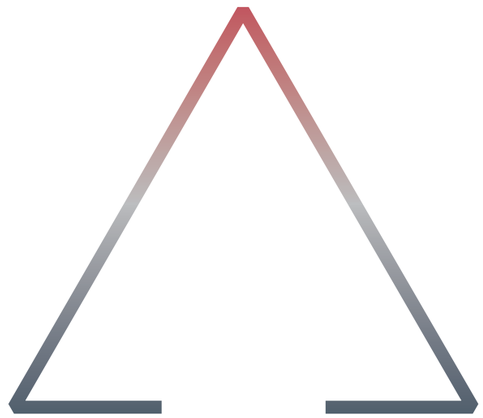


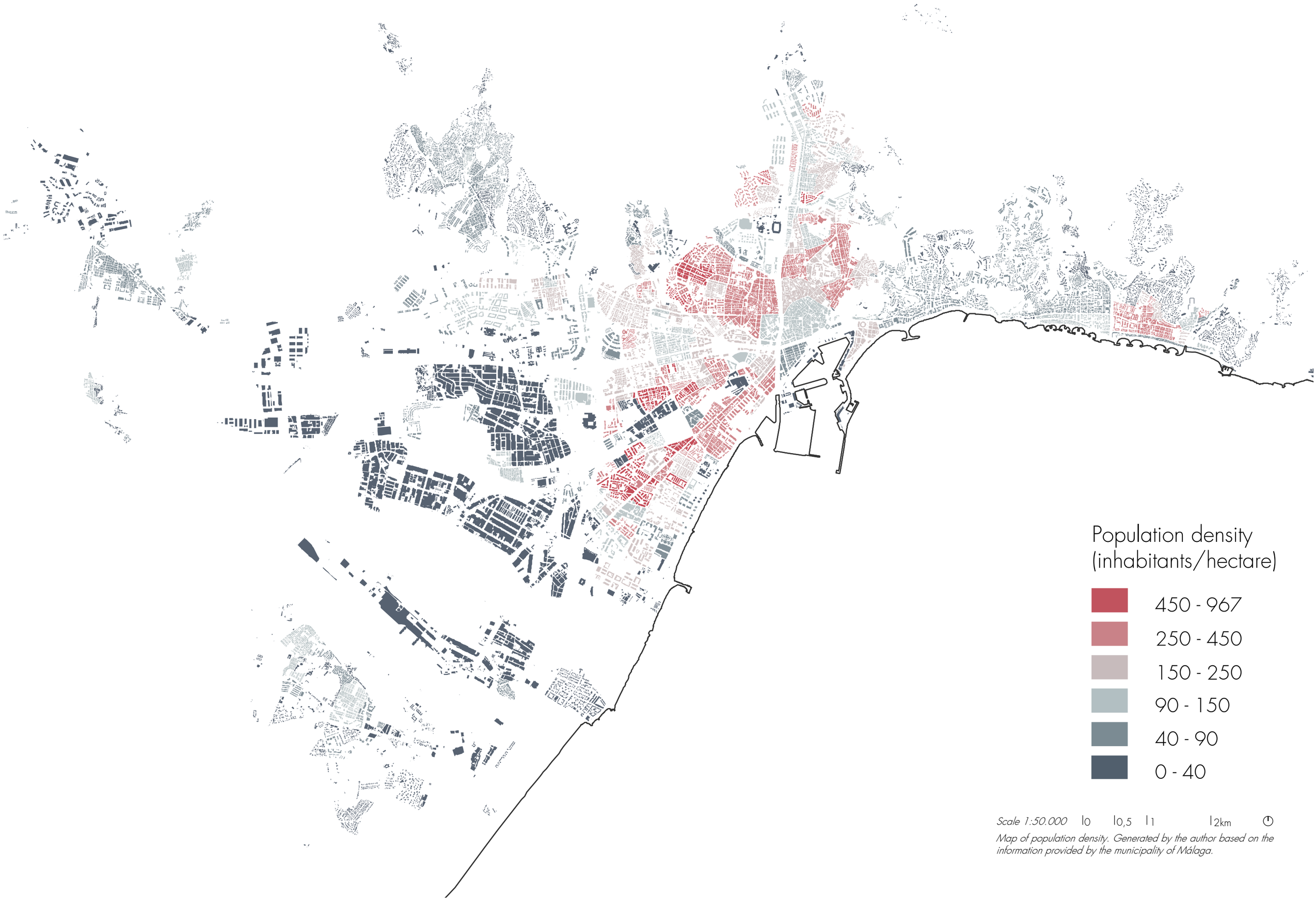
SUSTAINABLE SELF
LIVABLE NET

Balancing sustainability and livability in dense urban environments
through strategies for the mitigation of the UHI effect

MSc Thesis
Francisco Marín Nieto
4516281
29.06.17


MÁLAGA
Cártama
Alhaurín de la Torre
Rincón de la Victoria
Torremolinos
Benalmádena
Mijas
Fuengirola

DENSITY



Map of population density. Generated by the author based on the information provided by the municipality of Málaga.

Voorhof
240,9 inhabitants/hectare

Nuevo San Andrés 1
967,9 inhabitants/hectare

SUSTAINABILITY

LIVABILITY

INDICATORS OF SUSTAINABILITY

Lower capacity to cope with domestic waste

Higher potential for the implementation of innovations, aiming for a more efficient mobility

Lower quality of urban ecosystems

Lower pressure on agricultural and industrial land

Lower consumption of water

Higher per capita consumption of energy for long or leisure travel

Higher social diversity

Higher overal accesibility

Reduced fossil fuel emissions

Lower solar accessibility and potential for passive solar power

Preservation of green open spaces, flora and fauna within plan boundaries

Higher levels of competition over space and other conflicts

Higher energy consumption during construction

Lower energy consumption due to heat losses

Higher potential for green design

More efficient use of resources

Lower capacity of surfaces to absorb rainfall water

Higher social diversity

Higher potential for the introduction of urban agriculture

Higher presence of quality health, education,... services

Higher relative prices for dwellings

Higher levels of social support

Higher attractiveness for businesses, hotels, shopping ares...

Lower sense of community

Higher number of employment opportunities

More efficient use of resources

Higher inequality and segregation

Often, higher housing choice and affordability

Lower per capita consumption of energy for everyday travel

Higher levels of water pollution

Lower levels of social segregation and exclusion

Lower crime rates ("eyes on the street")

INDICATORS OF SUSTAINABILITY AND HIGH LEVELS OF DENSITY

-

Lower capacity to cope with domestic waste

Lower quality of urban ecosystems

Higher per capita consumption of energy for long or leisure travel

Lower solar accessibility and potential for passive solar power

Higher levels of water pollution

Higher energy consumption during construction

Lower capacity of surfaces to absorb rainfall water

Higher relative prices for dwellings

Higher levels of competition over space and other conflicts

Lower sense of community

Higher inequality and segregation

+

Higher number of employment opportunities

Lower pressure on agricultural and industrial land

Reduced fossil fuel emissions

Higher social diversity

Preservation of green open spaces, flora and fauna within plan boundaries

Higher overal accesibility

Lower per capita consumption of energy for everyday travel

Higher potential for the implementation of innovations, aiming for a more efficient mobility

Lower energy consumption due to heat losses

Higher social diversity

Higher potential for the introduction of urban agriculture

Higher potential for green design

Lower consumption of water

More efficient use of resources

More efficient use of resources

Higher presence of quality health, education,… services

Higher attractiveness for businesses, hotels, shopping ares…

Higher levels of social support

Often, higher housing choice and affordability

Lower levels of social segregation and exclusion

Lower crime rates (“eyes on the street”)

INDICATORS OF LIVABILITY

Lower general satisfaction with the neighbourhood

Lower water quality

Higher exposure to unfavourable climate conditions (UHI)

Lower access to green areas

Obstructing views and overshadowing

Higher likeliness of social and spatial constrains on individual behaviour

Lower levels of privacy

Higher levels physoclogical stress

Higher pedestrian congestion

Perceived cramped living environments

Higher levels of noise

Lower availability of public open space

Lower levels of maintenance

Lower availability of open public spaces

Higher likeliness of suffering from cognitive overload

INDICATORS OF LIVABILITY AND HIGH LEVELS OF DENSITY

-

Obstructing views and overshadowing

Higher exposure to unfavourable climate conditions (UHI)

Lower access to green areas

Lower availability of public open space

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Lower levels of privacy

Higher levels physoclogical stress

Higher levels of noise

Lower availability of open public spaces

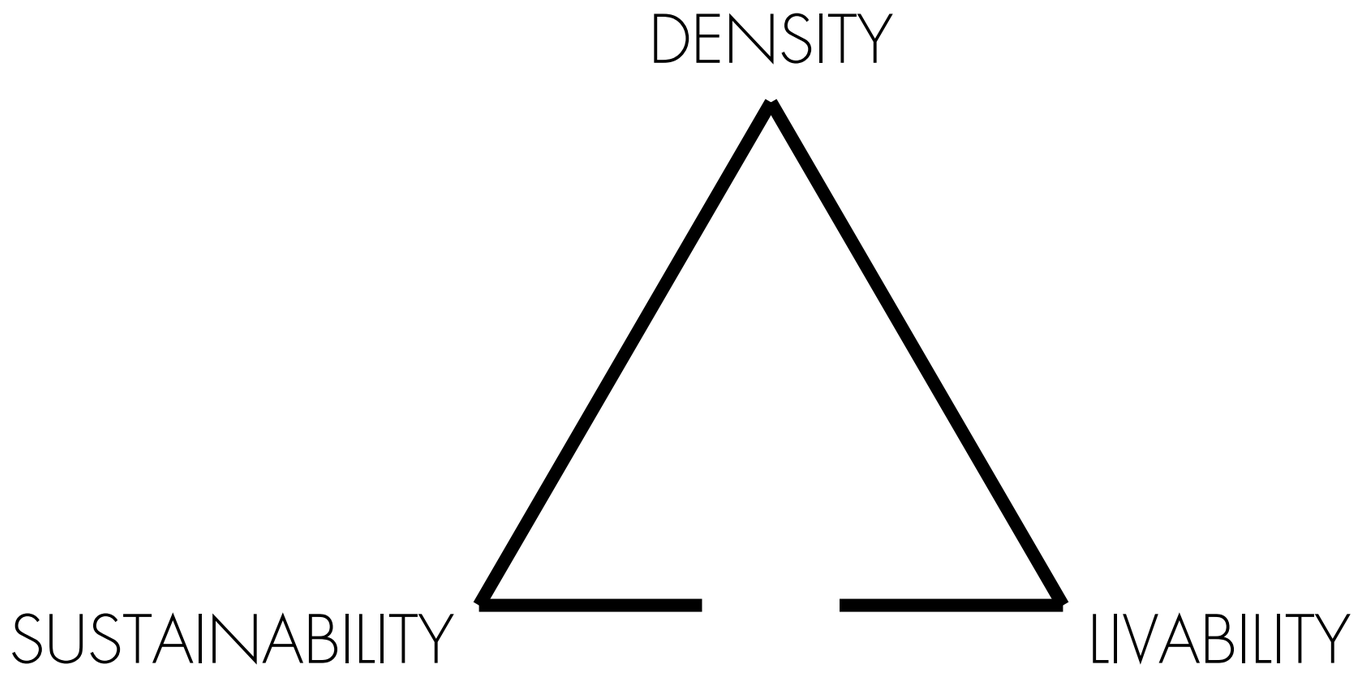
Perceived cramped living environments

Higher pedestrian congestion

Higher likeliness of suffering from cognitive overload

+

There is a discrepancy between sustainability and livability.


DENSITY
SUSTAINABILITY
LIVABILITY

"THE NET" AND "THE SELF"

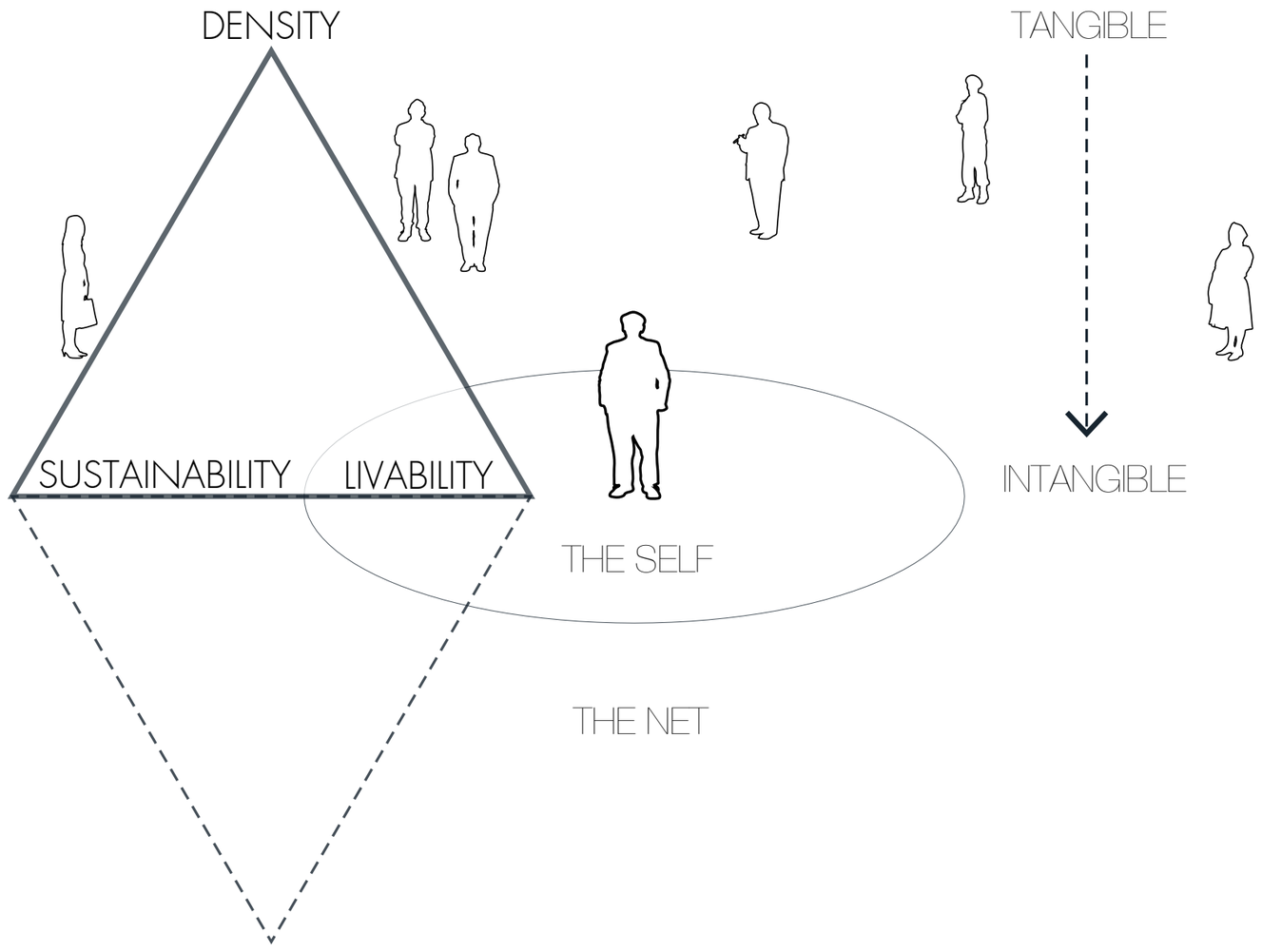
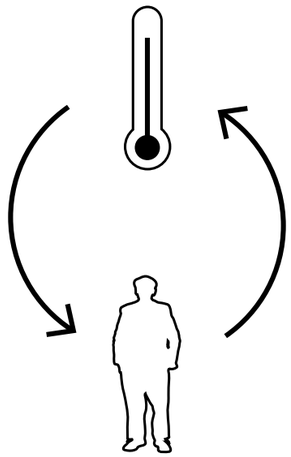


Diagram of the relation between Density, Sustainability and Livability with respect to the "Net/Self" perspective (Castells, 1996). Source: author.

