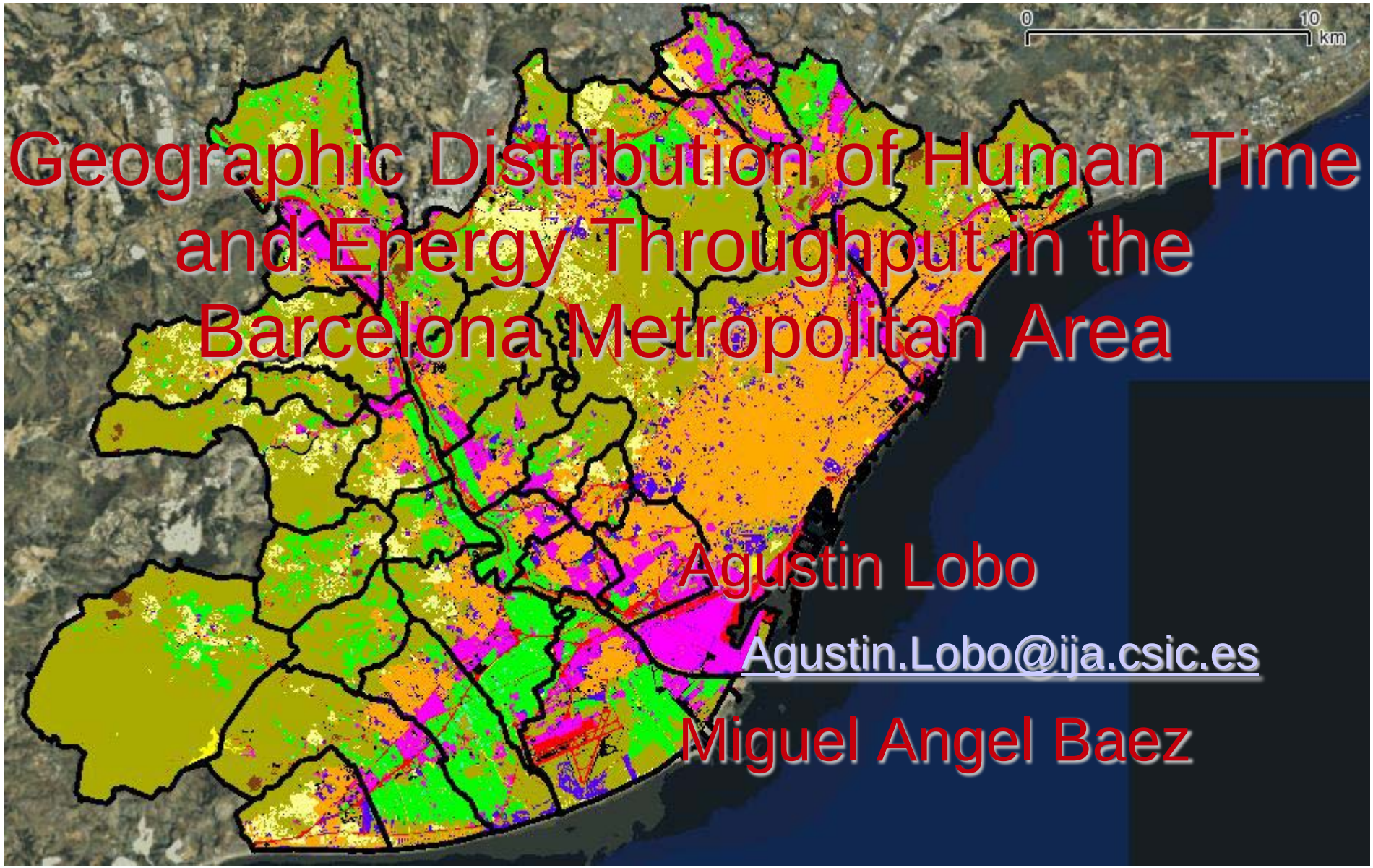

Geographic Distribution of Human Time and Energy Throughput in the Barcelona Metropolitan Area

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Miguel Angel Baez

Objectives

Geographic distribution of Human Time

Initial steps of Geographic Distribution of Energy Trhoughput

Ref. Giampietro et al. Energy 2008

General Goal: Spatial pattern of Functional Units and its relationship to Energy dissipation

In addition to the obvious *practical interest for policy makers*, this geogaphically-distributed MuSIASEM will let us investigate the internal organization of the system.

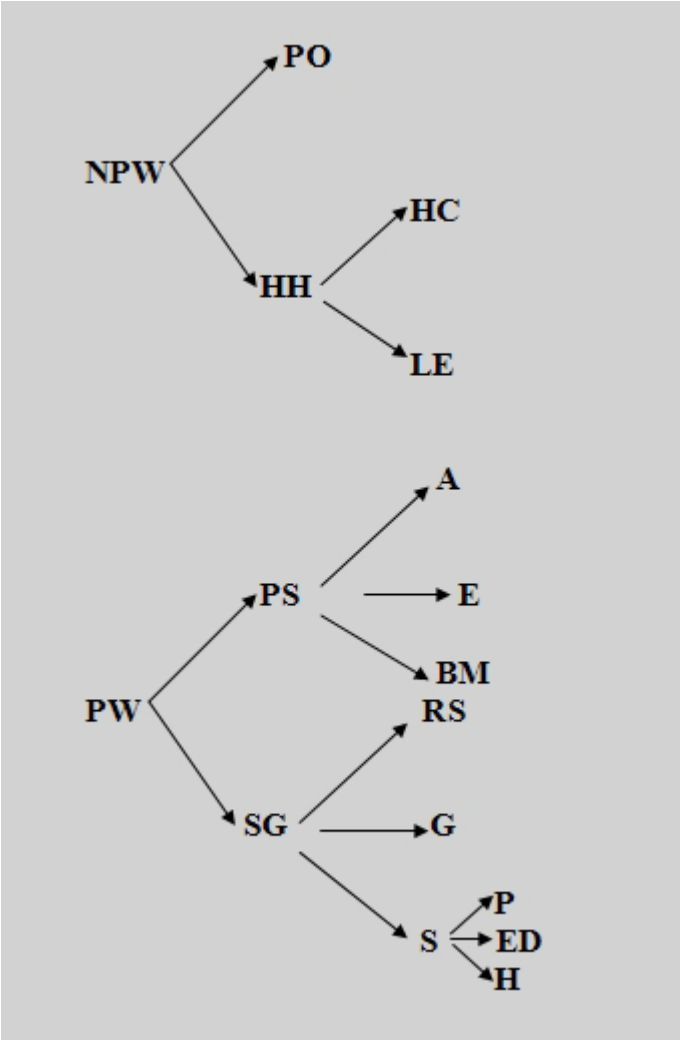
This is **important because**:

- **Space introduces constraints** on the actual location of human activities and
- **Slows down the dynamics of the system**, as goods (and human time!) have to be transported from one place to another.

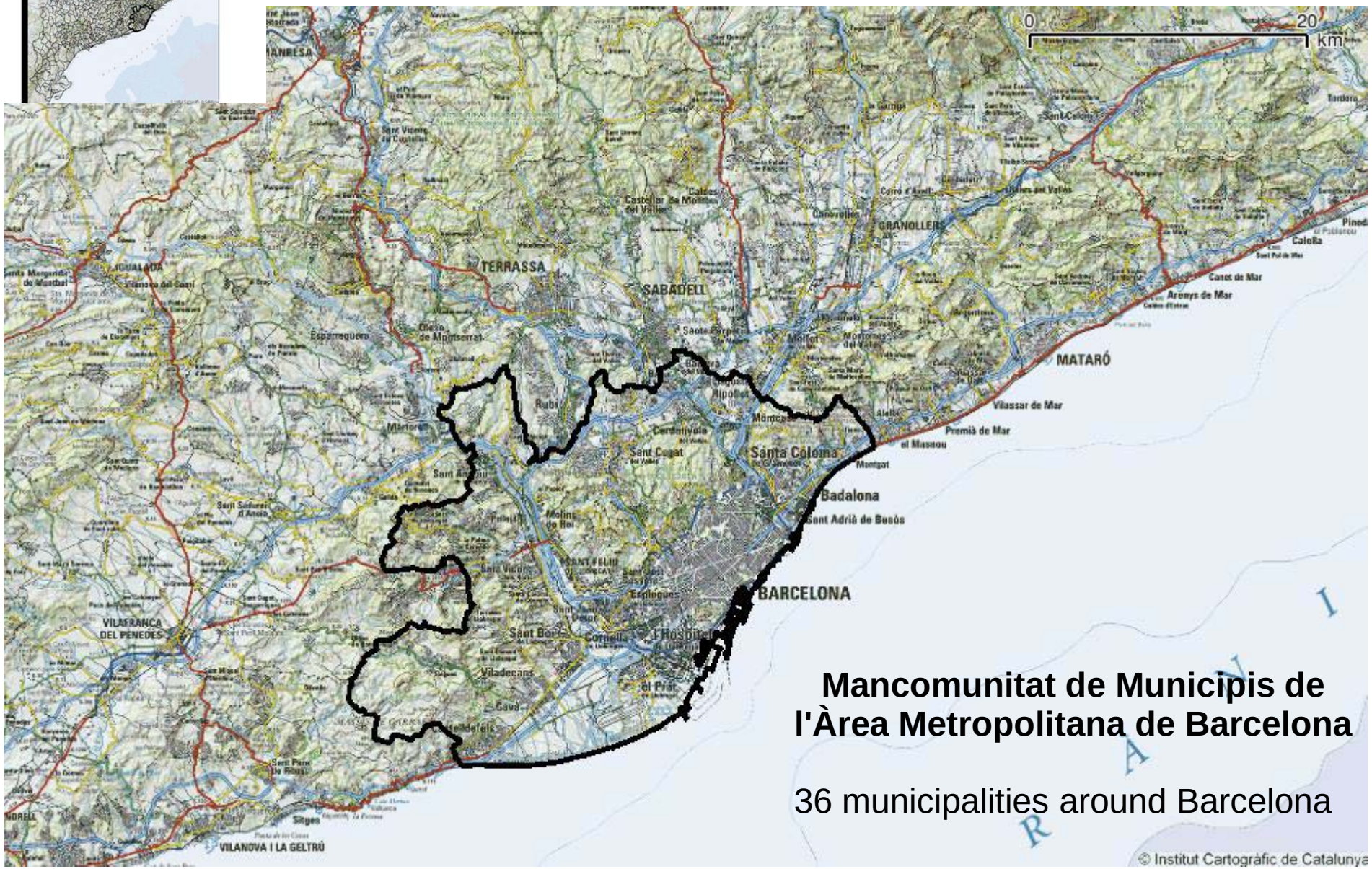
In this regard, we want to:

- **Assess the degree of spatial segregation** among different human activities and
- Investigate the **relationship between the spatial pattern and the flow of exosomatic energy**

Hierarchical typology of Human Time (HT)



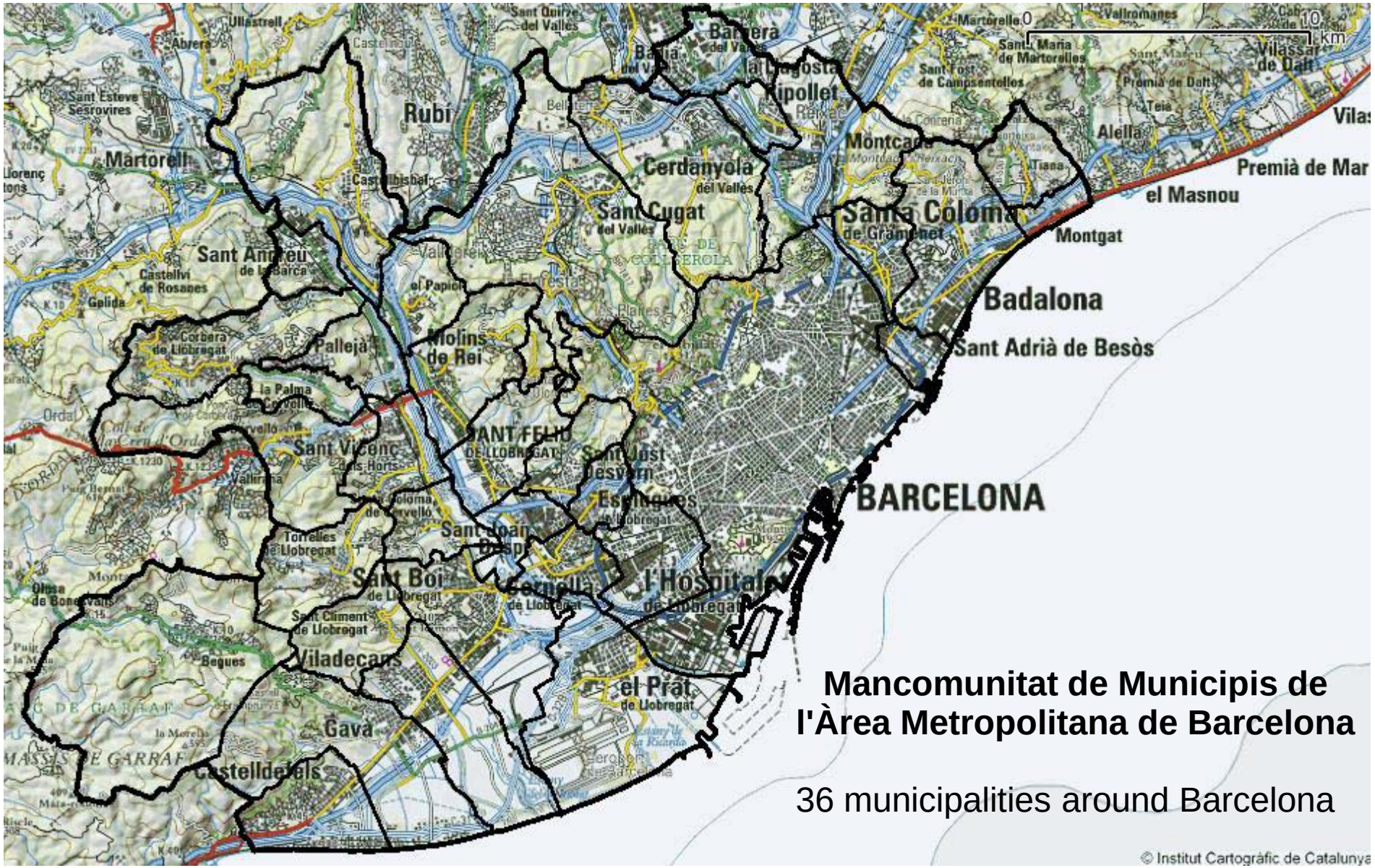
Area of Study



Mancomunitat de Municipis de l'Àrea Metropolitana de Barcelona

36 municipalities around Barcelona

Area of Study



Data: Human Activity

Not Paid Work

HH + PO

Household Chores + Physiological Overhead

Nb. of Habitants by sex, age, (origin)

Vector base of census tracts

Paid Work

BM

Building & Manufacturing

Nb. of workers by company

Zip code of company

Vector layer of Zip Codes

SG (RS)

Service & Government (Retail Sector)

Nb. of shops and Nb. Of workers on Retail Sector by “barris”

Vector layer of “Barris” and districts

PROBLEM: only for BCN by now

SG (no RS)

Service & Government (no Retail Sector)

Nb. of workers of SG by “comarca”

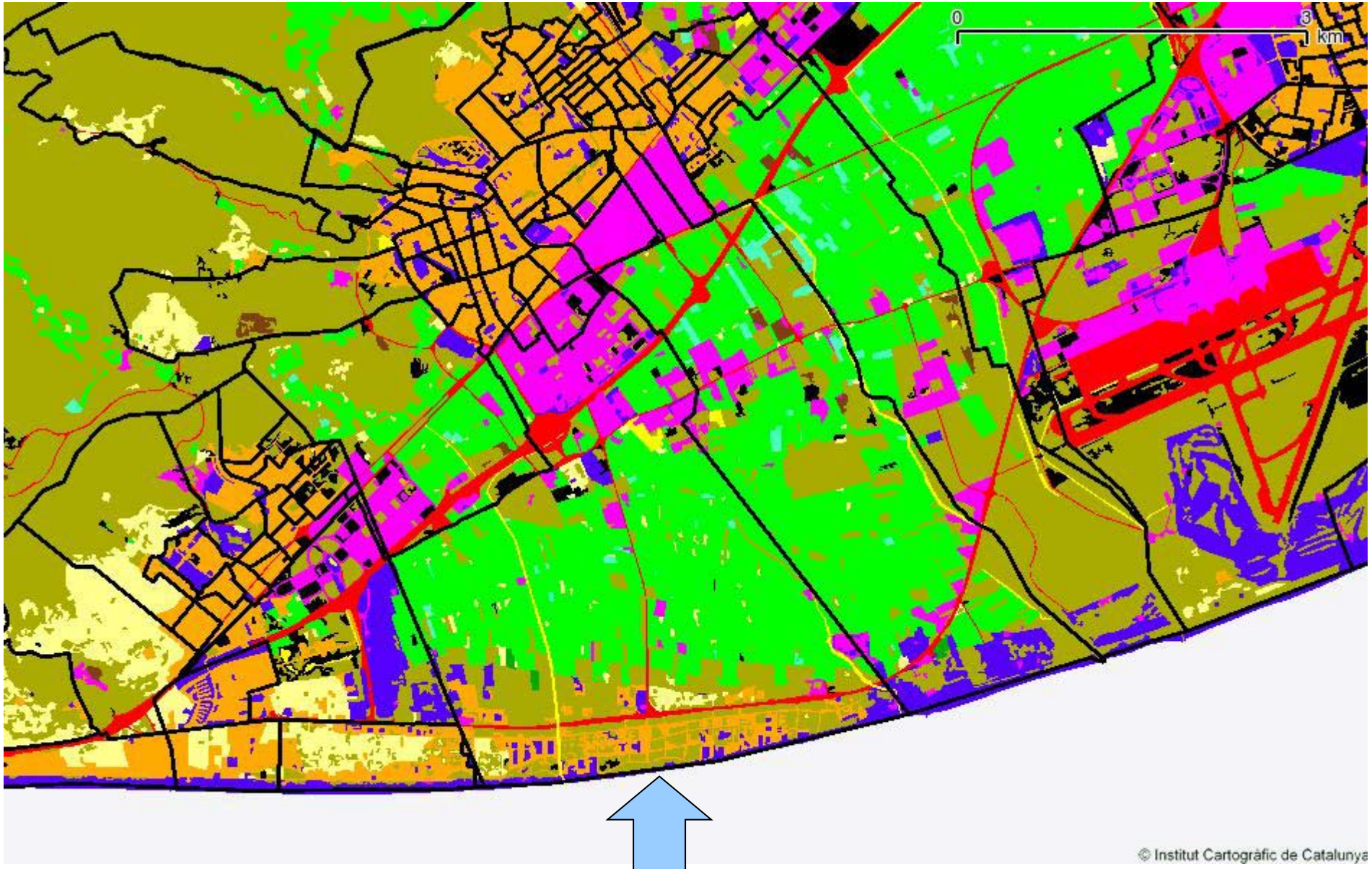
Vector layer of “comarques”

Methodological Problems

Arbitrary (administrative) spatial units

Different spatial units for each data set

Arbitrary (administrative) spatial units...

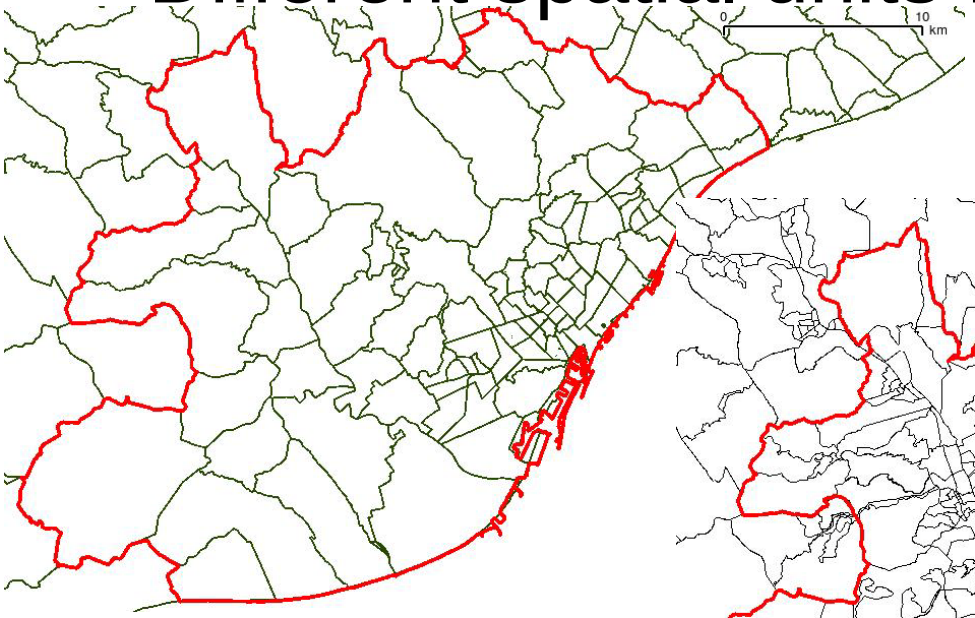


Most of the tract is actually not inhabited

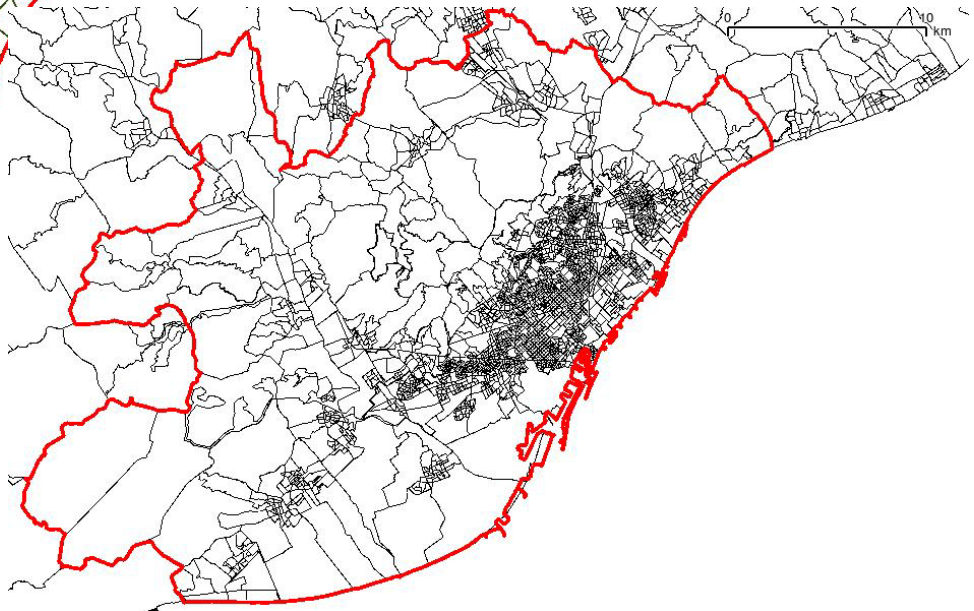
Arbitrary (administrative) spatial units...

