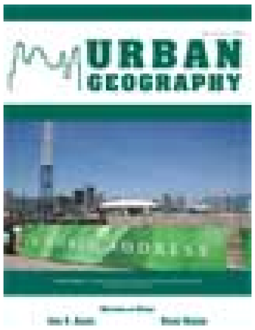

Urban Geography

ISSN: 0272-3638 (Print) 1938-2847 (Online) Journal homepage: https://www.tandfonline.com/loi/rurb20

Targeted urban consolidation or *ad hoc* redevelopment? The influence of cadastral structure and change on the urban form of Brisbane, Australia

Rachel Gallagher, Thomas Sigler & Yan Liu

To cite this article: Rachel Gallagher, Thomas Sigler & Yan Liu (2019): Targeted urban consolidation or *ad hoc* redevelopment? The influence of cadastral structure and change on the urban form of Brisbane, Australia, Urban Geography, DOI: 10.1080/02723638.2019.1663058

To link to this article: https://doi.org/10.1080/02723638.2019.1663058

Published online: 23 Sep 2019.

URBAN GEOGRAPHY
https://doi.org/10.1080/02723638.2019.1663058

Targeted urban consolidation or *ad hoc* redevelopment? The influence of cadastral structure and change on the urban form of Brisbane, Australia

Rachel Gallagher, Thomas Sigler and Yan Liu

School of Earth and Environmental Sciences, The University of Queensland, Brisbane, Australia

ABSTRACT

Cadastral structure exerts a significant influence on urban form. Efforts to adapt the built environment to accommodate social, environmental and economic shifts are often at odds with cadastral structure inflexibility, and urban consolidation can be particularly hampered by lot size and shapeThis research utilizes spatial analysis to examine the influence of cadastral change on infill development. Despite planning schemes encouraging urban consolidation, the results indicate that cadastral change is characterized by *ad hoc* redevelopment, favoring lots that are easily transformed, rather than guidance from regulatory bodies. This contradicts consolidation policies, as redevelopment occurs only where financially and statutorily viable, while further cadastral fragmentation portends that future consolidation will be made more difficult. We argue that policy mechanisms must address cadastral structure more directly, and that the difficulty of cadastral change may incentivize urban sprawl on greenfield sites.

ARTICLE HISTORY
Received 8 March 2019
Accepted 29 August 2019

KEYWORDS
Property; urban form; planning; land use; urban consolidation

Introduction

The built environment of cities is constantly adapting to shifting social, environmental, economic, and demographic conditions (Knox, 1991). Many global cities have statutory planning instruments that seek to contain growth to existing urban areas – referred to as "urban consolidation". Examples include Melbourne (Australia)'s *Plan Melbourne 2017–2050* (State Government of Victoria, 2016), Greater Manchester (United Kingdom)'s *Plan for home, jobs and the environment* (Manchester City Council, 2019) and Vancouver (Canada)'s *Metro Vancouver 2040: Shaping our Future* (Metro Vancouver, 2019). Although the adaptability of the built environment is influenced by planning norms (Cannon et al., 2013), housing and transport preferences (Davoudi & Sturzaker, 2017; Ryan, 2008; Webb & Webber, 2017; Zhou & Gao, 2018), and land tenure systems (Adams & Hutchinson, 2000; Easthope, Tice, & Randolph, 2009; Hastings & Adams, 2005; Puustinen & Viitanen, 2015), the nature of any change is often determined by the underlying structure and form of a city – its morphological frame of lots (also called a "plots" or "parcels") and streets. Despite the pressures of

CONTACT Rachel Gallagher r.gallagher4@uq.edu.au School of Earth and Environmental Sciences, The University of Queensland, Brisbane, Australia

population growth and changes in housing preferences, and even in the wake of catastrophic wars and natural disasters, a city's urban frame has been found to be highly resistant to alteration (Birkhamshaw & Whitehand, 2012; Conzen, 1960; Frederickson, Fergusson, & Wildish, 2016; Stell & Tait, 2016). While an abundance of research on the processes of intensification and urban redevelopment more broadly exists, there is a dearth of knowledge regarding the underlying stability of cadastral structure, and how urban consolidation and infill development can be achieved in the face of the fixity of lots (Frederickson et al., 2016; Louw, 2008; Newton et al., 2011).

This paper investigates the effectiveness of cadastral change in achieving the purported aims of planning schemes that target urban infill development as a means of consolidating urban form. Through analysis of cadastral change over a 10-year period (2007 to 2017) in Brisbane, Australia, it focuses on the relationship between residential intensification and cadastral change through boundary amalgamation, subdivision and reconfiguration across seven inner-city suburbs that – although geographically proximate – are quite distinct in character, land use, and history. We contend that the slow uptake of greyfield sites (existing underutilized residential areas) is attributable to multiple factors, namely the difficulties imposed by fragmented land ownership and the inability of developers to obtain lot sizes suitable for redevelopment, as well as an archaic planning system which largely ignores the intricacies of urban redevelopment in favor of the simple application of land use zoning. In the sections that follow, we highlight the influence of the cadaster on urban form, the constraints on redevelopment caused by existing cadastral structure, and that institutional change is necessary to ensure that our cities are adaptable to changing urban conditions.

Consolidation versus sprawl

Across the western world, the expansionary nature of urban development in the post-WWII period has concentrated growth, and often, resources firmly in suburbs (see Harris, 2004 for Canada; Duany, Plater-Zyberk, & Speck, 2000 for the United States; Pawson, Hulse, & Cheshire, 2015 for Australia). Sprawling metropolitan forms are characterized by homogenous land use, low-density dwellings, suburban office parks and car-oriented development (Hayden, 2003; Jackson, 1985). This applies to current urban expansion in many global regions, with research demonstrating that Asian, Latin American and African cities are also experiencing the relocation of retail and industry to outer suburbs, coupled with rising car ownership and housing preferences toward low-density suburbia, reforming existing cities as poly-centric and dispersed (for example, see Ren, 2015; Feng, Wang, & Zhou, 2009 for China; Loh & Brieger, 2014 for Malaysia; Guerra, 2013 for Mexico; Horn & Van Eeden, 2017 for South Africa).

Since approximately the 1980s, there has been a resolute focus on urban consolidation in both academic and policy circles (Michell & Wadley, 2004; Spearritt & DeMarco, 1988). Though in practice greenfield (previously undeveloped land) development has continued relatively unabated, several related planning practices have been pursued with the intention of reinvigorating inner cities, curbing the deleterious effects of suburban sprawl, reversing urban blight (Coffee, Lange, & Baker, 2016; Forster, 2006), and maximizing tax revenues from businesses and ratepayers (Caulfied 1991). Urban intensification has taken various forms, including Transit-Oriented

Developments (TODs), Compact Cities, Urban Containment, the Eco-City, and various technocratic solutions tied broadly to Smart Cities discourses. Within these various discourses, the purported benefits of intensification are tied to enhancing livability through shared services, infrastructure savings, reduced crime, and better public transportation services. Land-use planning has exerted a great influence on this transition, as have market-led forces by revalorizing urban lands that may have previously been vacant, underutilized, or derelict.

Urban consolidation not only requires a transformation of the type of dwellings being constructed, but also impacts the urban structure and form of the city (Murray & Khor, 2011). Voluminous urban morphology literature has shown that cadastral structure can be slow to change, as market-oriented land tenure systems often situate decision-making amongst individual landowners rather than with those responsible for city planning (Siksna, 1998; Whitehand, 1994). This creates an antagonistic relationship between the built environment and urban consolidation objectives insofar as property owners' behaviors are motivated by personal preference and financial gain, rather than planning directives with city-wide benefit (Frederickson et al., 2016; Lee, Won, & Kim, 2016; Sanders & Schroder, 2008; Siksna, 1998). Understanding the influence of cadastral structure can thus highlight the practical difficulties of urban consolidation efforts, particularly in cases where a range of lot shapes, sizes, and types exist.

