Strengthening the morphological study of informal settlements

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Neglected? Strengthening the Morphological Study of Informal Settlements

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Abstract

Methods of articulating the morphological structure of slums can have considerable potential in better planning for site-specific design or policy responses for these areas in the contemporary city. Although urban morphology traditionally studies landscapes as stratified residues with distinct divisions between lot and boundary, built and unbuilt, the authors find these definitions insufficient to address the complexity of slum morphology. Through this article, the authors' identify that morphological analysis of informal settlements needs to be sensitive to the dynamics and the absence (or blurring) of physical boundaries. By analyzing the spatial impact of social, economic, and political factors, situational and site factors, building typologies, and configurations of circulation space, an attempt to articulate the morphological structure of slums is made. Aiming to overcome the current polarization in the literature between the formal and informal city, this article adds to the ongoing research on the study of challenges within contemporary cities, by providing new methodologies for studying the morphology of slum urbanization and shaping planning practice.

Keywords

urban landscape, urban morphology, informal settlements, slum housing, housing, built landscape, urban mapping, informality, urbanity

No Longer Invisible: Expanding on Morphological Patterns of Study to Bridge Broader and Informal City Analysis

The world is now an urbanized planet with 95% of the urban population growth predicted to occur in cities of the developing world by 2045. One of the challenges of rapid urbanization in the 20th century is the burgeoning growth of urban poverty and slums, both spatially and demographically. Currently, one third of the global urban population lives in slums (UN-Habitat, 2003), with this number predicted to increase, causing an "urban tsunami" (Forman, 2008). Although many of these areas are considered "unplanned" or fringe areas, these peripheral urban landscapes are characterized by houses built on land for which the ownership is typically in question. The urban form is traditionally called spontaneous, irregular, informal, illegal, or squatter settlements. Although the study of slums has been predominantly focused on policy, housing and land tenure, and urban poverty, analyzing their morphological distinctiveness adds considerable potential to planning for site-specific design or policy responses (including mobility, access, and services) for these areas in the contemporary city.

Although informal settlements can be seen as a response to certain socioeconomic conditions (UN-Habitat, 2003), they are also tied to factors such as the growth limit of the broader city (built-up area) and the terrain and steepness of land and building conditions (Appadurai, 1996; Benton, Castells, & Portes, 1989; C. Gilbert & Vines, 2000). Within informal settlements, the blurring of boundaries between questionable property ownership and right of use, access to infrastructure and hazardous site, function and form, and public and private spaces, introduces a set of dynamics that existing methods of morphological study do not sufficiently address. If informal settlements are potential sites of future city growth, more attention should be paid to their distinct morphological characteristics. As an established field of study, urban morphology expanded on three broad geographical differentiations within the broader city (Conzen, 1958; Whitehand, 2009). First, the separation of function, form,

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and location; second, the physical and socioeconomic characteristics of the areas within which urban development and change take place, influencing the form of what is added or changed in terms of units of property ownership (Ward, 1982); third, the association with certain "morphological periods" (Conzen, 1960). Within the field of urban morphology, these three broad patterns of analysis (including the role of geographical differentiation through lot lines) has long been acknowledged (Conzen, 1958, 1960, 2004; Whitehand, 1992, 2009). Despite the development of methodologies to study the urban form (Gauthier & Gilliland, 2006; Sima & Zang, 2009; Whitehand, 1992, 2009), we find that the study of morphology of informal settlements has been largely neglected. More so as, the morphological models were developed in regions with long-established, precise legal property delineation that could be legally protected and clearly were not developed to explain ambiguities of spatial ownership of developing world slums. This article identifies the complexity of spatial forms of slums and methods through which morphological structure of slums can be articulated.

To study informal settlements and their morphology while extending and adapting the existing methods as developed by Conzen (1958) and Whitehand (2009), the authors propose the addition of five scaled analytical patterns. The first comprises nonspatial social, economic, and political factors that have spatial impact (including risk of eviction); the second comprises the influence of the broader city, and situational factors shaping slum settlements (including location and adjacencies to built and social infrastructure). The third comprises the influence of site factors such as topography and its rate of change on the form of informal settlements. The fourth focuses on circulation space configurations of both public and private movements due to ambiguities of ownership. The fifth constitutes the building typology as defined by the permanence of their built form. Although these proposed additions are by no means an exhaustive list, they can help initiate a discussion on how transformative dynamics vary within informal settlements. And, why traditional and long-established methods of urban morphology developed for precise property delineation were clearly not aimed at explaining the ambiguities of spatial ownership may be restrictive. By developing a systematic process and contextual framework within which slum morphology can be studied and understood, we aim to bridge the distinction between the study of morphology of the broader city and slum settlements.

