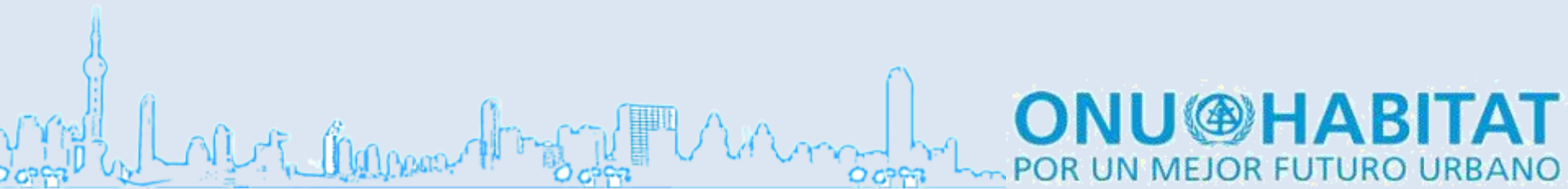


# CPI METHODOLOGY



# What is different with the CPI framework

- a) **A flexible monitoring framework**
- b) **A framework that promotes integration**
- c) **An innovative tool based on spatial analysis**
- d) **A multi-scale decision-making tool**





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**02. CLARIFICATION ON FEW INDICATORS**

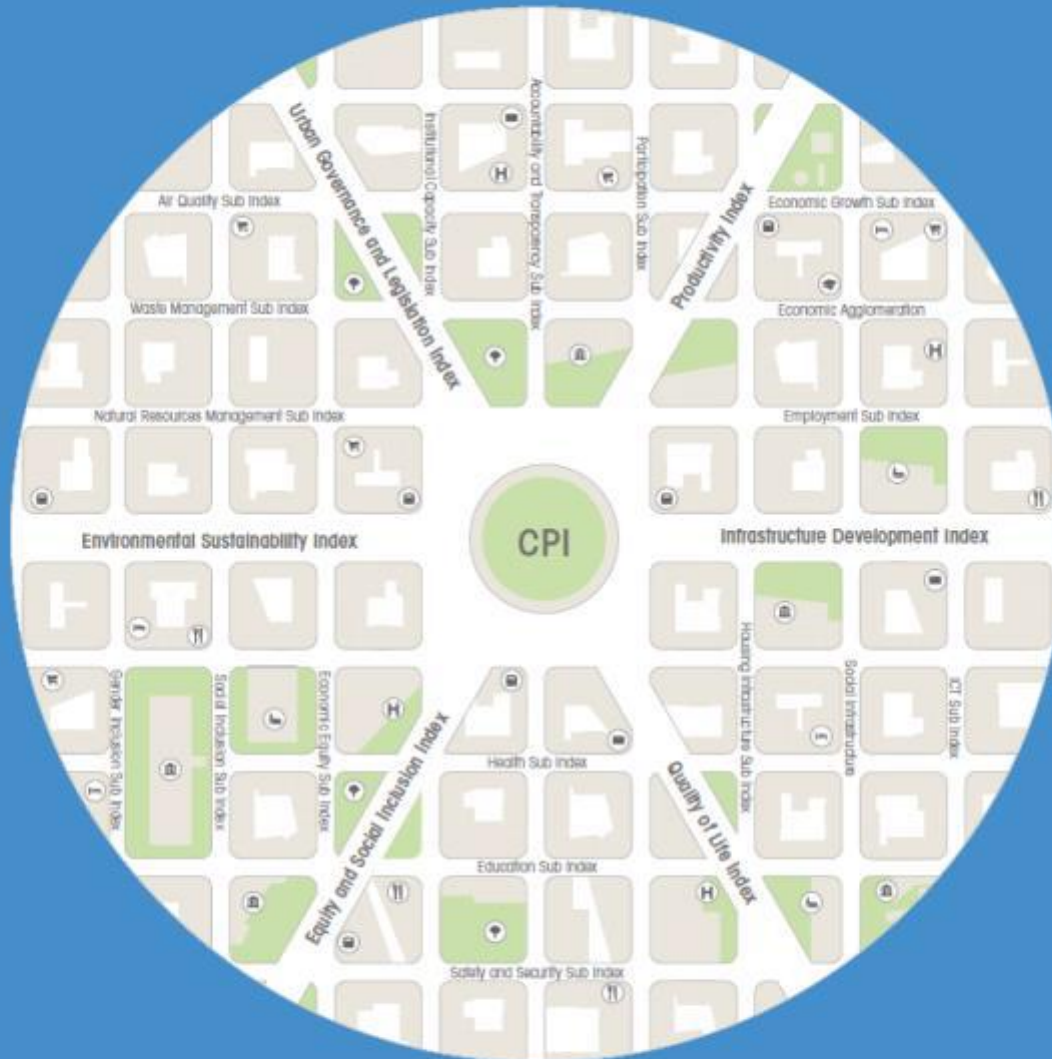
**03. SPATIAL INDICATORS**

**04. PLANNING AND INTERPRETATION**



# MEASUREMENT OF CITY PROSPERITY

## Methodology and Metadata



# 3. METADATA

## ICONS DESCRIPTION

Scope:  
Basic CPI  
Extended CPI  
Methodology CPI

Index number

Index code



Index logo

Index name

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## Indicator

Accessibility of Open Public Areas

## Scope

Extended CPI

## Rationale

This indicator provides information about the open public areas in a city has and whether this amount is sufficient for its population. Additionally, this indicator considers the accessibility of open public areas and the distribution of the total area across the city. In most countries, the concept of an open public area is related to green areas (where green areas are defined as public and private areas that have flora such as plants, trees and grass). Nevertheless, the two principal roles of an open public area are to provide a space for healthy social interaction space and improve air quality (WHO, 2012).

Individuals residing in towns and cities should have access to natural green spaces or open public spaces less than 300 meters from home (Natural England; see also The Wildlife Trust & Natural England, 2009; Harrison et al., 1995; Barker, 1997; Handley et al., 2003; Wray et al., 2005; [1])

A prosperous city has enough open public area for its residents, which is properly distributed and easy to access.

## Definition

The percentage of the urban area located less than 300 meters away from an open public space.

## Definition

An open area is concept is related to the concept of open space (Mellin (2013), Sandalack & Alar (2013), [2], open public spaces include:

- Parks: open spaces inside a city and contact with nature. Their main characteristic is a large portion of green area.
- Civic parks: open spaces created by the city, which was later transformed into a public space. They are characterised by commercial and cultural elements and are good place for cultural events.
- Squares: open spaces created by the city, which was later transformed into a public space. Its main characteristics are commercial elements and interaction among people. They are usually public spaces that are used for commercial, cultural or recreational development, or cultural interaction.
- Recreational green areas: public spaces for recreational and mental preservation. All recreational areas must be linked to urban infrastructure and must be linked to urban infrastructure and passive recreation.
- Facility public areas: open spaces created by the city, which are part of city facilities (defined as public spaces, i.e., public libraries, stadium, public buildings, etc.). They have the following characteristics: public spaces, both active and passive recreation.

## Unit [ ]

%

## Methodology

Methodology A:

Accessibility of open public areas

# Guidelines prepare clear standardization techniques

## Types of Standardization

- Not required
- Simple reversal
- Classic direct standardization
- Classic reversal standardization
- Standardization with the minimum target
- Standardization with the ultimate goal
- Standardization with single objective

**Each indicator of the CPI has a specific way to be standardized**

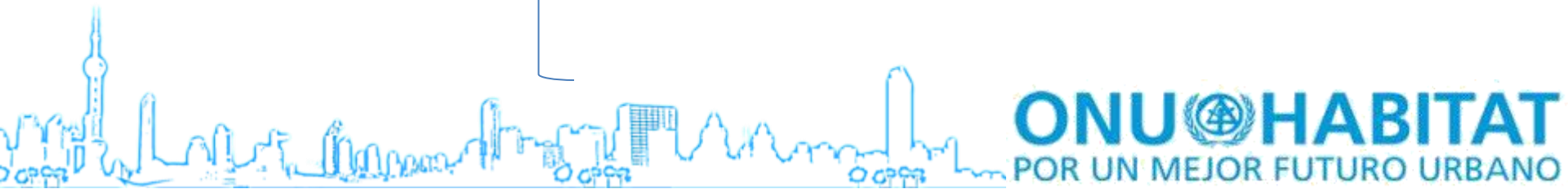


# Standardization: Simple Reversal

$$X^{(S)} = 100 - X$$

## Example:

- The **poverty rate**, which is measured in percent.
- The variable moves from 0 to 100.
- The relationship with the CPI is reversed (a rise in the poverty rate will generate a decrease in the level of prosperity of the city).



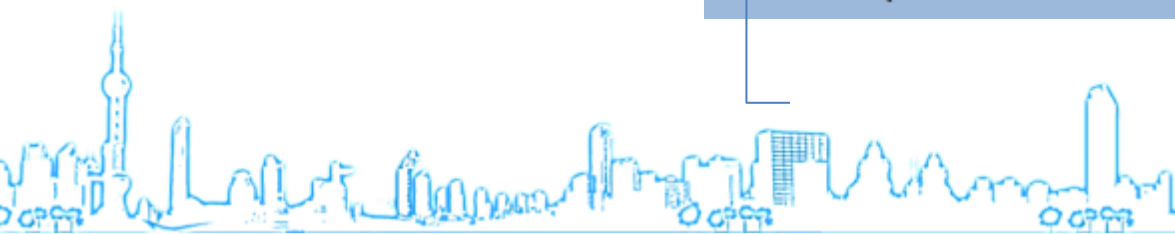
# Classic reversal standardization

## Example:

- Higher values are worst
- CO<sub>2</sub> emissions (measured in metric tons of CO2 per capita)
- WB (2008-2010)
  - Minimum 0.01
  - Maximum 44.20
- A city with 1.44 metric tons would have a standardized value of:

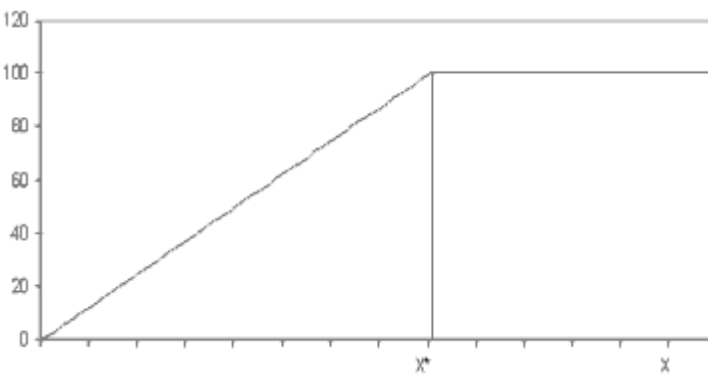
$$X^{(S)} = 100 \left( 1 - \frac{X - \text{Min}(X)}{\text{Max}(X) - \text{Min}(X)} \right)$$

$$X^{(S)} = 100 \left( 1 - \frac{1.44 \text{ toneladas métricas} - 0.01 \text{ toneladas métricas}}{44.20 \text{ toneladas métricas} - 0.01 \text{ toneladas métricas}} \right) = 96.76$$



# Standardization with minimum target

$$X^{(S)} = \begin{cases} 0 & \text{si } X < 0 \\ 100 \left( 1 - \left| \frac{X - X^*}{X^*} \right| \right) & \text{si } 0 \leq X < X^* \\ 100 & \text{si } X \geq X^* \end{cases}$$



## Example:

- Number of intersection per square kilometer
- UN-Habitat (2014) recommends 100 sq. km
- A city with 50 intersections would have a standardized value of:

$$X^{(S)} = 100 \left( 1 - \left| \frac{50 \text{ int/ km}^2 - 100 \text{ int/ km}^2}{100 \text{ int/ km}^2} \right| \right) = 50.00$$

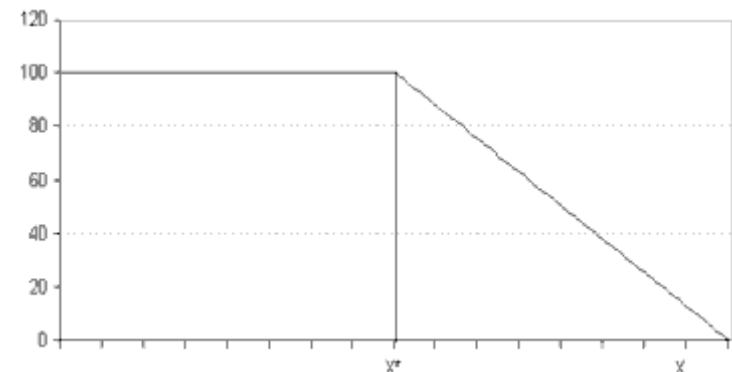
# Standardization with ultimate goal

$$X^{(S)} = \begin{cases} 0 & \text{si } X \geq 2X^* \\ 100 \left( 1 - \frac{|X - X^*|}{X^*} \right) & \text{si } X^* < X < 2X^* \\ 100 & \text{si } X \leq X^* \end{cases}$$

## Example:

- PM10 concentration (measured in micrograms per cubic meter).
- EC (2013) has set a target value recommended maximum = 40.
- To exceed a certain threshold value decreases (40=100)
- A city with = 54.63, its normalized value is:

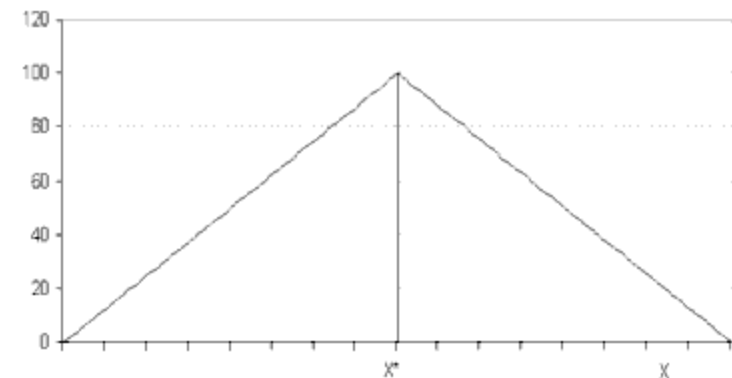
$$X^{(S)} = 100 \left( 1 - \frac{|54.63 \mu\text{g} / \text{m}^3 - 40 \mu\text{g} / \text{m}^3|}{40 \mu\text{g} / \text{m}^3} \right) = 63.43$$





# Standardization with single objective

$$X^{(s)} = \begin{cases} 0 & \text{si } X \leq 0 \text{ o } X \geq 2X^* \\ 100 \left( 1 - \left| \frac{X - X^*}{X^*} \right| \right) & \text{si } 0 < X < 2X^* \\ 100 & \text{si } X = X^* \end{cases}$$



## Examples:

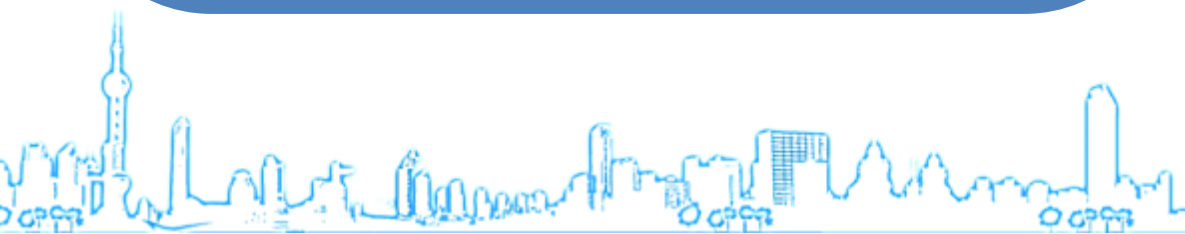
- Residential densities
- Women in Local Government (measured as a % target value)
- Mossuz-Lavau (2005) = 50%
- In a city with 31.22% of women in government, the standardized value would be:

$$X^{(s)} = 100 \left( 1 - \left| \frac{31.32\% - 50\%}{50\%} \right| \right) = 62.64$$

# Construction of a scheme of WEIGHTS

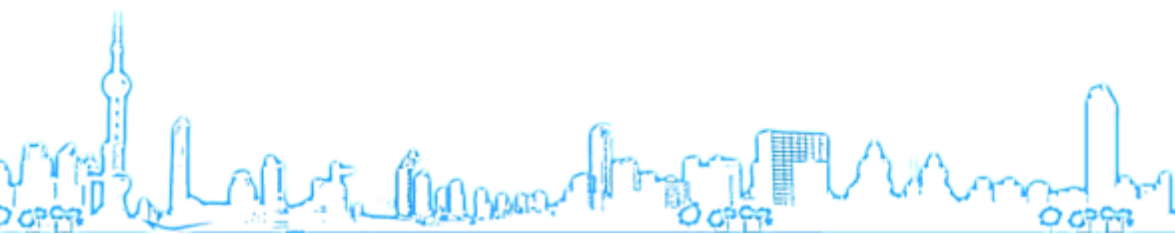
Once the variables have been standardized, there is a need to define a **methodology** to add the information on these variables in a new variable.

Need to define a weighting scheme for dimensions, sub-dimensions and variables.

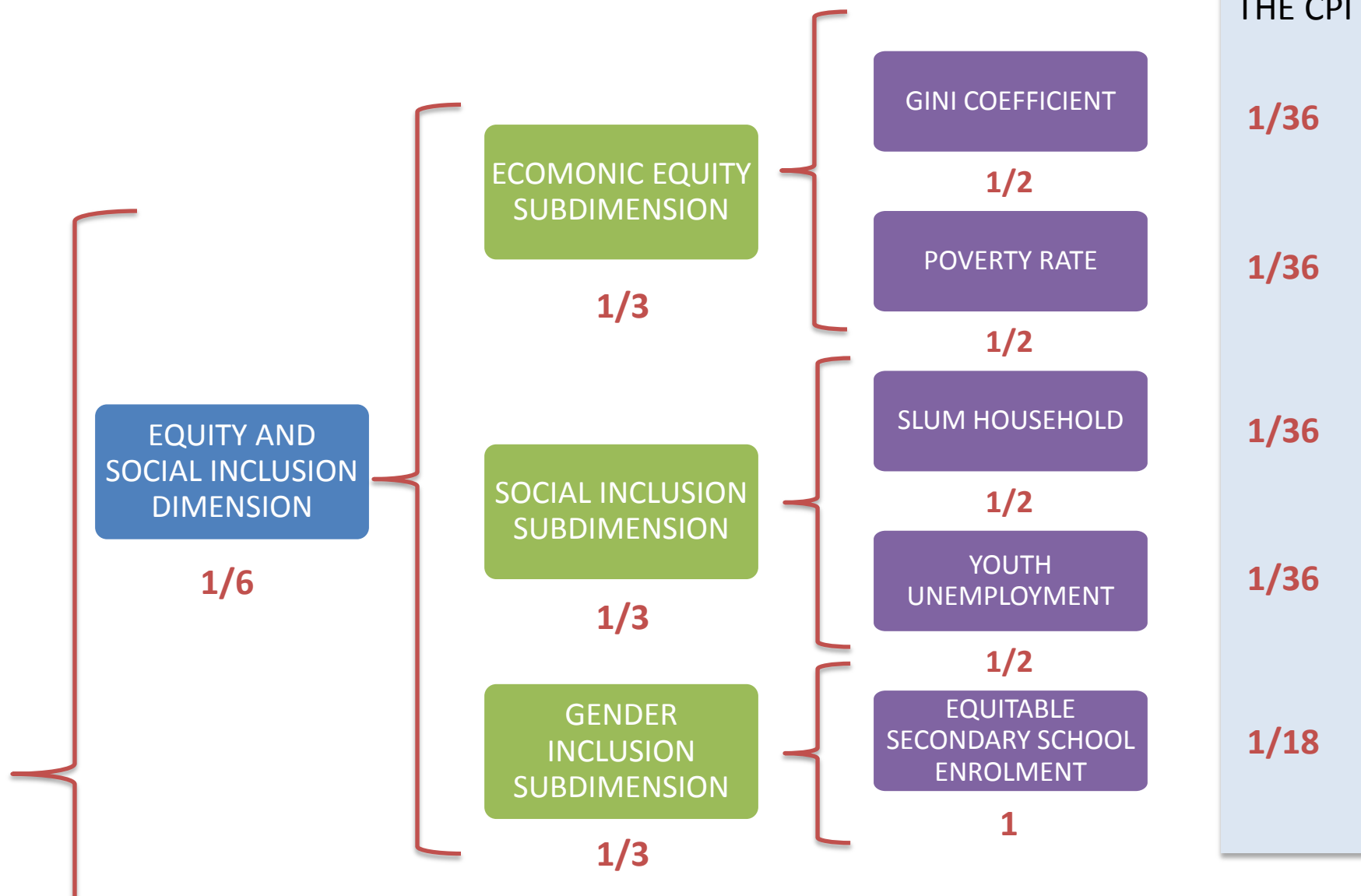


## Construction of a scheme of WEIGHTS

- a) The dimensions have an equal weight in the indicator.
- b) The sub-dimensions have equal weight within its dimension.
- c) The variables have equal weight within its sub-dimension



# Construction of a scheme of WEIGHTS







# CLARIFICATION OF INDICATORS



# CITY PRODUCT

## PURCHASING PARITY POWER (PPP)

Country	Per Capita GDP (Nominal)	Per Capita GDP (PPP)
United States	47,100	47,400
Germany	40,500	35,900
United Kingdom	36,200	35,100
Japan	42,500	34,200
Mexico	8,900	13,800
Brazil	10,100	10,900
China	4,300	7,400
India	1,200	3,400

PPP conversion factor, GDP (LCU per international \$)

Purchasing power parity conversion factor is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as U.S. dollar would buy in the United States.

This conversion factor is for GDP.

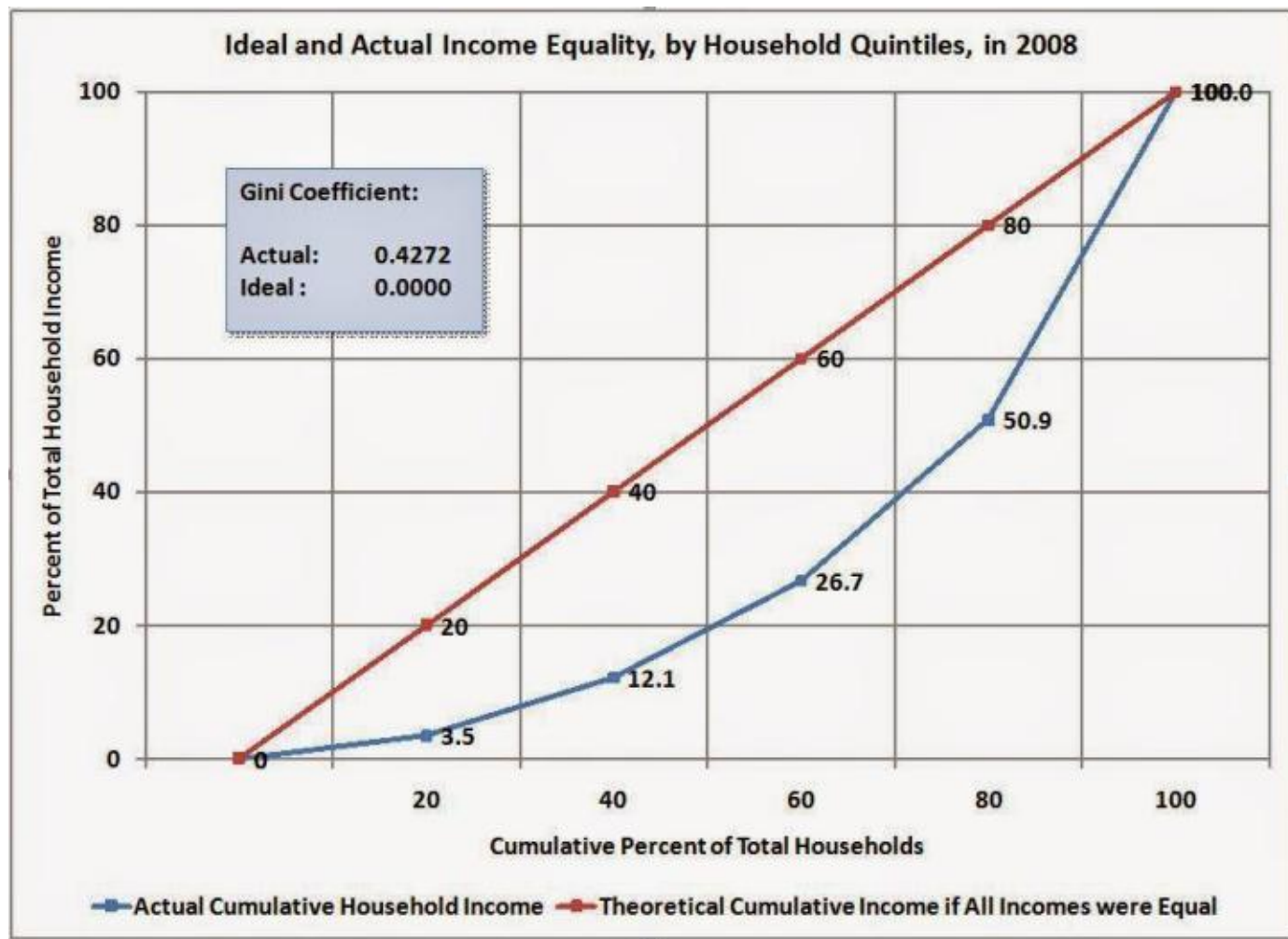
Source of Data:

<http://data.worldbank.org/indicator/PA.NUS.PPP>



# GINI COEFFICIENT

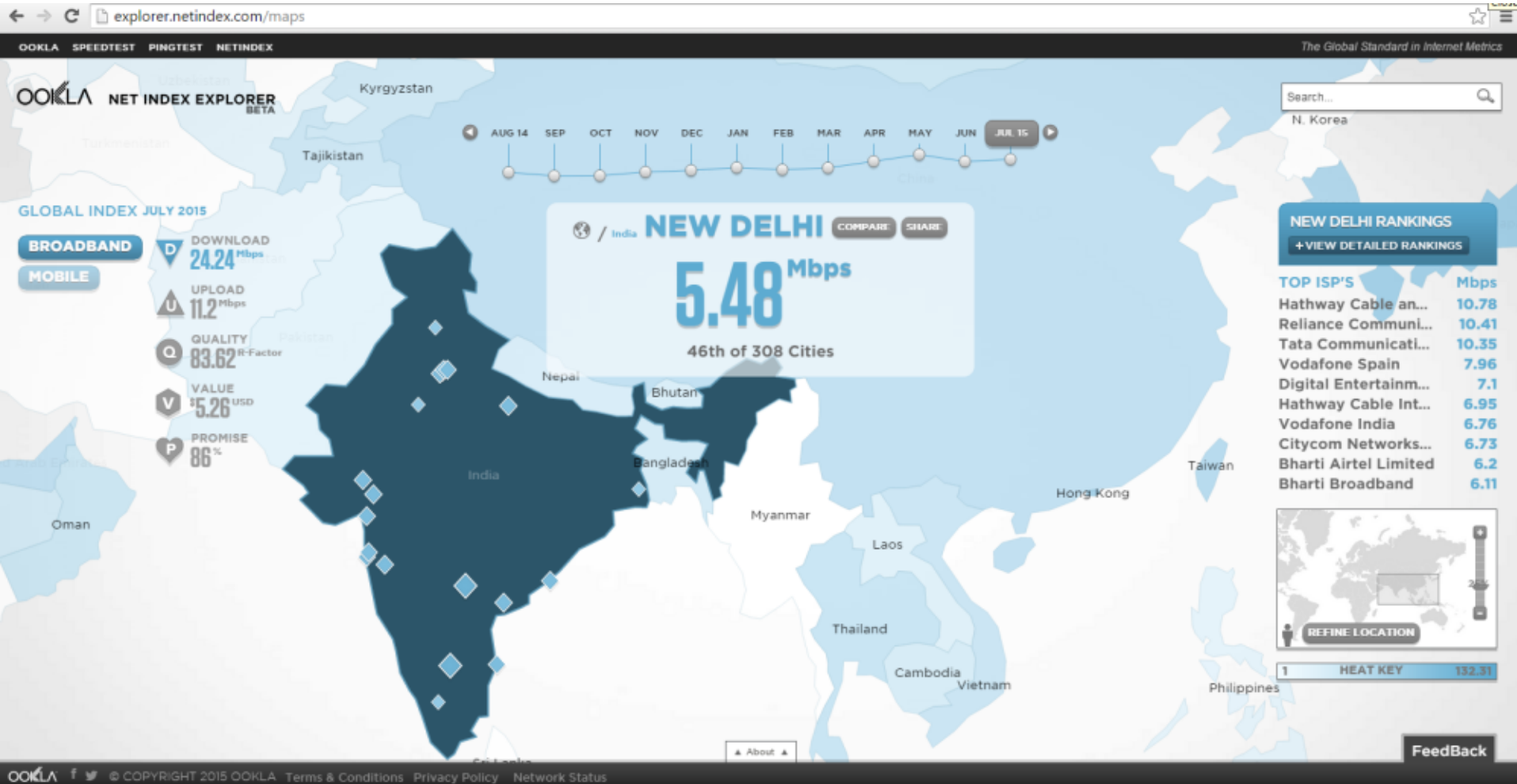
## MEASURING INCOME INEQUALITY





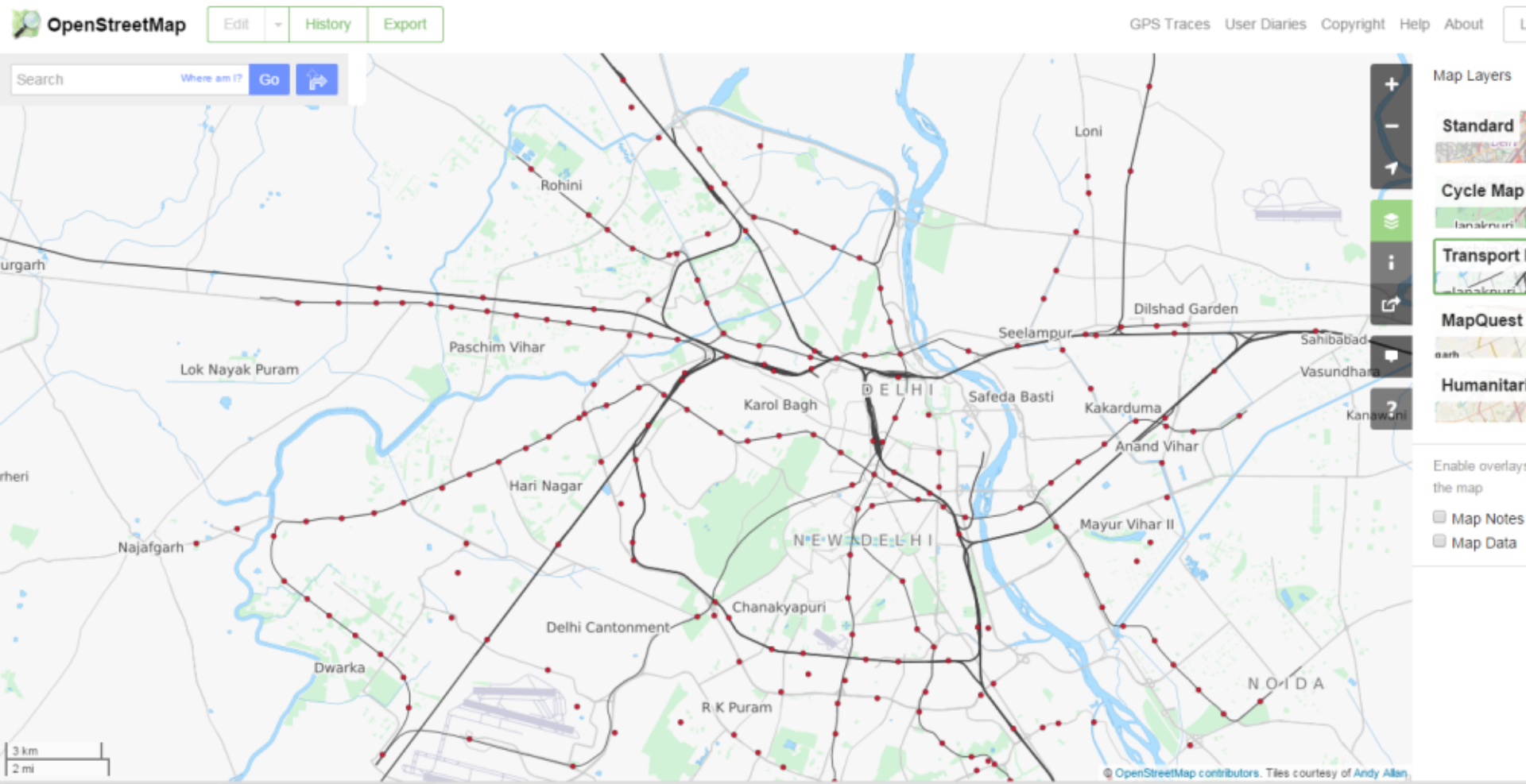
# AVERAGE BROADBAND SPEED

MAKING USE OF BIG –REAL TIME- DATA





# LENGTH OF MASS TRANSIT NETWORK

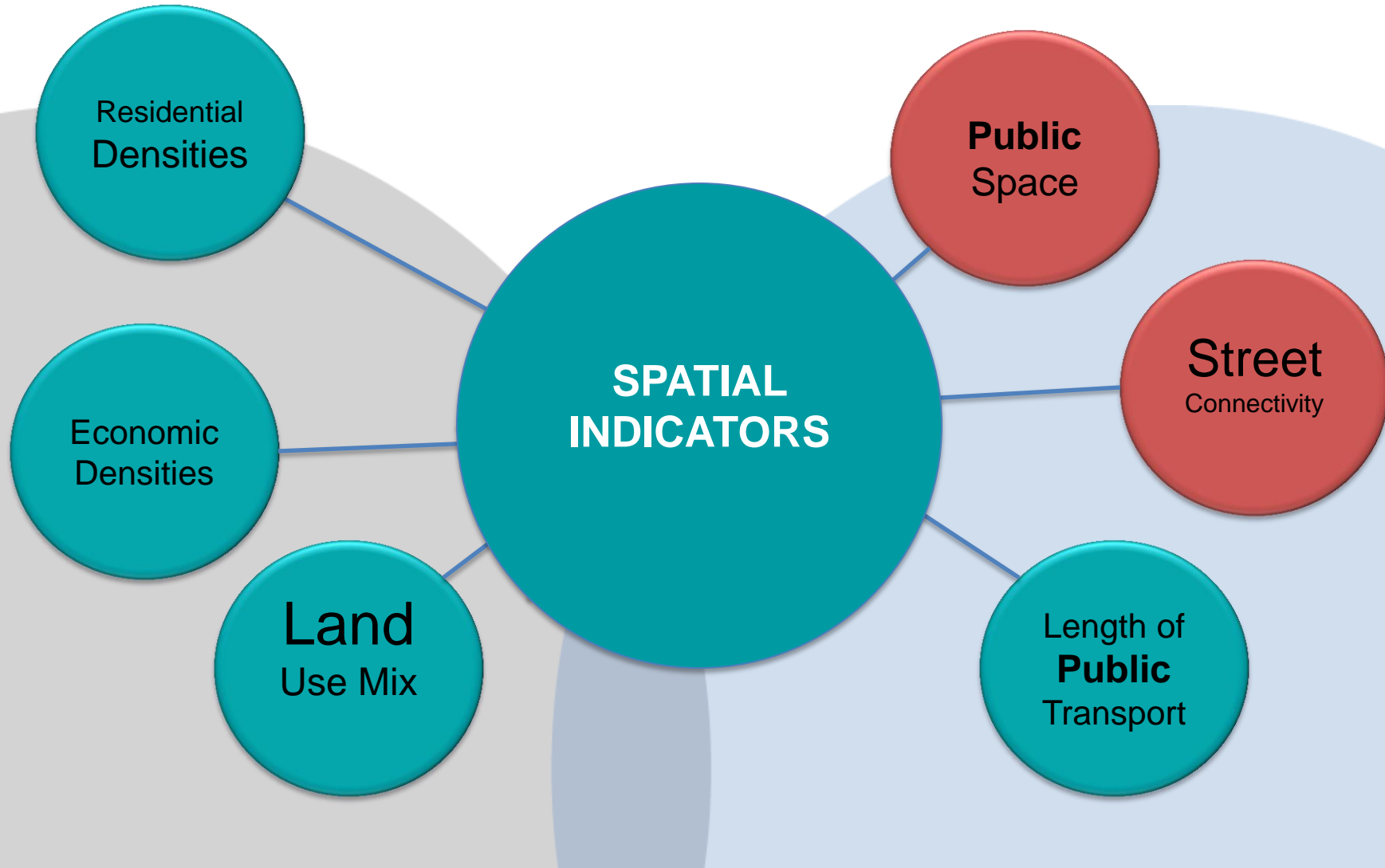
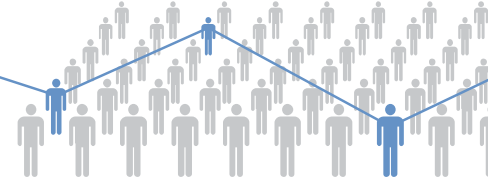


# SPATIAL INDICATORS

DEFINING AREA OF INTERVENTION



# An innovative tool based on spatial analysis





# PUBLIC SPACES



From motorway to Public Space.  
Cheonggyecheon River, Seoul. © John Dolci

# WHAT IS A PUBLIC SPACE?

**“Public spaces are all places publicly owned or of public use, accessible and enjoyable by all for free and without a profit motive”**

Charter on Public Spaces





## PUBLIC / PRIVATE

Both publicly-and privately-owned public spaces are considered, although public ownership often guarantees more stable access and enjoyment over time