Most of the tract is actually not inhabited

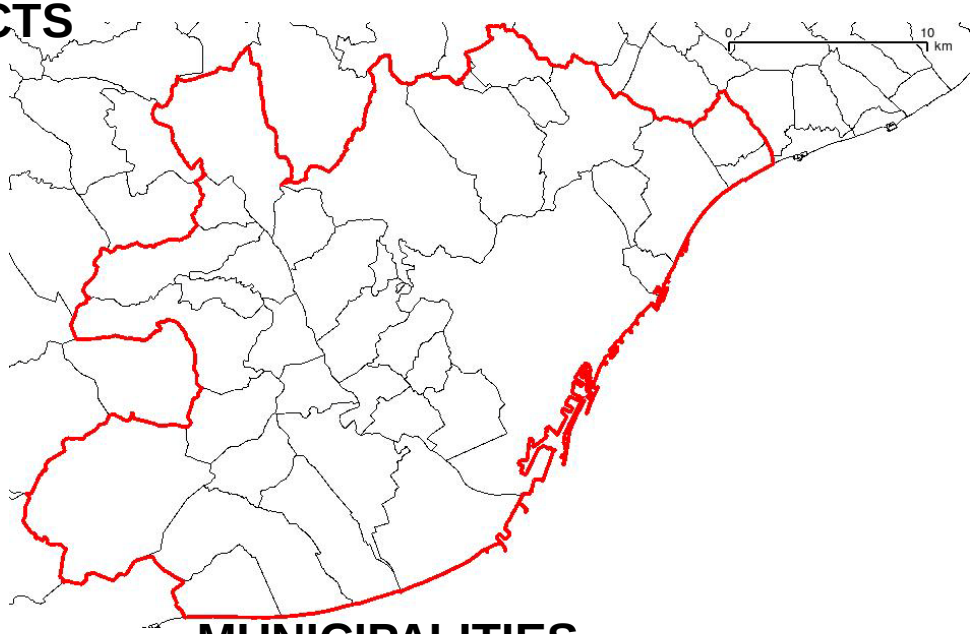
Different spatial units for each data set...



ZIP CODES



CENSUS TRACTS



MUNICIPALITIES

Methodological Solution

From a set of arbitrary administrative partitions to a common distribution of geographic units

Realistic spatial distribution

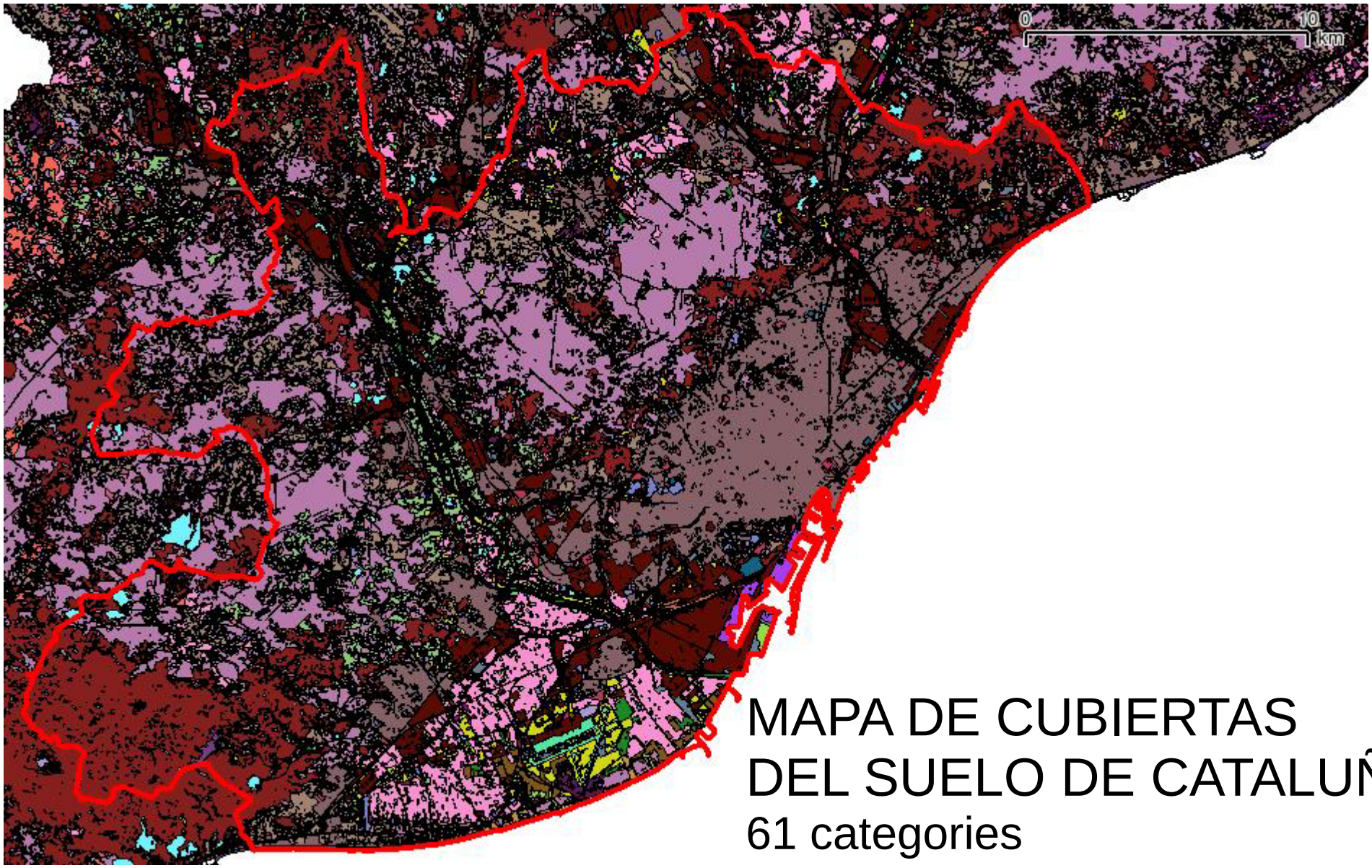
Intersect layer of geographic partition for the data (administrative boundaries) with Land Use

Definition of a Common Geographic Unit

CGU = ZIP CODES • CENSUS TRACKS • LAND USE

Re-distribute data on the CGU with appropriate LU categories only

Land Cover Map



MAPA DE CUBIERTAS
DEL SUELO DE CATALUÑA
61 categories

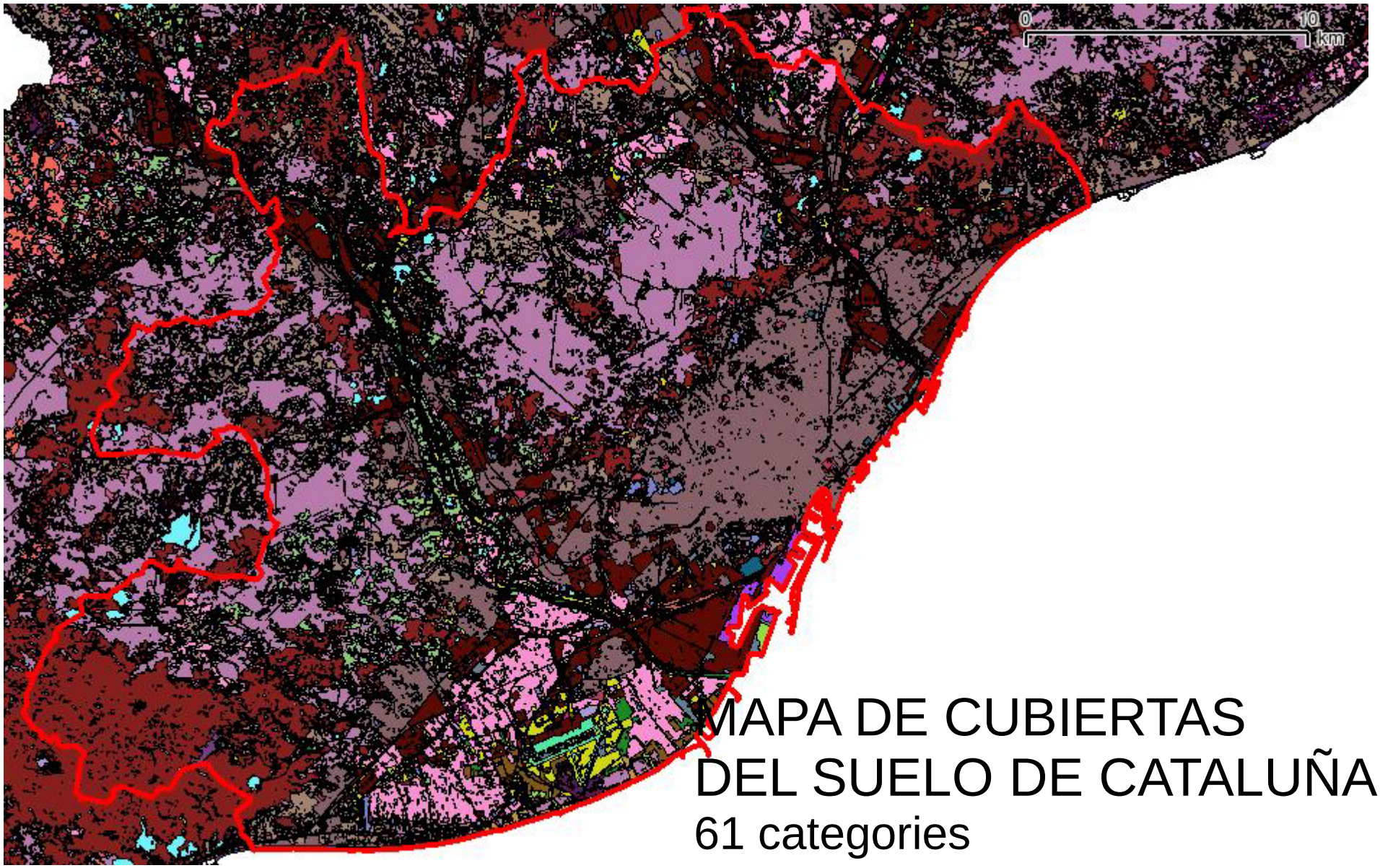
Land Use Map

LCLU1	LCLU2	Code
Agriculture	Low intensity Agriculture	A1
Agriculture	Modern Agriculture	A2
Agriculture	“Industrial Agriculture”	A3
Not Colonized Land	Not Colonized Land	NCL
Minery	Minery	E
Energy Production	Energy Production	
Urban	Compact Urban	UC
Urban	Loose Urban	UL
Urban	Industrial	UI
Urban	Urban Plot	US
Urban	Transport Infrastructure	T
Urban	Infrastructure for Services	IS
Urban	Leisure terrains	L

Multiple Use →

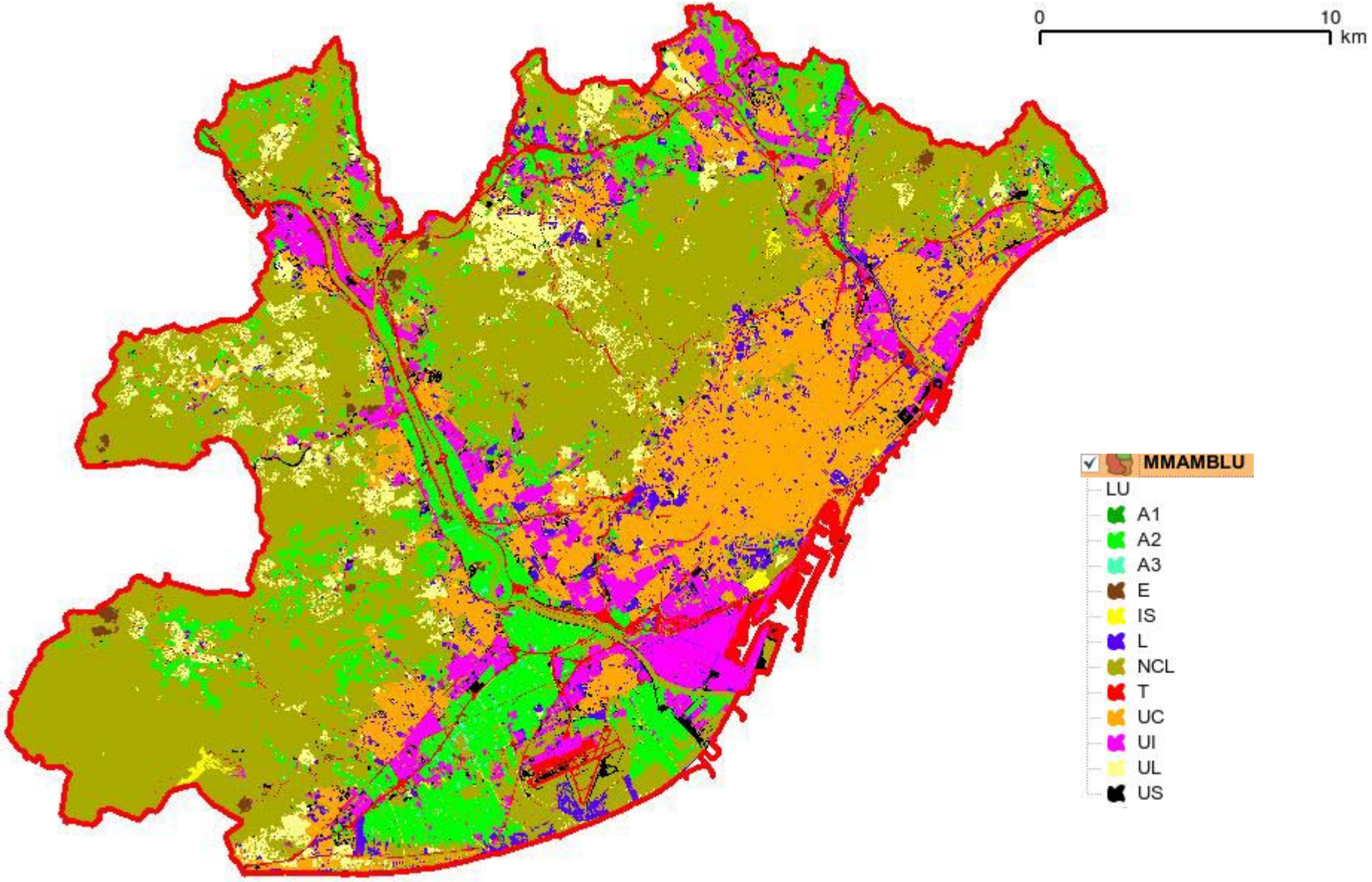
61 categories
recoded to 12 categories
(relevant for our HA types)

