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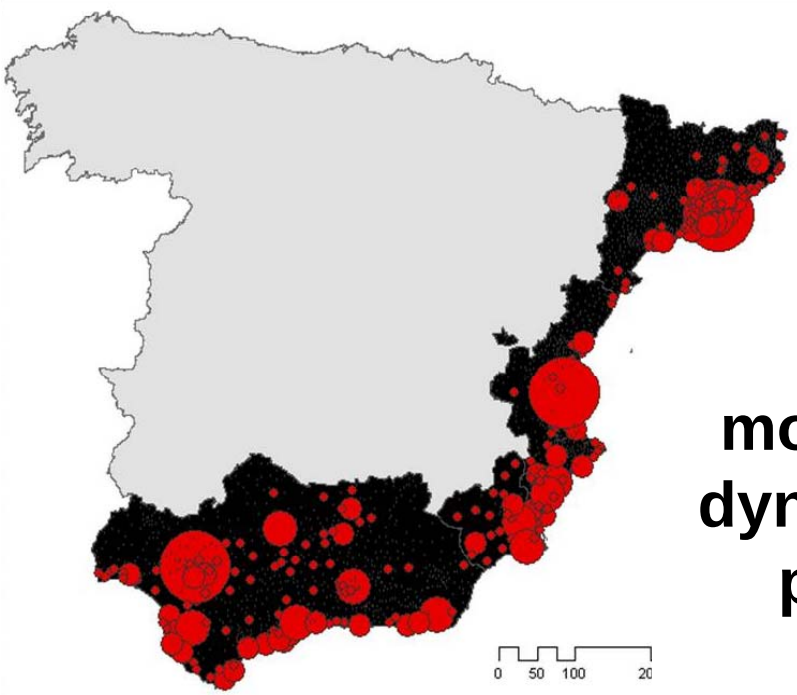

Spatial patterns of land use: morphology and demography, in a dynamic evaluation of urban sprawl phenomena along the Spanish Mediterranean coast

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Nicola **COLANINO**, Jorge **CERDA**, Josep **ROCA**

CONTENT OF THE PRESENTATION

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- **OBJECTIVES**
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- **METHODOLOGY**
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THE RESEARCH PROBLEM

- Urban form is one of the main characteristics of urban areas which affect its sustainability.

- Today is practically impossible discuss about European cities without taking into account phenomena of urban sprawl.

- The morphological approach is actually the main form to evaluated urban sprawl (dynamics of dispersion of artificial land in rural areas)

- Within these approach dominates a variety of relationships between the composing of parts or patches, such as the proximity, contiguity, distances, shape, etc.

- **It is not usual that the morphological approach take account demographic information, being that the resulting occupation of land (fragmentation and/or dispersion) is deriving from demographic and economic forces in time and space.**

OBJECTIVES

The present work propose a methodology to analyze the variation, in time and space, of the patterns of land occupation based on various indicators associated to the urban growth process.

The specifics objectives are:

- Calibrate a set of indicators capable to compose an explanatory model for delineating patterns of land occupation.

- Detect those areas of increasing urban pressure (in space and time) and the characters of urban models.

DATA AND STUDY AREA

The analysis takes into account the rate of population and the amount of land consumed for the urbanization, during around twenty years, with three temporal stages (1990, 2000, and 2006).

The database used to compute the developed area is the CORINE Land Cover project. The classes used in the analysis of urban land for this period, were those described in the first level of CORINE's artificial land

For the population data, was used the information of the Spanish National Statistics Institute (INE) for the years 1991, 2001 and 2006.

For all the country, we have information (developed land for three years and population) only for 3.500 municipalities, from the 8.000 municipalities in Spain.

METHODOLOGY

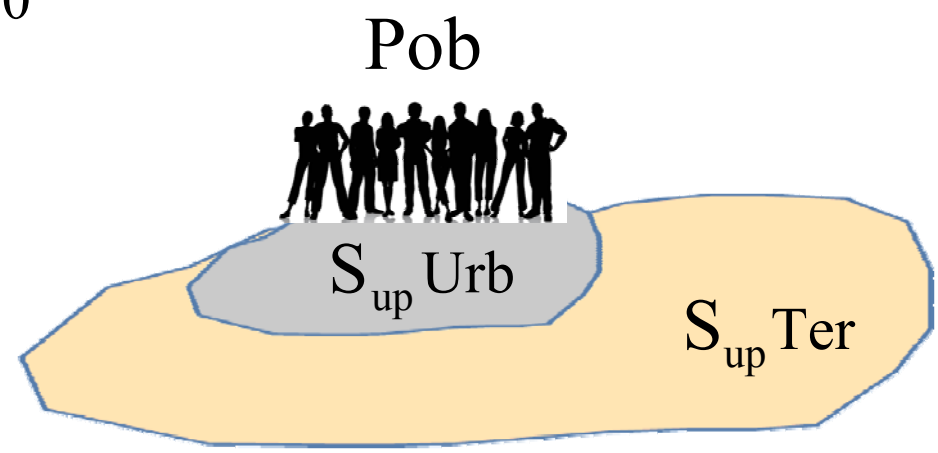
The analysis about urban models of territorial occupation is carried out by applying quantitative indices concerning to the form and structure of the profile of urban patches, and the intensity of urbanization in terms of density of population and occupied area. The different indices can be classified in four main dimensions:

1.- Population density and occupation

Land Occupation $$Os = \frac{S_{up}\,Urb}{S_{up}\,Ter} * 100$$

Gross Density $$D_B = \frac{Pob}{S_{up}\,Ter}$$

Net Density $$D_N = \frac{Pob}{S_{up}\,Urb}$$

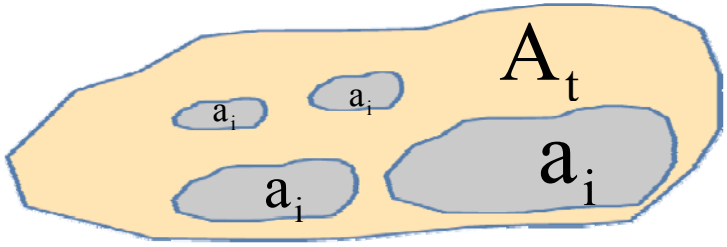


METHODOLOGY

2.- Diversity of patches

Shannon Diversity $$SHDI = -1 \sum_{i=1}^{n} [P_i (\ln P_i)]$$

Shannon Evenness $$SHEI = \frac{-\sum_{i=1}^{n} [P_i (\ln P_i)]}{\ln m}$$



Gini Relative Index of Concentration

$$C_G = \frac{2}{(n-1)} \sum_{i=0}^{n} (Pi - Qi)$$

$$Pi = \frac{a_i}{A_t}$$

Degree of Landscape Division

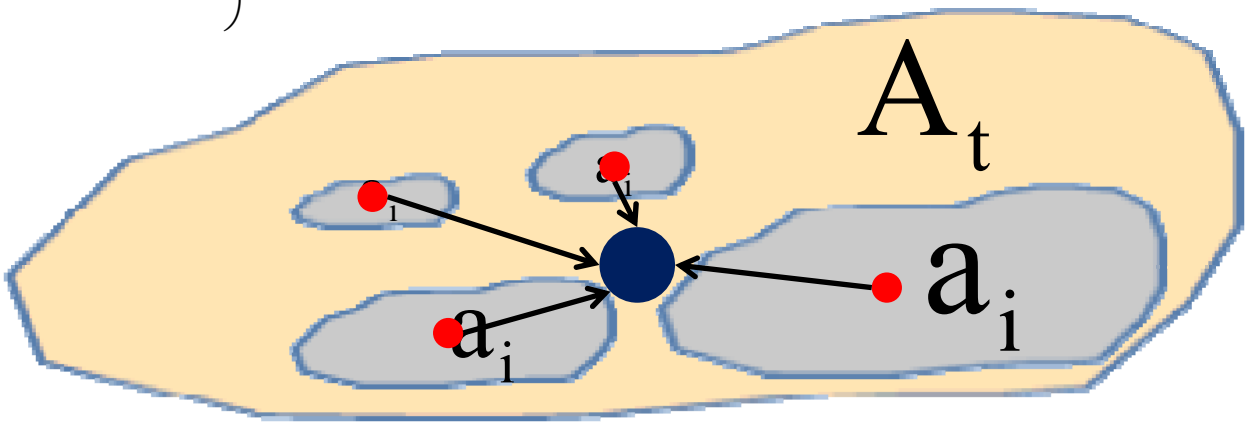
$$D = 1 - \sum_{i=1}^{n} \left(\frac{a_i}{A_t} \right)^2$$

METHODOLOGY

3.- Distance between patches

Standard Distance

$$SD_w = \sqrt{\left(\frac{\sum_{i=1}^{n} a_i (x_i - \bar{X})^2}{A_t}\right) + \left(\frac{\sum_{i=1}^{n} a_i (y_i - \bar{Y})^2}{A_t}\right)}$$

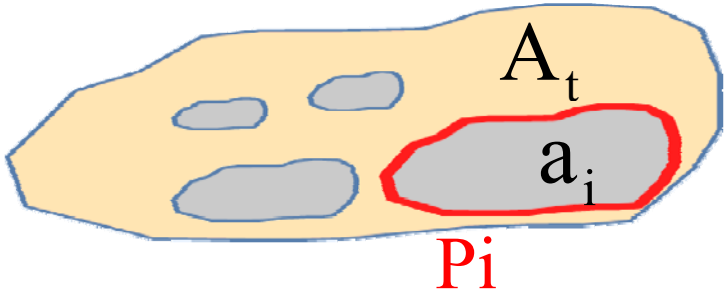


METHODOLOGY

4.- Form of patches

Area Weighted Mean Shape Index

$$AWMSI = \sum_{i=1}^{n} \frac{\left(\frac{p_i}{2\sqrt{\pi a_i}} \cdot a_i \right)}{A_t}$$