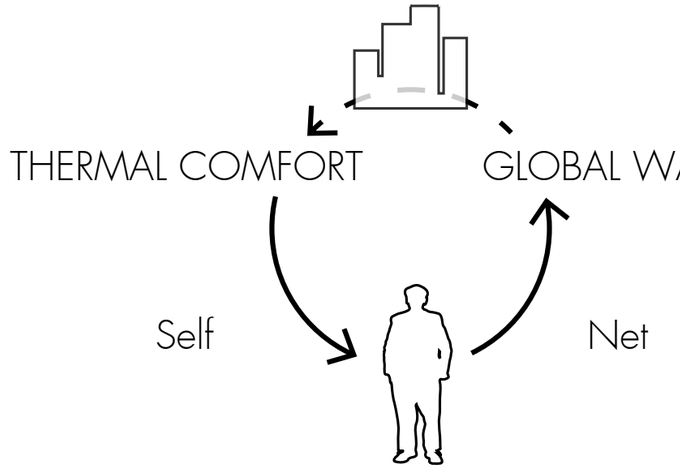
There is a gap in knowledge on the discrepancy between sustainability and livability.

In Málaga, this discrepancy can be aggravated by the particular conditions of its city form.

TEMPERATURE

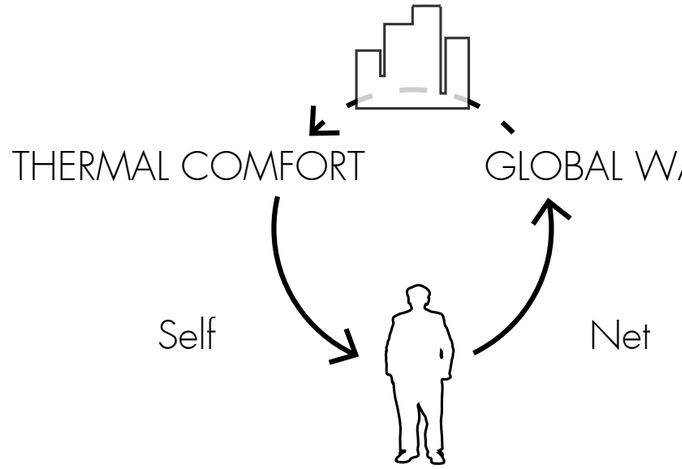


Source: author.



Source: author.

UHI EFFECT



Source: author.

Temperature (ºC)

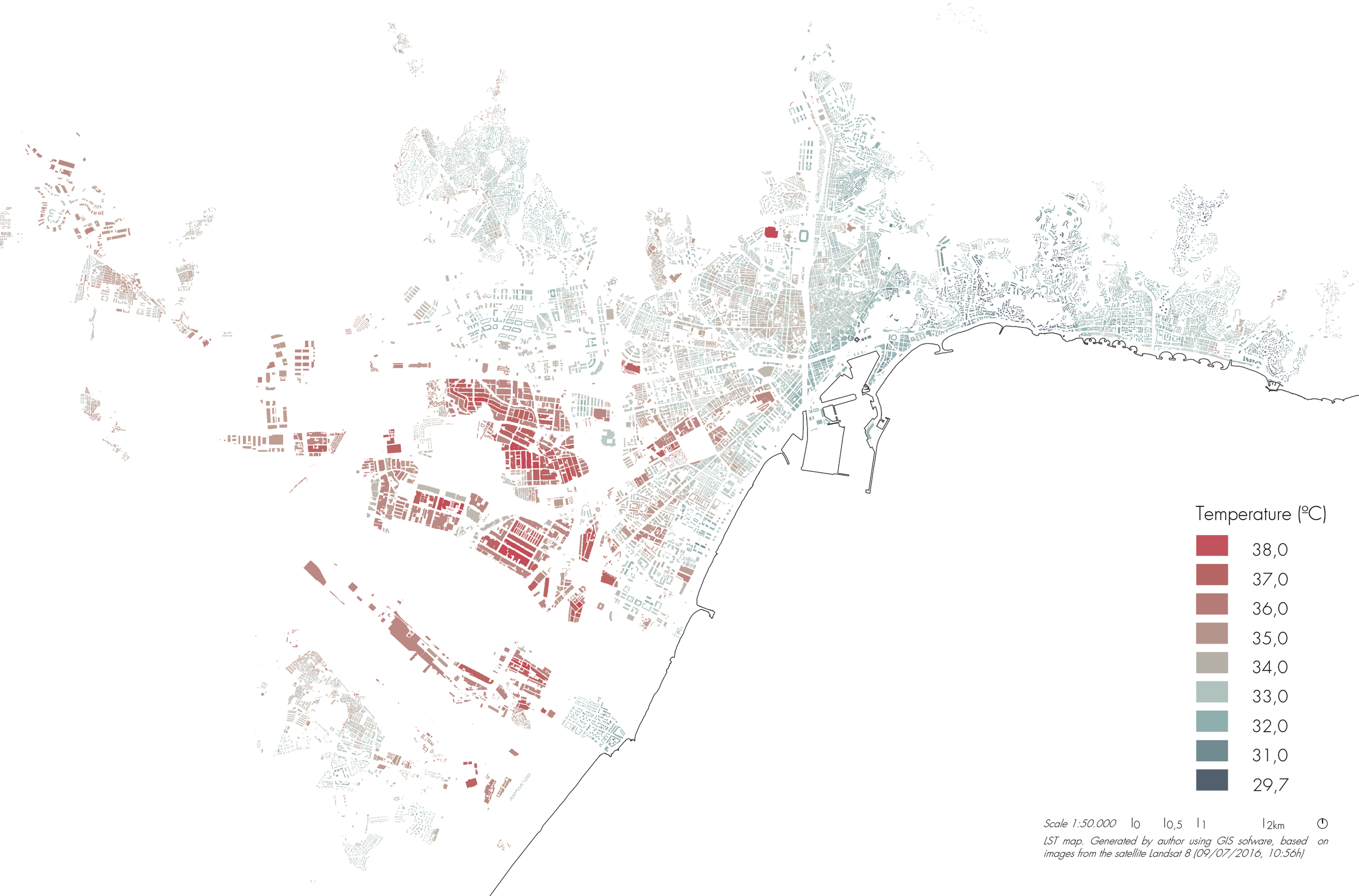
38,0
37,0
36,0
35,0
34,0
33,0
32,0
31,0
29,7

Scale 1:50.000 0 0,5 1 2km

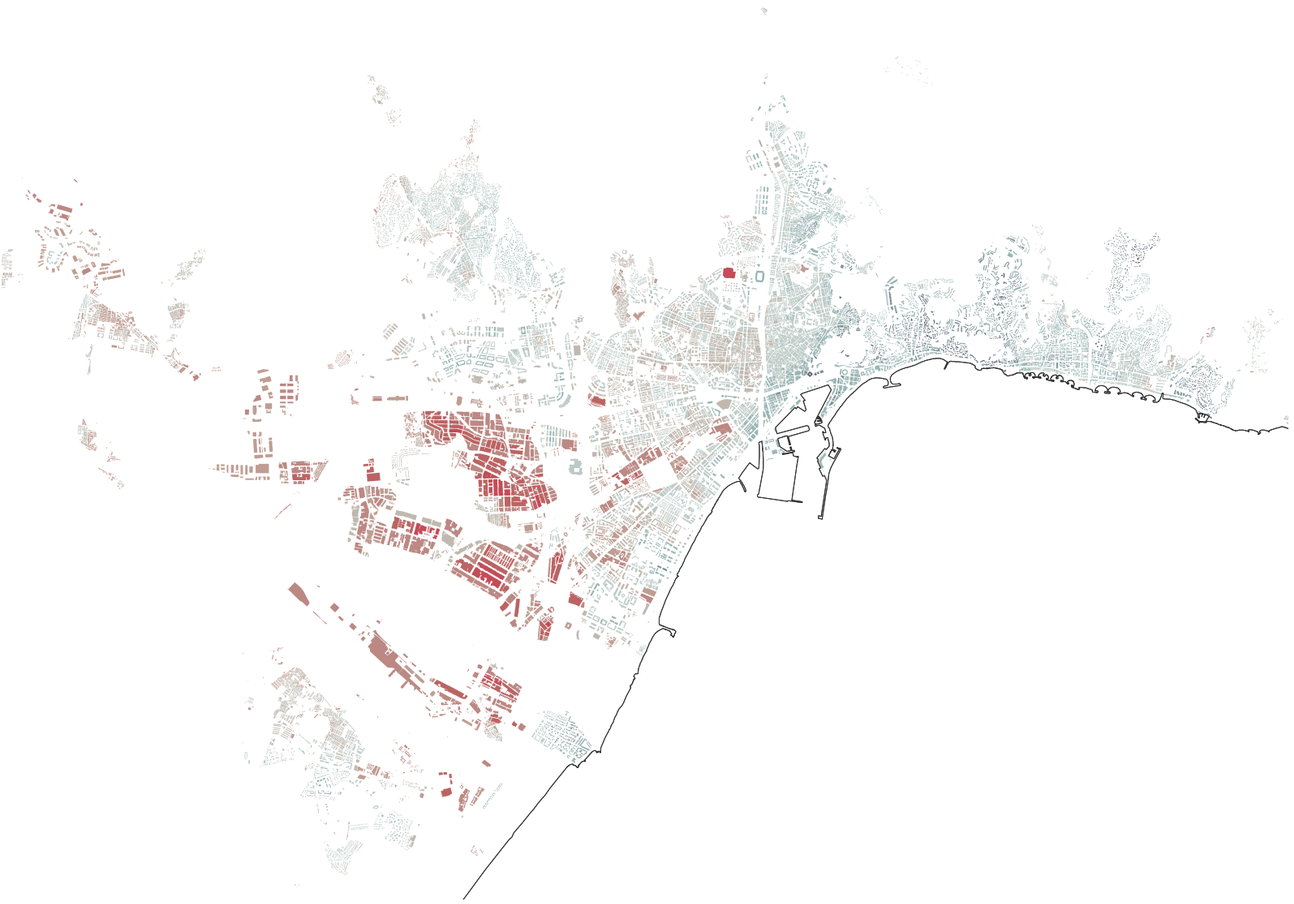
LST map. Generated by author using GIS sofware, based on images from the satellite Landsat 8 (09/07/2016, 10:56h)

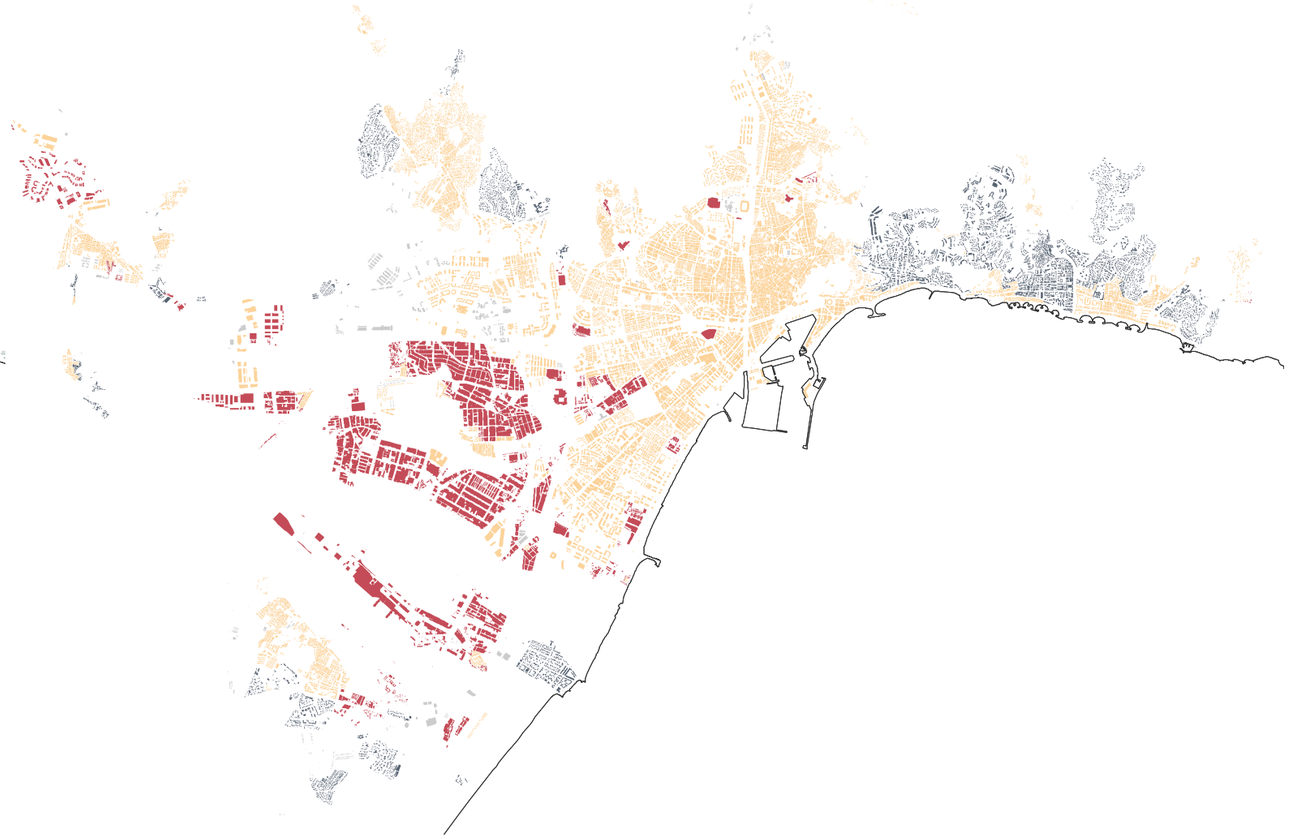
What spatial interventions can be applied in Málaga in order to mitigate the Urban Heat Island effect, as a way to overcome the discrepancy between sustainability and livability that characterizes dense urban environments?