Ouagadougou, Burkina Faso





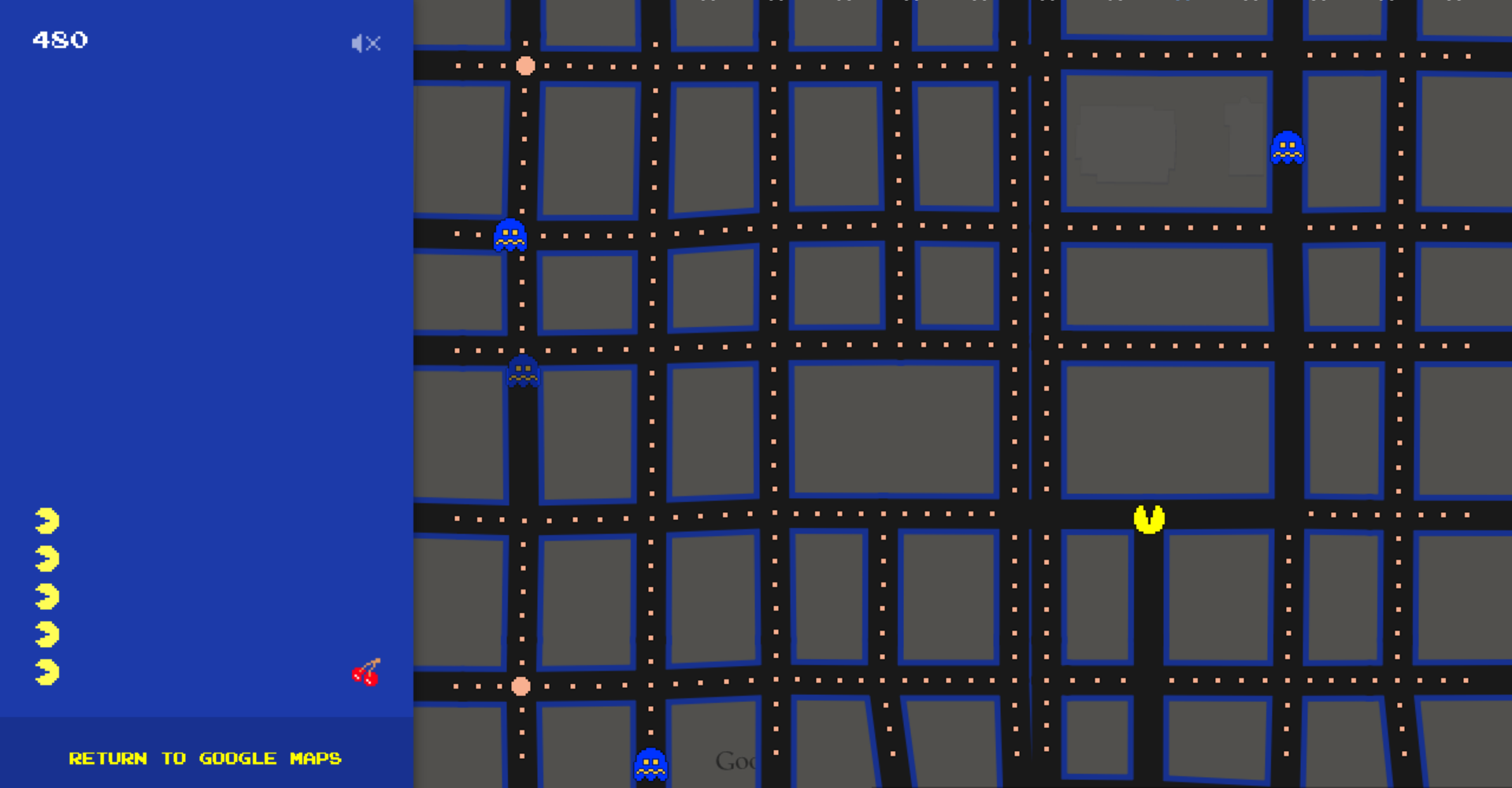
FORMAL / INFORMAL





# WHY IS PUBLIC SPACE IMPORTANT?

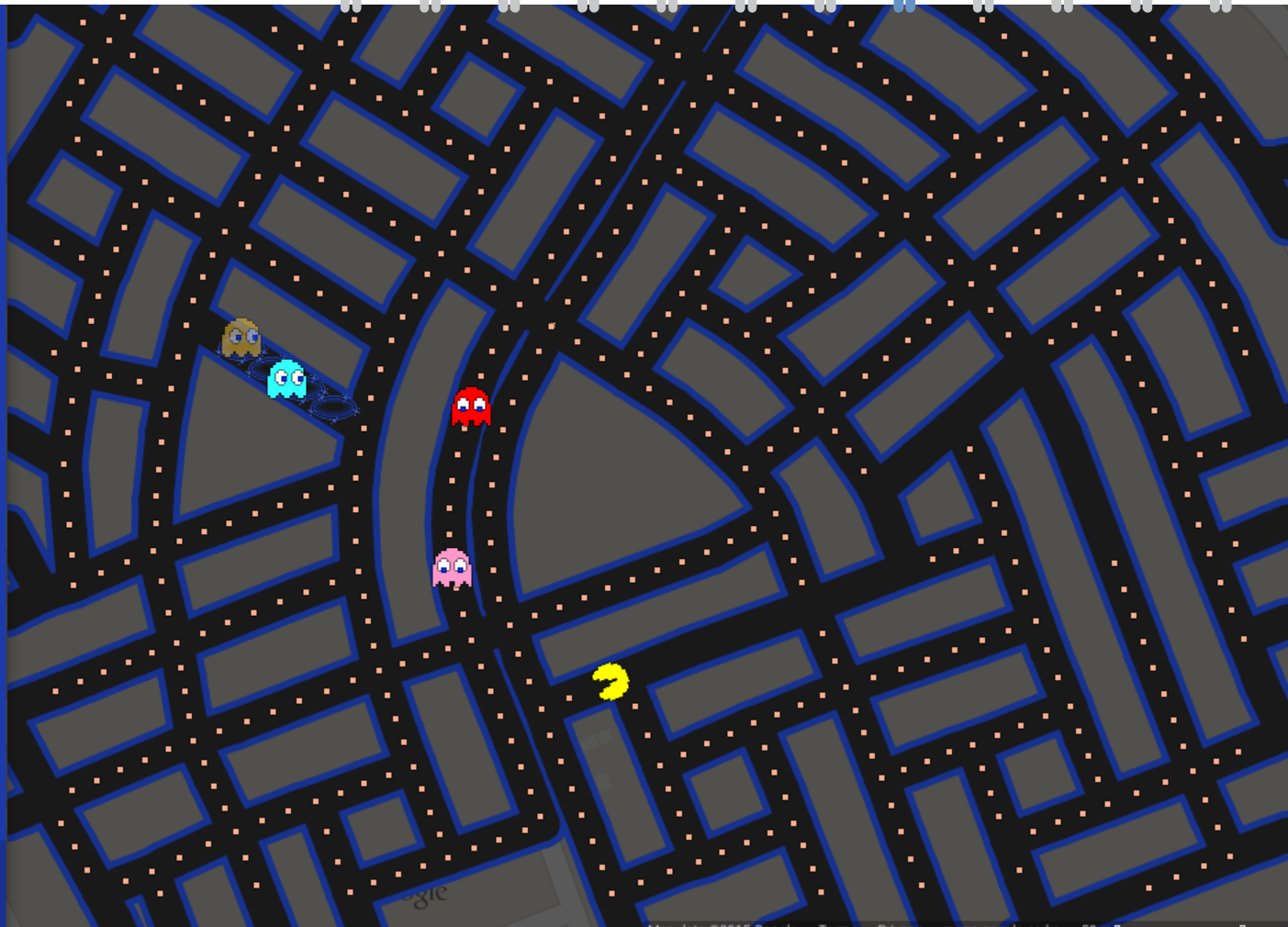
- Reduce the impact of climate change and heat island effect
- Encourage people to walk and cycle
- Contribute to develop a sense of civic cohesion and citizenship
- Improve safety and reduces fear of crime
- Increases prosperity





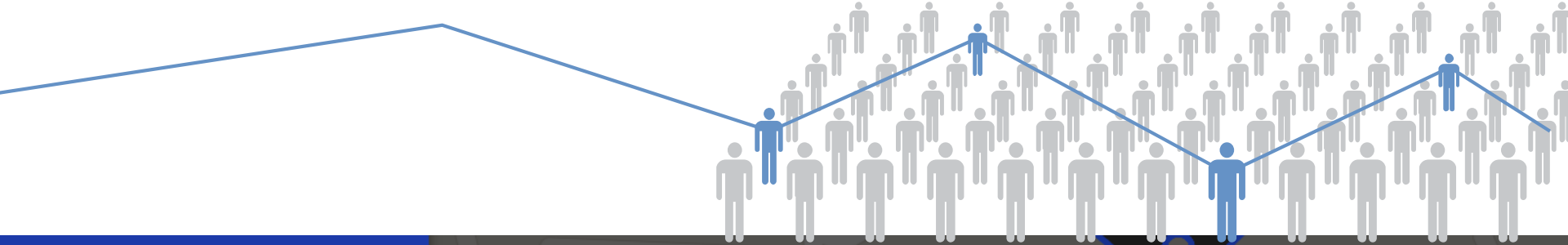


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[RETURN TO GOOGLE MAPS](#)

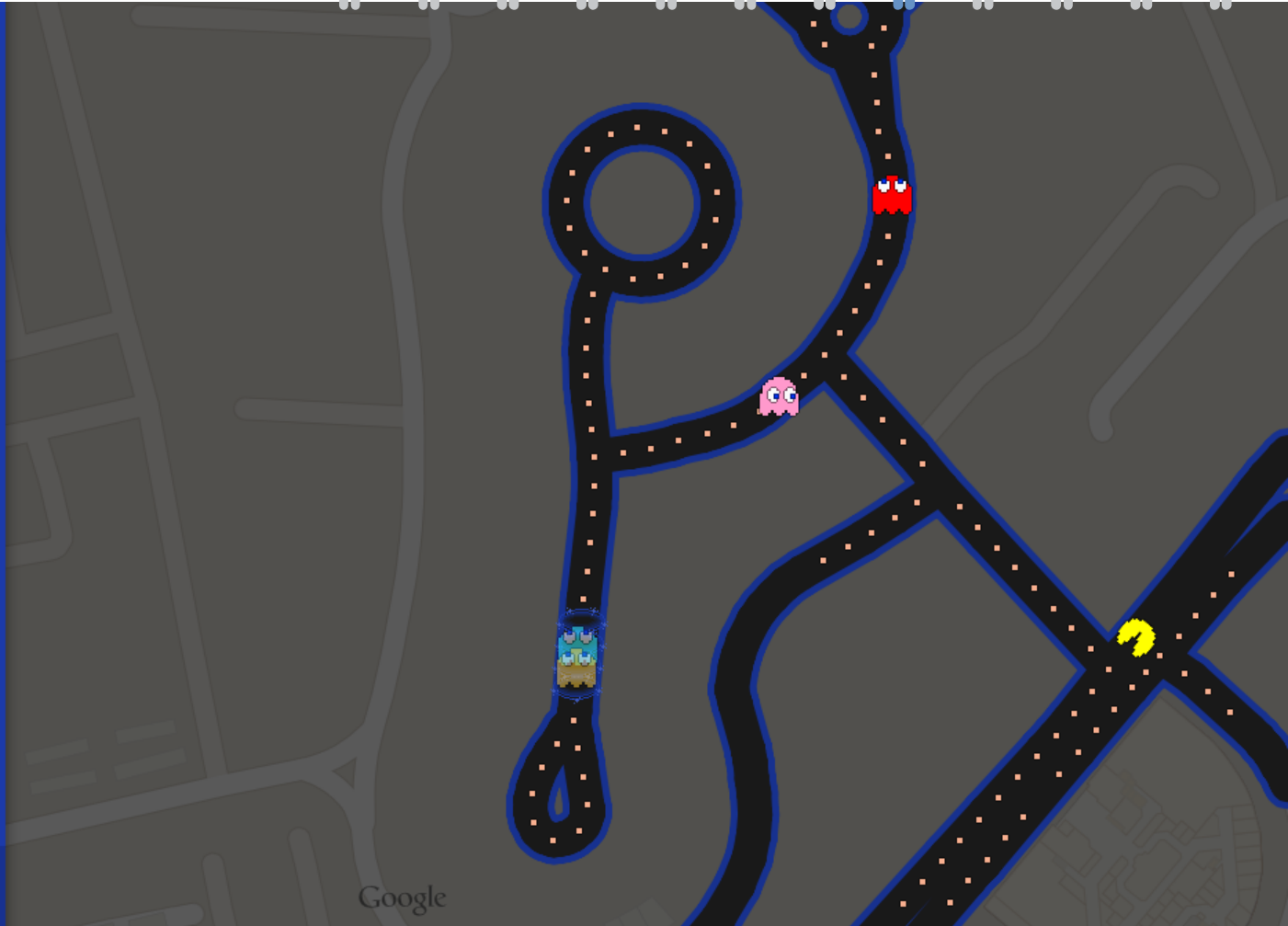
Map data ©2015 Google, Terms, Privacy, [map.google.com](#), 50 m



210



RETURN TO GOOGLE MAPS





## It looks like PAC-MAN can't play here

There aren't enough roads in this area for  
PAC-MAN to get around. Move the map  
or try your luck at a random location.

I'm feeling lucky

RETURN TO GOOGLE MAPS

Google





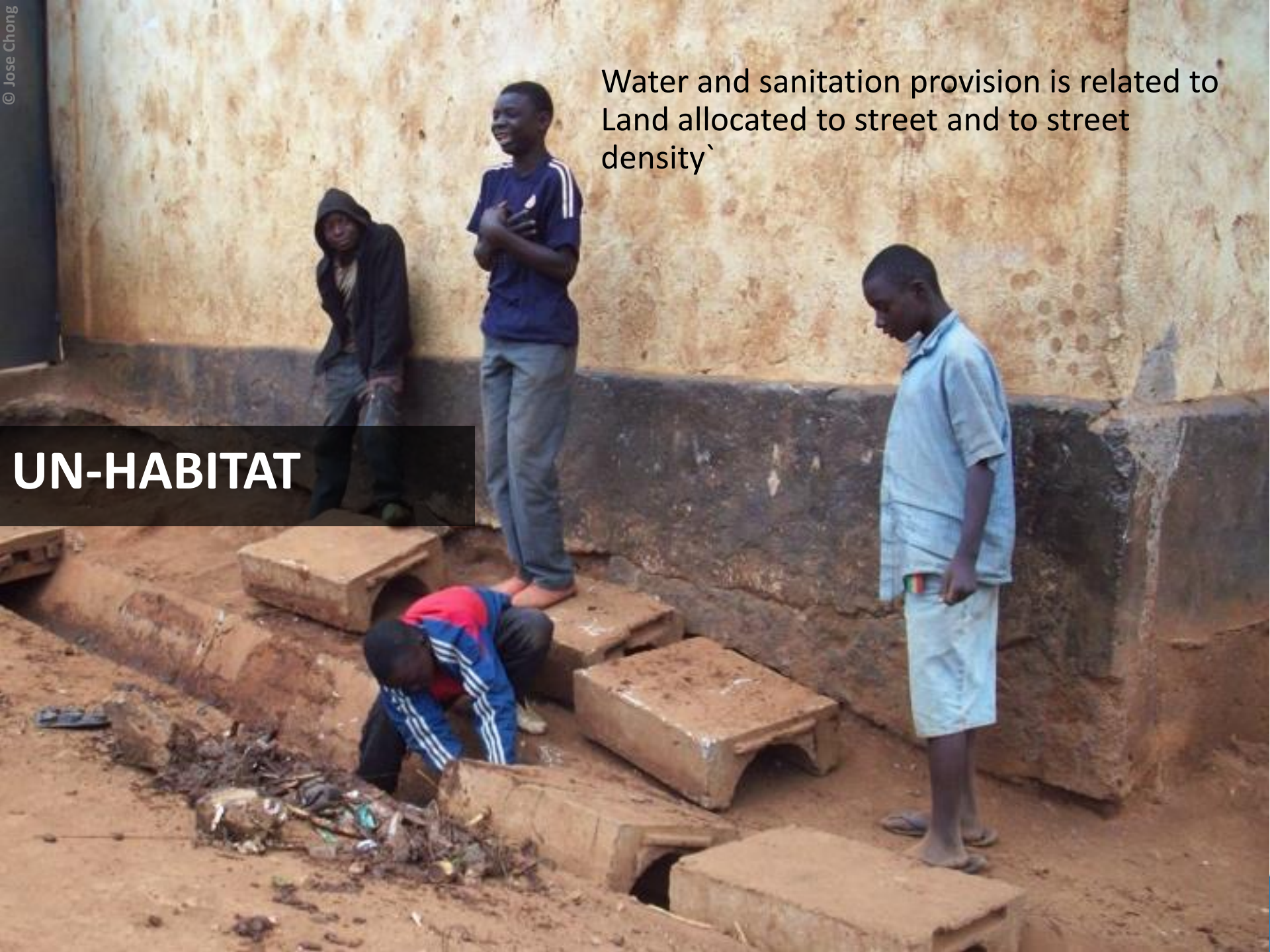
An aerial photograph of a city, likely Barcelona, showing a dense grid of streets and buildings. A prominent circular plaza or park is visible in the upper center. The image is used as a background for a text overlay.

