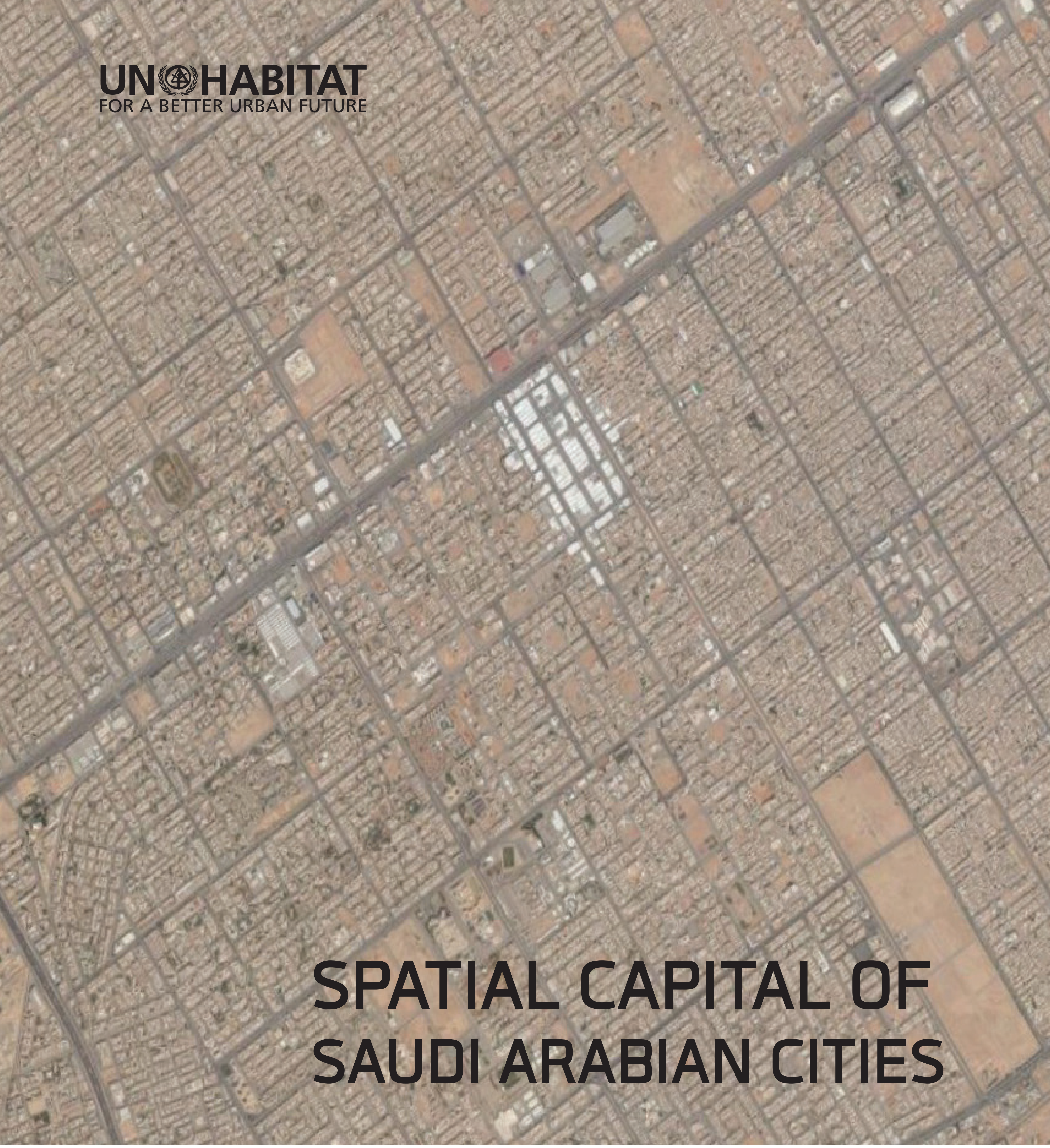

UN-HABITAT
FOR A BETTER URBAN FUTURE

SPATIAL CAPITAL OF SAUDI ARABIAN CITIES

STREET CONNECTIVITY STUDY FOR THE CITY PROSPERITY INITIATIVE

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Spatial Capital of Saudi Arabian Cities.
Street connectivity study for the City Prosperity Initiative

United Nations Human Settlements Programme (UN-Habitat) P.O. Box 30030
00100 Nairobi GPO KENYA. Tel: 254-020-7623120 (Central Office)
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Acknowledgements

Authors: Eduardo López Moreno, Regina Orvañanos Murguía

Background Documents: Manuel Madrid, Alexander Ståhle, Joel Hernbäck, Patrick Lamson-Hail, Pinar Caglin
Data Analysis: Regina Orvañanos Murguía, Manuel Madrid, Óscar Martínez, Antony Abilla
Institutional Review: Claudio Acioly, Rogier van den Berg, Kamel Bouhmad, Salvatore Fundaró, Åsa Jonsson, Marco Kamiya, Robert Lewis-Lettington, Liz Paterson, Raf Tuts,
Design and Layout: Regina Orvañanos Murguía

Programme Future of Saudi Arabian Cities:

Tarek El-Sheikh, UN-Habitat Programme Director, Kingdom of Saudi Arabia
Dr. Abdul Rahman Al-Sheikh, Chairman of Future Saudi Cities Management Board, Kingdom of Saudi Arabia

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CHAPTER 5:

The spatial capital of cities – comparing street connectivity with other variables

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KEY FINDINGS

Spatial Capital in Saudi cities

01. The Street Connectivity Index results from the combination of the three variables that assess the urban form of the city (the width, the length and the number of intersections of the street network). High connectivity translates in better accessibility, penetration, mobility and coverage of the whole city. In general terms, Street Connectivity values of Saudi cities correspond to other cities from the developing world. However, the factors and conditions creating these values are obviously different.

02. Largely based on the use of the automobile, the physical layout of Saudi cities has created low-density, single-use development, with spacious houses and buildings. This configuration in cities from Saudi Arabia has led to horizontal spreading of the urban areas with high fragmentation of spaces and some level of dispersion of house and buildings. Land ownership has historically created huge areas of open or vacant land inside city boundaries.

03. In most of the cities of Saudi Arabia open space and vacant land, constitute up to 46 per cent of the total land within city boundaries as UN-Habitat spatial analysis in the 17 cities shows. 'White land', as open and vacant land is called, is served with state infrastructure and despite the fact that it is complete with roads, water and streetlights it sits empty. This land is located mostly in the middle of the city and the city centres.

04. The analysis of street connectivity is determined to some extent by the existence of open land. High portions of non-occupied land in the city and the fragmentation of the urban fabric affect the overall connectivity of the city. This fragmentation and interstitial development compromises the street connectivity and affects the form and functionality of the city.

05. In general terms, street connectivity in the Saudi cities that are part of this study are varied. Excluding open space, in three cities connectivity is high, which means that conditions of connectivity are met with regards to land allocated to streets and intersection density. While in twelve cities connectivity is moderate, in the remaining two cities, connectivity is extremely low.

06. The study disaggregates the results of the Street Connectivity Index in seven typologies grouped by residential and non-residential. The residential type includes formal and informal subdivisions, housing projects and atomistic (organic) development. The non-residential type is comprised of urban amenities, vacant land and open space.

07. Values disaggregated at intra-city levels shows that, within the residential typologies, the informal subdivision has on average, the highest values. This type is characterized by some level of informality; yet informal subdivision does not refer to slum areas. The second residential typology with high values corresponds to the mass housing projects; followed by the formal subdivision type, which has moderate connectivity values. Among the residential typologies, the atomistic type has the lowest connectivity values.

08. Paradoxically, layouts in formal subdivisions are similar to the layouts of informal subdivisions, but exhibit a higher level of infrastructure and paved roads. Formal subdivisions also have better connections to arterial road networks and well-delimited sidewalks. Formal subdivisions cover as much as 45 per cent of the residential land uses. They are followed by informal subdivisions that represent nearly one third. Atomistic typology covers, on average, slightly less than one fifth of the residential surface.

09. On the other hand, non-residential land uses (urban amenities, vacant land and open space) account for slightly over two-thirds of the total areas of the 17 Saudi cities. The Street Connectivity Index in the non-residential land uses varies greatly. Vacant land has the highest score, followed by urban amenities and open space with the lowest values. Vacant land category is characterized by areas with urbanized land and clear street layouts that are not yet occupied. In principle, they represent the future urban developments.

COMPONENTS OF THE STREET CONNECTIVITY INDEX

10. Land allocated to streets. In general terms, most of the Saudi cities allocate a relative adequate proportion of land to streets. However in some cases, this proportion is over-dimensioned, which seems to be a distinctive case of the cities of the Kingdom. With important variations, informal subdivisions are the typology with the closest values to UN-Habitat standards. Interestingly, the formal subdivision typology provides land to streets in excess; slightly above the recommended threshold. In some cities values exceed –by far- those of developed cities, mainly due to disproportionally wide streets.

11. Street density. When open space is excluded street density reaches values relatively close to the standard proposed by UN-Habitat's City Prosperity Initiative (20 km). However, when open space is included, street densities reduce dramatically. At intra-city level, the indicator show higher values in residential areas than in non-residential areas. Informal subdivisions and housing projects appear as the typologies with more approrpirate values, non-residential areas, particularly the open space, and the urban amenities show very poor density of street, affecting the overall connectivity of the city.

Based on the land allocated to streets and the street density, it is possible to determine the average street widths. Data shows great variations within cities. Cities like Riyadh, Dammam and Tabuk, have the widest streets in the Kingdom, which is indicative of the widespread existence of large boulevards and avenues mostly designed to for private vehicles. The analysis at intra-city level shows large disparities. The typologies of formal and informal subdivisions of the city of Tabuk have an average street width of 19 m, while the atomistic typology of Medina, with the same amount of LAS, has street widths of only 8.6 m due to its extensive street network.

12. Intersection density, a good indicator of compactness and walkability, can make cities more conducive to the use of non-motorized transport. Saudi cities the average value is 136 intersections per square kilometre, above the optimal level estimated by UN-Habitat at around 100 intersections per square kilometre. Cities like Medina, with an organic street pattern at its core, and the city of Taif developed on the slopes of Sarawat Mountains, are optimal range. When open space is taken into consideration, the average value of is dramatically reduced. Due to fragmented urban development, eight cities fall below the minimum recommended values.

Atomistic or organic-development areas have the highest intersection densities. The historic cores of the cities of Medina and Tabuk contribute to increase the overall values of these cities' street density. Formal subdivisions and housing projects due to the presence of large number of gated communities, streets with dead-ends or 'T' intersections and a very dense street network explain this excessive number of intersections. With some exceptions, very high intersection densities do not translate in more connected places.

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INTRA-CITY ANALYSIS ON STREET CONNECTIVITY

A more refined analysis of the Street Connectivity Index based on the seven typologies, show great variances in the layout of the city and the street structure. This part analyzes residential typologies.

13. Formal subdivisions. This typology represents around 15 per cent of the total areas of the 17 Saudi cities and 45 per cent of the residential areas. This typology is characterized by an over dimension of the land allocated to streets and the excessive use of intersections with numerous 'T' crossings and other forms of cul-de-sacs; thus, resulting in moderate street connectivity values.

14. Informal subdivisions represent nearly one-fifth of the total areas of Saudi cities. Despite the fact that informal subdivision are in the process of consolidation (containing substandard housing and non-appropriate sidewalks), they are the typology that exhibits the best connectivity values, closer to UN-Habitat standards.

15. The mass housing project typology represents a very small fraction of the total area in the 17 cities (less than 2 per cent). However, in some cities this typology can reach up to 7 per cent of the total urban area and 20 per cent of all residential areas. Housing projects are the public and private response to low-cost and middle income housing demands. In spite of being planned interventions, they tend to have less land allocated to streets than formal and informal typologies. This seems to be a current practice of real estate developers that minimize the proportion of streets and public spaces in order to maximize the number of plots and houses for sell.

16. A particular case within the residential typologies is the atomistic development that can take the form of medina-type or the rural-type settlement. With an irregular street layout, intersections that are not frequent, roads with varying widths and inconsistent plot sizes; atomistic development devotes- on average- slightly less land to streets. However, the old medinas of cities like Jizan, Jeddah and Medina are characterized by a very dense street network and an intense number of intersections. Yet these parts of cities maintain, on average, proportions of land allocated to street within UN-Habitat recommended values. Surprisingly, rural-type developments of Saudi cities that are classified as atomistic have street widths that are notoriously large for the functionality of these areas.

SPATIAL CAPITAL OF CITIES

17. Connectivity is not a goal in itself, but a mean to create successful, prosperous cities. The role of the street is to connect spaces, people and goods, and thereby facilitating commerce, social interaction and mobility. But not just connectivity is an important spatial variable; cities consist of streets, buildings and open space. Their distribution and configuration constitute the spatial capital of a city. Based on spatial capital analysis that combines population densities with street connectivity, five cities feature high spatial capital; another seven cities have medium values, while the remaining five are considered with low spatial capital.

18. Street connectivity and built-up densities. Street morphology and plot density are highly correlated. Numerous studies show that as street length and intersections per square kilometre increase, so does the density of plots. Cities from Saudi Arabia are not strange to this relation. However, due to low population densities (47 inhabitants per hectare), relatively dense street systems serve a smaller number of people, and during most parts of the day many streets tend to remain empty.

19. In the 17 Saudi cities, it is possible to find a strong correlation between the density of streets and the proportion of the city that has high built-up densities. As the proportion of areas with high built-up density reduces, so does the street density. When open areas are excluded from the analysis and only the distribution of built-up densities is taken into account, high built-up densities make up to 80 per cent of the total area of the cities. However, the plot coverage of the entire area of all Saudi cities is only 17 per cent on average.

20. The analysis of different types of built-up areas (low, medium and high) against standard values of the Street Connectivity Index give higher scores to medium built-up density areas. This is because areas with high plot density tend to reduce values in the parameters of street density and intersection density. In other words, some cities are penalized either because of excessive number of intersections or extremely dense network of streets. The city of Medina is a point in case. In the areas identified as high built-up densities, the length of the street network is 35 per cent above the threshold, and the number of intersections is almost three times higher than minimum recommended values by UN-Habitat.

LEVERAGING DENSITIES, MAXIMIZING THE STREET NETWORK

21. The existence of white land (open space and vacant land) in Saudi cities is a major cause of low densities, wasteful use of the space, inefficient usage of the street network, unproductive infrastructure investment and lack of available land for affordable housing. While nearly half of land in Saudi cities remains empty, the possibility of sustainable urban development is compromised.

22. Building more outside the current urban perimeters is no longer an option in Saudi cities. The estimated population growth in the next 15 years in Saudi Arabia corresponds to a new city of the size of Najran or Hail every year. Most cities can accommodate all future growth in the existing 'white land' areas and still have provision for future growth. Leveraging densities can certainly maximize the street network.

CHAPTER 1:

Future Saudi Arabia Cities Programme and Street Connectivity – measuring urban form through the City Prosperity Initiative:

The Report on the Street Connectivity of the Saudi Cities is based on 17 cities that are part of the Future Saudi Arabia Cities Programme that aims to contribute to the achievement of sustainable urbanization in the Kingdom. This Programme is expected to improve evidence-based policy and government responses as measured by the City Prosperity Initiative (CPI).

By implementing the City Prosperity Initiative, Saudi Arabian authorities will be able to identify opportunities and potential areas of intervention for their cities to become more prosperous. The CPI includes various dimensions, sub-dimensions and indicators that are relevant to cities and important for prosperity-oriented public policy-making. It measures prosperity across six dimensions –productivity, infrastructure, quality of life, equity, environmental sustainability and governance and legislation.

Each one of these dimensions includes spatial indicators. For example, the dimension of productivity analyses economic agglomerations; the dimension of quality of life the accessibility to public spaces; the dimension of equity integrates an indicator on land use mixes; and the dimension of infrastructure measures street connectivity, as a proxy of urban form.

In recent publications, UN-Habitat has shown that "the expansion of cities has been accompanied by changes in land use, both in terms of form as well as structure."[1] Cities with endless peripheries, low residential densities, poor economies of agglomeration, insufficient land to street development and poor provision of public areas are unsustainable in their form and functionality. Innovative spatial indicators of the CPI aim to measure these transformations in order to address them with reinvigorated urban planning and design, adequate laws and institutions and local economic development solutions.

UN-Habitat has shown in previous studies that the adequate provisioning of streets and public spaces, as part of the street connectivity sub-dimension, is associated with urban prosperity. Typically, more efficient and productive cities, with better quality of life and environmental indicators are often cities with better street connectivity.[2]

Street connectivity along with other spatial indicators represents an important innovation in data collection and analysis. The CPI is a unique tool that associates urban form, planning and the structure of the city to the notion of prosperity. Studies conducted in more than 130 cities have provided an exceptional innovation in infrastructure development and the layout of the cities with findings that pave way for state-of-the-art analysis on the relationship of public space, economies of agglomeration, including residential and infrastructure densities.

1.1 The City Prosperity Initiative – Integrating spatial analysis

In 2012, UN-Habitat created a tool to measure the sustainability of cities. This tool, known as The City Prosperity Index, was accompanied by a conceptual matrix, the Wheel of Urban Prosperity. In the following year, UN-Habitat received numerous requests from local authorities and central governments to estimate their respective prosperity indexes. Mayors and other decision-makers wanted to know how their cities feature in comparison with other cities. This included knowledge on how to improve ratings and measurements of cities towards the prosperity path, including gaining critical insights into which programmes and policies work, and the possible impacts these actions may have.

As a result of these demands, UN-Habitat transformed the City Prosperity Index into a global initiative known as the City Prosperity Initiative. This initiative is both a metric and a policy dialogue, which offers cities from developed and developing countries the possibility to create indicators and baseline information, often for the first time. It also serves to define targets and goals that can support the formulation of evidence-based policies, including the definition of city-visions and long-term plans that are both ambitious, and measurable.

UN-Habitat City Prosperity Initiative (CPI) not only provides indices and measurements relevant to cities; it also enables city authorities, as well as local and national stakeholders, to identify opportunities and potential areas of intervention for their cities to become more prosperous.

1 UN-Habitat (2013) Streets as Public Spaces and Drivers of Urban Prosperity, Nairobi
2 Ibid.

The CPI: A flexible monitoring framework. The CPI takes into account the contextual needs and particularities of cities. Although it promotes a new urbanization model that is universal (cities that are compact, resilient, socially diverse, energy efficient and economically sustainable), it recognizes the need to be adaptable to different city and country circumstances, according to diverse urbanization challenges and opportunities.

The CPI: A framework that promotes integration. The CPI promotes integration in the implementation of a more sustainable urbanization model, in order to address the environmental, social and economic objectives of sustainability. This integration looks at the mutually reinforcing aspects of the different components of the urbanization process.

The CPI: A multi-scale decision-making tool. The CPI objective is to support decision-making for multi-scale levels of government ranging from national urban policies to regional and metropolitan strategies; and city-wide interventions to sub-city districts or neighbourhoods. The CPI gives decision-makers the ability to make adequate and evidence-based decisions from a territorial perspective, thus articulating different tiers of government and sectoral interventions in urban areas.

The CPI: An innovative tool based on spatial analysis. The CPI structure provides a wealth of new analytical tools based on spatial indicators. New indicators such as street connectivity, public space, agglomeration economies provide clear spatial distributions that help increase value judgment and support decision-making.

CHAPTER 2:

Street Connectivity, Indicators and the Infrastructure Development Subindex

In the reports *The relevace of street patterns and public space in urban areas* and *Streets as public spaces and drivers of urban prosperity*, UN-Habitat analysed for the first time the urban form through the Street Connectivity Index (SCI). This index is composed of three components: the proportion of land allocated to streets, street density and intersection density.[3] To create the composite index, each indicator is then standardized according to UN-Habitat recommended values in order to create the composite index.[4]

2.1 The City Prosperity Initiative and street connectivity

In 2012, UN-Habitat conducted surveys in 54 cities from the developing world, to conceptualize prosperity and identify its most critical components. Experts from Asia, Africa, Arab countries and Latin America agreed that a prosperous city integrates 6 critical dimensions: 1) productivity; 2) infrastructure development; 3) quality of life; 4) equity and social inclusion; 5) environmental sustainability and; 6) governance and legislation. These dimensions are the structural component of the City Prosperity Index.