Method

Studying spatial structure and characters of informal settlements under the auspices of urban morphology requires an adaptation of current methods of study that better accommodates the forces shaping the morphology of informal settlements. This article uses existing urban morphology literature and methods to identify possible additions that can be employed when analyzing informal settlements. The aim of this article is twofold: (a) to establish the need to expand on existing morphological analysis into informal settlements and (b) to propose additions to existing morphological analysis to be able to perform analysis into informal settlements.

To build an overview of existing approaches that address morphological analysis, the authors conducted a broad search into topics related to urban morphology and its existing approaches. The absence of informal areas as a neglected part of morphological analysis has been identified previously by authors such as Sobreira (2005), Fabricus (2008), Duarte (2009), and Belsky et al. (2013). With the growing visibility of informal settlements in academic and broader literature (Brillembourg & Klumpner, 2008; Castillo, 2000; Davis, 2006; Duarte, 2009; Fabricus, 2008; A. Gilbert, 2007; Neuwirth, 2005), we intend to expand the understanding of informal areas based on their morphology and morphological representation. We advocate for inclusion and contextualization in identifying the morphological distinctiveness of informal settlements and mapping their urban structure. To do so, the authors put forward five scaled analytical patterns that can help in the morphological analysis of informal areas.

Literature Review: Existing Morphological Analysis

As an established area of study, urban morphology focuses on the spatial structure and character of a metropolitan area, city, town, or village by identifying and examining the patterns of its component parts, as well as the process of its development and its subsequent transformations. Urban morphologists view the city as an amalgamation and accumulation of many actions by individuals and groups, in turn shaped by cultural, social, and economic forces (Conzen, 1962; Kostof, 1985; Whitehand, 2009). The process of development leaves traces on the ground that further mold and structure subsequent building activity and provides opportunities and constraints for city-building processes, such as land subdivision, infrastructure development, or building construction (Holland, 1995; McCartney, 2012).

Urban morphology as the study of urban tissue, or fabric, is a means of discerning the underlying structure of the built landscape that emphasizes the relationships between the components of the human settlement. Analysis is undertaken at different scales in identifying not only physical structures but also patterns of land use, movement, or connectivity. This superimposition of patterns and scales sometimes referred to collectively as the "urban grain" focuses on fixed street patterns, lot patterns, and building patterns. Articulating and analyzing the logic of these interrelated traces is the central focus of urban morphology (Conzen, 1958, 1960, 1962).

Prior to the 20th century, pictorial records of urban settlements existed, although urban morphology as an analytical tool had not yet emerged. The 20th century, however,

saw the emergence of three mainstream schools in urban form analysis: British, Italian, and French (Moudon, 1994). With the introduction of the International Seminar on Urban Form (ISUF), the three schools came together, bringing geography and architecture and planning together, following the seminal work of M.R.G. Conzen and Saverio Muratori. One of the field's more influential theoreticians of the British School, M. R. G. Conzen, demonstrated how the historical development of urban form could be expressed in detail cartographically, as shown in his diagram "Alnwick-Types of plans-units" (Conzen, 1960). Saverio Muratori, demonstrated how the "operational histories" of Venice and Rome, and thus their urban forms where rooted in building types. The emergence of "space syntax" in the late 20th century bought scientific precision to the quantitative analysis of urban spatial configurations (Hillier & Hanson, 1984). Nevertheless, despite advances in urban morphology, much study is still required to clarify the physical constituents and processes of urban areas. The identification and analysis of each of the following six existing patterns allows urban morphologists to better understand the city as a whole.

1. Economic, political, and social interactions of people and their resultant building activities and land consumption within the formal land market.
2. Hierarchical street and public space network, initially created by beaten paths of real journeys by inhabitants, then formalized and added to by municipal and regional institutions.
3. Legally land parcels, known as lots or plots.
4. Topography of the site, including land contours and the location of water bodies that typically constrain broader city development.
5. Existing and proposed land use and flows of inhabitants.
6. Three-dimensional composition of the city's built form, outlining built, and unbuilt areas.