Urban morphology in a contemporary context

Urban morphology is the study of change in the built environment of cities over time (Moudon, 1997). Studies of urban morphology involve multiple fields focusing on the processes of city formation and transformation (Kropf, 2017). They can be roughly divided into three schools: the Italian and French, which arose independently but both generally focus on architectural heritage and building-scale redevelopment, and the British, which focuses on cadastral analysis (Kropf, 2017; Moudon, 1997; Sanders & Schroder, 2008; Whitehand, 2001). There has been a convergence of these three major schools in recent times due to greater linkage and collective work being undertaken by urban morphologists from each tradition (Moudon, 1997; Racine, 2019). For the context of this study, the British urban morphology framework developed by Conzen (1960) is most relevant, as its focus on town plans, land use, and building forms is important to a contemporary understanding of the modern city and how it evolves over time (see also, Whitehand, 2001).

Several interrelated issues have sparked a renewed interest in urban morphology. First, a post-industrial shift has catalyzed urban redevelopment, drawing professionals toward inner-city housing, and reformulating workplaces toward smaller and mixed-use office spaces (Easthope et al., 2009; Knox & McCarthy, 2012; Miller, 2014; Nelson, 2009). A corollary to this has been a transition toward more flexible and nimble office configurations, eschewing the segregated block-style office buildings of the 20th century and rendering much of the existing commercial building stock obsolete or in need of significant retrofitting (Harris, 2015; Weber, 2016). Second, a countermovement against suburban sprawl (Ewing, Pendall, & Chen, 2003; Hayden, 2003; Jackson, 1985; Michell & Wadley, 2004) has led many to reconsider expansionary land tenure arrangements that favor greenfield sites as cheaper alternatives to existing urban spaces. In this regard, issues such as traffic congestion, pollution, infrastructure costs and long commute times have instigated major policy revisions for many metropolitan regions aimed at centralizing and densifying existing urban areas (Trubka, Newman, & Bilsborough, 2010; Zhou & Gao, 2018; Ziegler, 2009). Third, scholars have noted a plurality of influences on the ability of planners to shape urban development, with the regulatory stasis ensuing from lack of political will or authority to intervene, as well as the ownership of the land, and size and configuration of the property, having a significant impact on whether existing urban areas can be redeveloped, with many cities experiencing little to no change in their property boundaries over time (Frederickson et al., 2016; Gabbe, 2017; McDonald, 2004; Oliver, 1983).

Influence of the cadaster on redevelopment

Contemporary studies on cadastral change focus on how the theoretical framework of urban morphology can be applied to understanding the complexities of a 21st century metropolis (Racine, 2019; Ryan, 2008; Sanders & Schroder, 2008; Stell & Tait, 2016). While there is a large body of research investigating the patterns of urban change, and the fundamental role played by property boundaries in some jurisdictions (see, for example, Conzen, 1960; Scrase, 1989; Whitehead 2001; Stell & Tait, 2016 in the United Kingdom; Asami & Niwa, 2008; Asami & Ohtaki, 2000; Gao & Asami, 2007 in Japan), much published global research focuses on the transformation of whole blocks, being the smallest area surrounded by streets and containing many individual lots, and street layouts over time, rather than individual lots (for example, see Ryan, 2008 for Detroit; Sanders & Woodward, 2015 for Brisbane, Australia; Siksna, 1998 for eight cities in Australia and the United States; Taima, Asami, & Hino, 2019 for Tokyo; Scoppa & Peponis, 2015 for Buenos Aires). These studies provide important insight, as block size directly influences the density of buildings (Taima et al., 2019) and walkability (Stewart & Moudon, 2014), which is highly linked to a city's livability (Yassin, 2019). Nevertheless, while there is a growing body of literature on the importance of lot structure, as it has a determinative influence on urban productivity (for example, see Bobkova, Marcus, Pont, Stavroulaki, & Bolin, 2019's research on London, Amsterdam, and Stockholm) and redevelopment potential (Charles, 2013; Dovey, Pike, & Woodcock, 2017; Gao & Asami, 2007), limited research exists on how lots change size and shape to suit contemporary development conditions, including policies aimed at urban consolidation (Frederickson et al., 2016).

Permanence of cadastral structure

The legacy of historical lot patterns exerts a strong influence on urban form, both in shaping individual building sites and lots between them, as well as shaping city blocks (Asami & Ohtaki, 2000; Dovey et al., 2017; Siksna, 1998). In the United Kingdom, medieval lot boundaries have acted as site constraints from their inception, influencing the design and configuration of both individual building structures and groups of buildings (Conzen, 1960; Stell & Tait, 2016). In their study of Scottish towns, Stell and Tait (2016) found that lot boundaries in urban centers persisted over time, despite population growth pressures, with many lot boundaries and street frontages remaining in their original positions, leading to the tall and long buildings characteristic of Scottish urban architecture. Generally, dense downtowns such as Manhattan (New York), Chicago and San Francisco experience very little cadastral change due to the expense of resuming the land required to facilitate largescale redevelopment (Ryan, 2008). Costly slender skyscrapers are examples of developers working with existing lot sizes when land is in short supply and cadastral change is too slow to keep pace with market conditions (Cheung, 2018; Sanders & Schroder, 2008). Examples include the 6.7 m-wide and 29-storey apartment building at 82 Flinders Street in Melbourne, and Manhattan's 28-m-wide 432 Park Avenue, which at 425.5 m is currently the world's tallest residential building.

Perhaps the strongest evidence of the permanence of property boundaries over time is that not even natural disasters or large-scale state-sponsored programs (such as highway construction) have contributed strongly to cadastral change over time (McDonald, 2004; Oliver, 1983). The two most significant factors that influence urban form – property boundaries and topography – generally remain unchanged even after a natural disaster or war (McDonald, 2004). Fredrickson (2015) describes property boundaries as "sticky", as the ownership of the land as well as the size and configuration of the property has a significant impact on how existing urban areas are redeveloped, if they experience change at all (Frederickson, 2015, p. 1). Generally, even after the whole cities are demolished, they are reconstructed along the same property boundaries (Frederickson et al., 2016; Lee et al., 2016; Oliver, 1983). In Incheon, South Korea, a new gridiron pattern was superimposed over the neighborhood of Songhyun-dong in an attempt to revitalize the former retail hub and, while this increased the street frontage of lots, it did nothing to alter lot patterns, and in fact led to oddly shaped lots, alleys leading to nowhere and open spaces with triangular shapes (Lee et al., 2016).

There are, however, notable exceptions to the stability of property boundaries. Rotterdam in the Netherlands, for instance, experienced significant change following the city's WWII bombardment. With extensive state involvement and funding, its post-war 1946 Basic Plan outlined new city center functions and an expanded road network (McCarthy, 1998). Christchurch, New Zealand, is another example. Devastating earthquakes in 2010 and 2011 caused some land to spread, contract or slip, leading to property lots that had changed shape and location. The New Zealand government introduced the *Canterbury Property Boundaries and Related Matters Act 2016* to clarify that property boundaries moved with earthquake movement and still coincide with physical features on the property such as fences (Land Information New Zealand, 2018).

Cadastral adaptability

Cadastral adaptability influences a city's ability to evolve to meet the changing needs of its population, such as catering for shifting preferences in dwelling type, transport or industry (Lee et al., 2016; Scheer & Ferdelman, 2001; Siksna, 1997). Several signs point to the fact that transformation is possible, particularly in the wake of widespread de-industrialization. American cities such as Detroit and Cleveland have each lost hundreds of thousands of residents and tens of thousands of housing units since the 1960s (Ryan, 2006). In 1896, Detroit city had a dense street and city block network that, by 1970, had been radically transformed into a city of large superblocks and highways. The reconfiguration of Detroit was made possible by the oversupply of cheap, vacant land; therefore, developers faced few spatial constraints and completely abandoned the original street and lot layouts (Psarra, Kickertt, & Pluviano, 2013; Ryan, 2008). In the 1990s some residential areas experienced redevelopment, with new housing constructed on sites that had been vacant for decades. The six largest redevelopments of this kind were once mixed land use with diverse housing types (as recorded in 1951), but the new redevelopments were homogenous in their low-density residential land use (Ryan, 2006).