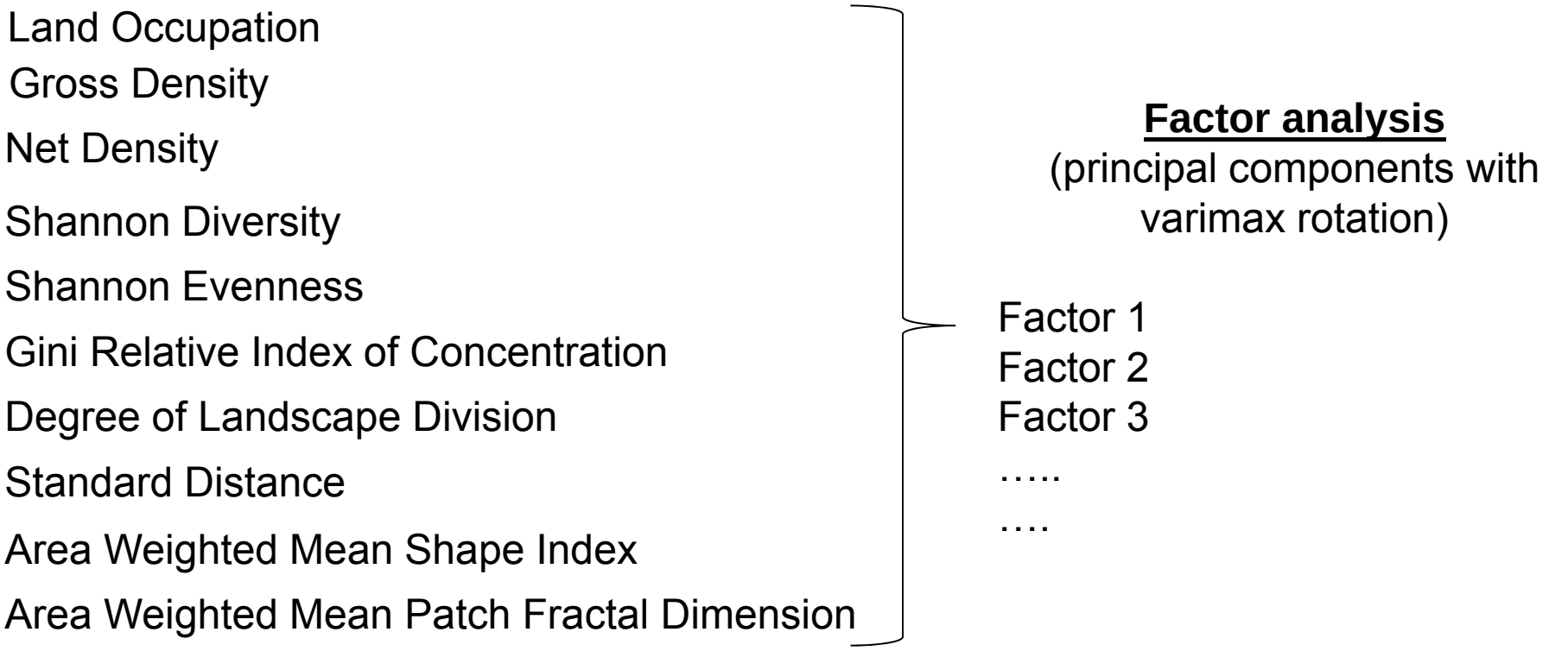


Area Weighted Mean Patch Fractal Dimension

$$AWMPFD = \sum_{i=1}^{n} \frac{\left[\frac{2\ln(0{,}25 \cdot p_i)}{\ln a_i} \cdot a_i \right]}{A_t}$$

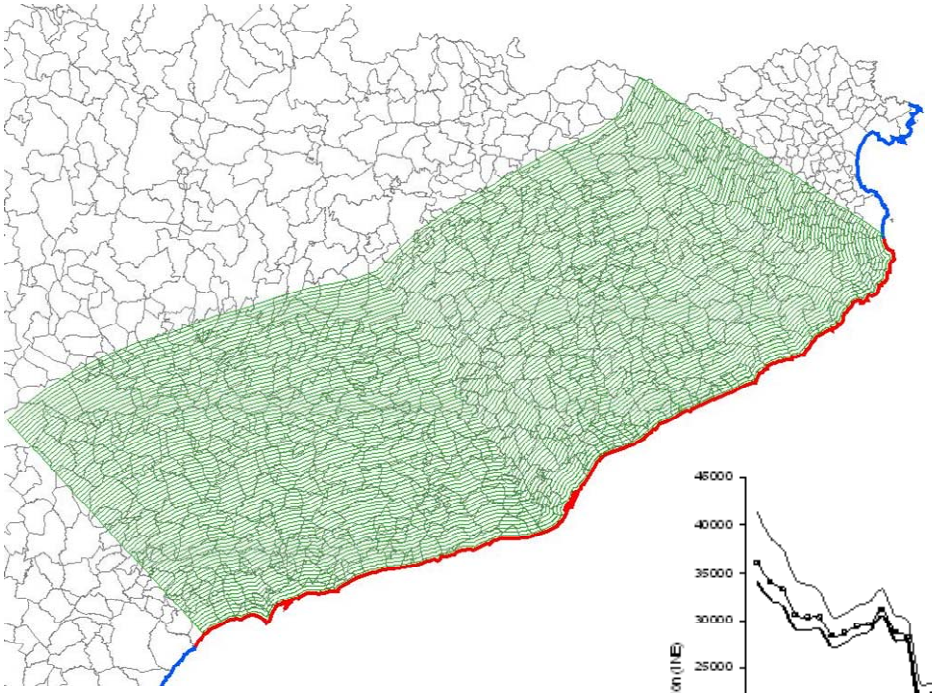
METHODOLOGY

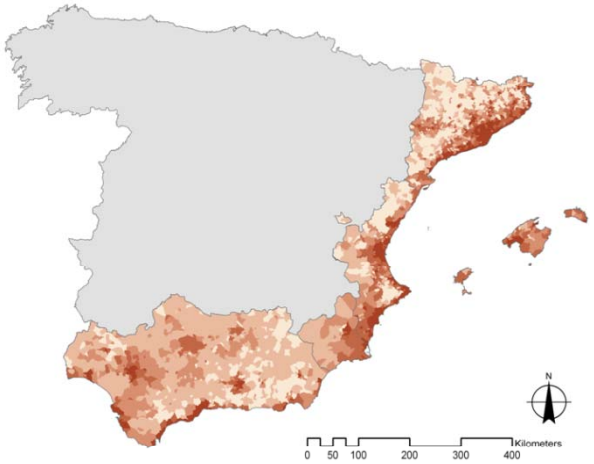
The exploratory statistical analysis of the different indicators **show strong correlations between them**. So, it was decided to employ the method of principal components of the factorial analysis to avoid colinearity, and in order to obtain synthetic indicators taking into account the main characteristics of the initial indices.

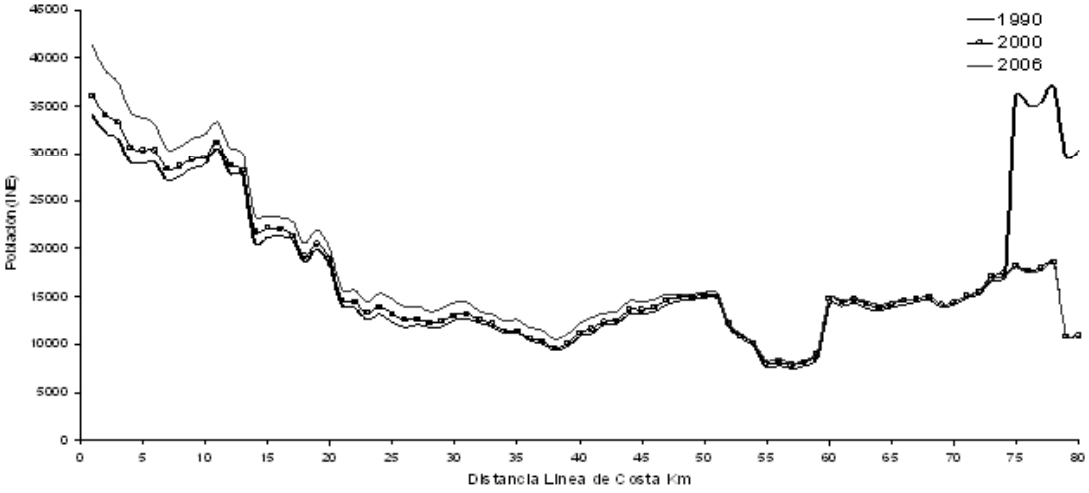


METHODOLOGY

To plot the trend of the indices along the Mediterranean coast, between 1990 and 2006, it has been calculated the average of variables at each kilometer of land parallel to the coastal line, and up to 80 km. So, we obtain the “profile” from the coast to the 80 km, of the different synthetics indices.