See Table 1 for summarized analysis of how each of the existing six patterns of morphological analysis are insufficiencient to address informal areas.

Why Have Slums and Informal Settlements Not Been Accounted for in Urban Morphology?

Although the field of urban morphology has long emphasized the study of the broader city, little has been done to understand the characteristic urban forms of settlements of the urban poor (Duarte, 2009). The urban condition cannot be understood one-dimensionally, and the divisions of formal and informal in the literature promote marginalization, and prevent integration between various branches of similar research. The literature approaches the topic of informal and formal settlements within the study of urban morphology either through an analysis of housing types or as if the two forms of settlement constituted physically different cities (Castillo, 2000; Fabricus, 2008). The polarization of these terms in the literature and in the practice of city building can be problematic. The polarization of the city leads to the exclusion of many of its citizens and has historically created different levels of mapped and photographic representation (Fabricus, 2008), causing the study of slums and informal areas to be almost completely absent from the morphological literature. In addition to lacking mapped and photographic representation of informal areas, morphological processes were originally created in areas similar to the broader city, to account for change, areas where long-established detailed property demarcation was available with legal and administrative systems to defend them.

Historical cartography, maps, and plans figure prominently in the urban morphologists' representations of urban form. Slum areas have long been neglected in both large- and small-scale maps of cities (Belsky et al., 2013; Fabricus, 2008). This unavailability of information and maps has largely been considered the cause of the neglect of slum morphology within the broader city literature. But the advent of Google Earth and other mainstream geo-information systems has made quantifiable previously "hidden" communities. Field surveys to characterize and identify slums can be supported by satellite-based remote sensing (RS) data that provide an opportunity to locate and study slum areas. Paired with overviews of the settlements and cities, it is now possible to construct a narrative about a location within the broader city, including terrain, surrounding infrastructure, and building conditions. In mapping the morphology of the urban poor, inclusion of whole cities is needed not only to integrate planning strategies for the entire city but also to study the physical manifestations and transformations of urban poverty.

The term *informal*, used in categorizing types of urbanization, has sometimes been used synonymously with terms such as irregular, illegal, uncontrolled, unauthorized, unplanned, self-generated, marginal, or even self-help. Each of these terms, while related to the others and describing the same phenomena, emphasizes one aspect of the subject of research (Castillo, 2000). Generally, informal urbanization can be considered urban development that takes place outside the legal, planned, and regulated channels of city making and has ambiguities of spatial ownership. As Francois Tomas has pointed out, the notion of irregularity depends on the existence of norms. "Irregularity enters our consciousness the moment that the State decides to normalize practices once considered marginal" (Azuela & Tomas, 1997, p. 234).

Informal urbanization is characterized by one or more of the following traits: indiscriminate occupation of land, lack of official approval, lack of property titles, makeshift housing, and absence of utilities and human services (Cymet,

Table 1. Existing Patterns of Morphological Analysis and Their Insufficiencies to Address Informal Areas.

Existing patterns of morphological analysis	Interaction between people as a factor of organizing the city	Street network	Land parcels/lot lines	Topography of the site	Land use	3D built form
Broader city	Human building and consuming land within the formal land market; urban growth and affordability as responses to certain economic, political, and social forces. Plan-unit analysis.	Public circulation space is organized as a hierarchical network determined and implemented by municipal and regional institutions.	Documenting the legal splitting, and consolidation of land parcels into street-blocks. Thereby determining constraints of buildings, lot coverage, and right-of-way corridors.	Topography using land contour and location of water bodies and rivers is typically a constraint to development	Existing and proposed zoned land use and flows of inhabitants.	Three-dimensional composition of the city's built form as defined by built and unbuilt areas.
Informal areas	This existing pattern is insufficient because human building and consumed land has been pushed out of regularized and formal land markets. Organizational principals determined by different economic, political, and social forces. Plan-unit analysis cannot be applied.	This existing pattern is insufficient because public circulation space is negotiated space between individuals rather than a hierarchical network determined by municipal and regional institutions.	This existing pattern is insufficient because there are few land parcels/legal boundaries. Ongoing social negotiations between individuals determine boundaries.	This existing pattern is insufficient because terrains and topographical impediments are used to their advantage. Dynamic location of water bodies is not a constraint to development.	This existing pattern is insufficient because land use is mixed and dynamic making documentation transient. Absence of zoned land use allows inhabitants to meet their needs.	This existing pattern is insufficient because the permanence of buildings are scaled between built and unbuilt.

