, many villas were built far out in suburbs like Chowringhee, Baliganj, Rasa Pagla (Tollyganj), Garden Reach, and Chitpur by the English as well as by the rising native rich class. Some of these areas like Chowringhee were dominated by the English, while others like Chitpur were dominated by the natives. Together, they made Kolkata 'a city of palaces'. In all these residential areas, there might have been a significant increase in building density from 1857 to 1957, as shown in the maps of Chowringhee (**Figure 2c**).

Besides residential and monumental public buildings, a wide variety of religious structures, public and private memorials, and educational and cultural institutions were also built in Colonial Kolkata, contributing to a variety of built heritage. In essence, Colonial Kolkata, as shown in the maps (**Figures 1 &2**), embodies Europeans ideas of planning, townscape and layout in its English parts, imposed on a scale that no other colonial city in South Asia had observed before. Side by side, it also embodies a mostly native built heritage created by different ethnic groups that by now formed Kolkata's society. This native built heritage shows very little similarities to its English counterparts, except the fact that large houses in both parts often show some external affinities despite having distinctly different interiors (Losty 1990) .

MODERN TOWN PLANNING AND KOLKATA'S BUILT HERITAGE

Throughout the twentieth century, Kolkata has been losing its historic identity and gaining the character of a generic city of a developing country due to rapid urbanization and a general ignorance concerning its built heritage (Bose 2016). Deplorable hygiene resulting from tremendous urban growth and developments has also compelled the municipal and state governments to undertake many primary infrastructural improvement projects in the city. Unfortunately, as these governments undertook development projects, they did not see the built heritage of the city as an important part of its history. Therefore, it also did not see a need for developing the city according to an overall plan saving parts of its built heritage.

It was only in the late 1990s that a need to preserve the city's built heritage was recognized by policy makers. The West Bengal Government set up an 'Expert Committee on Heritage Buildings' (Dutta, Banerjee, and Husain 2005). The objective of this Committee was to review the lists of heritage buildings already published in different Land Use and Development Control Plans of the Kolkata Metropolitan Development Authority (CMDA). The Committee used historical, physical, and socio-cultural-economic criteria to categorize buildings; and identified 1300 buildings and sites following this categorization. So far, the state government restored only a few government-owned buildings, and a few private buildings were restored by their owners. The HUL of Kolkata along with numerous other non-listed but historically important buildings still remain neglected (Bose 2016).

Now in the early part of the twenty first century, the urban conditions of Kolkata are made worse under the impacts of a fast-rising global economy. Large investments in real estate development associated with new economic opportunities have led a construction boom in Kolkata. The development of high-rise residential buildings, office buildings, commercial buildings, shopping centers, multiplexes, and many other construction projects have gradually gained momentum with little or no consideration for the built heritage of the city. As a result, Kolkata is seeing a categorical demolition and erosion of the historic and old ordinary buildings, settings and open spaces. From April 2005 to March 2010, the total number of building proposals approved for construction in the municipal corporation area alone was 17,819 with a total area of 9.46 million sq. m (Bose 2016). Uncontrolled and incompatible modifications of historic buildings and their surroundings, as well as the gradual development and encroachment of slums and squatter settlements in historic areas have also posed as great threats for Kolkata's HUL. Therefore, there is an urgent need to save Kolkata's HUL. In this regard, the significance of a traditional heritage planning approach that focuses on old buildings and sites cannot be undermined, but we must also acknowledge that Kolkata's HUL represented and still represents a way of life, an experience that can only be preserved if considered as a whole in relation to history, society, culture, and place.

AN ANALYSIS OF THE MORPHOLOGICAL EVOLUTION OF KOLKATA'S HUL

To understand Kolkata's HUL as an urban landscape, I study the growth and evolution of its urban morphology in this section of the chapter. For my morphological study, I collected several maps of Kolkata prepared and/or published in the following years: 1742, 1753, 1756, 1784, 1832, 1838, 1842,

1849, 1852, 1854, 1858, 1893, 1901, 1911, 1914, 1924, and 1957. After a careful consideration of the contents of these maps, I divided the urban morphological history of the city in three different phases:

- The first morphological phase began in 1690 with the founding of the city. It ended in 1772 when Kolkata became the capital of British India. The 1742, 1753, and 1756 maps represented this morphological phase.
- The second morphological phase began in 1772 and ended in 1876 when the Victorian era in India was formalized by the Queen's assumption of the title Empress of India. The 1784, 1832, 1838, 1842, 1849, 1852, 1854, and 1858 maps represented this morphological phase.
- The third morphological phase began in 1876 and ended in the 1950s when the city had gained some political and social stability after the British had withdrawn from Colonial India and when the post-colonial phase of the city had truly begun. The 1893, 1901, 1911, 1914, 1924, and 1957 maps of Kolkata represented this phase of the city.

Using techniques similar to Conzen, first I study how street grids, as morphological frames, helped define the form of Kolkata's HUL overtime. Following this, I study how land use patterns had changed over time to understand the evolving functional organization of the city. Then, I study how the distribution of landmarks had changed over time to understand the shifting imageability of the city. After this, using Space Syntax I study the evolving structure of experience of Kolkata's HUL defined based on accessibility and visibility. Finally, I study the interrelationships among streets, land use, landmarks, accessibility and visibility within the evolving morphology of the city. My overall aim is to find ways to understand and preserve Kolkata's built heritage through maintaining stronger whole and parts relationships; retaining functionality and imageability; and improving accessibility and visibility within Kolkata's HUL.