RESULTS

Factor analysis (principal components with varimax rotation)

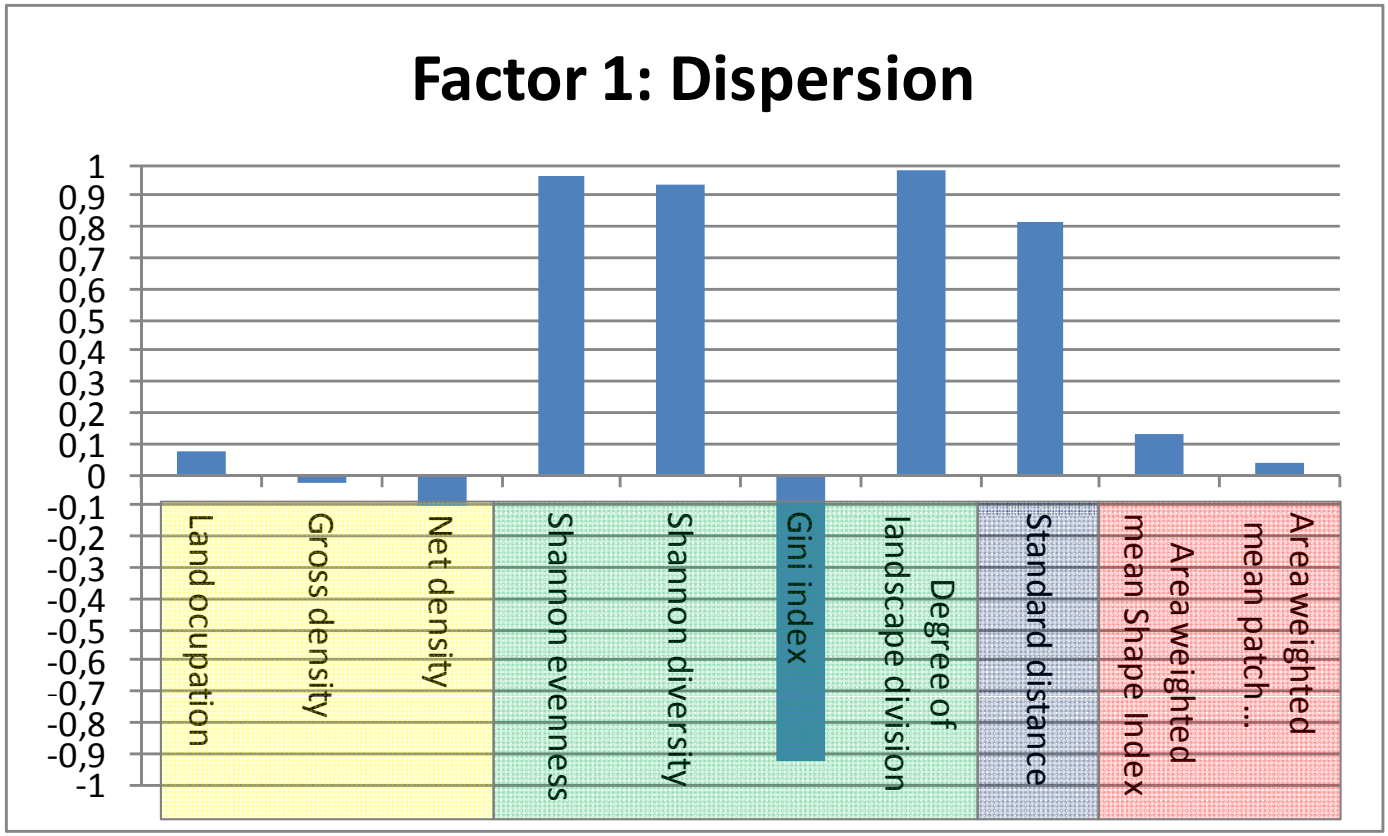
Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	% of Variance	Total	% of Variance	Cumulative %
1	4,420	44,201	44,201	4,420	44,201	44,201	4,315	43,152	43,152
2	2,015	20,150	64,351	2,015	20,150	64,351	1,824	18,235	61,387
3	1,607	16,066	80,418	1,607	16,066	80,418	1,774	17,737	79,124
4	,916	9,163	89,581	,916	9,163	89,581	1,046	10,457	89,581

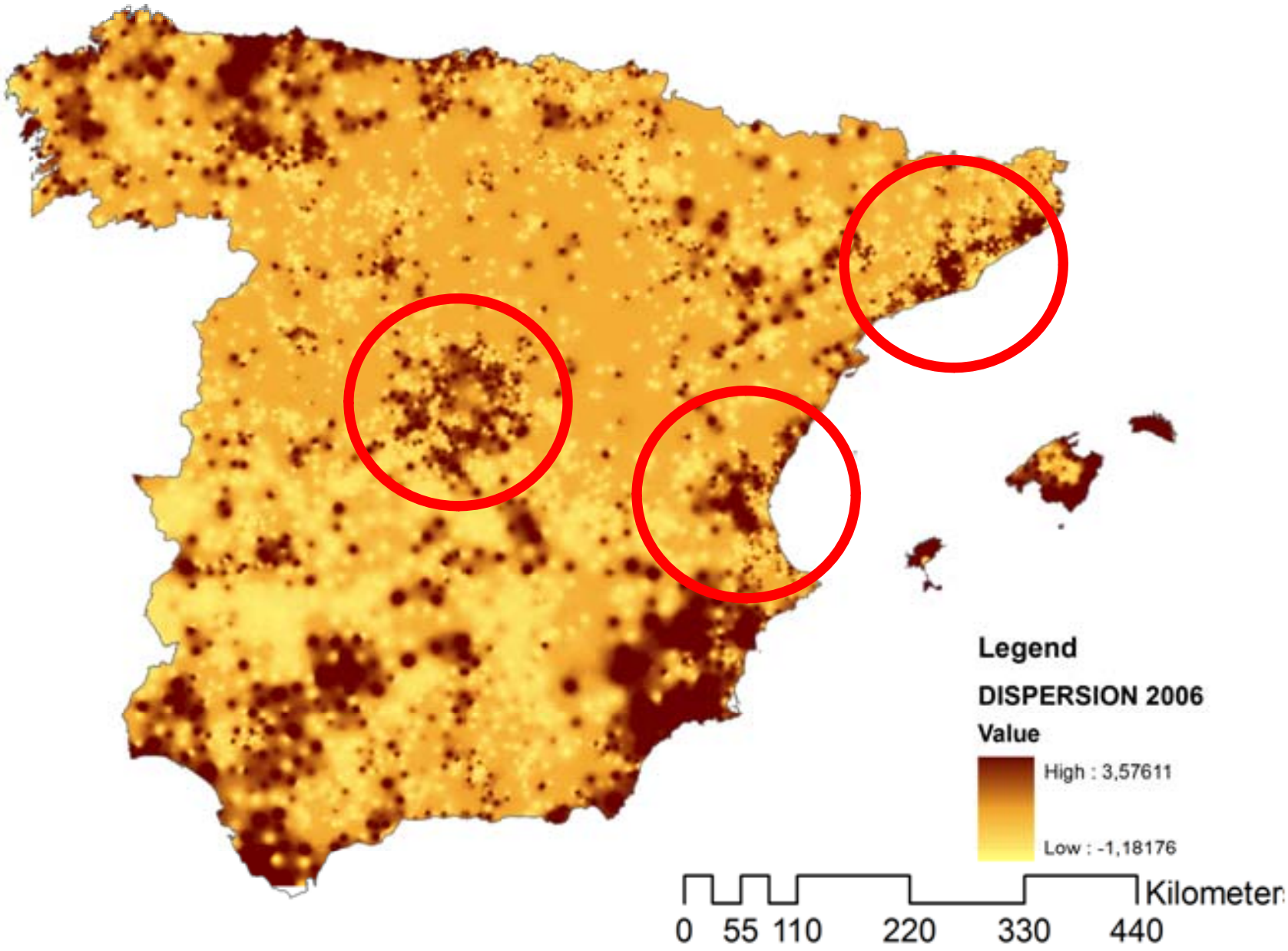
Extraction Method: Principal Component Analysis.