Source. Authors.

1992). Within informal developments, although the actors are not the same as those in the broader city, the process of construction and transformation in informal areas are the same, albeit in the reverse order (Baross, 1993): occupation occurs before shelter construction, infrastructure development, planning, and ownership.

Understanding the built structure of slum communities will help quantify the form of the settlements to determine the location-dependent motivation for settlement, assets existing within the communities, development options and collective potentials of the urban poor, not only within the communities themselves but also at the scale of the region. It is also essential to verify the priorities of the urban poor in the context of conflicting spatial interests and disparate development objectives. The study of the morphology of urban poverty would encourage analysis of the structures of these communities and processes of formation and transformation, building conditions, and the blurring of lines between what is considered de jure and de facto public and private areas.

Although slums have long been neglected in morphological studies, they can be analyzed as visible formations in a city by acknowledging their physical attributes and vocabulary. Building on Castillo's (2000) "Urbanisms of the Informal" and McCartney's (2012) "At the Limit: Vulnerable Morphologies in Urban Areas," both of which re-conceptualize the complex phenomenon of informality, the current article expands on the characteristics, contextualization, scales, and patterns that must be included in analyzing the morphological structure of these settlements. If the field of urban morphology aims to expand on various scales through which the broader city can be studied, the authors highlight that the current methods of morphological analysis need to be expanded upon to capture the dynamics of informal settlements.

Overcoming Neglect: The Expansion of Existing Patterns of Urban Morphological Analysis

Building on McCartney's (2012) "At the Limit: Vulnerable Morphologies in Urban Areas," we show that slum settlements are a morphological response to pressures from the broader city (economic and spatial). To build an overview of the city at large, and overcome the division of formal and informal city, we propose the following additions to the existing morphological patterns of analysis (Figure 1):

1. Nonspatial social, economic, and political factors that have spatial impact;
2. Situational factors;
3. Site factors;
4. Circulation space configurations;
5. Building typology.

Nonspatial Social, Economic, and Political Factors That Have Spatial Impact

Urbanization is the result of millions of design decisions taken by a wide spectrum of stakeholders seeking to solve immediate problems or exploit income-generating opportunities (Evans, 2005). Individuals, companies, and institutions interact within the physiography of the environment to address problems or seize opportunities. Operating within various policies, social and economic constraints, these actors satisfy the demand for diverse uses (residential, commercial, etc.), thereby expanding cities and consuming land. The morphology of the city is in turn shaped by these decisions and lends itself to certain representations.

To understand and interpret these forms from the past, it is essential to appreciate the current expansion of urban footprints by fast-growing cities and their slum settlements. If certain economic, social, and political forces shape the morphology of the broader city, then slum settlements or informal urbanisms (Castillo, 2000), although situated within these forces, are pushed out of what can be considered as regularized frameworks of a precise legal land market. This in turn affects land affordability and the growth of slum development, and in turn its morphological forms (McCartney, 2012). The lack of affordability produces slums that are located in zones of the city with situational factors that offer residents the best opportunities in the form of underdeveloped land and proximity to infrastructure and employment, despite these zones being comprised of land that are hazardous or without secure tenure by the inhabitants.

Without tenure and precise legal property delineation on the ground, and security that comes with it, inhabitants of these informal areas live without ownership title, leaving them vulnerable to eviction by the private or public land owner and the inability to be included in traditional morphological studies. The risk of eviction at the time of inhabitation by the community has spatial effects on informal settlements, where inhabitants may live on hazardous or (and) illegal lands within a city; the threat of eviction (not the granting of tenure) causes certain shifts in the morphological structure of slum blocks. Political or administrative factors also contribute to the perceived security of tenure by residents. As Doebele (1983) and Razzaz (1993) observed, low-income residents consider perceived security of tenure as important as the legal status of their land in warding off eviction. Without the political or administrative will to uphold the legal division of property and evict people from their homes, inhabitants feel a greater sense of security in their homes. In addition, if politicians invest in these communities by bringing formal infrastructure to gain their support at the polls, then inhabitants also perceive a greater sense of security. This sense of security may lead to different morphological patterns and hierarchies of streets and dwellings within the structure of the