A prosperous city deploys the infrastructure, physical assets and amenities, required to sustain both the population and the economy, and provide better quality of life. Further, it requires an adequate provision of streets that are well designed throughout the urban extent in an orderly manner that optimizes the form and functionality of the city. Although parameters of connectivity are universal, at the same time they need to be adapted to local context and conditions.

As part of the infrastructure dimension of the CPI, the street connectivity is one of the sub-dimensions along with housing, social infrastructure, urban mobility and ICT. As a sub-dimension, the street connectivity is defined by three indicators that together define the characteristics of the urban form. These indicators are:

- Proportion of land allocated to street, measured as the percentage of land area covered by streets from the total land area of the city;
- Street density, measured by the length of the street network per square kilometre;
- Intersection density, measured by the number of intersections per square kilometre.

Street connectivity is today measured in more than 100 cities across the world as part of the City Prosperity Initiative. Working with partners, UN-Habitat has developed an appropriate methodology to measure and understand urban form. This innovative work has defined indicators; it has also created metadata and parameters of optimal values. The most important methodological aspects of this innovative approach are the definition for urban boundaries, the sampling technique of street measurements, the estimation of built-up densities and related methodological considerations and the disaggregation of the city by urban typologies.

2.2 Urban boundaries

The measurement of spatial indicators require boundaries, and these are not easy to define due to the uniqueness of the urban form, the fragmented and interstitial of the urban development, the blur of the urban-rural transition areas, and the 'metastasis' of urban development; all this generating different patterns and conditions of urban growth. The lack of standard of international definition or delimitation of an urban area, or geospatial data that uses different geographic definitions are just among the many challenges of measuring spatial indicators.[5]

The core of the urban form analysis for the City Prosperity Index is the built-up area of the continuous urban agglomeration. The built-up area comprises the city centre and the suburbs forming a continuous settlement. In many cases the metropolitan areas or administrative boundaries are larger than the built-up settlements and comprise rural parts with very low densities; while in other cases, the administrative boundaries are smaller than the actual urban agglomerations.[6] Both cases create distortions in the measurements that hinder their comparability.

UN-Habitat defines the 'built-up area' of a city is the

3 UN-Habitat (2013) Streets as Public Spaces and Drivers of Urban Prosperity. Nairobi

4 Recommended values are a target values of 30 per cent land allocated to streets, 20 km of streets per km^2 for the indicator of street density, and a range between 100 and 140 intersections per km^2

5 IEAG (2014) A World that Counts: Mobilizing the Data Revolution for Sustainable Development.

6 UN-Habitat (2004) Urban Indicators Guidelines. Nairobi

Figure 1: Delimitation of urban, suburban and rural areas

Figure 2: Halton sequence ofcoordinates used to select sample of locales in an urban area

Figure 3: Digitalization of streets and intersections in a locale

contiguous area occupied by buildings and other impervious surfaces including the vacant areas in and around them but excluding rural areas beyond the urban fringe. The delimitation of the built-up areas distinguishes urban, suburban and rural areas based on the built-up densities. According to this definition, the concept of 'urban' is considered as the area with more than 50 per cent built-up density (or plot coverage); suburban is defined as areas that have plot coverage between 50 and 10 per cent; and rural areas have less than 10 per cent of built-up density (Figure 1).

In order to determine the boundary of the built-up area, it is crucial to identify the border between urban and suburban areas with rural areas. This transition will be marked by a threshold of 100 metres between isolated buildings, which will be included in the continuous urban footprint. Some exceptions for the delimitation of the contiguous built-up area include:

- Rivers: urban and suburban areas separated from the main urban area by a river must be considered contiguous.
- Subdivided land count as suburban area regardless of its built-up density. Therefore, urban and suburban built-up areas separated from the main urban area by unbuilt subdivided land are considered contiguous.

Thus, the 'urban built-up area' includes: all the buildings, the small open space areas (smaller than 200 ha) that are totally surrounded by buildings, the open space fringe that is within 100 meters of urban and suburban areas. On the contrary, it does not include: the exterior open countryside and open space areas, larger than 200 ha that are totally surrounded by buildings.

2.3 Sampling of street connectivity - spatial analysis

The calculation of the three metrics of street connectivity -the average share of land used by streets, the length of streets and the number intersections, which is a proxy of urban form, is based on spatial sampling technique. This technique relies on a Halton Sequence of coordinates that uses a semi-random selection of 10-hectare locales. Locales are randomly selected 10-hectare sample points that contain a set of city blocks surrounded by streets, and bounded by the medians of all blocks within these areas (Figure 2).

The density of sample points or locales depends on the study area size. In large urban areas of over 25 km^2, a density of one sample point per hectare is used, while in small study areas a density of one locale per two hectares is used. The three metrics of Street Connectivity are measured in each locale. The average values for an urban area are calculated by sampling the necessary number of locales until the variance and standard error declines below an acceptable value7 (Figure 3).

Urban typologies definitions

The study separates land uses for streets and roads from land in other uses. For that purposes it uses three main categories:

1) Open space that is intended to identify unbuilt areas and it includes open countryside, forests, crop fields, parks, water bodies and unbuilt urban areas that have not been subdivided;
2) Non-residential areas; a category that includes all built-up areas, both public and private that are not for residential use. Some examples include urban ammenities like industrial parks, railway stations, bus terminals, parking lots, airports, sport facilities, schools, universities and public buildings. The categories vacant and open space are also included in this group.
3) Residential areas; a category that includes four subcategories: a) atomistic or organic; b) informal subdivision; c) formal subdivision and d) housing project.[8] These categories are organized around the evolution of the housing sector related to institutional frameworks, capital availability, and maturity of the construction sector.

The concept of the plot is very important in assessing these residential categories. Much like the concept of right-of-way, the concept of plot relies on surface indicators, pattern recognition, and comparisons with nearby areas to get a sense of the underlying division of land in a given area. A suburban plot in a formal development might contain several structures – a house, a garage, and a toolshed, for example. To determine what category is correct for a given plot or block, the project considers: the homogeneity of structure/plot size; the relationship of plots to each other; the regularity of the street network/block size; and the quality of public services visible in the satelite imagery (usually limited to paved/unpaved roads).

7 UN-Habitat (2014) Methodology for Measuring Street Connectivity Index

8 The definition of these typologies is presented in Chapter 4 Intra-city analysis on street connectivity.

CHAPTER 3:

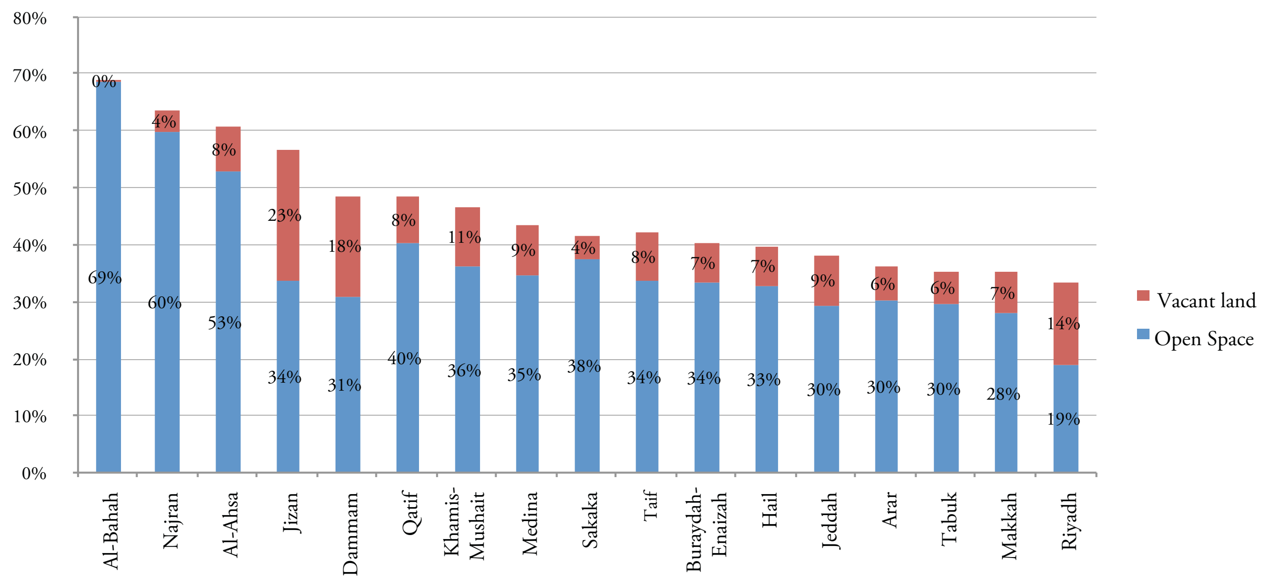
General results: Street Connectivity Index Saudi Cities

As explained in Chapter 2, the different components of street connectivity used in this Report are the proportion of land allocated to streets, street density and intersection density. From these components it is possible to derive a Street Connectivity Index.

The more a city has appropriate land allocated to streets, the more it has sufficient intersections available to facilitate shorter distances and reduce travel times, the more it has adequate street network to cover all areas, the city's infrastructure is optimal, facilitating connectivity and mobility, and better functionality. As connectivity increases, travel distance decreases, and route options and travel modes increase.[9]

Largely based on the use of the automobile, the layout of Saudi cities has created low-density, single-use development, with spacious houses and buildings. This physical layout of cities in the Kingdom has led to horizontal spreading of the city areas with high fragmentation of spaces and some level of dispersion of house and buildings. Land ownership has historically created huge areas of open or vacant land inside the city boundaries.

Graph 1: Proportion of 'white land' in the cities of Saudi Arabia



3.1 Open space or 'white land' within cities

In most of the cities of Saudi Arabia open space and vacant land constitute up to 46 per cent of the total land within city boundaries, as UN-Habitat spatial analysis in the 17 cities shows. According to this study open/vacant land or 'white land' makes up as much as 69 per cent in the city of Al-Bahah, 64 per cent in Najran, 61 per cent in Al-Asha and 57 per cent in Jizan (Graph 1). 'White land' in the Capital of the Kingdom is the lowest in proportion, amounting up to 34 per cent; but considering the extension of the urban footprint, it has the highest number of acres. 'White land' is served with state infrastructure and despite the fact that it is complete with roads, water and street lights it sits empty.[10] This land is located mostly in the middle of the city and the city centres. In some cases it has remained empty for years because the owners have no incentive to build on them or they draw benefits for some forms of speculation.[11]

For this study, two categories of white land are differentiated: open space and vacant land. Open space refers to a variety of situations. In some cases these are huge portions of land- less than 200 ha- within the city that has not being developed yet. This land is typical of a fragmented and interstitial model of urbanization. In other cases, it refers to natural barriers

9 UN-Habitat (2013) Streets as Public Spaces and Drivers of Urban Prosperity. Nairobi

10 Ernst and Young (2013), Housing the Growing Population – Jeddah Economic Forum. Fattah Deema, Almashabi (2015) Bloomberg Business.

11 Especially in the vacant land that has already built the street network. However, in general terms land prices have increased historically at an average of 7 per cent per annum, due to the trend of owning and not developing/selling lands previously. NCB Capital (2015), Saudi Arabia approves fees on white land.

or land in riverbanks, water bodies and parks; it also refers to hazardous areas that eventually will remain vacant. On the contrary, vacant land refers to areas with urbanized land and clear street layouts that are not yet occupied.

The analysis of street connectivity is determined to some extent by the existence of open land. For instance, when calculating the land allocated to streets in the 17 cities of the sample the difference between values with or without open space vary, on average, 5.6 per cent. However, in cities like Al-Bahah or Najran the variances are 14 per cent and 8.3 per cent, respectively.

Henceforth, the analysis of street connectivity for the three different indicators will be done excluding the open land to avoid statistical distortions. However, the computation of the Street Connectivity Index will integrate this information, considering that high portions of non-occupied land in the city and the fragmentation of the urban fabric affects the overall connectivity of the city.

3.2 The Street Connectivity Index

The Street Connectivity Index results from the combination of the three variables presented in chapter 2. It assesses the urban form of the city through the analysis of street connectivity considering the width, the length and the number of intersections. In 14 cities out of 17 analyzed in this study, the index is higher than 80 points out of 100, which means that connectivity is quite good, as per UN-Habitat standards.[12] High connectivity translates in better accessibility, penetration, mobility and coverage of the whole city. In 3 cities connectivity index is around 71, which indicates medium connectivity. The three cities in this group are Najran that has a very poor street network and Medina and Taif that suffer, on the contrary, from a high number of intersections.

These values are high because open space is not included in the analysis. However, as mentioned before, the fragmentation of the layout and the interstitial development that open space generates end up by compromising street connectivity and affecting the form of the city. A fresh analysis including open space that represents 46 per cent of the total area of the 17 Saudi cities shows that Street Connectivity Index reduces from 86 points to 68 points. This drastic reduction means that Saudi cities from the sample move from the group of high connectivity (above 80 points) to the group of moderate connectivity (60 to 80 points). These new values correspond to various other cities from the developing world, particularly from Latin America.13

Table 1 presents the general results of the Street Connectivity Index in the 17 cities including open space. On top of the list appear Arar, Medina and Riyadh that have indexes above 80 points. In these three cities conditions of connectivity are met with regards to land allocated to streets and intersection density; they have low values on street density (around 57 points), which means that not all parts of the city are well covered by streets. There is a second group of cities (12 cities) with an index between 60 to 80 points. This group is composed by the cities of Taif, Buraydah-Enaizah, Hail, Makkah, Khamis-Mushait, Tabuk, Jeddah, Al-Asha, Jizan, Sakaka, Dammam and Qatif. All these cities have good intersection density indicator (94 points), relatively medium values in land allocated to streets (75 points) and poor street density (43 points). It is mostly this last indicator which penalizes their overall connectivity, with wide streets of up to 18 meters, but a limited number of streets. Finally, at the bottom of the list are the cities of Al-Bahah and Najran, whose values are around 30 points, which denote extremely poor connectivity. These cities have low values in land allocated to streets (42 points) and exceptionally low street density values that are below the minimum benchmark of UN-Habitat City Prosperity Initiative (10 km of streets per km^2). Not surprisingly Al-Bahah and Najran are the two cities with the highest proportion of open space from all Saudi cities, with values that represent 69 and 63 per cent, respectively, of the total area of the city. Al-Bahah connectivity is particularly challenged by its difficult topographic conditions.

Table 1: Street Connectivity Index and components for selected cities by groups (values including open space)

CITY	LAS	SD	ID	SCI
ARAR	96	61	100	86
MEDINA	89	57	100	82
RIYADH	91	52	100	81
GROUP 1	92	57	100	83

12 Cities in this range (more than 80 points) include Tokyo, Hong Kong and Cape Town, UN-Habitat, 2013.

13 Cities in the range of 60 points include various medium size cities from Mexico and Colombia. UN-Habitat City Prosperity Initiative, 2015.

CITY	LAS	SD	ID	SCI
TAIF	74	68	98	80
BURAYDAH-ENAIZAH	84	54	100	79
HAIL	82	46	100	76
MAKKAH	78	48	100	75
KHAMIS-MUSHAIT	68	56	100	75
TABUK	90	43	84	72
JEDDAH	74	34	100	69
AL-AHSA	70	44	93	69
JIZAN	74	37	95	69
SAKAKA	71	29	90	63
DAMMAM	78	30	78	62
QATIF	58	34	91	61
GROUP 2	75	44	94	71

CITY	LAS	SD	ID	SCI
AL-BAHAH	35	3	56	31
NAJRAN	49	0	43	31
GROUP 3	42	1	50	31

Street Connectivity Index at intra-city level

When the Street Connectivity Index is disaggregated at intra-city level the informal subdivision has, on average the highest index among the different typologies (residential and non-residential) with 85 points (refer to chapter 2). This could seem as a paradox, but informal subdivisions are not slum areas. Their plot sizes are regular or semi-regular and the structures are laid out along linear or generally linear roads, with regular intersections and standardized width. Informal subdivisions have regularity of block sizes. They classified as informal subdivisions because they are lacking visible evidence of formality, such as paved streets, street-lights, or sidewalks. Although they represent on average 11 per cent of the total area of the 17 cities, the area they occupy in cities varies a lot from 0.14 per cent in the city of Al-Bahah, 0.89 per cent in Dammam and 1.9 per cent in Riyadh to 20 per cent in Medina and up to 22 per cent in Hail.

As indicated in Table 2, Street Connectivity Index is also high in the housing projects typology with 78 points, followed by the formal subdivisions typology that has an index value of 67 points; both corresponding to the moderate connectivity group (60 to 80 points). As part of the residential

Table 2: Street connectivity by typologies

TYPOLOGY	SCI	% of the urban area
RESIDENTIAL		
INFORMAL SUBDIVISION	84.5	10.56%
HOUSING PROJECT	78.3	1.42%
FORMAL SUBDIVISION	67.4	14.53%
ATOMISTIC	50.8	5.92%
NON-RESIDENTIAL		
VACANT	82.8	8.68%
URBAN AMENITIES	63.7	21.57%
OPEN SPACE	26.3	37.31%

typologies (refer to chapter 2), the atomistic or organic type has the lowest values at 51 points that make it fall in the low connectivity group.

Table 2 also shows the proportion of each typology with regards to the total built-up area of the city. For instance, formal subdivisions represent, on average, 15 per cent of the urban areas of the 17 cities, while the atomistic typology account for 6 per cent and the housing projects type for only 1.4 per cent of total urban areas.

Layouts in formal subdivisions are similar to the layouts of informal subdivisions, but exhibit a higher level of infrastructure and paved roads. They also have better connections to arterial road networks and sidewalks that are visible. As part of the different residential land uses, formal subdivisions have the highest presence in the cities of Saudi Arabia (45 per cent), with cases like Riyadh that accounts for 30 per cent of the surface of the city. Formal subdivisions exhibit also huge variances in the Street Connectivity Index at city level, with cities like Makkah and Jizan with values of 98 and 96 points, respectively. Other cities such as Arar and Khamis-Mushait have extremely low values of 34 and 27 per cent, respectively, penalized by an over dimension of the street network (nearly 40 per cent of land allocated to streets).

Non-residential land uses account for up to 68 per cent of the total areas of the 17 Saudi cities. This category is composed by three typologies: open space that represents, on average, 37 per cent of all urban areas; urban amenities that cover 22 per cent of the cities' areas; and vacant land that accounts for 9 per cent on average. The Street Connectivity Index in the non-residential land uses varies a lot with vacant land having the highest score at 83 points, followed by urban amenities with 64 points and open space with the lowest value at 26 points. As described before, vacant land is characterized by areas with urbanized land and clear street layouts that are not yet occupied. In principle, they correspond to future urban developments. The port and oil city of Jizan has vacant land that represents nearly one-fourth of the surface of the city (23 per cent) and Dammam the most important port on the East part of the country has vacant land that accounts for 18 per cent of the city's built-up area. Overall, Street Connectivity Index in vacant land is quite homogeneous in the different Saudi cities.

3.3 Land allocated to streets

In general terms, most of the cities of Saudi Arabia allocate a relative adequate proportion of land to streets. Data collected in the 17 cities of the national sample shows, in general, that the land allocated to streets (LAS) varies between 10.6 per cent and 28.9 per cent, with an average of 22.3 per cent. These values appear to be relatively low because open space – that is quite high in most Saudi cities – is included. However, when open space is excluded, the average of land allocated to streets in the 17 cities increases up to 27.8 per cent, which is fairly close to UN-Habitat threshold (30 per cent). Variations are more limited and range from a minimum of 23 per cent and a maximum value of 33.6 per cent (Graph 2). While the cities of Arar and Medina have values of 33 per cent, which are the result of a dense street system, the cities of Najran and Qatif have the lowest proportion of land allocated to streets with less than 24 per cent. Cities like Dammam, Jizan, Makkah and Taif allocate around 27 percent of their land to streets, which is close to the average of the sample of Saudi cities (27.8 per cent). In addition to sufficient land allocated to streets, various Saudi cities have well-connected street networks, with intersection densities well above the threshold of 100 intersections per square kilometre.