LAND SURFACE TEMPERATURE (LST)



LST map. Generated by author using GIS software, based on images from the satellite Landsat 8 (09/07/2016, 10:56h)





Temperature (ºC)

- 38,0
- 37,0
- 36,0
- 35,0
- 34,0
- 33,0
- 32,0
- 31,0
- 29,7

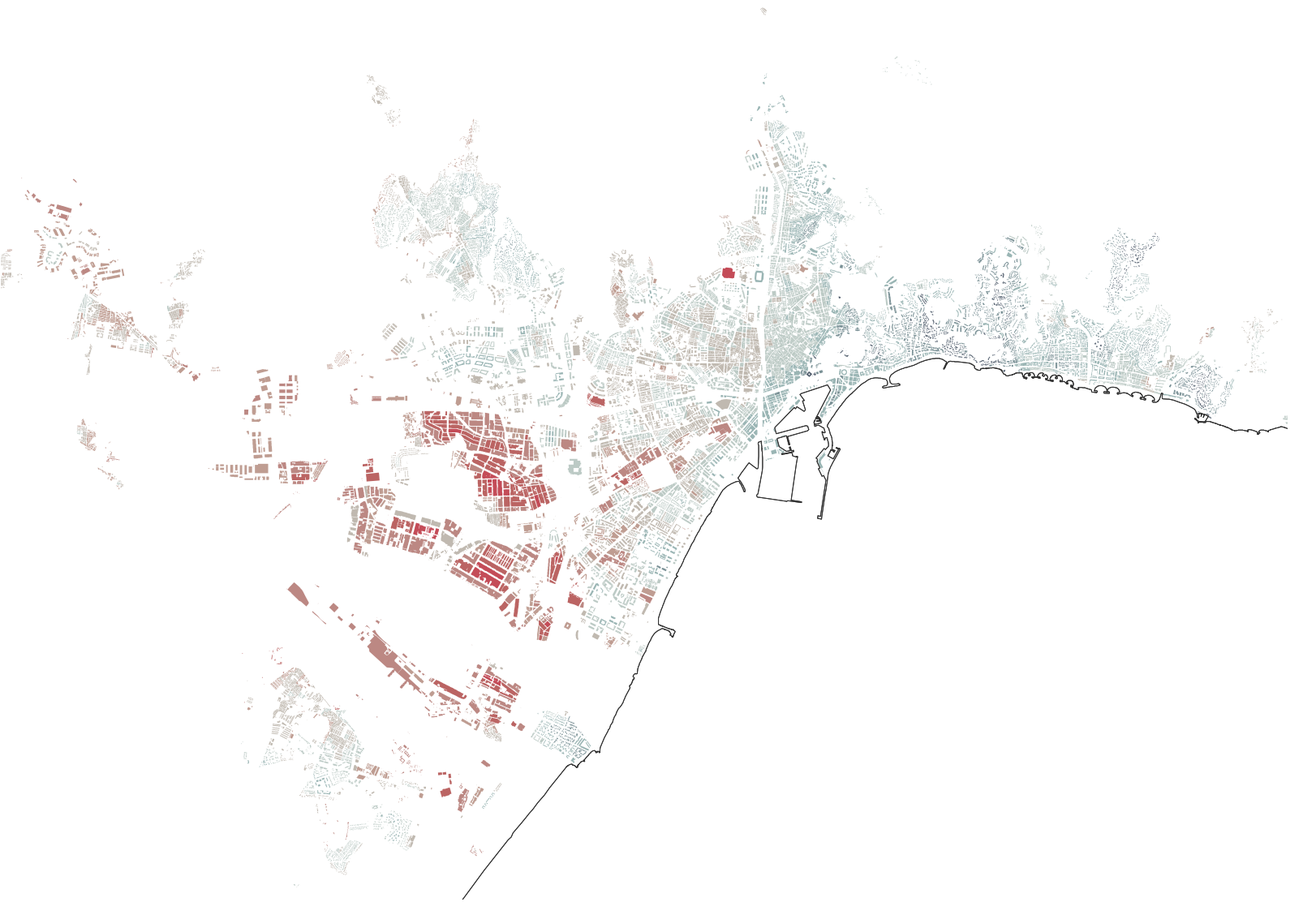
Main land use

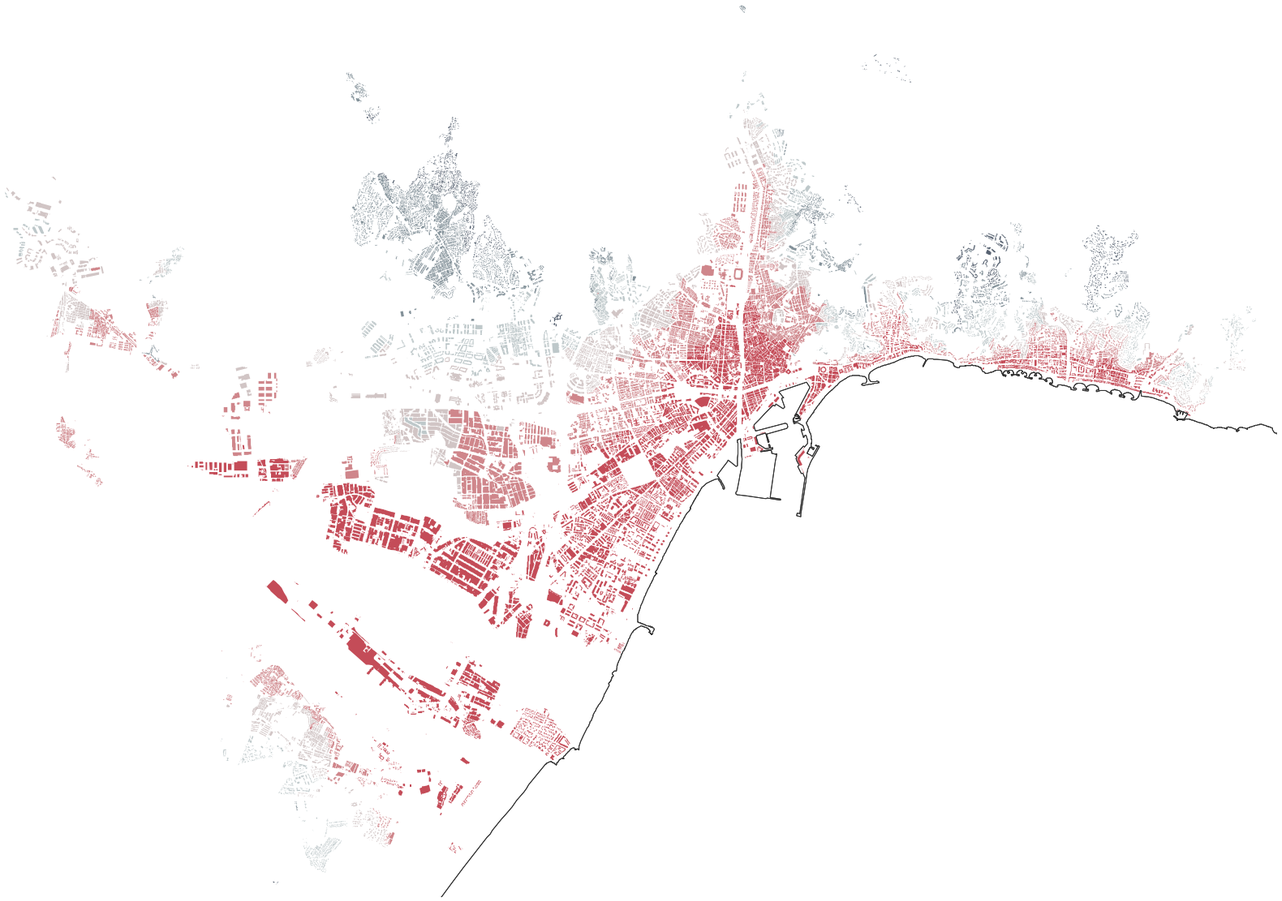
- Industrial
- Residential
- Residential (low density)
- Other

LST AND LAND USE

(Left) LST map. Generated by author using GIS sofware, based on images obtained from the satellite Landsat 8 (09/07/2016, 10:56h). Mean LST of each urban block displayed on the buildings layer.
(Right) Land Use map. Generated by author using GIS sofware, based on the information provided by the Municipality of Málaga on its Open data portal. For this analysis, only residential (low and medium/heigh density) and industrial uses have been considered.

Scale 1:100.000 0 1 2 5km





LST AND ALTITUDE

(Left) LST map. Generated by author using GIS sofware, based on images obtained from the satellite Landsat 8 (09/07/2016, 10:56h). Mean LST of each urban block displayed on the buildings layer.

(Right) Height map. Generated by author using GIS software, based on the Digital Elevation Model (MDT5) provided by the National Geographic Institute (Instituto Geográfico Nacional - IGN). Mean height of the ground within each urban block, represented on the buildings layer.

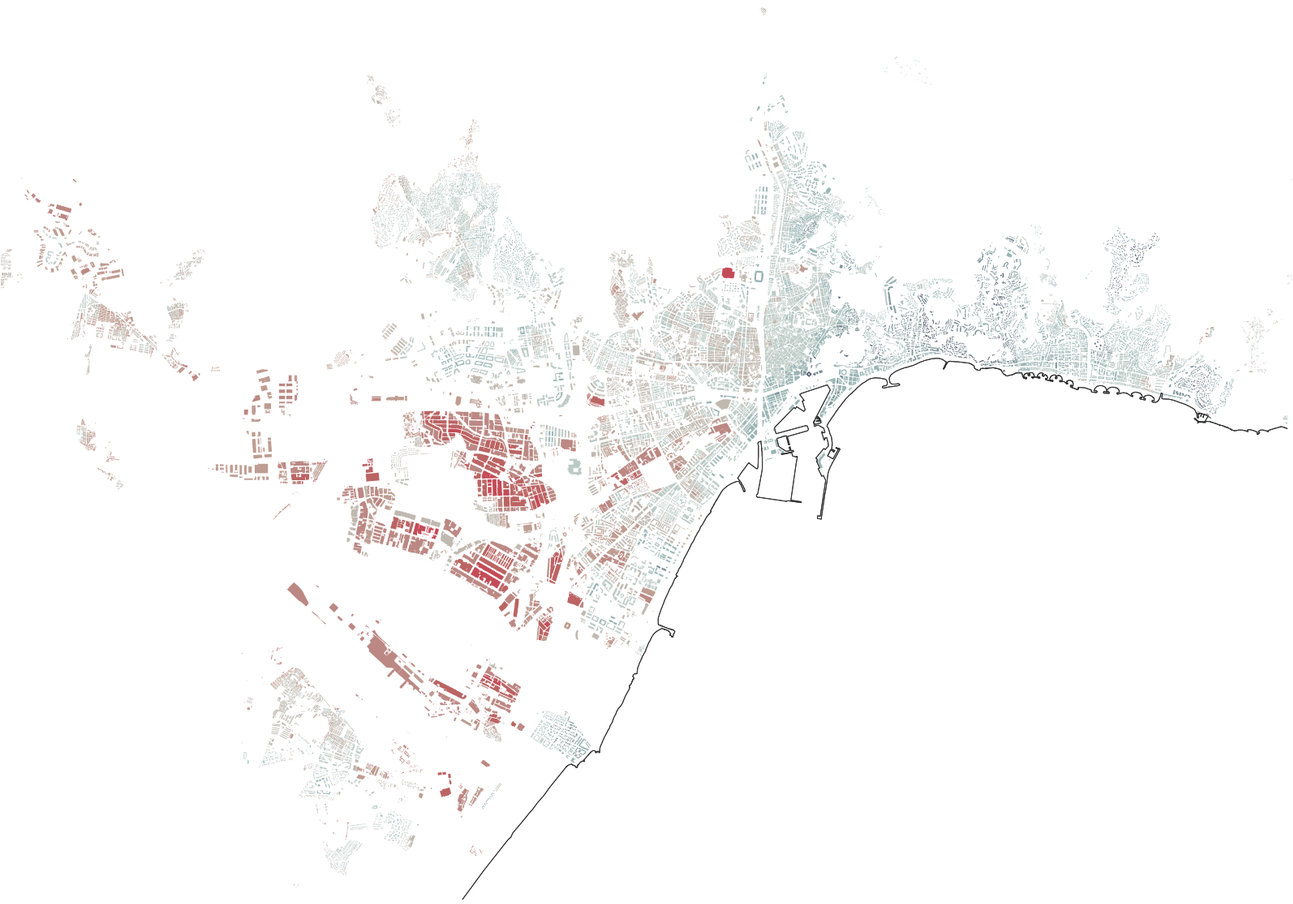
Scale 1:100.000 0 1 2 5km

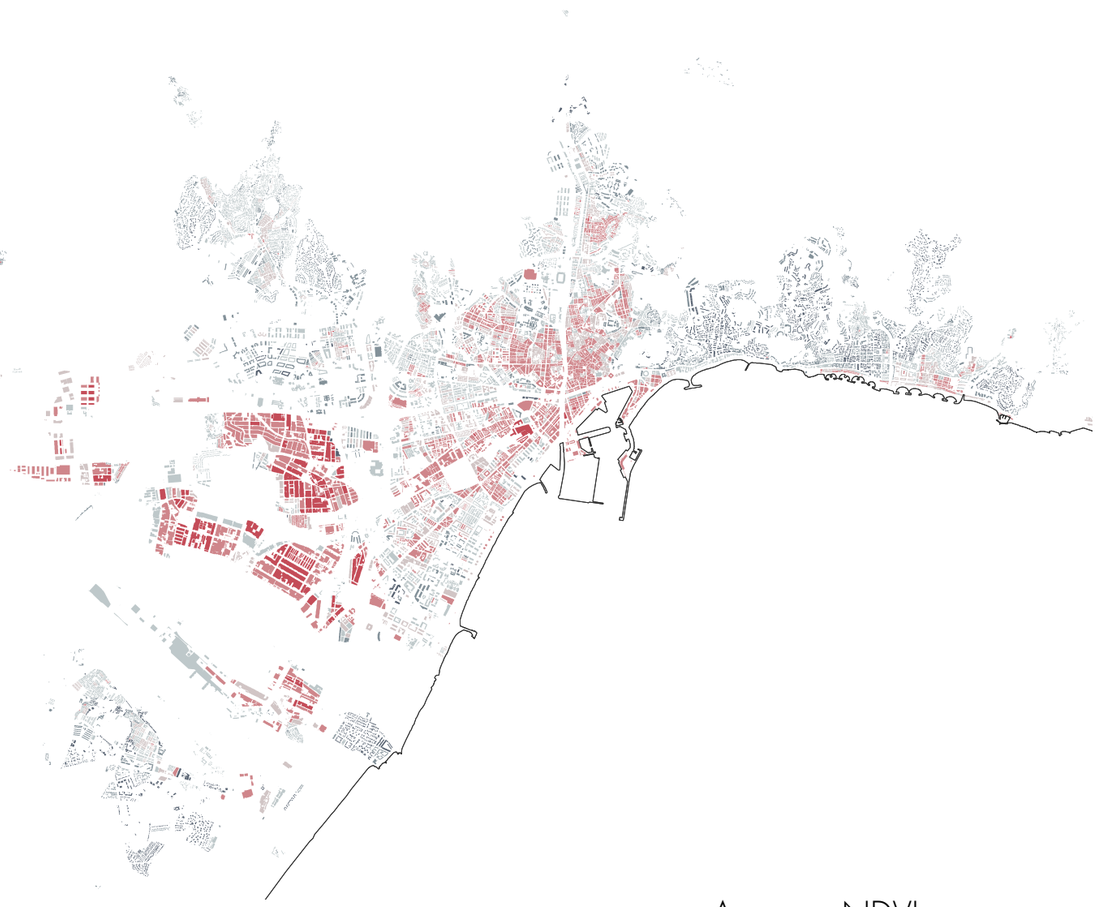
Temperature (ºC)