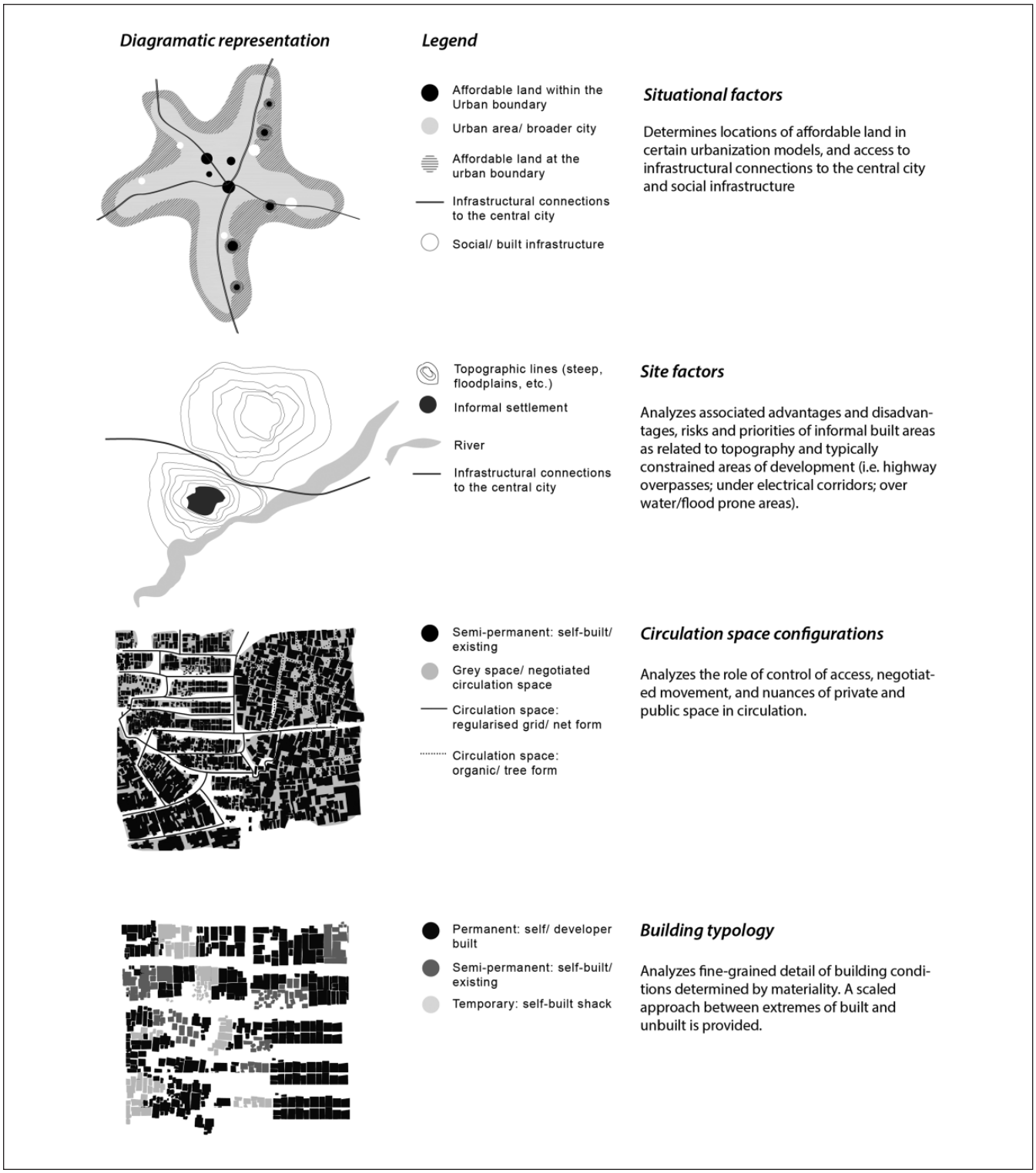

Figure 1. Representative diagram of morphological analysis and factors to strengthen the study of informal settlements.
Source. Authors.

slum (McCartney, 2012), due to the role of control and protection of the inhabitants from those that may evict or police them. Perceived sense of security of tenure not only alters the urban form of their community to encourage more connectivity, but inhabitants are also more likely to invest and build more permanent homes.

Situational Factors

Urbanization decisions of nonspatial social, economic, and political factors that have spatial impact made by thousands or millions of actors result in distinct urban forms rooted in historical periods and specific geographies. Interpreting these forms or "morphological periods" of growth has always been a part of the study of urban morphology (Conzen, 1962; Whitehand, 2009). Forman (2008), for example, introduced four spatial models to examine urban growth. Each model highlights morphological responses to certain economic, political, and social forces. The four models are the concentric-zones model, the satellite-cities model, the transportation-corridors model and the dispersed-sites model (Forman, 2008).