The land allocated to streets in the cities of Saudi Arabia is close to that observed in many cities of the developed world. Graph 2 on this indicator shows 3 main groups:

1. Cities with low and moderate levels of land allocated to streets between 23 and 28 per cent that is rather low if compared to UN-Habitat proposed standards in the City Prosperity Initiative (30).[14] This group is composed of 11 Saudi cities that are: Al-Ahsa, Al-Bahah, Dammam, Jeddah, Jizan, Khamis-Mushait, Makkah, Najran, Qatif, Sakaka and Taif.
2. Cities with values that are closed to Habitat threshold, ranging from 28.5 to 31 per cent. This group is constituted by 3 cities: Buraydah-Enaizah, Hail and Tabuk.
3. Cities with high levels of land allocated to streets with more than 33 per cent and slightly above UN-Habitat proposed standards. This group is composed of three cities: Arar, Medina and Riyadh.

Table 3: Land allocated to streets by typologies

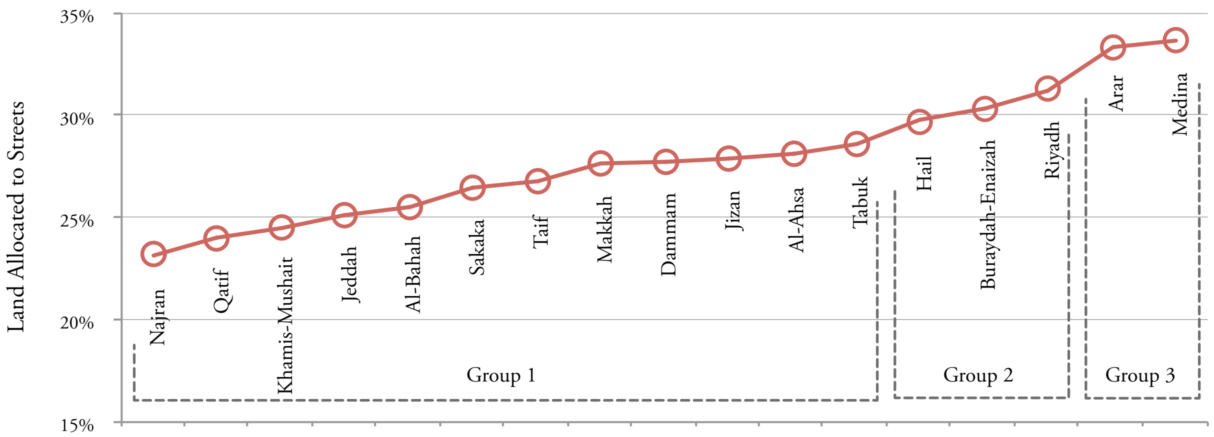
Urban Typology	Land Allocated to Streeeet
RESIDENTIAL	
ATOMISTIC	25.23%
FORMAL SUBDIVISION	33.60%
INFORMAL SUBDIVISION	27.92%
HOUSING PROJECT	26.26%
NON-RESIDENTIAL	
VACANT	29.79%
URBAN AMENITIES	24.80%
OPEN SPACE	13.45%

Land allocated to streets at intra-city level

When land allocated to streets is disaggregated at intra-city level, the informal subdivisions appear again as the typology with the values closer to UN-Habitat standards (refer to Table 3), as defined by the CPI (29 per cent of LAS v 30 per cent). Some cities have however smaller share of land to streets in the informal subdivisions, such as Najran (15 per cent) and Riyadh (24 per cent), which reflect clear insufficiencies to provide a connected street network in this typology (Graph 3). On the contrary, other cities have a high share of land allocated to streets in informal subdivisions, such as Medina with 35 per cent and Tabuk and Dammam both with 33 per cent.

Interestingly, the formal subdivisions typology provides land to streets in excess that on average represent 34 percent, instead the threshold of 30 per cent. This appears to be a distinctive case of Saudi cities, since in other countries formal subdivisions tend to have values below UN-Habitat standards. Cities like Tabuk and Najran dedicate 40 and 38 per cent of land to streets, respectively, way above the optimal values and exceeding by far the percentages of developed cities.[15] In the two Saudi cities, the high values of LAS are mainly due to disproportionate widths of the street network in the formal subdivisions that make up to 18 meters on average.[16]

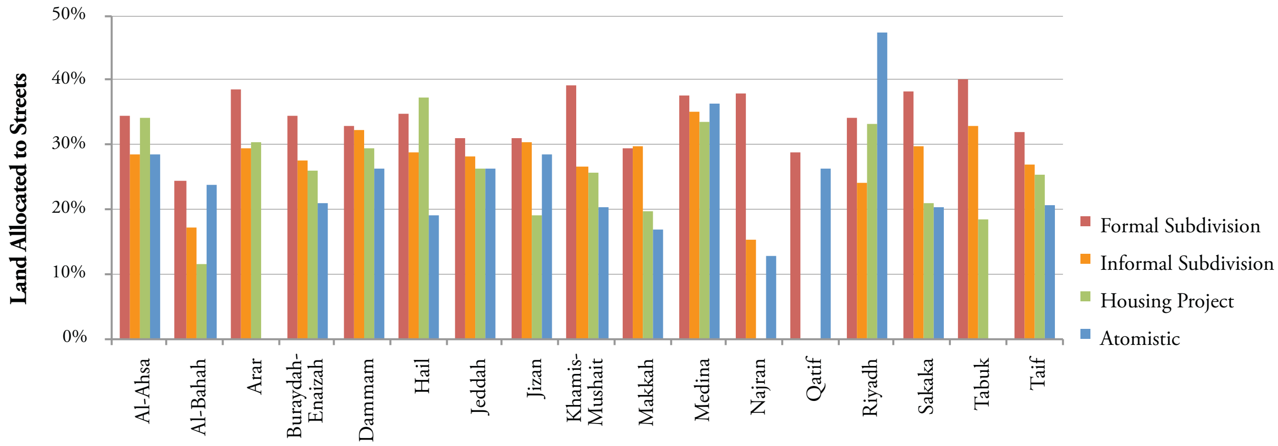
Graph 2: Land allocated to streets (excluding open space)



14 These values are excluding open space.

15 New York City in Manhattan has 36 of land allocated to streets. Cities like Montreal, Paris and Amsterdam have values of 29 per cent. UN-Habitat, 2013.
16 The average street width is obtained through the division of the land allocated to streets by the length of the street network (street density).

Graph 3: Land allocated to streets in cities by residential typologies



The atomistic typology is also interesting in itself. The average of LAS in the 17 cities reaches only 25 per cent. With an irregular street layout, intersections that are not frequent, roads with width variations and inconsistent plot sizes, the atomistic typology takes two clear forms in the Saudi cities:

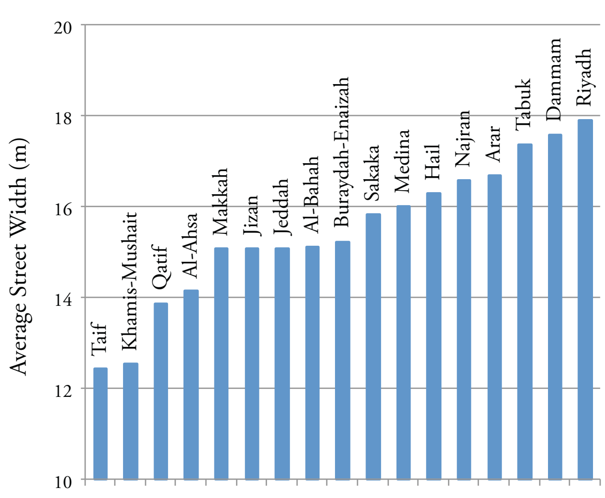
- The medina's type development with an organic pattern of streets, very dense street network (over 40 km of streets per km^2) and intense number of intersections (around 650) have on average, LAS within recommended values (around 30). This corresponds to cities like Medina, Jizan and Jeddah that have adequate to high proportion of land dedicated to streets with very narrow streets or alleys varying from 6 to 8 meters. This typology that is socially vibrant, economically active and culturally and environmentally adapted to the extreme weather conditions, represents on average 4 per cent of the total surface of these three cities.

- The rural-type development with homes that have been built-up in large open space blocks, including long strips of homes on the edges of rural roads. With large amounts of open space in the middle, the land is not considered 'subdivided' because no spatial planning took place to make room for infrastructure to facilitate and orderly transition from rural to urban. This corresponds to cities like Sakaka, Qatif and Al-Bahah that have streets widths of around 12 meters despite their atomistic structure.

Street widths

Based on the land allocated to streets and the length of the street network, measured by the street density, it is possible to determine how narrow streets are. Data from the 17 Saudi cities analyzed shows great variations within cities. While

Graph 4: Average street widths



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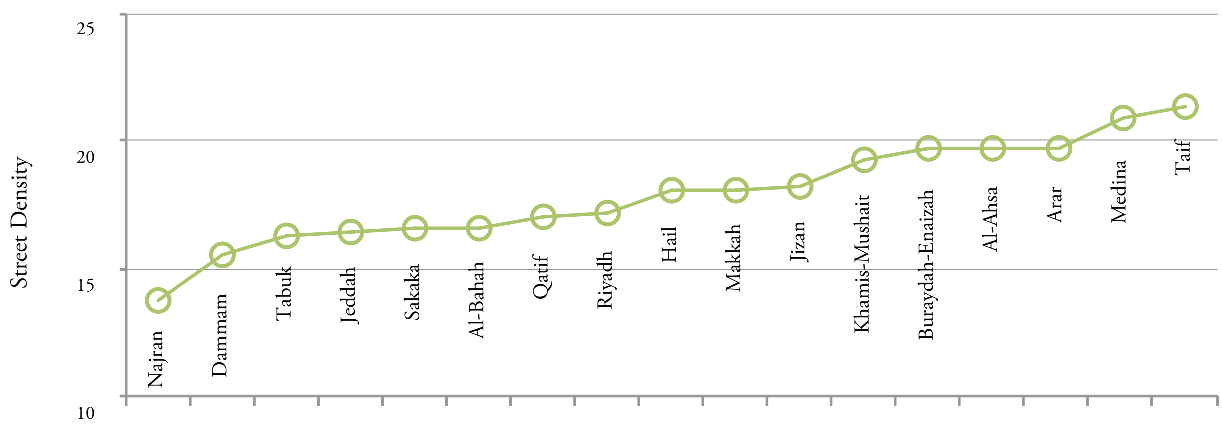
the average street width for the cities of Saudi Arabia is 15.5 m, cities like Taif and Khamis-Mushait have the narrowest streets among the Kingdom (12.5 m). On the contrary, the cities of Riyadh, Dammam and Tabuk, have wide streets of around 17.6 m, which is indicative of the widespread existence of large boulevards and avenues mostly designed to accommodate private vehicles (Graph 4).

At city level, the average street width can hide great disparities that exist at city within the city. While large boulevards may be appropriate for the primary roads, the same width in excess for residential areas. Cities that in average overpass the threshold of 33 per cent of land allocated to street are a point in case. When calculated at the typology level, the street widths that depend on the density of their street networks and will show great variety. For example, with 37 per cent of land allocated to streets, the typologies of formal and informal subdivisions of the city of Tabuk have an average street width of 19 m, while the atomistic typology of Medina, also with 37 per cent of LAS, has average street widths of only 8.6 m due to its extensive street network. Both cases exemplify the variety of urban configurations that can exist within a same city.

Notwithstanding that the study measures the availability of road space, it is the distribution and use of such road space that can make an important difference in the way that various modes of transport are accommodated in an equitable manner. Through urban design, cities can make interventions to redistribute the space allocated to streets in order to facilitate the use public and non-motorized mobility, promote human interaction and enhance social cohesion.

Graph 5: Street density (excluding open space)



3.4 Street density

Street density (SD) measures the length of the street network per square kilometre. According to the study conducted in the 17 Saudi cities, this indicator reaches, on average, 18 km streets per km^2, which is relatively close to the standard proposed by UN-Habitat City Prosperity Initiative (20 km). In the cities of Medina and Taif, the values are slightly above this threshold (21 and 21.5 per cent, respectively). Meanwhile, in the cities of Al-Bahah (16.8), Dammam (15.7), Jeddah (16.6), Sakaka (16.7) and Tabuk (16.4) values are relatively low, which obviously denote fewer streets, but perhaps a pattern of larger blocks and more linear development (Graph 5). Notable is the case of the city of Najran that has a street density of 14 which is quite low for national standards.

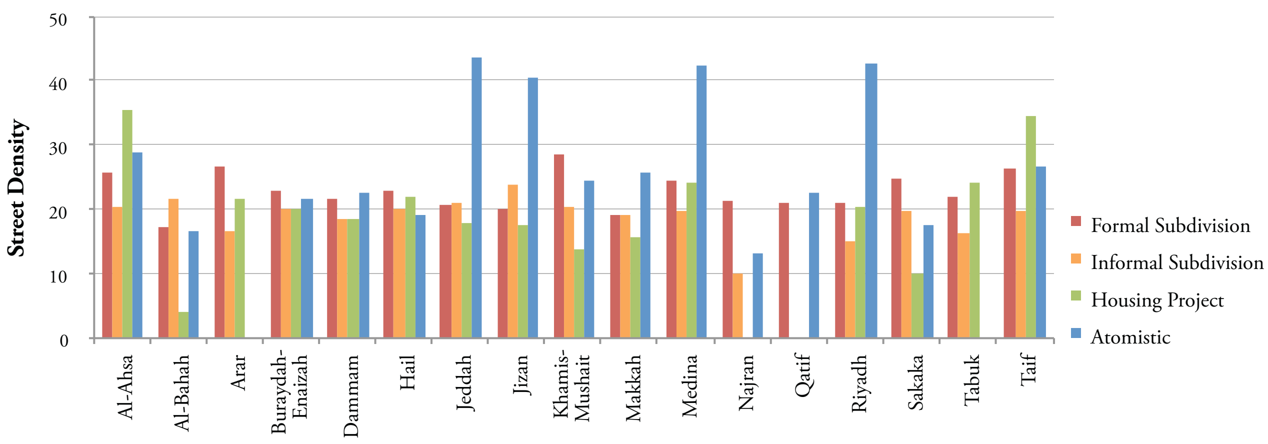
However, when open space is included, street densities reduce dramatically to an average of 14 km per km^2 for the 17 Saudi cities. Only two cities (Taif and Arar) have street density values above 16 km that would qualify them as moderate connectivity, while eight cities[17] have low street density values (15), and six cities[18] have very low values (13). The city of Najran, with merely 9 km of streets per km^2 falls once more below the minimum benchmark set by UN-Habitat.

Street density at intra-city level

Street densities analyzed at intra-city level show notably higher values in residential areas than in non-residential areas of the 17 Saudi cities of the sample (22 and 13 km of streets per km square respectively). Within the residential typologies, informal subdivisions and housing projects appear as the typologies with the values closer to UN-Habitat recommendation of 20 km per km square (Table 4). The atomistic and formal subdivisions typologies have values above UN-Habitat standard (27 and 23, respectively). On the contrary, non-residential areas, particularly the open space (8) and the urban amenities (13) show very poor density of street, which negatively affects the overall connectivity (walkability) of the city.

More detailed analysis of the street density at intra-city level show that some cities have a very intricate network of streets in the atomistic, formal subdivision and housing project typologies (Graph 6). Values that double those recommended by UN-Habitat appear in the atomistic areas of Jeddah (44) Riyadh (43) Medina (42) and Jizan (40). One particularity of the densely network of streets in the atomistic areas of these four cities, is that they have equally excessive number of intersections (650). Nevertheless, with the exception of

Graph 6 Street density in cities by residential typologies



17 Medina, Khamis-Mushait, Buraydah-Enaizah, Riyadh, Makkah, Hail Al-Ahsa and Tabuk.
18 Jizan, Qatif, Jeddah, Dammam, Sakaka and Al-Bahah

Table 4: Street density by typologies

Urban Typology	Street Density
RESIDENTIAL	
ATOMISTIC	27
FORMAL SUBDIVISION	23
HOUSING PROJECT	21
INFORMAL SUBDIVISION	19
NON-RESIDENTIAL	
VACANT	18
URBAN AMENITIES	13
OPEN SPACE	8

Medina, in which atomistic or organic areas represent 7 per cent of the urban area, this typology account for less than 2 per cent of the surface of Jeddah, Riyadh and Jizan.

Even as the average street density values that remain close the recommended threshold, the housing project is the second typology that also has values above 35 km per km^2 in the cities of Al-Ahsa and Taif (see Graph 6).

Finally, formal subdivision, as the second highest typology for street density (refer to Table 4), have more uniform values across the 17 cities. All cities, except for Al-Bahah and Makkah have street networks that are above the standard. However, six of the cities of the sample19 present values overpassing 24 km per km^2. This indicator reflects a particular trend of formal urbanization in Saudi cities that provides street network in excess, due to which are penalized in the Street Connectivity Index.

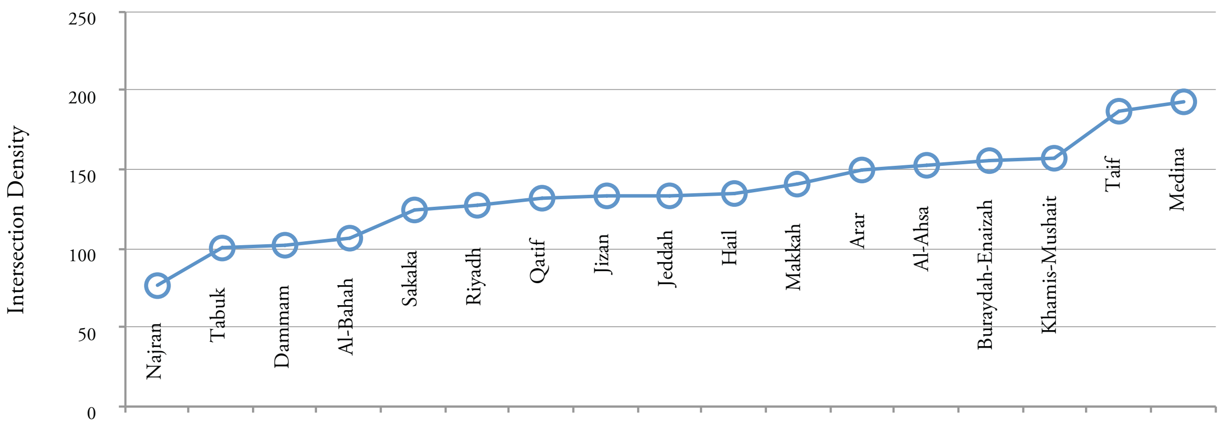
3.5 Intersection density

Intersection density (ID) is a good indicator of compactness and walkability. At an optimal level estimated by UN-Habitat at around 100 intersections per square kilometre, the city, or part of it, is more conducive to the use of non-motorized transport. In the national sample of Saudi cities the average value is 136 intersections per square kilometre. The cities of Al-Ahsa (153), Arar (150), Buraydah-Enaizah (156), Khamis-Mushait (158) and Makkah (142) are all slightly above the national average. The city of Medina with an organic street pattern at its core has 193 intersections per km^2 and the city of Taif developed on the slopes of Sarawat Mountains has 187 intersections; both cities above the optimal range.

The organic or atomistic development, as explained in chapters 2 and 5, is characterized by an irregular street layout; variations in road widths within the same street, and inconsistent plot sizes. The cities of Medina and Taif have very

19 The six cities are Khamis-Mushait (29), Arar and Taif (27), Al-Ahsa (26), and Medina and Sakaka (25).

Graph 7: Intersection density (excluding open space)



high intersections densities in the medina's development areas that reach 622 and 311, respectively. These historic cores represent 7 and 10 per cent of the total area of the city and contribute to increase the overall values of the cities' street density. With some exceptions, very high intersection densities do not translate in more connected places.

Graph 7 displays the intersection densities of the 17 Saudi cities. At the bottom of the graph appears the city of Najran that has very poor connectivity in the three indicators, with a very limited street network, low proportion of land allocated to streets, and restricted number of intersections. Najran's streets are slightly wider than the national average, they do not cover all parts of the city and the blocks are 40 percent larger than the average of the 17 cities, dramatically reducing the number of crossings.

When open space is taken into consideration, the average value of intersection density is drastically reduced by 40 per cent to an average of 99 intersections per km^2. Due to fragmented urban development, eight cities fall below the minimum recommended values, while the cities of Al-Bahah and Najran decrease into low intersection density values (56 and 43, respectively).

