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Towards more resilient cities: land use and urban efficiency

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Keywords

Urban efficiency, resilience, architecture, planning, spatial planning

Abstract

High rates of urbanization lead to a fragmented urban form with unequal access to jobs, amenities and public services. The lack of efficient and adaptive layout and design, integrated land uses (Paton et al., 2013; Saunders & Becker, 2015), urban connectivity (Taaffe et al., 1963) and sufficient forward planning at all levels of government is identified as a shortcoming which only exacerbates the consequences of urbanization.

Based on an analysis of spatial planning principles, this paper proposes a practical and policy-related set of tools for improved forward planning, promoting resilient layout planning and smart land use management as a means to enable diverse settlements to respond to events such as intense levels of urbanization. The case study is focused on the dualistic urban settlements of South-Africa, but principles proposed could be applied to other settlements with similar spatially distorted patterns. The proposed set of tools could potentially improve urban resilience and efficiency.

Introduction

According to the World Bank (2015), the world's urbanization level is drastically increasing and stands at an even higher 53% urbanization rate. This assertion is clearly reflected in South Africa as well, the UN projects that 71% of South Africa's population will live in urban areas by 2030, reaching almost 80% by 2050 (UN Habitat, 2016). Turok (2012:21) reveals that urbanization leads to a fragmented urban form with unequal access to jobs, amenities and public services in South Africa. This, in turn, leads to a number of challenges including inefficient infrastructure, long travel distances, poor service delivery, low-quality spaces, disintegration, and separation. The ineffective and inadaptable layout and design, non-integrated land uses and insufficient forward planning at all levels of government and aspects result in the inability of some cities to effectively keep up with a high urbanization rate, therefore exacerbating the problems. By taking these various components into account and determining what causes one city to handle and absorb rapid urbanization better than others, a framework may be established which will lead to more resilient cities. This study was initiated to potentially provide a practical set of land use management tools that will lead to improved urban resilience and efficiency. This will potentially improve and simplify the implementation of urban resilience and efficiency, and enable cities to plan for shocks and recover from them with faster and more effective adaption. Most of the available studies and research focus on resilience in terms of natural disasters and shocks, with little or no emphasis on urban resilience, especially pertaining to land use types. This study focuses on the numerous theories and principles associated with land use planning, resilience, and efficiency, and identifies key aspects of urban resilience and urban efficiency. The article will explore the different spatial components influencing the

capacity of a settlement to respond positively to rapid changes, and subsequently propose a multi-faceted approach that leads to urban resilience and efficiency Proposals will also be made regarding a tool for the government to enhance resilience and efficiency and guide development through land use management systems.

Land Use Planning

Land use planning in this century faces both threats and opportunities. It is expected that land use planning should deliver sustainable development and livable communities, but it should also cope with serious conflicts regarding these two visions (Godschalk, 2004:5). It seems that the future of land use planning depends on how it resolves these conflicts and creates cities that are liveable and sustainable. The New Urban Agenda (Habitat III UN, 2016) embraces urbanization and calls for "more appropriate policies (which) can take advantage of urbanization across physical space". Urban sprawl could be identified as one of the main challenges of land use management and refers to land development that occurs at a specific pattern and a specific pace, where the pace refers to the rate which land is consumed for urban processes to ensure the growing population has sufficient land to develop on (Pfister, 2004:4). Urban sprawl also refers to the following (Burchell et al., 1998:43): (i) low-density development dispersed over a large area of land; (ii) geographic separation of necessary resources such as work, homes, schools, and shopping; and (iii) high dependence of automobiles. Therefore, urban sprawl leads to higher public and private costs, being less economic as the cost to supply infrastructure and services are more expensive (Bhatta, 2010:28). He suggests that mixed land-use planning will fight against urban sprawl, otherwise it causes separation and fragmentation which in turn leads to urban sprawl. In answer to the challenges experienced worldwide, and more specifically in the South African context, various aspects are identified which facilitated the application of land use management practices to address these challenges, i.e. densification, zoning, mixed land use, corridor connections and sense of community.

Densification is discussed extensively in planning literature as a possible way to achieve compact cities, combat sprawl and create urban sustainability (Daneshpour & Shakibamanesh, 2011:110; Gordon & Richardson, 1997:97). Therefore, depending on the context, densification can mean different building forms and processes. The approach aims to counteract negative effects of urban sprawl in terms of ineffective land-use and related environmental problems through densification and compact building. Dowall and Clark (1997:16) suggest that zoning measures are one of the most commonly used planning tools. They state that land zoning provides landowners with information on how their land can be optimized and where to situate buildings. to improve the different uses. Zoning regulates the use of land in residential, industrial, commercial, agricultural or other land-use areas and is used to control population density, urban sprawl, traffic, and other urban problems. Drescher (2015:2) argues that mixed zoning is important especially in clustered developments where residential areas and working sites are planned as one entity. In many developing countries, the impromptu squatter settlements around the outskirts of cities, where small-scale industries, housing, and agriculture are located in close proximity to each other, are also mixed zoning models. Du Plessis (2015: 218) asserts that the concept of mixed land use types in the South African context, has remained prominent on the spatial planning agenda since the early 1990s, and was most profoundly influenced by the seminal work of Dewar and Uytenbogaardt (1991) in which they argue that 'the multifunctional use of space and facilities is not only desirable: it is economically essential (Dewar & Uytenbogaardt, 1991:59). They also identify the integration of urban activities and land use types as one of five central conceptual changes required for the transition of South African cities onto a more positive urban developmental path.