When considering the growth of cities and their influence on slum settlements, it is important to examine when the growth occurred, how this growth is manifested spatially in terms of land consumption, and how this growth has shaped the location of a slum in a peripheral or nonperipheral location (McCartney, 2012). Although morphological periods define particular physical characteristics of a city, urbanization models (location of peripheral land) can help in determining the location of affordable land—for example, at the edge of a city, or in centrally located high-risk areas along flood plains or on steep slopes. Authors such as Fainstein and Campbell (1996) and Hack and Simmonds (2000) have also described how the availability of affordable land varies across time periods in different cities or models. These dynamics dictate where and how low-income housing or slum settlements can be located. By elaborating on the representation of the broader city through its expansion patterns, insights into the locations of slums within certain areas of the city can be established, leading to better understanding of the forces that shape slum morphology.

The real estate principle "location, location, location" is popular for emphasizing how the location of a property largely determines its value. Within today's burgeoning cities, this principle continues to hold influence. The affordability of land, methods of access, and connectivity as defined by proximity to social, built, and economic infrastructure determines the location of an informal or slum settlement, in symbiotic relationship with the growth models shaping a particular city. Affordable land may be found in one of two places:

1. At the edge of the urban boundary;
2. Clusters within the urban boundary.

McCartney (2012) classified these two locations as Perimeter and Opportunistic, respectively. Within regularized models of urban growth (such as concentric models), affordable land is often pushed to the edges of the growth boundary. Informal settlements located here (outside urban growth boundaries) often lack access and connectivity (transport and social infrastructure) to the city, but may be protected from political or administrative oversight. But as the city expands outward, these locations may be engulfed by more formal developments and be subject to a shift in security of tenure. Busquets (1996) noted that in some places such as Barcelona, people have built and then upgraded low-income settlements on the edges of cities for centuries, and these areas have matured to become valuable parts of the city.

Site Factors

If situational factors determine where pockets of affordable land are created through certain urbanization models, the third addition details the locations of slum settlements, and their associated advantages and disadvantages, and risks and priorities.

Affordable land within the urban growth boundary usually consists of areas deemed unfeasible or too costly for development. Typically, these sites are exposed to physical hazards and may even violate zoning laws respecting flood plains, parks, or transportation or utility rights of way. These locations, however, provide insight into the importance of access and connectivity to physical and social infrastructure and economic centers to informal settlements. However, these sites have a higher degree of vulnerability to administrative and political interference, as these lands either become subject to zoning law enforcement or become more economical to develop. Bélanger and Koolhaas (2000) wrote, the "terrain" of slums produces unfamiliar patterns of urbanization, and informal settlements use these impediments to their advantage. "Contour maps no longer describe geological features, but altitudes of money. Peaks and troughs are no longer physical changes in terrain, but represent [the] topography of market potential, indicating levels of income and spending" (Boeri, Koolhaas, Kwinter, Tazi, & Obrist, 2001, p. 182). Terrain, here becomes a third addition within the analysis that helps describe urban form.

Although site factors and topography take advantage of location to the urban center and its services, deterrents to conventional development, such as challenges of terrain, can be advantageous to slum inhabitants. Topography includes geographical features that act as constraints to broader city development and, by representing the limits of where and how the city will grow, influence its resulting form. Squatter settlements typically appear in types of terrain that can be considered perilous: flood-prone areas, steep slopes, former waste sites, and forgotten spaces around transportation corridors (rivers, railways, sewage trunk pipes, roadways, overpasses, or drainage ditches) and flat lands where land values are currently low. Often these locations are vulnerable to natural disasters (such as floods, earthquakes, mudslides, or tsunamis) and health risks (caused by the leaching of heavy metals, pollution, or sewage disposal). These locations and associated terrain conditions are typically considered impediments to broader city developments; slum settlements use innovative morphological responses within these constraints, as risk of eviction is lessened.