**A ratio of 50% of public space is common in successful cities. Manhattan, Barcelona, and Brussels have up to 35% of city area allocated to street space and an additional 15% for other public uses.**



Water and sanitation provision is related to  
Land allocated to street and to street  
density`

**UN-HABITAT**

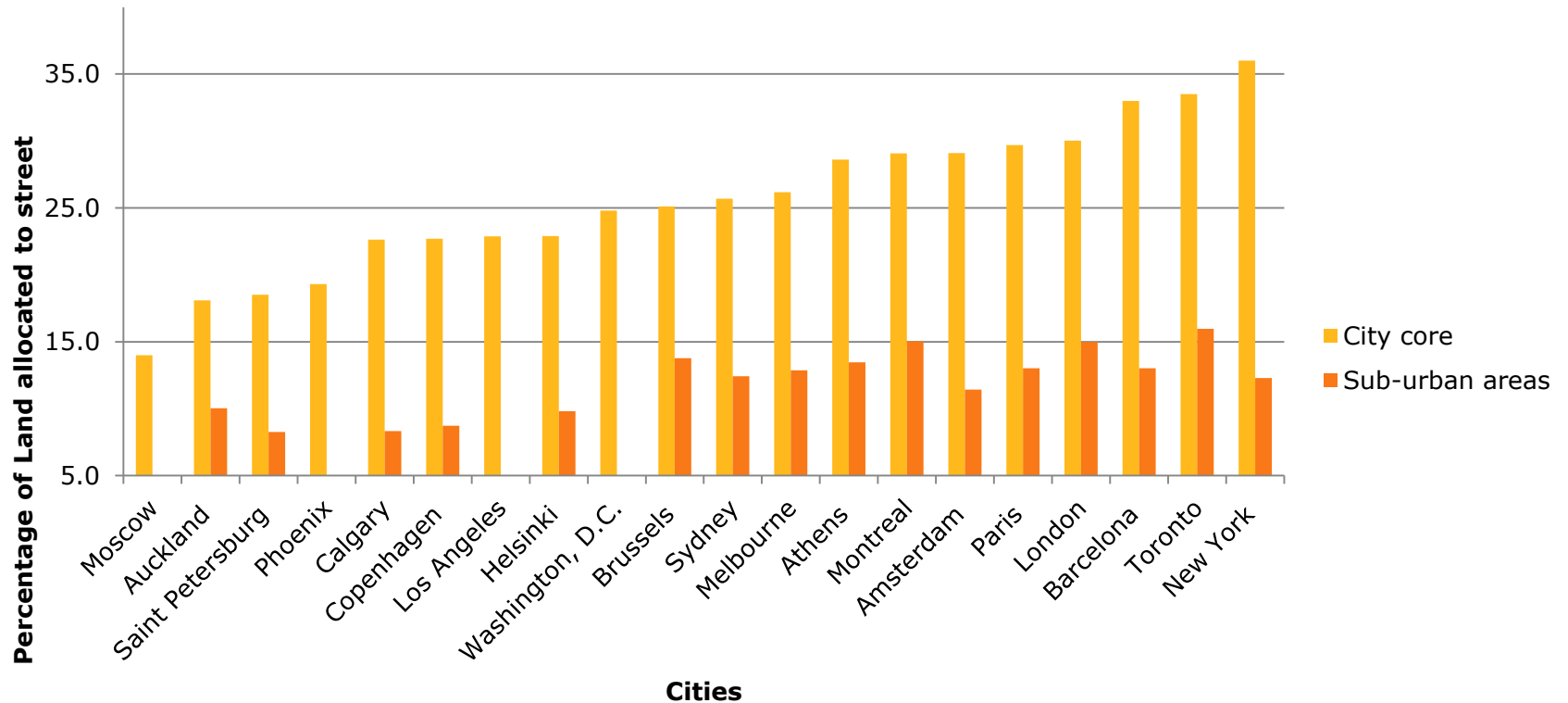






## Required conditions for Public Transport

## Land allocated to street (LAS) in cities, Europe, North America & Oceania



**Disconnected, fragmented suburbs adjacent to well-connected city cores**

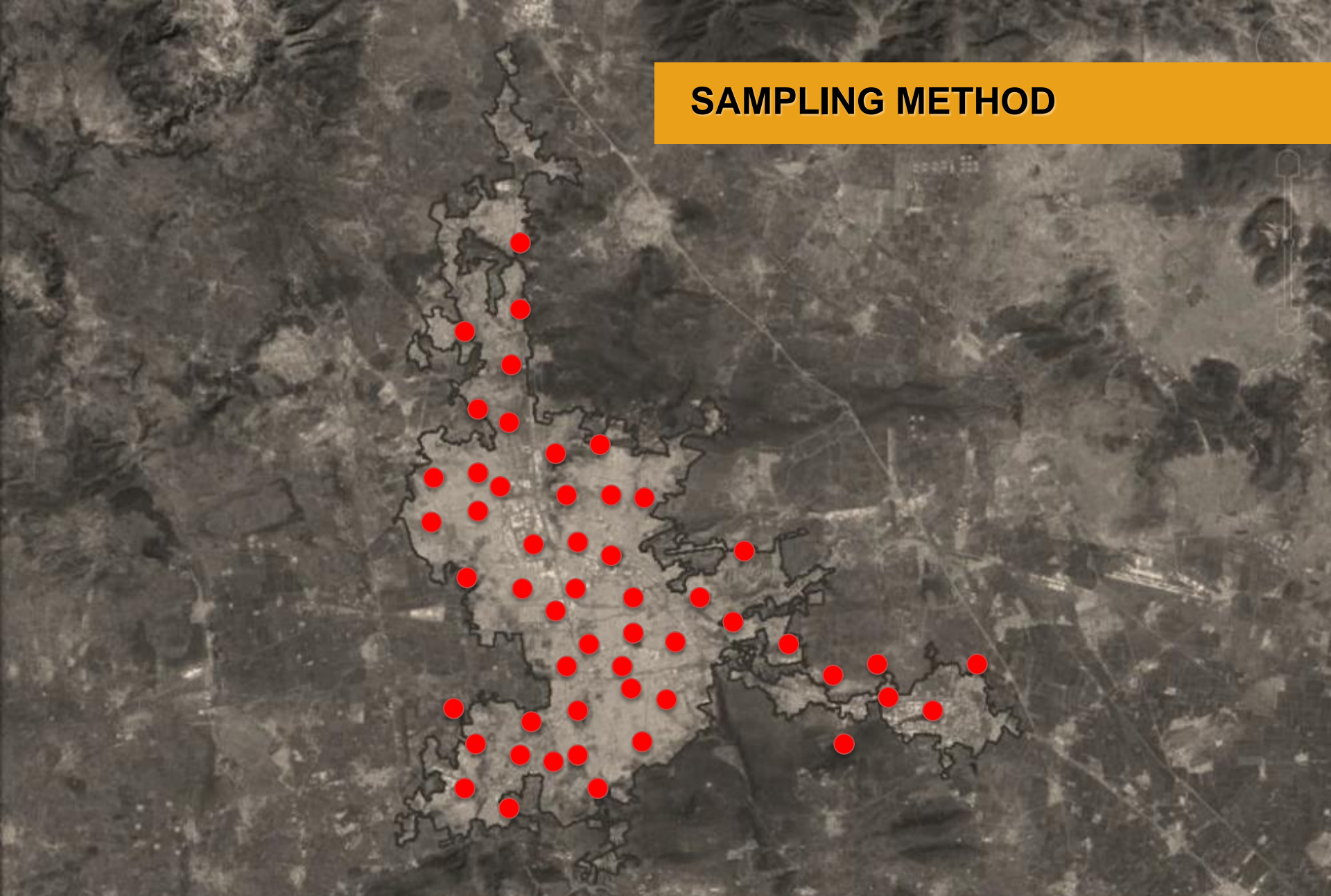
An aerial photograph of a densely populated urban area, likely Madrid, Spain. The image shows a vast expanse of multi-story buildings with red-tiled roofs. A prominent green corridor, possibly a park or a tree-lined avenue, runs vertically through the center of the city. In the background, a body of water and a distant shoreline are visible under a clear sky.

# **A WELL PLANNED URBANIZATION:**

A KEY COMPONENT OF  
SUSTAINABLE  
DEVELOPMENT



## SAMPLING METHOD





# Saudi Arabia CPI – Jeddah

## (Patterns at intra-city level)



### Atomistic areas

Land allocated to streets 25.99

Street density 46.4

Intersection Density 925

### Residential areas

Land allocated to streets 34

Street density 19

Intersection Density 130

### Informal areas

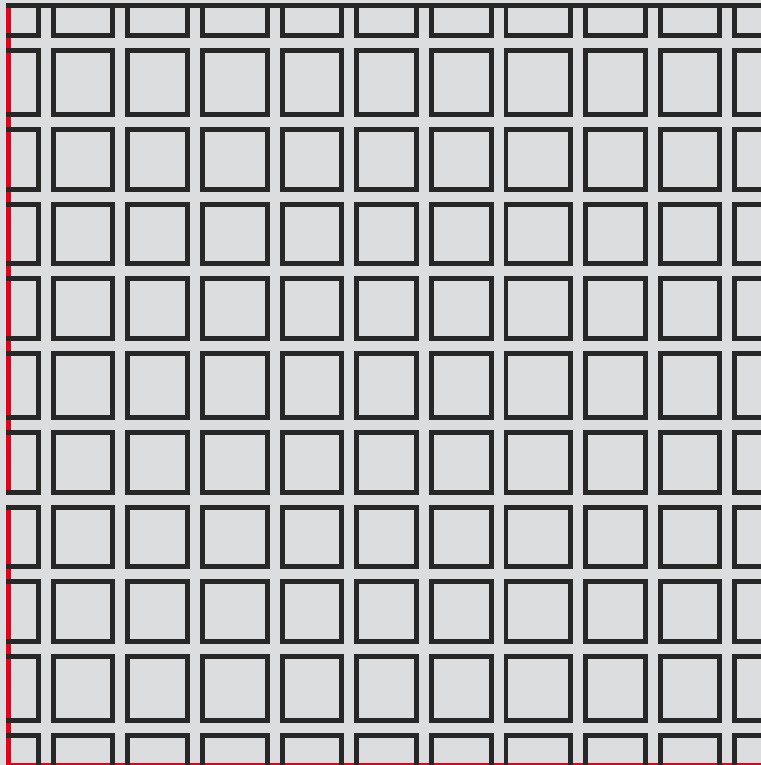
Land allocated to streets 33

Street density 21

Intersection Density 151

# CPI

## STREET CONNECTIVITY AND SPATIAL INDICATORS



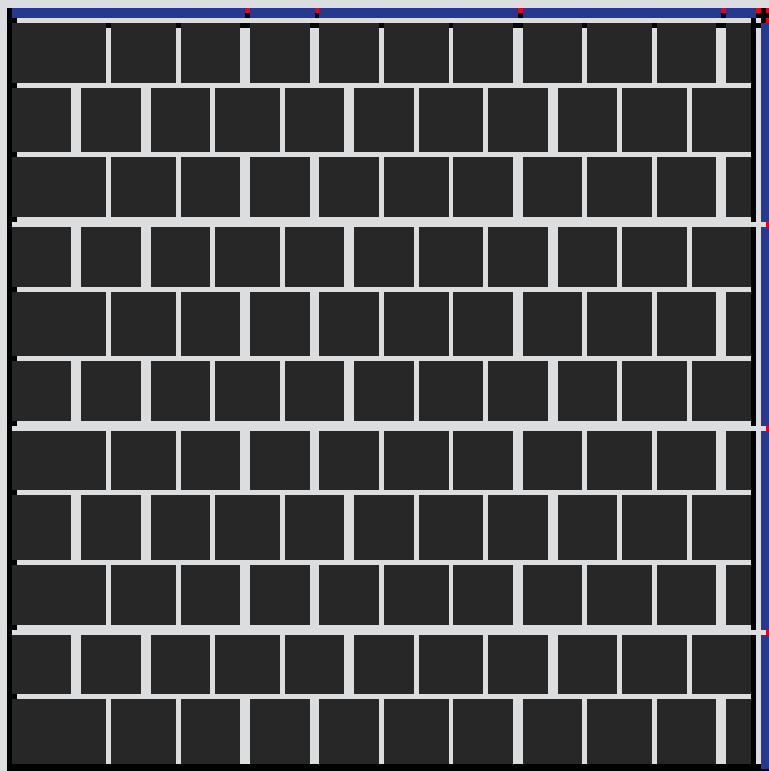
### UN-Habitat recommendation:

Land Allocated to Streets:	30%
Street Density:	20 km /km <sup>2</sup>
Intersection Density:	100 / km <sup>2</sup>

Average street width:	15 m
Street-to-street distance:	100 m
Distance between intersection:	85 m