Economic or development corridors are defined by Brunner (2014:29) as integrated networks of infrastructure within a geographical area designed to stimulate economic development and it may be developed within a country or between two or more countries. Similarly, Octaviano (2014: 2) and Bowland and Otto (2012: 3) affirms that development corridors may be created to link manufacturing hubs, areas with high supply and demand, and manufacturers of value-added goods and often feature integrated infrastructure, such as highways, railroads and ports, and may link cities or countries. McMahon (2012:2) defines a sense of community is a unique collection of qualities and characteristics – visual, cultural, social, and environmental – that provide meaning to a location. The sense of place is what makes one city or town different from another, but the sense of community is also what makes our physical surroundings worth caring about (McMahon, 2012:2). Deitrick and Ellis (2004:428) suggest that aspects such as street connectivity, mixed land use, and accessible destinations along with moderate

to higher levels of residential density, public gathering places and quality parks and open space all lead to an improved sense of community. The Sustainable Cities Institute (2012) states that a strong sense of community is a vital principle for sustainable land use management.

Urban Resilience

This section connects resilience to the planning realm and determines how land use types and urban efficiency could improve the resilience of a city. According to Christopherson et al. (2010:3), the term resilience originates from the field of environmental studies where it is used to describe the biological capacity to adapt and thrive under adverse environmental conditions. Stumpp (2013:231), recognizes that the concept of resilience has been applied to different systems and increasingly understood in more fields for the last forty years, with its definition becoming ambiguous. Meerow et al. (2016:42) argue that the problem with resilience is its multitude of different definitions and turning any of them into operational tools. He further states that the definition has become so broad that it is seemingly meaningless.

In order to define the term urban resilience within an urban system, it is important to establish a common understanding of the term urban system and what it entails. Many early writers, such as Christaller (1966), Harris and Ullman (1945) and Lösch (1954) discussed the origin and nature of systematic variations in the characteristics of urban places, however, a lot of detail remains uncovered. Bourne and Simmons (1978:15) stress that the mere understanding of how a city changes (grows, stagnates or declines) is not enough to study that particular city. Rather, the city should be seen as part of a larger system. According to Bourne and Simmons (1978:15), it is a complex system where the strong interaction between the elements creates "feedback effects which regulate growth and change", however this complex system was modelled as a relatively simple hierarchical order of cities- "a national system dominated by metropolitan centers and characterized by a step-like hierarchy". Bourne (1975:32) states that the cities and urban regions of a modern industrial economy constitute a set of interrelated subsystems nesting in a complex hierarchy of increasing scale upward from individual urban areas to a national urban system. He adds that urban systems are structures which are determined by the spatial distribution of centers of production and consumption in the private and public sectors of the economy. He further categorizes an urban system into three levels, i.e. the national system, the subsystem at the regional level and the daily urban system. For the purpose of this study, references regarding the urban system will be focused on the third level (daily urban system) only, although it is apparent that each level impacts on the larger urban system as referred to by Bourne (1975). According to Bretagnolle et al. (2010:1), the organization of urban systems can be defined on three main levels: the (i) micro level represents elementary units (persons, firms, institutions) that are living together in a city, (ii) the meso level corresponds to the city itself (as a consistent geographical entity), and the (iii) macro level is the system of cities, which is made up of a large number of towns and cities which interact under a combined control (national political territory or a global economic network). This organization is shaped by interactions operating on different spatial and temporal scales of observation.

A comprehensive definition of urban resilience needs to incorporate these four sub-systems conducted from the daily urban system and its interactions and to do so in an inclusive and flexible way, it is essential to allow some degree of perspectives and emphases to remain. Consequently, for the purpose of this paper urban resilience is defined as:

"the ability of a daily urban system-and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity". This definition was carefully worded and developed to articulate each of the sub-systems. Urban resilience operates in non-equilibrium and emphasizes the importance of timescales and adaptive capacity and recognizes multiple change pathways (Meerow et al. 2016:45). It is also safe to say that resilience shares much with other key contemporary urban goals such as sustainability, governance and economic development (Hurlston & Thompkins, 2012:171).

Dewar and Uytenbogaardt (1991:22) identify the integration of urban activities and land uses as one of six central conceptual changes required for the transition of cities onto a more positive urban developmental path. The other changes include (i) balance, (ii) freedom, (iii) equity, (iv) intensity, diversity and necessary complexity, and (v) community. They argue that positively performing urban environments

reflect a high degree of integration between different parts and elements of the city. Groups and communities should be able to benefit from a greater range of opportunities and facilities. For this to occur, they suggest that the more intensive activities and events need to be exposed to the inhabitants of many local areas. These principles will subsequently form part of the tools as identified in section 4.