Where property boundary change does occur, a process of incremental change can make block patterns more suitable for desired development. This is where lots, city blocks and streets are altered to create a "better fit" for changing development requirements (Siksna, 1998, p. 281). Adaptability indicates that a city has scope to evolve to meet the changing needs and conditions. Urban forms that are adaptable allow a growing city to evolve based on changing societal needs, or at least provide more predictable patterns of change that can be used to guide government authorities and developers into the future. Small blocks of about 60 to 80 m were found to be better suited to urban development and more adaptable to both historical and contemporary development needs, when compared to larger blocks, as they allow for greater circulation as well as more coherent building fabrics with both low and high-rise buildings (Siksna, 1997). Land assembly can form an integral aspect (and major constraint) of the property development process if existing lot sizes are inadequate for the proposed scale of a redevelopment (Adams & Hutchinson, 2000). In cities that have changed form, extensive government involvement (through policy but, most importantly, funding) or underutilized land (and low levels of discontent from residents and less political backlash) are common factors (Gabbe, 2017; McCarthy, 1998; Neilson 2008; Newton et al., 2011; Ryan, 2006).

Study context, data, and method

Australian cities' development from initial settlement in the 19th century onward was characterized by relatively low-density urban expansion. This accelerated in the post-WWII period with an increasing prevalence of detached dwellings on generous blocks, especially in Brisbane, the third largest city in the country. The Australian land tenure system, which heavily favors private ownership over alternative models, has led to highly variegated ownership structures and cadastral arrangements, particularly in inner cities. Section 51 of the Australia Constitution inherently protects private property, with the last 100 years of jurisprudence confusingly oscillating between ensuring the legislative power of government to acquire land and protecting individual rights (Stubbs, 2011). Australia's market-oriented land tenure systems distinguish it from many other global contexts in which state land resumption, compulsory acquisition, and/or expropriation are commonplace. As a legacy of this, the existing cadaster is fragmented in its ownership which can limit the types of buildings able to be constructed.

Both in Victorian times and today, planning norms play a heavy hand in urban development, from the anti-slum ordinances regulating minimum lot sizes in the 19th century to mandatory setbacks and street frontages of contemporary planning schemes.

Australia's largest cities continue to experience growth in their urban footprints, with the highest levels of population growth in the country observed in the outer suburbs of Sydney, Melbourne and Brisbane – growth that is associated with continued suburbanization and greenfield development (Australian Bureau of Statistics (ABS), 2018; Coleman, 2016). Population growth in major cities has driven state and local government policies aimed at urban consolidation but these policies leave it to private developers to enact change on the ground. In practice, this means that residential intensification in established inner areas (often through mixed use and TOD) occurs at the same time as low-density greenfield development on the urban periphery. This leads to two conflicting but co-existing urban structures within the same city – relatively high density and well-serviced inner areas and low-density sprawl in the outer suburbs. At the same time, the concepts developed by Conzen (1960) have not been investigated in depth in Australia (Gu, 2010; Siksna, 2006).

Brisbane, Australia

Brisbane is located on the eastern coast of Australia, is the capital city of the State of Queensland and is centrally located within the metropolitan region referred to as South East Queensland (SEQ). It has historically had some of the highest rates of population growth in the country (Australian Bureau of Statistics [ABS], 2016a). Like most government structures in Australia, the local government, being Brisbane City Council, undertakes most of the decisions around urban planning and development. This study focuses on seven inner southern suburbs directly across the Brisbane River from Brisbane's central business district (CBD), including Dutton Park, East Brisbane, Highgate Hill, Kangaroo Point, South Brisbane, West End and Woolloongabba (Figure 1).

The study area was selected as the inner suburbs of Brisbane are the primary focus of consolidation policy. It is a region that has experienced significant change and redevelopment since its settlement in the 19th century. Referred to as "Kurilpa" by the Jagera and Turrbal peoples, Aboriginal people permanently occupied the study area for at least 30,000 years prior to Brisbane being opened for European settlement in 1838 (Kidd, 2001). In fact, much of the study area was managed in such a way to make settlement more straightforward, with Aboriginal trails becoming major roads and significant Aboriginal sites becoming today's suburbs, with their original names retained, including "Woolloongabba" which roughly translates to "place of fight talk" (Kidd, 2001, p. 470). The initial settlement of the study area was confined to the riverbank, which was dominated by wharves and other industry. As a comprehensive tram network spread outwards from the CBD connecting all suburbs in the study area, the construction of detached houses occurred along these routes. Suburbs such as Highgate Hill and East Brisbane have generally been featured by residential land use since settlement.

The situation provided by early colonialism, including the need to transport new products to global markets, import labor throughout the British Empire and the perceived need to protect the colony's population from the land's original inhabitants, provided the motivation for deliberate urban planning policy (Proudfoot, 2000). Recognizing the thousands of years of Aboriginal land management which aided future city-building, Brisbane was settled as a greenfield site and the colonial government

Figure 1. Location of the study area in Brisbane and eastern Australia. Data sources: ABS (2018) and Google Earth (2017).

surveyed land before it was granted or sold, resulting in rare opportunity for unplanned settlement (Kidd, 2001; Siksna, 2006; Troy, 2004). As such, a British standardized town plan was imported to Brisbane, with components including a grid pattern of streets, rectangular lots and land rights allocated in a combination of town, suburban and country lots (Home, 1997). Instead of creating through-lots (that is, lots that connected to streets on both ends), the original town plan for Brisbane created back-to-back lots. Sanders and Schroder (2008), in their analysis of Brisbane's CBD, noted that the initial layout of the town was "generous" in city block and lot size, resulting in underutilized space which later experienced significant subdivision (p. 5).

Historically, the lot pattern in Brisbane's CBD only rarely provided for systematic subdivision or amalgamation, and instead, changes occurred in an *ad hoc* and irregular manner (Siksna, 1998). Many lots in Brisbane were subdivided during the 19th century, with very few lots amalgamated to create through-lots (Siksna, 1998). Moreover, Queensland's unique *Undue Subdivision of Land Prevention Act 1885*, introduced not long after the study area became open to settlement, enforced a minimum lot size of 404 square meters and a minimum frontage of approximately 10 m as a public health and slum eradication measure. This effectively eliminated small lots, ended row housing (Laverty, 1970) and, arguably, legislated the beginning of urban sprawl in Brisbane. This is an example of an unintended outcome but emphasizes that the layout of cities is not due to some "invisible hand" but particular ideas and decisions (Talen, 2011, p. 974). In fact, outcomes like urban sprawl can often be directly attributed to government policy.

Development patterns in Brisbane have had some of the lowest densities of any Australian city. Contemporary planning in Brisbane is governed by statutory planning instruments at both a state and local government level. All local government planning schemes must follow the Queensland Government's *SEQ Regional Plan 2017*. This regional plan covers the metropolitan and regional cities of which Brisbane is at the center and sets urban infill targets for each city (Department of Local Government, Infrastructure and Planning [DLGIP], 2017).

These policies not only result from the work of government but also a number of related actors in the property development sector. Public and private initiatives include the state government's "Density and Diversity Done Well" competition with private sector submissions used to guide preferred development, outlining climate-sensitive design that addresses the "missing middle" housing – the type of density between detached houses and apartment buildings such as townhouses, which are expected to achieve the number of new dwellings required without the need to expand into greenfield sites (Department of Housing and Public Works, 2018). Ultimately, however, it is the market that decides which sites are developed. The local government of Brisbane, through its planning scheme – the *Brisbane City Plan 2014* – codifies the specific requirements for development applications including building density, height, street frontages, setbacks and provision of infrastructure such as utilities, roads and community space. Typically, Brisbane City Council planning officials determine applications from developers (be they major corporations or owner-developers) to alter lot alignments or sizes through amalgamation, subdivision or reconfiguration; they also assess development applications for demolitions of existing dwellings and the construction of new ones (see Queensland's *Planning Act 2016*).