- 38,0
- 37,0
- 36,0
- 35,0
- 34,0
- 33,0
- 32,0
- 31,0
- 29,7

Height (m)

- 150 - 413
- 90 - 150
- 55 - 90
- 35 - 55
- 15 - 35
- 0 - 15





Temperature (ºC)

- 38,0
- 37,0
- 36,0
- 35,0
- 34,0
- 33,0
- 32,0
- 31,0
- 29,7

Average NDVI

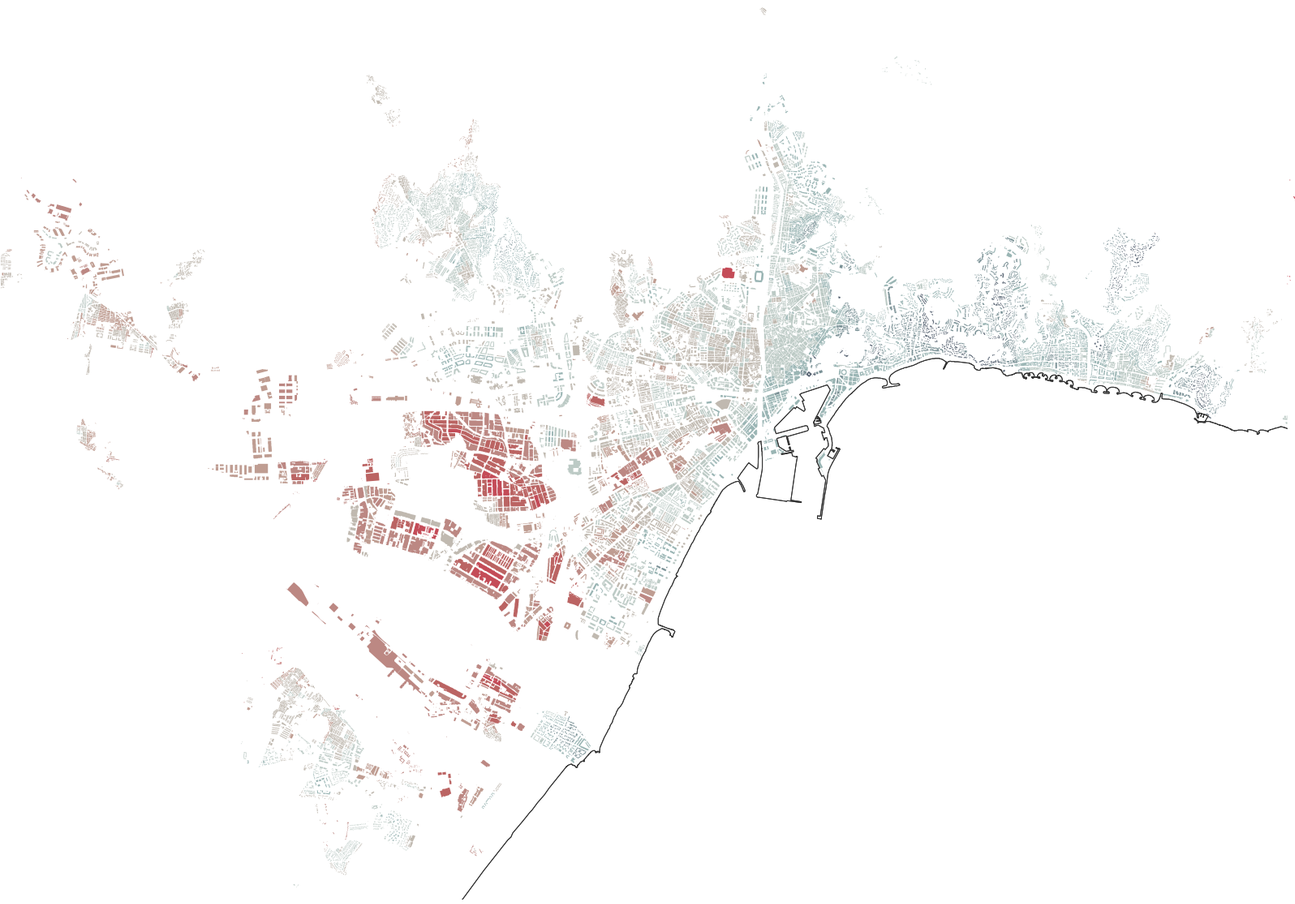
- 0 - 0,045
- 0,045 - 0,080
- 0,080 - 0,100
- 0,100 - 0,140
- 0,140 - 0,180
- 0,180 - 0,320

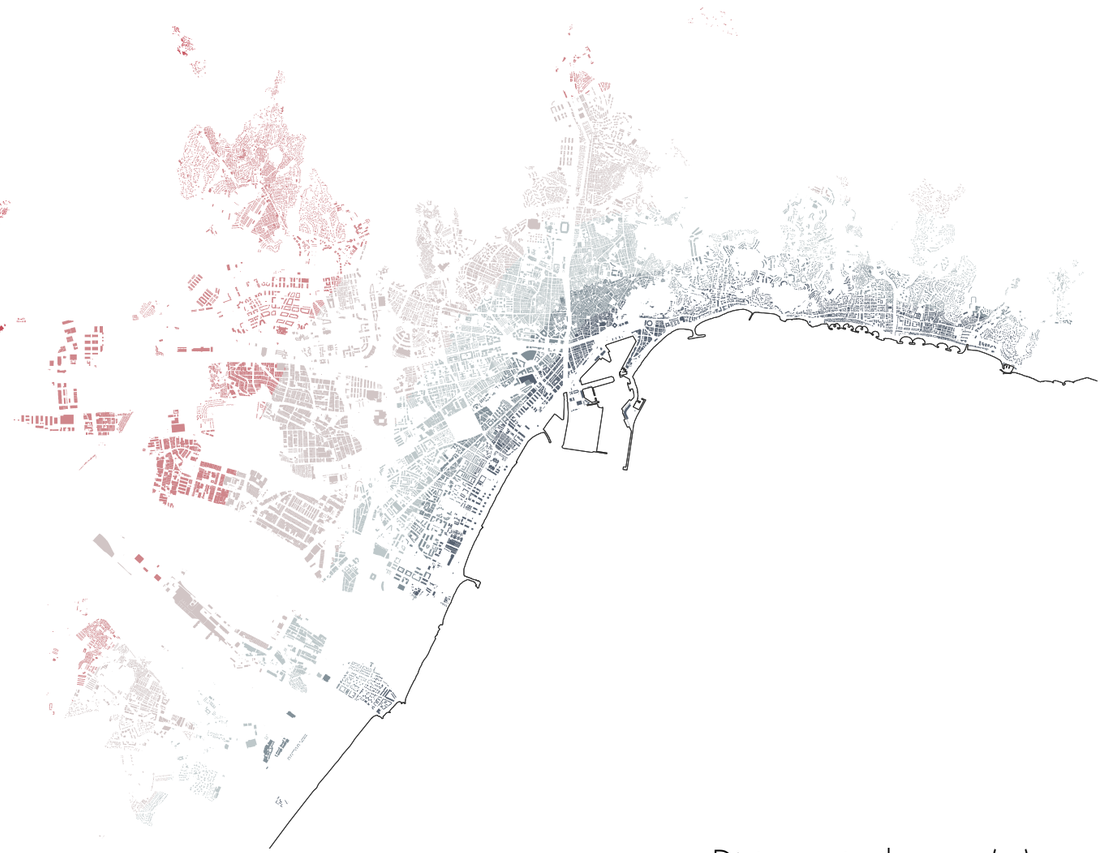
LST AND VEGETATION

(Left) LST map. Generated by author using GIS sofware, based on images obtained from the satellite Landsat 8 (09/07/2016, 10:56h). Mean LST of each urban block displayed on the buildings layer.

(Right) Vegetation index map. Generated by author using GIS software, based on images obtained from the satellite Landsat 8 (09/07/2016, 10:56h). Mean Normalized Difference Vegetation Index (NDVI) of each urban block, represented on the buildings layer.

Scale 1:100.000 0 1 2 5km





Temperature (ºC)

- 38,0
- 37,0
- 36,0
- 35,0
- 34,0
- 33,0
- 32,0
- 31,0
- 29,7

Distance to the sea (m)

- 8000 - 13000
- 4000 - 8000
- 2000 - 4000
- 1000 - 2000
- 500 - 1000
- 0 - 500

LST AND WATER

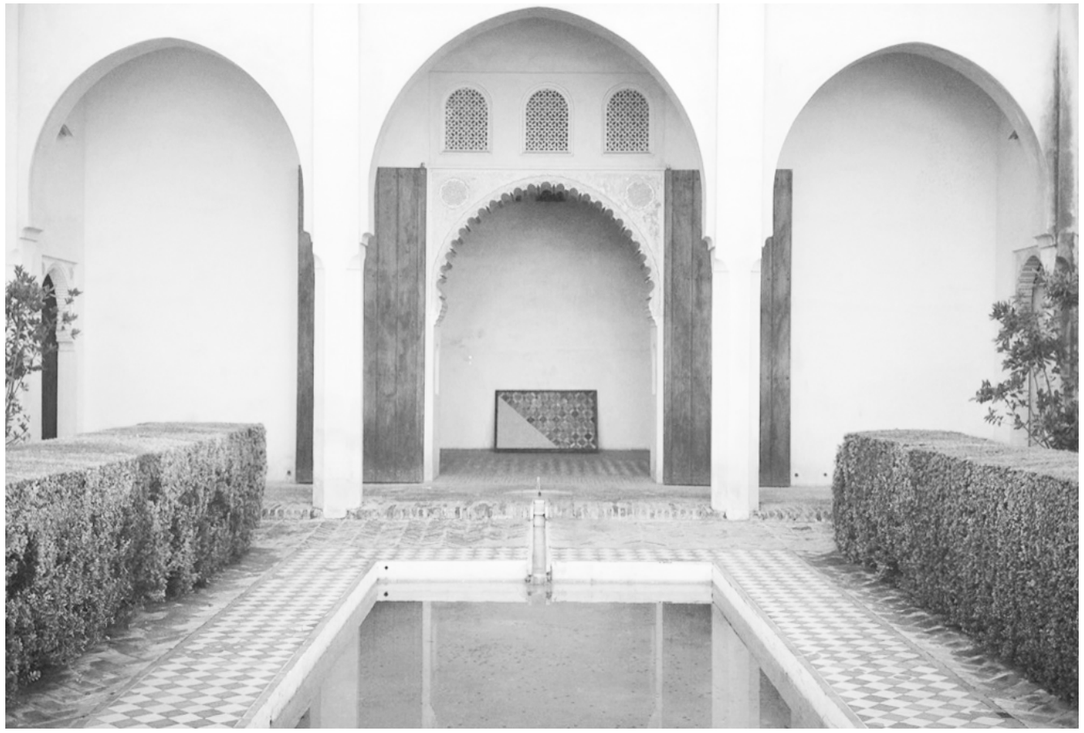
(Left) LST map. Generated by author using GIS sofware, based on images obtained from the satellite Landsat 8 (09/07/2016, 10:56h). Mean LST of each urban block displayed on the buildings layer.

(Right) Vicinity to water map. Generated by author using GIS sofware, based on the information provided by the Municipality of Málaga on its Open data portal. For this analysis, only the Mediterranean Sea has been considered.

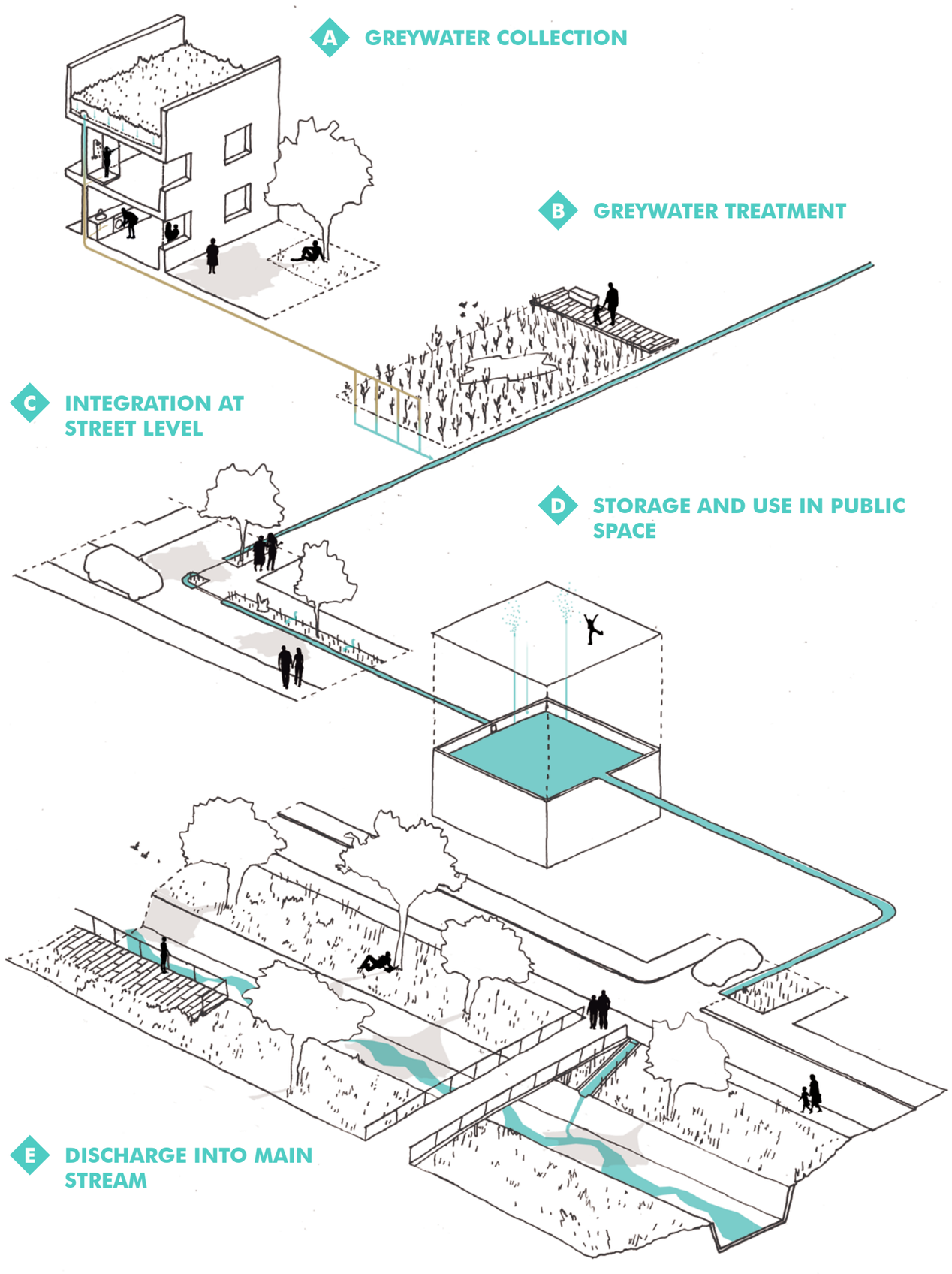
Scale 1:100.000 0 1 2 5km

Some structural features of Málaga and its territory play a big role in determining the city’s temperature.

Any integral approach towards the issue of the UHI effect should take into consideration the intervention at metropolitan scale.