Land Cover Map

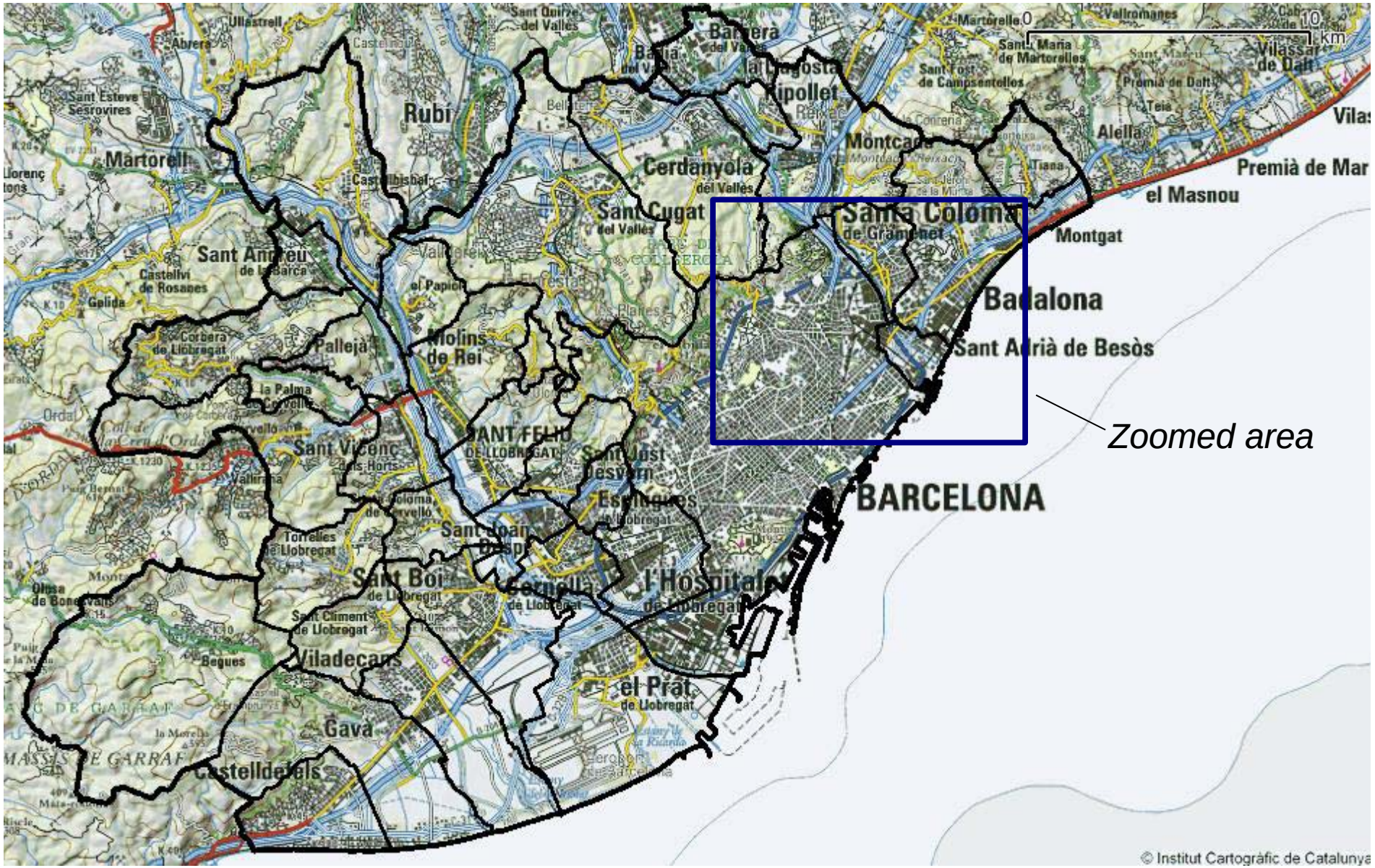


MAPA DE CUBIERTAS
DEL SUELO DE CATALUÑA
61 categories

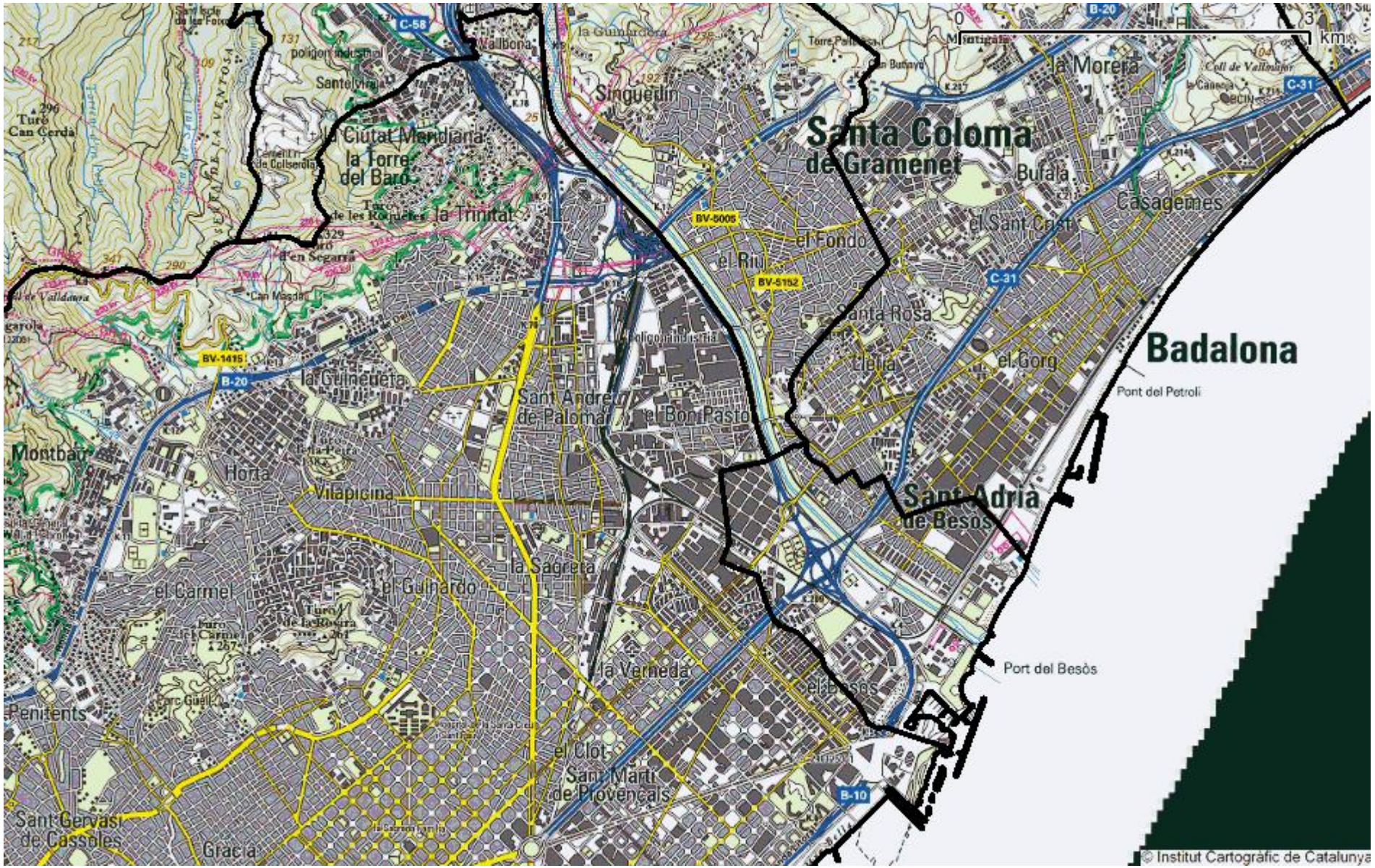
Recoded Map: Land Use



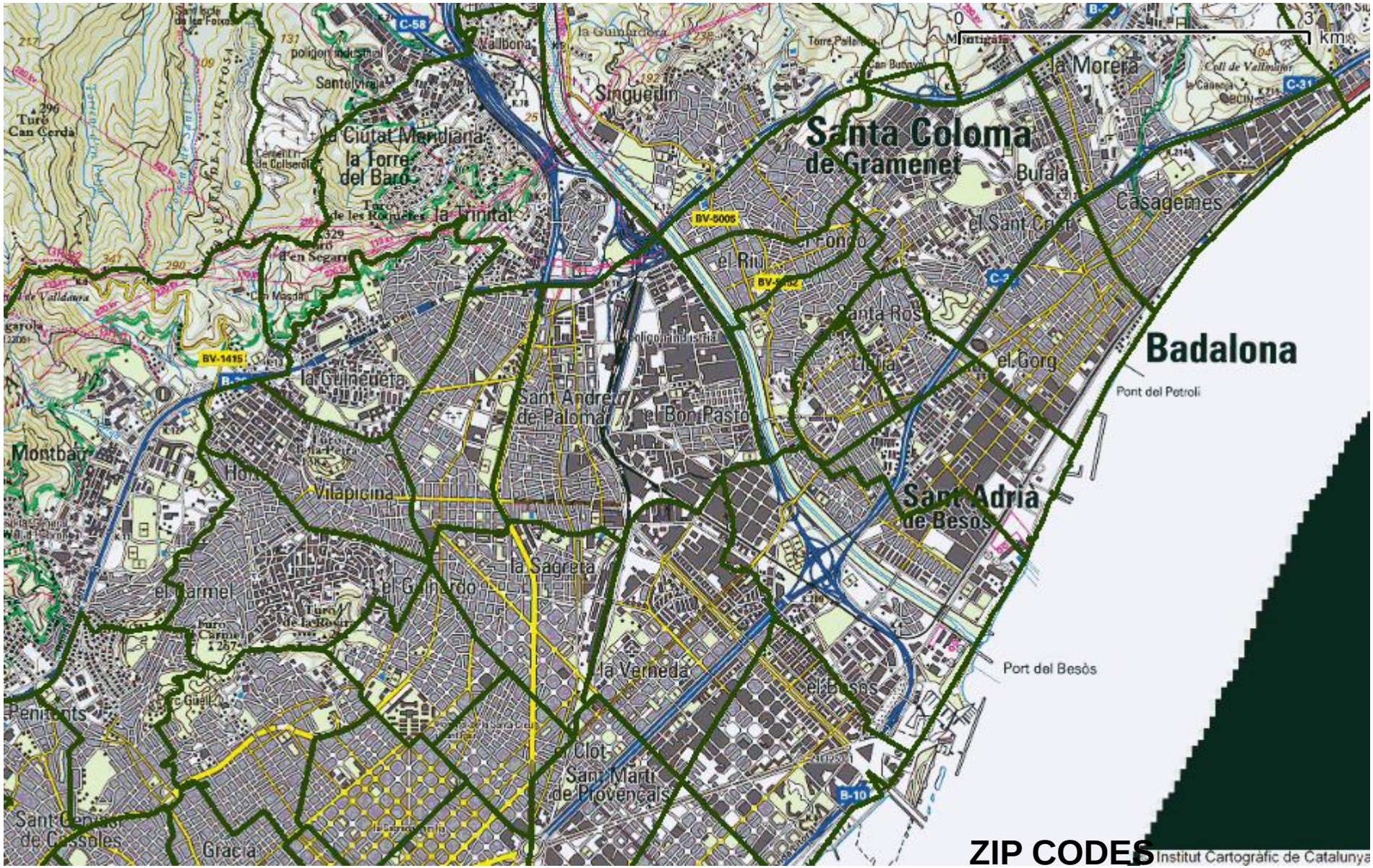
METHODOLOGY: Definition of Common Geographic Units (CGU)



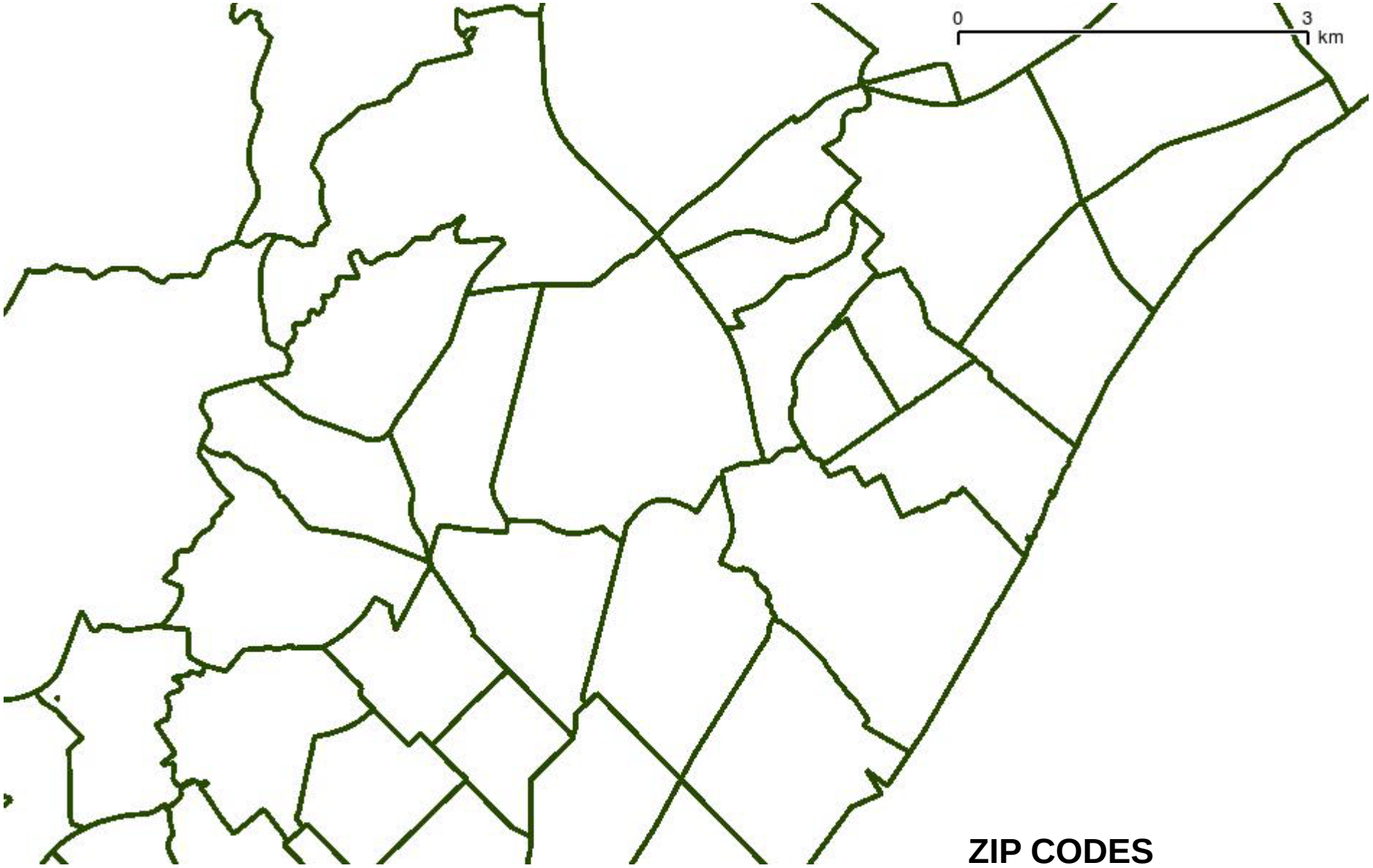
METHODOLOGY: Definition of Common Geographic Units (CGU)


Santa Coloma de Gramenet
Badalona
Sant Adrià de Besòs
la Morera
Bufalà
Casagemes
el Sant Crist
el Fondo
el Riu
Santa Rosa
Lletra
el Gorg
Pont del Petroli
Port del Besòs
el Besòs
Singuerlín
la Ciutat Meridiana
la Torre del Baró
la Trinitat
la Guineueta
Sant Andreu de Palomar
el Bon Pastor
Montbau
Horta
Vilapicina
la Sagrera
el Guinardó
el Carmel
la Verneda
el Clot
Sant Martí de Provençals
Penitents
Sant Gervasi de Cassoles
Gràcia
Santa Eulàlia
Can Cerdà
Can Magdalena
Can Segarra
Can Baró
Can Butsenit
Can Peixauet
Can Ruscalleda
Can Mariner
Can Tunis
Can Vidalet
Can Valldaura
Can Mercader
Can Mateu
Can Rosés
Can Rosés
Can Rosés

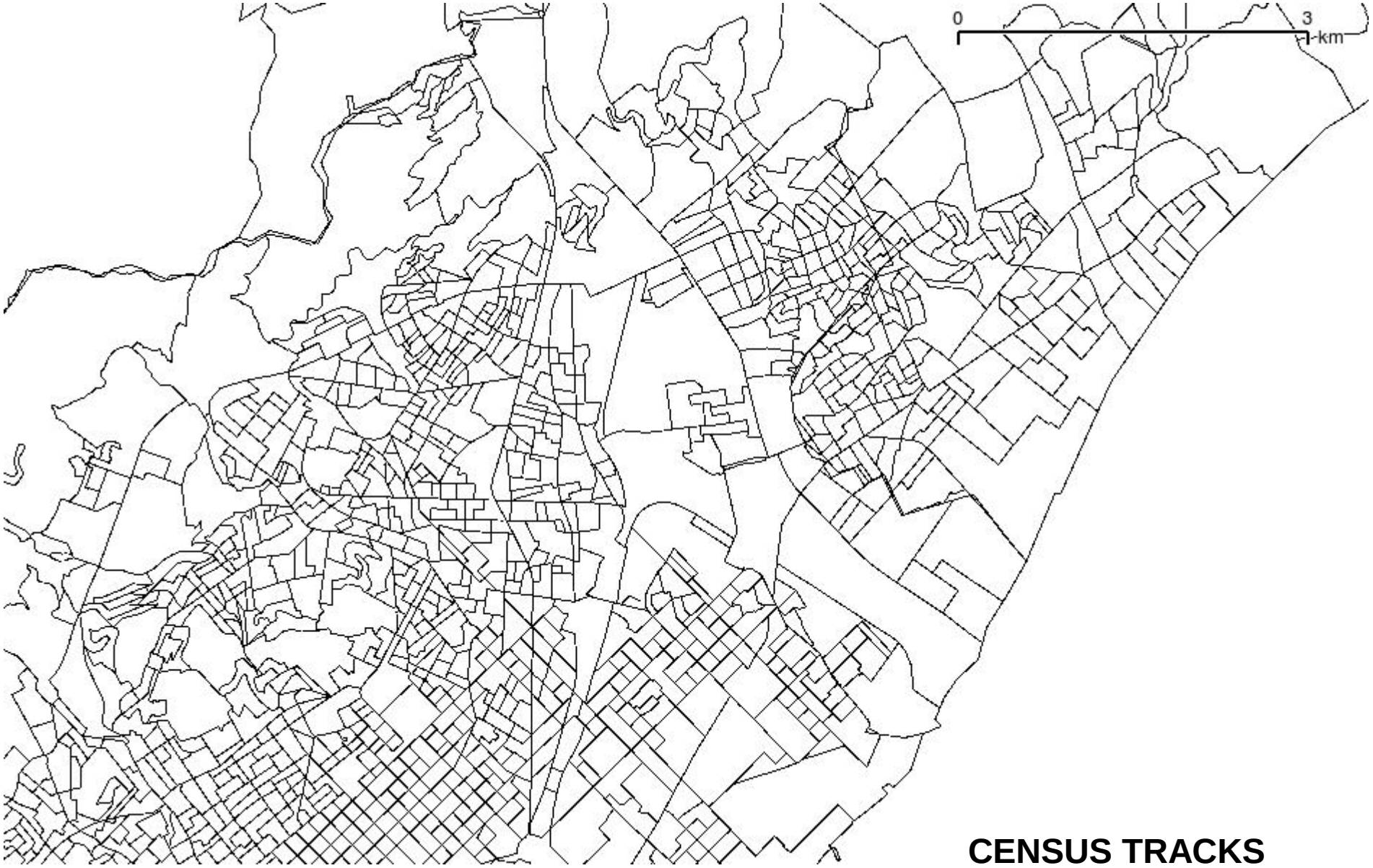
METHODOLOGY: Definition of Common Geographic Units



METHODOLOGY: Definition of Common Geographic Units (CGU)

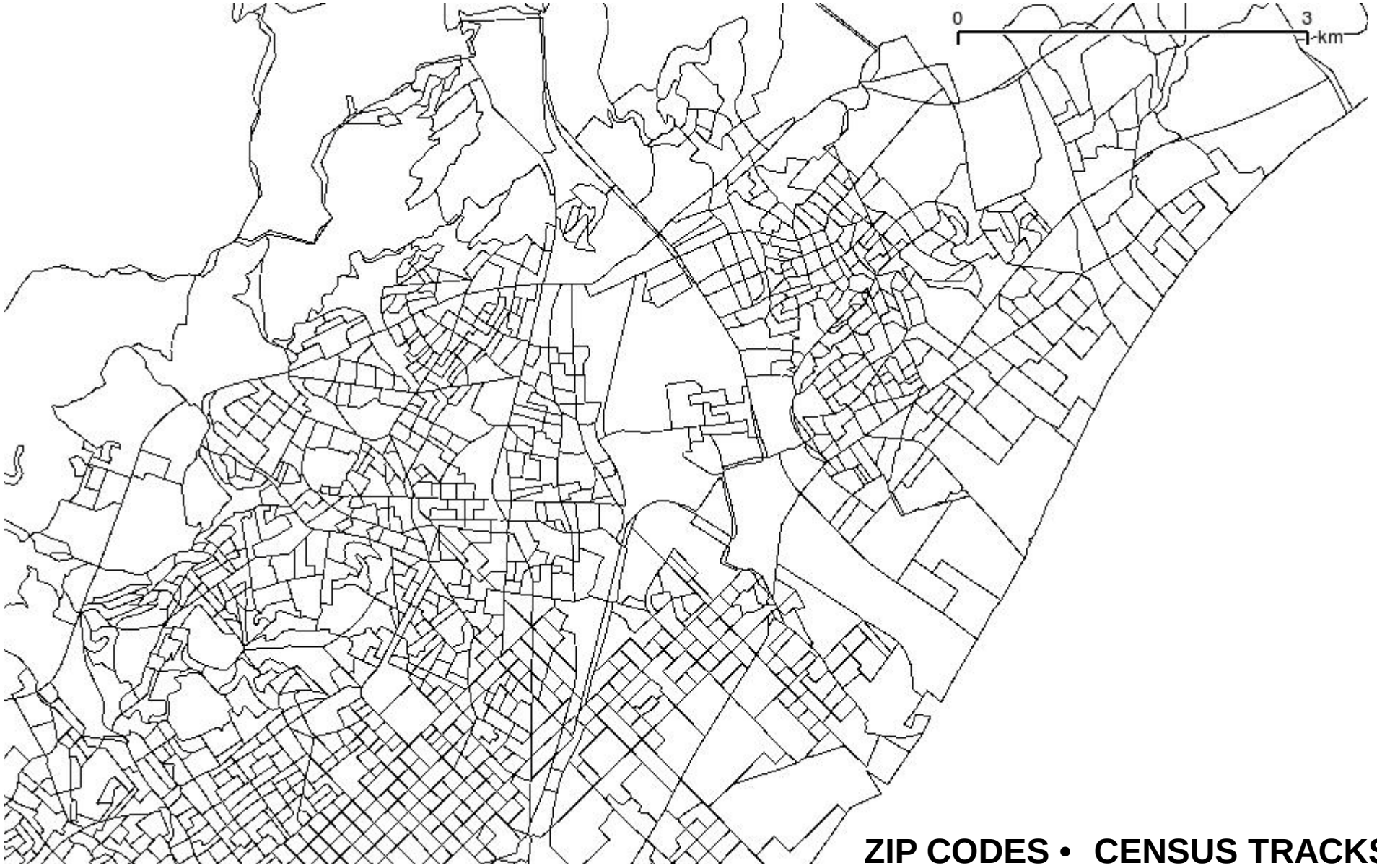


METHODOLOGY: Definition of Common Geographic Units (CGU)



CENSUS TRACKS

METHODOLOGY: Definition of Common Geographic Units (CGU)