Resilience and Spatial Planning Principles

According to ICLEI (2012:2), integrated land-use planning is an essential key to land use decisions and zoning extensions; they argue that a better land use management and integrated urban planning strategy, are essential to improve the current and future resilience of cities and that it should involve all levels of governance and local communities. Saunders and Becker (2015:75) state that land use planning is one of the main measures that contribute to resilience. This idea is supported by Paton et al. (2013:38), who argue that land use planning is an integral part of creating a resilient society. Therefore, it is vital to refer back to land use planning to try and establish the theoretical principles for successful land use compilation in order to achieve urban resilience. Through an extensive literature review on best practice and generally agreed upon and accepted doctrines for sound spatial planning, the following principles were identified: place-making, opportunity, efficiency, choice, identity and change, proportion and scale, liveability, enclosure, access, movement networks, public transport, open spaces, public facilities and economy. Lynch's (1984:121) study on the several principles that contribute to the best practice city, shows that a city and its planning policies should make provision for the following dimensions:

Table 1: Lynch's spatial planning principles for the best practice city

Vitality	The degree to which the form of the settlement supports the vital functions.
Sense	The degree to which a city can be clearly perceived and mentally differentiated and structured in time and space.
Fit	The degree to which the form and capacity of spaces, channels, and equipment in a city match the pattern and quantity of actions.
Access	The ability to reach other persons, resources, information, services and other people.
Control	The degree to which the use and access to spaces and activities, and their modification and management are controlled by those who use, work, or reside them.
Efficiency	The cost of creating and maintaining the city.
Justice	The way in which the environmental benefits and costs are distributed among people.

Source: Adapted from Lynch (1984: 121)

Lynch regards the above-mentioned principles important for the spatial planning of an urban area. Similarity may be observed from Behrens and Watson (1996) and Lynch and Hack (1984) in some of the principles, which highlight the importance of these principles.

Behrens and Watson (1996:66) state that the following principles are intended to contribute to the best practice city. The principles are discussed as normative concerns presented:

Table 2: Behrens and Watson's spatial planning principles for the best practice city

Placemaking	The concept of a 'sense of place' attainment cannot be accomplished through the submission of standardized planning actions: it results from imaginative, appropriate actions based on an understanding of the site, human need, function, and culture.
Scale	The design of widths, heights, surfacing, and operations of a number of elements of a layout plan from the perspective of the person on foot has implications for the planning and design of public facilities.
Access	Circulation needs and maximization of levels of access should be met, especially to commercial, facility and employment opportunities. Public transport, road network design and city-wide land use distribution patterns are important and therefore have implications for planning and design of circulation and public facility systems.
Opportunity	Maximization of the economic opportunities happens in large agglomerations of people through the arrangement of infrastructural investments in space. Local economic development and creation of economic opportunities have implications for the planning and design of amenity, circulation and utility systems.

Efficiency	Land use policies, transport policies, and capital investment programs are affected by the cost-effective utilization of land and financial resources.
Choice	The maximization of the range of choices available to end-user communities regarding housing consolidation, urban surroundings, service provision and movement modes affects design and planning of circulation, utility systems, and amenity.

Source: Adapted from Behrens and Watson (1996:66)

Behrens and Watson's (1996) principles are very similar to Lynch's (1984) identified principles, but it is notable that Behrens and Watson (1996) elaborate more on these principles which might ease the application by making the principles more understandable and practical. Lynch and Hack (1984:75) suggest that the following principles will lead to the best practice city:

Table 3: Lynch and Hack's spatial planning principles for the best practice city

Identity and change	Each site is unique and different in some degree. Interrelations on sites indicate the planner's limits and point out the damage that may be imposed since site development can provide unexpected effects that pass along the entire chain.
Proportion and scale	Spatial character varies with proportion and scale. Proportion is the internal relation between parts or areas, while the scale is the relation of size of elements to the size of other objects through the observer.
Enclosure	Outdoor spaces are defined by trees, buildings, hedges, and hills, but are seldom completely enclosed. Level changes can define spaces while creating effects of dynamic movement. The success of a site is more dependent on the levels than the general shape itself.
Access	Access is the degree to which users can reach other persons, resources, services, places or information. The quality of dealing with traffic is a fundamental advantage of any organized site, therefore it is important to create linkages between important activities with provision to various kinds of transport.

Source: Adapted from Lynch and Hack (1984:75).

Lynch and Hack (1984:75) emphasize the enclosure and access of an urban area which contributes to the aesthetic and the practical aspects of the city, as it assists to maintain the balance in the spatial aspects of an urban area. Chapin and Kaiser (1979:39-75) suggest that the following principles will lead to the best practice city:

Table 4: Chapin and Kaiser's spatial planning principles for the best practice city

Liveability	The qualities in the physical environment of the urban area which tend to induce the citizens a feeling of mental, physical, and social well-being.
Health and safety	This refers to regulatory measures such as health, sanitation, housing and building codes. This includes density controls and controls over hazardous areas
Convenience	Public convenience is an element of the public interest in upholding the construction of streets and highways as a public purpose.
Economy	This term is associated with efficiency in the land use pattern and its public cost implications in terms of municipal expenditures etc.
Amenity	This term refers to the pleasantness of the urban environment as a place in which to live, work and spend leisure time.