STREET GRIDS

The three stages of the street grids of Kolkata's HUL, established from the maps of the city identified above, are shown in **Figure 3**. The street map representing the first morphological phase shows that, after almost 80 years of its founding, Kolkata remained a small settlement with a very few streets. The two of the three early villages that formed the settlement were only minimally connected with the central village of Kalikata (later Calcutta and now Kolkata).

The street map representing the second morphological phase shows that the city had grown substantially along the East bank of the Hoogly River within a hundred years after the first morphological phase (**Figure 3**). The primary streets of the first phase had persisted in the second phase, but they were now extended to serve an area 6 to 7 times larger than what it was during the first morphological phase. Secondary streets had filled in the grid defined by the primary streets of the earlier phase. As the map shows, both primary and secondary streets had extended beyond the initial boundaries of the city.

During the third morphological phase, the primary street grid of the earlier phases continued to persist within Kolkata's HUL. However, many more secondary and neighborhood streets were added in this phase increasing the density of streets both within and beyond the HUL. One thing to note here is that changes in density did not occur uniformly everywhere in the city. The English parts of the city, as shown in **Figure 3,** changed less than the native areas of the city, which overtime became more irregular and complex.

As shown in **Figure 3**, a grid defined by a set of primary streets of the early settlement had continued to serve as a morphological frame defining Kolkata's HUL throughout its history. Therefore, this grid should be considered as an important part of Kolkata's built heritage.

LAND USE PATTERNS

The three stages of land use of Kolkata's HUL established from the maps of the city are shown in **Figure 4**. According to the land use map representing the first morphological phase, the English areas of the city remained small. The area contained only a few buildings – the port, the old fort, the Governor's House, a church, a warehouse, open spaces, ponds, batteries and several English houses. Outside the English areas of the city, but within a perimeter defined by Maratha Ditch and fortified walls, were lands covered with vegetation and numerous sporadic small native structures (not shown in the land use map). These native structures were connected by networks of irregular paths. Beyond the Martha Ditch were irregular farmlands. Even at this early stage of development, the distribution of land use showed a radial pattern, where the center was occupied by the English and their buildings surrounded by native quarters on the north and the east. On the south side of the English area, the city had an open space, which would eventually become a part of a huge open park, known as the Maidan of the city (**Figure 4**). Just like a typical fringe-belt, the Maidan included and continue to include considerably larger plots, less hard surfaces, and fewer roads than normal residential developments. These plots were used as parks, sports grounds, public utilities, and as public institutional buildings, just in the way Conzen envisioned the functions of a fringe belt (Conzen 1960).

Even though the radial land use pattern continued to exist in the second morphological phase, a few differences need to be mentioned. With many more buildings, the central zone of the English area of the city now had taken the form of a more familiar central business district (CBD) that commonly characterized a European mercantile city. The CBD contained almost exclusively European types of commercial, managerial, and administrative activities (**Figures 2 & 4**). Located on the immediate north and west of the CBD were the English residential areas. Beyond this area were the much larger native residential areas. On the south of the CBD were the new fort and the Maidan. Also on the south, beyond the native residential quarters, another English residential area with a regular street layout and independent residences was founded. Many have argued that this isolated residential area away from the CBD was an early instance for suburban living that would become a common phenomenon in Europe and America much later (Bowden 1975, Hornsby 1997). It should be emphasized that early European suburbanization occurred in India at a time when typical modes of transportation were horses, pony-drawn carriages, ox-drawn carts, and palanquins carried by coolies. (Kosambi and Brush 1988b)

In the third morphological phase, the radial land use pattern of Kolkata grew by adding an industrial layer on its periphery (**Figure 4**). Therefore, in this phase the principal components of the city included the fort adjacent to the commercial waterfront, an open space around the fort, a CBD at the center of the city, separate European and native residential sectors close to the CBD, separate European and native commercial areas, a grey residential area for a population of mixed origin between European and native residential areas, and a peripheral manufacturing/industrial zone adjoining the native sector. In general, during this phase the growth of native quarters was remarkable. It expanded in a compact fashion either inside or outside the old limits of the city and close to the waterfront when and where possible. Separate English and native residential suburbs were formed at distances of two to five miles from the nucleus of the city. While some of the older suburbs became dense by the end of this phase (**Figure 4**), in general the

new suburbs continued to be sparsely built with large houses in contrast to the very densely populated native quarters within the city core. Already at this stage of development, industrial employment produced congested rental housing and squatter settlements close to the native quarters and industrial suburbs of the city.

During this third morphological phase, Howrah on the west bank of the Hoogly River also observed significant growth and land use changes with a new industrial zone next to the bank (**Figure 10**). Because Kolkata had no space for large manufacturing plants, Howrah, where the railroads from northern, central, and southern India had their terminals, was the favored location for these plants. Manufacturing in Howrah included food processing, jute textiles, chemicals, shipbuilding, and heavy steel fabrication. Immediately next to this zone, a native residential zone also developed on this side of the river.