Intersection density at intra-city level

More detailed analysis at intra-city level shows great differences among urban typologies (Table 5). Overall, residential typologies in the cities of Saudi Arabia have intersection densities above UN-Habitat threshold (193), while non-residential typologies are below the minimum recommendation (77).[20]

Atomistic or organic-development areas, with 309 intersections per km^2, have the highest intersection densities (refer to chapter 5), followed by formal subdivisions and housing projects (186 and 146 respectively). The presence of large number of gated communities, streets with dead-ends or 'T'[21] intersections and a very dense street network explain this excessive number of intersections that often interrupt connectivity. As shown in Graph 8, the typologies of atomistic and formal subdivisions provide intersections in excess in 6 and 2 cities respectively. In some cases, like in the city of Medina this pattern accounts for 16 per cent of the urban area, followed by Makkah with 12 per cent of its surface.

On the category of non-residential areas, vacant land, which evidence the urbanization pattern of areas of future expansion, have appropriate densities of intersections (119), whereas urban amenities (81) and open spaces (33) have low and very low values. Such low connectivity, particularly in urban amenities denotes urban forms more oriented to motorized means of transport.

20 UN-Habitat has established recommended values for intersection densities between 100 and 140 intersections per km^2.
21 According to the methodology, 3-way intersections –or 'T' intersections- are counted equal as 4-way or 5-way intersections, contributing to the increase in the intersection density.

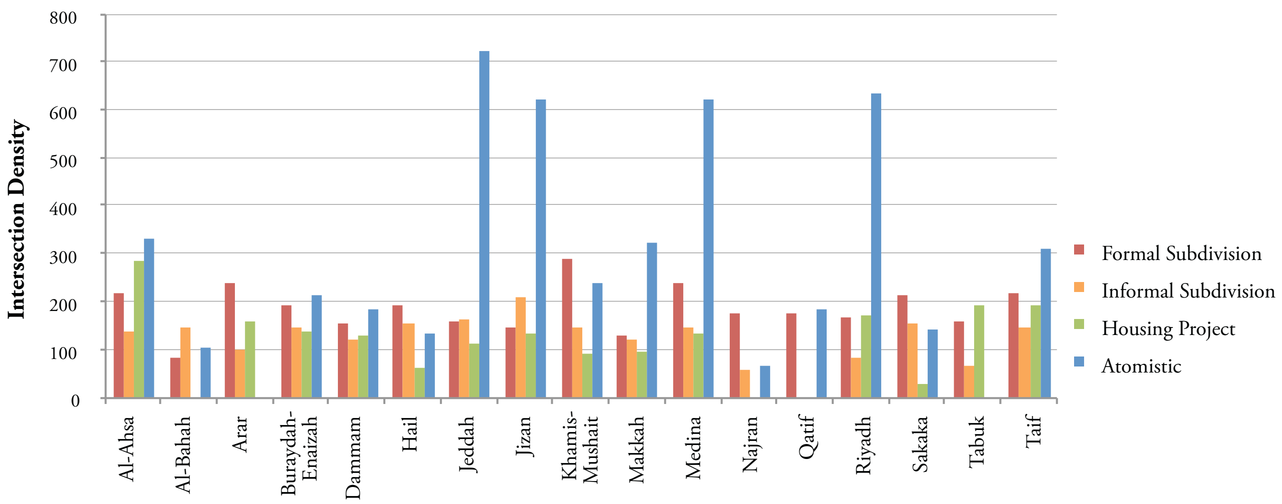
Table 5: Intersection density by typologies

Urban Typology	Intersection Density
RESIDENTIAL	
ATOMISTIC	309
FORMAL SUBDIVISION	186
HOUSING PROJECT	146
INFORMAL SUBDIVISION	131
NON-RESIDENTIAL	
VACANT	119
URBAN AMENITIES	81
OPEN SPACE	33

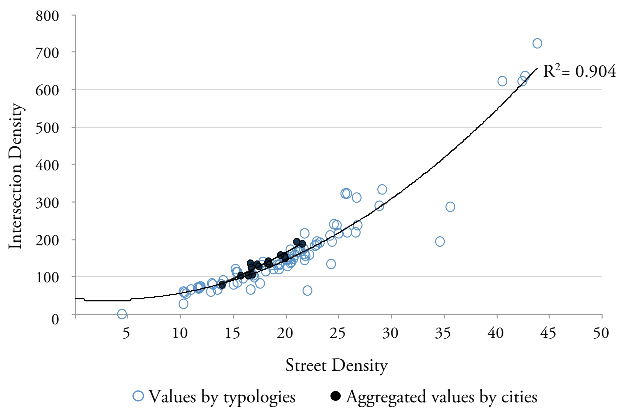
Intersection density and street density ratio

The number of intersections in a city or city-area is the result of the length of the streets network and its layout. A city with a 'perfect' grid street pattern, with square blocks and a street every 100 m on each direction would have 100 intersections per km^2. Whereas a city that has expanded in a linear manner due to complex topographic conditions would have reduced connectivity. On the opposite case, cities with organic street patterns will tend to increase exponentially the number of intersections as a result of a denser street

Graph 8: Intersection density in cities by residential typologies



Graph 9: Street Density: Intersection Density ratio. Aggregated vs. disaggregated values



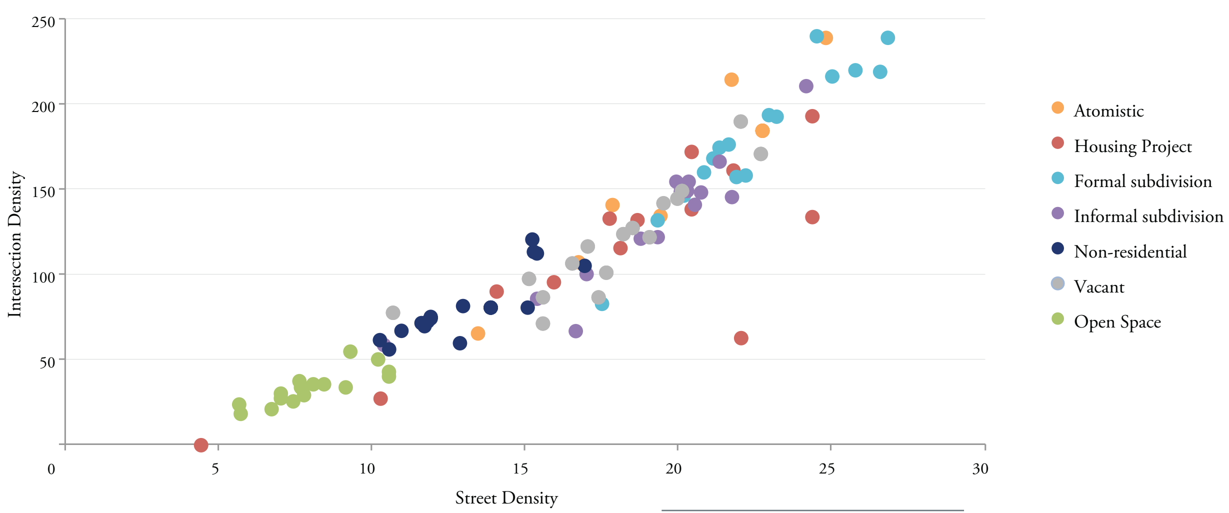
The differentiation of this trend by urban typologies (Graph 10), of the typologies that are within standard values evidence a clear pattern behind each typology. Urban typologies with lower connectivity (open space and urban amenities) are located towards the lower-left corner, while typologies with highest connectivity (atomistic) are in the upper-right extreme.

Based on this model, vacant land, informal subdivision and certain housing projects are located in the middle of the quadrant, within UN-Habitat recommended thresholds for both indicators. Finally, it is possible to identify as outliers below the trend the Housing Projects in Sakaka, Hail and Medina;[22] the Atomistic areas of Khamis-Mushait and Buraydah-Enaizah, and the formal subdivision of Medina on the above the trend-line.[23]

networks and non-parallel streets that naturally produce more junctions.

An analysis of the relationship between intersection density (#/km²) and street density (km/km²) in the 17 Saudi cities show that there is a high correlation between these two variables (R^2=0.9). Such evident trend is consistent with UN-Habitat studies in other parts of the world and equally applies to the city as a whole (aggregated values), and to particular parts or typologies of the cities (disaggregated values). Graph 9 shows the relationship between intersection density and street density (otherwise expressed ID:SD ratio) for the seven urban typologies, as well as the average values for the 17 Saudi cities in the sample.

Graph 10: Street Density: Intersection Density ratio. Values by urban typologies (close-up)



22 All with ID:SD ratios below 6 denoting low connectivity levels)
23 The three cities have ID:SD ratios of 10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CHAPTER 4:

Intra-city analysis on street connectivity – Getting inside the city

In order to analyze in more detail general results of the Street Connectivity Index and the related indicators, this section proposes to 'get inside the city' to examine how the different areas and functions of the city perform. Using the same methodology proposed by the University of New York and GvSig (refer to section 2), 7 typologies are proposed divided in two groups:

- Group 1 – residential (4 types): atomistic, formal subdivisions, informal subdivisions and housing projects;
- Group 2 – non-residential (3 types): urban amenities, open space and vacant land.

The information of these typologies can be used to refine the analysis of the different street connectivity indicators, and assess which urban areas have better morphology. This information and knowledge will provide light on the urban types that are more conducive to prosperity, considering, as UN-Habitat has already indicated, that "streets as public spaces are drivers of urban prosperity"[24]. At a later stage, this knowledge can also inform the targeting of interventions to ensure that the urban structure is orderly, equitable, and sustainable.

4.1 Residential – formal subdivisions

Formal layouts are similar to informal layouts, but exhibit a higher level of infrastructure. Specifically, all roads must be paved for an area to qualify as a formal subdivision. Sidewalks are also often visible. Formal layouts are also often characterized by better connections to arterial road networks and a linear relationship to the existing road system (for example, a road in a formal subdivision will generally meet a pre-existing road at a 90 degree angle). The quality of the structures can be similar to that of an informal layout, but it will often be somewhat higher.

Formal subdivisions represent around 15 per cent of the total areas of the 17 Saudi cities. In aggregated values, they have a Street Connectivity Index of 67 points that qualifies as moderate connectivity. As part of Group 1 of Residential Areas, formal subdivisions represent 45 per cent of the residential areas of all the cities in the sample. They rank as the second best typology after informal subdivisions mainly due to the over dimension of the land allocated to streets (20 per cent

24 UN-Habitat (2013) Streets as Public Spaces and Drivers of Urban Prosperity. Nairobi

Table 6: Distribution of land within residential areas

TYPOLOGY	% of the residential areas
ATOMISTIC	18.26%
FORMAL SUBDIVISION	44.80%
HOUSING PROJECT	4.37%
INFORMAL SUBDIVISION	32.57%
TOTAL	100.00%

more) and the excessive use of intersections with numerous 'T' crossings and other forms of cul-de-sacs. For example, in the City of Tabuk (Graph 11), as it happens in nearly half of Saudi cities analyzed, formal subdivisions represent 16 per cent of the city, and the value of land allocated to streets is as high as 40 per cent, with streets widths of 18 meters.[25] The values of formal subdivisions with regards to the proportion of land allocated to streets and street network and intersections is quite homogenous among the 17 cities.[26]

4.2 Residential – informal subdivisions

Informal subdivisions are areas in which land has been subdivided for urban use, but lacking visible evidence of legal formality, such as paved streets, streetlights, or sidewalks. Plot sizes are regular or semi-regular. Structures are laid out along linear or generally linear roads, with regular

25 On average, assuming lanes of three meters a width of 18 meters can accommodate up to 4 lanes in an area that is mostly residential.
26 Standard deviation of all values of the cities is around 18 per cent.

Graph 11: Tabuk city, formal subdvisions

intersections and standardized width. Blocks are also regular or semi-regular in size and shape (variations may be due to topography, for example). Because of these factors – the consistency in plot size, the linearity of the road network, the frequency of intersections, and the regularity of block sizes – the structures also exhibit a high degree of regularity. Despite differences in individual constructions, the size of the structures and the layout of the compounds is generally highly normalized. The primary roads in these areas are all unpaved, indicating that the area was constructed without the full complement of formal services.

Informal subdivisions represent 19 per cent of the total areas of the 17 Saudi cities. On average, they have a Street Connectivity Index of 79 points that qualifies as moderate connectivity. As part of Group 1 of Residential Areas, informal subdivisions represent 11 per cent of the residential areas of all the cities in the sample. They rank as the best typology since values are closer to UN-Habitat recommended thresholds, particularly with regards the land allocated to streets (28 per cent, on average).[27] Still in the process of consolidation, informal subdivisions can contain substandard housing and neighbourhoods without all formal services and amenities. Many of their streets do not have appropriate sidewalks and some may not be paved. Values on street connectivity across all Saudi cities in informal subdivisions are relatively homogenous.[28] The Cities of Makkah and Al-Ahsa have connectivity values closer to recommended standards in the informal subdivisions that represent 6 and 8 per cent of the total area of the city, respectively.[29] Conversely, the City of Najran has extremely poor connectivity in the informal subdivisions with an aggregated index of 37 points and values as low as 15 per cent in the land allocated to streets, 10 km of streets per km^2 and only 58 intersections per km^2.

4.3 Residential – housing projects

Housing projects can include a range of scenarios of layout and development, ranging from large apartment towers to suburban tract housing. Housing projects share one feature – the structures must be homogenous. These are projects in which all structures are built off the same plan, or a variation on the same plan. Housing projects could include apartment blocks or subdivisions in which all houses are built by one developer at the same time or in phases. Housing projects are not auto-housing: the people living in the structures do not have a role to play in their construction. The layout of the roads can be similar to that of formal layouts, but the layout may often involve curvilinear designs and cul-de-sacs, with an aim toward minimizing connectivity with outside road networks. At least three buildings must be identical for a given group to be labelled a housing project.

The housing projects typology represents a very small fraction of the total area in the 17 cities (1.8 per cent on average). However, in cities like Tabuk and Riyadh this typology accounts for 7 and 6 per cent, respectively, representing up to 20 and 16 per cent of the total residential areas. This is the

Graph 12: Jeddah, Informal subdivisions

Graph 13: Riyadh, Mass housing projects

result of massive housing development made by public and private developers to produce low-cost and middle income housing. Housing projects typology has an index of 67 points that is considered as moderate connectivity. However, it has vast variances among the 17 cities, ranging from 95 points (Dammam) to 13 points (Al-Bahah). The morphology of housing projects varies also a lot with streets widths over 20 meters (Sakaka) and very narrow streets of 7 meters (Tabuk and Taif). The design of housing projects typology denotes a clear intention to minimize the land allocated to streets as it happens in many other cities in the developing world. This practice of real estate developers and city planners aims to increase the number of plot and houses, while at the same time reducing streets and public spaces.

4.4 Residential - atomistic or organic

Atomistic development is irregular in layout and was not subdivided before residential development took place. As a category, it includes all residential development that is not a subdivision or a project. In general, identifying this kind of development is simple, because land that is in this use does not have a regular street layout, intersections are irregular in frequency, road width varies within a given linear stretch, and plot sizes are inconsistent. Other types of atomistic development include homes that have been built in large open space blocks, including long strips of homes on the edges of rural roads. In these areas, with large amounts of open space in the middle, the land is not considered 'subdivided' because no spatial planning took place to make room for infrastructure to facilitate an orderly transition from rural to urban. This is also indicated by the lack of a pattern to the development. Homes that have been built on small plots that were formerly used for agriculture would also count as atomistic. This is most common on the urban fringe, in areas where agricultural and new residential development mix.

Graph 14: Jeddah, atomistic development

Atomistic typology covers, on average, 6 per cent of the total area of the 17 Saudi cities and 18 per cent of the residential category (refer to section 2.4). This typology has important variations at city level. In some urban areas it is almost inexistent (Dammam and Riyadh) and in other cities it represents up to 19 per cent (Al-Bahah).[30] Atomistic development is very close to organic type of growth and suffers from irregular patterns of street layout and blocks. As a result, Street Connectivity Index is very low around 48 points. However, values of this typology differ from 86 points (Hail), 41 points (Khamis-Mushaid) to 18 points (Riyadh). Urban development in atomistic areas has a very particular pattern characterized by a very profuse street density (around 40 km of streets per km^2) in the cities of Medina, Jizan, Jeddah and Riyadh. With an organic pattern the number of street intersections in these cities increases almost exponentially to 600 and 700 per sq. kilometre. The ratio between street density and intersection density in many of the atomistic areas is quite high (above 10) with numerous nodes that are 'T' junctions favourable for walkability, intensive pedestrian live and local economic activities.[31] However as various studies have shown, the organic pattern often hinders the provision of basic services, mass transportation and the creation of public spaces of a certain dimension.

30 Values above 10 per cent appear in 5 cities: Al-Babah (19), Makkah (12), Sakaka and Taif (11) and Khamis-Mushait (10 per cent).
31 The width of streets in cities like Jeddah and Mekkak is around 6 meters.

CHAPTER 5:

The spatial capital of cities – comparing street connectivity with other variables

5.1 City prosperity is made possible by its spatial capital: the density, streets and public open space

Connectivity is not a goal in itself, but a mean to create successful, prosperous cities. The role of the street is to connect spaces, people and goods, and thereby facilitating commerce, social interaction and mobility.[32] But not just connectivity is an important spatial variable; cities consist of streets, buildings and open space, their distribution and configuration constitute the spatial capital of a city.

This chapter describes the spatial properties and needs in 17 Saudi Arabian cities. Cities that have appropriate layouts, adequate street connectivity and sufficient open public spaces are cities that have a spatial capital. This capital can support development in various other areas and contribute to enhance social cohesion and economic productivity. Since spatial capital is suggested to be an important basis to create successful and prosperous cities it is highly relevant to view it in relation to indicators of socioeconomic performance.[33]

The properties of spatial capital could consist of a range of different measurement. For this study and based on available data, the most adequate aspects for a city's spatial performance are suggested to be built-up density and connectivity; but measurements of public open space and land use are highly relevant to describe the spatial capital of a city.[34]

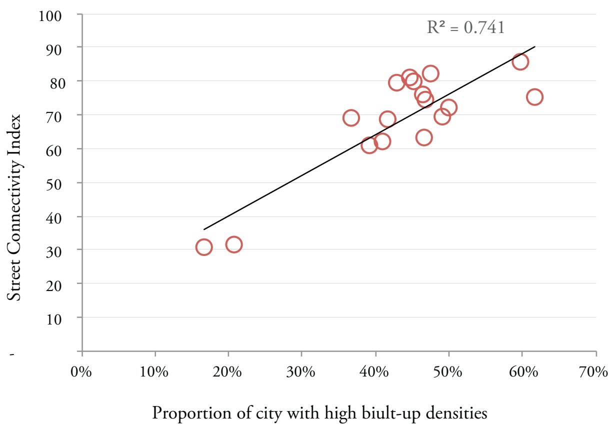
5.2 Street connectivity and built-up densities

Street morphology and plot density are highly correlated. Numerous studies show that as street length and intersections per square kilometre increase so does the density of plots. Other studies prove the contrary: the density of streets increases in proportion to the density of properties.[35] Regardless of causality, it is clear that the density of the street network increases to service a larger number of plots and people. Cities from Saudi Arabia are not strange to this relation. However, in the cities of Saudi Arabia, due to low population densities (47 inhabitants per hectare on average), relatively dense street systems serve a smaller number of people, and during most parts of the day many streets tend to remain empty.

Using data on estimated plot densities in the 17 Saudi cities, it is possible to find a strong correlation between the connectivity of streets (street connectivity index) and the proportion of the city that has high built-up densities (R2=0.74). As the proportion of areas with high built-up density reduce, the connectivity of cities subsequently declines (refer to graph 15). In the 17 cities, high built-up densities represent, on average, 43 per cent and medium built-up densities 7 per cent from the total surface of the city. In cities like Makkah and Arar, high built-up densities can reach up to 62 and 60 per cent, respectively.

As mentioned before, Saudi cities have a high proportion of open or 'white' lands that amount up to 46 per cent of the total footprint of the 17 cities. In some of them, open and vacant land sums up to two-thirds of the total urban area. These excessive amounts of white lands are traduced into very low population densities in 11 out of the 17 sample cities.

Graph 15: Street Connectivity Index (including open space) and proportion of the city with built-up densities



When open areas are excluded from the analysis and only the built-up areas are taken into account, high built-up densities make up to 80 per cent of the total built-up areas of the cities. In Al-Asha, Arar, Jizan and Makkah, they are virtually the principal form of plot occupation (around 95 per cent).