In the next few decades, Brisbane's inner-city suburbs will continue to experience population growth because of local and state government urban consolidation policies, with little strategic guidance in the practical implementation of these policies (Walters & McCrea, 2014). Brisbane will require an additional 188,000 new dwellings by 2041 (DLGIP 2017). To meet these predicted figures, the Queensland Government (the level of government responsible for overarching legislation that Brisbane City Council is responsible for implementing on the ground) has developed policies to use land more efficiently through compact and higher density development within the existing urban footprint known (DLGIP, 2017). The Queensland Government has acknowledged that greenfield land is a limited resource and infill has been identified to manage population growth, with a target of 60% of additional dwellings within all of SEQ to be infill development and setting specific targets for local government. These range from 0% for some local governments to the 94% required by Brisbane City Council (DLGIP, 2017). This is consistent with many urban consolidation strategies across the world, such as TOD which use mechanisms to encourage development around activity centers or existing transport (Gillen, 2006). Despite the best intentions of urban consolidation policies, the type of redevelopment often seen in Australian cities is not adequate in contributing to sustainable growth due to its low density and quality (Newton, Meyer, & Glackin, 2017; Ruming, Randolph, Pinnegar, & Judd, 2007). The informal and piecemeal application of single lot subdivisions, which is currently occurring in cities across Australia, reduces housing diversity both now and into the future (Newton et al., 2011). It also makes it more difficult for change to occur, given that assembly of lot sizes suitable for higher density redevelopment becomes increasingly difficult with more landowners to negotiate with.

Data and methods

This study aims to understand the role of cadastral change in urban infill development across seven Brisbane suburbs. We use the digital cadastral database (DCDB) provided by the Queensland Government's Department of Natural Resources and Mines

(DNRM) to identify where changes of property boundaries occurred and to measure the incidence of change in lot patterns over a ten-year period from 2007 to 2017. This period was selected as the year 2007 is the earliest year where cadastral data are available in a similar format as the latest data in 2017; it also enables a clear comparison of boundary change over a decade when active redevelopment and changes have occurred. Rather than counting individual lots, the term "boundary change" is used throughout this article as it covers one event, be that an amalgamation, subdivision or reconfiguration, regardless of how many lots are involved.

To identify property boundary change, we first converted the 2007 cadastral data from polygon features to points using ESRI's ArcGIS, a commonly used Geographic Information Systems (GIS) software program, with each point representing the centroid of the corresponding polygon feature. Thereafter, adapting the methods applied by Frederickson et al. (2016), we overlaid the point data from the 2007 cadastral data on 2017 cadastral polygon data and calculated the number of points in each polygon data, resulting in three possible outcomes: (1) no point (subdivision occurred); (2) one point (no change); (3) two or more points in a polygon (amalgamation occurred). Figure 2 illustrates the process we take using a subdivision of one polygon in 2007 into two polygons in 2017 as an example, and illustrates the three types of cadastral boundary changes that have occurred within our study area, including amalgamation (combining two or more lots into a single lot), subdivision (where a single lot is broken down into two or more lots) and reconfiguration (all other changes). This assists in isolating boundary change events in a way that is previously underexplored in the literature, by targeting both spatial and temporal change.

Given the complexity of changes that may have occurred on the ground, a manual review was undertaken to verify which properties experienced residential intensification, and to exclude lots that have experienced property boundary changes for other purposes such as commercial development or state infrastructure construction. We used Google Earth satellite imagery, Google's current and historical street view imagery, Brisbane City Council's Planning and Development Online (an online portal that collates planning and development applications within the local government area from 2004 onwards) as well as site inspections to verify and validate each property change that we identified from the DCDB data in GIS. Furthermore, we categorized the changes identified through the GIS mapping and manual validation processes into two categories based on housing types: single dwellings (detached house) or multiple dwellings (apartments, townhouses, and duplexes).

Results

We observed property boundary changes on 402 individual residential lots in 2007, which became 254 lots in 2017. This represents 2.0% of the total number of lots in the study area in 2017. In terms of boundary change events, encapsulating amalgamation, subdivision, and reconfiguration regardless of the amount of lots involved, a total of 182 boundary change events were identified over the period from 2007 to 2017. This includes 93 amalgamations, 67 subdivisions, and 22 reconfigurations, resulting in 115 multiple dwellings, 64 additional single dwellings (noting that 62 boundary changes occurred but some lots were subdivided into more than two lots, with more than one additional dwelling. Including the original lot

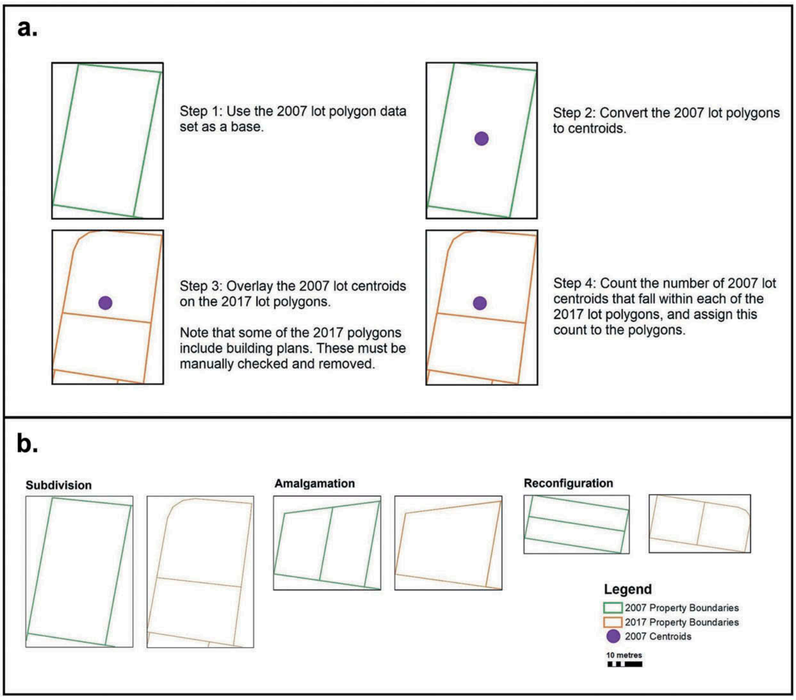

Figure 2. (a) An illustration of the method we adapt from Fredrickson et al. (2016) to identify property boundary change (using a subdivision of one polygon in 2007 into two polygons in 2017 as an example). (b) Three types of property boundary changes in the study area. Data source: DNRM 2007; DNRM 2017.

and dwelling, this is 126 single dwellings in 2017) and five vacant properties. There is no greenfield land within the study area, so these vacant lots are a result of demolition or "backyard" subdivision. The five properties that remained vacant after being subdivided have the potential to be redeveloped, with three of these properties being owned by individuals and the other two owned by one small land development company. Most redevelopments occurred on properties that contained a detached house (118 out of 182). Figure 3 illustrates the number of properties and the types of changes that occurred in the study area over the decade period.

The number of boundary change events varied considerably by suburb in terms of the type of boundary change (amalgamation, subdivision or reconfiguration) and the dwelling type resulting from the boundary change (Figure 4). West End experienced the highest number of property boundary changes (40), including the highest number of amalgamations (22). Highgate Hill and Woolloongabba experienced the highest number of subdivisions (both 16).

Our results show that *ad hoc* development was prevalent throughout the study area. The Brisbane City Plan 2014 seeks to consolidate growth through targeted densification. The dominant zonings throughout the study area are Character Residential (Infill), which generally covers inner-city, low-density areas comprised of existing houses built in 1946 or before, or higher density zones ranging from medium (5 storeys) to high density (maximum of 8 or 15 storeys). The Character Residential (Infill) zone allows for

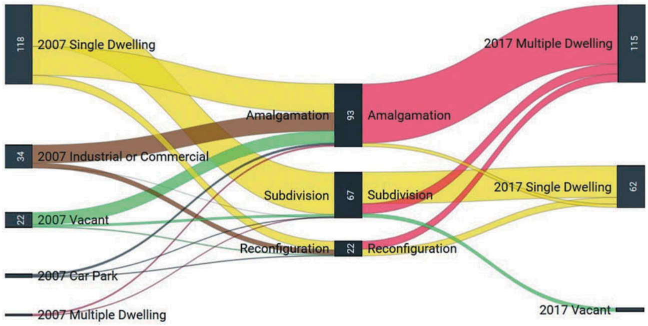

Figure 3. Number of properties with boundary changes and the types of changes observed from 2007 to 2017 (n = 182). Single dwellings are detached houses and multiple dwellings include apartment buildings, townhouses or duplexes.