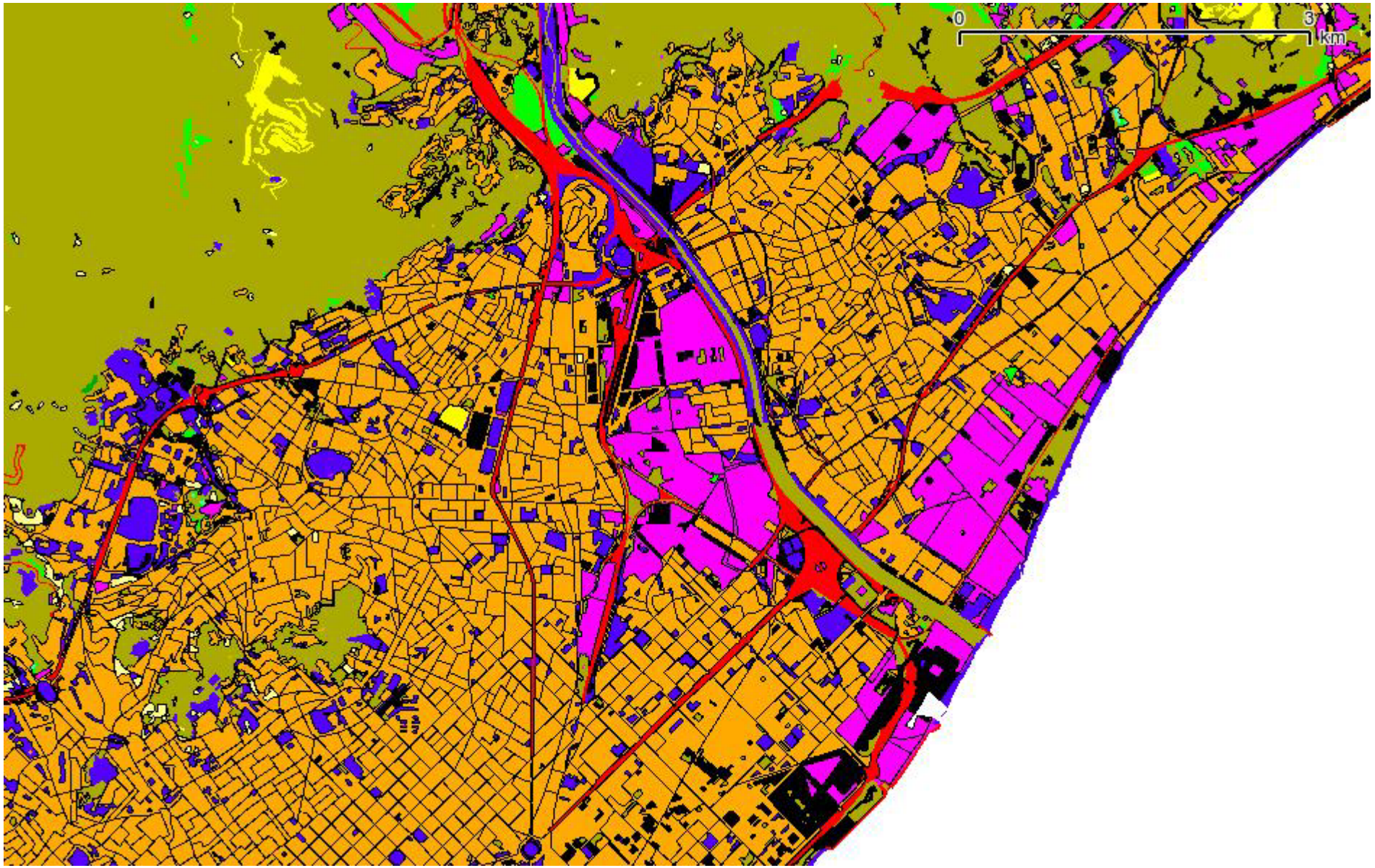


ZIP CODES • CENSUS TRACKS

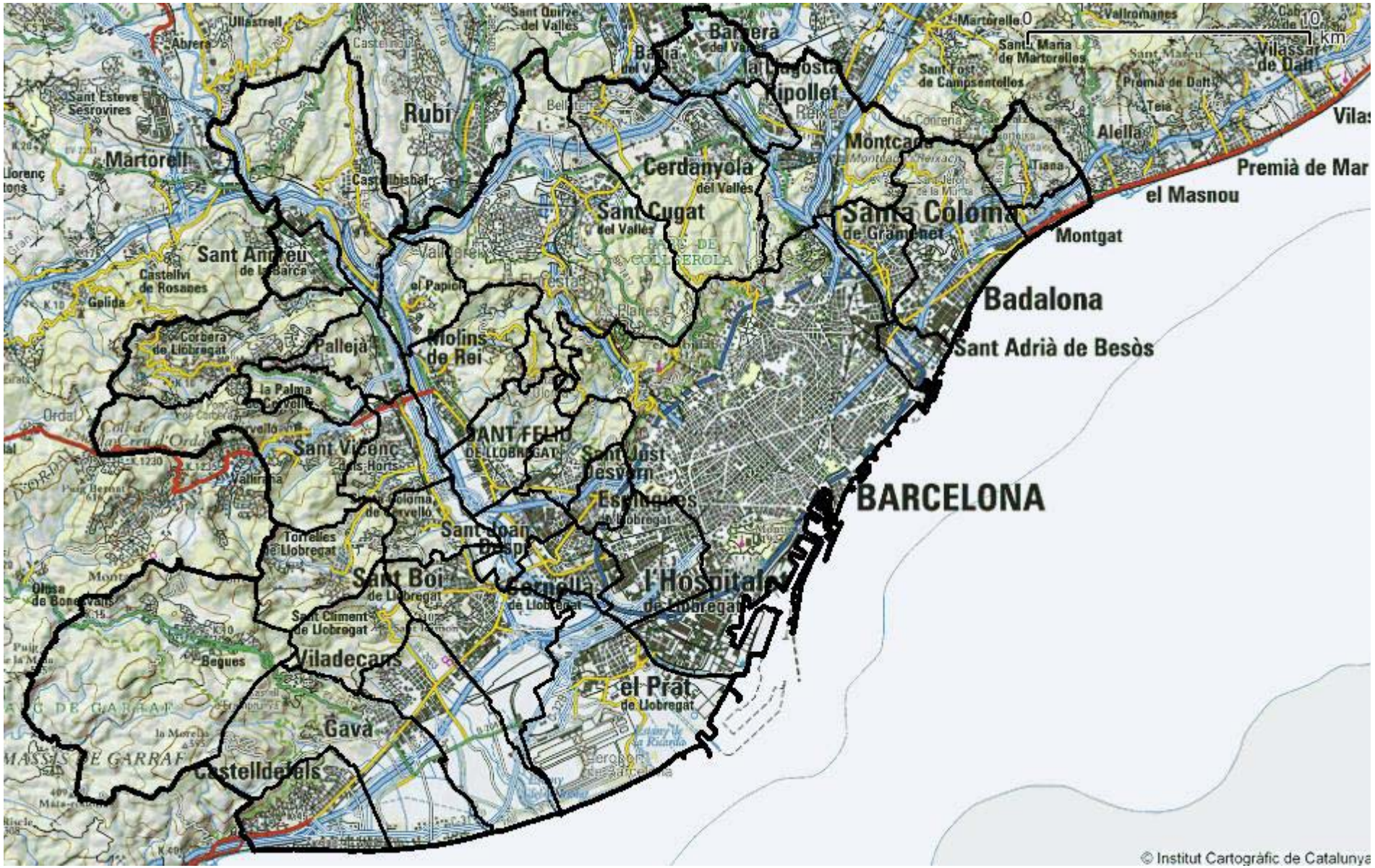
METHODOLOGY: Definition of Common Geographic Units (CGU)

ZIP CODES • CENSUS TRACKS • LAND USE

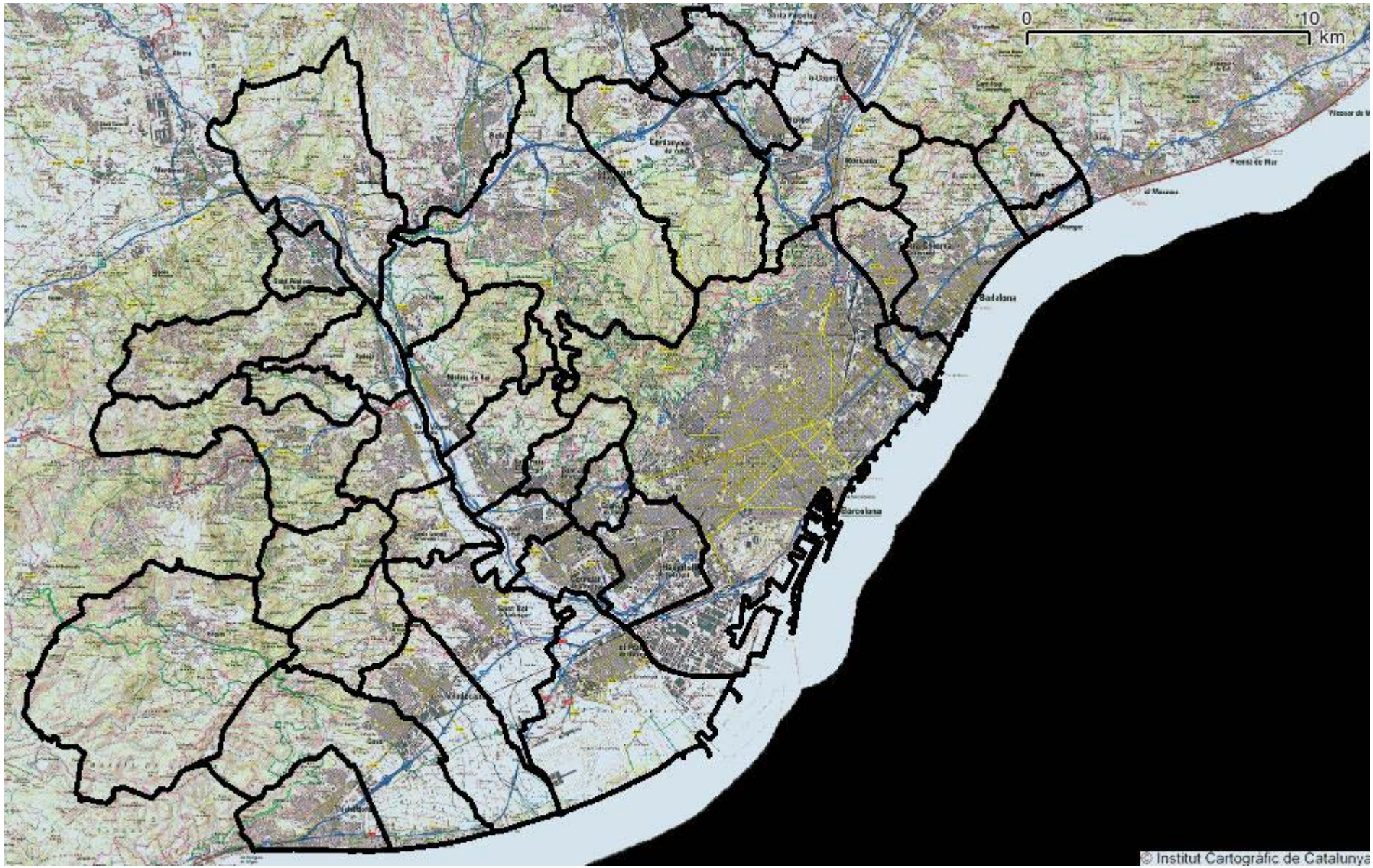
METHODOLOGY: Definition of Common Geographic Units (CGU)

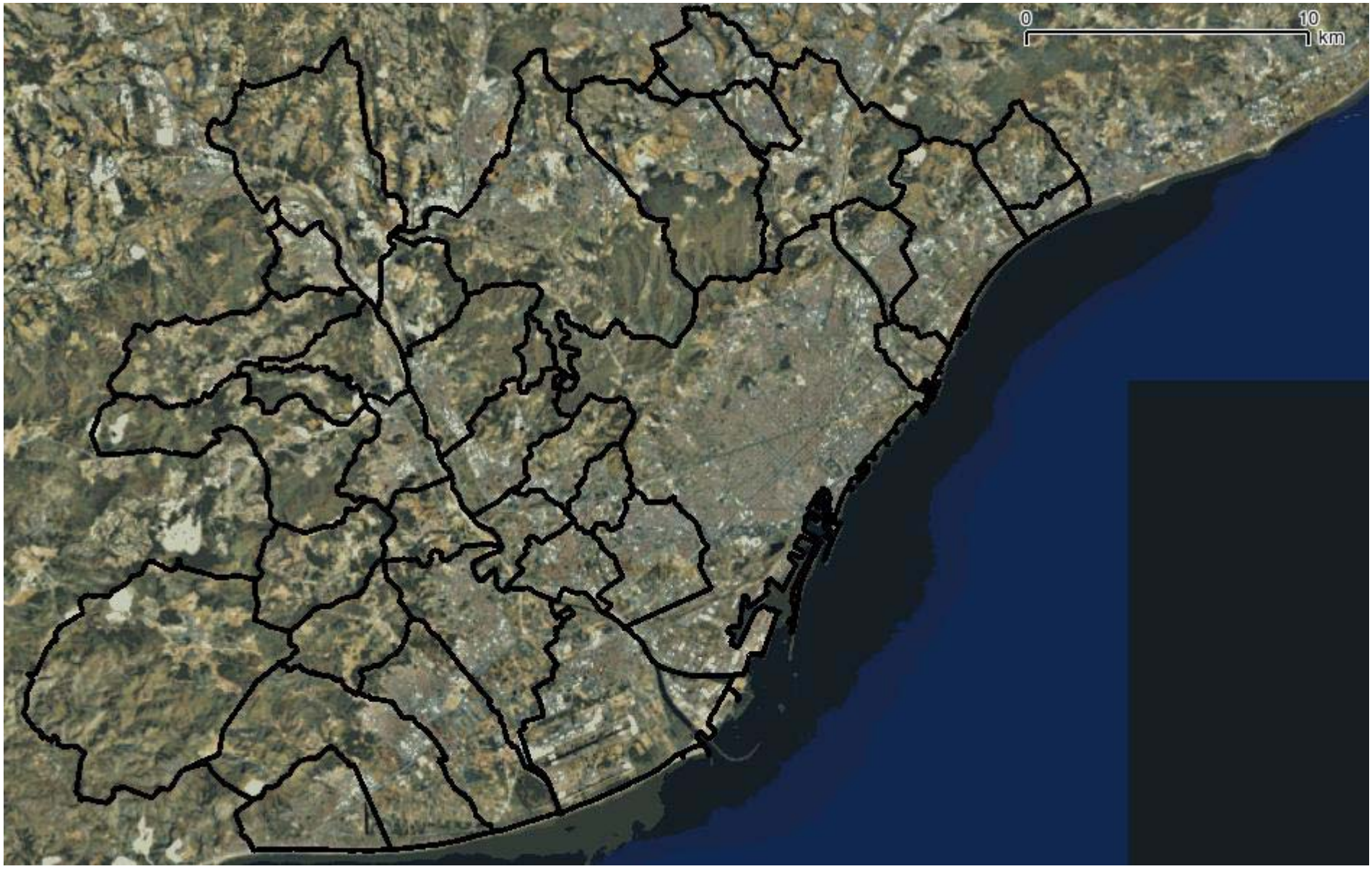


CGU = ZIP CODES • CENSUS TRACKS • LAND USE



0
10
km
Rubí
Martorell
Sant Andreu de la Barca
Castellví de Rosanes
Gelida
Corbera de Llobregat
Pallejà
Molins de Rei
Sant Vicenç dels Horts
SANT FELIU DE LLOBREGAT
Sant Just Desvern
Esplugues de Llobregat
Sant Joan Despí
Torrelles de Llobregat
Sant Boi de Llobregat
Cornellà de Llobregat
l'Hospitalet de Llobregat
Sant Climent de Llobregat
Viladecans
Begues
Gavà
Castelldefels
el Prat de Llobregat
Cerdanyola del Vallès
Sant Cugat del Vallès
Barberà del Vallès
Ripollet
Montcada
Santa Coloma de Gramenet
Badalona
Sant Adrià de Besòs
BARCELONA
Montgat
el Masnou
Premià de Mar
Alella
Vilassar de Dalt
Vallromanes
Martorelles
Sant Fost de Campsentelles
Sant Esteve Sesrovires
Ullastrell
Abrera
Castellbisbal
Sant Quirze del Vallès
Bellaterra
Tiana
Teià
Premià de Dalt
Sant Maria de Martorelles
© Institut Cartogràfic de Catalunya