32 UN-Habitat (2013) Streets as Public Spaces and Drivers of Urban Prosperity. Nairobi

33 Spacescape (2015) Street connectivity and land use in 17 Saudi Arabian cities, background paper prepared for UN-Habitat for this study.

34 In other cases, it can be assesses by the five principles for sustainable neighbourhood planning developed by UN-Habitat: adequate space for streets, high population density, mixed land uses, social diversity and limited land use specialization. UN-Habitat (2014) A New Strategy of Sustainable Neighbourhood Planning: Five principles – Urban Planning, Discussion Note 3, Nairobi.

35 Peponis John, Allen Douglas et at (2007) Street Connectivity and Urban Density: Proceedings, 6th International Space Syntax Symposium, Istanbul.

Table 7: Population and plot densities in selectied cities of Saudi Arabia.

City	Population Density (inhab./ha)	Plot Density (% of Urban area)
QATIF	87.22	15.1%
AL-BAHAH	85.28	7.8%
MAKKAH	83.84	22.1%
TABUK	66.96	21.4%
TAIF	66.37	17.3%
RIYADH	60.01	21.0%
JEDDAH	53.91	19.0%
MEDINA	50.82	19.1%
ARAR	47.63	23.3%
AL-AHSA	37.03	12.8%
KHAMIS-MUSHAIT	36.87	16.7%
NAJRAN	34.63	8.0%
DAMMAM	28.03	16.4%
SAKAKA	26.29	17.9%
JIZAN	25.26	14.6%
BURAYDAH-ENAIZAH	25.01	18.1%
HAIL	23.85	18.9%
AVERAGE	49.35	17.0%

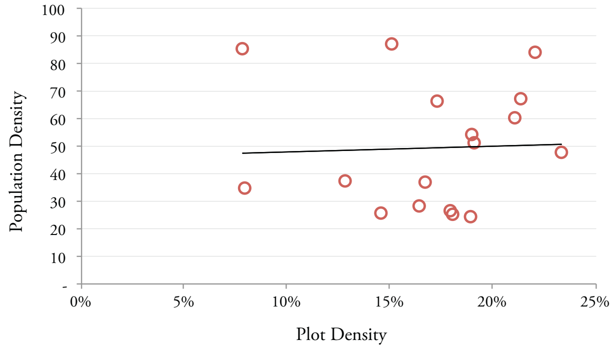
Only in Najran city they represent slightly less than half (46 per cent). However, presented in this manner, the data can be misleading and give the impression that cities in Saudi Arabia have high built-up densities. In reality the weighted total plot coverage of the entire city- or plot density- is around 17 per cent in the cities that are part of the sample. Thus, plot densities are also affected by the large quantity of open and vacant land.[36]

Plot density has been estimated as the weighted average of the urban surfaces with high, medium and low built-up densities,[37] and take in consideration the amount of open and vacant land in the city. Thus, the value represents the total surface of the city covered by buildings. Values range from 23 per cent in Arar and 19 per cent in Medina to 8 per cent in Al-Bahah and Najran. It is worth noting that plot density and population density are not statistically correlated, as shown in Graph 16 (R^2=0.04). Plots that are densely occupied can have only one building and one single family. Residential densities remain extremely low, at an average of 49 inhabitants per hectare, with values ranging from 87 in Qatif to 23 in Hail (Table 7).

Notwithstanding the high correlation that is found between the measures of street configuration and built-up areas, particularly with regards to high built-up area (refer to Graph 15), it is interesting to notice that when the different types of built-up areas (low, medium and high) are compared with standard values of the Street Connectivity Index, medium built-up density appear with the highest values (81 points). This is because areas with high plot density occupation tend to reduce their Street Connectivity Index values, particularly with regards to street density (70 points) and intersection density (48 points). Some cities are penalized either because of excessive number of intersections or extremely dense network of streets.

The City of Medina is a point in case. In the areas identified as high built densities, the length of street network is 35 per cent above threshold and the number of intersections almost three times higher than minimum recommended values by UN-Habitat. Despite these high values in street and intersection density, the city of Medina and other urban centres with a traditional or organic layout, follow a clear pattern that is statistically consistent (with a R^2 equal to 0.9). In other words, the ratio between intersection density and street density follows a regular trend that identifies the atomistic typology of the old medina, as shown in Graph 9 in Chapter 3.

Graph 16: Population and plot densities in Saudi Cities

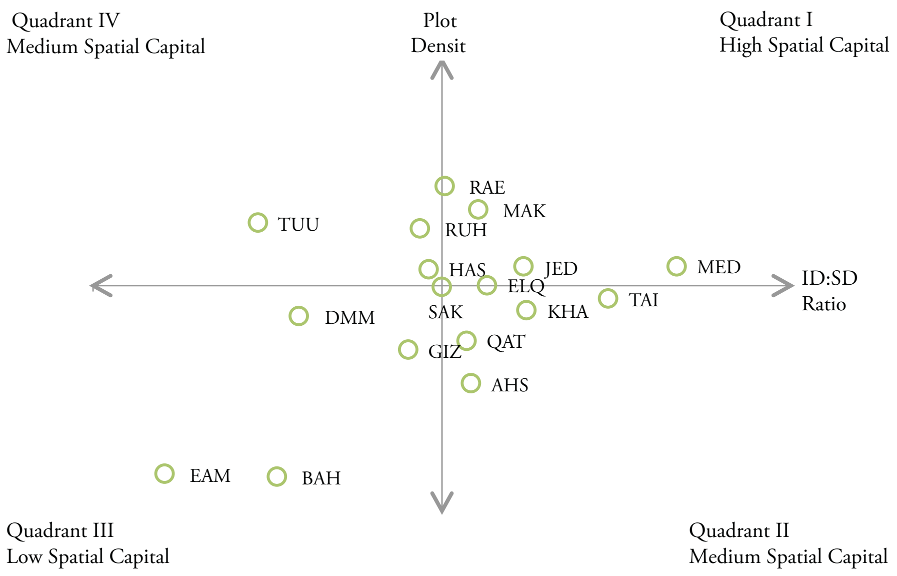


36 Plot density refers to the proportion land within the cities' built-up that is classified as low, medium and high density according to the coverage of the plot (data excludes open and vacant land).
37 Built-up density is defined by the proportion of the plot's surface that is covered by buildings, excluding streets. Applied weights are 80% for high built -up density areas; 50% for medium built-up density areas; and 25% of low built-up density areas.

5.3 Spatial capital model

As presented in Section 5.1, the spatial capital exhibits the mode in which cities can make optimal use of their spatial structure to improve the way in which inhabitants can profit from the benefits of urban agglomeration; while enhancing the functionality of cities and improving quality of life, social development, and other key components of human well being.

Graph 17: Spatial capital of cities (Plot density and ratio of ID:SD)



Graph 17 illustrates the spatial capital model developed for Saudi Arabian cities. This spatial capital is expressed by the relationship between plot density and connectivity, measured as the ratio of intersection density and street density (ID:SD). According to this model, based on recommended values of plot density and ID:SD ratio,[38] cities that combine high connectivity and plot density are considered as having 'high spatial capital' (quadrant I). Cities in which plot densities reduce, but still maintain a good level of connectivity, as well as cities that have high plot densities but lower levels of connectivity are considered to have 'medium spatial capital' (quadrant II and IV, respectively). Finally, cities with low plot densities and low levels of connectivity are classified as having 'low spatial capital' (quadrant III).

Thanks to the data available for all 17 cities, it is possible to observe that 5 cities are located in quadrant I 'high spatial capital',[39] another 7 cities in quadrant II and IV that represent 'medium spatial capital'[40] and 5 cities are placed in quadrant III 'low spatial capital'.[41] Spatial capital can be enhanced through urban planning and design interventions. In cases where the ratio ID: SD is below the minimum acceptable (5), urban planning and design can increase pedestrian links and a number of intersections to favour walkability. When plot density is low, there is a need to leverage densities to maximize the street network.

38 Target values are at least 30 per cent of plot density, and a ID:SD ratio of 10. A higher ID:SD ratio is a feature of a denser street grid network.

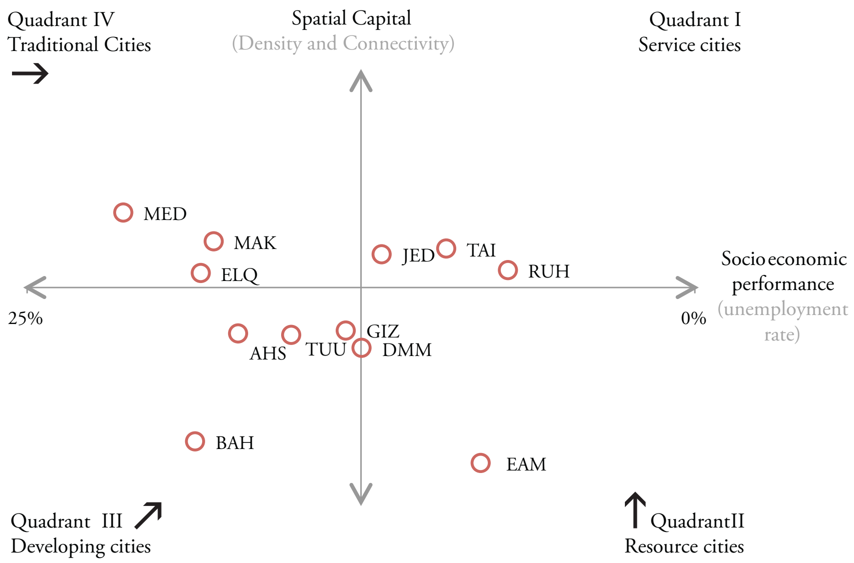
39 The 4 cities in quadrant 1 'high spatial capital' are Arar, Medina, Makkah, Jeddah and Buraydah-Enaizah.

40 Cities in quadrant II and IV 'medium spatial capital' are Riyadh, Tabuk, Hail, Taif, Khamis-Mushait, Qatif and Al-Ahsa

41 Cities in quadrant III 'low spatial capital' are Sakaka, Dammam, Jizan, Najran and Al-Bahah

5.4 Spatial capital and socioeconomic performance

Graph 18: Spatial capital and socioeconomic performance of cities



As in many other cities in the world, there is a relation between form and functionality of the city. As an explanatory model for this relation (Graph 18), the cities are categorized by their layout and functional structure based on the relationship of spatial capital (refer to section 5.3) with their socioeconomic performance. Socioeconomic performance could be measured by the combination of two groups of variables: economic strength (city product and employment) and economic equity (Gini coefficient and poverty rates) as per the framework of the City Prosperity Initiative.[42] For this case, and determined by available data, the socio economic performance is measured by the employment rate.[43] This results in four functional groups of cities:[44] 1) service cities; 2) resource cities; 3) developing cities and 4) traditional cities.[45]

As a result of this model, 3 cities in quadrant I with high spatial capital and relatively low unemployment rate can be considered as 'service' cities.[46] Another 3 cities in quadrant IV also with high spatial capital, but high unemployment rate, correspond to 'traditional' cities.[47] In quadrant II is located 1 'resource' city that have relatively low unemployment rate, but poor spatial capital.[48] Finally, in quadrant III appear 5 'developing cities' that are characterized by high unemployment rate and poor spatial capital.[49]

Graph 18 also shows a negative correlation between spatial capital and socio-economic performance using the unemployment rates (cities in Saudi Arabia that have higher spatial capital tend to have higher unemployment rates). This calls for the use of additional economic and social data in order to avoid that a single proxy variable defines the complexity of the socioeconomic performance. More data will help to better understand the role of spatial capital as a vector of economic prosperity.[50]

5.5 Leveraging densities and maximizing the street network to increase the spatial capital

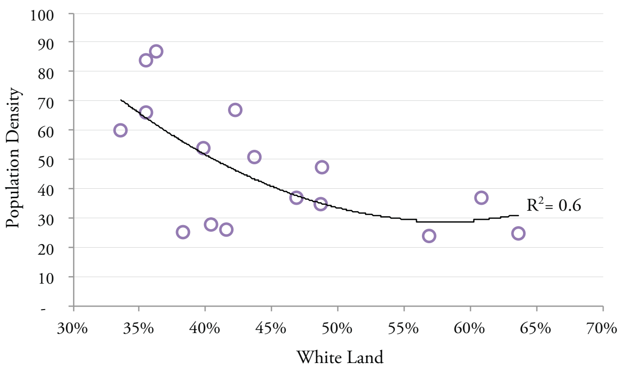
As previously explained, the existence of 'white land' (open space and vacant land) is a major cause of low residential and plot densities, wasteful use of the space, inefficient

42 City Prosperity Initiative, index framework. These indicators are part of the productivity and the equity dimensions.
43 GDP is only available for few cities. The variable of employment rate that is available for 12 cities. The cities of Arar, Hail, Khamis-Mushait, Qatif and Sakaka are not included in this model. The CPI will provide information for additional cities and the model will be reviewed with the revised variables.
44 The arrows indicate where cities may be heading.
45 This categorization is provisional and needs to be further analyzed.
46 'Service' cities in quadrant I 'high spatial capital' are Jeddah, Riyadh and Taif.
47 'Traditional' cities Makkah, Medina and Buraydah-Enaizah
48 'Resource' cities is only Najran
49 'Developing' cities are Al-Bahah, Al-Ahsa, Tabuk, Jizan and Dammam and they correspond to quadrant III 'low spatial capital'.
50 CPI results for 17 Saudi cities are expected to produce this information that is crucial to understand the relationship of streets as drivers of urban prosperity.

usage of the street network, unproductive infrastructure investments and lack of available land for affordable housing. While nearly half of land in Saudi cities remains empty, "the government is being forced to look to the edges of the desert to build and this is not economical or sustainable to develop outside urban boundaries."[51] According to UN DESA World Urbanization Prospects in the next 15 years, the Kingdom's urban population will increase from 24.8 million in 2015 to 30 million in 2030.[52] This will represent an increase of nearly one-fourth of the urban population, which corresponds to a new city of the size of Najran or Hail every year. Most cities can accommodate all future growth in the existing 'white land' areas and still have provisions for future growth.

Building on white land can also increase densities that according to preliminary data from the City Prosperity Initiative represent on average 49 inhabitants per hectare. In half of the 17 cities, densities are as low as 30 inhabitants per hectare, making very difficult to create economies of scale and agglomeration. Studies show that at around 30 inhabitants per hectare, it is extremely difficult to provide public transport and public goods.[53]

Graph 19: 'White land' and population density



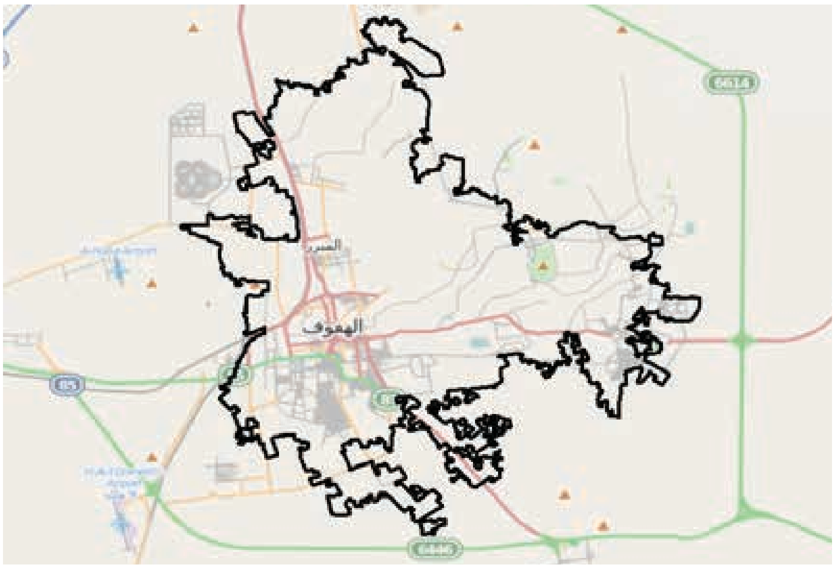
Building outside the current urban perimeters is no longer an option in Saudi cities. This will require extensive infrastructure to make it habitable and this obviously will increase unnecessarily land prices, consequently excluding low-cost housing for vast areas and populations in the Kingdom.[54] Paradoxically, roads, bridges, electricity, water and telecommunication infrastructure already exists in most of the 'white lands'. Even more, the Street Connectivity Index in vacant land is the second best among all typologies (83 per cent). Informal subdivisions and vacant land are the only typologies that qualify in the group of high connectivity among all types of land uses. As shown in graph 19 'white lands' is negatively correlated with population densities (R^2=0.6) in such a way that as vacant land increases, densities dramatically decrease.

By making best use of this land, it will be possible to attain appropriate densities and prevent or slow down urban expansion onto desert areas. It will be possible to optimize infrastructure, particularly the street network, and expand land availability for affordable housing.[55] Developing 'white land' areas should be part of an urban consolidation project aiming to support more sustainable urban form in Saudi cities.

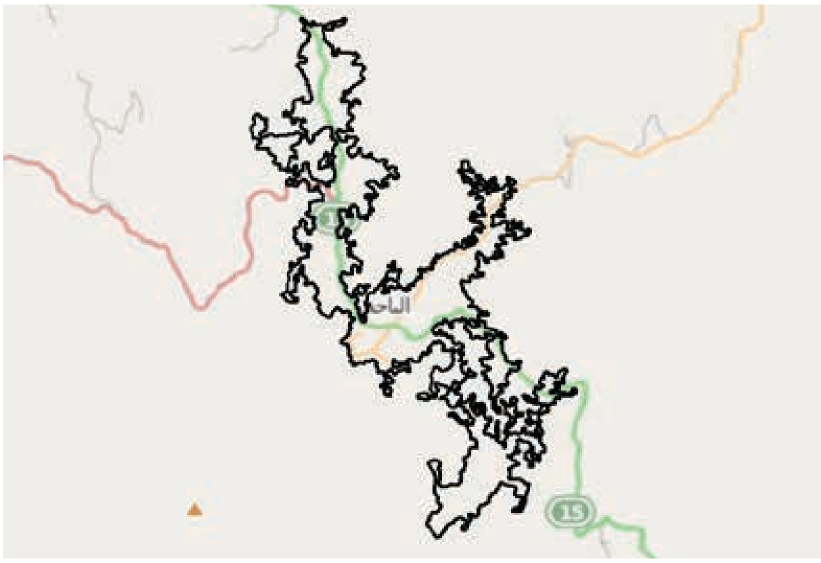
51 Adnan Ghosheh, adviser to the country's Housing Ministry in Blomberg Business (2013) 'Saudi Arabia's Affordable Housing Shortag'. Zainab Fattah. March 28, 2013
52 UNDESA (2015) World Urbanization Prospects – The 2105 Revision, New York.
53 Shlomo Angel (2012) Planet of cities. Lincoln Institute of Land Policy.
54 Mohammad Alwazir, senior economist at The National Commercial Bank in Blomberg Business (2013) 'Saudi Arabia's Affordable Housing Shortag'. Zainab Fattah. March 28, 2013
55 UN-Habitat (2014) Urban Patterns for a Green Economy: Leveraging Density, Nairobi

ANNEX 1

City Footprints and Street Connectivity Indicators

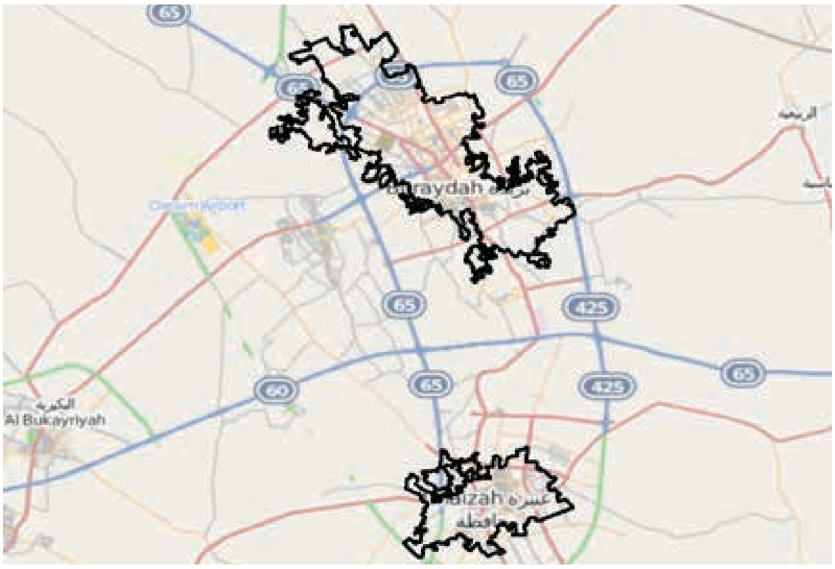


City	Al-Ahsa
Area (km)	287.10
Land Allocated to Streets (%)	21.56
Street Density (km/km²)	14.09
Intersection Density (#/km²)	110.9