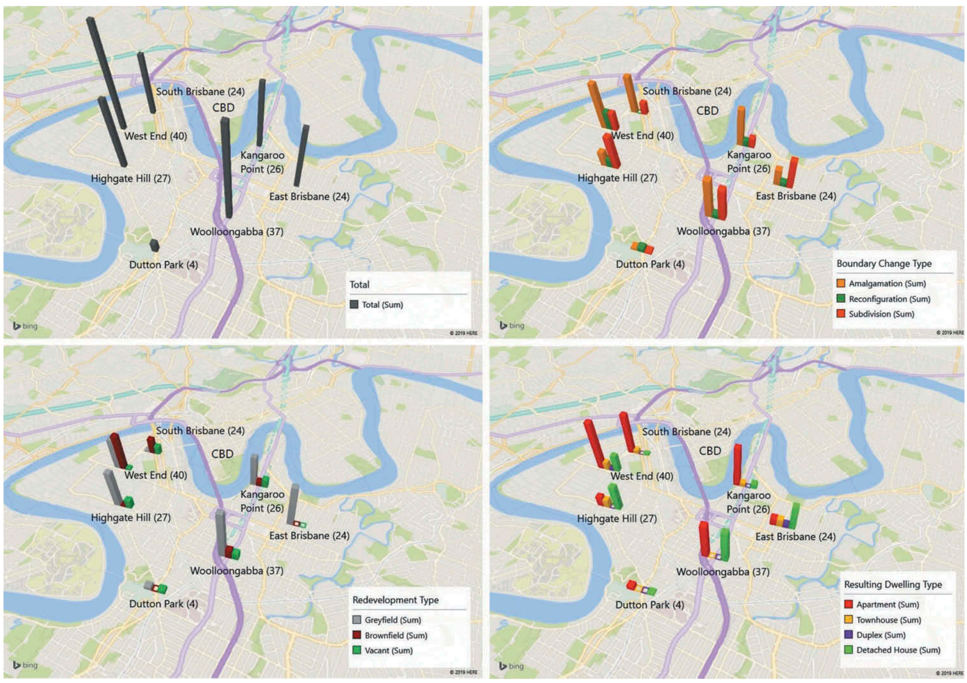

Figure 4. Number of property boundary changes by suburb and by type. Base layer map source: HERE 2019.

infill development that retains the existing pre-1946 house, with the Brisbane City Plan 2014 hoping to achieve a greater choice in dwellings by facilitating the construction of dual occupancy (duplexes), two-storey low-rise multiple dwellings (such as row houses or townhouses), rooming accommodation or residential care facilities (Brisbane City Council, 2014, para 6.2.1.5). This study identified that the fixity of property boundaries makes redevelopment at higher densities difficult to achieve in a practical sense. Table 1 shows properties in a residential zone, excluding properties that were in zones allowing

Table 1. Zoning under the current Brisbane city plan 2014 of the properties identified in this study purely zoned as residential.

Brisbane City Plan 2014 Residential Zone	Number of properties
Character residential (infill housing)	60
Low-medium density residential (2 or 3 storey mix)	32
High-density residential (up to 15 storeys)	30
High-density residential (up to 8 storeys)	20
Medium-density residential (up to 5 storeys)	6
Low-Medium-density residential (up to 3 storeys)	1

for mixed uses, as density of these zones depends on the location. This table shows that the most common form of land-use zoning for the properties identified in this study was Character Residential (Infill), but 71.7% of properties constructed in this infill housing zone after a boundary change were additional detached houses, rather than multiple dwellings. Subdivisions generally facilitate the construction of additional detached houses.

In fact, the majority (70.1%) of subdivisions resulted in the construction of one or more additional single dwelling (detached house), whereas 94.6% of amalgamations resulted in the construction of multiple dwellings (apartment buildings, townhouses or duplexes). Almost all sites that underwent amalgamations were owned by property development companies of varying sizes, whereas the properties that experienced subdivisions were generally owned by individuals. This result is not unexpected given that apartment buildings require a larger building footprint and outlay of funding. Moreover, the momentum for further subdivisions (with more detached houses in walking distance of Brisbane's CBD) is tied to Australia's land tenure regime with its strong focus on private ownership, despite this process running counter to the objectives of relevant planning schemes. In fact, infill development at higher densities is often not associated with land-use zoning or proximity to public transport or activity centers but is in fact correlated with local factors such as an area already being higher density, or physical ease of development such as a flat slope (Mustafa, Van Rompaey, Cools, Saadi, & Teller, 2018; Phan & Chandra, 2008).

Redevelopment types

Across all suburbs, 66.5% of redevelopments were greyfield development occurring on existing residential land; 21.2% were brownfield (former industrial or commercial land) development and only 12.1% of redevelopment occurred on vacant land formed following a boundary change. Despite their close proximity to each other (the study area is only approximately 5 km horizontally across), the results demonstrate that the suburbs are each very different in terms of their boundary changes and subsequent urban infill development. Greyfield development was the predominant type of redevelopment observed on land experiencing a boundary change in East Brisbane (100.0%), Highgate Hill (77.8%), Kangaroo Point (69.2%) and Woolloongabba (75.7%). West End was the only suburb that experienced a majority of brownfield developments (52.5%).

These differing results can largely be attributed to the available land in each suburb and the types of property boundary changes that occurred. The study area contains one of the largest urban renewal projects in Queensland's history, the former docklands in

South Brisbane. South Bank Corporation, a statutory body, was formed in 1989 after the Queensland Government decided to redevelop the area (including reconfigure lots) into parklands, rather than selling the site for commercial development. There are many other large lots consisting of former and operational industrial sites. A major dairy factory, occupying a site of thousands of square meters, is still operational in South Brisbane directly across the river from Brisbane's CBD. West End was formerly dominated by wharves and industry, with the largest West End site identified in this study (as experiencing a boundary change and subsequent redevelopment) covering a huge former industrial area of 64,740.0 square meters. Former industrial sites of that size are scarce in other suburbs such as East Brisbane, where residential land use has dominated throughout its history. West End's mean lot size of redeveloped properties was 5,181.4 square meters, far outstripping the mean for any other suburb by over 1,000 square meters – and being over 4,000 square meters larger than the mean in East Brisbane. It would require at least six typical East Brisbane properties to obtain land of the mean size of a West End lot – requiring negotiation with at least six landholders.

The brownfield sites utilized in West End, and seemingly favored by developers, are large and often under single ownership, meaning that acquisition and development are a relatively straightforward transaction. They are also well-located and serviced, given the proximity of the study area to Brisbane's CBD, and their size is of such a large scale that it is closer to the sizes provided by greenfield development (Adams, Disberry, Hutchinson, & Munjoma, 2001; Ruming et al., 2007). These large lots in the inner-city are most attractive to major developers, more often because land assembly is not required (Newton et al., 2011). It is these sites where the state has a heavy influence, with state and local authorities either owning the site or directly involved in negotiating the rezoning and conversion from industrial to residential use, with Brisbane City Council in conjunction with the Queensland Government master planning the renewal of industrial riverfront properties in West End and South Brisbane.

Permanency of the cadaster

The low numbers of cadastral change observed (182), when compared to the large number of building approvals (1,298 for high-rise development in South Brisbane alone in 2016, according to the Australian Bureau of Statistics [ABS], 2016b), indicate that cadastral change is not readily utilized as a means of achieving redevelopment, even when considering that not all building approvals result in actual construction. Once the street layout and property boundaries have been created, they are extremely difficult to reverse. Brisbane was originally settled based on a plan of street spacing of 221 by 111 m, blocks of 200 by 90 m in rectangular dimensions and blocks containing 20 equal lots (Siksna, 1997). As Figure 5 shows, many blocks still match the original dimensions. The first available survey plan of this area (undertaken in 1895) overlaid with the 2017 property boundary map show the changes in these lots over 122 years. The lots inside have obviously been subdivided, amalgamated or reconfigured over time but the original 20 equal lots of 45.3- and 20.2-m dimensions are still visible, and most still remain. In East Brisbane, the mean size for all lots in 2017 was only 906.3 square meters, just slightly below the mean size of Brisbane's original lots as surveyed in 1895 (which were approximately 915.1 square meters).