In summary, Kolkata showed a shifting radial land use pattern with a growing CBD wrapped around by layers of different land uses that gradually decreased in rent value from the center to the periphery of the city. This was a common phenomenon in most mercantile cities of Europe and America, but what was uncommon about Kolkata was the fact that that it had separate English and native areas with a grey area in between; that the morphology of its English and native areas were driven by different economic systems – the former by a mercantile economy, while the later by a traditional bazaar economy; and that the density of native quarters in this city was much higher than that of English areas. It is possible that such a disposition of land uses might have made the city unique in terms of function and experience and, therefore, should be considered carefully as a feature of Kolkata's built heritage.

LANDMARKS
Figures 3 & 5 show the distribution of landmarks in the city during the three morphological phases of the city. These landmarks include important administrative, commercial, institutional and religious buildings of different types. One thing to note here is that these landmarks do not include residential buildings. As 'a city of palaces', there were simply too many very large residential buildings to be included in these figures.

According to the figures, there were at least a dozen landmarks in the city during the first morphological phase. They included, among other things, the port, the old fort, the Governor's House, a church, a warehouse, a park, and several batteries. They were all located along the primary streets in or near the central area of the settlement.

During the second morphological phase, the city possessed over two dozens of landmarks. Again, except a few, these landmarks were located next to each other in the central area of the settlement. Outside the central area, landmarks were located along the primary streets in areas that were not adjacent to the fort or the central area of the city.

During the third phase, the number of landmarks was over one hundred. According to figures, though the central area had the highest concentration of these landmarks, a majority of them were located elsewhere within Kolkata's HUL. By this time, a few landmarks were also located beyond Maratha Ditch, which by now was a major street of the city, and on the other side of the river. These distant landmarks indicate that the growth of the city by this time were no more dependent on the commercial and administrative functions of the CBD or on the security provided by the fort.

Overall, the findings of this study indicate that the changes in the patterns of distribution of landmarks might have been related to the changes in the primary street grid of the city. As these streets gradually extended beyond the boundaries of the city of an earlier phase, so did the distribution of landmarks. Therefore, an important character of the built heritage of Kolkata's HUL might have been the fact that the experience of Kolkata's HUL in different phases of development might not have been dependent only on its primary street grid and land use patterns, but also on its shifting imageability defined by an increasing number of landmarks.

ACCESSIBILITY AND VISIBILITY

For this part of the study, the axial maps of the three morphological phases of Kolkata were analyzed using Space Syntax. The syntactic structures of the street network of the city in each of its three morphological phases, thickened using integration values, are shown in **Figure 5.** In essence, these maps show how each street of the city were connected to all the other streets of the city in terms of accessibility and visibility. In these maps, thicker lines have higher integration than thinner lines.

As can be seen in the figure, during the first morphological phase the most integrated lines of the maps were located in and around the central area of the settlement. During the second morphological phase, some highly integrated lines remained directly connected to the central area of the city, while other highly integrated lines were found along the old perimeter of the city where Maratha Ditch was located. The syntactic structure of the city also highlights the fact that during this phase the city was divided into two separate parts by the river – the streets of the main part of the city on the eastern bank were generally more integrated than those on the western bank of the river.

Finally, during the third phase a bridge was built connecting the two parts of the city on the opposite sides of the river. The bridge changed the syntactic structure of the eastern side of the city less than the syntactic structure of the eastern part of the city. In the latter case, a syntactic center was created by a set of highly integrated lines right next to the bridge, where there was none in the earlier phase.

Therefore, our study reveals that the most integrated lines in each of the three morphological phases of the city had existed in and around the CBD of Kolkata's HUL. As the city grew and changed, so did the shape of the syntactic structure of the city. It is possible that the syntactic structures of the city have changed once again since 1957. From a heritage planning perspective, however, it is important that we remain careful not to change the syntactic structures of the HUL in any significant ways. Such changes can affect movement and, consequently, everyday life in the HUL.

MORPHOLOGICAL INTERDEPENDENCIES

Morphological interdependencies are long term processes defining the effects of different morphological features on each other. Such interdependencies are important, because short-term social processes are rarely sufficient to explain long term morphological changes. Our study reveals strong interdependencies among primary streets, land use patterns, landmark locations, and street integration patterns in all three morphological phases of Kolkata's HUL. Such interdependencies are indicated by the fact that, during all three morphological phases, the primary streets of the city were among the most integrated streets, and important landmarks and commercial land uses of the city were located along these streets (**Figures 3-5**). Additionally, as evident in the figures, the city grew along the most integrated streets. Furthermore, though not shown in the maps, most shopping streets and traditional bazaars were located on most

integrated streets, and residential quarters on less integrated streets of the city. It should, however, be noted that while the morphological elements and syntactic structures of the city changed as the city grew, their patterns of interdependencies did not change. Using Jane Jacobs (Jane 1961), one could argue that such interdependencies are important for urban vitality and liveliness. Therefore, it is necessary that we continue to preserve such interdependencies where they exist, and try to re-establish them where they might have been broken due to careless urban developments.