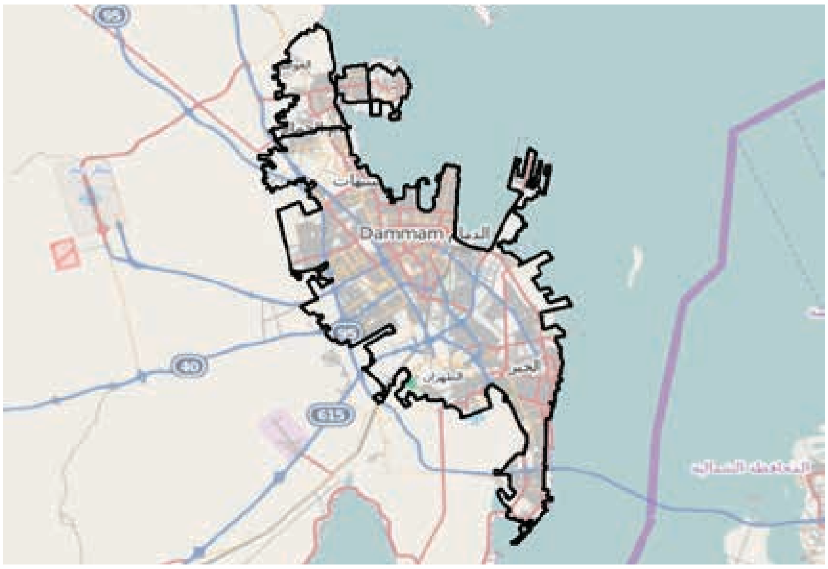


City	Al-Bahah
Area (km)	48.30
Land Allocated to Streets (%)	13.98
Street Density (km/km²)	10.34
Intersection Density (#/km²)	59.35

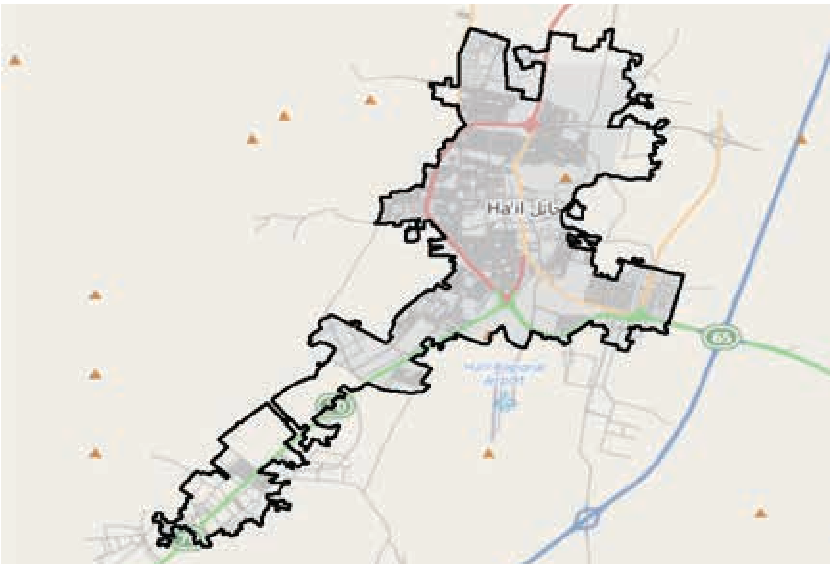
City	Arar
Area (km)	34.80
Land Allocated to Streets (%)	29.27
Street Density (km/km²)	16.03
Intersection Density (#/km²)	115.4



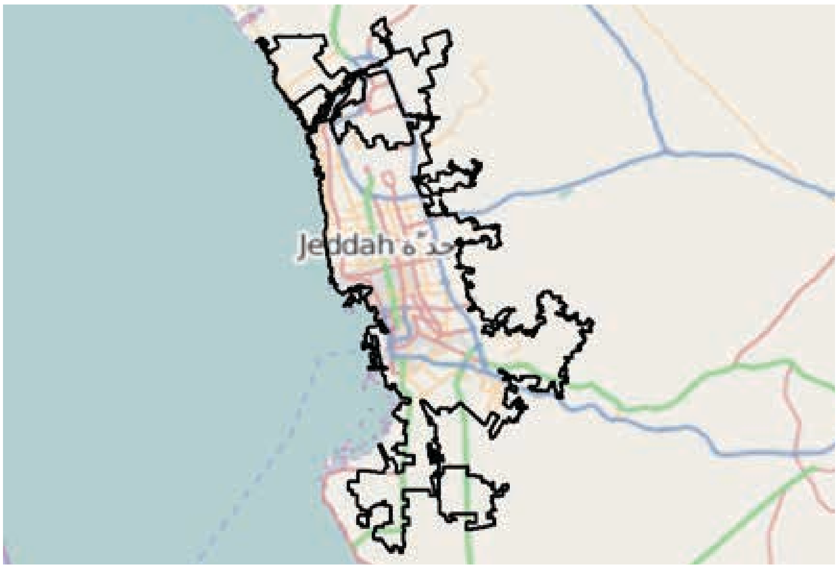
City	Buraydah-Enaizah
Area (km)	223.80
Land Allocated to Streets (%)	25.26
Street Density (km/km^2)	15.39
Intersection Density (#/km^2)	123.50



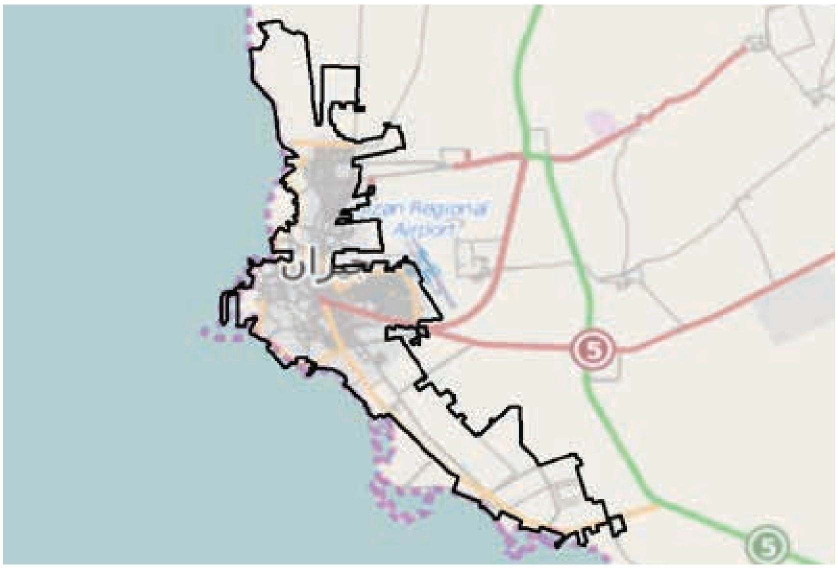
City	Damman
Area (km)	562.30
Land Allocated to Streets (%)	23.97
Street Density (km/km^2)	13.38
Intersection Density (#/km^2)	93.44



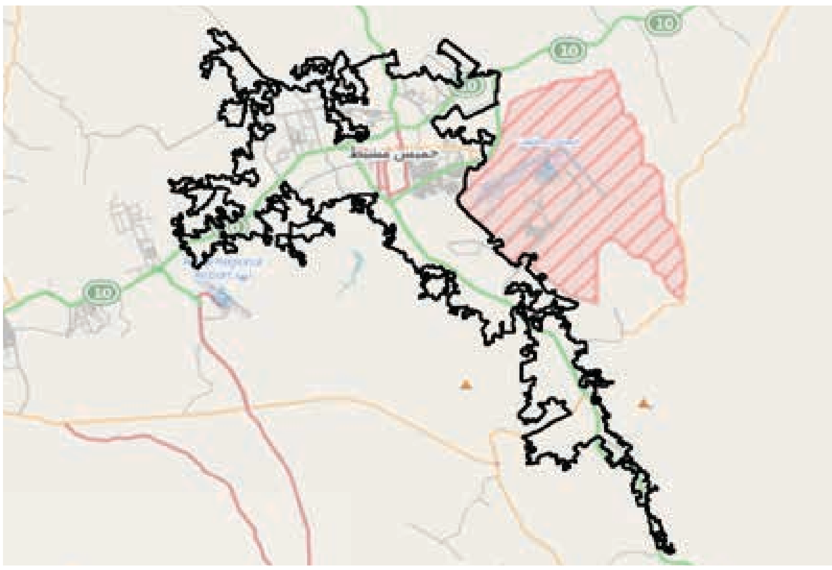
City	Hail
Area (km)	147.90
Land Allocated to Streets (%)	24.49
Street Density (km/km^2)	14.75
Intersection Density (#/km^2)	110.90



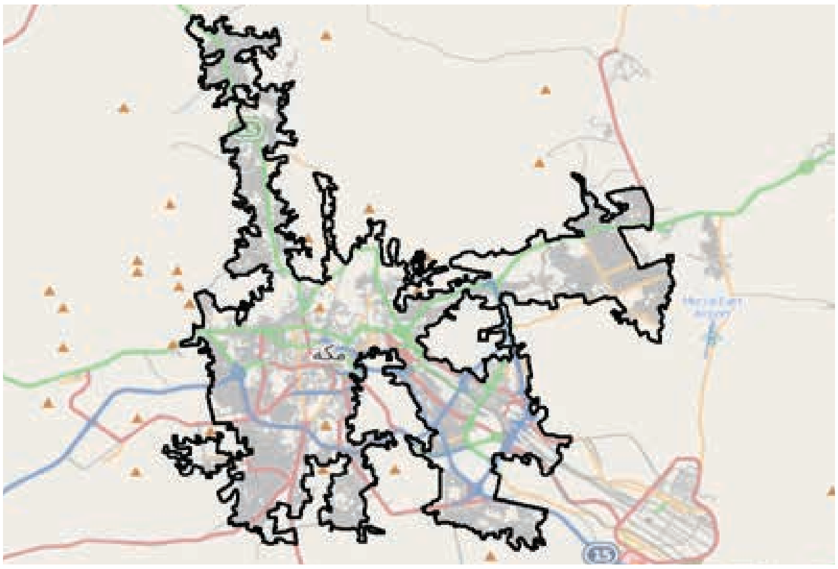
City	**Jeddah**
Area (km)	756.00
Land Allocated to Streets (%)	22.83
Street Density (km/km^2)	14.08
Intersection Density (#/km^2)	125.70



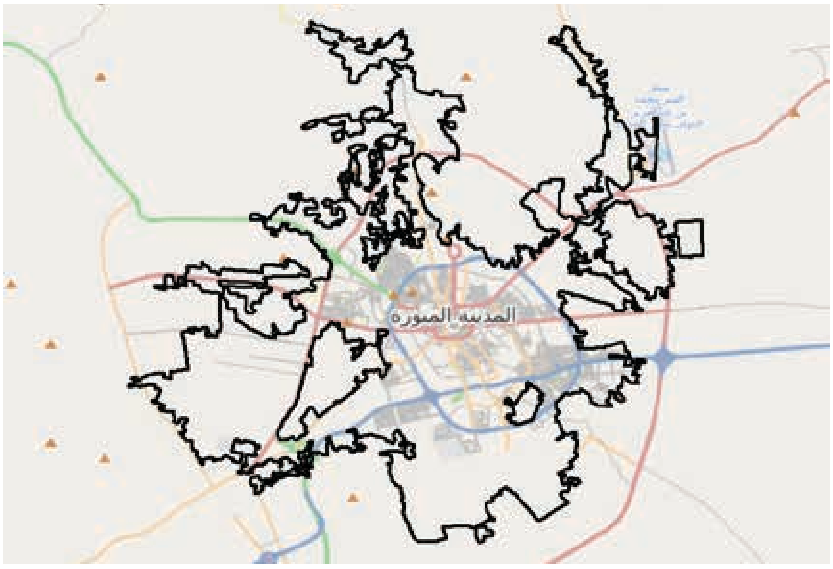
City	**Jizan**
Area (km)	44.90
Land Allocated to Streets (%)	22.72
Street Density (km/km^2)	13.71
Intersection Density (#/km^2)	105.50



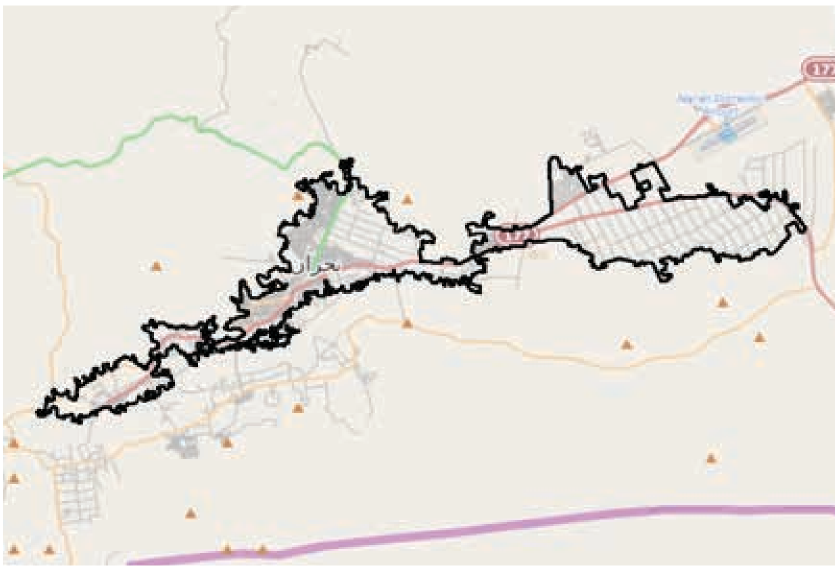
City	**Khamis-Mushait**
Area (km)	131.70
Land Allocated to Streets (%)	20.98
Street Density (km/km^2)	15.45
Intersection Density (#/km^2)	123.00



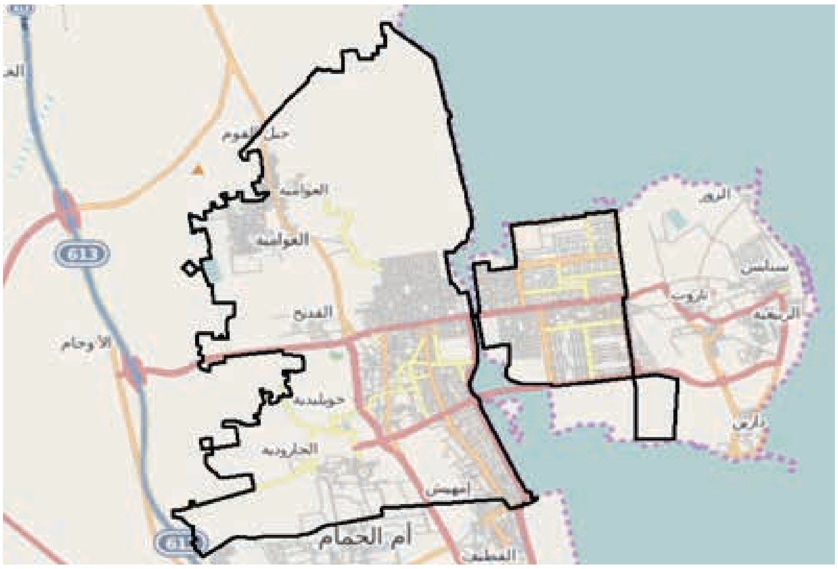
City	**Makkah**
Area (km)	211.2
Land Allocated to Streets (%)	23.12
Street Density (km/km^2)	14.98
Intersection Density (#/km^2)	111.10



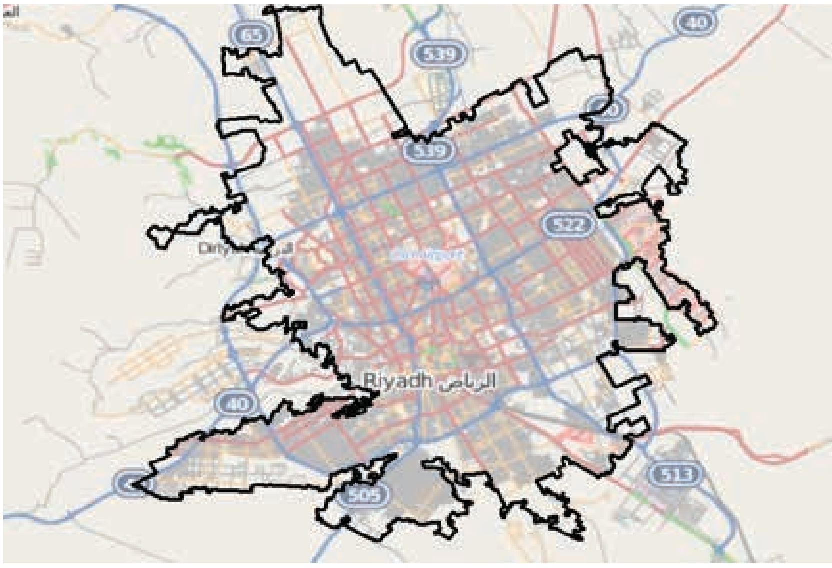
City	**Medina**
Area (km)	251.9
Land Allocated to Streets (%)	27.19
Street Density (km/km^2)	15.85
Intersection Density (#/km^2)	153.80



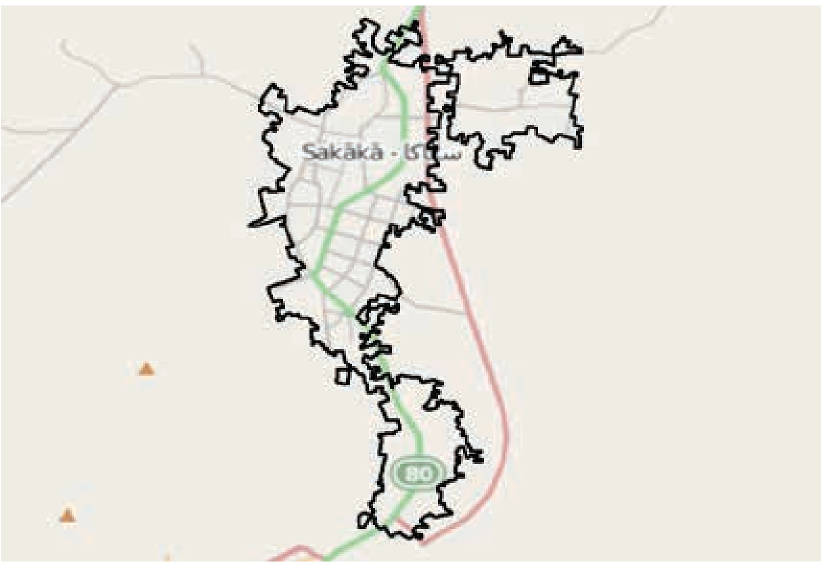
City	**Najran**
Area (km)	101.00
Land Allocated to Streets (%)	15.00
Street Density (km/km^2)	10.06
Intersection Density (#/km^2)	53.21



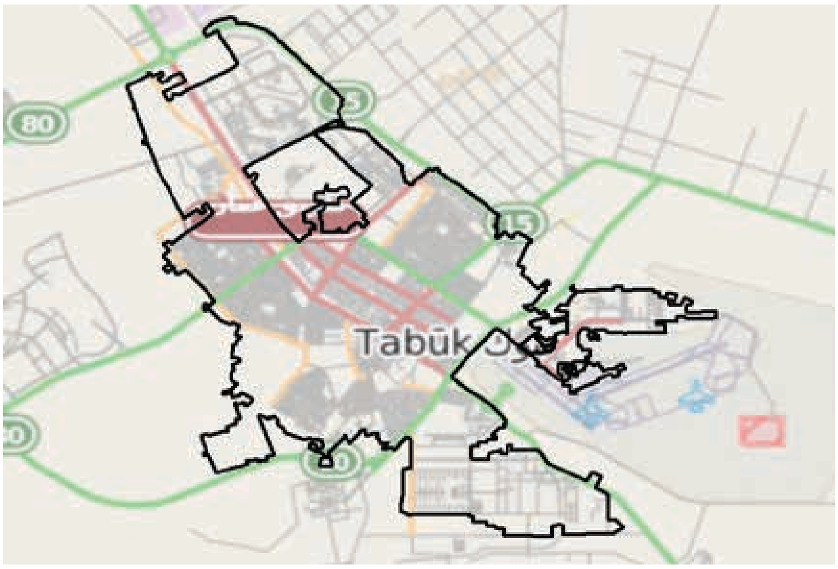
City	**Qatif**
Area (km)	58.70
Land Allocated to Streets (%)	22.51
Street Density (km/km^2)	14.74
Intersection Density (#/km^2)	108.90