0
10
km
Badalona
Barcelona
© Institut Cartogràfic de Catalunya


0
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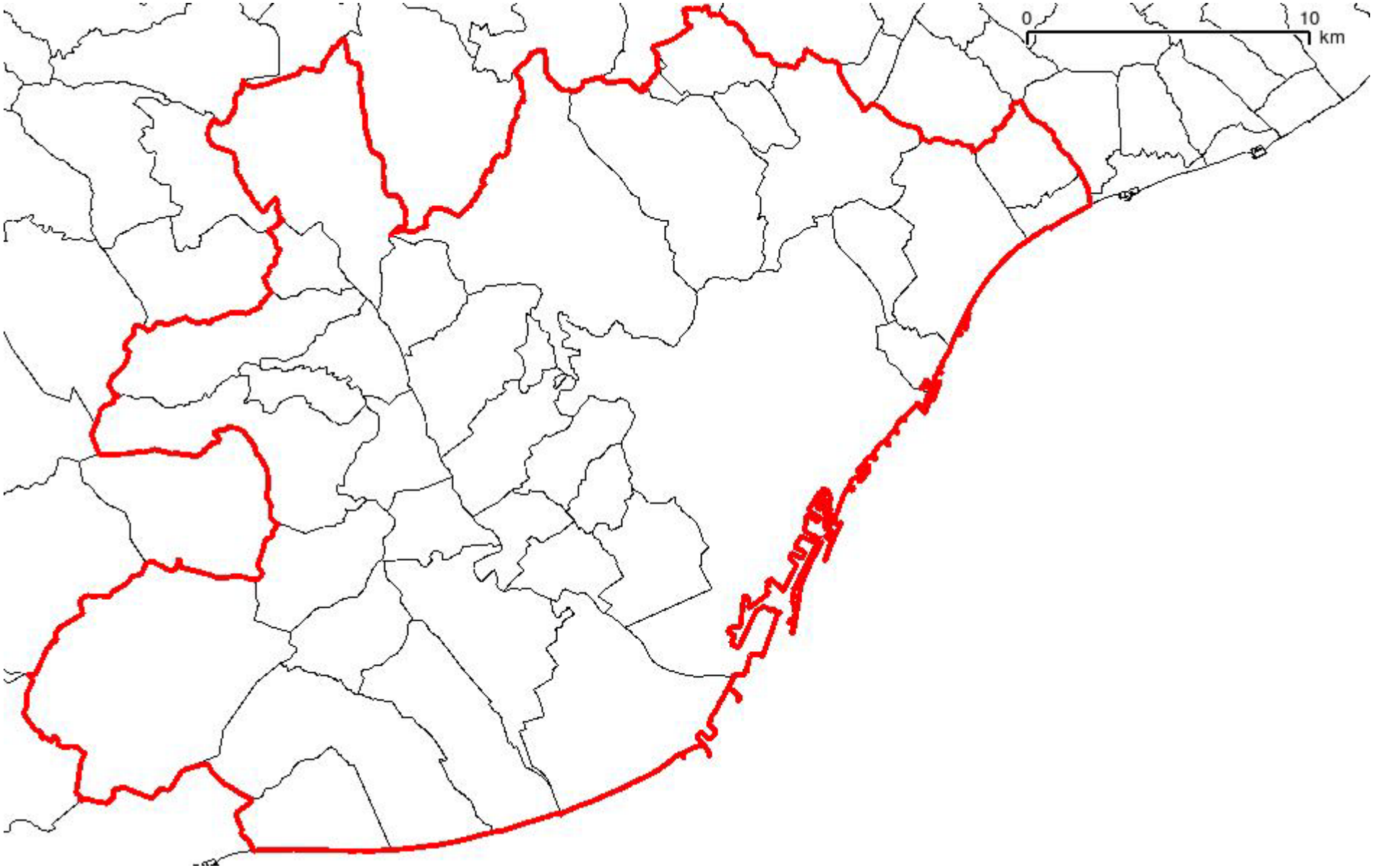
km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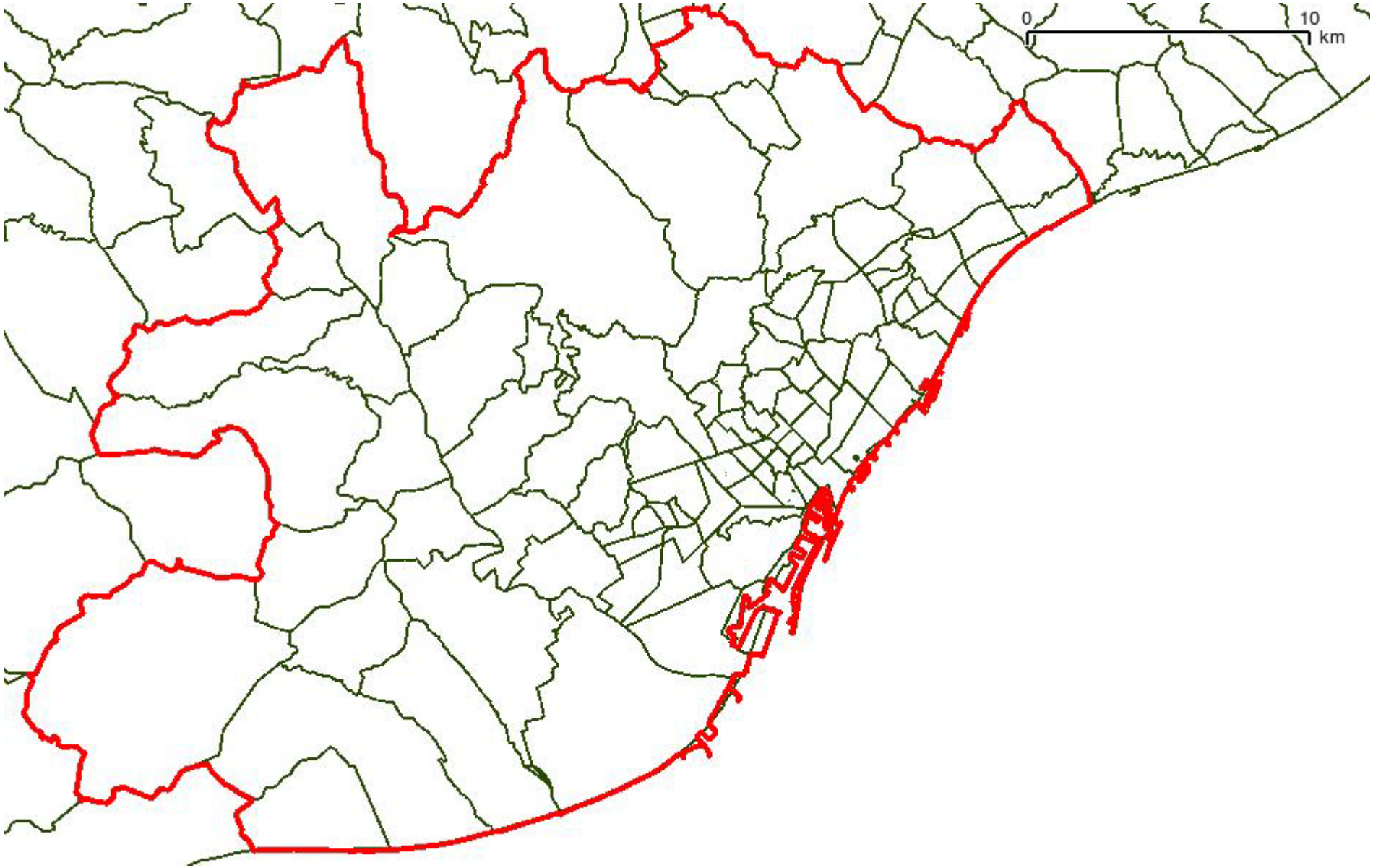
km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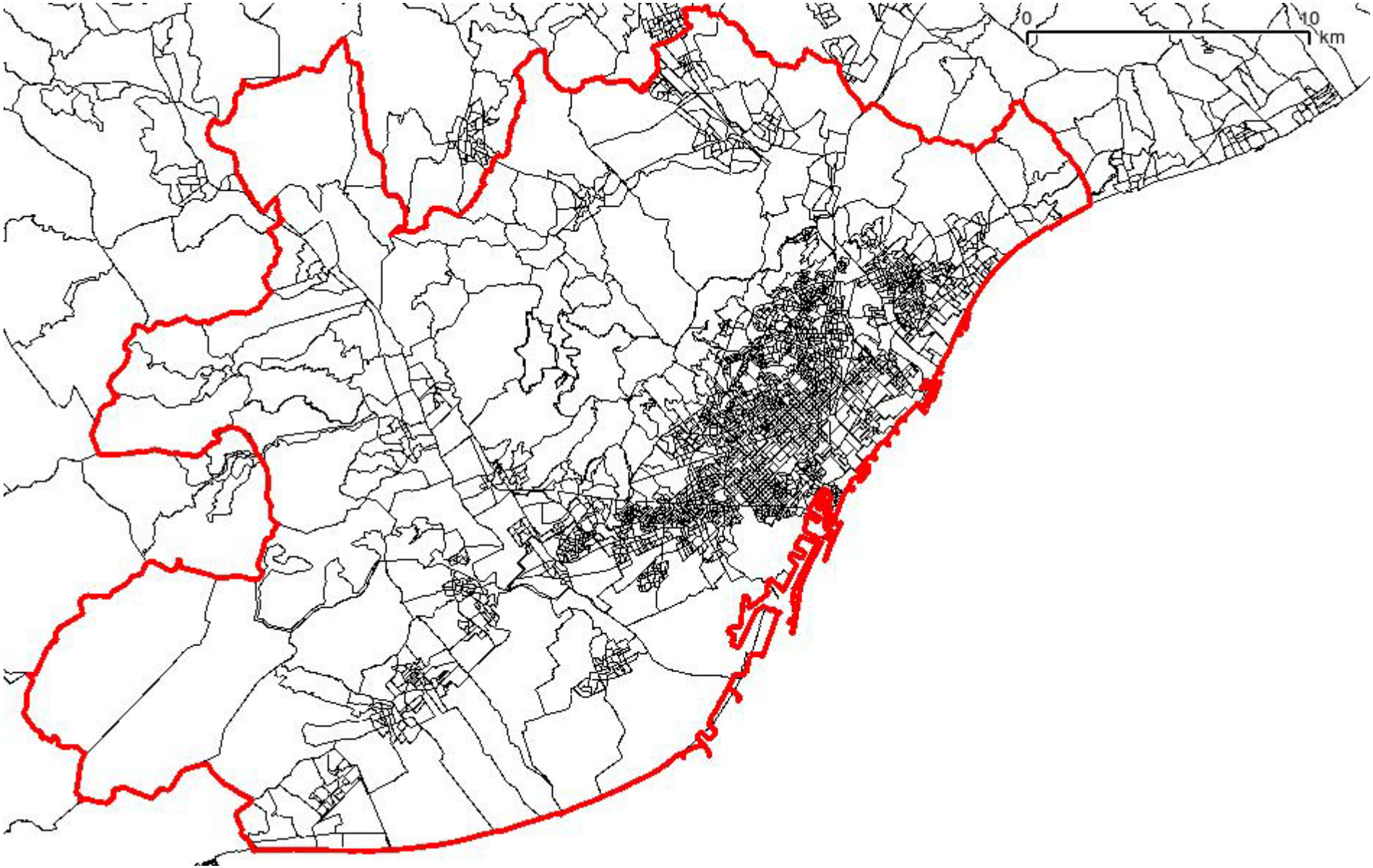
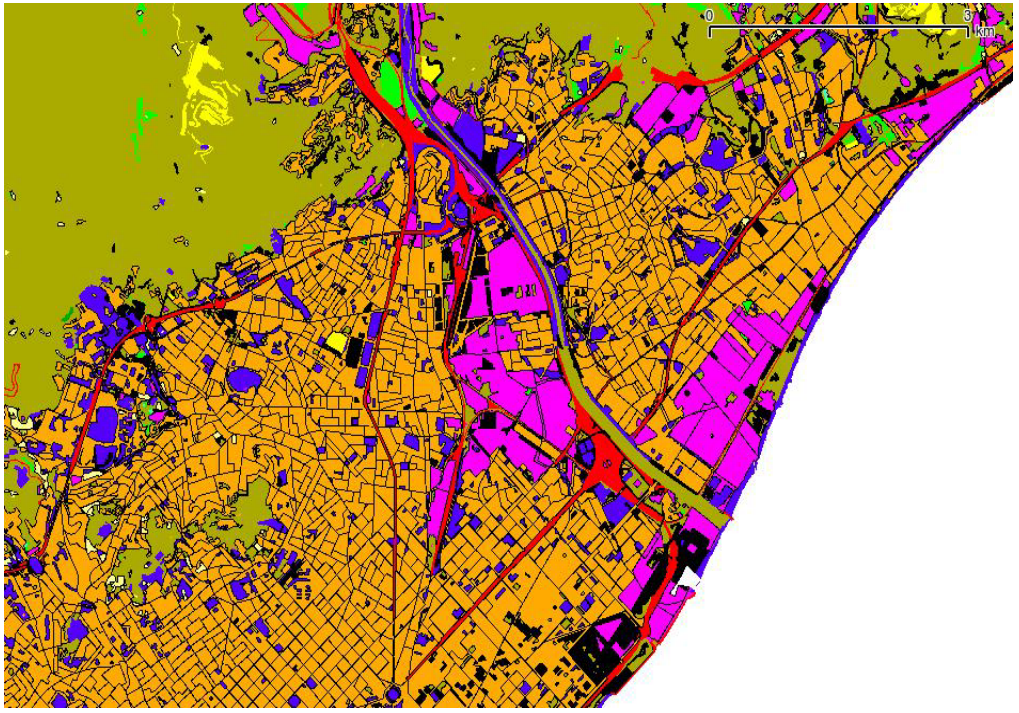
km


0
10
km

METHODOLOGY: Re-distribution of data among CGU of LU

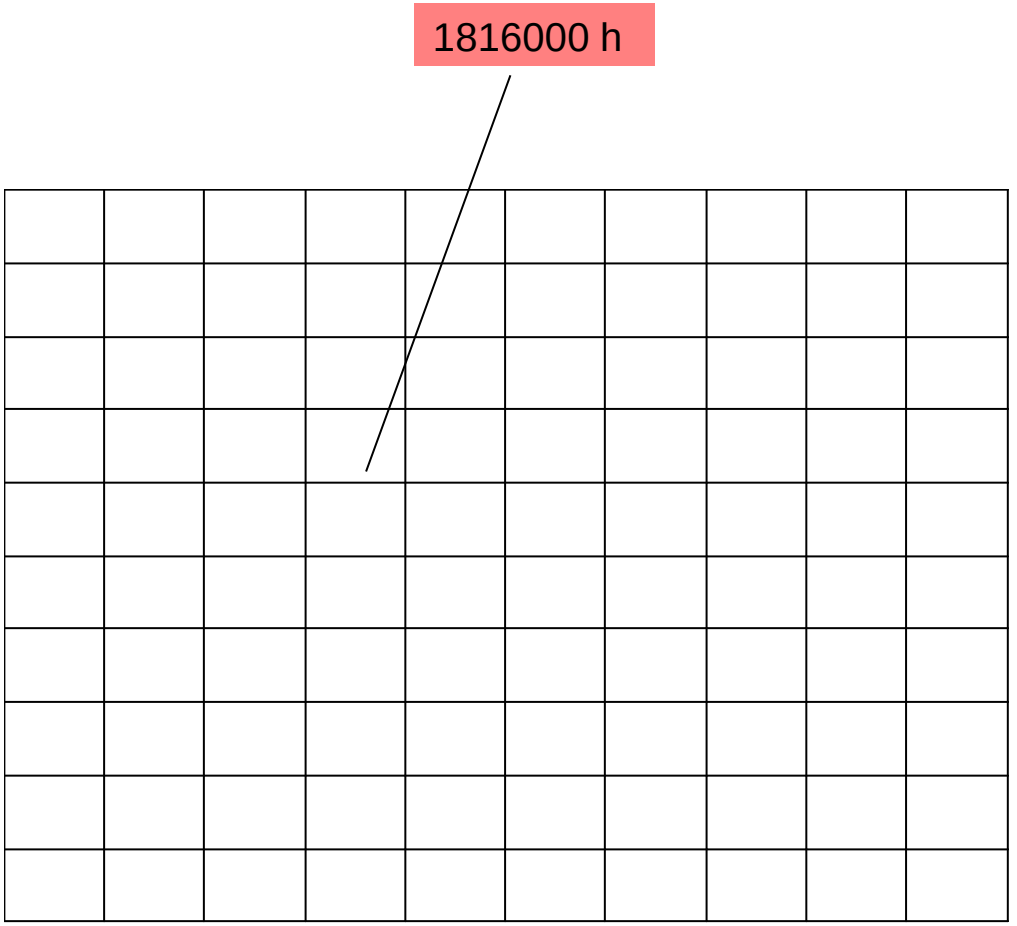
CGU



Census Population
Concentrated Residential
Loose Residential
Workers (BM)
Concentrated Residential
Industrial Areas
Workers (SG)
Concentrated Residential

Mean field estimate:

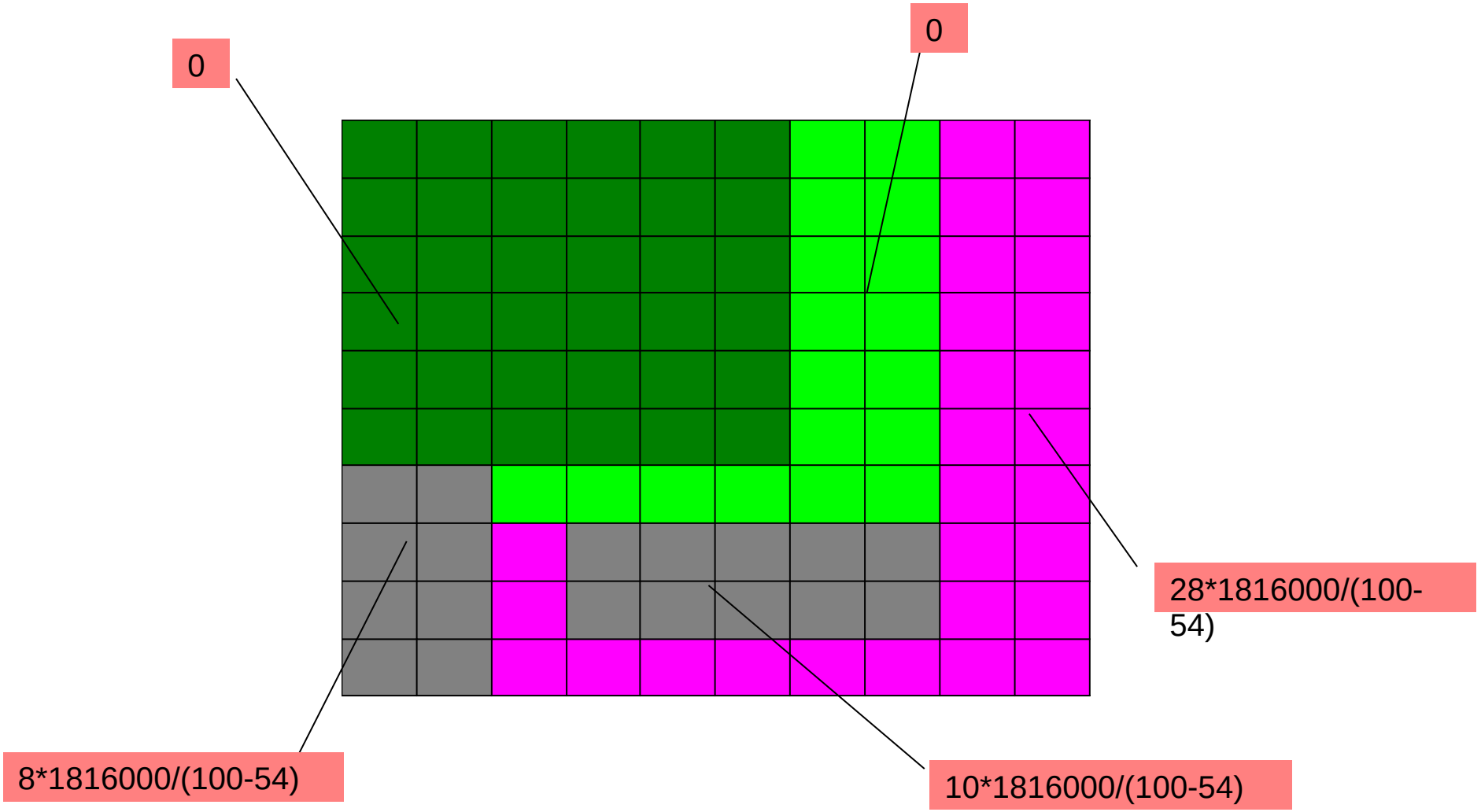
Uniform distribution of Total labour (1816000 h)
in total surface of the Zip Code (100 ha)



Stratified estimate:

Labour time in the ZC weighted by surface fraction of the CGU

Compatible surface: Surface of LC compatible with LU “work in the PS” (100 - 54 = 46 ha)
Weight = Surface of each CGU/Compatible Surface



RESULTS
attempt

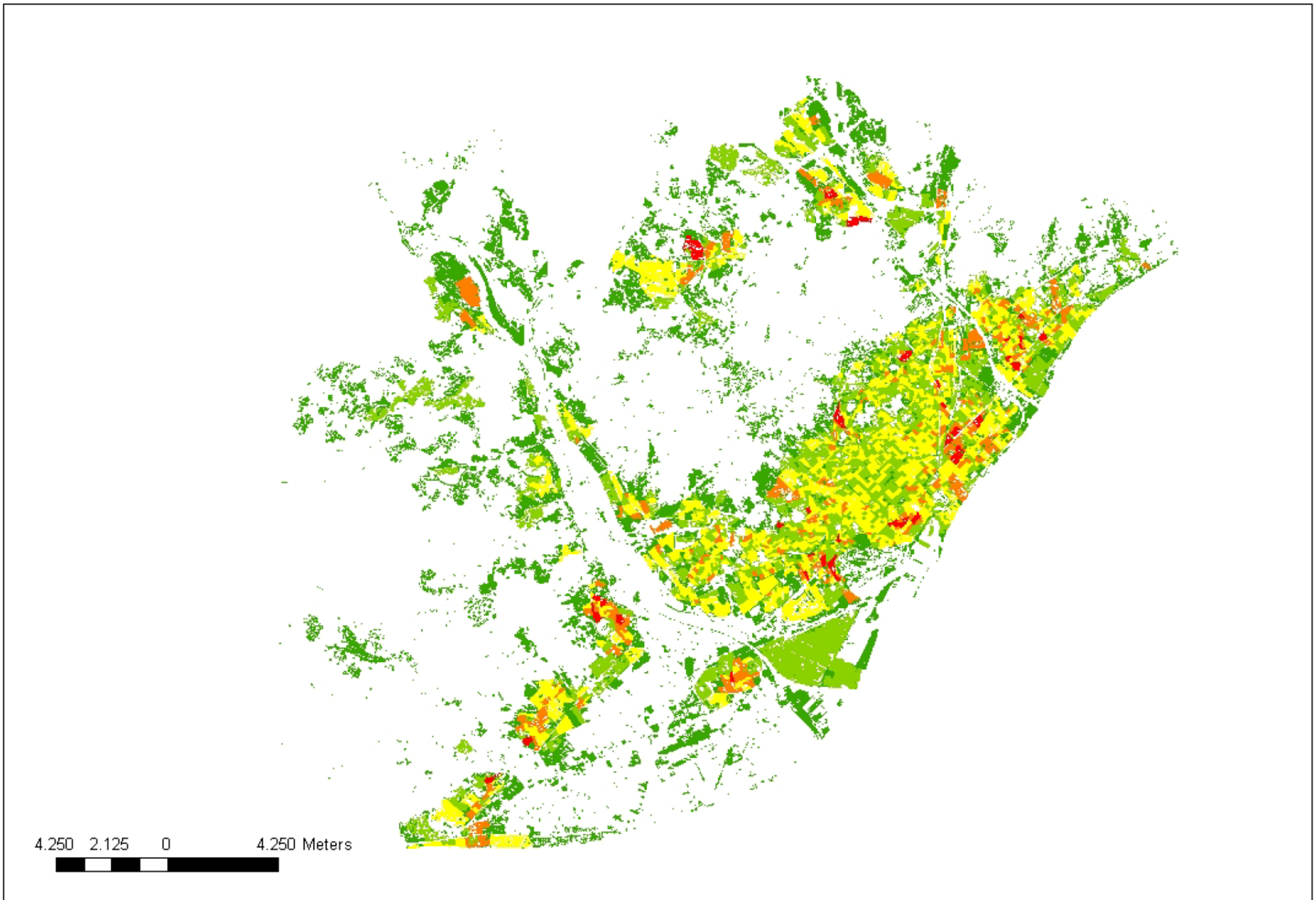
i.e. for NPW (HH + PO)

CGU defined by

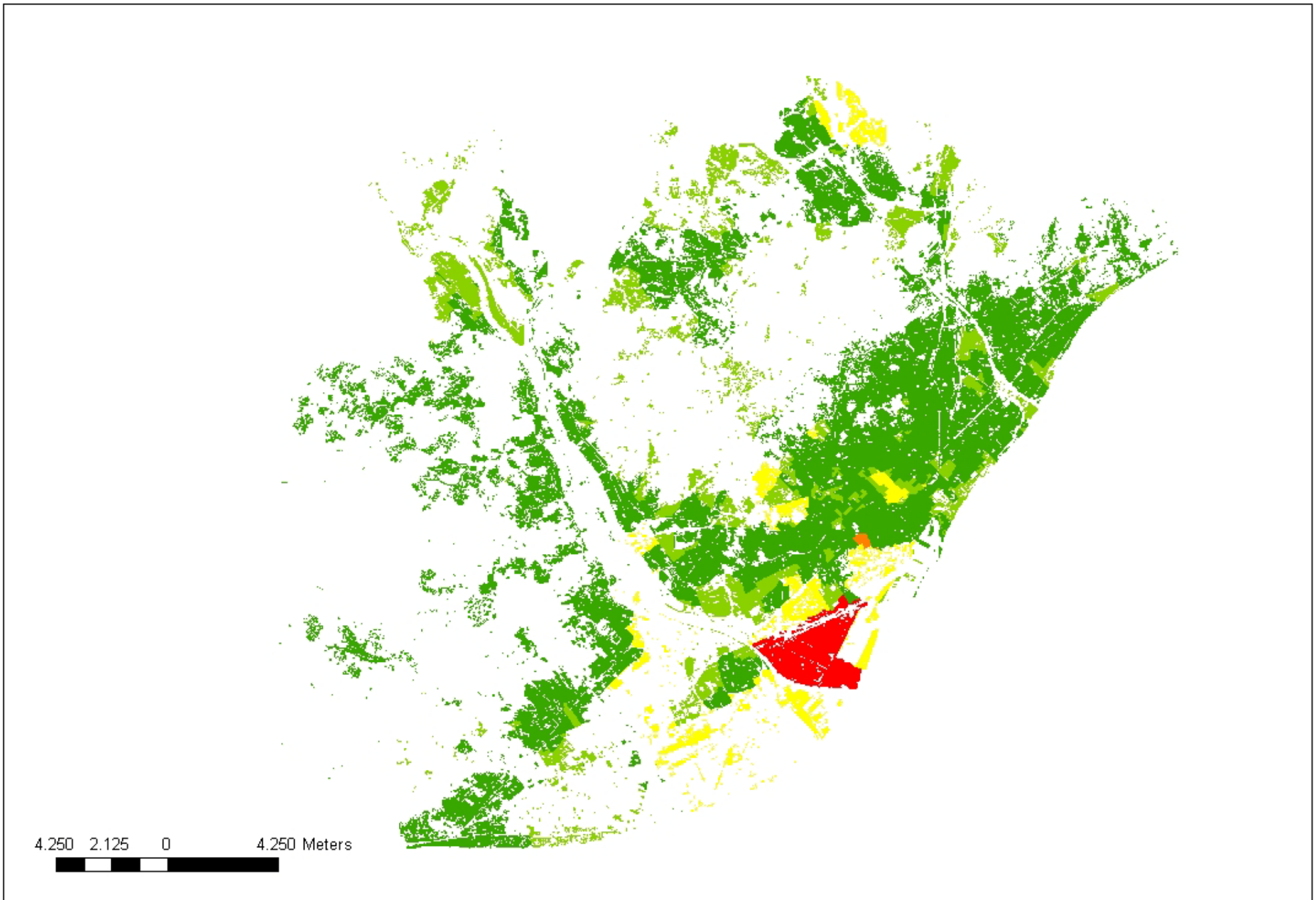
Intersecting census tracts and Land Cover