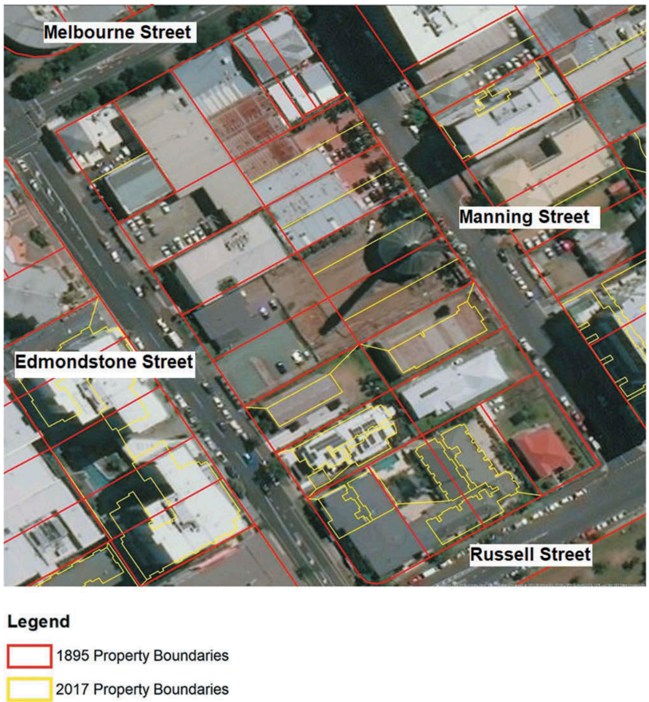

Figure 5. Property boundaries in 1895 and 2017 of the block surrounded by Melbourne Street, Manning Street, Russell Street and Edmondstone Street in South Brisbane. With 19 equal-sized lots and three small lots in 1895, this block has only five subdivisions and one amalgamation after 122 years. Sources: McKellar (1895); Department of Natural Resources and Mines (DNRM) (2017); Google Earth (2017).

Similarly, Siksna (1997) concluded that the block size in Brisbane was, in comparison to other cities, of a medium size and that as a result the urban frame is less susceptible to subdivision and remains intact over time. The results of this study demonstrate that boundary changes generally arise spontaneously through the initiative of individuals, be that owner-developers or development companies. Public authorities currently have little influence where redevelopments occur, with most potential for intervention occurring on large sites that require rezoning in return for redevelopment.

Further fragmentation of the cadaster

While land release and zoning are determined by government, the direction of investment is determined by the market. As such, government intervention has minimal substantive impact and the resulting urban form is a disorganized, patchy and fragmented mix of redevelopment (Randolph & Freestone, 2012). Figure 6 of Carl Street, Woolloongabba, demonstrates this phenomenon, where a consistent low-density residential streetscape in 2007 becomes a patchy streetscape in 2017 with detached houses neighboring apartment buildings.

Our findings show that most redevelopment (118 out of 182 or 64.8%) occurred on properties with a detached house, which are attractive to smaller developers or owner-

Figure 6. Street view of Carl Street, Woolloongabba in 2007 and 2017 (Google, 2017).

developers. Moreover, 62 redevelopments resulted in the construction of additional detached houses, within 2 km of Brisbane's CBD. While such developments contribute to urban infill targets, detached houses being constructed in Brisbane's inner suburbs simply further fragments the cadaster, which will make largescale urban infill development more difficult when vacant or industrial land with large lot sizes is no longer available.

Conclusion

For cities to adapt to fast-changing social, environmental, economic, and demographic imperatives, it is essential that urban planners, developers, and local government better understand how property amalgamation, subdivision, and reconfiguration take place in practice. This study shows that cadastral change in greyfield areas largely results in additional lots with more detached houses, rather than multiple dwellings, and that developers building multiple dwellings continue to favor brownfield sites, even when the amalgamation of lots is required. To this end, brownfield sites are those in which the state has the most direct influence, as industrial conversion through rezoning, and land acquisition for other uses (such as parks and schools) is facilitated through negotiation with a single owner on a large-footprint land lot. Outside of these former industrial areas, cadastral change in Brisbane's inner suburbs proceeds without statutory guidance from regulatory bodies, propagating *ad hoc* redevelopment.

Urban infill targets of 94% will be difficult to achieve if cadastral change in inner-city suburbs continues to fragment the cadaster with smaller lots and low-density dwellings.

Most lacking is guidance for how developers should approach infill in the statutory planning instruments applicable to Brisbane at both a local government and state level (Department of Local Government, Infrastructure and Planning (DLGIP), 2017; Brisbane City Council, 2014). The existing planning systems, primarily planning schemes that utilize land-use zoning as a means of altering building form, manage impacts from individual developments rather than delivering outcomes for the community. The state government's overarching *SEQ Regional Plan 2017* sets an infill target but the responsibility for the approval of development largely rests with local government. Brisbane City Council uses zoning as a means of densification, with many areas within the study area zoned as High-Density residential areas. Density is also incentivized, as some regions with larger footprints can build taller buildings.

Nevertheless, our results demonstrate that it is the market that decides whether the dwellings in those zones change form. Lack of political will combined with Australia's strong private property rights creates a situation where private ownership interests take preference over wider community considerations, and the existing planning systems largely ignore the economic factors of redevelopment, including site acquisition and composition, and ignore the scale of planned development. The local government takes an active role in approving specific developments (assessing their codified requirements around height, density, setbacks, car parking spaces and the like) but takes a step back to bigger picture issues such as how multiple developments interact and how cohesive they are within a neighborhood. If current trends continue and cadastral change in greyfield areas is limited to subdivision of existing lots (and developers continue to preference brownfield land for largescale developments), cities will be limited in their ability to adapt to a changing world and meet the demands of new industry and technology.

Attempts at urban infill can be hampered by the physical structure of the city, but our research also highlights that current redevelopment efforts are a direct consequence of Australia's land tenure system, which favors private ownership and low state intervention in development. Future policy should be mindful of the constraints imposed by weak planning instruments, and the lack of statutory specificity with regards to inner-city redevelopment. If infill development is to take the forms desired by existing local and state government planning schemes, the state must play a more active role in site acquisition and redevelopment. There are very few mechanisms for authorities to assemble land in Australia (except by compulsory acquisition), whereas European nations such as France, Germany and the Netherlands all have public authorities with a range of powers that allow them to overcome ownership constraints and assemble the necessary lots for redevelopment, even if that means selling the land to private developers once the lots are reconfigured (Louw, 2008). This research goes some way in analyzing the physical barriers to infill development but also demonstrates the scope for future quantitative analysis of the factors that influence cadastral change, as well as socio-political factors including community opposition to urban infill and the political will for reform.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Rachel Gallagher http://orcid.org/0000-0001-9243-5121
Thomas Sigler http://orcid.org/0000-0002-7789-0916
Yan Liu http://orcid.org/0000-0002-1612-779X

References

Adams, D., Disberry, A., Hutchinson, N., & Munjoma, T. (2001). Ownership constraints to brownfield development. *Environment and Planning A*, *33*, 453–477.

Adams, D., & Hutchinson, N. (2000). The urban task force report: Reviewing land ownership constraints to brownfield redevelopment. *Regional Studies*, *34*(8), 777–792.

Asami, Y., & Niwa, Y. (2008). Typical lots for detached houses in residential blocks and lot shape analysis. *Regional Science and Urban Economics*, *38*(5), 424–437.

Asami, Y., & Ohtaki, T. (2000). Prediction of the shape of detached houses on residential lots. *Environment and Planning B*, *27*(2), 283–295.

Australian Bureau of Statistics (ABS). (2016a). *2016 Australian census*. Retrieved from http://www.abs.gov.au/websitedbs/censushome.nsf/home/2016

Australian Bureau of Statistics (ABS). (2016b). Building approvals by greater capital cities statistical area. Retrieved from http://stat.data.abs.gov.au/Index.aspx?DataSetCode=BA_GCCSA

Australian Bureau of Statistics (ABS). (2018). 3218.0 - Regional population growth, Australia, 2016-17. Retrieved from https://www.abs.gov.au/ausstats/abs@.nsf/mf/3218.0

Birkhamshaw, A., & Whitehand, J. (2012). Conzenian urban morphology and the character areas of planners and residents. *Urban Design International*, *17*(1), 4–17.

Bobkova, E., Marcus, L., Pont, M., Stavroulaki, I., & Bolin, D. (2019). Structure of plot systems and economic activity in cities: Linking plot types to retail and food services in London, Amsterdam and Stockholm. *Urban Science*, *3*(66), 1–22.