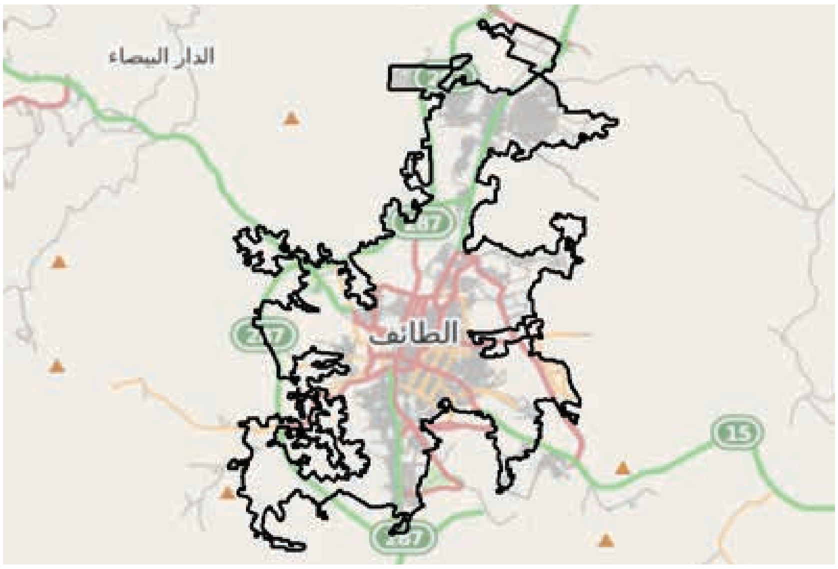
City	**Riyadh**
Area (km)	1061.50
Land Allocated to Streets (%)	27.87
Street Density (km/km^2)	15.21
Intersection Density (#/km^2)	109.60



City	**Sakaka**
Area (km)	56.50
Land Allocated to Streets (%)	21.43
Street Density (km/km^2)	12.57
Intersection Density (#/km^2)	90.67



City	**Tabuk**
Area (km)	86.00
Land Allocated to Streets (%)	26.65
Street Density (km/km^2)	14.21
Intersection Density (#/km^2)	86.67



City	**Taif**
Area (km)	95.10
Land Allocated to Streets (%)	22.65
Street Density (km/km^2)	16.70
Intersection Density (#/km^2)	146.10

ANNEX 2

City of Al-Ahsa

Including Open Space

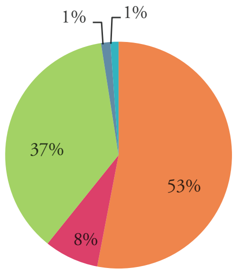
City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
AL-AHSA	20.93%	14.44	93.06	6.44	14.49
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	94%	103%	94%	93%	92%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
AL-AHSA	28.10%	19.89	153.32	7.71	14.13
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	100.91%	110%	113%	104%	91%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	61%	
OPEN SPACE		53%
VACANT LAND		8%
BUILT-UP DENSITY	39%	
HIGH BUILT-UP DENSITY		37%
MEDIUM BUILT-UP DENSITY		1%
LOW BUILT-UP DENSITY		1%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	3.98%	28.66%	29.09	332.13	11.42	9.85
HOUSING PROJECT	0.05%	34.29%	35.53	285.71	8.04	9.65
FORMAL SUBDIVISION	12.02%	34.52%	25.79	219.66	8.52	13.39
INFORMAL SUBDIVISION	7.89%	28.85%	20.54	140.54	6.84	14.05
RESIDENTIAL WEIGHTED AVERAGE (A)	23.94%	31.68%	24.62	212.38	8.45	13.01
NON-RESIDENTIAL						
URBAN AMEMITIES	15.30%	22.70%	13.91	80.13	5.76	16.33
VACANT	7.74%	27.71%	17.07	115.32	6.75	16.23
OPEN SPACE	53.02%	14.59%	10.48	39.67	3.78	13.92
NON-RESIDENTIAL WEIGHTED AVERAGE	76.06%	17.56%	11.84	55.51	4.48	14.64

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	90%	118%	156%	135%	76%
HOUSING PROJECT	108%	144%	135%	95%	74%
FORMAL SUBDIVISION	109%	105%	103%	101%	103%
INFORMAL SUBDIVISION	91%	83%	66%	81%	108%
RESIDENTIAL WEIGHTED AVERAGE (A)	31.68%	24.62	212.38	8.45	13.01

City of Al-Bahah

Including Open Space

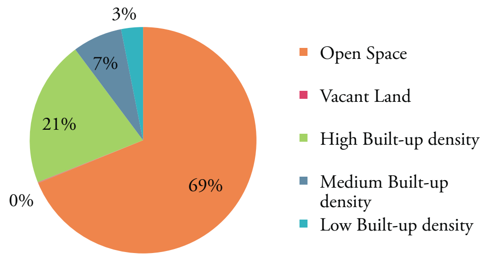
City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
AL-BAHAH	10.61%	10.26	56.28	5.48	10.34
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	48%	73%	57%	79%	66%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
AL-BAHAH	25.50%	16.86	106.44	6.31	15.12
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	91.55%	93%	78%	85%	98%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	69%	
OPEN SPACE		69%
VACANT LAND		0%
BUILT-UP DENSITY	31%	
HIGH BUILT-UP DENSITY		21%
MEDIUM BUILT-UP DENSITY		7%
LOW BUILT-UP DENSITY		3%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	18.54%	24.02%	16.73	106.79	6.38	14.36
HOUSING PROJECT	0.24%	11.69%	4.45	N.D.	N.D.	26.28
FORMAL SUBDIVISION	0.87%	24.65%	17.52	82.16	4.69	14.07
INFORMAL SUBDIVISION	0.14%	17.39%	21.73	144.93	6.67	8.00
RESIDENTIAL WEIGHTED AVERAGE (A)	19.79%	23.85%	16.65	104.70	6.24	14.45
NON-RESIDENTIAL						
URBAN AMEMITIES	11.25%	28.24%	16.93	104.45	6.17	16.67
VACANT	0.14%	36.96%	40.03	507.25	12.67	9.23
OPEN SPACE	68.82%	8.36%	7.68	33.49	4.36	10.88
NON-RESIDENTIAL WEIGHTED AVERAGE	80.21%	11.20%	9.04	44.28	4.63	11.69

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	101%	100%	102%	102%	99%
HOUSING PROJECT	49%	27%	N.D.	N.D.	182%
FORMAL SUBDIVISION	103%	105%	78%	75%	97%
INFORMAL SUBDIVISION	73%	130%	138%	107%	55%
RESIDENTIAL WEIGHTED AVERAGE (A)	23.85%	16.65	104.70	6.24	14.45

City of Arar

Including Open Space

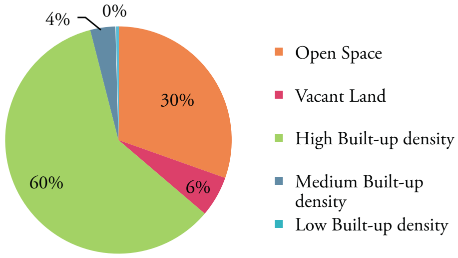
City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density ($\#/km^2$)	Ratio of ID:SD	Average Street Width (m)
ARAR	28.89%	16.13	114.60	7.11	17.91
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	130%	115%	116%	103%	114%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density ($\#/km^2$)	Ratio of ID:SD	Average Street Width (m)
ARAR	33.32%	19.96	149.98	7.51	16.69
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	119.64%	110%	110%	101%	108%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	36%	
OPEN SPACE		30%
VACANT LAND		6%
BUILT-UP DENSITY	64%	
HIGH BUILT-UP DENSITY		60%
MEDIUM BUILT-UP DENSITY		4%
LOW BUILT-UP DENSITY		0%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density ($\#/km^2$)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
HOUSING PROJECT	2.69%	30.64%	21.77	160.71	7.38	14.07
FORMAL SUBDIVISION	22.33%	38.80%	26.82	239.01	8.91	14.47
INFORMAL SUBDIVISION	21.50%	29.59%	16.98	99.22	5.84	17.43
RESIDENTIAL WEIGHTED AVERAGE (A)	46.52%	34.07%	21.98	169.87	7.41	15.81
NON-RESIDENTIAL						
URBAN AMEMITIES	17.27%	30.41%	15.28	113.20	7.41	19.90
VACANT	5.79%	35.96%	17.68	99.88	5.65	20.33
OPEN SPACE	30.42%	18.70%	9.13	33.69	3.69	20.49
NON-RESIDENTIAL WEIGHTED AVERAGE	53.48%	24.35%	12.04	66.54	5.10	20.28

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density ($\#/km^2$)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	N.D.	N.D.	N.D.		
HOUSING PROJECT	90%	99%	95%	100%	89%
FORMAL SUBDIVISION	114%	122%	141%	120%	91%
INFORMAL SUBDIVISION	87%	77%	58%	79%	110%
RESIDENTIAL WEIGHTED AVERAGE (A)	34.07%	21.98	169.87	7.41	15.81

City of Buraydah-Enaizah

Including Open Space

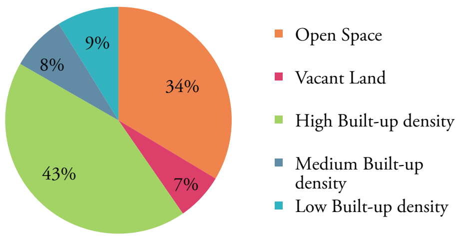
City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
BURAYDAH-ENAIZAH	25.26%	15.41	115.01	7.46	16.39
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	113%	110%	116%	108%	104%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
BURAYDAH-ENAIZAH	30.29%	19.89	155.59	7.82	15.23
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	108.78%	110%	114%	105%	99%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	40%	
OPEN SPACE		34%
VACANT LAND		7%
BUILT-UP DENSITY	60%	
HIGH BUILT-UP DENSITY		43%
MEDIUM BUILT-UP DENSITY		8%
LOW BUILT-UP DENSITY		9%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	4.70%	21.30%	21.75	214.67	9.87	9.79
HOUSING PROJECT	0.94%	26.24%	20.40	138.30	6.78	12.87
FORMAL SUBDIVISION	18.52%	34.56%	23.21	192.80	8.31	14.89
INFORMAL SUBDIVISION	17.64%	27.84%	20.30	148.91	7.34	13.72
RESIDENTIAL WEIGHTED AVERAGE (A)	41.80%	30.05%	21.76	175.51	8.04	13.77
NON-RESIDENTIAL						
URBAN AMEMITIES	17.83%	30.70%	15.41	111.77	7.25	19.92
VACANT	6.78%	30.76%	20.16	147.98	7.34	15.26
OPEN SPACE	33.59%	15.18%	8.11	35.12	4.33	18.72
NON-RESIDENTIAL WEIGHTED AVERAGE	58.20%	21.75%	11.75	71.75	5.58	18.69

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	71%	100%	122%	123%	71%
HOUSING PROJECT	87%	94%	79%	84%	93%
FORMAL SUBDIVISION	115%	107%	110%	103%	108%
INFORMAL SUBDIVISION	93%	93%	85%	91%	100%
RESIDENTIAL WEIGHTED AVERAGE (A)	30.05%	21.76	175.51	8.04	13.77

City of Dammam

Including Open Space

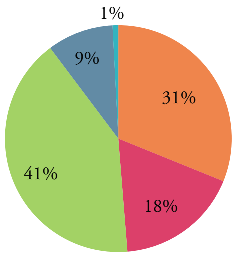
City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
DAMMAM	23.26%	13.04	78.14	5.99	17.84
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	104%	93%	79%	87%	113%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
DAMMAM	27.73%	15.78	102.24	6.48	17.57
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	99.55%	87%	75%	87%	114%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	49%	
OPEN SPACE		31%
VACANT LAND		18%
BUILT-UP DENSITY	51%	
HIGH BUILT-UP DENSITY		41%
MEDIUM BUILT-UP DENSITY		9%
LOW BUILT-UP DENSITY		1%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	0.46%	26.56%	22.74	184.62	8.12	11.68
HOUSING PROJECT	2.73%	29.72%	18.64	131.95	7.08	15.94
FORMAL SUBDIVISION	21.56%	33.00%	21.90	156.59	7.15	15.07
INFORMAL SUBDIVISION	0.89%	32.58%	18.78	120.44	6.42	17.35
RESIDENTIAL WEIGHTED AVERAGE (A)	25.65%	32.52%	21.46	153.21	7.13	15.18
NON-RESIDENTIAL						
URBAN AMEMITIES	25.64%	22.08%	10.54	55.39	5.25	20.94
VACANT	17.59%	28.97%	15.14	96.21	6.36	19.14
OPEN SPACE	31.13%	13.39%	7.42	25.05	3.37	18.04
NON-RESIDENTIAL WEIGHTED AVERAGE	74.35%	20.07%	10.32	52.34	4.73	19.30

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	82%	106%	121%	114%	77%
HOUSING PROJECT	91%	87%	86%	99%	105%
FORMAL SUBDIVISION	101%	102%	102%	100%	99%
INFORMAL SUBDIVISION	100%	87%	79%	90%	114%
RESIDENTIAL WEIGHTED AVERAGE (A)	32.52%	21.46	153.21	7.13	15.18

City of Hail

Including Open Space

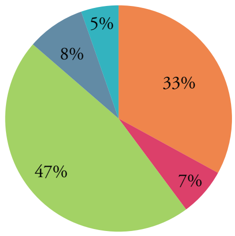
City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
HAIL	24.73%	14.55	102.23	7.02	16.99
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	111%	104%	103%	101%	108%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
HAIL	29.75%	18.27	135.25	7.40	16.28
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	106.82%	101%	99%	99%	105%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	40%	
OPEN SPACE		33%
VACANT LAND		7%
BUILT-UP DENSITY	60%	
HIGH BUILT-UP DENSITY		47%
MEDIUM BUILT-UP DENSITY		8%
LOW BUILT-UP DENSITY		5%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	4.29%	19.40%	19.42	134.00	6.90	9.99
HOUSING PROJECT	0.44%	37.44%	22.02	63.19	2.87	17.00
FORMAL SUBDIVISION	14.49%	34.89%	22.95	193.46	8.43	15.20
INFORMAL SUBDIVISION	21.82%	29.01%	20.35	154.28	7.58	14.26
RESIDENTIAL WEIGHTED AVERAGE (A)	41.04%	30.18%	21.19	165.02	7.76	14.18
NON-RESIDENTIAL						
URBAN AMEMITIES	19.11%	28.98%	11.92	74.48	6.25	24.30
VACANT	6.87%	29.35%	18.51	126.49	6.83	15.86
OPEN SPACE	32.97%	14.54%	8.46	35.10	4.15	17.17
NON-RESIDENTIAL WEIGHTED AVERAGE	58.96%	20.94%	10.76	58.52	5.14	19.33

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	64%	92%	81%	89%	70%
HOUSING PROJECT	124%	104%	38%	37%	120%
FORMAL SUBDIVISION	116%	108%	117%	109%	107%
INFORMAL SUBDIVISION	96%	96%	93%	98%	101%
RESIDENTIAL WEIGHTED AVERAGE (A)	30.18%	21.19	165.02	7.76	14.18

City of Jeddah

Including Open Space

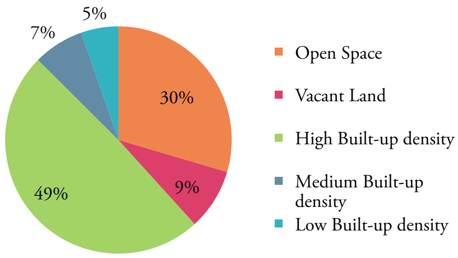
City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
JEDDAH	22.34%	13.37	103.54	7.75	16.71
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	100%	95%	105%	112%	106%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
JEDDAH	25.08%	16.64	134.49	8.08	15.08
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	90.07%	92%	99%	109%	98%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	38%	
OPEN SPACE		30%
VACANT LAND		9%
BUILT-UP DENSITY	62%	
HIGH BUILT-UP DENSITY		49%
MEDIUM BUILT-UP DENSITY		7%
LOW BUILT-UP DENSITY		5%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	3.27%	26.68%	43.86	722.69	16.48	6.08
HOUSING PROJECT	1.27%	26.56%	18.12	115.23	6.36	14.66
FORMAL SUBDIVISION	14.86%	31.14%	20.83	159.33	7.65	14.95
INFORMAL SUBDIVISION	7.04%	28.33%	21.36	165.75	7.76	13.27
RESIDENTIAL WEIGHTED AVERAGE (A)	26.45%	29.62%	23.69	228.67	8.71	13.39
NON-RESIDENTIAL						
URBAN AMEMITIES	35.29%	20.06%	10.96	66.72	6.09	18.30
VACANT	8.70%	31.67%	18.20	123.10	6.76	17.40
OPEN SPACE	29.56%	15.81%	7.01	29.76	4.24	22.54
NON-RESIDENTIAL WEIGHTED AVERAGE	73.55%	19.73%	10.23	58.54	5.43	19.90

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	90%	185%	316%	189%	45%
HOUSING PROJECT	90%	76%	50%	73%	109%
FORMAL SUBDIVISION	105%	88%	70%	88%	112%
INFORMAL SUBDIVISION	96%	90%	72%	89%	99%
RESIDENTIAL WEIGHTED AVERAGE (A)	29.62%	23.69	228.67	8.71	13.39

City of Jizan

Including Open Space

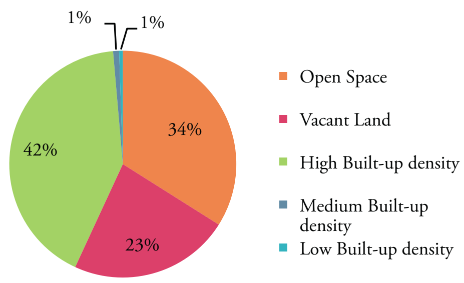
City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
JIZAN	22.31%	13.67	94.77	6.93	16.32
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	100%	97%	96%	100%	103%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
JIZAN	27.84%	18.48	134.04	7.25	15.07
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	99.98%	102%	98%	97%	98%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	57%	
OPEN SPACE		34%
VACANT LAND		23%
BUILT-UP DENSITY	43%	
HIGH BUILT-UP DENSITY		42%
MEDIUM BUILT-UP DENSITY		1%
LOW BUILT-UP DENSITY		1%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	2.16%	28.79%	40.47	620.95	15.34	7.11
HOUSING PROJECT	0.63%	19.21%	17.74	132.45	7.47	10.83
FORMAL SUBDIVISION	0.86%	31.22%	20.19	146.34	7.25	15.46
INFORMAL SUBDIVISION	16.67%	30.64%	24.16	210.69	8.72	12.68
RESIDENTIAL WEIGHTED AVERAGE (A)	20.32%	30.11%	25.52	249.05	9.32	12.15
NON-RESIDENTIAL						
URBAN AMEMITIES	22.79%	24.53%	15.08	80.20	5.32	16.27
VACANT	22.93%	29.13%	15.61	85.63	5.49	18.66
OPEN SPACE	33.96%	11.56%	5.74	18.42	3.21	20.14
NON-RESIDENTIAL WEIGHTED AVERAGE	79.68%	20.33%	11.25	55.44	4.47	18.61

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	96%	159%	249%	165%	59%
HOUSING PROJECT	64%	70%	53%	80%	89%
FORMAL SUBDIVISION	104%	79%	59%	78%	127%
INFORMAL SUBDIVISION	102%	95%	85%	94%	104%
RESIDENTIAL WEIGHTED AVERAGE (A)	30.11%	25.52	249.05	9.32	12.15