WATER



Elements conforming the metropolitan system, according to their water function. Elaborated by the author.

Fig. 92. Existing stream network and main sewage collectors. Elaborated by the author based on municipal information.

Surface stream/river

Underground stream/river

Main sewage collector

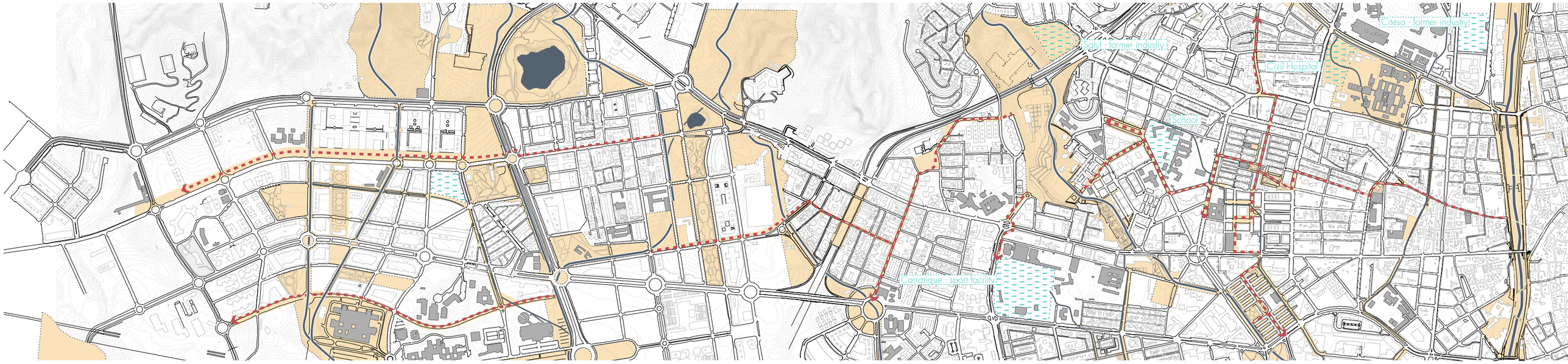
Fig. 93. Catchment delineation and stream network based on the existing topography, calculated using ArcGIS' Hydrology Toolbox. Elaborated by the author.

Generated stream network

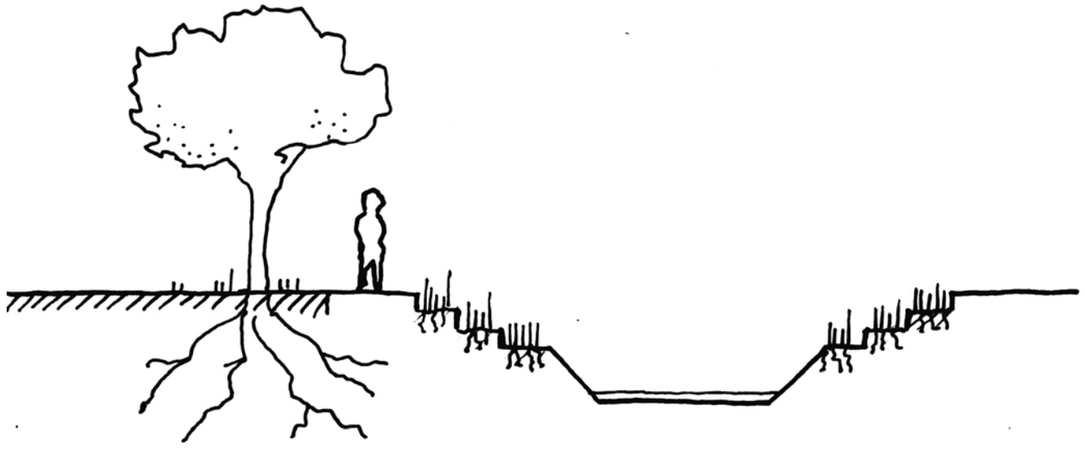
Catchment area

METROPOLITAN SYSTEM

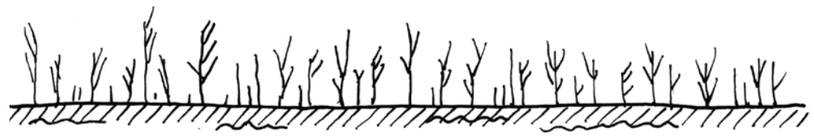
Proposed network of green and blue main corridors. Elaborated by the author.



Main corridors

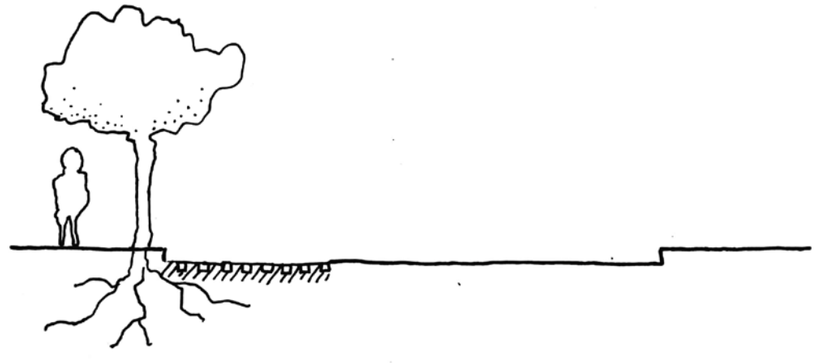


Areas with potential for water treatment



Secondary corridors

Qualified routes



Higher retention and discharge capacity

PCI effect and higher vicinity to green

Biodiversity corridors and facilitation of wind flows

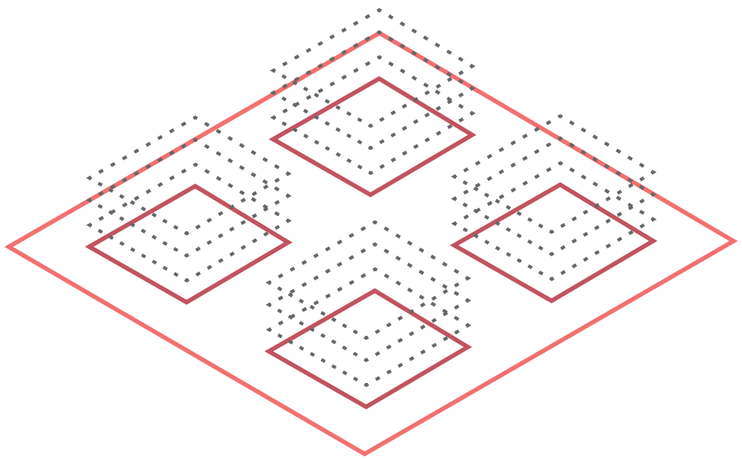
Current street section in Ingeniero De la Torre Acosta street.

Proposed street section in Ingeniero De la Torre Acosta street.

The characteristics of the urban fabric determine the ways in which such a system might be integrated in the city.

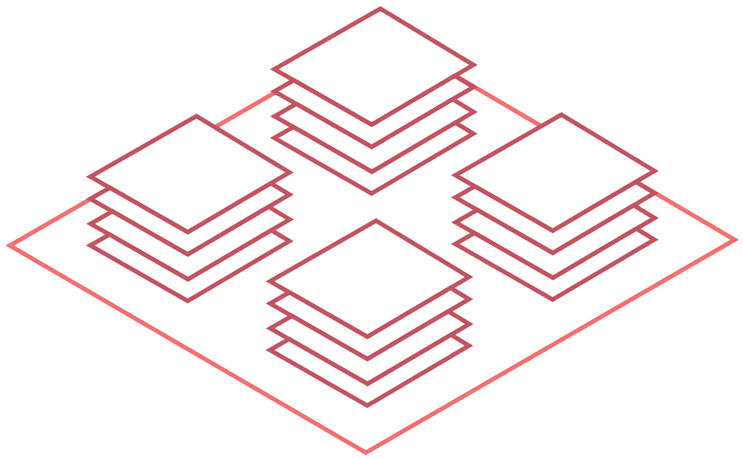
Density is one important factor defining the difference among types of environments.

Measuring density



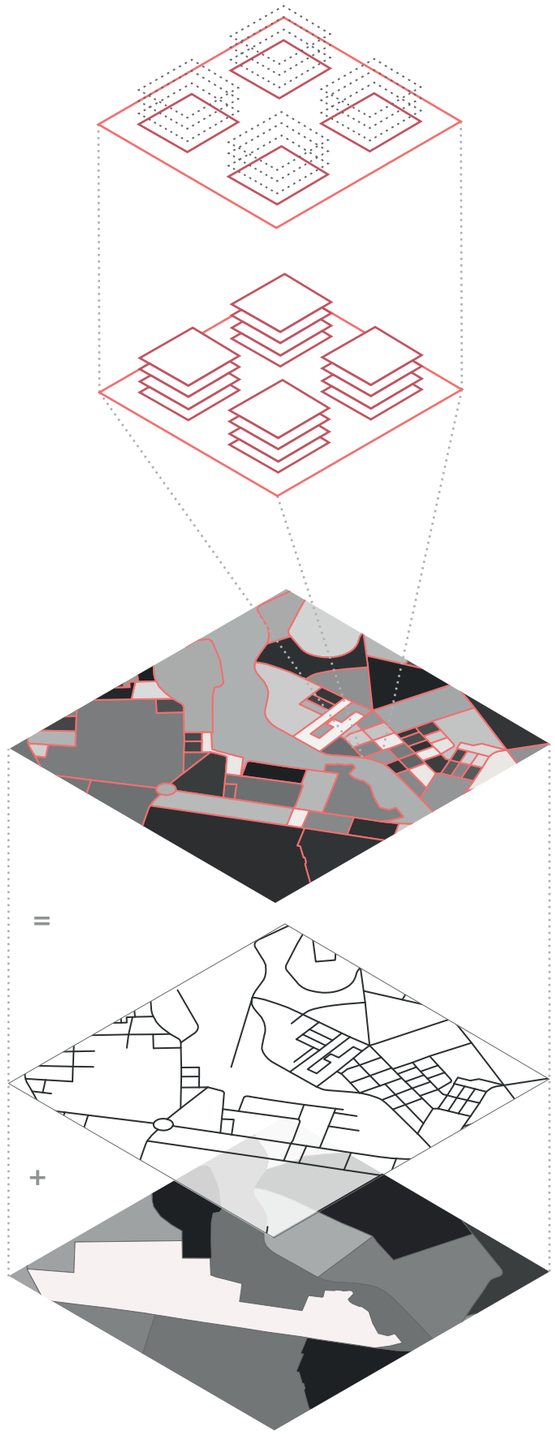
GSI

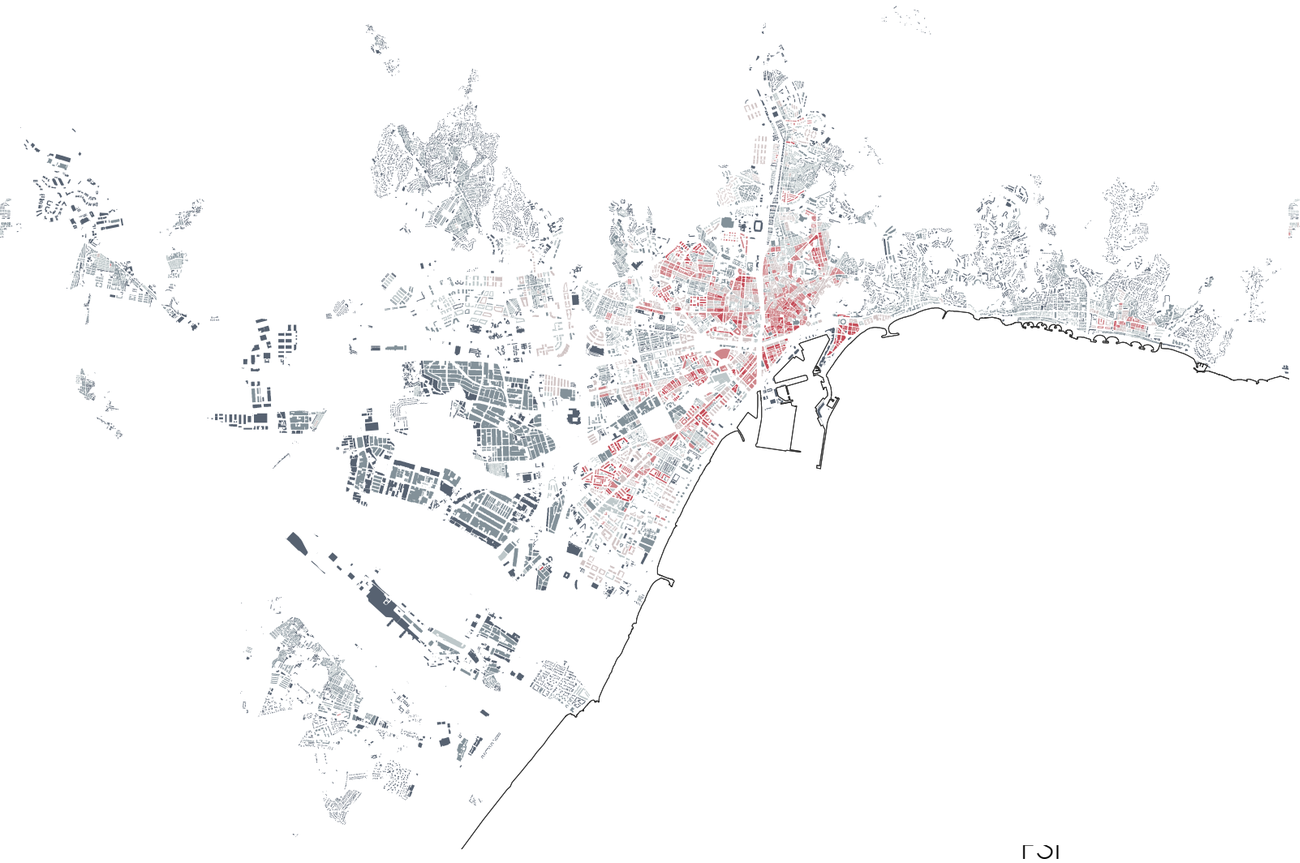
Measuring density



FSI

Measuring density



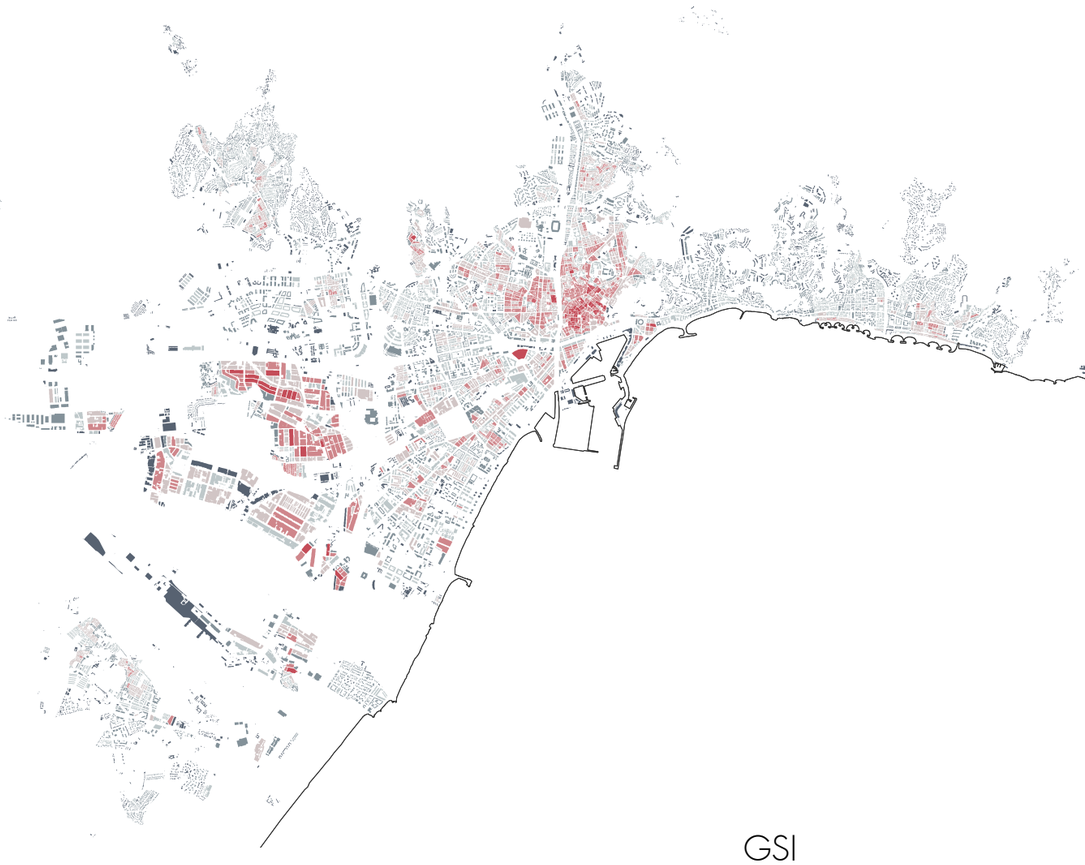


FSI

0,00 - 0,50
0,50 - 1,00
1,00 - 1,50
1,50 - 2,50
2,50 - 3,50
3,50 - 7,52

Scale 1:50.000 0 0,5 1 2km

Floor Space Index (FSI) map of Málaga. Generated by author using GIS sofware, based on the information provided by the Municipality of Málaga and the Online Office of the Land Registry. Information displayed on the buildings layer.