CONCLUSIONS

In historic cities of developing countries, like Kolkata, urban conservation or urban heritage planning is rarely a priority. Here, financial constraints, a lack of political will, a lack of cooperation among different stakeholders, and a preference to progress and development over preservation and conservation are among many difficult problems that need to be solved before the conservation, preservation and management of HULs could become a priority. However, the purpose of this chapter was not to explore how these prevalent problems could be solved, but to show how various techniques of urban morphological analysis could help us understand the significance of HULs in cities, such as Kolkata.

Many have already used and/or suggested urban morphological analysis as a way to determine strategies for the management of HULs (Jokilehto 1998, 2009, Whitehand and Gu 2010, Whitehand 2012, Whitehand 2007). This study has been different from the previous studies, because it has tried to combine multiple existing morphological approaches to augment our understanding of HULs in general and of Kolkata's HUL in particular. Conzenian morphological approach was useful, because it allowed us to take a comprehensive look at the morphological history of HULs using well defined morphological elements and concepts. Space syntax was useful for its flexible techniques, which were used to study the growth of the city based on the connectedness, accessibility and visibility of its street networks. They were also used to describe the whole and the parts relationships showing how the connectedness, accessibility and visibility of streets at one location could change due to changes in streets at other locations in the city (for example, the bridge connecting the two parts of the city), and why it might not be a good idea to treat individual buildings or sites independent of their morphological contexts in heritage planning and management.

It is fair to say that this study has not taken the full advantage of what Conzenian and space syntax approaches have to offer in terms of urban morphological analysis. They include many more concepts, techniques and measures than what have been used here in this study. With regards to the Conzenian approach, of the three basic elements of urban morphology, my focus was more on town plan and land use and less on building fabric. Among the important Conzenian concepts, I have used the Conzen's concepts of morphological frame and period at some length. I have used fringe belts, morphological region, and morphological units in a limited way, and have not used burgage cycle at all. Based on the previous studies, we can safely assume that these unexplored concepts would also have strong relevance to a study of HUL anywhere, anytime.

With regards to space syntax, my study was limited to the study of syntactic structures defined using the axial map analysis of Kolkata in its three morphological phases. Space syntax provides many more techniques – each describing different configurations of urban morphology. Several previous studies have indicated that these other techniques are useful for describing the historical, social, and cultural processes

of the city. Yet, I have not taken advantage of these techniques. While I have used integration to measure the connectedness, accessibility, and/or visibility of different axial lines of Kolkata's HUL, I also have not used numerous other measures such as choice, control, and entropy that could have been used to get further insights on the syntactic structures of this HUL. Therefore, I ask interested readers to consult the references cited earlier in this chapter for additional information on Conzenian and space syntax approaches to urban morphological analysis.

Nevertheless, using Conzenian and space syntax approaches in a limited way, this study has revealed that the growth and evolution of Kolkata's HUL was defined and/or controlled by a grid of primary streets that evolved from a much smaller grid of the first English settlement of Kolkata when it was a trading post. It has also revealed that in the earliest phase Kolkata was clearly divided into the English and the native parts. The division became increasingly blurred with grey areas as the city continued to grow. However, a radial pattern of land use—where the center was occupied by a CBD, the periphery by native quarters, and the in-between area by the English and the people of mixed origin—had persisted in different forms throughout the morphological history of Kolkata. The city had also included some of the earliest examples of suburban developments. Concerning landmarks, the study has revealed that these were not distributed randomly in the city. Instead, most of them were located on the primary street grid in the central area of the city. They continued to spread outward as the street grid continued to grow outward from the center, but the center continued to have the highest concentration of landmarks. Finally, the study has revealed that while some of the most integrated streets were always located in the central area of the city, the other more integrated streets continued to change locations as the city continued to grow. First, they stretched out from the central areas to the periphery of the HUL along the street that replaced Maratha Ditch. Then, they stretched out to the other side of the river along the bridge. In each phase, the locations of the most integrated lines were correlated with the direction of growth, the land use patterns, and the locations of landmarks of the city showing morphological interdependencies.

In essence, streets, land use, landmarks, and accessibility and visibility were uniquely related to the growth of Kolkata, giving its HUL a distinct character in terms of morphological history. To eliminate any historical morphological characteristics in the name of development and progress may destroy the unique qualities of this HUL, as it has been done during the last fifty to sixty years. It is vital that any management plan of the built heritage of the city consider these and other morphological characteristics of the city in developing appropriate heritage management strategies.