# CPI

## STREET CONNECTIVITY AND SPATIAL INDICATORS



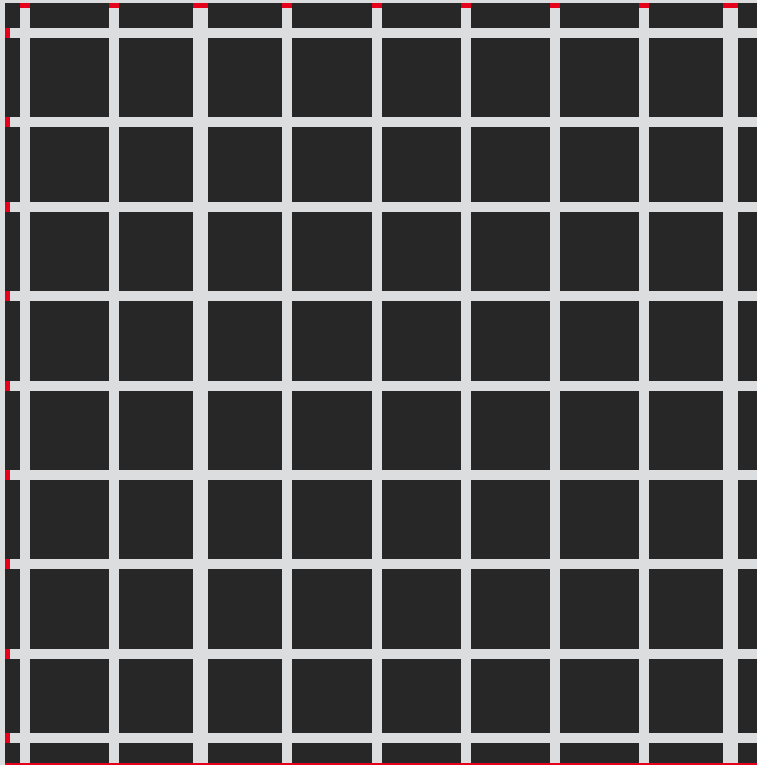
### Neiva, Colombia:

Land Allocated to Streets:	22.5%
Street Density:	25.75 km /km <sup>2</sup>
Intersection Density:	243 / km <sup>2</sup>

Average street width:	9.1 m
Street-to-street distance:	80.8 m
Distance between intersection:	71.7 m

# CPI

## STREET CONNECTIVITY AND SPATIAL INDICATORS



### Dammam, Saudi Arabia:

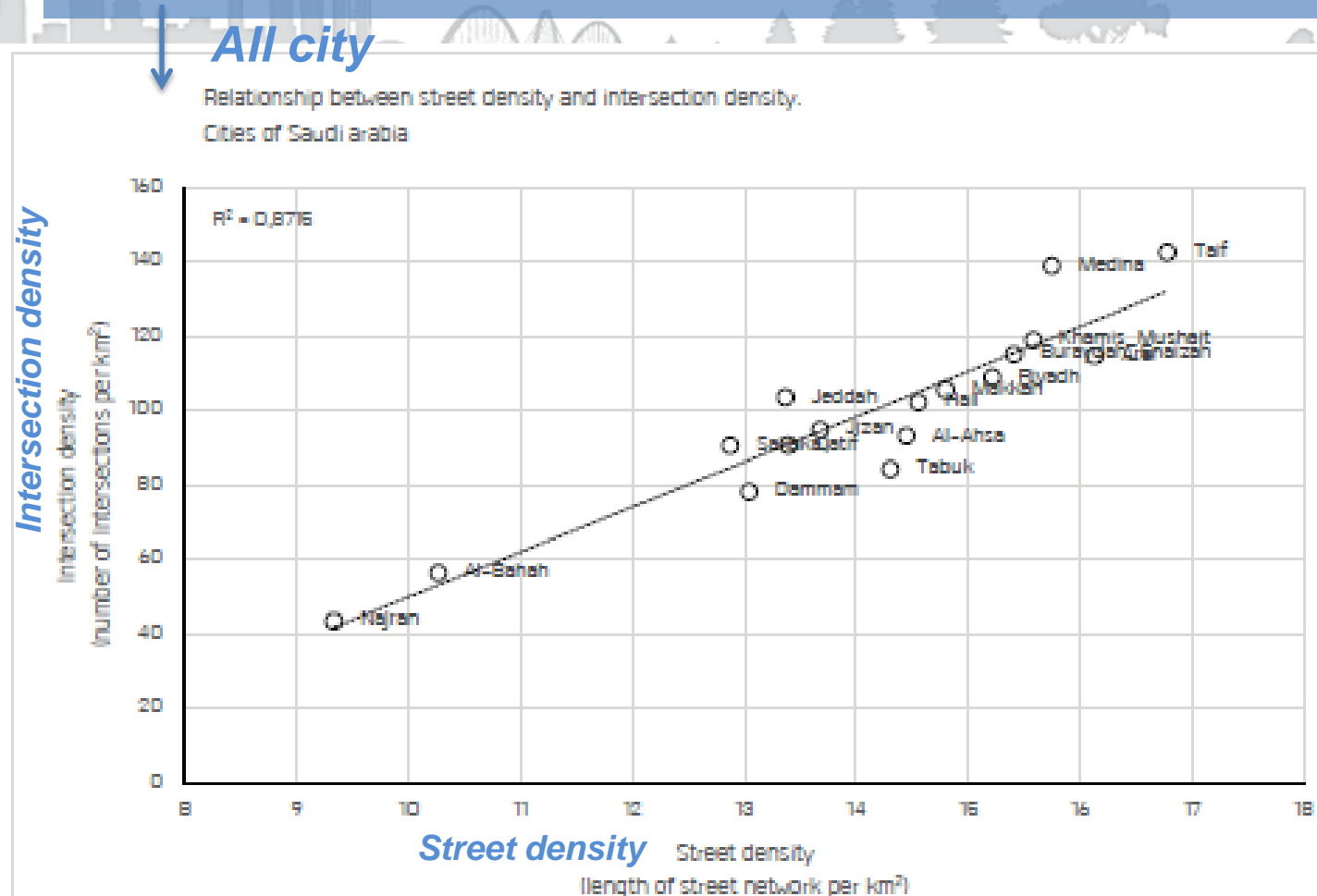
Land Allocated to Streets:	23 %
Street Density:	17 km /km <sup>2</sup>
Intersection Density:	72 / km <sup>2</sup>

Average street width:	17.9 m
Street-to-street distance:	149.5 m
Average block size:	131.6 m

# CPI

## STREET CONNECTIVITY AND SPATIAL INDICATORS

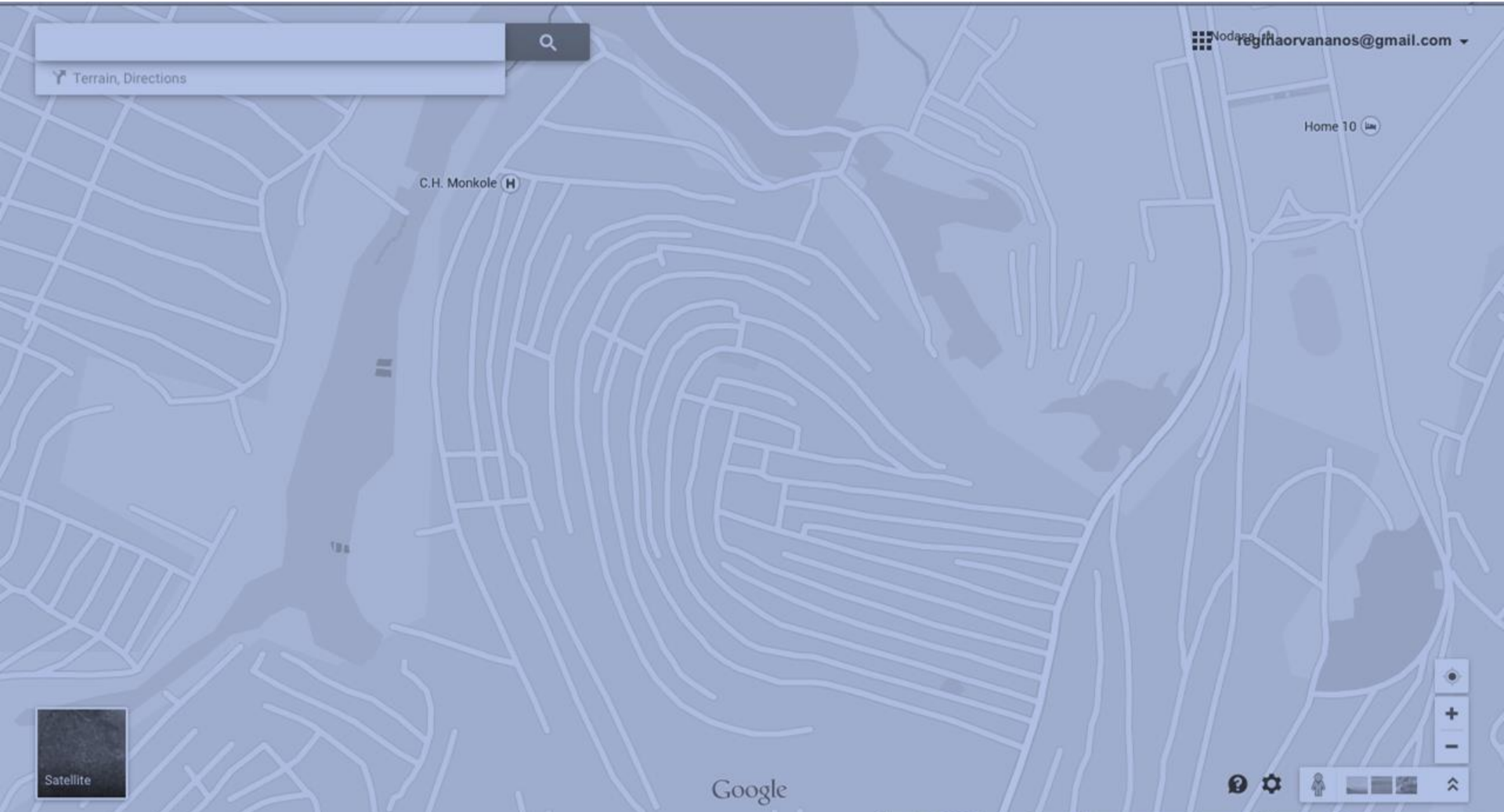
### Correlation between street density and intersection density





# SD:ID ratio

Measures the **skewness** of the urban pattern



# CPI

## CLASIFICATION OF CITIES: CLIMATIC CONDITIONS





# CPI

## CLASIFICACION OF CITIES: CLIMATIC CONDITIONS





## CLASIFICACION OF CITIES: URBAN BOUNDARIES





# CPI

## CLASIFICACION OF CITIES: URBAN TOPOGRAPHY



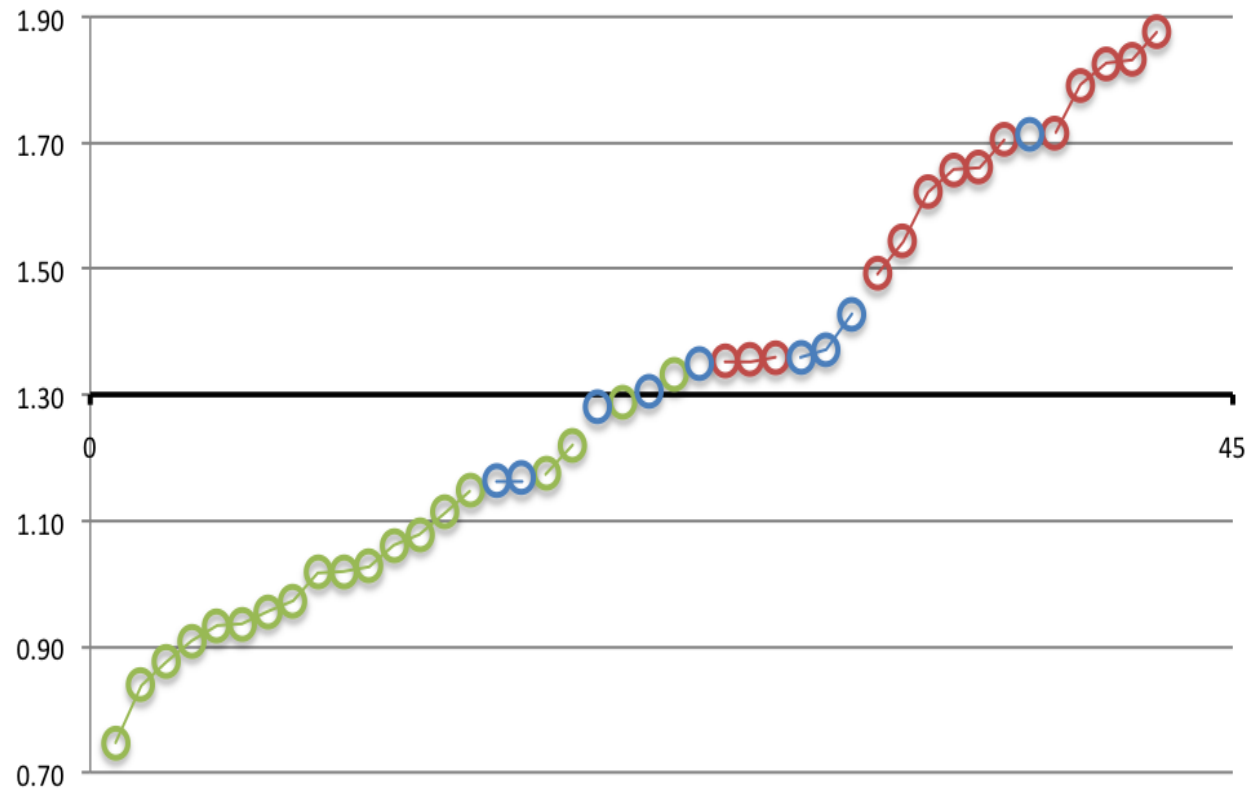
# Street Connectivity – The Form of the City - SA