Redistributing Census Data to urban classes (Uc, Ul)

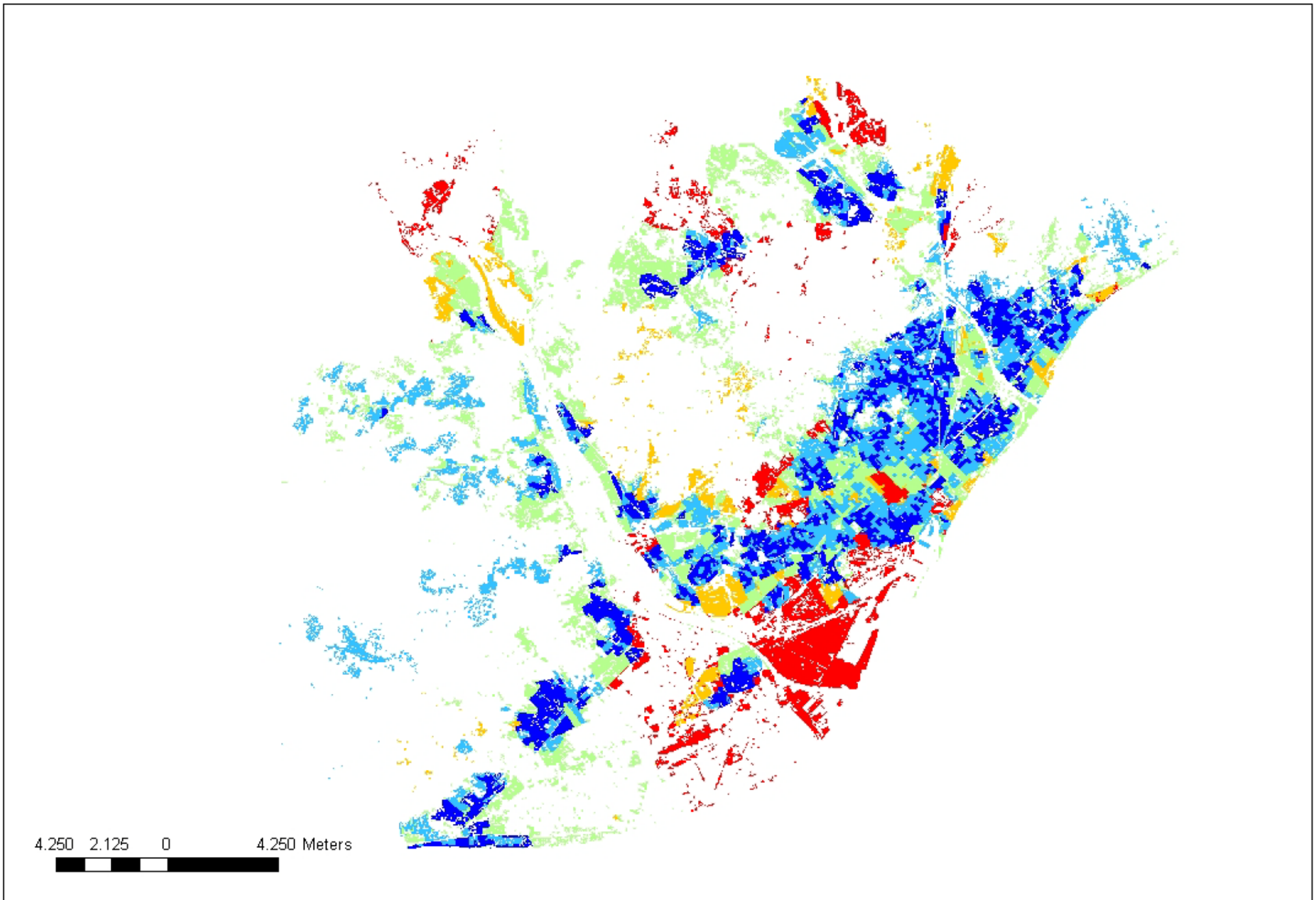
Available WF



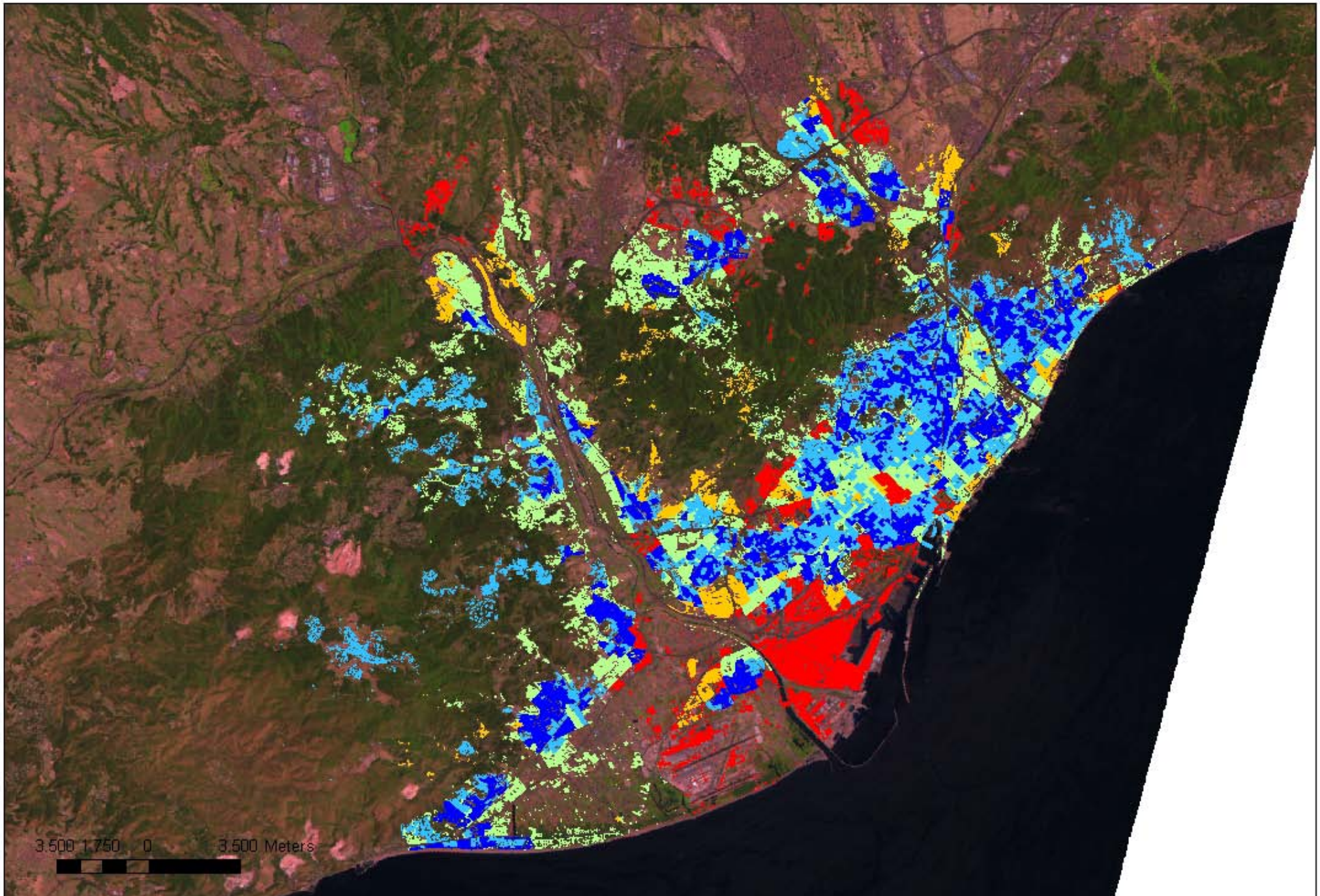
Invested WF



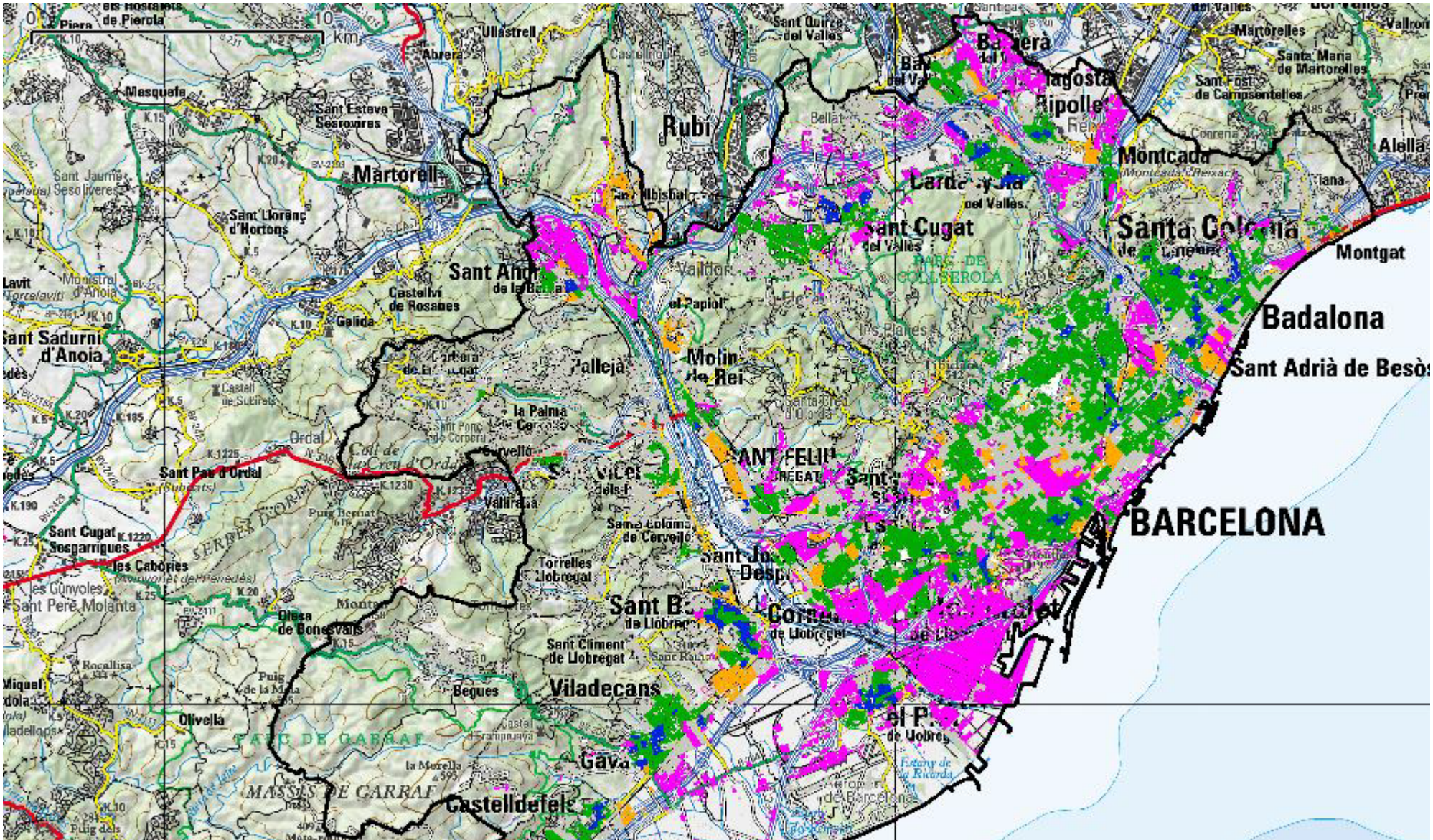
Available WF - Invested WF



Available WE - Invested WE



Available WF - Invested WF



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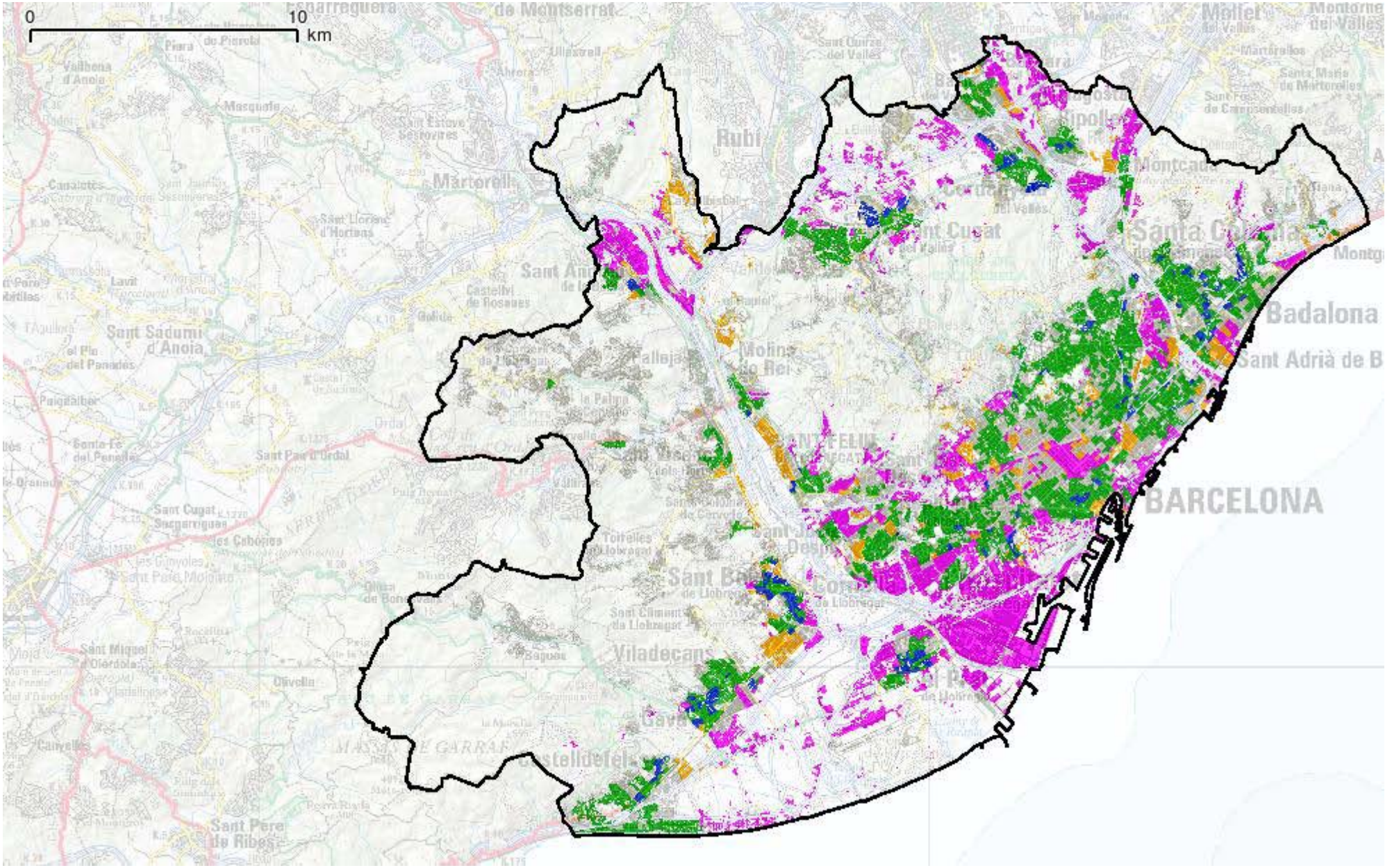