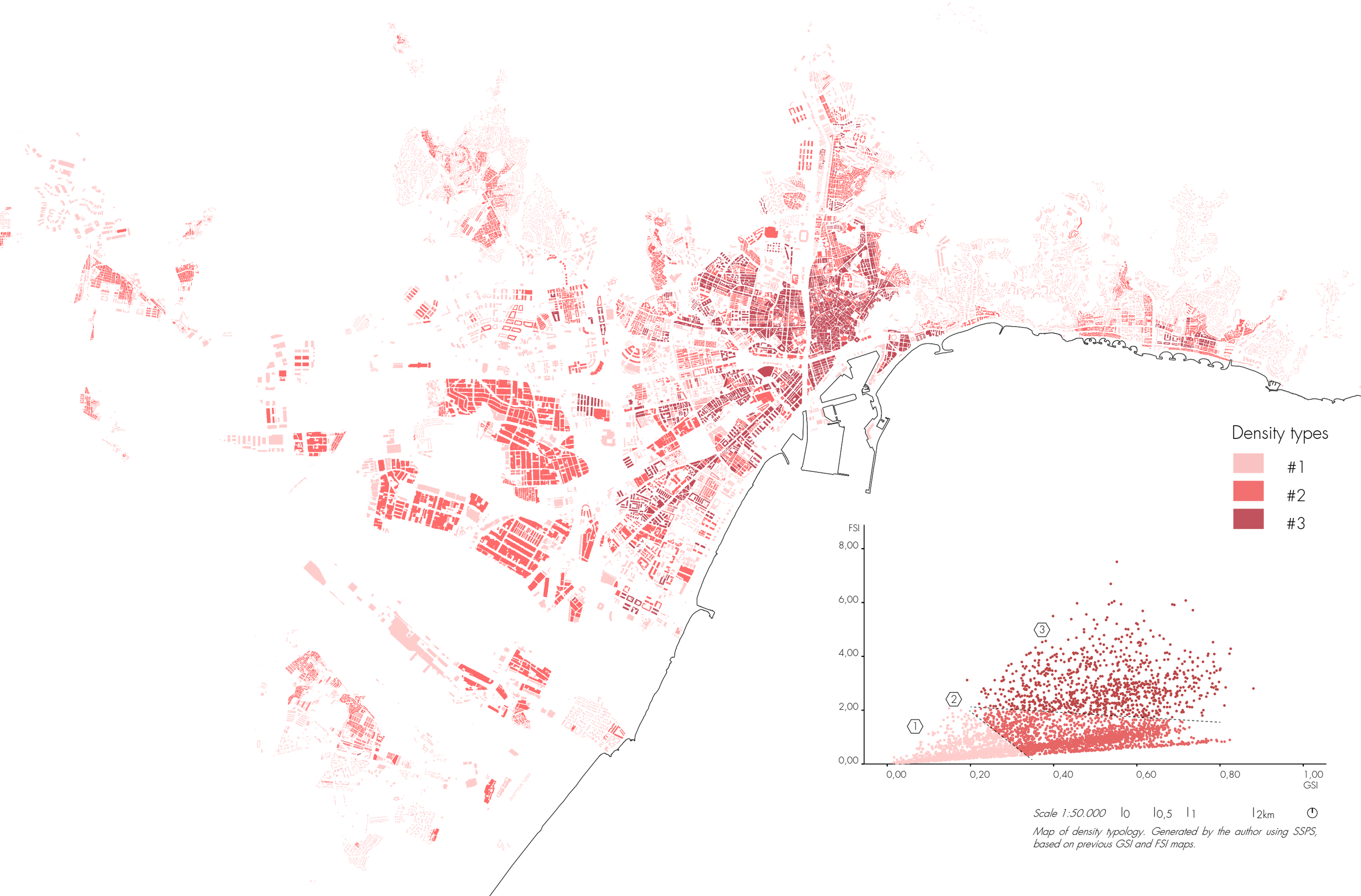
GSI

0,00 - 0,15
0,15 - 0,30
0,30 - 0,45
0,45 - 0,60
0,60 - 0,75
0,75 - 0,90

Scale 1:50.000 0 0,5 1 2km

Ground Space Index (GSI) map of Málaga. Generated by author using GIS sofware, based on the information provided by the Municipality of Málaga and the Online Office of the Land Registry. Information displayed on the buildings layer.

DENSITY TYPOLOGY

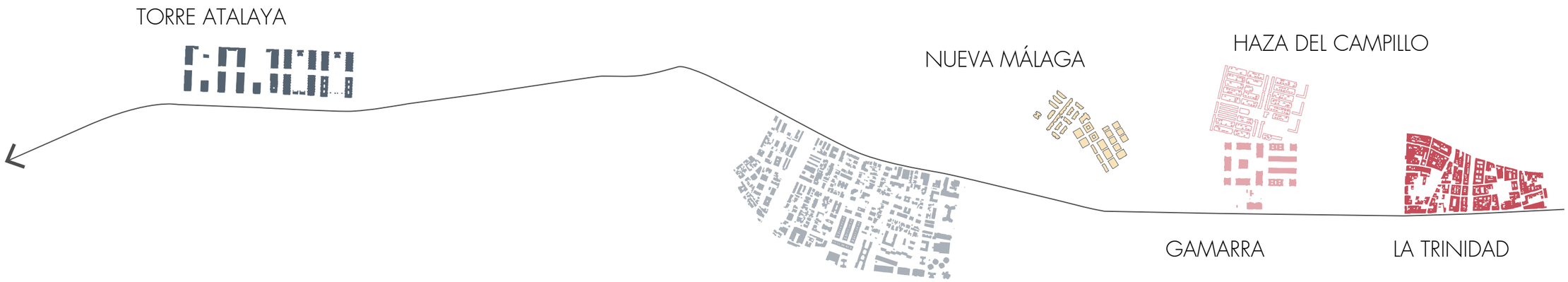


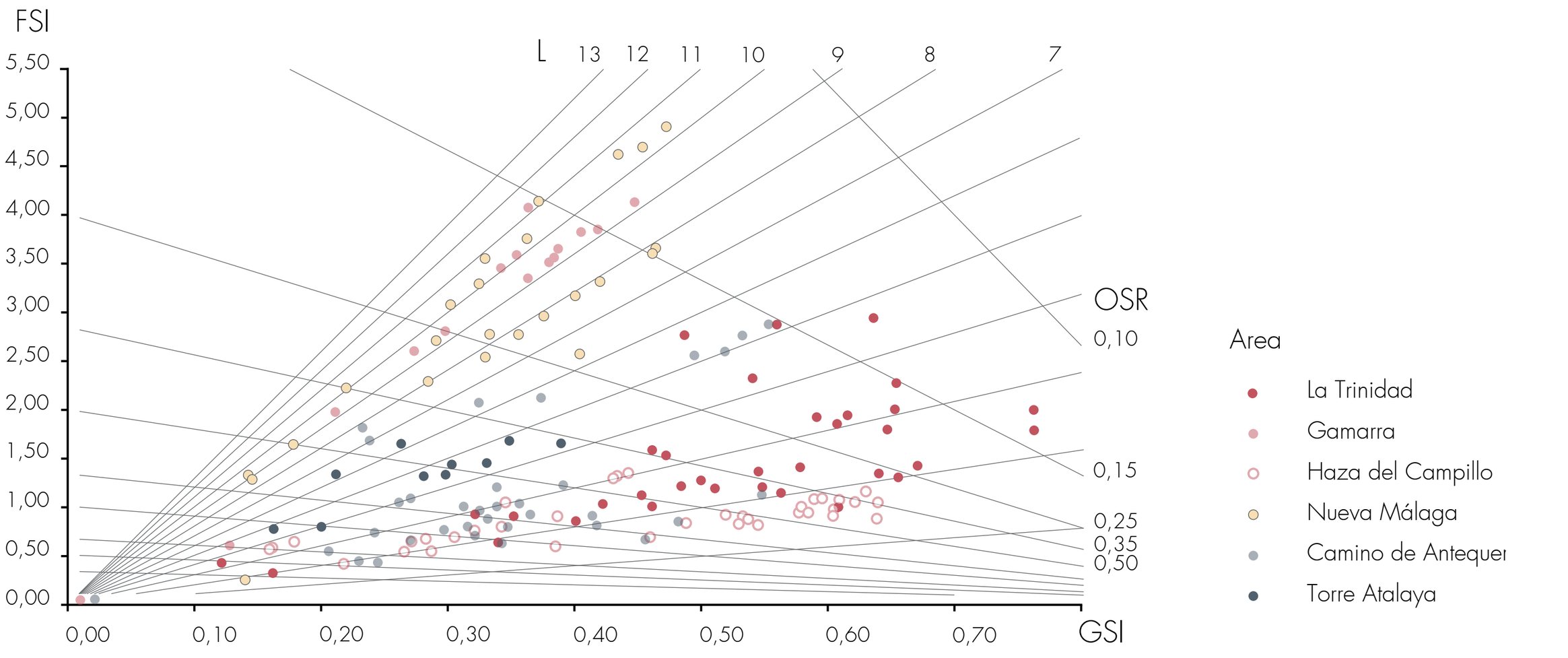
Scale 1:50.000 0 0,5 1 2km

Map of density typology. Generated by the author using SSPS, based on previous GSI and FSI maps.

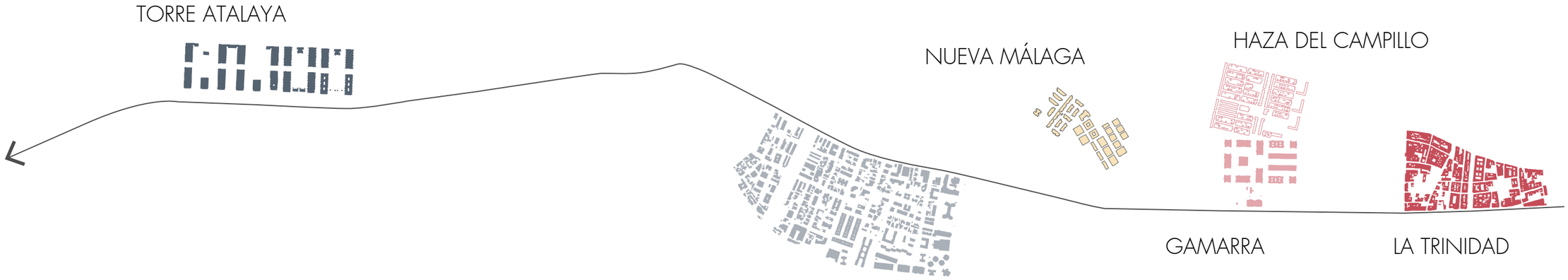
SITE SELECTION

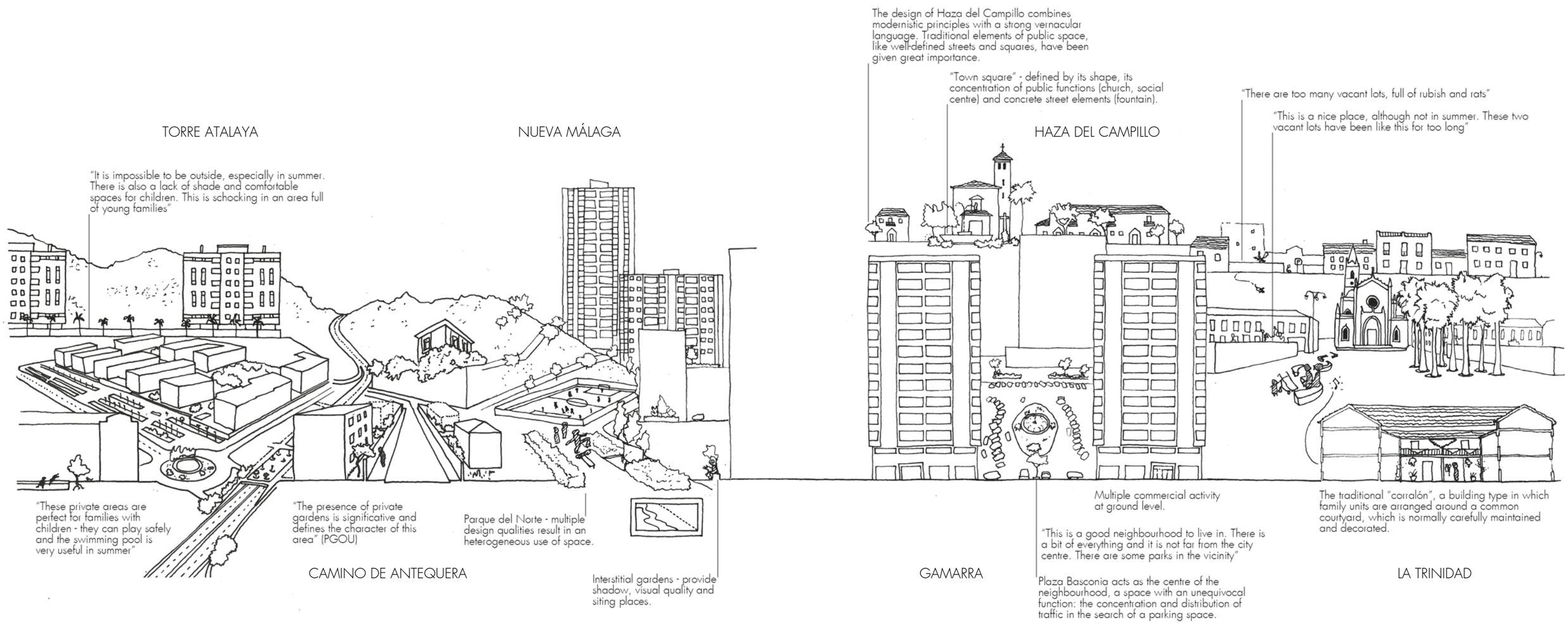
Map of density typology. Generated by the author using SSPS, based on previous GSI and FSI maps.