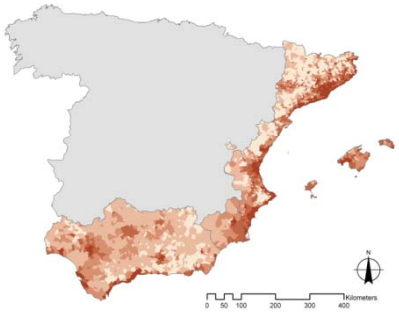
KMO= 0,688

RESULTS

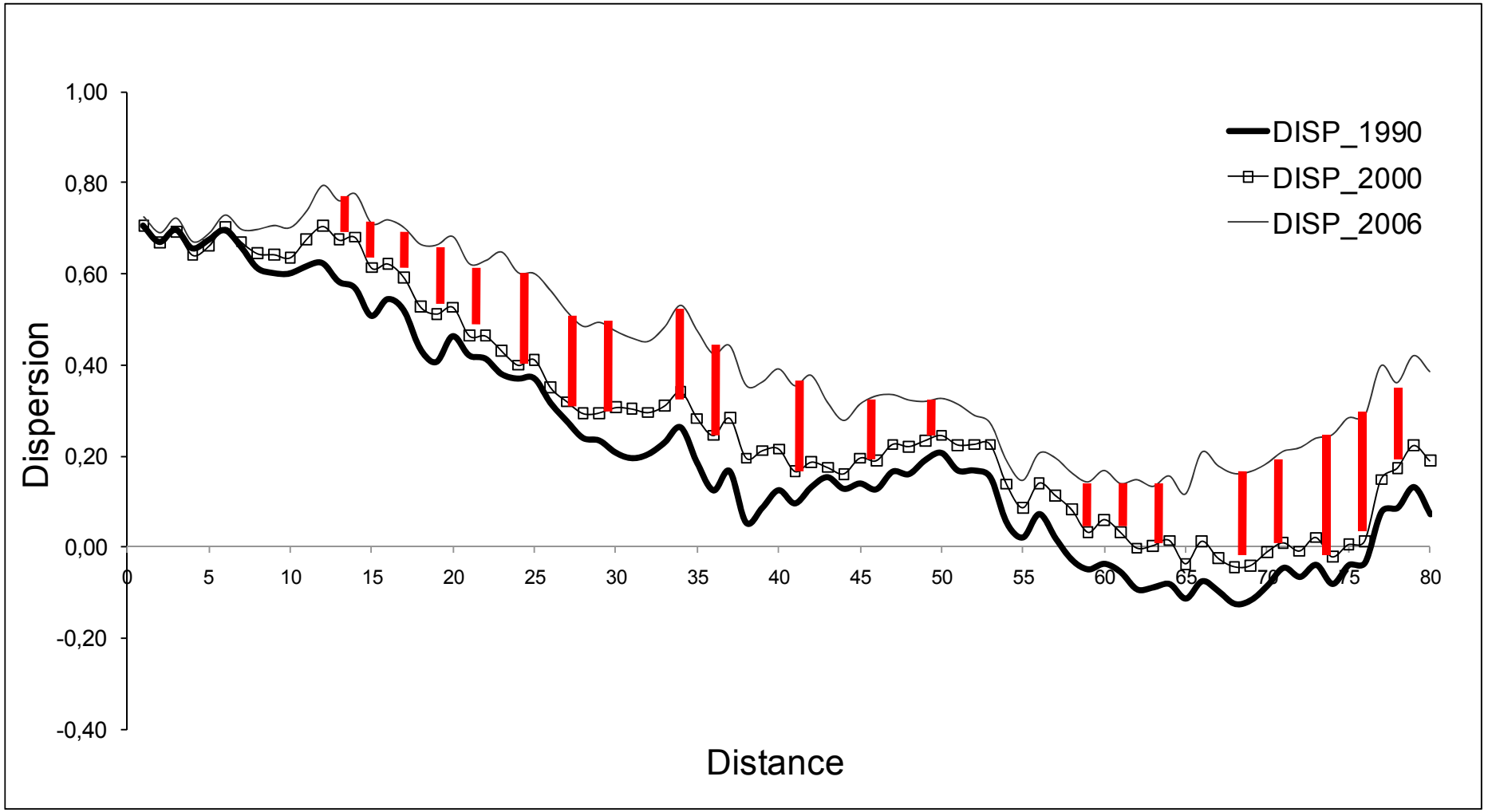

Factor 1: Dispersion
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
-0,1
-0,2
-0,3
-0,4
-0,5
-0,6
-0,7
-0,8
-0,9
-1
Land ocupation
Gross density
Net density
Shannon evenness
Shannon diversity
Gini index
Degree of landscape division
Standard distance
Area weighted mean Shape Index
Area weighted mean patch ...

RESULTS

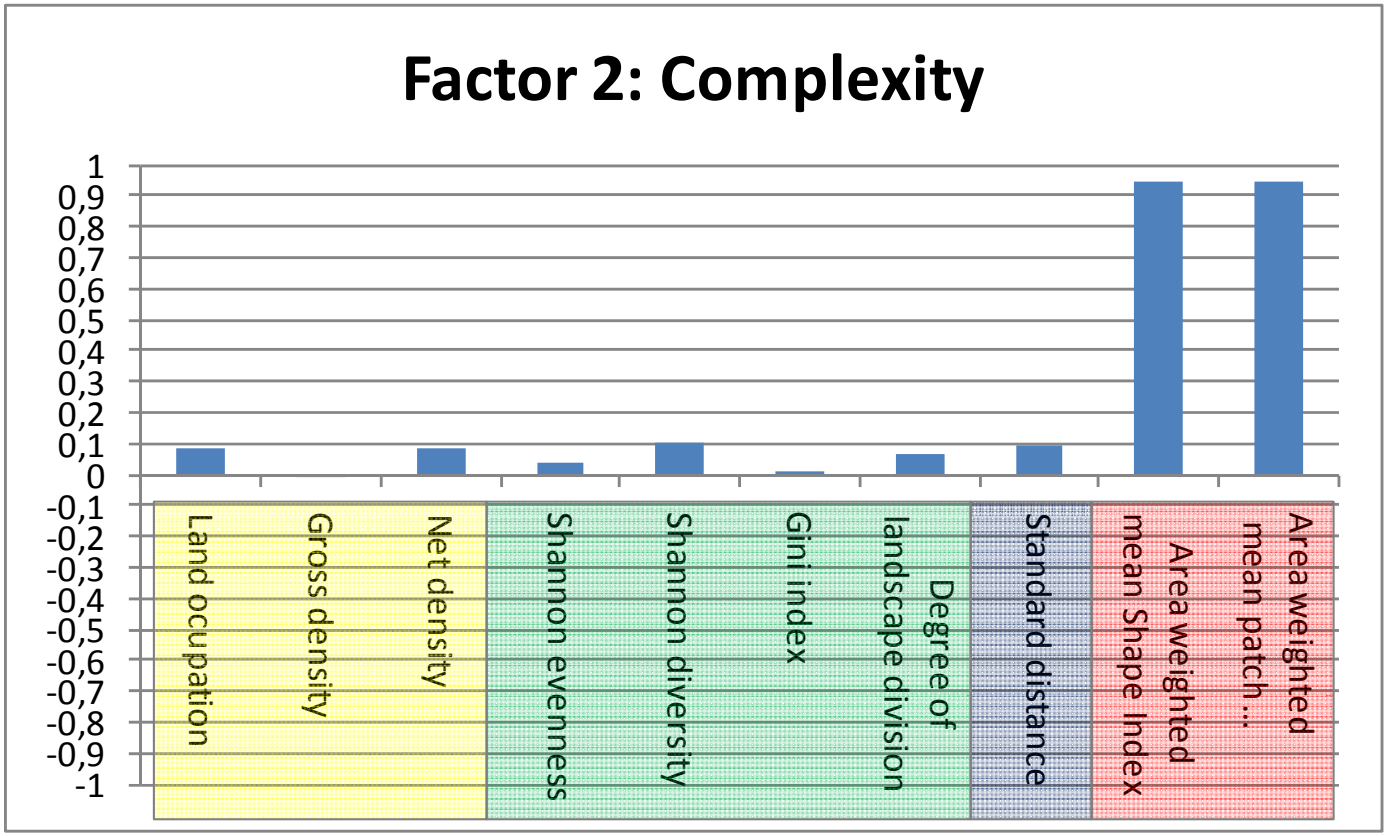

Legend
DISPERSION 2006
Value
High : 3,57611
Low : -1,18176
0 55 110 220 330 440
Kilometers

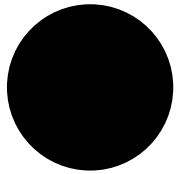


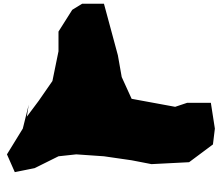
RESULTS


1,00
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
Dispersion
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Distance
DISP_1990
DISP_2000
DISP_2006