Brisbane City Council. (2014). Brisbane city plan 2014. Retrieved from http://eplan.brisbane.qld.gov.au/

Cannon, C., Thomas, S., Treffers, R., Paschall, M., Heumann, L., Mann, G., … Nauenberg, S. (2013). Testing the results of municipal mixed-use zoning ordinances: A novel methodological approach. *Journal Health Politics, Policy & Law*, *38*(4), 815–839.

Caulfield, J. (1991). Community power, public policy initiatives and the management of growth in Brisbane. *Urban Policy and Research*, *9*(4), 209–219.

Charles, S. (2013). Understanding the determinants of single family residential redevelopment in the inner-ring suburbs of Chicago. *Urban Studies*, *50*(8), 1505–1522.

Cheung, A. (2018). Why Melbourne will see more skinny skyscrapers. Retrieved from https://www.commercialrealestate.com.au/news/why-melbourne-will-see-more-skinny-skyscrapers/

Coffee, N., Lange, J., & Baker, E. (2016). Visualising 30 years of population density change in Australia's major capital cities. *Australian Geographer*, *47*(4), 511–525.

Coleman, S. (2016). Built environment: Increased urban footprint. In *Australia state of the environment 2016*. Canberra: Australian Government Department of the Environment and Energy. Retrieved from https://soe.environment.gov.au/theme/built-environment/topic/2016/increased-urban-footprint

Conzen, M.R.G. (1960). Alnwick, Northumberland: A study in town-plan analysis. *Institute of British Geographers Publication 27*. London: George Philip.

Davoudi, S., & Sturzaker, J. (2017). Urban form, policy packaging and sustainable urban metabolism. *Resources, Conservation and Recycling*, *120*, 55–64.

Department of Housing and Public Works. (2018). Density and diversity done well. Retrieved from http://www.hpw.qld.gov.au/aboutus/OQGA/Pages/DensityDiversityDoneWellOpenIdeaCompetition.aspx

Department of Local Government, Infrastructure and Planning (DLGIP). (2017). *Shaping SEQ: South East Queensland regional plan*. Brisbane: Queensland Government.
Department of Natural Resources and Mines (DNRM). (2007). *Digital cadastral database: Brisbane LGA*. Brisbane: Queensland Government, DNRM.
Department of Natural Resources and Mines (DNRM). (2017). Digital cadastral database, Queensland government, Retrieved from https://data.qld.gov.au/dataset/cadastral-data-queensland-series
Dovey, K., Pike, L., & Woodcock, I. (2017). Incremental urban intensification: Transit-oriented re-development of small-lot corridors. *Urban Policy and Research*, *35*(3), 261–274.
Duany, A., Plater-Zyberk, E., & Speck, J. (2000). *Suburban nation: The rise of sprawl and the decline of the American Dream*. New York: North Point Press.
Easthope, H., Tice, A., & Randolph, B. (2009). *The desirable apartment life? The demand for higher density housing in Sydney and Melbourne Working Paper 5* (ARC Project DP0773388). Sydney: City Futures Research Centre, University of New South Wales.
Ewing, R., Pendall, R., & Chen, D. (2003) Measuring sprawl and its impact, smart growth America. Retrieved from https://smartgrowthamerica.org/app/legacy/documents/measuring sprawltechnical.pdf
Feng, J., Wang, F., & Zhou, Y. (2009). The spatial restructuring of population in metropolitan Beijing: Toward polycentricity in the post-reform era. *Urban Geography*, *30*(7), 779–802.
Forster, C. (2006). The challenge of change: Australian cities and urban planning in the New Millennium. *Geographical Research*, *44*(2), 173–182.
Frederickson, C. (2015) *Density through amalgamation? Battling the sticky cadastre*. Paper presented at State of Australian Cities Conference, Gold Coast, Australia.
Frederickson, C., Fergusson, E., & Wildish, B. (2016). *Residential property amalgamation and aggregation in Auckland 2004-2014*. Auckland: Auckland Council.
Gabbe, C.J. (2017). Why are regulations changed? A parcel analysis of upzoning in Los Angeles. *Journal of Planning Education and Research*, *38*(3), 289–300.
Gao, X., & Asami, Y. (2007). Influence of lot size and shape on redevelopment projects. *Land Use Policy*, *24*(1), 212–222.
Gillen, M. (2006). The challenge of attaining a sustainable urban morphology for South East Queensland. *Planning Practice & Research*, *21*(3), 291–308.
Google. (2017). Google maps. Retrieved from http://www.google.com.au/maps
Google Earth. (2017). Brisbane, Australia 27.4698° S, 153.0251° E, version 7.3. Retrieved from http://www.google.com/earth/index.html
Gu, K. (2010). Urban morphological regions and urban landscape management: The case of central Auckland, New Zealand. *Urban Design International*, *15*(3), 148–164.
Guerra, E. (2013). *The new suburbs: Evolving travel behavior, the built environment, and subway investments in Mexico City* (PhD Thesis). Berkeley: University of California.
Harris, R. (2004). *Creeping conformity. How Canada became suburban, 1900–1960*. Toronto: University of Toronto Press.
Harris, R. (2015). The changing nature of the workplace and the future of office space. *Journal of Property Investment & Finance*, *33*(5), 424–435.
Hastings, E. M., & Adams, D. (2005). Facilitating urban renewal: Changing institutional arrangements and land assembly in Hong Kong. *Property Management*, *23*(2), 110–121.
Hayden, D. (2003). *Building suburbia: Green field and urban growth, 1820-2000*. New York: Vintage.
Home, R. (1997). *The 'grand modell' of colonial settlement. Of planting and planning: The making of British colonial cities*. Melbourne: E & FN Spon.
Horn, A., & Van Eeden, A. (2017). Measuring sprawl in the Western Cape Province, South Africa: An urban sprawl index for comparative purposes. *Regional Science Policy and Practice*, *10*(1), 15–23.
Jackson, K. (1985). *Crabgrass frontier: The suburbanization of the United States*. Oxford: Oxford University Press.

Kidd, R. (2001). Aboriginal history of South Brisbane. *Journal of the Royal Historical Society of Queensland*, *17*(11), 463–480.
Knox, P., & McCarthy, L. (2012). *Urbanization: An introduction to urban geography* (3rd ed.). Pearson: Boston.
Knox, P. L. (1991). The restless urban landscape: Economic and sociocultural change and the transformation of metropolitan Washington, DC. *Annals of the Association of American Geographers*, *81*(2), 181–209.
Kropf, K. (2017). *The handbook of urban morphology*. Chichester, UK: John Wiley and Sons Ltd.
Land Information New Zealand. (2018). Impact of the canterbury property boundaries and related matters Act 2016 on survey and title. Retrieved from https://www.linz.govt.nz/kb/896
Laverty, J. (1970). The Queensland Economy 1860-1915. In D. Murphy, R. Joyce, & CA. Hughes (Eds.), *Prelude to Power: Rise of the Labour Party in Queensland 1885-1915* (pp. 28–44)). Brisbane: Jacaranda Press.
Lee, J., Won, S., & Kim, S. (2016). Describing changes in the built environment of shrinking cities: Case study of Incheon, South Korea. *Journal of Urban Planning Development*, *142*(2), 1–10.
Loh, L., & Brieger, W. (2014). Suburban sprawl in the developing world: Duplicating past mistakes? The case of Kuala Lumpur, Malaysia. *International Quarterly on Community Health Education*, *34*(2), 199–211.
Louw, E. (2008). Land assembly for urban transformation – The case of 's-Hertogenbosch in the Netherlands. *Land Use Policy*, *25*(1), 69–80.
Manchester City Council. (2019). Greater Manchester's plan for homes, jobs and the environment. Retrieved from https://secure.manchester.gov.uk/info/200024/consultations_and_surveys/7725/greater_manchester_s_plan_for_homes_jobs_and_the_environment
McCarthy, J. (1998). Reconstruction, regeneration and re-imaging: The case of Rotterdam. *Cities*, *15*(5), 337–344.
McDonald, C. (2004). The promise of destruction. *The Australian Journal of Emergency Management*, *19*(4), 51–55.
McKellar, A. (1895). 6 chain McKellar series 1895—Brisbane, Queensland Government. Retrieved from: https://data.qld.gov.au/dataset/historical-cadastral-map-seriesqueensland/resource/f599c6d2-92db-450c-9918-77bbb3fa095d
Metro Vancouver. (2019). Metro Vancouver 2040: Shaping our future. Retrieved from http://www.metrovancouver.org/services/regional-planning/metro-vancouver-2040/Pages/default.aspx
Michell, A., & Wadley, D. (2004). The process and progress of urban consolidation. *Australian Planner*, *41*(4), 56–65.
Miller, N. (2014). Workplace trends in office space: Implications for future office demand. *Journal of Corporate Real Estate*, *16*(3), 159–181.
Moudon, A. (1997). Urban Morphology as An Emerging Interdisciplinary Field. *Urban Morphology*, *1*, 3–10.
Murray, S., & Khor, L. (2011). Renovating the Suburbs. *Architecture Australia*, 100(3), 35–37.
Mustafa, A., Van Rompaey, A., Cools, M., Saadi, I., & Teller, J. (2018). Addressing the determinants of built-up extension and densification processes at the regional scale. *Urban Studies*, *55*(15), 3279–3298.
Neilson, L. (2008). The 'Building Better Cities' program 1991-96: A nation-building initiative of the Commonwealth Government. In J. Butcher Ed., *Australia Under Construction: Nation-building past, present and future*, 83-117. Canberra: ANU Press.
Nelson, C. (2009). The new urbanity: The rise of a new America. *The Annals of the American Academy of Political and Social Science*, *626*(1), 192–208.
Newton, P., Meyer, D., & Glackin, S. (2017). Becoming urban: Exploring the transformative capacity for a suburban-to-urban transition in Australia's Low Density Cities. *Sustainability*, *9*, 1–22.