Spacemate graph of the density values per block. Elaborated by the author.





Perceptive/subjective analysis. Author

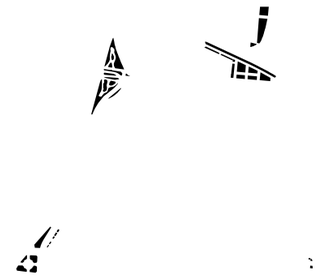
Density typology

LST

Private ground

Unbuilt private space

Accessible green

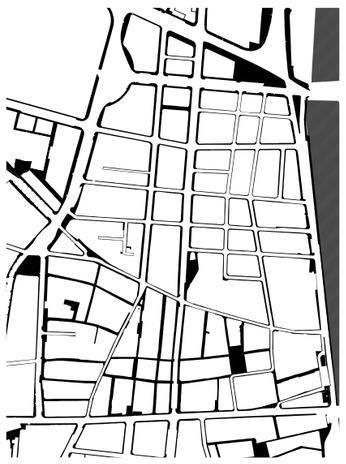


FSI

NDVI

Public ground

Pedestrian space



Not-accessible green

GSI

Albedo

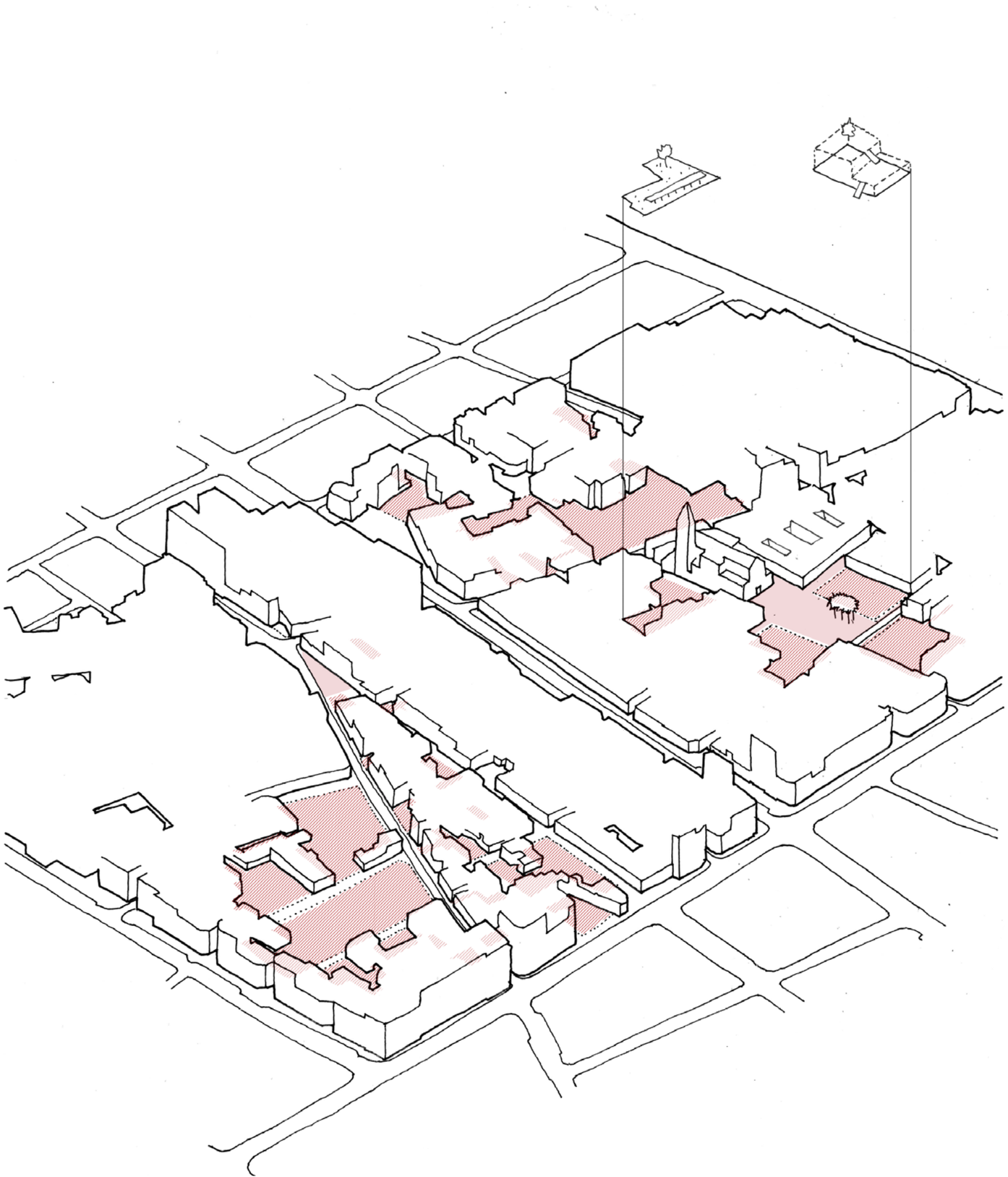
Built area

Traffic space

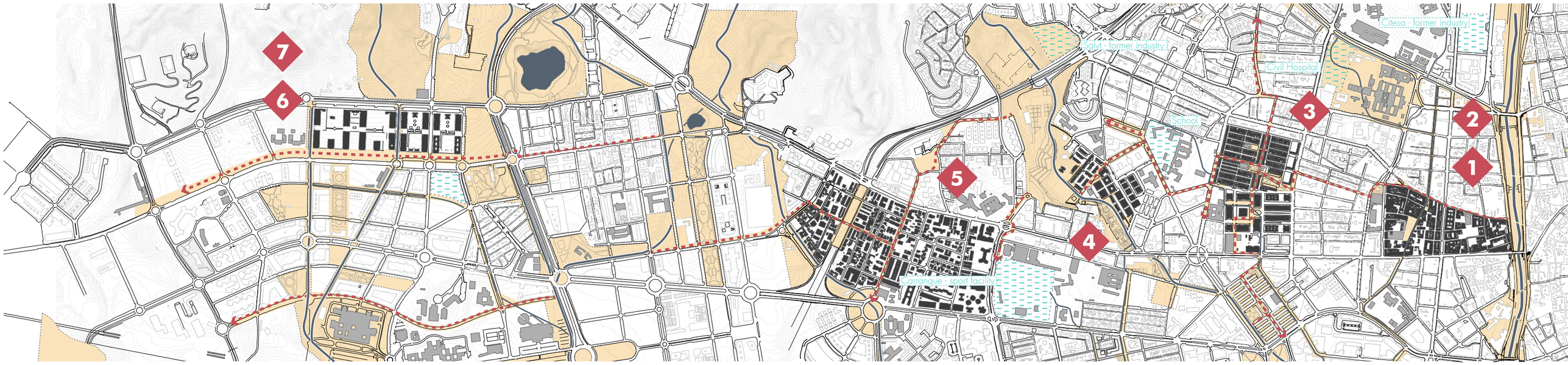
Scale 1:10.000 0 50 200m

Characterization and quantification of surfaces in La Trinidad. Elaborated by the author.

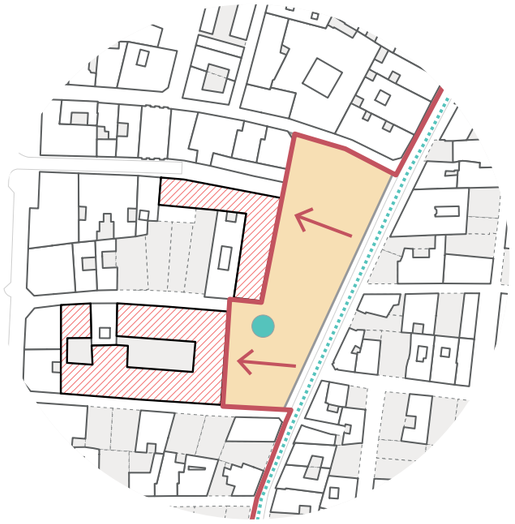
IDENTIFICATION OF POTENTIALS

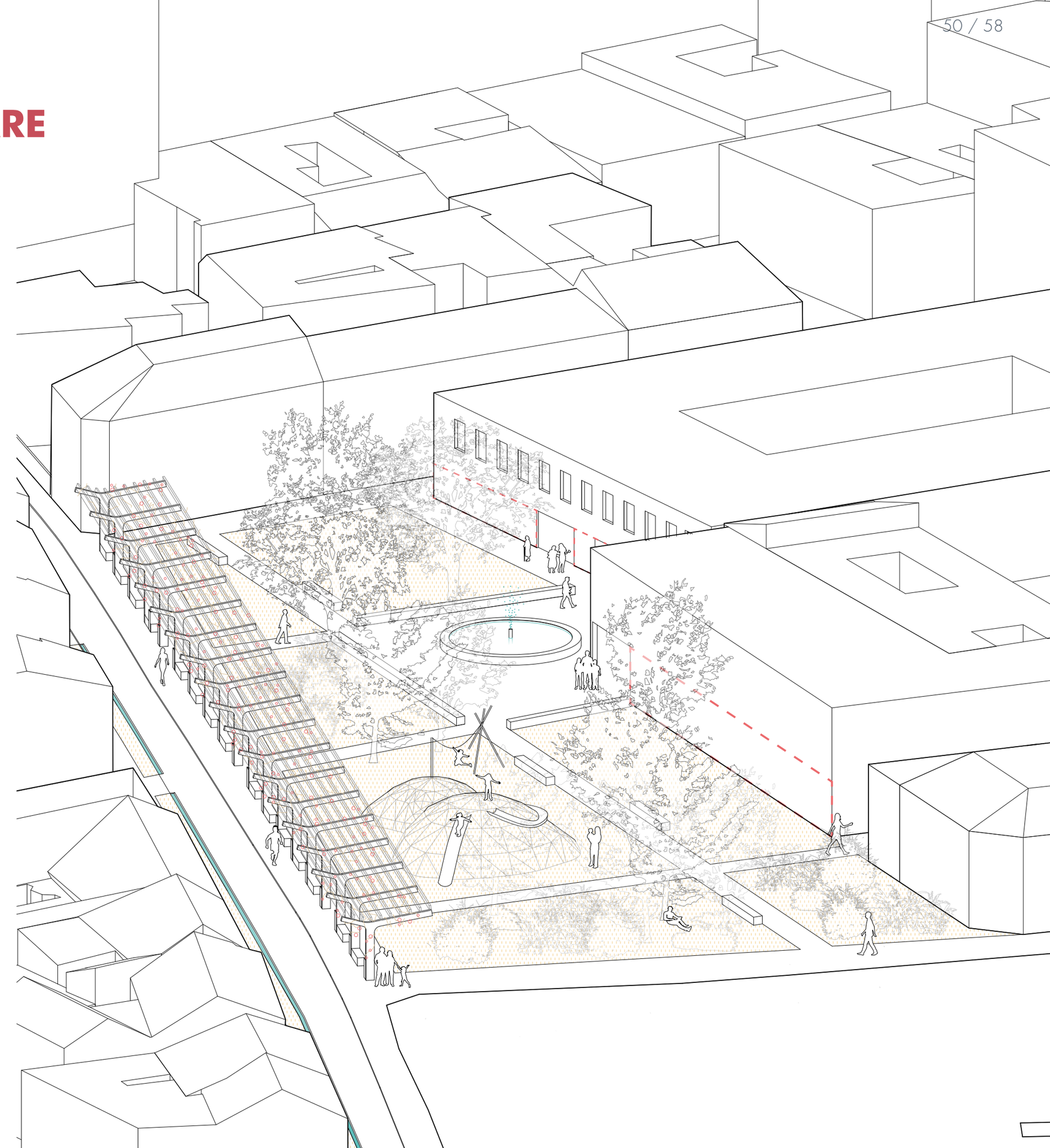


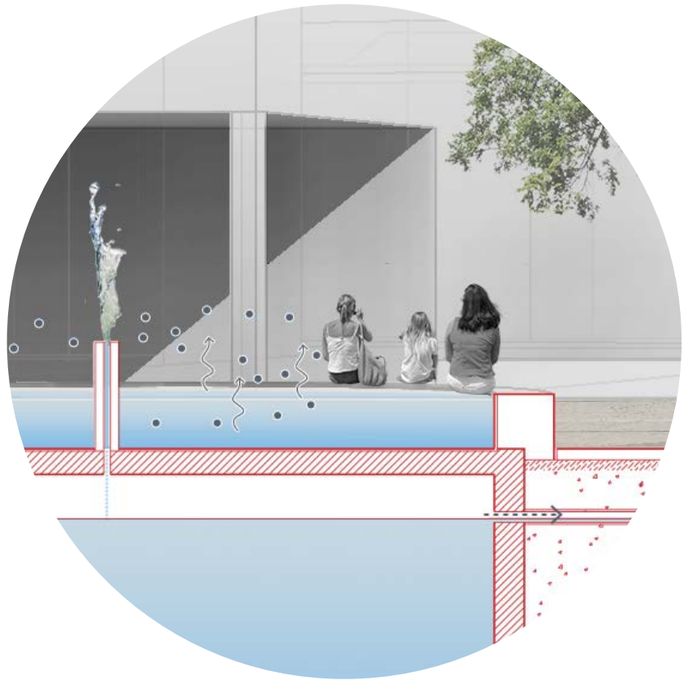
La Trinidad's map of potentials.