Source: Adapted from Chapin and Kaiser (1979:39-75).

From the preceding table, it is evident that Chapin and Kaiser has a different approach to the spatial planning principles with emphasis on aspects such as the economy. It is less corresponding with other sources, which means that the combination of these different sources will lead to a comprehensive set of principles. The preceding tables (Table 1- Table 4) illustrate that there is a lot of agreement between the different sources. It can be concluded that the overarching and most important principles consist of the following: place-making, opportunity, efficiency, choice, identity and change, proportion and scale, liveability, enclosure, access, movement networks, public transport, open spaces, public facilities, and economy. It is argued that these principles can be applied in the urban planning process in order to improve urban resilience.

The principles identified in the literature review were in turn linked to six land use planning tools (zones of public transport, infill planning, open space systems, mixed land use, densification, urban edge) available to address issues in relation thereto (Richter, 2016).

Table 5: Relationship between land use management tools and spatial planning principles

	Public transport	Infill planning	Open space systems	Mixed land-use	Densification	Urban edge
Place Making			X	X		
Opportunity	X	X	X	X	X	
Efficiency	X	X		X	X	X
Choice	X	X		X	X	
Identity and Change		X	X			X
Proportion and Scale		X	X			X
Liveability	X		X	X	X	
Enclosure			X	X		X
Access	X	X		X	X	
Movement Networks	X			X		
Public Transport	X					
Open Spaces			X			
Public Facilities	X		X	X	X	
Economy	X	X		X	X	X

Source: Richter, 2016.

From the above table, it is apparent that all the recurrent aspects treated in the study can be addressed through more concentrated, integrated and combined principles. This will lead to improved implementation as it is simpler and has fewer aspects or requirements to adhere to. These six principles (x-axis) were selected on the basis of a vigilant and transparent process to ensure that it touches all the fourteen aspects (y-axis) which theorists and legislation argue have the greatest contribution towards urban efficiency and urban resilience. The six concepts are a simplified, comprehensive and inclusive version of the fourteen principles. This table buttresses the main argument of the study which states that the implementation of an appropriate land use and densification model will lead to more resilient and efficient cities.

Empirical Study

The literature study highlights that there are various opinions and views regarding the morphology of urban models, and their sustainability and resilience. Given the fact that spatial aspects ought to be combined from the different urban models, it is implausible to proclaim a specific model as being more resilient and more sustainable than another. Rather an integrated approach which assimilates the positive aspects of the various models should be, as such an approach is more likely to improve the resilience and sustainability of an urban area. The empirical study was performed using South Africa as the focal case study on both a qualitative and quantitative basis. As a result of South Africa's history in terms of Apartheid and urban form, it is important to create a South African context to understand the background and origin of South African cities. It will also contribute to the background and basis of South African cities throughout the rest of the study. In 1981, Davies developed the Apartheid city model, which was preceded by his segregation model (Davies, 1981:59), and had strong resemblances to Hoyt's classic sector model (1939). The Apartheid city was the result of the 1950 Group Areas Act, which sought to separate various racial groups in South Africa into distinct areas (Christopherson, 1984:77). The South African cities are often regarded as a unique, defying contrast. A white minority were practicing the policies, while it led to racial discrimination and no freedom or independence to several races (Simon, 1989:191). He states that South Africa shares a colonial history of European conquest and is influenced by the early British ‘native’ policy which leads to segregation and became the model for German and other British settlement colonies in Africa. Afrikaner nationalists adopted and systemized this inheritance of native reserves and urban segregation of Africans which resulted in the features of the Apartheid city, as subsequently illustrated.

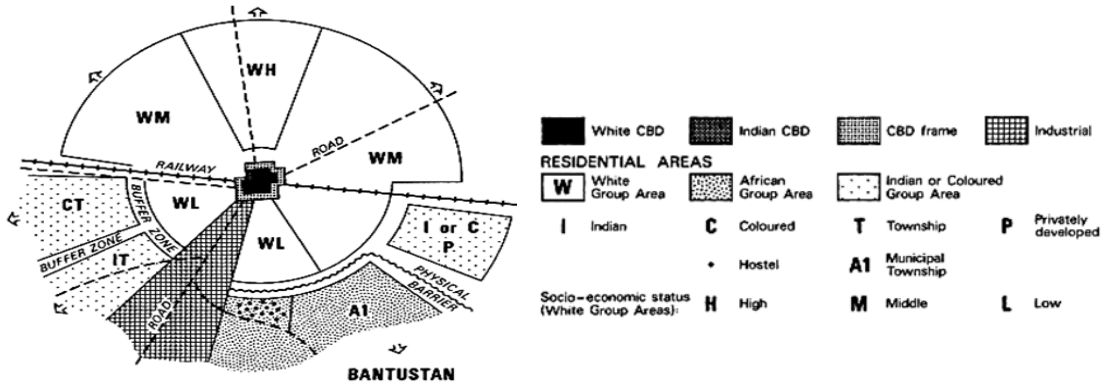

Figure 1: The original Apartheid city model
Source: Davies (1981:64).