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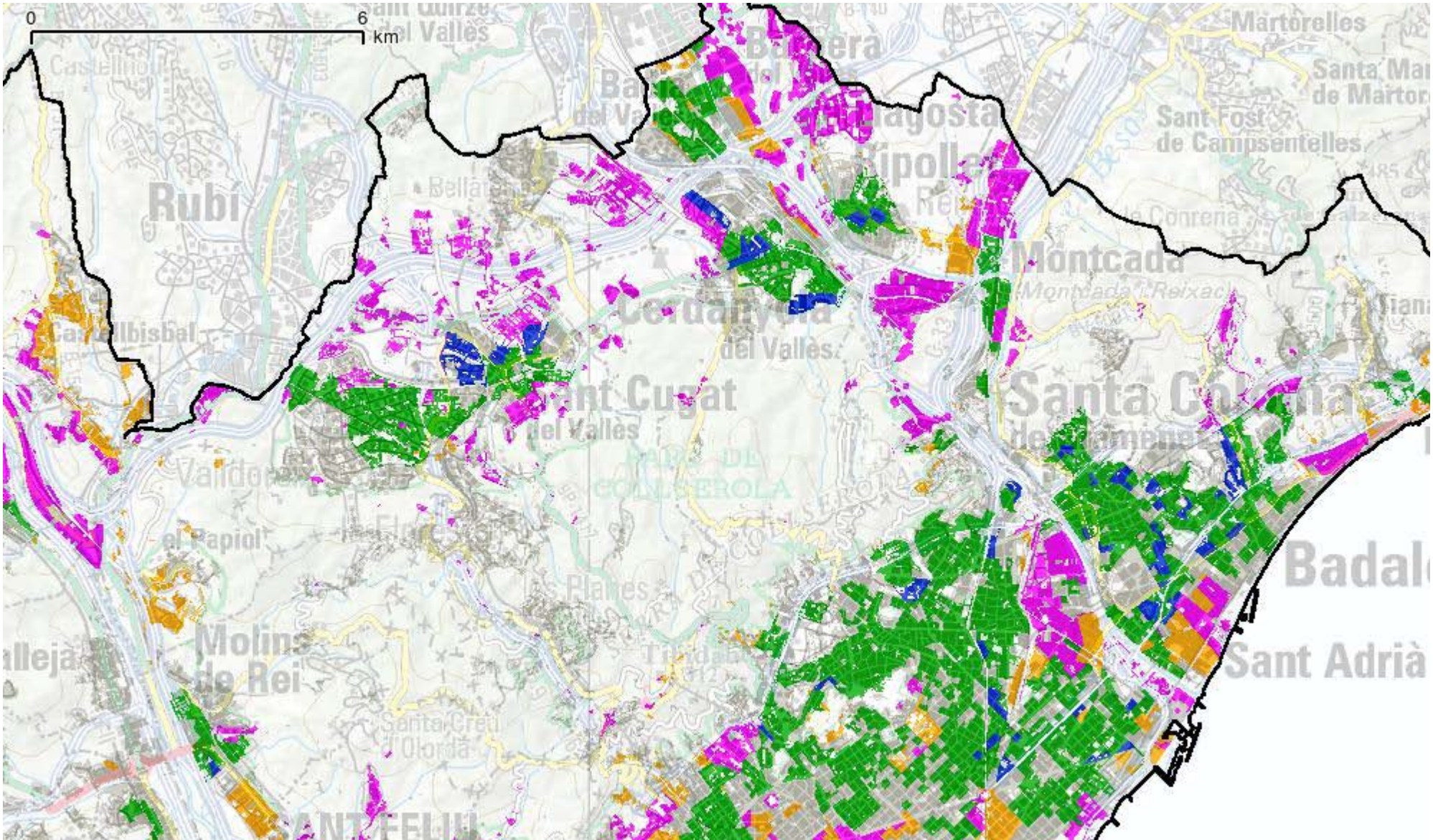
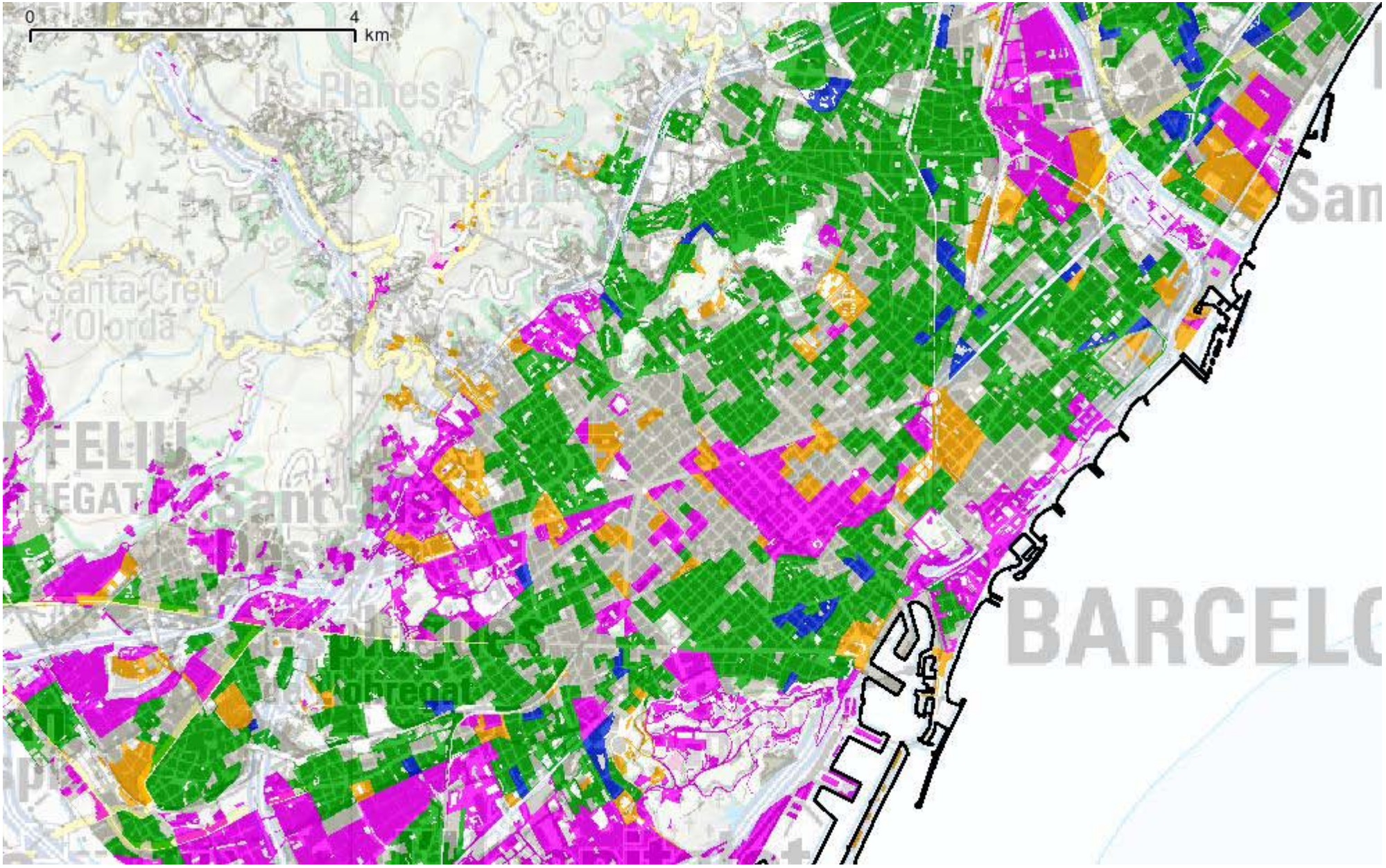
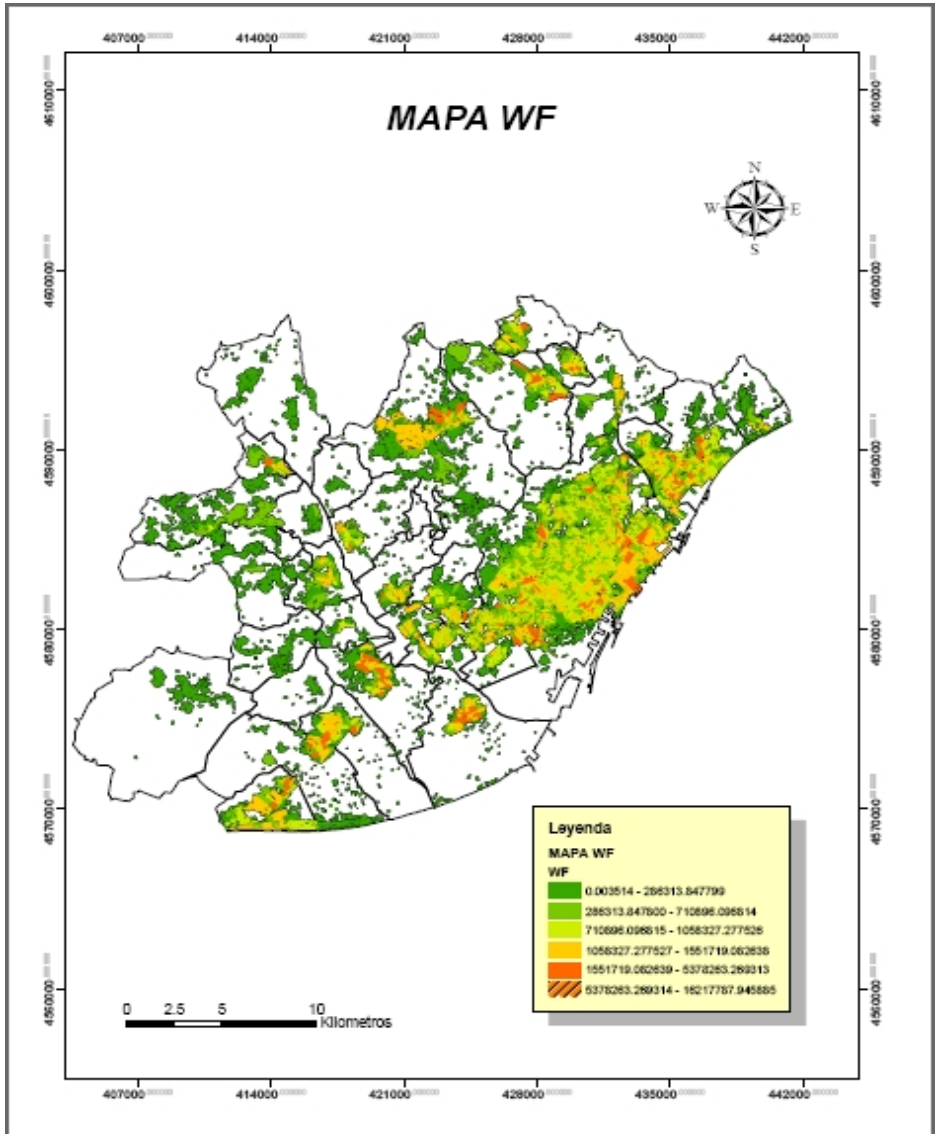


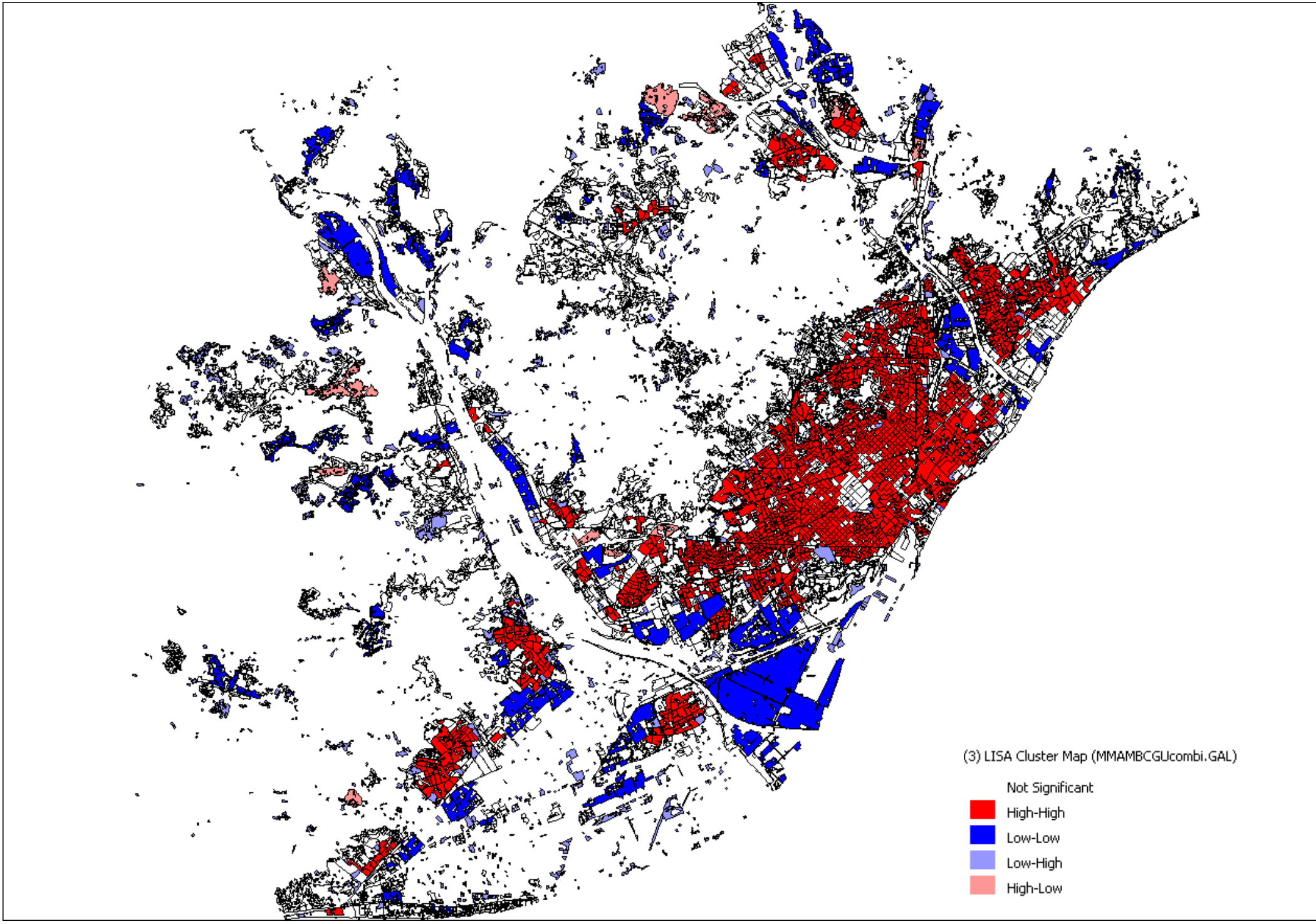
Available WF - Invested WF



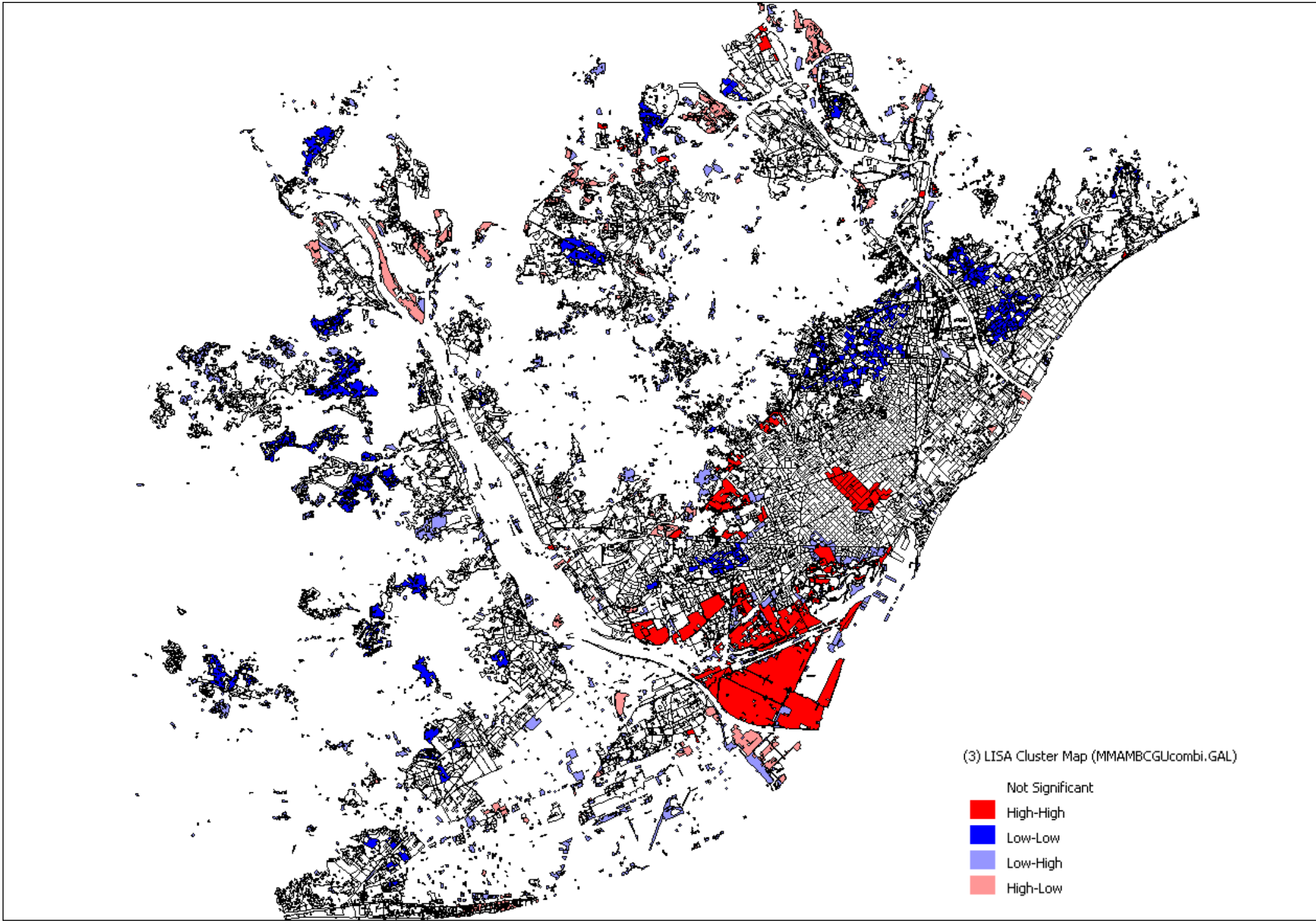
Available WF

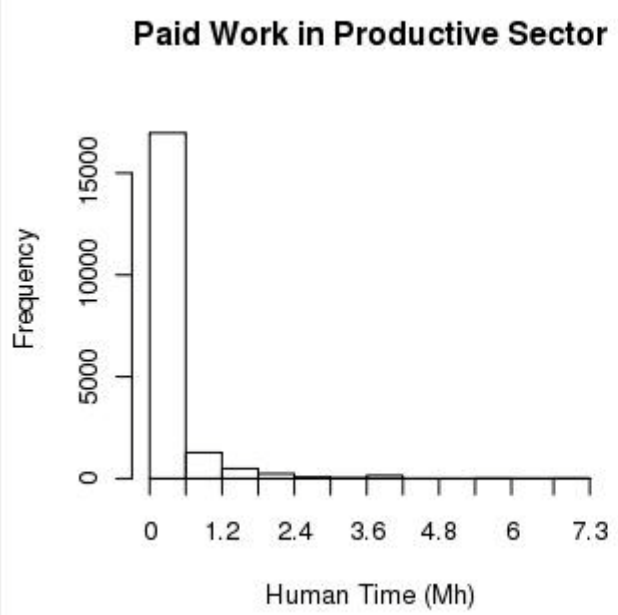


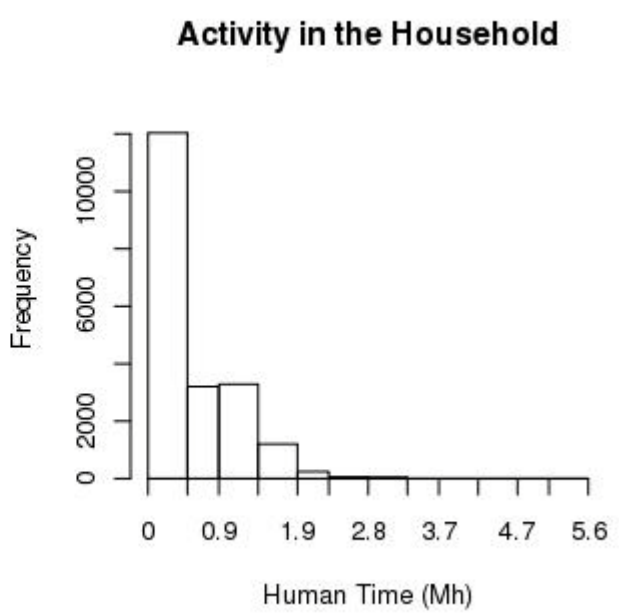
TIME SPENT IN HOUSEHOLD ACTIVITIES

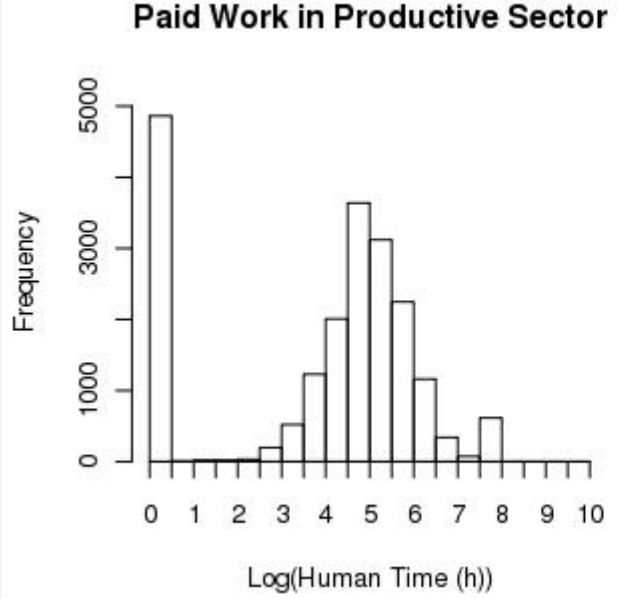


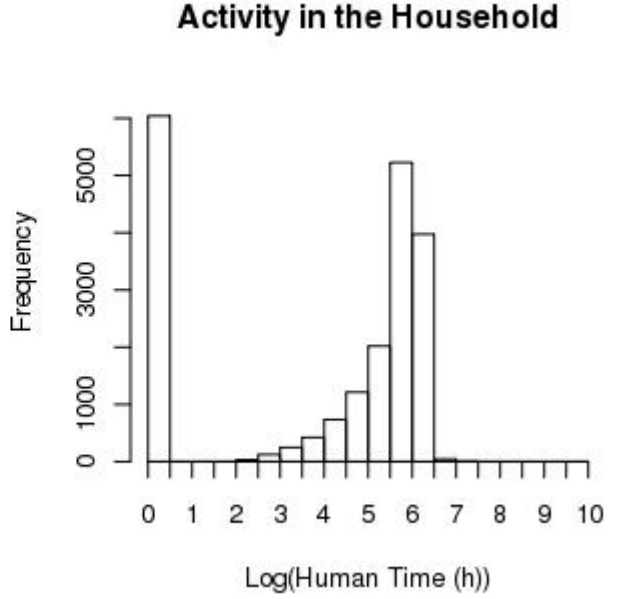
TIME SPENT IN PAID WORK IN PRODUCTIVE SECTORS