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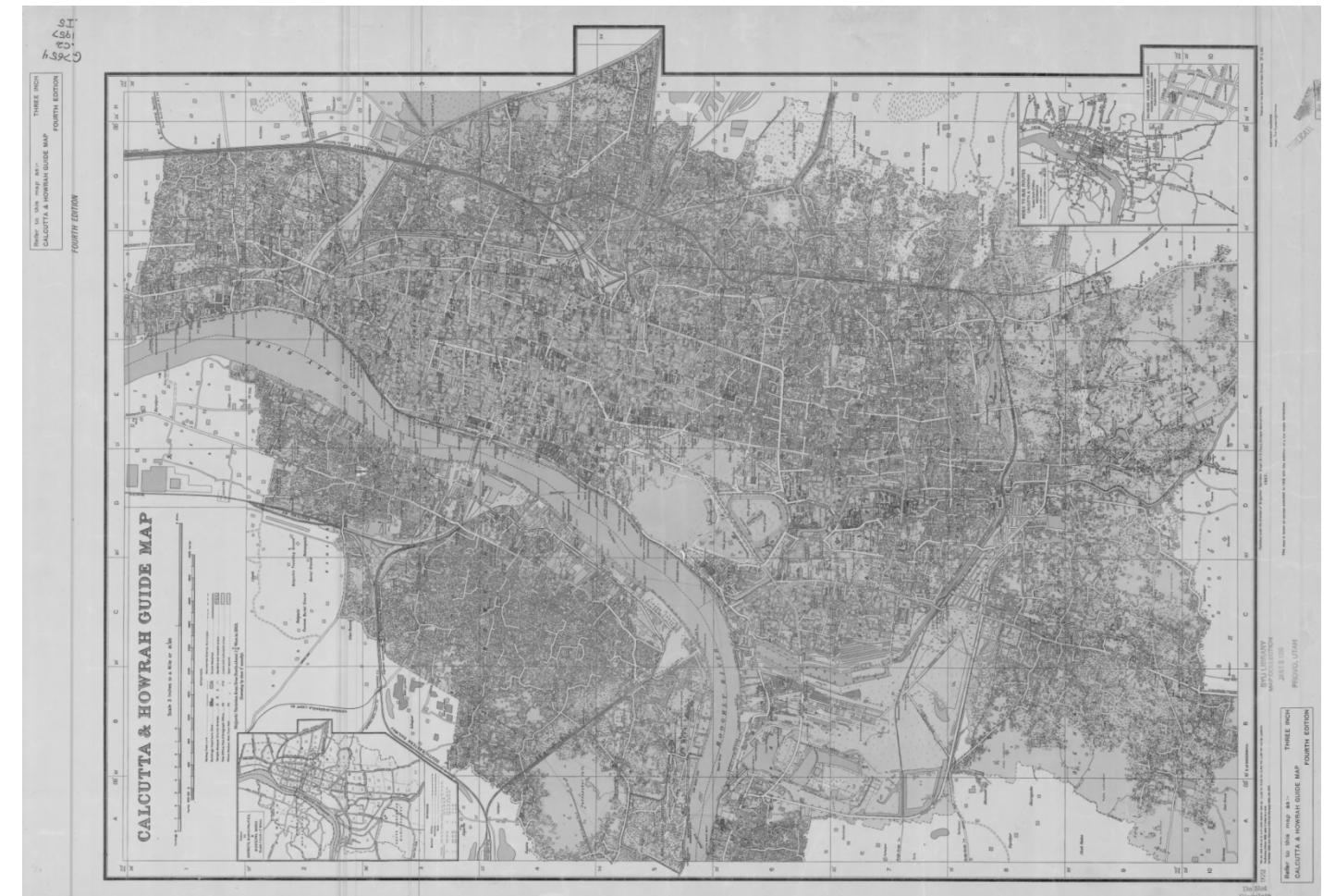Zhu, J. 2004. *Chinese spatial strategies: imperial Beijing, 1420-1911*. London: Routledge Curzon.
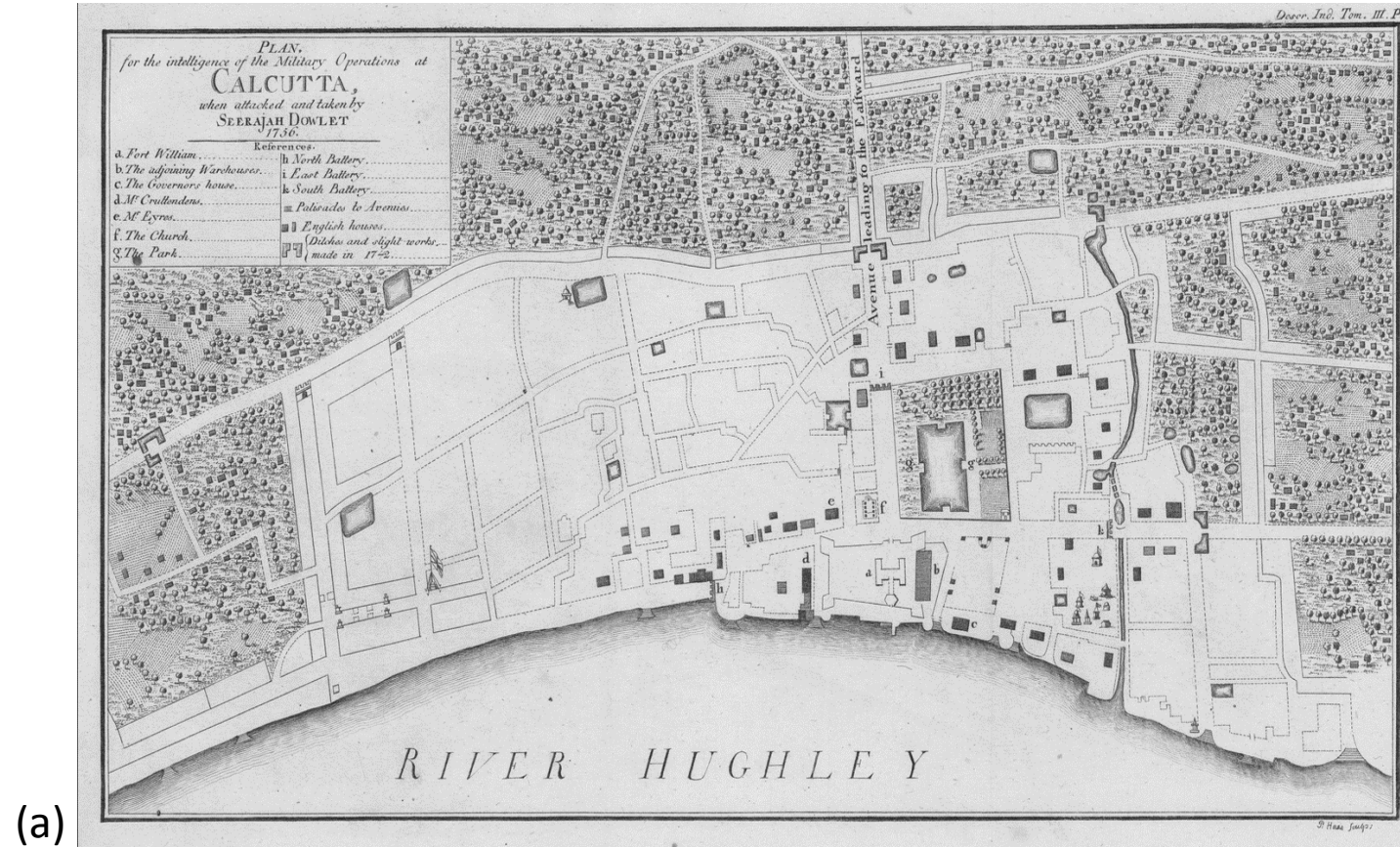
Figure 1: Maps of Kolkata. (a) Plan for the intelligence of the military operations at Calcutta, when Attacked and Taken by Seerajah Dowlet, 1756. Downloaded from http://catalogue.bnf.fr/ark:/12148/cb40723610s. (b) Thomas Kitchin's map of Calcutta, first issued in 1763. Downloaded from https://www.raremaps.com/gallery/detail/48750/territory-of-calcutta-mdcclvii-surveyor-general-of-india . (c) A nineteenth century map of Kolkata (Simms, F. W., Thuillier, H. L., Smyth, R. & J. & C. Walker. (1857) *Map of Calcutta from actual survey in the years -1849*. [Published by John Walker, Geographer to the Honble. East India Co., Jany. 20th] [Credit: Library of Congress, Geography and Map Division. https://www.loc.gov/item/2005634004/.] (d) A twentieth century map of Kolkata and Howrah (Calcutta and Howrah Guide Map of 1957. Fourth Edition. Published by the Surveyor General of India based on surveys executed in 1943 with the addition of a few minor corrections. (Copyright information (a), (b), & (d) is not available.)
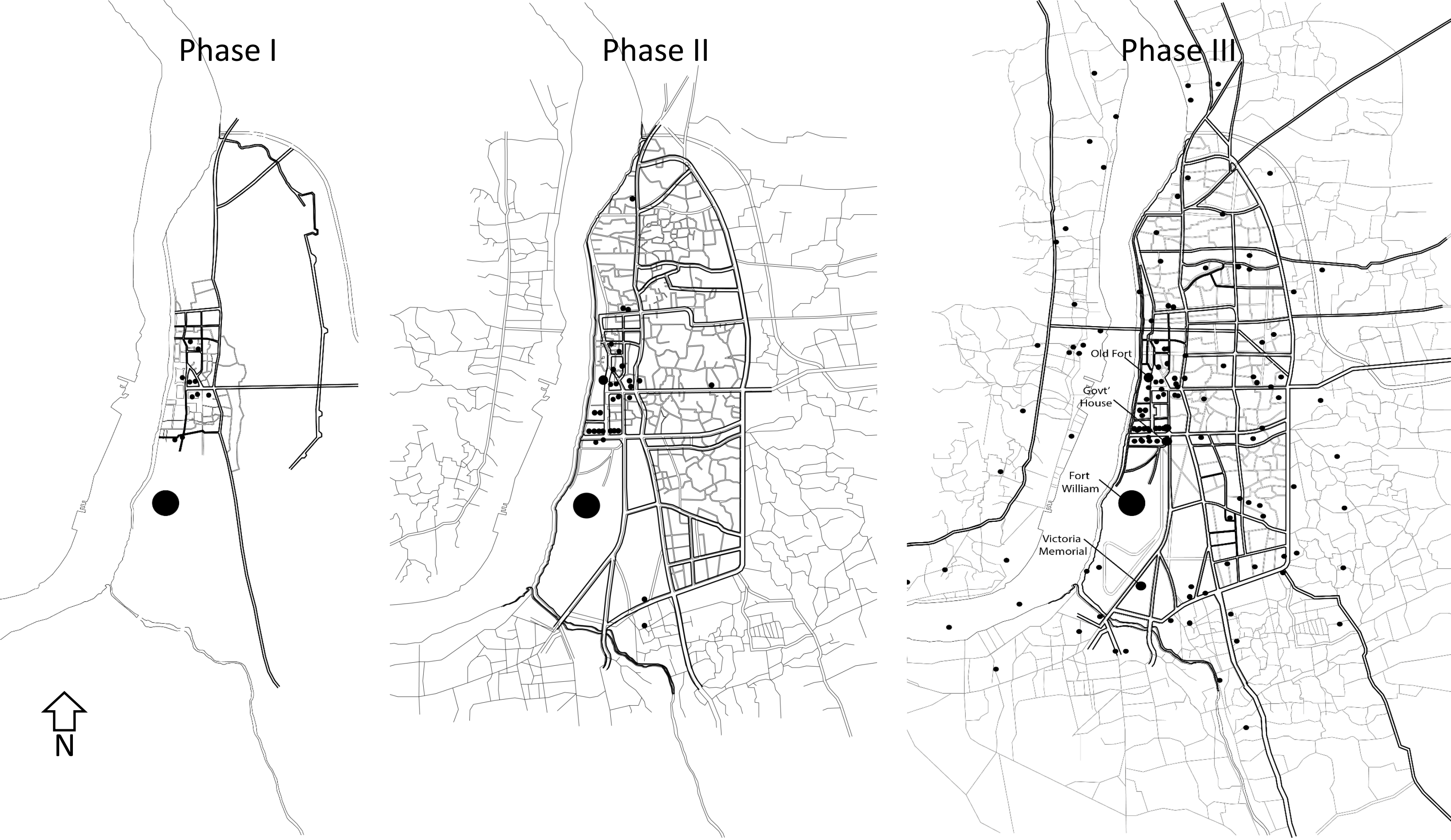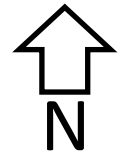
Figure 2: 1857 and 1957 maps of Kolkata areas, enlarged from Figures 1c & 1d. (a) The Maidan of Kolkata. According to these maps, significant changes were made in the upper and lower right corners of the Maidan. Even though not shown in the 1957 map, the fort remained unchanged during this period. (b) The central business district of Kolkata with the Esplanade. According to these maps, the district changed very little during this period. (c) An English suburban (Chowringhee) development. The regular street layout of the area was very different from the irregular street layout of native areas. The maps show that numerous independent structures were added in the area during the period.