The decision to use the generic twin city as a case study, rather than limit the study to one specific settlement, is informed by the uniform approach in land use and layout planning throughout South Africa through various policies and legislation, the most recent being SPLUMA (South Africa, 2013). In the case of South Africa, the Apartheid city led to a physical gap between the city and the informal settlements (twin city) as previously discussed. This situation is not only visible in South African cities, it is also found in other international cities, which contributes to the development of slum areas and urban decay within the CBD area. Land use management as a regulatory tool is one of the aspects that strongly influences the urban resilience of a city. The application mechanisms of land use management directly refer to tools that can improve urban resilience. These urban areas are seemingly non-resilient, unsustainable in certain levels, inaccessible due to non-integrated nodes and corridors, and inefficient as a result of urban sprawl. Similarly, dilapidated areas are apparent in many settlements and the inefficient land uses directly affect the end-user. As a result, it is pertinent to find tools to improve communication, integration, and application of guidelines and policies across all levels of government.

In order to minimize interracial contact, the simplified urban structure with its racially exclusive and unequal residential areas, health, and education and recreation facilities were designed. Simon (1989:191) asserts that future growth occurs outwards from each segment to assure that the pattern remains preserved (Figure 1). This white dominated urban structure reflects and reinforces the social formation required by the domination, whereby overcrowded African townships were designed with the minimum cost.

The findings throughout the study reveal that contemporary South African cities are faced with several slow-burn challenges. Evidently, there is a lack of practical policy and tools that can address these problems. The subsequent figure (Figure 2) is based on a generic South African city with a typical Apartheid city morphology where there is a rigid separation between the city and the informal settlements (twin city). The twin city is a smaller replica of the city, but with organic development with little town planning principles and tools applied to this area. This morphology and its related problems lead to non-resilient and inefficient cities.

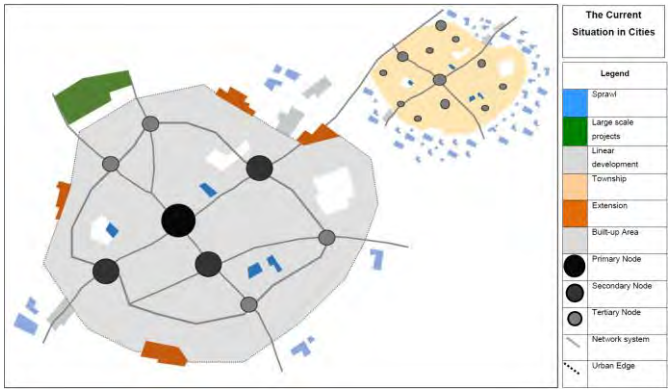

Figure 2: Current dualistic cities
Source: Richter, 2016.

In the State of South African Cities Report (SACN, 2016) it is emphasized that spatial form, human settlement, and public transport interventions are interdependent and will undermine each other if planned and implemented separately. The challenge for cities is to enhance their spatial form in a way that makes them increasingly economically efficient and resilient, as well as more inclusive, enabling people to access different economic opportunities across city space. Cities, therefore, need to use their spatial planning and land-use management (zoning) instruments, and human settlement and public transport investments more effectively to concentrate and densify where people live and where they work along core public transport corridors and economic centers (SACN, 2016). This is subsequently addressed through various land use management instruments.

Urban sprawl can be addressed by implementing the urban edge and applying densification within the boundaries of the city with a specific focus on important nodes and around corridors. Segregation will be eliminated through the integration of corridors enhancing efficient transport systems and integration between the city and twin city, eradicating the invisible boundary between the city and its twin city.

Economic inefficiency can be transformed through enhancing and developing nodes and corridors that lead to improved competitiveness. Land use inefficiencies will be addressed through densifying primary and secondary nodes, setting an urban edge and planning for mixed land use types (Figure 3 refers).

Public transport has significant potential to contribute to the urban resilience of a city. It helps foster a sense of community by connecting people and providing accessible transport for people regarding their social or demographical status. It encourages people to have a healthier lifestyle with more available options regarding walking or cycling. Public transportation also reduces the need for building car parks, leading to the more efficient use of land. It also leads to a better natural environment with less pollution. Important movement corridors and networks should be identified within the urban area. These networks and corridors should be divided into certain zones due to the capacity and daily movement. Efficient ways of public transport should be implemented within the identified zones.

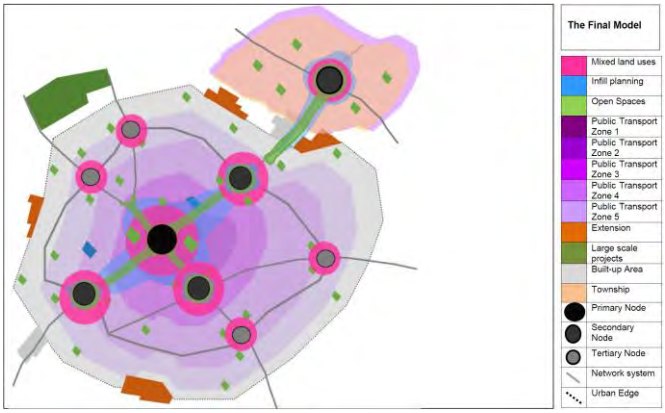

Figure 3: Urban resilience and efficiency model
Source: Richter, 2016.