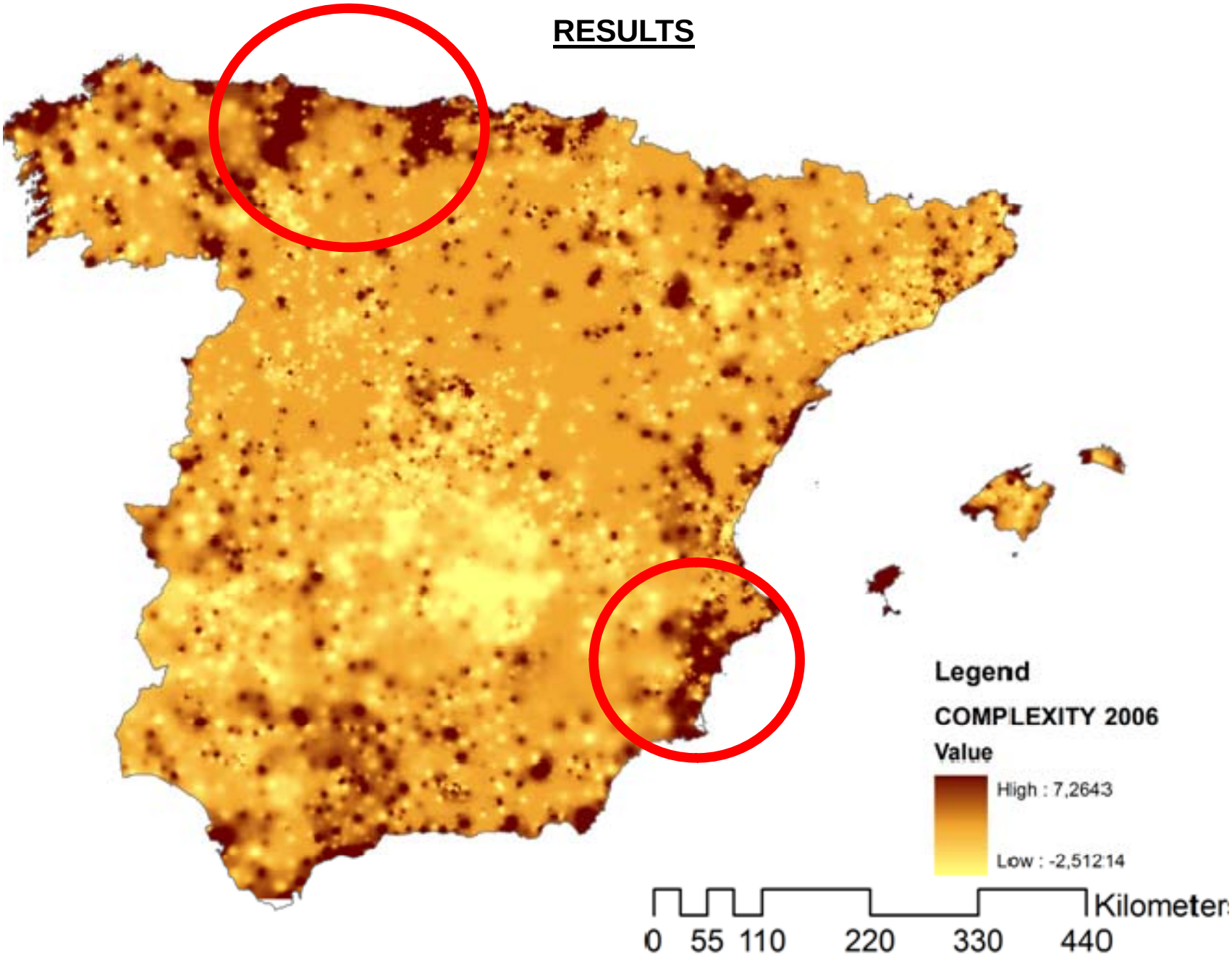
RESULTS

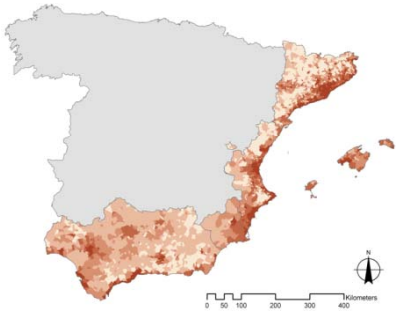

Factor 2: Complexity
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
-0,1
-0,2
-0,3
-0,4
-0,5
-0,6
-0,7
-0,8
-0,9
-1
Land ocupation
Gross density
Net density
Shannon evenness
Shannon diversity
Gini index
Degree of landscape division
Standard distance
Area weighted mean Shape Index
Area weighted mean patch ..



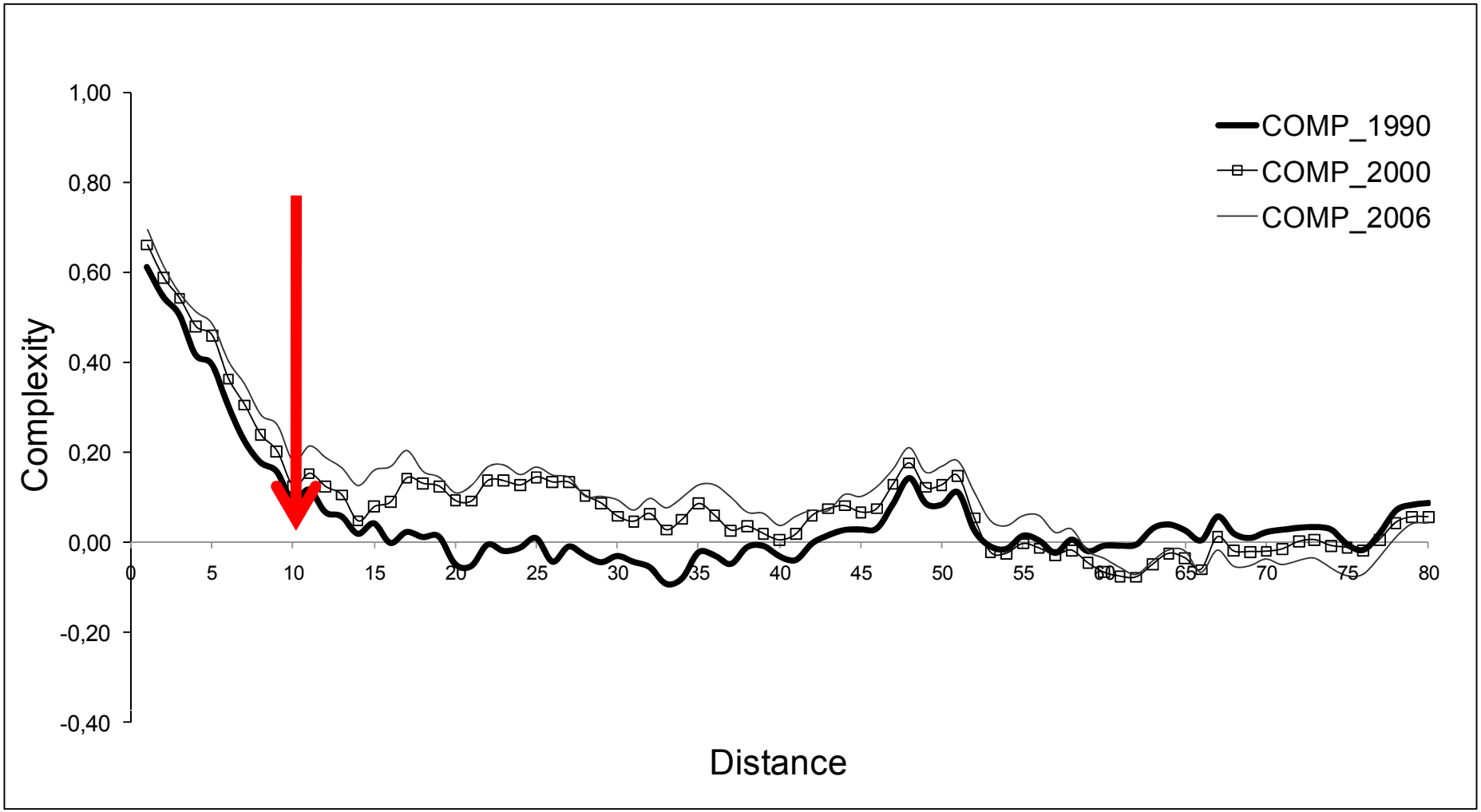


RESULTS

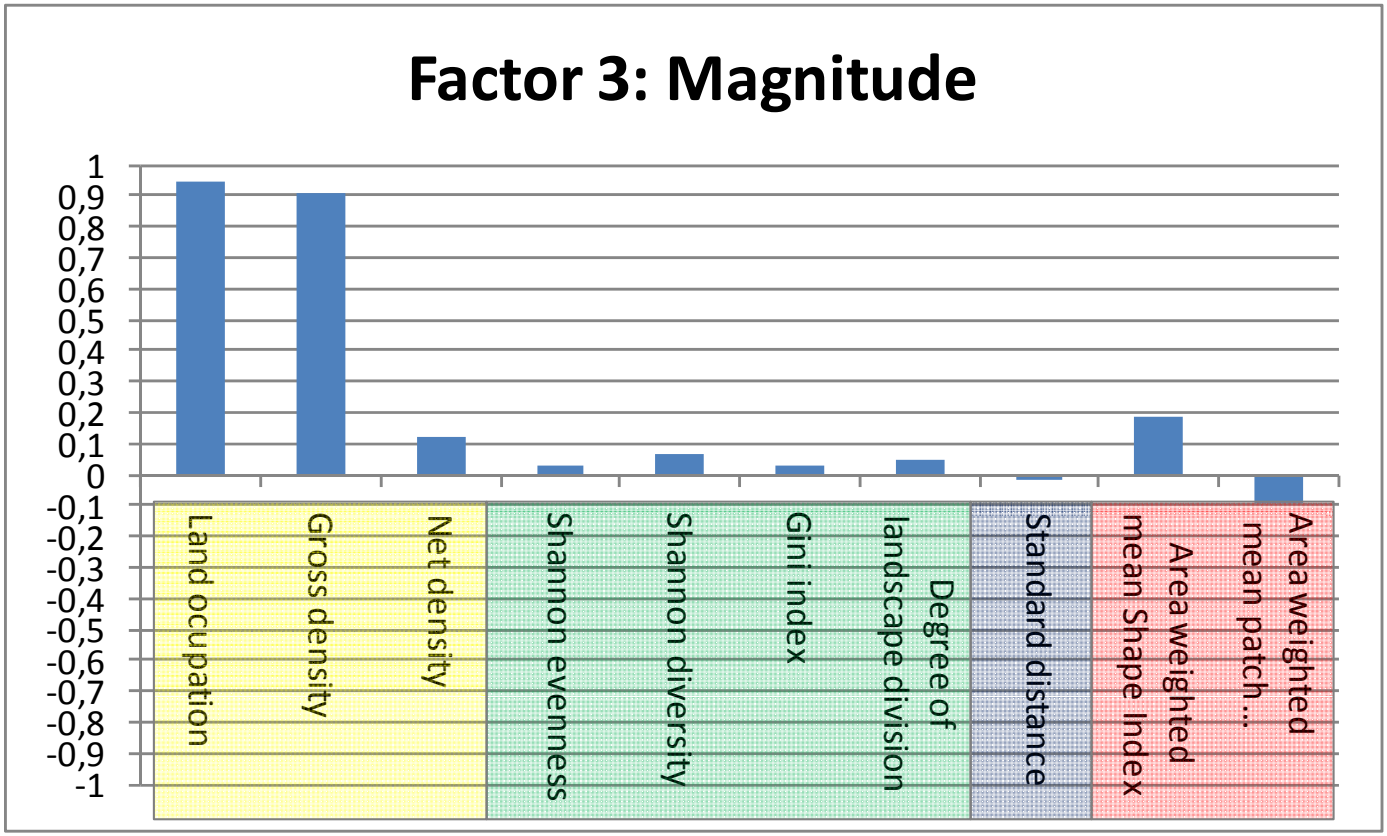

Legend
COMPLEXITY 2006
Value
High : 7,2643
Low : -2,51214
0 55 110 220 330 440
Kilometers



RESULTS


1,00
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
Complexity
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Distance
COMP_1990
COMP_2000
COMP_2006