Figure 3: The street systems, the primary street systems (in darker lines), and the landmarks in different morphological phases of Kolkata. According to these diagrams, most landmarks were placed on or close to the primary streets of the city.

Phase I

Phase II

Phase III

Maidan

N

Original port

Indian residential areas

English & European residential areas

Hybrid Anglo-Indian residential areas

Green spaces

Central business district (CBD)
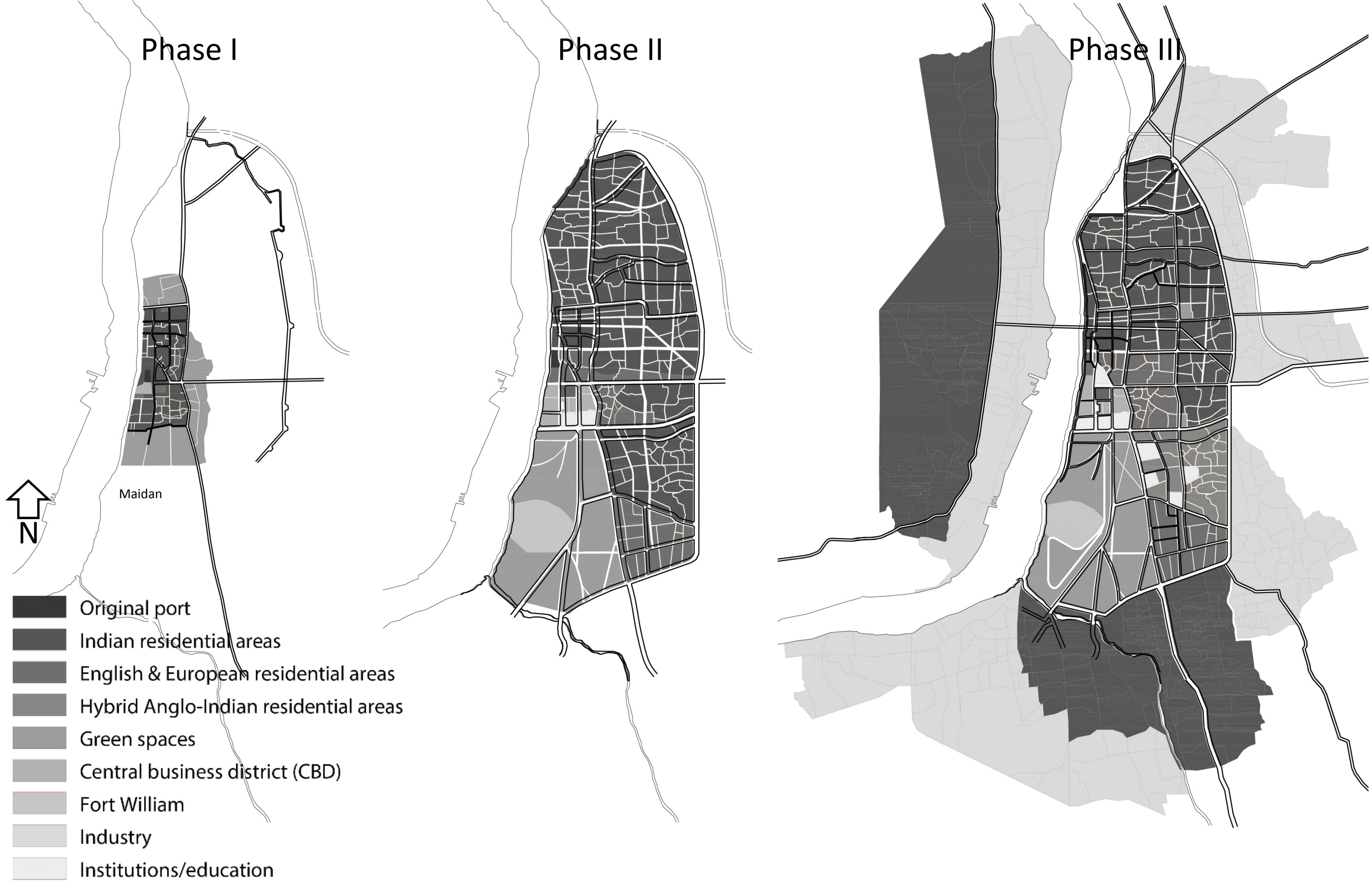
Fort William