Transport modes may vary from bus transport systems, railway systems, and bicycle systems according to the distance from the CBD. Although focus should be placed in and around the central area of the city, it is essential that the "twin city" forms part of this system to eliminate the gap or zone of segregation. Efficient, effective and affordable public transport options are essential in this area. Public transport zones, as illustrated in Figure 3, will increase the number of opportunities in communities by having improved access to social, economic and environmental facilities. With more alternatives and different modes of transport people will have better choices and access to workplaces and other amenities. This will, in turn, have a positive impact on the economy of the city and lead to more efficient and livable cities with less traffic, improved accessibility and less pollution.

Infill planning will assist in regenerating areas and prevent urban decay, and by doing so, contribute to improved urban resilience. It will improve the air quality through improved transportation and shorter travel distances. Daily needs and services are more accessible to the community. Infill planning encourages quality affordable housing which improves choice, opportunity, and efficiency. Areas within the urban edge should be identified where infill planning can be implemented. These areas may include open or unplanned areas (note that this does not include open space or protected areas), and areas with

ineffective use. The areas identified should have the necessary potential to contribute to urban resilience. Within these areas specific focus should be on other principles that improve resilience, it should accommodate mixed land uses, zones of public transport, open space systems and densification. As Figure 3 illustrates, infill planning will lead to areas with higher densities and mixed land uses. This will increase opportunity and choice in terms of housing and other social and economic amenities and improve efficiency and accessibility through the development of nodes which will provide the community with various facilities and services. Infill planning will improve the safety and identity of urban areas by regenerating these areas.

Open spaces are a key part of any urban system. Open spaces should not only provide for the physical and social needs of a community but should also increase the overall quality of the environment through accommodating natural systems, by protecting and conserving the biodiversity. It improves the physical and psychological health of people and strengthens communities Open spaces make cities and neighborhoods attractive and liveable with adequate proportion and scale. It encourages people to socialize and integrate irrespective of race or demographic status. Zones and systems should be identified and planned for. Instead of creating one or two single large open spaces, cities should rather plan for more open spaces, which are smaller areas but serve part of a larger system of continuity. This will not only improve urban resilience but will also contribute to easier access to these areas. As illustrated in Figure 3, open space systems improve the quality of an area; more open spaces will lead to improved social and environmental opportunities and choices. This will assist in creating an improved balance between the proportion of built areas thereby leading to aesthetically attractive and more livable cities.

Mixed land use types directly contribute to urban resilience. Mixed land use types also lead to improved efficiency, sustainability, liveability and sense of place by enhancing the area's unique identity and development potential. Areas will have continuous movement, which will decrease crime and prevent urban decay by enhancing revitalization. Mixed land use types encourage high-quality design by providing greater flexibility and more control. It increases opportunities and choices regarding housing, retail, public transport, and recreation. It promotes pedestrian and bicycle travel and reduces auto dependency, roadway congestion, and air pollution by co-locating multiple destinations. Mixed land use nodes will also promote efficient use of land and infrastructure and guide development towards established areas, protecting outlying rural areas and environmentally sensitive resources. Implementation of mixed land uses should be implemented next to main corridors and main focus areas. This will enable the development of mixed-use nodes which may extend to surrounding areas, creating a spread effect. As Figure 3 indicates, mixed land uses would result in multi-purpose areas with improved opportunities, choice, and access to housing, services, work and other amenities. It could also lead to places that are aesthetically more attractive with an improved sense of place where people can live, work and play. This will ultimately accelerate the creation of liveable, resilient and efficient urban areas.

If implemented appropriately, densification is arguably one of the most powerful tools that a municipality or city can adapt to achieve resilient, sustainable, competitive and livable cities. Well-designed density has the ability to shift transportation away from automobiles to other modes of transport and possibilities. It makes retail, recreation, and business more efficient and supports daily services close to residential areas; this also improves walkability and makes it more enjoyable. Densification requires more high-density residential areas, which can be more affordable and more efficient. Furthermore, it fosters a public realm with activities and facilities that encourage interaction between residents. Densification also limits urban sprawl, thereby motivating improved preservation of farmlands and other heritage areas. Densification should be applied along main corridors, within the CBD and other secondary nodes. Different intensities of densification could be developed, descending from the primary focus areas outwards to the surrounding areas. This will make a significant contribution to the overall urban resilience. As Figure 3 demonstrates, densification will assist in creating more sustainable and affordable housing options which will, in turn, expedite improved opportunities and choices in terms of different densities and types of housing. In a similar vein, access to public facilities and other amenities will be enhanced due to the proximity of services, amenities and the development of nodes and resulting in overall efficient cities.