RESULTS



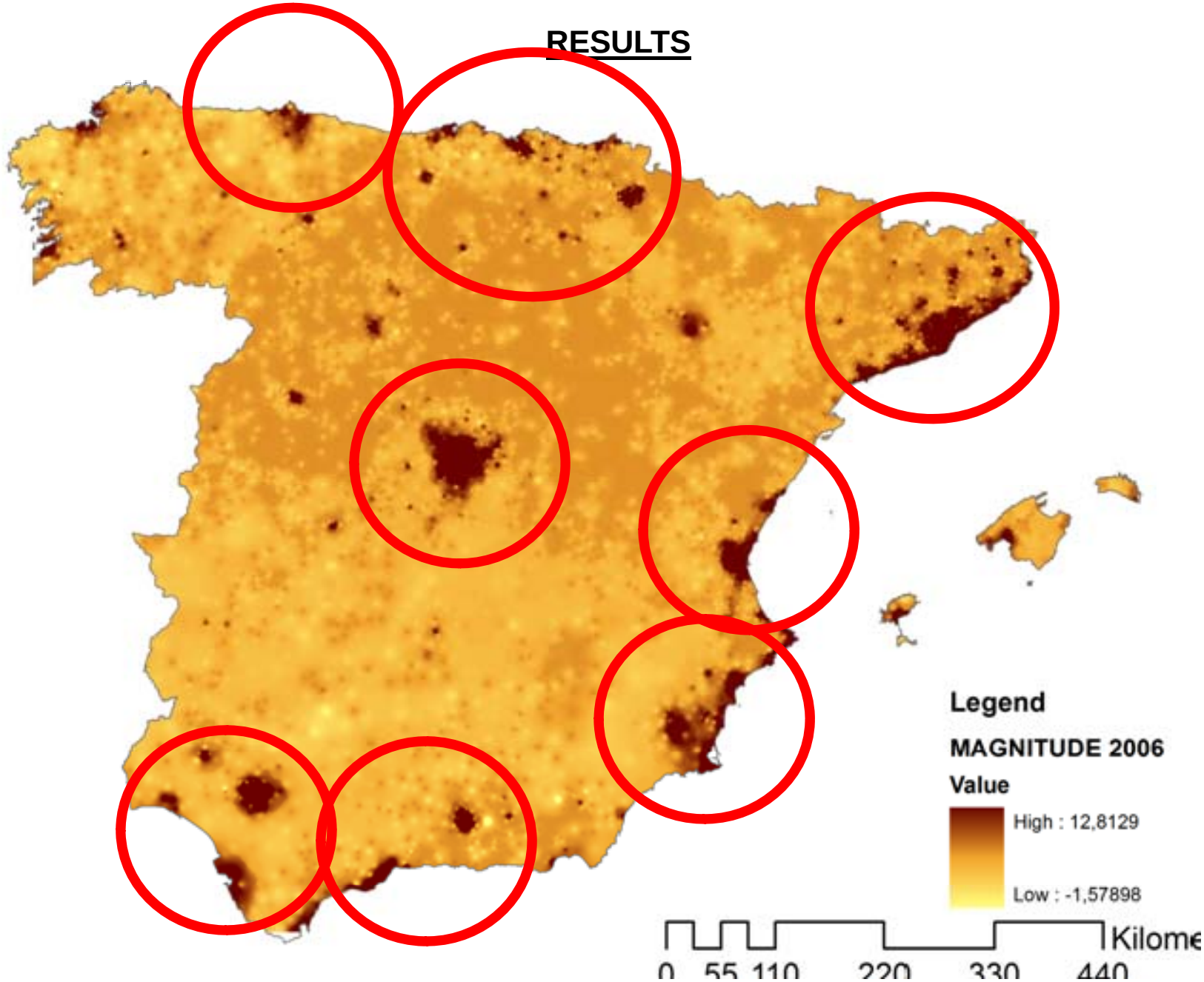
$S_{up}\,Urb \approx Pob$

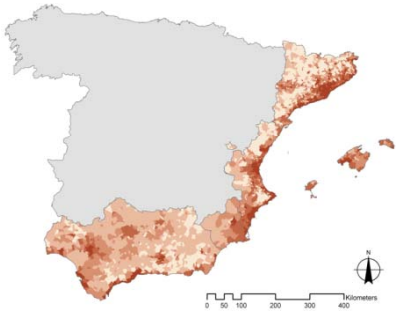
$S_{up}\,Urb \not\approx Pob$

$$Os = \frac{S_{up}\,Urb}{S_{up}\,Ter} * 100$$

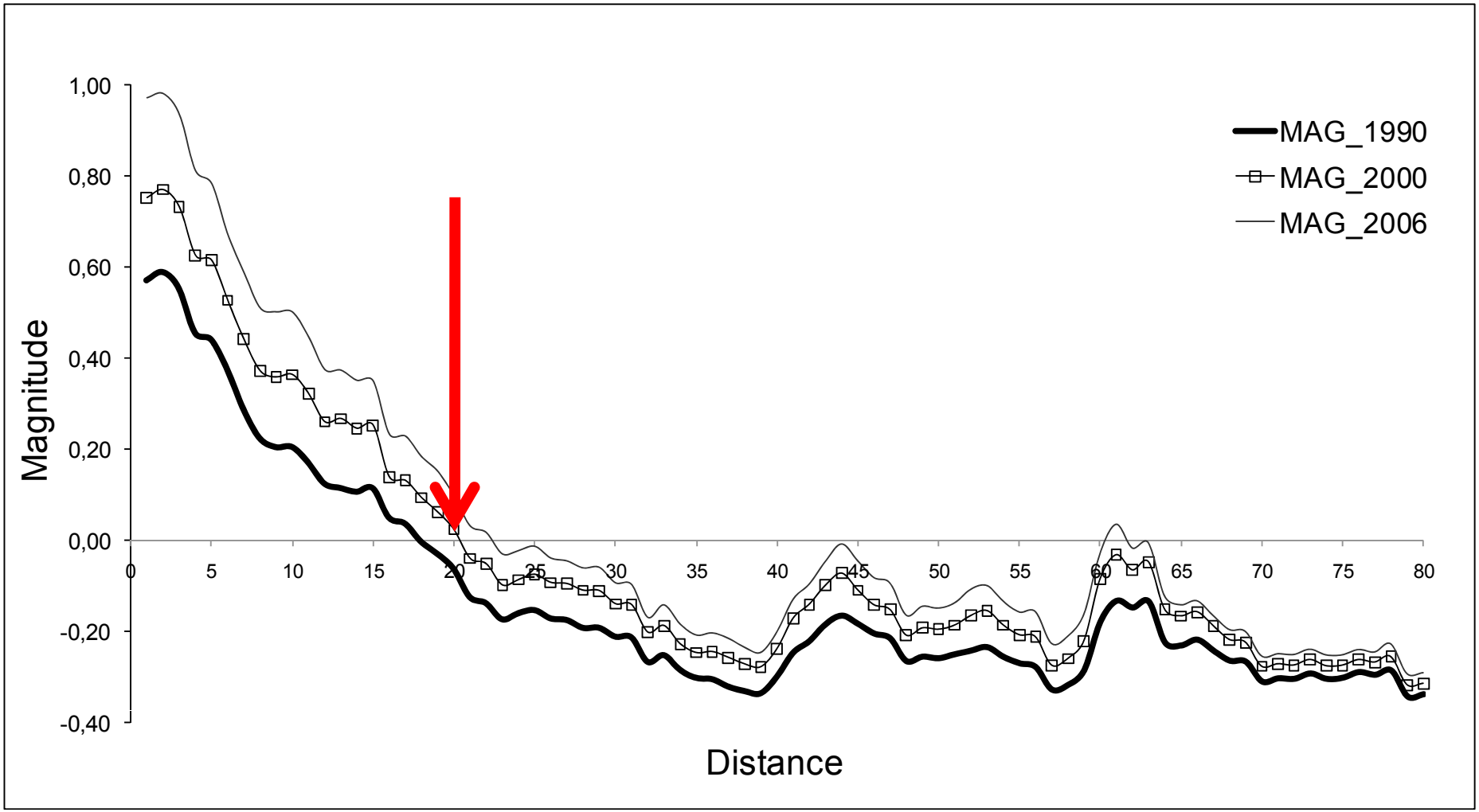
$$D_B = \frac{Pob}{S_{up}\,Ter}$$

RESULTS

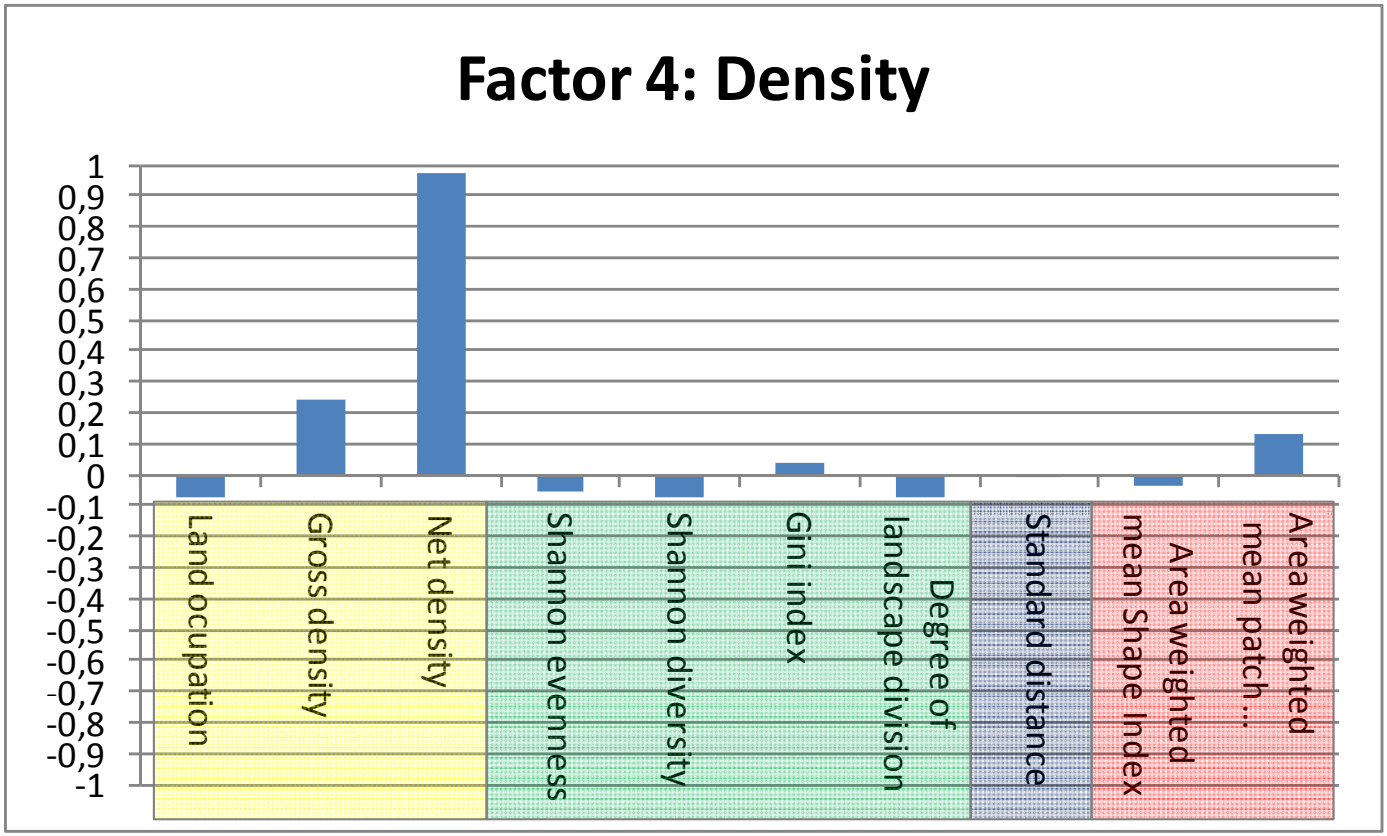

Legend