Newton, P., Murray, S., Wakefield, R., Murphy, C., Khor, L., & Morgan, T. (2011). *Towards a new development model for housing regeneration in greyfield residential precincts*. Melbourne: Australian Housing and Urban Research Institute, Swinburne-Monash Research Centre.

Oliver, E. (1983). *The rebuilding of the city of St John's after the Great Fire of 1892: A study in urban morphogenesis (Master of Arts)*. Memorial University of Newfoundland, St John's Newfoundland.

Pawson, H., Hulse, K., & Cheshire, L. (2015). *Addressing concentrations of disadvantage in urban Australia* (AHURI Final Report No.247). Melbourne: Australian Housing and Urban Research Institute.

Phan, T. J., P., & Chandra, S. (2008). Urban infill: Extent and Implications in the City of Monash. *People and Place*, *16*(4), 23–31.

Proudfoot, H Hamnet, S. & Freestone, R. (eds (2000). Founding cities in nineteenth-century australia. In Hamnet, S. & Freestone, R. (eds (eds), *The australian metropolis*. NSW: Allen & Unwin: St Leonards.

Psarra, S., Kickertt, C., & Pluviano, A. (2013). Paradigm lost: Industrial and post-industrial Detroit – An analysis of the street network and its social and economic dimensions from 1796 to the present. *Urban Design International*, *18*(4), 257–281.

Puustinen, T., & Viitanen, K. (2015). Infill development on collectively owned residential properties: understanding the decision-making process – Case studies in Helsinki. *Housing, Theory and Society*, *32*(4), 472–498.

Racine, F. (2019). The influence of urban design theories in the transformation of urban morphology: Montreal from 1956 to 2018. *Journal of Urban Design*, 1–25.

Randolph, B., & Freestone, R. (2012). Housing differentiation and renewal in middle-ring suburbs: The experience of Sydney, Australia. *Urban Studies*, *29*(12), 2557–2575.

Ren, X. (2015). Territorial expansion and state rescaling: A critique of suburbanization studies in China. In M. Clapson & R. Hutchison (Eds.), *Suburbanization in Global Society* (Vol. 10, pp. 347–366). Bingley, UK: Emerald Publishing.

Ruming, K., Randolph, B., Pinnegar, S., & Judd, B. (2007). *Delivering sustainable renewal in Australia's middle and outer suburbs: Council reflections*, Paper presented at State of Australian Cities Conference, Adelaide.

Ryan, B. (2006). Morphological change through residential redevelopment: Detroit, 1951-2000. *Urban Morphology*, *10*(1), 5–22.

Ryan, B. (2008). The restructuring of Detroit: City block form change in a shrinking city 1900-2000. *Urban Design International*, *13*(3), 156–168.

Sanders, P., & Schroder, N. (2008). *The genealogy of urban form: Brisbane case study*. Paper presented at Subtropical Cities 2008: From Fault-lines to Sight-lines -Subtropical Urbanism in 20-20, 3-6 September 2008, Brisbane, State Library of Queensland.

Sanders, P., & Woodward, S. (2015). Morphogenetic analysis of architectural elements within the townscape. *Urban Morphology*, *19*(1), 5–24.

Scheer, B., & Ferdelman, D. (2001). Inner-city destruction and survival: The case of Over-the-Rhine, Cincinnati. *Urban Morphology*, *5*(1), 15–27.

Scoppa, M., & Peponis, J. (2015). Distributed attraction: The effects of street network connectivity upon the distribution of retail frontage in the City of Buenos Aires. *Environment and Planning B*, *42*(2), 354–378.

Scrase, A. J. (1989). Development and change in burgage plots: The example of Wells. *Journal of Historical Geography*, *15*(4), 349–365.

Siksna, A. (1997). The effect of block size and form in North American and Australian city centres. *Urban Morphology*, *1*, 19–33.

Siksna, A. (1998). City centre blocks and their evolution: A comparative study of eight American and Australian CBDs. *Journal of Urban Design*, *3*(3), 253–283.

Siksna, A. (2006). The study of urban form in Australia. *Urban Morphology*, *10*(2), 89–100.

Spearritt, P., & DeMarco, C. (1988). *Planning Sydney's future*. Sydney: Allen and Unwin.

State Government of Victoria. (2016). Plan Melbourne 2017-2050. Retrieved from https://www.planmelbourne.vic.gov.au/

Stell, G., & Tait, R. (2016). Framework and form: Burgage plots, street lines and domestic architecture in early Scotland. *Urban History*, *43*(1), 2–27.
Stewart, O., & Moudon, A. (2014). Using the built environment to oversample walk, transit and bicycle travel. *Transportation Research Part D*, *32*, 15–23.
Stubbs, M. (2011). *The eminent domain in Australia: The 'Individual Rights' Approach to section 51(xxxi) of the Australian Constitution* (PhD Thesis). Adelaide: University of Adelaide.
Taima, M., Asami, Y., & Hino, K. (2019). The relationship between block size and building shape. *Environment and Planning B*, *46*(1), 103–121.
Talen, E. (2011). Sprawl retrofit: Sustainable urban form in unsustainable places. *Environment and Planning B*, *38*, 952–978.
Troy, P. (2004). *The structure and form of the Australian city: Prospects for improved urban planning (Issues Paper 1)*. Brisbane: Urban Policy Program, Griffith University.
Trubka, R., Newman, P., & Bilsborough, D. (2010). The costs of urban sprawl - infrastructure and transportation. *Environment Design Guide*, *83*, 1–6.
Walters, P., & McCrea, R. (2014). Early gentrification and the public realm: A case study of West End in Australia. *Urban Studies*, *51*(2), 355–370.
Webb, B., & Webber, S. (2017). The implications of condominium neighbourhoods for long-term urban revitalisation. *Cities*, *61*, 48–57.
Weber, R. (2016). Performing property cycles. *Journal of Cultural Economy*, *9*(6), 587–603.
Whitehand, J. (1994). Development cycles and urban landscapes. *Geography*, *79*(1), 3–17.
Whitehand, J. (2001). British urban morphology: The conzenian tradition. *Urban Morphology*, *5* (2), 103–109.
Yassin, A. (2019). Livable city: an approach to pedestrianization through tactical urbanism. *Alexandria Engineering Journal*, *58*(1), 251–259. doi:10.1016/j.aej.2019.02.005
Zhou, H., & Gao, H. (2018). The impact of urban morphology on urban transportation mode: A case study of Tokyo. In *Case Studies on Transport Policy*.
Ziegler, E. (2009). The case for megapolitan growth management in the twenty-first century: Regional urban planning and sustainable development in the USA. *International Journal of Law in the Built Environment*, *1*(2), 105–129.