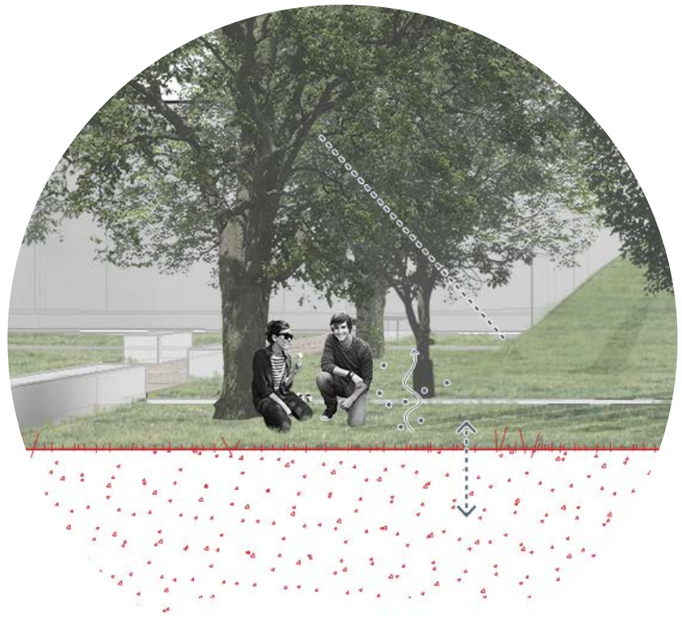

7
6
5
4
3
2
1
Citesa : former industry
Calvi : former industry
Civil Hospital
School
Carrangue : sport facility

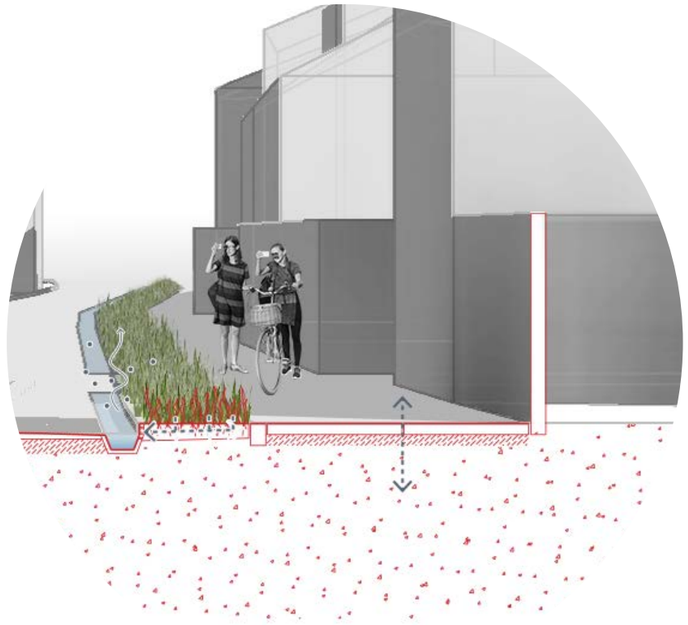
1 A SUMMER SQUARE



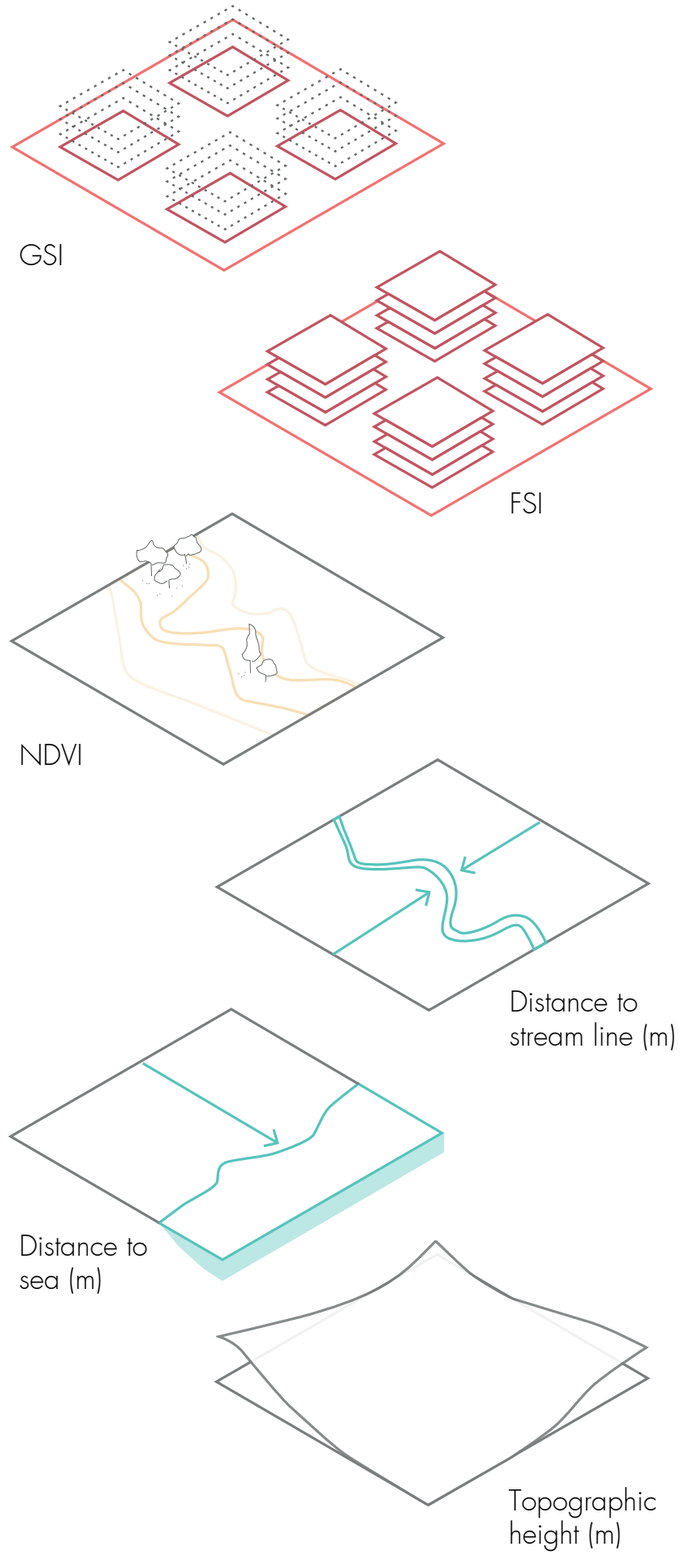




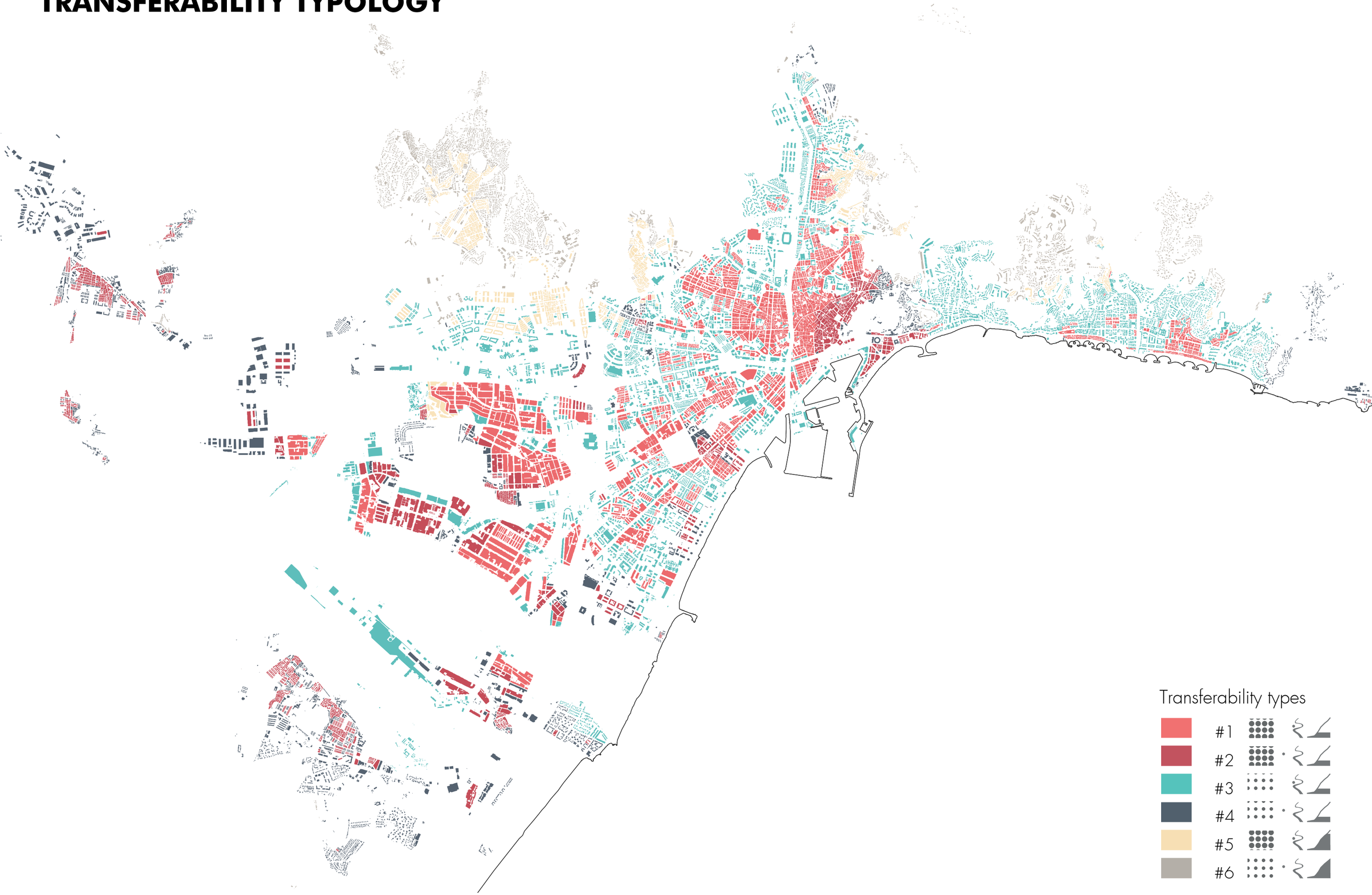


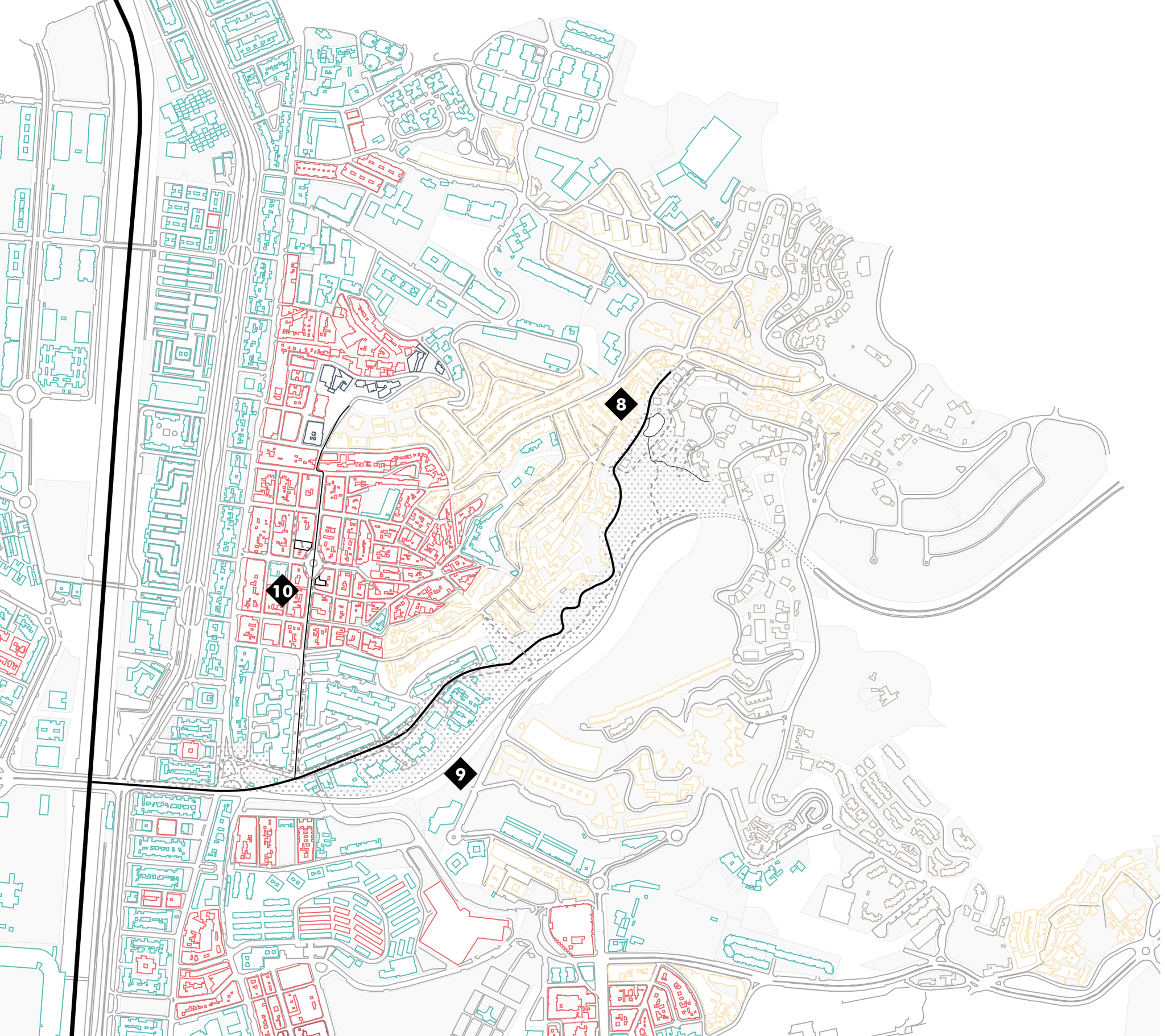


TRANSFERABILITY



TRANSFERABILITY TYPOLOGY




8
9
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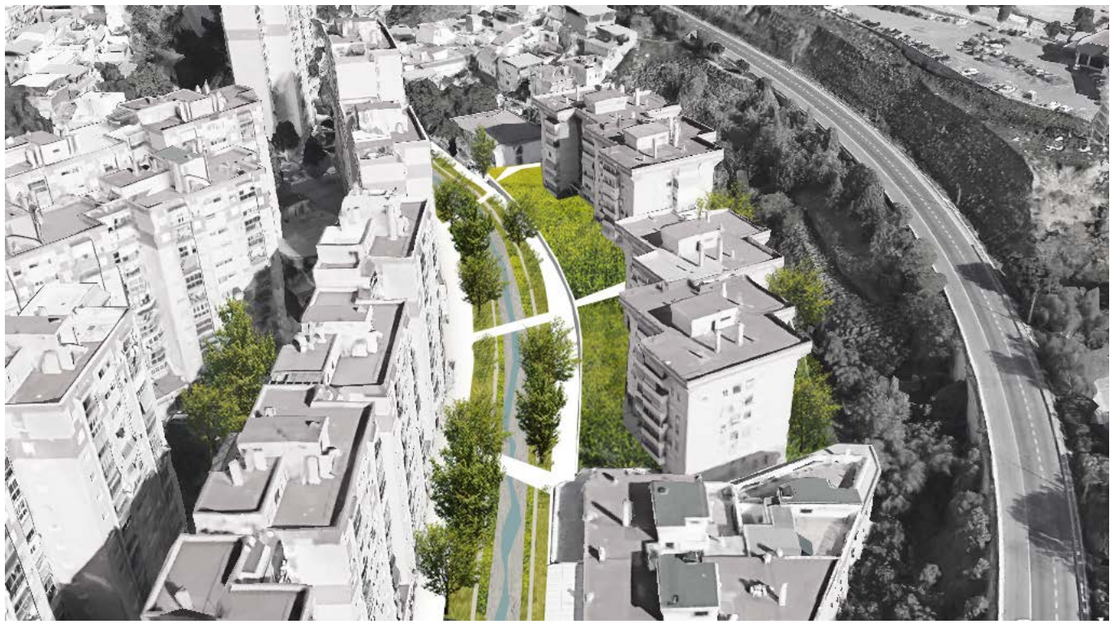
Transferability types
#1
#2
#3
#4
#5
#6

8

9



10

REFLECTION