MAGNITUDE 2006
Value
High : 12,8129
Low : -1,57898
0 55 110 220 330 440
Kilome



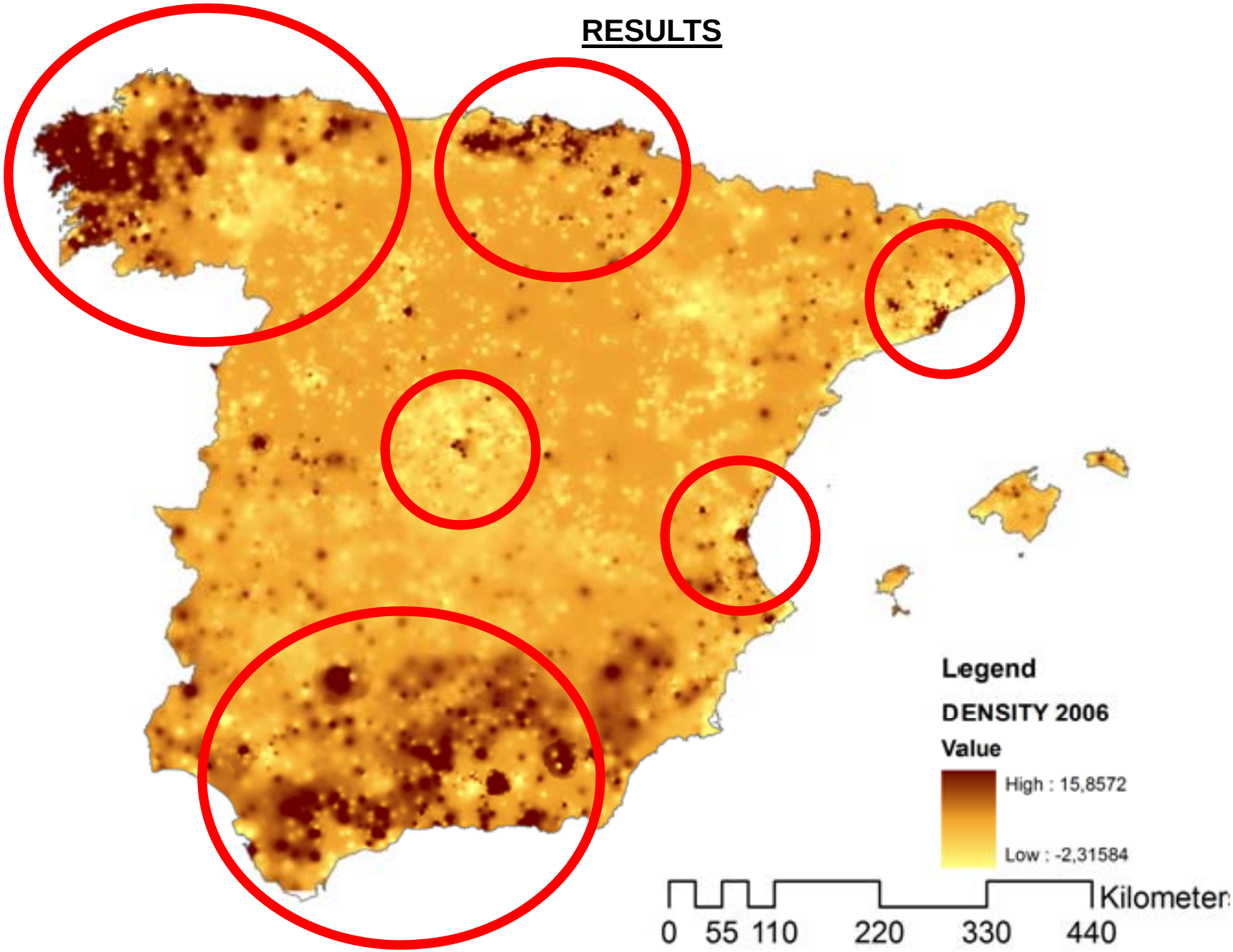
RESULTS

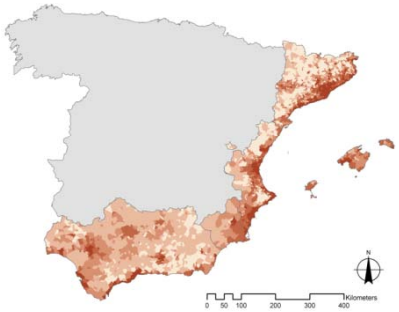

1,00
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
Magnitude
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Distance
MAG_1990
MAG_2000
MAG_2006