Industry

Institutions/education

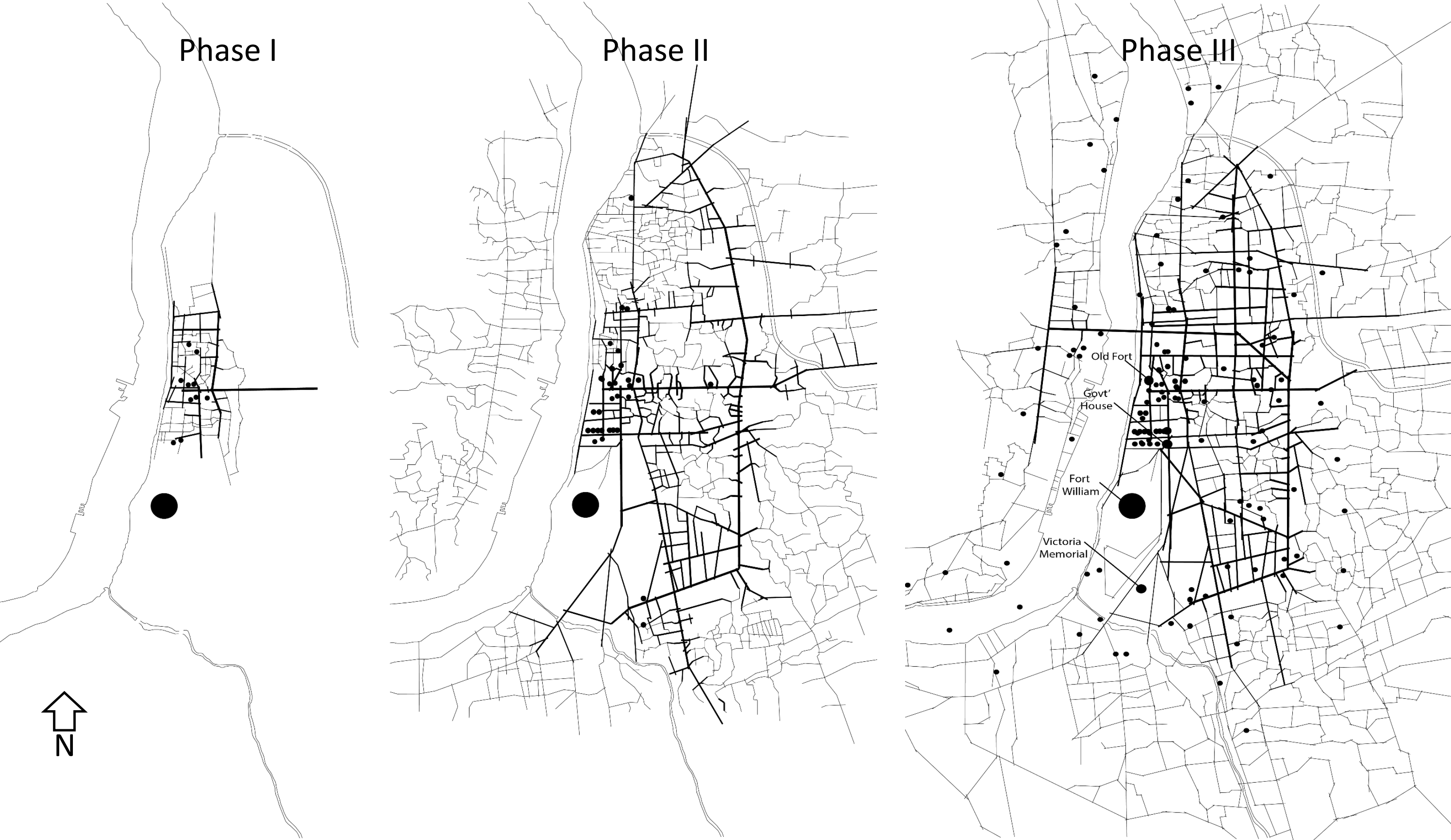Figure 4: The land use patterns in different morphological phases of Kolkata.

Figure 5: Landmarks in the axial maps of different morphological phases of Kolkata. In these maps, thicker lines represent higher integration values than the thinner lines. According to these diagrams, most landmarks in the city were placed on or close to the lines with high integration values.