The urban edge is regarded as a primary strategy to counter urban sprawl, encourage densification and protect natural resources. It facilitates efficient use of land and urban services within the boundary of the urban edge. This will signal future spatial locations and developments. The urban edge will prevent market failures and the misallocations of resources that lead to urban sprawl and developmental advantages in suburbs by internalizing and limiting externalities that may arise through shopping malls,

office parks, and residential development. The urban edge should include and integrate the city and the township. It must be as limited as possible to contain development. The edge must be strictly adhered to, with no development outside the edge. As an attempt to make the urban edge more efficient and resilient, it could be operated for longer periods. For instance, if a boundary is currently set for a period of five years, it may be increased through setting it as the urban edge for the next ten years. Figure elucidates the argument that an urban edge will limit urban sprawl and will, therefore, lead to improved efficiency through the efficient use of land. The proportion and scale of an area will also be protected and enhanced.

Figure 3 illustrates the fact that all these tools are interdependent of one another and form part a cohesive network of urban resilience and efficiency, as has been extensively discussed in the study. Each of these tools contributes towards a renewed urban form that demonstrates a continuous strive to be more resilient and more efficient.

Conclusion

It is necessary for resilient planning to be based on systems analysis, which enables it to define the points and issues of the vulnerability of urban systems and focus on the key issues such as the gap or the zone of inaccessibility between the city and the twin city. This will provide possibilities and improve opportunities in terms of access to workplaces, social amenities, and other facilities which make the city more efficient. In relative terms, the use of public transport will reduce the dependence on oil and other fossil fuels and lead to a more self-sufficient and energy efficient city. Based on Ahern's (2011) resilience principles, when a function or service is provided by a central entity of urban infrastructure it is more vulnerable and likely to fail. However, when the same function is provided by a distributed or decentralized system it becomes more resistant to disturbance. The green infrastructure allows for redundancy and modularization – that is, spreading risks across geographical areas, time and multiple systems. This is a result of the social, physical and economic diversity of green infrastructure that forms part of an effective strategy for supporting urban resilience. Densification and infill planning need to be accompanied by a diversification of land uses, increased access to both social and physical infrastructure, better links to public transport, and integration with public and green spaces. This should eventuate in a more efficient, equitable, sustainable and resilient growth trajectory. The urban edge will further propel the growth trajectory even more resilient and efficient by combating urban sprawl through limiting growth within a reasonable and effective urban edge.

This study concludes that the implementation of an appropriate land use and densification model will lead to more resilient cities. It was the objective of this study to achieve three succinct goals; firstly, to explore the different spatial components influencing the capacity of a settlement to respond positively to rapid changes. Secondly, to propose a multi-faceted approach that leads to resilience through the implementation of mixed land uses and therefore more resilient settlements. Finally, to create a tool for local government to enhance resilience and guide development through existing policy and legislation. These objectives have been dealt with and illustrated using the theories of Young (1993), Nel (2011), Chapin and Kaiser (1979), ICLEI (2012), Saunders and Becker (2015) and Paton et al. (2015), which all agree that land use planning is one of the main measures that contribute to what has been defined as urban resilience and efficiency. It is argued that the recommendations made in this section could improve urban efficiency and urban resilience within urban areas by providing possible solutions which could be integrated into policy and legislation, and by providing local government with a practical set of tools. It is envisaged that the utilization of urban efficiency and urban resilience will broaden cities' and government's views on resilient and efficient urban planning and development.

References

1. Ahern, J. 2011. From fail-safe to safe-to-fail: sustainability and resilience in the new urban world. *Landscape and urban planning*, 100(4):341–343.
2. Behrens, R., Watson, V. 1996. Making urban places. Cape Town: Creda Press.
3. Bhatta, B. 2010. Analysis of urban growth and sprawl from remote sensing data. Springer Science and Business Media.
4. Bourne, L.S. & J. Simmons. 1978. Systems of cities. New York: Oxford University Press.
5. Bourne, L.S., 1975. Urban systems: strategies for regulation: a comparison of policies in Britain, Sweden, Australia, and Canada. Oxford: Clarendon Press.