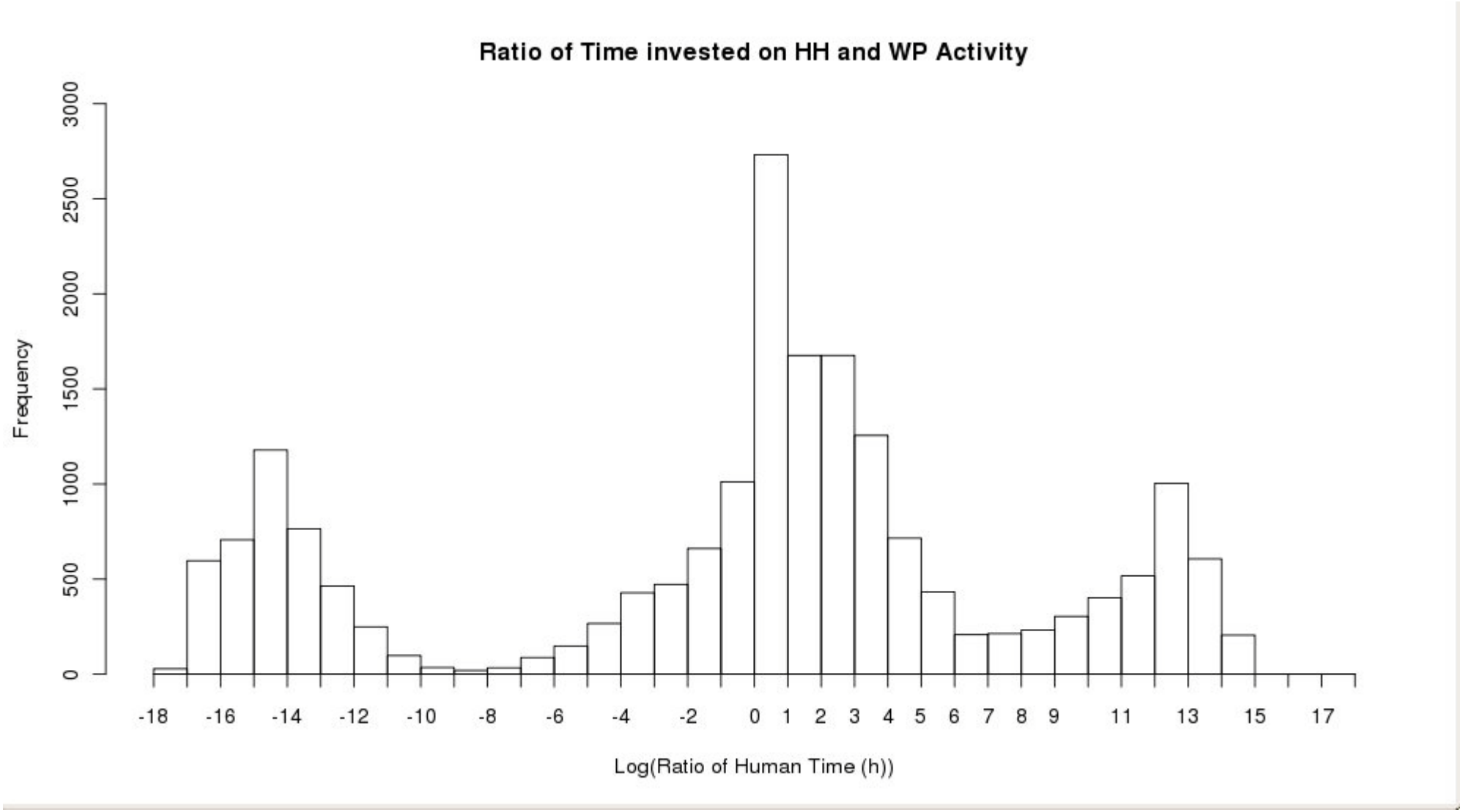


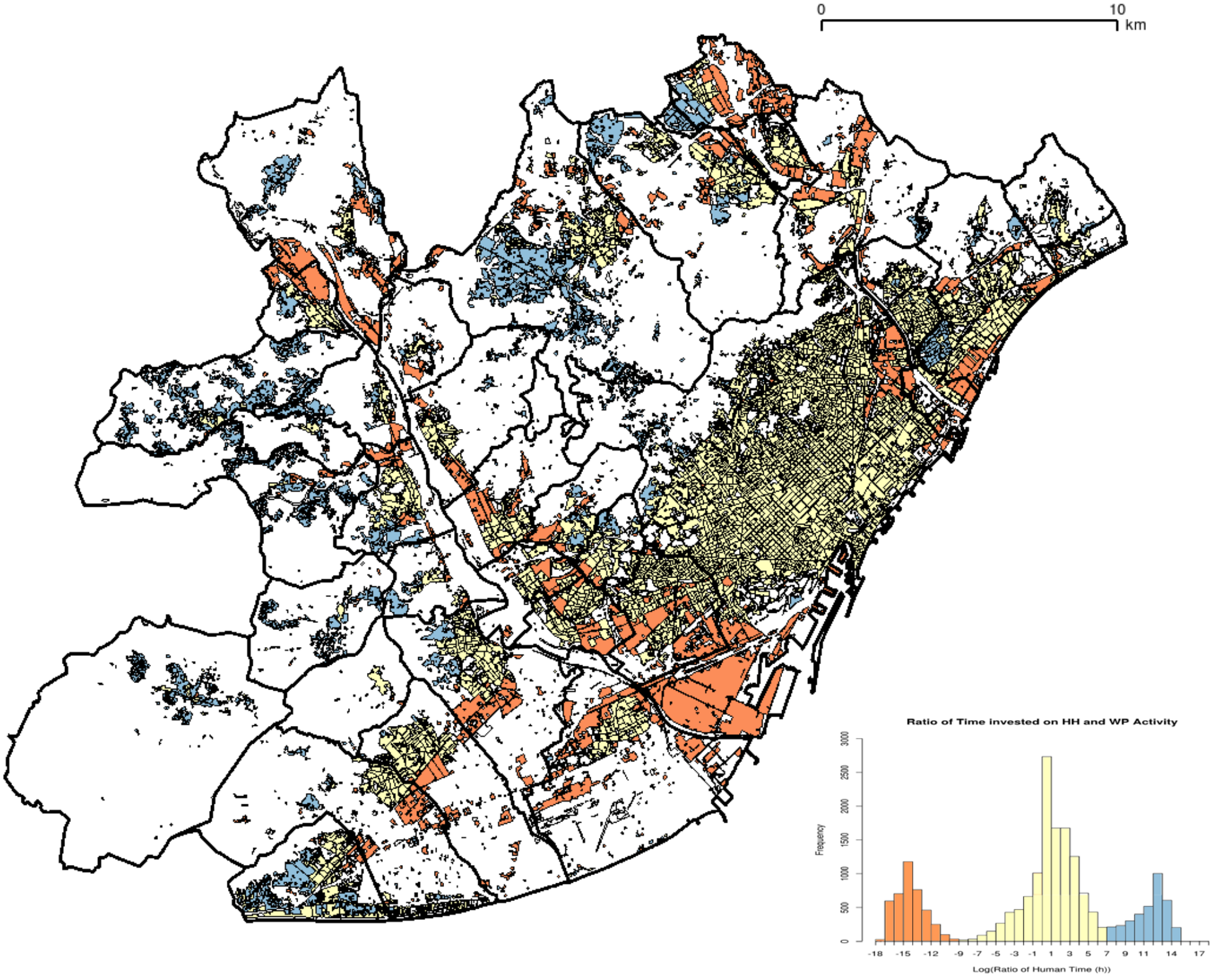

Paid Work in Productive Sector
Frequency
0
5000
10000
15000
0
1.2
2.4
3.6
4.8
6
7.3
Human Time (Mh)

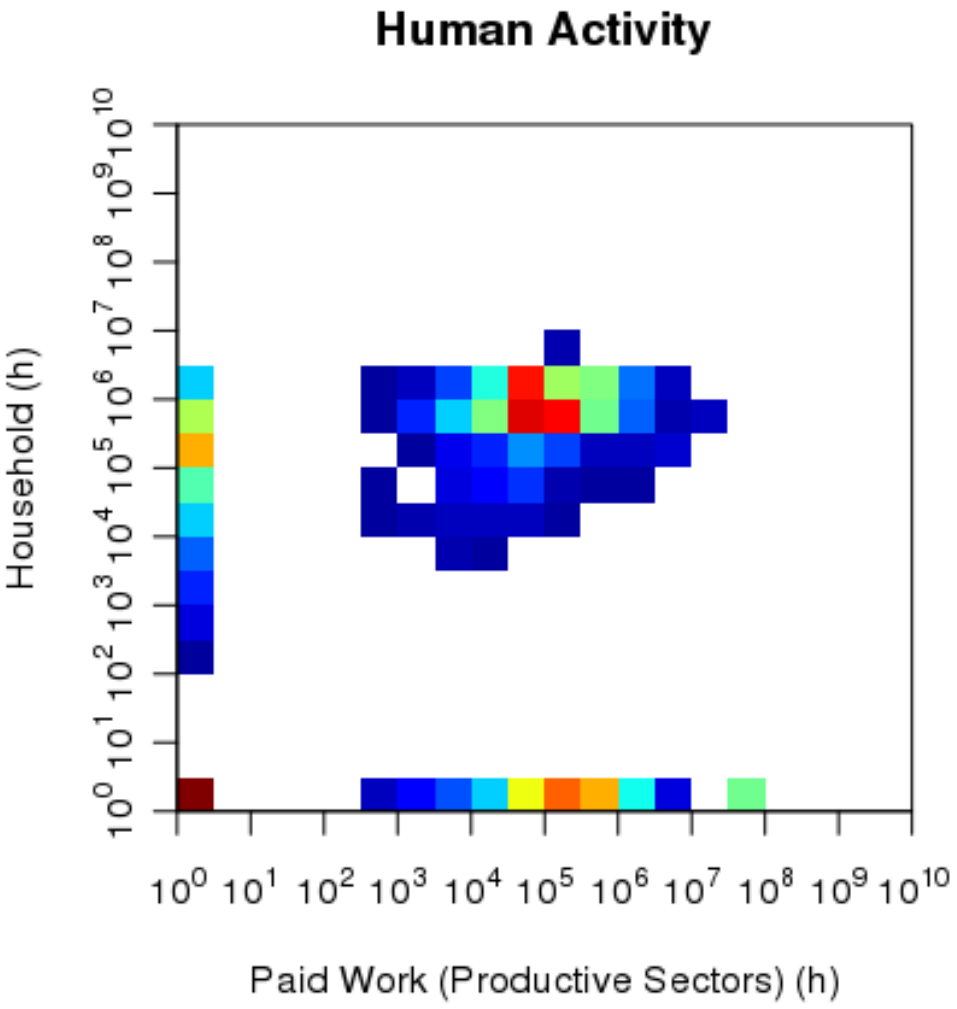

Activity in the Household
Frequency
0
2000
6000
10000
0
0.9
1.9
2.8
3.7
4.7
5.6
Human Time (Mh)

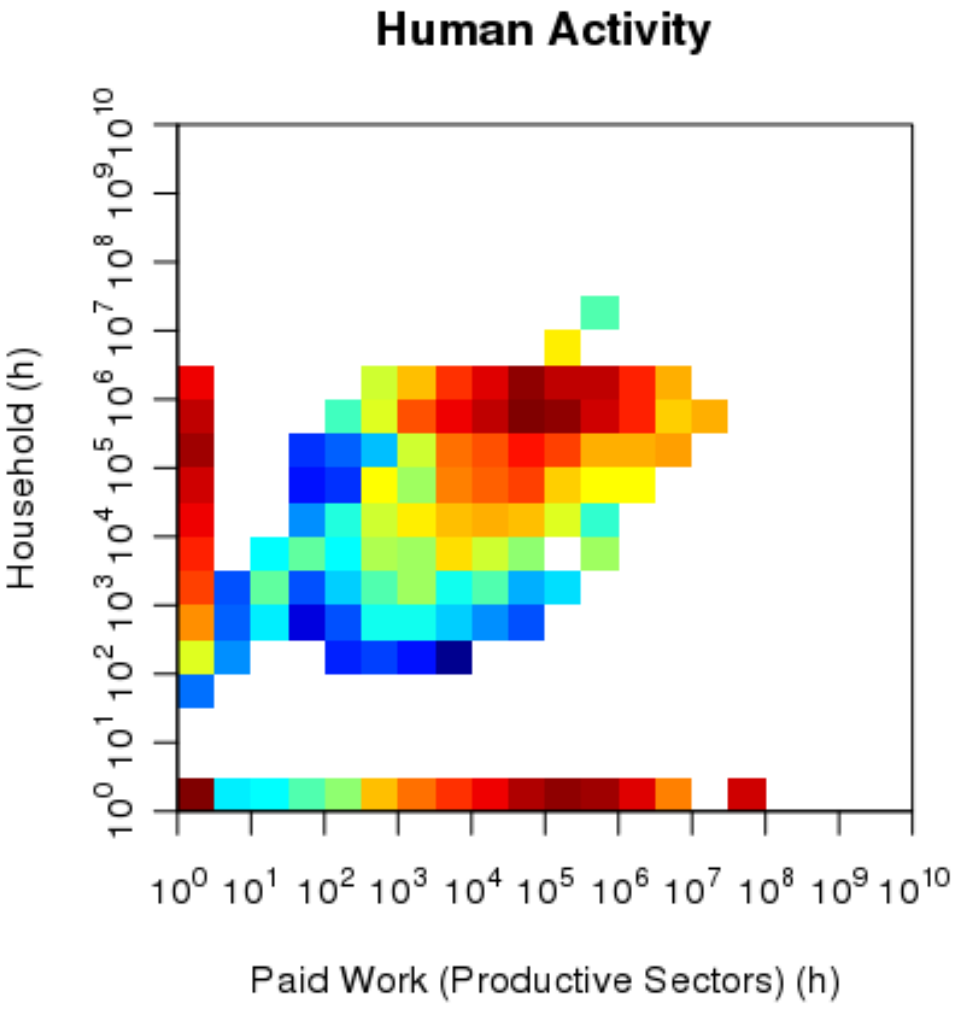

Paid Work in Productive Sector
Frequency
0
1000
3000
5000
0
1
2
3
4
5
6
7
8
9
10
Log(Human Time (h))

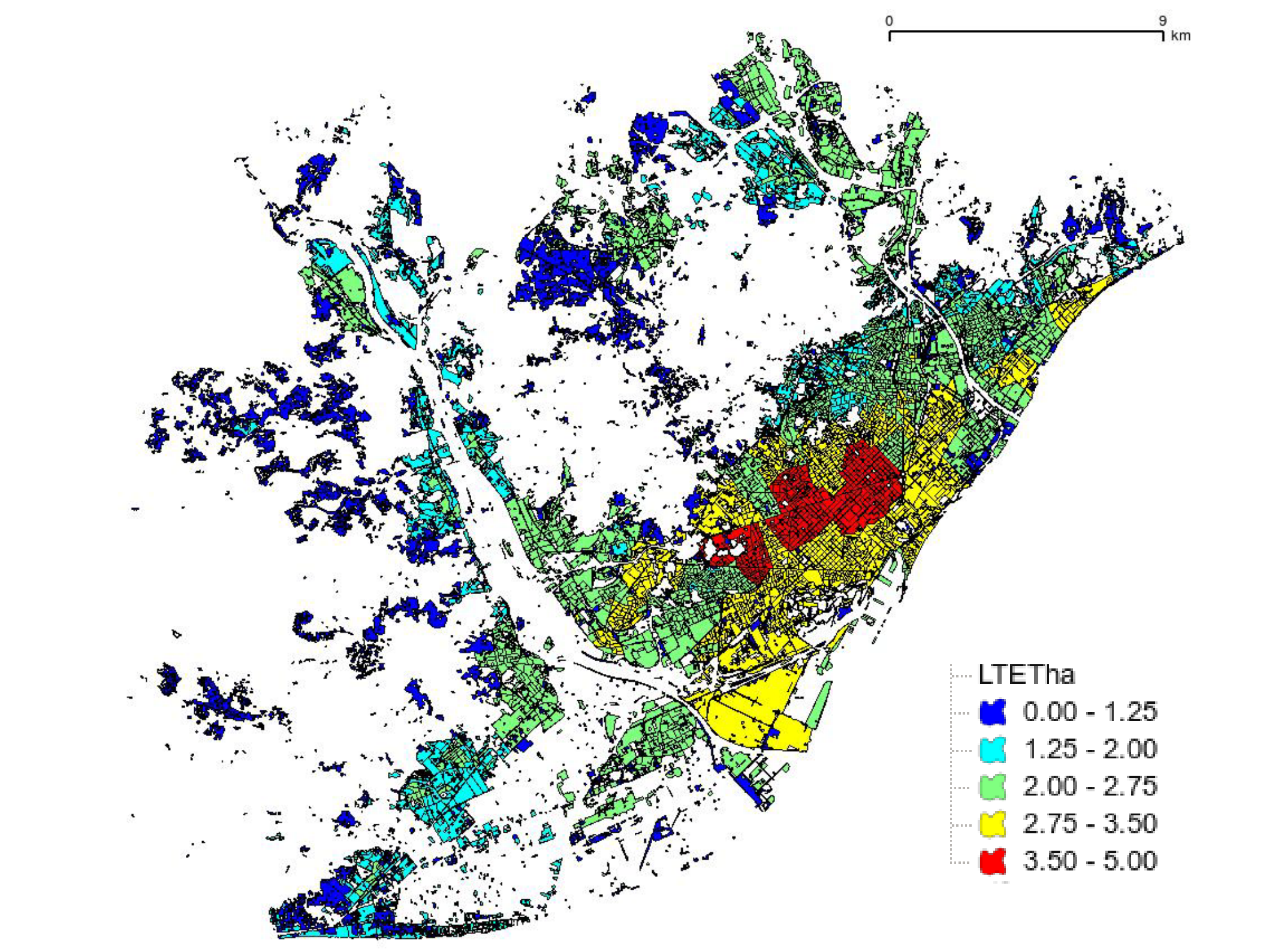

Activity in the Household
Frequency
0
1000
3000
5000
0
1
2
3
4
5
6
7
8
9
10
Log(Human Time (h))

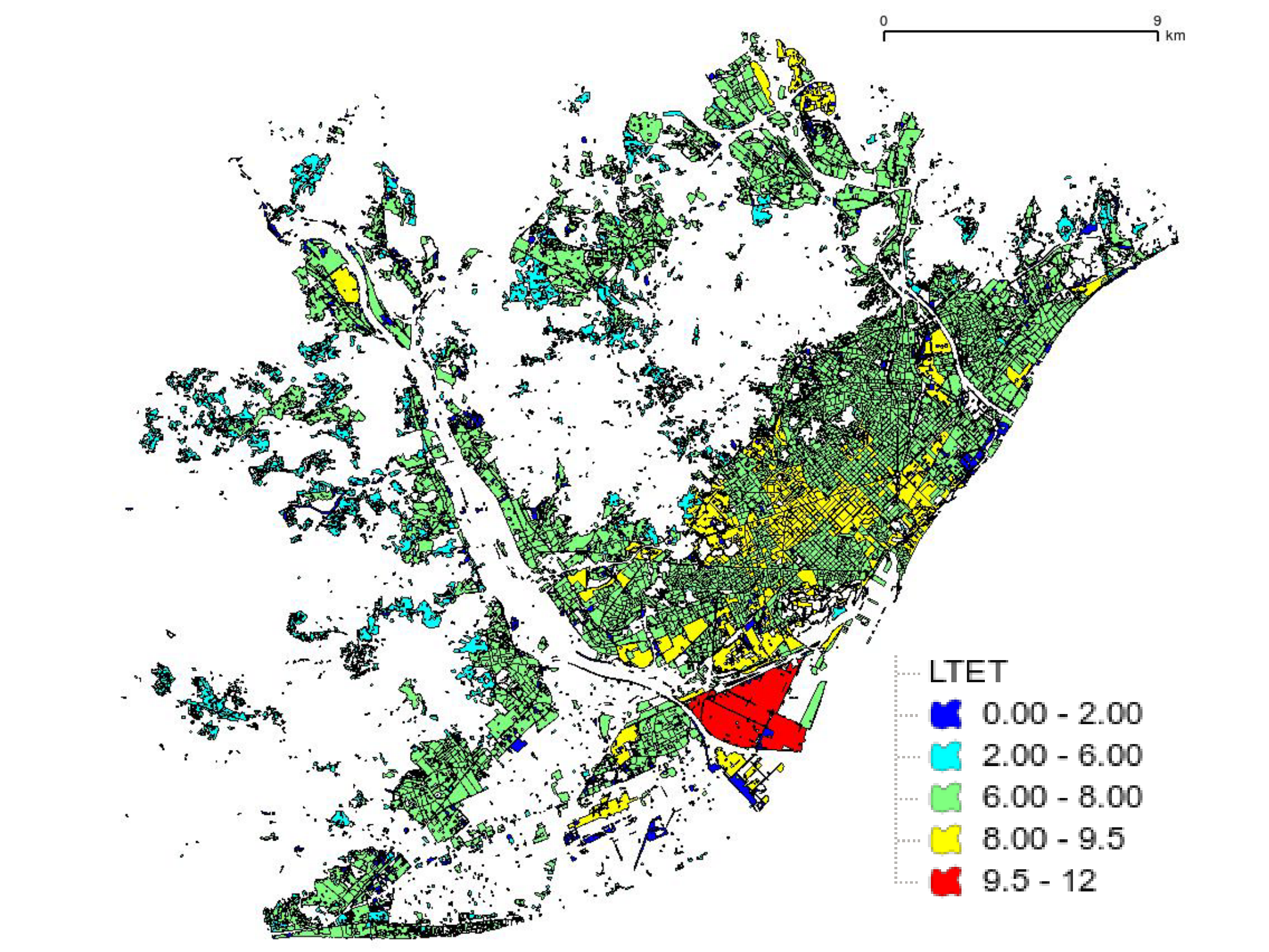

Ratio of Time invested on HH and WP Activity
Frequency
0
500
1000
1500
2000
2500
3000
-18
-16
-14
-12
-10
-8
-6
-4
-2
0
1
2
3
4
5
6
7
8
9
11
13
15
17
Log(Ratio of Human Time (h))


0
10
km
Ratio of Time invested on HH and WP Activity
Frequency
0
500
1000
1500
2000
2500
3000
-18
-15
-12
-9
-7
-5
-3
-1
1
3
5
7
9
11
14
17
Log(Ratio of Human Time (h))


Human Activity
Household (h)
10^0 10^1 10^2 10^3 10^4 10^5 10^6 10^7 10^8 10^9 10^{10}
10^0 10^1 10^2 10^3 10^4 10^5 10^6 10^7 10^8 10^9 10^{10}
Paid Work (Productive Sectors) (h)


Human Activity
Household (h)
10^0 10^1 10^2 10^3 10^4 10^5 10^6 10^7 10^8 10^9 10^{10}
10^0 10^1 10^2 10^3 10^4 10^5 10^6 10^7 10^8 10^9 10^{10}
Paid Work (Productive Sectors) (h)


0
9
km
LTEThа
0.00 - 1.25
1.25 - 2.00
2.00 - 2.75
2.75 - 3.50
3.50 - 5.00


0
9
km
LTET
0.00 - 2.00
2.00 - 6.00
6.00 - 8.00
8.00 - 9.5
9.5 - 12