McCartney (2012) outlined that slum settlers use various terrains and topographies to their advantage, including moderate and steep slopes, land under highway overpasses or under electrical corridors, and shoreline areas. Furthermore, one can determine the priorities of a particular settlement by analyzing elements within the terrain. McCartney (2012) wrote the following:

> community values can be exhibited in many ways, including what urban facility (school, sports field, church) the community places on the most valuable land (the flattest piece of land with the best access). For example, if the school is on the flattest site with the best access, it is apparent the community values education, because the land of highest value, and least risk, was given to this use. Similarly, if football or soccer is highly valued by the community, the pitch will occupy the flattest portion of the site and will not be encroached upon by members of the community or others. (p. 363)

Duarte (2009) highlighted the influential relationship between morphological analysis and design. We would add that by determining the type of location, policy responses or design can be customized. For example, slums on the edge of the urbanization model require servicing and mobility responses, whereas slums within built-up areas require administrative interventions such as the stabilization of tenure. Terrain, when used as a scaled analytical pattern of morphological analysis within the study of slums, provides a layer of classification that winnows down the types of urban fabric that can develop in a location while expanding on its risks, advantages, constraints, and priorities.

Circulation Space Configurations

The morphological analysis of the broader city includes studying street networks, movement, and through space syntax their accessibility within the network, but the fourth addition to the morphological analysis of slums has to include circulation space configuration in the role of control and protection of the inhabitants, negotiated movement, and nuances of negotiations of private and public space in circulation.

Access and connectivity are highly valued by inhabitants but a perceived lack of security of tenure by residents, and political or administrative will to uphold the legal division of property and the possibility of evicting people from their homes shapes settlement patterns (Sotomayor, 2015). Inhabitants build urban forms with different levels of connectivity and control that differentiate residents and those from outside the community (including law enforcement officers). This sense of security and thus need for control over access to the community at the time of inhabitation may lead to different morphological patterns and hierarchies of access in circulation spaces within informal urbanisms (McCartney, 2012).

Depending on the perceived sense of security, two broad patterns of development can be recognized using Habraken's (1998) definitions: a regularized grid or net form or an organic tree form. Both patterns of development have different levels of connectivity and control that allow residents and those from outside the community (including law enforcement officers) to enter and move around the community.

A grid or net form of urban development develops when the sense of security is higher at the initial time of inhabitation. It allows traffic to freely filter, creating multiple linkages and options for inhabitants to select from many possible paths through an urban area or neighborhood in an accessible and well-connected form. It also allows for policing. This form uses a large percentage of land for circulation and thus is a morphological type that responds to large sites or areas in which street frontage and direct street access have priority. A tree form assumes branching structures with inward flow from the broader city at one point distributed to many points (Habraken, 1998). The tree form develops when the perceived sense of threat is higher and allows for more control of access by the inhabitants at the initial time of inhabitation.

Morphological analysis introduces the complexity associated with grid or tree forms through the breakdown of its block structure. For example, public space within a grid form may be predetermined, while in the tree form, public space has to be negotiated. Typically, in both forms, all open areas can be identified as private or public and depend on accessibility, maintenance, and negotiations between inhabitants. Although in many instances, the configuration of the buildings creates roads, here walkways and courtyards define public space. These spaces, rather than being defined by lines, can be visualized as overlapping territories, resulting in blurred areas of "ownership" that are socially but not legally established and are open to interpretation and constant change. Thus, "lot lines" cannot be established through traditional morphological analysis.

This change from road to home, and from public space to private space is often immediate, without transitional territorial spaces between the two. To further understand the nature of permanence of what McCartney (2012) determined as "grey space," closer examination of these communities is required as circulation space can be through open covered areas or through private buildings. Hence, circulation cannot be solely observed through remote sensing or quantitative analysis, as it requires on the ground examination and discussion of social contracts of access between residents. Unbuilt space is typically the only circulation space but built space can also act as circulation space when the only access to a private space is through someone else's private built space and can only be accessed through negotiation, leading to the blurring of public and private circulation space.

Building Typology

Urban morphology deals with the three-dimensional composition of the city's built form by outlining the built and the unbuilt. Within slums, however, as demonstrated by the

Table 2. Analytical Patterns Added to Strengthen the Study of Informal Settlements.

Nonspatial social, economic, and political factors that have spatial impact	Situational factors	Site factors	Circulation space configurations	Building typology
Addresses how economic, political, and social forces affect the informal land market and built areas.	Analyzes how affordable and informal lands are created through certain urbanization models and how proximity to social, built, and economic infrastructure effects informal built areas.	Analyzes associated advantages and disadvantages, and risks and priorities of informal built areas as related to topography and typically constrained areas of development (i.e., highway overpasses; under electrical corridors; over water/flood prone areas).	Analyzes the role of control of access, negotiated movement, and nuances of private and public space in circulation.	Analyzes fine-grained detail of building conditions determined by materiality. A scaled approach between extremes of built and unbuilt is provided.