City	Land / streets	Street density	Intersection D
Riyadh	27.87	15.21	109.6
Makkah	23.12	14.98	111.11
Jeddah	22.83	14.08	125.71
Taif	22.65	16.7	146.13
Medina	27.19	15.85	153.83
Tabuk	26.65	14.21	86.67
Khamis Mushait	20.98	15.45	123.04
Najran	15	10.06	53.21
Jizan (Jazan)	22.72	13.71	105.45
Ha'il (Hail)	24.49	14.75	110.91
Arar (Araar)	29.27	16.03	115.42
Al Bahah	13.98	10.34	59.35
Sakaka	21.43	12.57	90.67



# LAS:SD ratio

Measures the **scale** of the urban grain



- Colombian Cities
- Saudi Arabian Cities
- Latin American Cities



Medellin / Riyadh

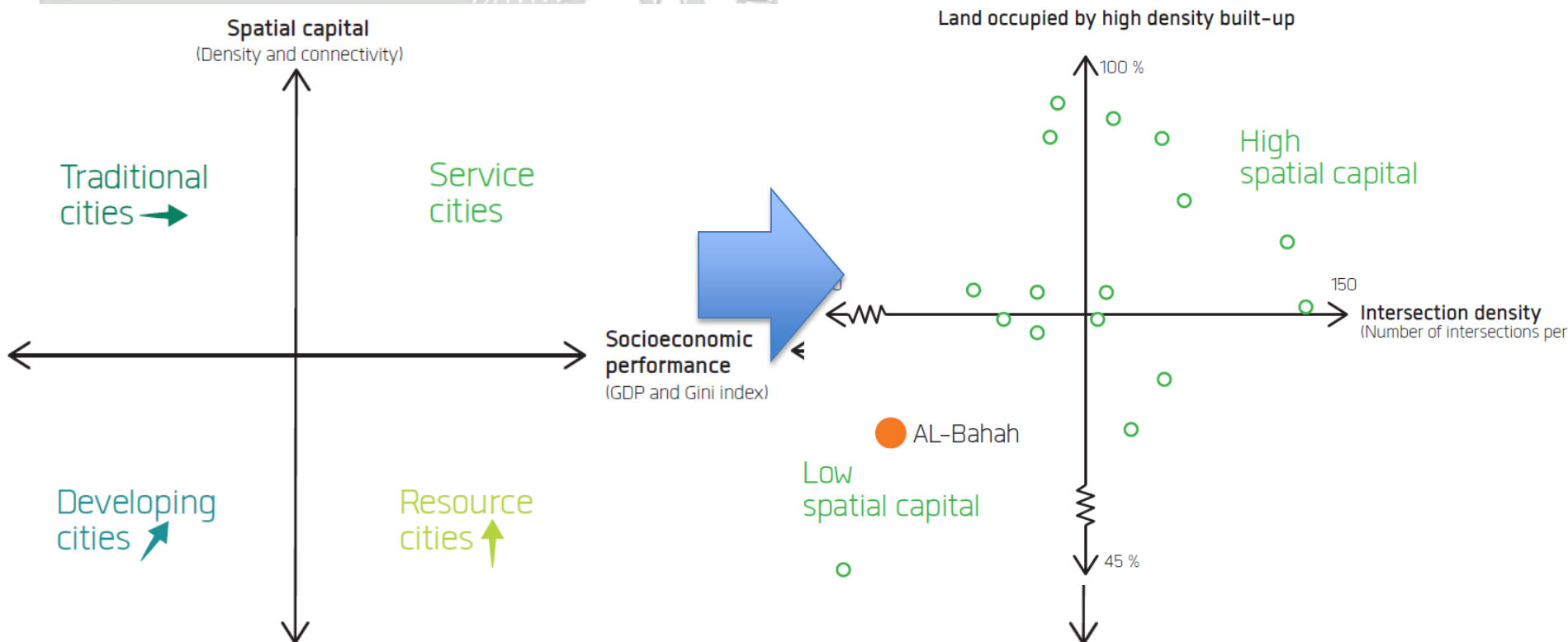




# CPI

## STREET CONNECTIVITY AND SPATIAL INDICATORS

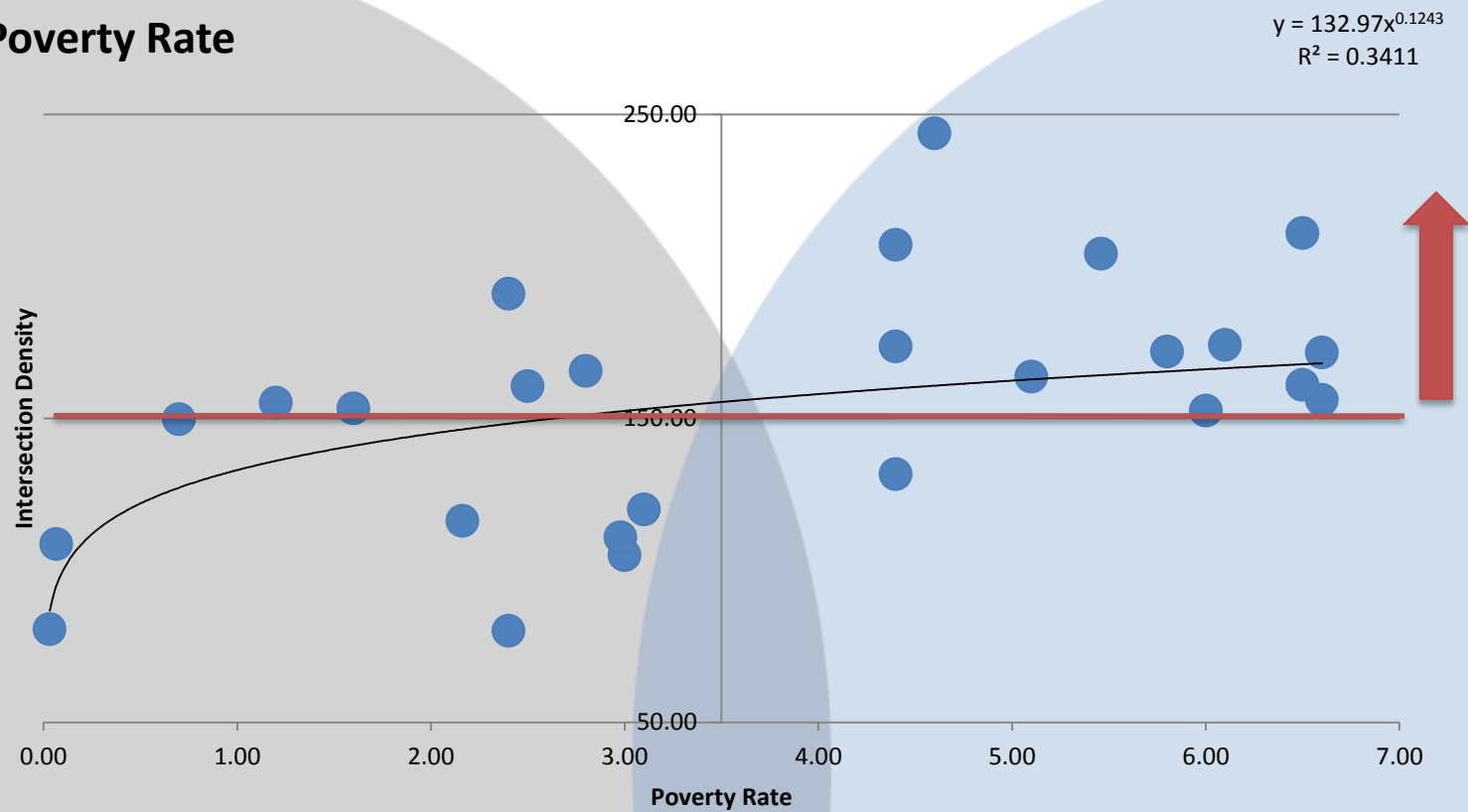
City prosperity is made possible by its **spatial capital**  
- the density, streets and public open space





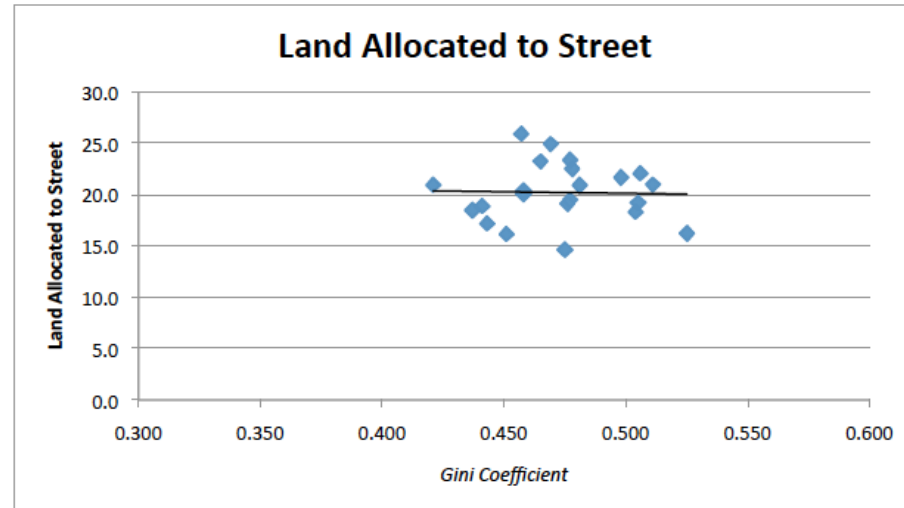
## IDENTIFYING THRESHOLDS

Poverty Rate

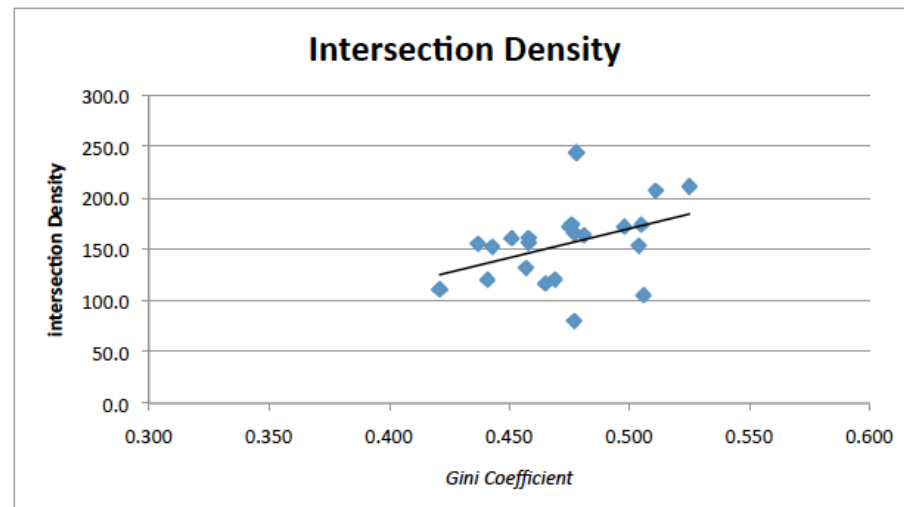


# IDENTIFYING FACTORS WITH LARGER INFLUENCE

	<i>Gini Coefficient</i>
Land Allocated to Street	-0.028



	<i>Gini Coefficient</i>
Intersection Density	0.405







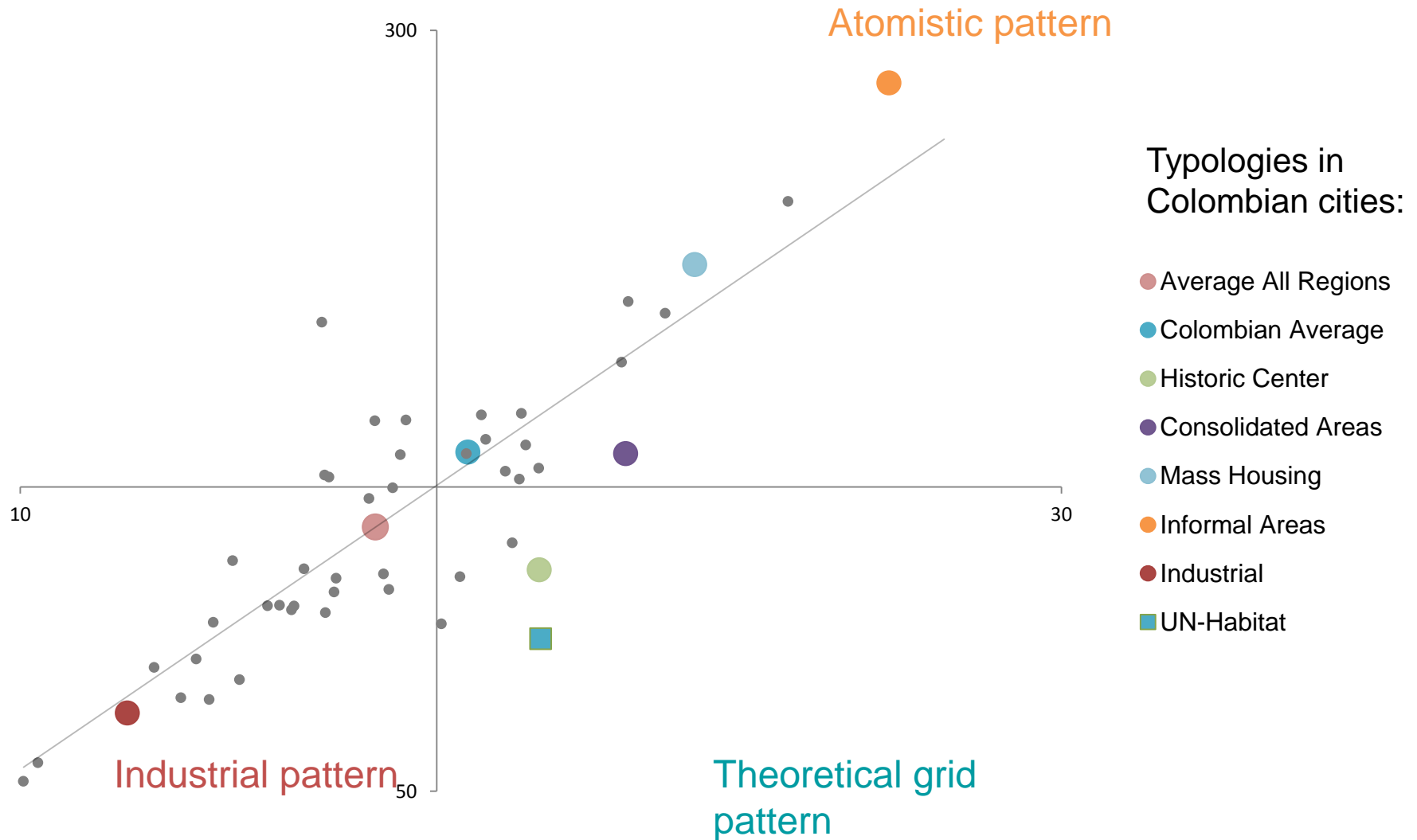
## CPI AND THE STREET CONNECTIVITY

Deviation from City Core values in Colombian cities	Land Allocated to Streets	Street Density	Intersection Density
Mass Housing Projects	-16 %	15 %	82 %
Informal Areas	-34 %	34 %	130 %
Industrial Areas	-31 %	-40 %	-38 %