6. Bowland, C. & Otto, L. 2012. Implementing development corridors: lessons from the Maputo corridor. SAIIA Policy Briefing, 54.
7. Bretagnolle, A., Pumain, D., and Vacchiani-Marcuzzo, C., 2009. The organization of urban systems. In Complexity perspectives in innovation and social change (pp. 197-220). Springer Netherlands.
8. Brunner, J., Cozens, P. 2013. 'Where have all the trees gone?' Urban consolidation and the demise of urban vegetation: a case study from Western Australia. Planning practice res., 28:231–255.
9. BurchellL, R.W., Shad A.N, Listokin, D., Phillips, H., Downs, A., Seskin, S., Davis, J.S., Moore, T., Helton, D. & Gall, M. 1998. The costs of sprawl – revisited. Washington, DC: National Academy Press. (Report 39, Transportation Research Board).
10. Chapin, F.S., Jr. & Kaiser, E.J. 1979. Urban land use planning. USA: University of Illinois Press.
11. Christaller, W. 1966. Central places in southern Germany. Translated by Baskin, C.W. New Jersey: Prentice-Hall.
12. Christopherson, A.J. 1984. South Africa: the impact of past geographies. Kenwyn: Juta.
13. Christopherson, S., Michie, J. & Tyler, P. 2010. Regional resilience: theoretical and empirical perspectives. *Cambridge journal of regions, economy and society*, 3(1):3-10.
14. Daneshpour, A. & Shakibamanesh, A. 2011. Compact city; does it create an obligatory context for urban sustainability? International journal of architectural engineering & urban planning, 21(2):110–118.
15. Davies, R. 1981. The spatial formation of the South African city. *GeoJournal*, 2:59-72.
16. Deitrick, S., & Ellis, C. 2004. New urbanism in the inner city: a case study of Pittsburgh. *Journal of the American Planning Association*, 70(4):426–442.
17. Dewar, D. & Uytenbogaardt, R. S. 1991. Cape Town: University of Cape Town, Urban Problems Research Unit.
18. Dowall, D. & Clark, G. 1997. Urban land policies for the uninitiated. Economic and Social commission for Asia and the Pacific. http://www.unescap.org/huset/land_policies/
19. Drescher, A.W. 2015. Technical tools for urban land use planning. http://www.ruaf.org/
20. Du Plessis, D.J. 2015. Land-use mix in South African cities and the influence of spatial planning: Innovation or following the trend? *South African geographical journal*, 97:3, 217-242.
21. Godschalk, D.R. 2004. Land use planning challenges. *Journal of the American Planning Association*, 70(1):5-13.
22. Gordon, P. & Richardson, H. W. 1997. Are compact cities a desirable planning goal? *Journal of the American Planning Association*, 63(1):96–106.
23. Habitat III, United Nations. 2016. A new urban agenda. Quito declaration on sustainable cities and human settlements for all. Quito UN Habitat.
24. Harris, C. & Ullman, E.L. 1945. The nature of cities. *The Annals of the American Academy of Political and Social Science*, 242(1): 7-17.
25. Hoyt, H. 1939. The structure and growth of residential neighbourhoods in American cities. Washington: Federal housing administration.
26. Hurlston, L. & Thompkins, E. 2012. Public-private partnerships in the provision of environmental governance: a case of disaster management. Adapting institutions: governance, complexity and social-ecological resilience. Cambridge: Cambridge University Press.
27. ICLEI (Local Governments for Sustainability). 2012. Integrated land use planning for resilient urban communities. http://resilient-ities.iclei.org
28. Losch, A. 1954. The economics of location. London: Geoffrey Cumberlege, Oxford University Press.
29. Lynch, K. 1984. Good city form. 2nd ed. Massachusetts, London: MIT.
30. Lynch, K. & Hack, G. 1984. Site planning. 3rd ed. London: MIT.
31. McMahon, T. 2012. Why sense of place is worth caring about. http://www.planetizen.com
32. Meerow, S., Newell, J.P. & Stults, M. 2016. Review: defining urban resilience: a review. Landscape and Urban Planning, 147:38-49
33. Nel, V. 2011. Land-use management system as a tool towards achieving low-carbon cities in South Africa. http://www.ajol.info/
34. Octaviano, T. 2014. Economic corridors boost markets, living conditions. http://research.bworldonline.com/
35. Paton, D., Mamula-Seadon, L. & Selway, K. 2013. Community resilience in Christchurch: adaptive responses and capacities during earthquake recovery. *GNS science report*, 37:28-39.
36. Pfister, J.L. 2004. Using landscape metrics to create an index of forest fragmentation for the State of Maryland. Master Thesis, Towson University. https://tigerweb.towson.edu/
37. Richter, M. 2016. Land use and urban efficiency: towards more resilient cities. Dissertation. Potchefstroom Campus, North-West University.
38. SACN. 2016. State of South African Cities Report 2016. Johannesburg: SACN.

39. Saunders, W. & Becker, J.S. 2015. A discussion of resilience and sustainability: land use planning recovery from the Canterbury earthquake sequence, New Zealand, *International journal of disaster risk reduction*, 14:73–81.

40. Simon, D. 1989. Crisis and change in South Africa: implications for the apartheid city. *Transactions of the Institute of British Geographers,* January (1):189-206.

41. South Africa. 2013. Spatial Planning and Land Use Management Act No. 16 of 2013.

42. Stumpp, E. 2013. Viewpoint: new in town? On resilience and "resilient cities". *Cities*, 32:164-166.

43. Sustainable Cities Institute. 2012. Land use and planning. http://www.sustainablecitiesinstitute.org/

44. Taaffe, E. J., Morrill, R. L. & Gould, P. R. 1963. Transport expansion in underdeveloped countries: a comparative analysis. *Geographical review*, 53:503–529.

45. The World Bank. 2015. Urbanisation REVIEWS. http://www.worldbank.org/

46. Turok, I. 2012. Urbanisation and development in South Africa: economic imperatives, spatial distortions and strategic responses. London: Human Settlements Group.

47. UN Habitat. 2016. World Cities Report 2016: Urbanization and Development: Emerging Futures. http://wcr.unhabitat.org

48. Young, A. 1993. Guidelines for land use planning. Rome: Food and Agriculture Organisation.