Source. Authors.

preceding elements of analysis, the establishing of "lot lines" and "land uses" is far from straightforward. Both the urban fabric and its individual buildings are the antithesis of homogeneous form. It is within the fine-grained detail of building conditions that the built and unbuilt can be classified, and the difficulty of drawing distinct lot lines highlighted.

Though buildings change over time, space and the materiality of urban form lends itself to characteristics associated with a sense of permanence. Similarly, slum settlements from different time periods vary according to levels of investment in housing and security of tenure. McCartney (2012) identified six main types of building conditions within slum settlements that reflect duration, investment, and tenure: (a) developer-built, (b) formally built multifamily housing, (c) self-built permanent, (d) self-built semipermanent, (e) existing formally built tenement, and (f) self-built shack. Permanent housing can be either developer- or self-built, sometimes to code, using durable building materials, although likely without foundations, whereas temporary structures do not have secure foundations and are typically constructed from nonpermanent building materials (such as cardboard or tarpaulins).

This classification aids in fine-grained analysis of the varied building conditions within slum settlements. Although the morphology of the broader city is focused on its three-dimensional composition, this classification highlights the inadequacy of current morphological analysis to address the material composition of slums. This typology of building conditions call attention to the range of housing forms observable within slum settlements. These distinctions are important, as morphology is focused on transformation and slums are established through built and unbuilt forms rather than lot lines.

Within informal areas, a lot line or a boundary is a result of negotiations between a space's inhabitants rather than a formal contract. This introduces a softening of boundaries between private and public space, and needs to be accounted for. Also, the permanence of the materials used to create structures indicates the rate of expected transformation. For example, investment in shelter through tarpaulins indicates nonpermanent solutions, whereas a house made of brick and mortar indicates greater investment and thus more stability. This observation and classification adds layers of complexity that can easily be ignored by conventional morphological analysis.

Conclusion: Blurred Lines and Documenting Negotiated Space

The study of urban morphology as developed by Conzen (1958, 1960) rested on the supposition that precise edges and boundaries can be identified within urban settlements as the study areas had long-established, precise property delineation on the ground. Although the Conzen method can be used to study various types of urban settlement in different parts of the world, as seen in the article by Whitehand (2009), the basic assumptions of studying informal settlements remain the same: the study of the urban grain and its networks, the parceling out of land and topography, and the composition of the formal urban form. Recognizing that urban landscapes are highly complex and although the Conzen method can be applied to a variety of urban landscapes, we assert that using the same approach to studying slums will not provide a complete picture. The forces that shape the form and location of slums and the difficulty of delineating lot lines call for innovative ways to read the morphology of slum areas (Table 2).

For years, one of the many challenges to the study of slums was the lack of mapping technologies and difficulty in accessing the communities. As a result, informal and slum areas became neglected areas within the literature of urban morphology. With the growing visibility of slums through geospatial technologies, morphological analysis can provide more nuanced insight into these areas. To address the multiple dynamics and factors that shape and influence the growth of slum settlements, a sound methodology is needed to study these areas. This article outlines the addition of five scaled analytical patterns that highlight how insufficiencies within current morphological analysis can be addressed and the city be studied as one entity.

As we have shown, while the dynamics of the creation and transformation of informal areas are affected by factors that shape the broader city, they operate outside regularized frameworks. Therefore, morphological analysis of these areas needs greater subtlety in its methodological framework. The impossibility of drawing lot lines, the blurring of boundaries between private and public through the negotiation of private and circulation space, and the constant struggle to secure permanence cannot be accounted for if traditional morphological analysis is used. This article expands on the fundamentals needed to study slum morphology, and shows why they differ from those used in broader city analysis.

The introduction of this system of classification is intended to expand the lexicon used to describe slums and informal settlements while assisting with better descriptions of transformation within these settlements and thus contribute to better design, policy, and practice. Going further, this article also argues that the distinction between formal and informal development is no longer useful in understanding the dynamics of urbanization of the contemporary city. By further developing these methods, the study of slum morphology can eventually become as well-established a field as that of traditional urban morphology, and contribute to a unified study of urban landscapes.

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