# SD:ID ratio

## Urban Pattern Quadrants



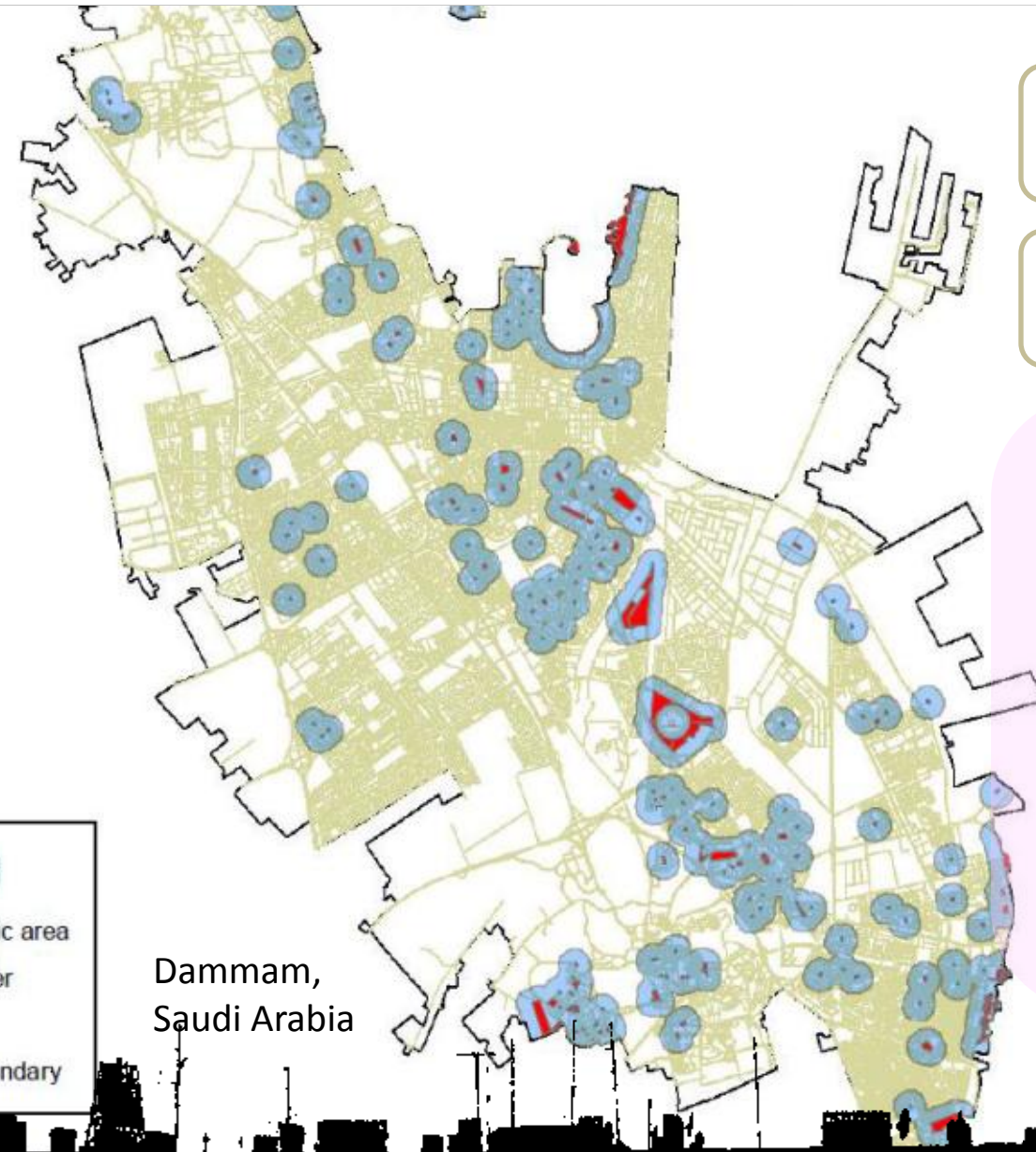


City Prosperity Initiative  
Regina Orvañanos Murguía

[Regina.orvananos@unhabitat.org](mailto:Regina.orvananos@unhabitat.org)



# Accessibility to Public Space

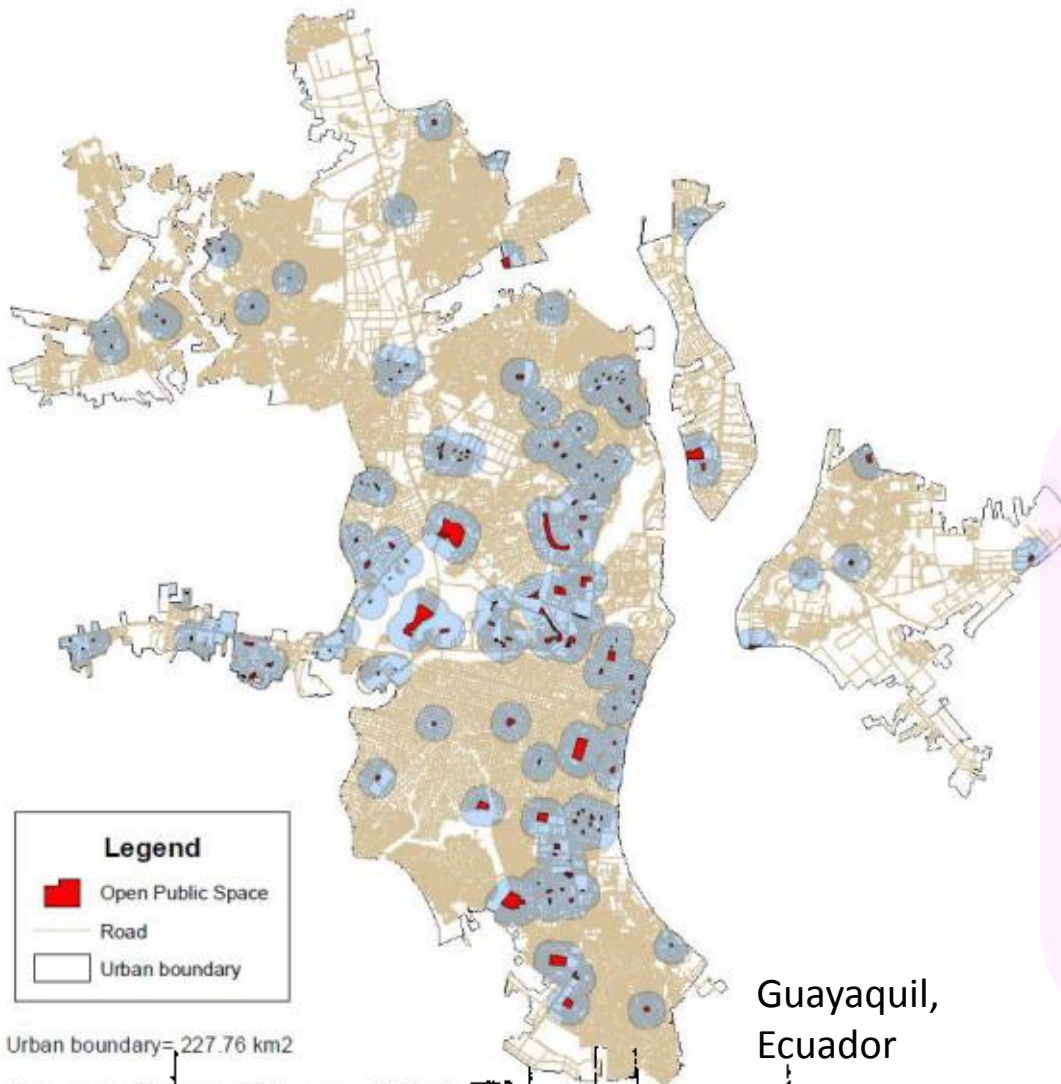


1. Green Area per Capita

2. Accessibility to Open Public Space

- % urban AREA within 400m from open public space
- % urban AREA within 1000m from **major** open public space

# Accessibility to Public Space

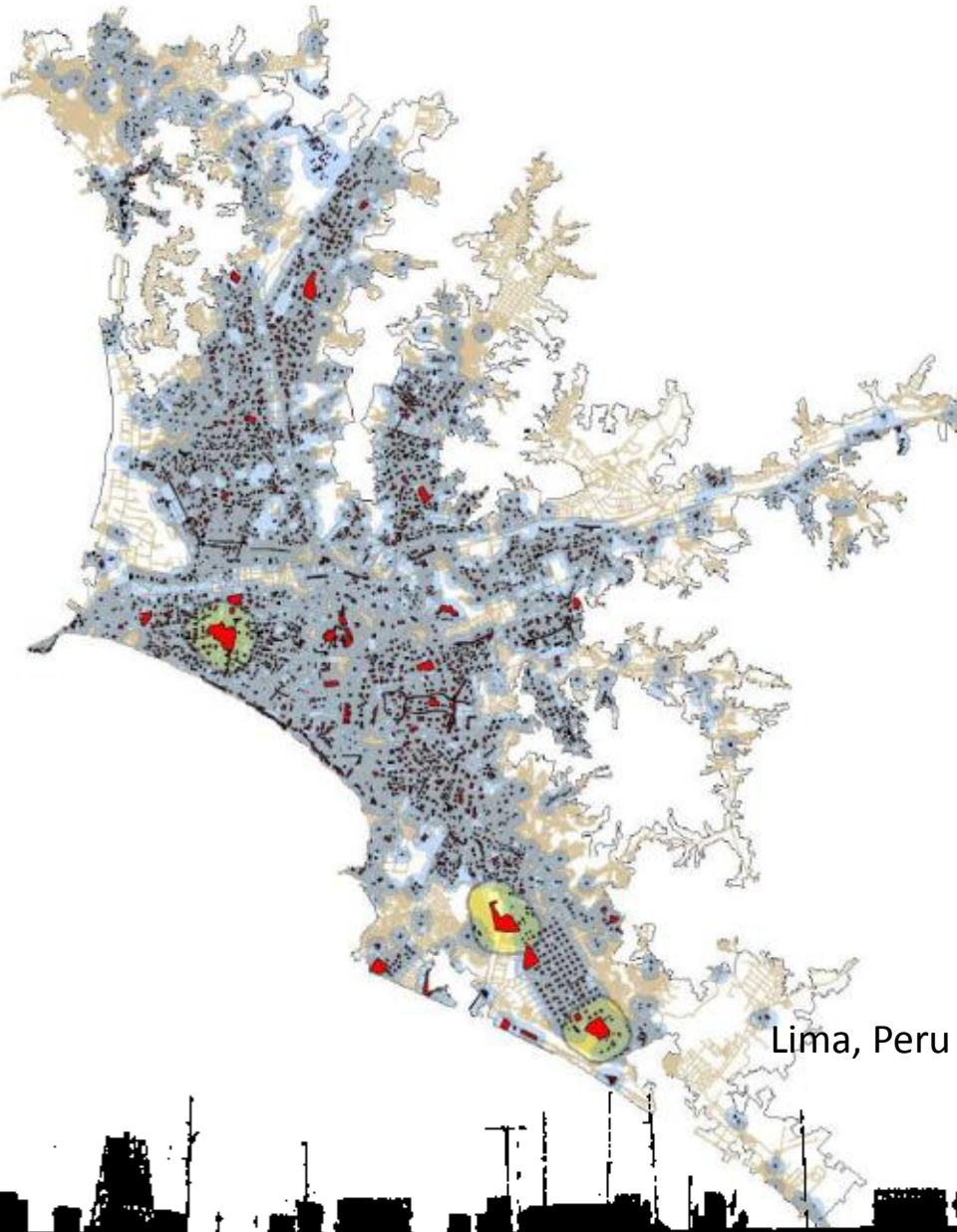


1. Green Area per Capita

2. Accessibility to Open Public Space

- % urban AREA within 400m from open public space
- % urban AREA within 1000m from **major** open public space

# Accessibility to Public Space



1. Green Area per Capita

2. Accessibility to Open Public Space

- % urban AREA within 400m from open public space
- % urban AREA within 1000m from **major** open public space