City of Khamis-Mushait

Including Open Space

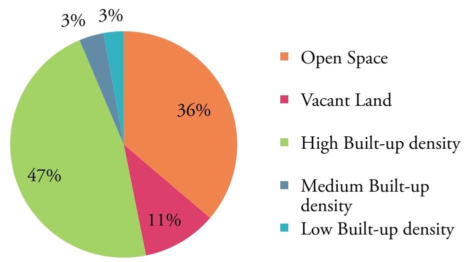
City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
KHAMIS-MUSHAIT	20.40%	15.58	118.81	7.63	13.10
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	92%	111%	120%	110%	83%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
KHAMIS-MUSHAIT	24.45%	19.52	158.25	8.11	12.53
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	87.80%	108%	116%	109%	81%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	47%	
OPEN SPACE		36%
VACANT LAND		11%
BUILT-UP DENSITY	53%	
HIGH BUILT-UP DENSITY		47%
MEDIUM BUILT-UP DENSITY		3%
LOW BUILT-UP DENSITY		3%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	10.46%	20.65%	24.80	239.07	9.64	8.33
HOUSING PROJECT	1.45%	25.76%	14.04	90.45	6.44	18.34
FORMAL SUBDIVISION	9.28%	39.23%	28.83	289.92	10.06	13.61
INFORMAL SUBDIVISION	12.37%	26.89%	20.72	147.58	7.12	12.98
RESIDENTIAL WEIGHTED AVERAGE (A)	33.56%	28.31%	23.95	213.02	8.69	11.94
NON-RESIDENTIAL						
URBAN AMEMITIES	19.60%	17.79%	11.91	73.74	6.19	14.93
VACANT	10.60%	24.55%	19.54	141.08	7.22	12.56
OPEN SPACE	36.25%	13.26%	10.23	49.44	4.83	12.96
NON-RESIDENTIAL WEIGHTED AVERAGE	66.44%	16.39%	12.21	71.22	5.61	13.48

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	73%	104%	112%	111%	70%
HOUSING PROJECT	91%	59%	42%	74%	154%
FORMAL SUBDIVISION	139%	120%	136%	116%	114%
INFORMAL SUBDIVISION	95%	87%	69%	82%	109%
RESIDENTIAL WEIGHTED AVERAGE (A)	28.31%	23.95	213.02	8.69	11.94

City of Makkah

Including Open Space

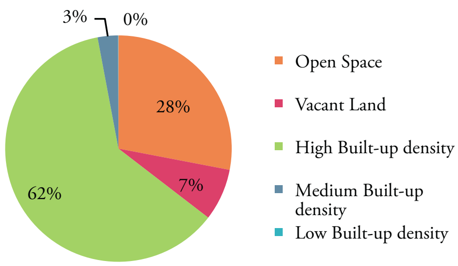
City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
MAKKAH	23.35%	14.80	105.43	7.13	15.78
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	105%	105%	107%	103%	100%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
MAKKAH	27.59%	18.32	142.06	7.75	15.06
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	99.08%	101%	104%	104%	97%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	35%	
OPEN SPACE		28%
VACANT LAND		7%
BUILT-UP DENSITY	65%	
HIGH BUILT-UP DENSITY		62%
MEDIUM BUILT-UP DENSITY		3%
LOW BUILT-UP DENSITY		0%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	12.07%	17.02%	25.80	322.18	12.49	6.60
HOUSING PROJECT	0.19%	20.00%	15.95	95.24	5.97	12.54
FORMAL SUBDIVISION	19.26%	29.77%	19.33	131.61	6.81	15.40
INFORMAL SUBDIVISION	5.66%	29.92%	19.34	121.42	6.28	15.48
RESIDENTIAL WEIGHTED AVERAGE (A)	37.19%	25.60%	21.41	191.74	8.57	12.54
NON-RESIDENTIAL						
URBAN AMEMITIES	27.37%	27.77%	13.91	80.40	5.78	19.97
VACANT	7.42%	36.90%	19.09	120.53	6.31	19.33
OPEN SPACE	28.02%	12.45%	5.69	23.95	4.21	21.88
NON-RESIDENTIAL WEIGHTED AVERAGE	62.81%	22.02%	10.85	59.96	5.14	20.75

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	66%	120%	168%	146%	53%
HOUSING PROJECT	78%	74%	50%	70%	100%
FORMAL SUBDIVISION	116%	90%	69%	79%	123%
INFORMAL SUBDIVISION	117%	90%	63%	73%	123%
RESIDENTIAL WEIGHTED AVERAGE (A)	25.60%	21.41	191.74	8.57	12.54

City of Medina

Including Open Space

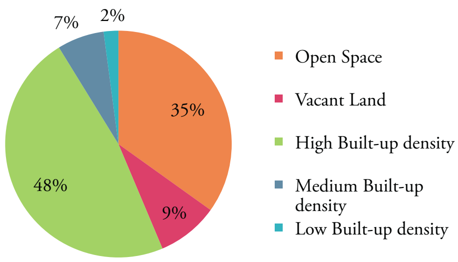
City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density ($\#/km^2$)	Ratio of ID:SD	Average Street Width (m)
MEDINA	26.71%	15.75	138.77	8.81	16.97
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	120%	112%	140%	127%	108%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density ($\#/km^2$)	Ratio of ID:SD	Average Street Width (m)
MEDINA	33.67%	21.05	193.29	9.18	15.99
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	120.91%	116%	142%	123%	103%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	44%	
OPEN SPACE		35%
VACANT LAND		9%
BUILT-UP DENSITY	56%	
HIGH BUILT-UP DENSITY		48%
MEDIUM BUILT-UP DENSITY		7%
LOW BUILT-UP DENSITY		2%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density ($\#/km^2$)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	7.09%	36.53%	42.36	621.76	14.68	8.62
HOUSING PROJECT	0.58%	33.67%	24.30	133.33	5.49	13.86
FORMAL SUBDIVISION	9.53%	37.92%	24.52	240.03	9.79	15.47
INFORMAL SUBDIVISION	20.02%	35.26%	20.08	147.99	7.37	17.56
RESIDENTIAL WEIGHTED AVERAGE (A)	37.22%	36.16%	25.52	261.57	9.35	15.26
NON-RESIDENTIAL						
URBAN AMEMITIES	19.14%	25.58%	11.61	71.05	6.12	22.03
VACANT	8.76%	40.80%	22.68	170.27	7.51	17.99
OPEN SPACE	34.88%	13.72%	7.64	36.99	4.84	17.94
NON-RESIDENTIAL WEIGHTED AVERAGE	62.78%	21.11%	10.95	65.97	5.60	19.19

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density ($\#/km^2$)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	101%	166%	238%	157%	56%
HOUSING PROJECT	93%	95%	51%	59%	91%
FORMAL SUBDIVISION	105%	96%	92%	105%	101%
INFORMAL SUBDIVISION	98%	79%	57%	79%	115%
RESIDENTIAL WEIGHTED AVERAGE (A)	36.16%	25.52	261.57	9.35	15.26

City of Najran

Including Open Space

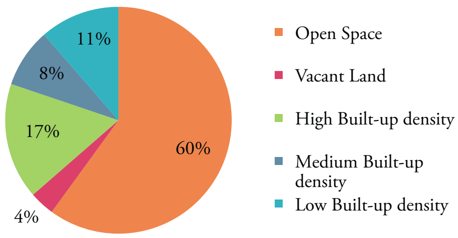
City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
NAJRAN	14.80%	9.33	43.31	4.64	15.86
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	66%	66%	44%	67%	100%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
NAJRAN	23.15%	13.98	77.04	5.51	16.57
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	83.14%	77%	57%	74%	107%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	64%	
OPEN SPACE		60%
VACANT LAND		4%
BUILT-UP DENSITY	36%	
HIGH BUILT-UP DENSITY		17%
MEDIUM BUILT-UP DENSITY		8%
LOW BUILT-UP DENSITY		11%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	7.10%	13.10%	13.48	64.76	4.81	9.72
HOUSING PROJECT	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
FORMAL SUBDIVISION	5.47%	38.05%	21.64	175.95	8.13	17.58
INFORMAL SUBDIVISION	7.27%	15.47%	10.41	58.00	5.57	14.86
RESIDENTIAL WEIGHTED AVERAGE (A)	19.85%	20.85%	14.61	92.95	6.00	13.77
NON-RESIDENTIAL						
URBAN AMEMITIES	16.55%	25.61%	12.87	59.55	4.63	19.91
VACANT	3.57%	24.57%	15.63	69.68	4.46	15.72
OPEN SPACE	60.02%	9.21%	6.71	20.84	3.11	13.73
NON-RESIDENTIAL WEIGHTED AVERAGE	80.15%	13.28%	8.38	31.01	3.48	15.09

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	63%	92%	70%	80%	71%
HOUSING PROJECT	N.D.	N.D.	N.D.	N.D.	N.D.
FORMAL SUBDIVISION	183%	148%	189%	135%	128%
INFORMAL SUBDIVISION	74%	71%	62%	93%	108%
RESIDENTIAL WEIGHTED AVERAGE (A)	20.85%	14.61	92.95	6.00	13.77

City of Qatif

Including Open Space

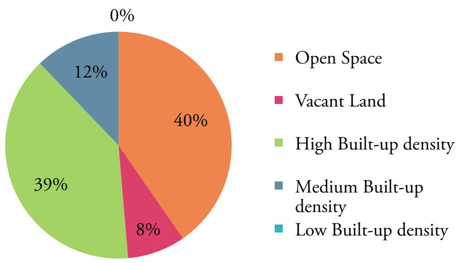
City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
QATIF	17.34%	13.39	90.58	6.76	12.95
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	78%	95%	92%	98%	82%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
QATIF	23.93%	17.25	132.42	7.67	13.87
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	85.94%	95%	97%	103%	90%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	49%	
OPEN SPACE		40%
VACANT LAND		8%
BUILT-UP DENSITY	51%	
HIGH BUILT-UP DENSITY		39%
MEDIUM BUILT-UP DENSITY		12%
LOW BUILT-UP DENSITY		0%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	5.53%	26.56%	22.74	184.62	8.12	11.68
HOUSING PROJECT	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
FORMAL SUBDIVISION	28.71%	29.18%	21.32	174.55	8.19	13.69
INFORMAL SUBDIVISION	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
RESIDENTIAL WEIGHTED AVERAGE (A)	34.24%	28.76%	21.55	176.18	8.18	13.37
NON-RESIDENTIAL						
URBAN AMEMITIES	17.12%	18.08%	11.84	71.86	6.07	15.27
VACANT	8.29%	16.09%	10.70	76.75	7.17	15.03
OPEN SPACE	40.36%	7.61%	7.77	28.75	3.70	9.78
NON-RESIDENTIAL WEIGHTED AVERAGE	65.76%	11.40%	9.20	46.02	4.75	11.87

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	92%	106%	105%	99%	87%
HOUSING PROJECT	N.D.	N.D.	N.D.	N.D.	N.D.
FORMAL SUBDIVISION	101%	99%	99%	100%	102%
INFORMAL SUBDIVISION	N.D.	N.D.	N.D.	N.D.	N.D.
RESIDENTIAL WEIGHTED AVERAGE (A)	28.76%	21.55	176.18	8.18	13.37

City of Riyadh

Including Open Space

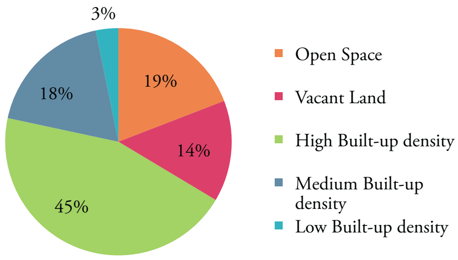
City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
RIYADH	27.40%	15.21	108.84	7.15	18.01
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	123%	108%	110%	103%	114%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
RIYADH	31.24%	17.45	128.10	7.34	17.90
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	112.17%	96%	94%	99%	116%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	34%	
OPEN SPACE		19%
VACANT LAND		14%
BUILT-UP DENSITY	66%	
HIGH BUILT-UP DENSITY		45%
MEDIUM BUILT-UP DENSITY		18%
LOW BUILT-UP DENSITY		3%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	0.43%	47.60%	42.65	635.01	14.89	11.16
HOUSING PROJECT	6.31%	33.34%	20.43	171.70	8.40	16.32
FORMAL SUBDIVISION	30.15%	34.44%	21.14	168.12	7.95	16.29
INFORMAL SUBDIVISION	1.92%	24.45%	15.37	85.25	5.55	15.91
RESIDENTIAL WEIGHTED AVERAGE (A)	38.81%	33.91%	20.98	169.76	7.98	16.22
NON-RESIDENTIAL						
URBAN AMEMITIES	27.63%	28.89%	12.96	81.27	6.27	22.28
VACANT	14.42%	28.54%	16.58	105.66	6.37	17.22
OPEN SPACE	19.15%	11.19%	7.06	27.54	3.90	15.86
NON-RESIDENTIAL WEIGHTED AVERAGE	38.81%	33.91%	20.98	169.76	7.98	16.22

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	140%	203%	374%	187%	69%
HOUSING PROJECT	98%	97%	101%	105%	101%
FORMAL SUBDIVISION	102%	101%	99%	100%	100%
INFORMAL SUBDIVISION	72%	73%	50%	69%	98%
RESIDENTIAL WEIGHTED AVERAGE (A)	33.91%	20.98	169.76	7.98	16.22

City of Tabuk

Including Open Space

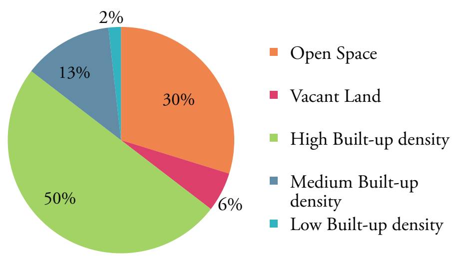
City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
TABUK	26.86%	14.30	84.14	5.88	18.78
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	121%	102%	85%	85%	119%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
TABUK	28.59%	16.46	101.67	6.18	17.37
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	102.66%	91%	75%	83%	112%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	35%	
OPEN SPACE		30%
VACANT LAND		6%
BUILT-UP DENSITY	65%	
HIGH BUILT-UP DENSITY		50%
MEDIUM BUILT-UP DENSITY		13%
LOW BUILT-UP DENSITY		2%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
HOUSING PROJECT	6.59%	18.64%	24.36	193.05	193.05	7.65
FORMAL SUBDIVISION	15.84%	40.25%	22.20	157.98	157.98	18.13
INFORMAL SUBDIVISION	10.27%	33.09%	16.66	65.66	65.66	19.85
RESIDENTIAL WEIGHTED AVERAGE (A)	32.70%	33.65%	20.90	136.05	6.28	16.56
NON-RESIDENTIAL						
URBAN AMEMITIES	31.89%	23.57%	11.74	69.33	5.91	20.08
VACANT	5.63%	27.66%	17.43	85.18	4.89	15.87
OPEN SPACE	29.78%	22.79%	10.55	42.80	4.06	21.59
NON-RESIDENTIAL WEIGHTED AVERAGE	67.30%	23.57%	11.69	58.92	5.00	20.40

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km^2)	Intersection Density (#/km^2)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	N.D.	N.D.	N.D.	N.D.	N.D.
HOUSING PROJECT	55%	117%	142%	126%	46%
FORMAL SUBDIVISION	120%	106%	116%	113%	109%
INFORMAL SUBDIVISION	98%	80%	48%	63%	120%
RESIDENTIAL WEIGHTED AVERAGE (A)	33.65%	20.90	136.05	6.28	16.56

City of Taif

Including Open Space

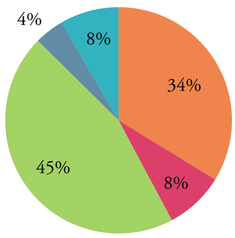
City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
TAIF	22.26%	16.78	142.48	8.49	13.27
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	100%	119%	144%	123%	84%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
TAIF	26.76%	21.54	187.24	8.69	12.42
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	96.08%	119%	137%	117%	80%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	42%	
OPEN SPACE		34%
VACANT LAND		8%
BUILT-UP DENSITY	58%	
HIGH BUILT-UP DENSITY		45%
MEDIUM BUILT-UP DENSITY		4%
LOW BUILT-UP DENSITY		8%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	10.64%	20.93%	26.70	311.61	11.67	7.84
HOUSING PROJECT	0.86%	25.45%	34.59	193.94	5.61	7.36
FORMAL SUBDIVISION	14.27%	32.18%	26.59	218.39	8.21	12.10
INFORMAL SUBDIVISION	12.26%	27.30%	20.08	148.79	7.41	13.60
RESIDENTIAL WEIGHTED AVERAGE (A)	38.04%	27.31%	24.70	221.48	8.86	11.28
NON-RESIDENTIAL						
URBAN AMEMITIES	19.76%	24.80%	15.24	120.58	7.91	16.28
VACANT	8.43%	28.87%	22.06	188.98	8.57	13.09
OPEN SPACE	33.77%	13.46%	9.31	54.71	5.87	14.45
NON-RESIDENTIAL WEIGHTED AVERAGE	61.96%	19.17%	12.94	93.99	6.89	14.85

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	77%	108%	141%	132%	69%
HOUSING PROJECT	93%	140%	88%	63%	65%
FORMAL SUBDIVISION	118%	108%	99%	93%	107%
INFORMAL SUBDIVISION	100%	81%	67%	84%	120%
RESIDENTIAL WEIGHTED AVERAGE (A)	27.31%	24.70	221.48	8.86	11.28

City of Sakaka

Including Open Space

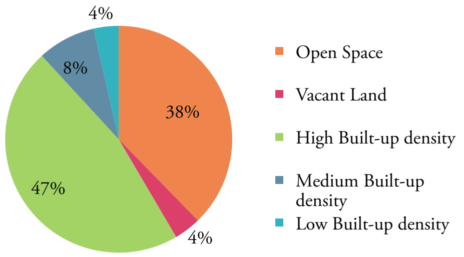
City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
SAKAKA	21.28%	12.87	90.46	7.03	16.54
AVERAGE SAUDI CITIES	22.28%	14.05	98.85	6.92	15.78
COMPARISSON	96%	92%	92%	102%	105%

Excluding Open Space

City	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
SAKAKA	26.44%	16.72	125.35	7.50	15.81
AVERAGE SAUDI CITIES	27.85%	18.12	136.28	7.44	15.45
COMPARISSON	94.93%	92%	92%	101%	102%

Proportion of built-up densities

City	Proportions (%)	Built-up areas plot coverage
NON BUILT-UP AREAS	42%	
OPEN SPACE		38%
VACANT LAND		4%
BUILT-UP DENSITY	58%	
HIGH BUILT-UP DENSITY		47%
MEDIUM BUILT-UP DENSITY		8%
LOW BUILT-UP DENSITY		4%
TOTAL URBAN FOOTPRINT AREA	100%	100%



Disaggregated values at intra-city level

Urban Typologies	Area of the city (%)	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
RESIDENTIAL						
ATOMISTIC	10.74%	20.73%	17.86	140.89	7.89	11.61
HOUSING PROJECT	0.39%	21.31%	10.27	27.32	2.66	20.75
FORMAL SUBDIVISION	8.65%	38.53%	25.01	216.43	8.65	15.40
INFORMAL SUBDIVISION	16.10%	30.07%	19.91	154.22	7.75	15.10
RESIDENTIAL WEIGHTED AVERAGE (A)	35.87%	29.21%	20.42	163.83	7.95	14.19
NON-RESIDENTIAL						
URBAN AMEMITIES	22.57%	21.77%	10.28	61.07	5.94	21.18
VACANT	3.84%	27.95%	20.01	143.80	7.19	13.97
OPEN SPACE	37.71%	12.76%	7.72	32.84	4.25	16.53
NON-RESIDENTIAL WEIGHTED AVERAGE	64.13%	16.84%	9.36	49.42	5.02	18.02

Relative comparisson to Residential Average (a)

Urban Typologies	Land Allocated to Streets (%)	Street Density (km/km²)	Intersection Density (#/km²)	Ratio of ID:SD	Average Street Width (m)
ATOMISTIC	71%	87%	86%	99%	82%
HOUSING PROJECT	73%	50%	17%	33%	146%
FORMAL SUBDIVISION	132%	123%	132%	109%	109%
INFORMAL SUBDIVISION	103%	98%	94%	97%	106%
RESIDENTIAL WEIGHTED AVERAGE (A)	29.21%	20.42	163.83	7.95	14.19

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