RESULTS

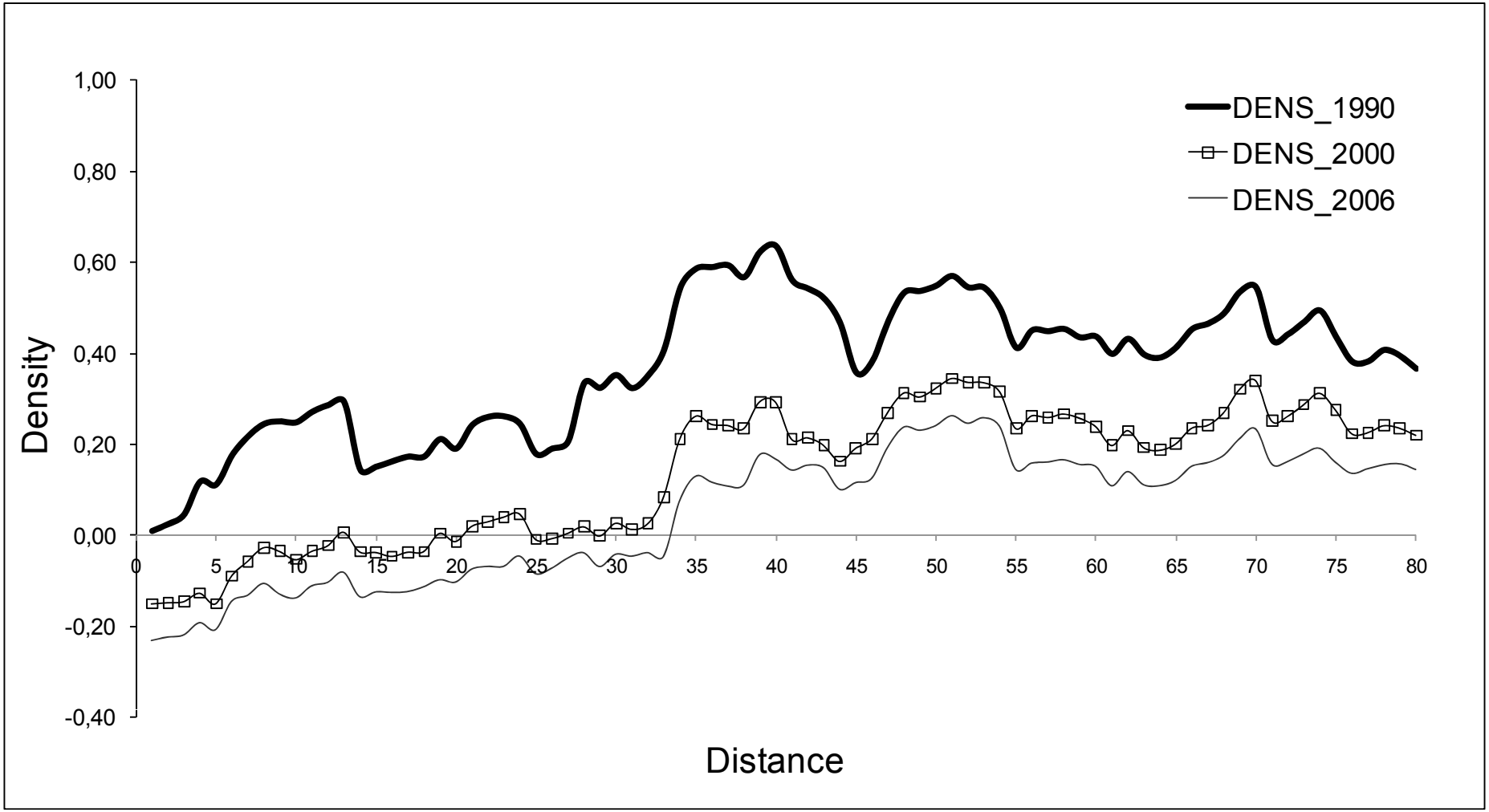

Factor 4: Density
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
-0,1
-0,2
-0,3
-0,4
-0,5
-0,6
-0,7
-0,8
-0,9
-1
Land ocupation
Gross density
Net density
Shannon evenness
Shannon diversity
Gini index
Degree of landscape division
Standard distance
Area weighted mean Shape Index
Area weighted mean patch ..

RESULTS

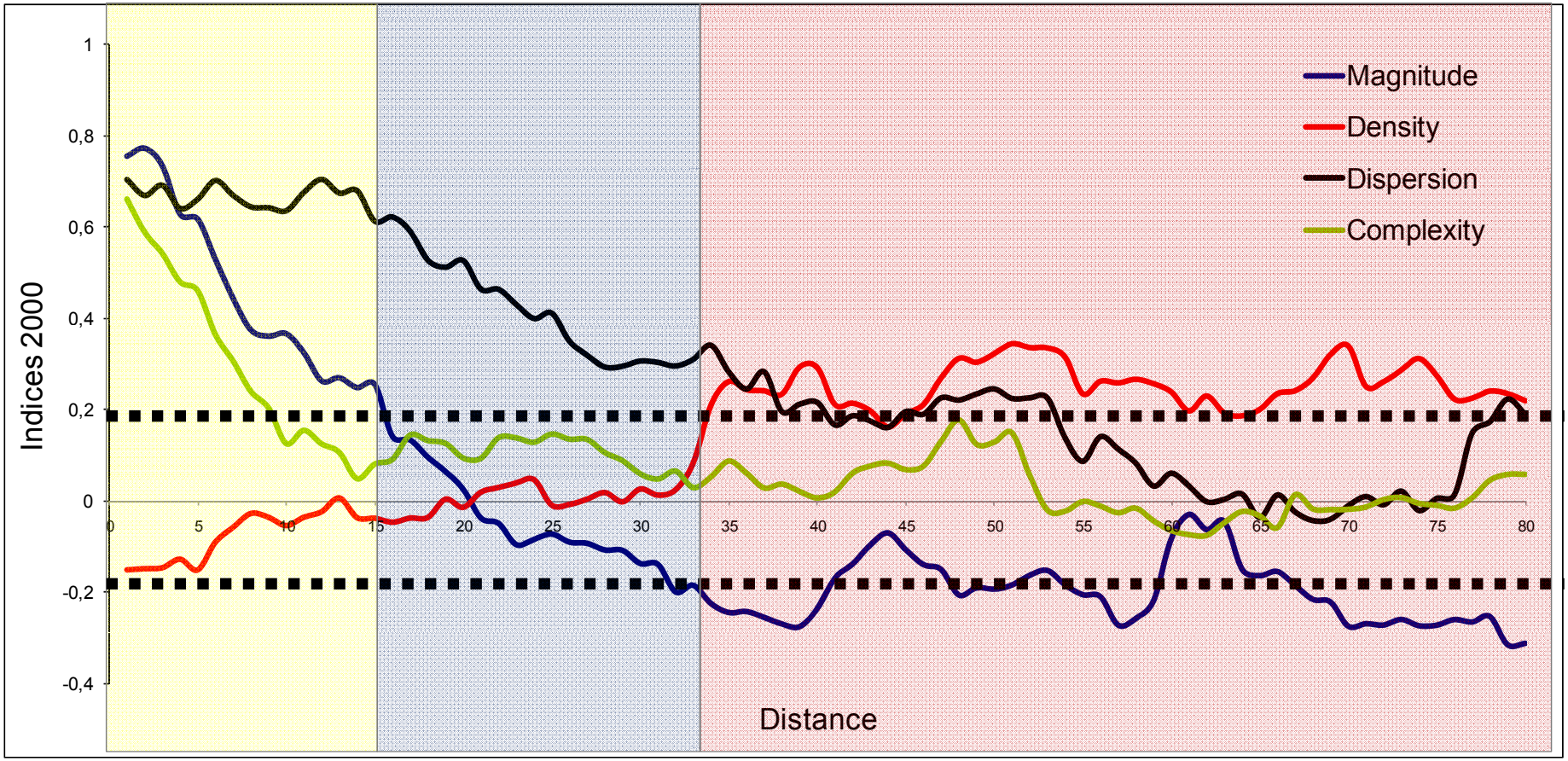

Legend
DENSITY 2006
Value
High : 15,8572
Low : -2,31584
0 55 110 220 330 440
Kilometers



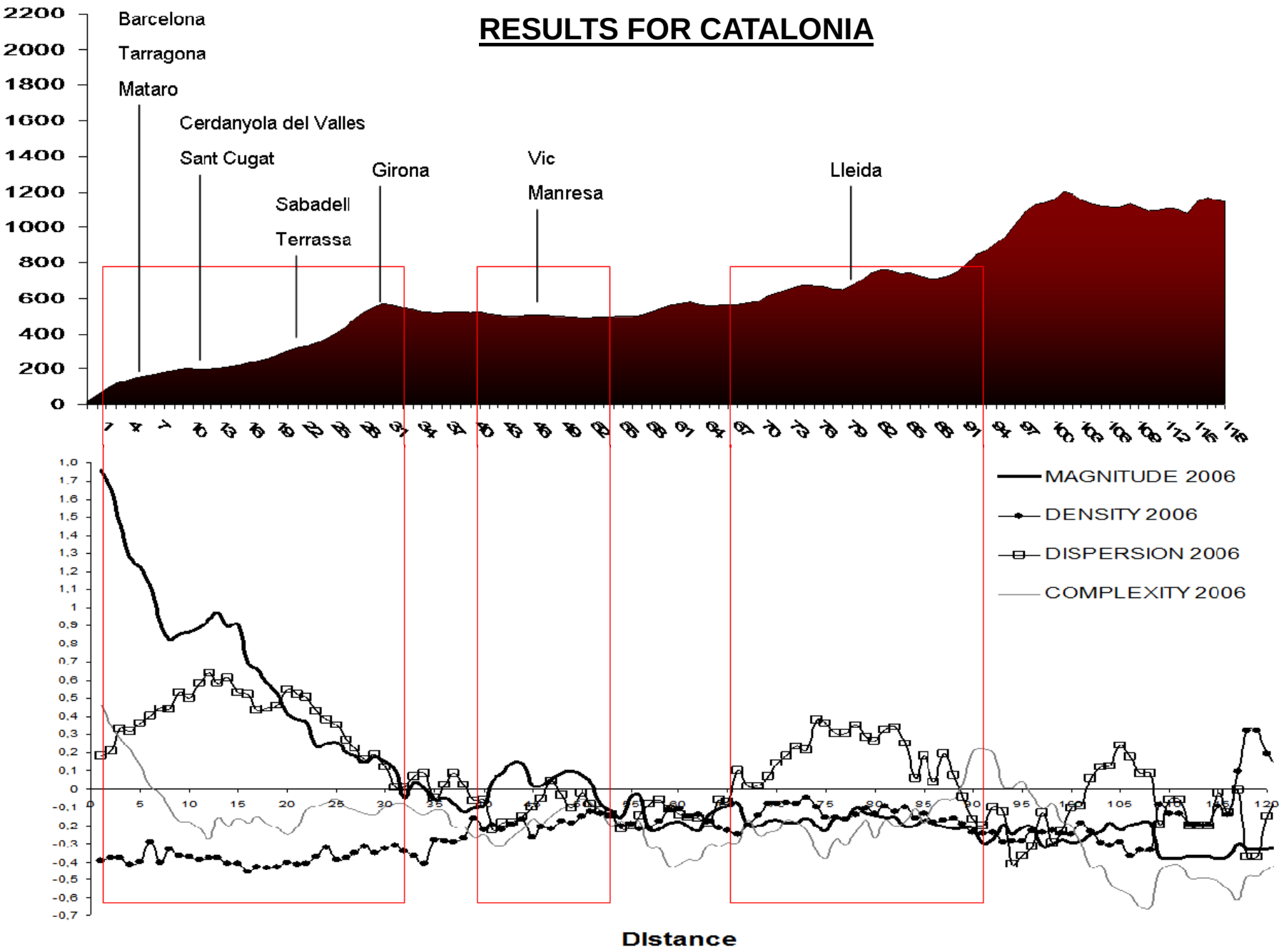
RESULTS


1,00
0,80
0,60
0,40
0,20
0,00
-0,20
-0,40
Density
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Distance
DENS_1990
DENS_2000
DENS_2006

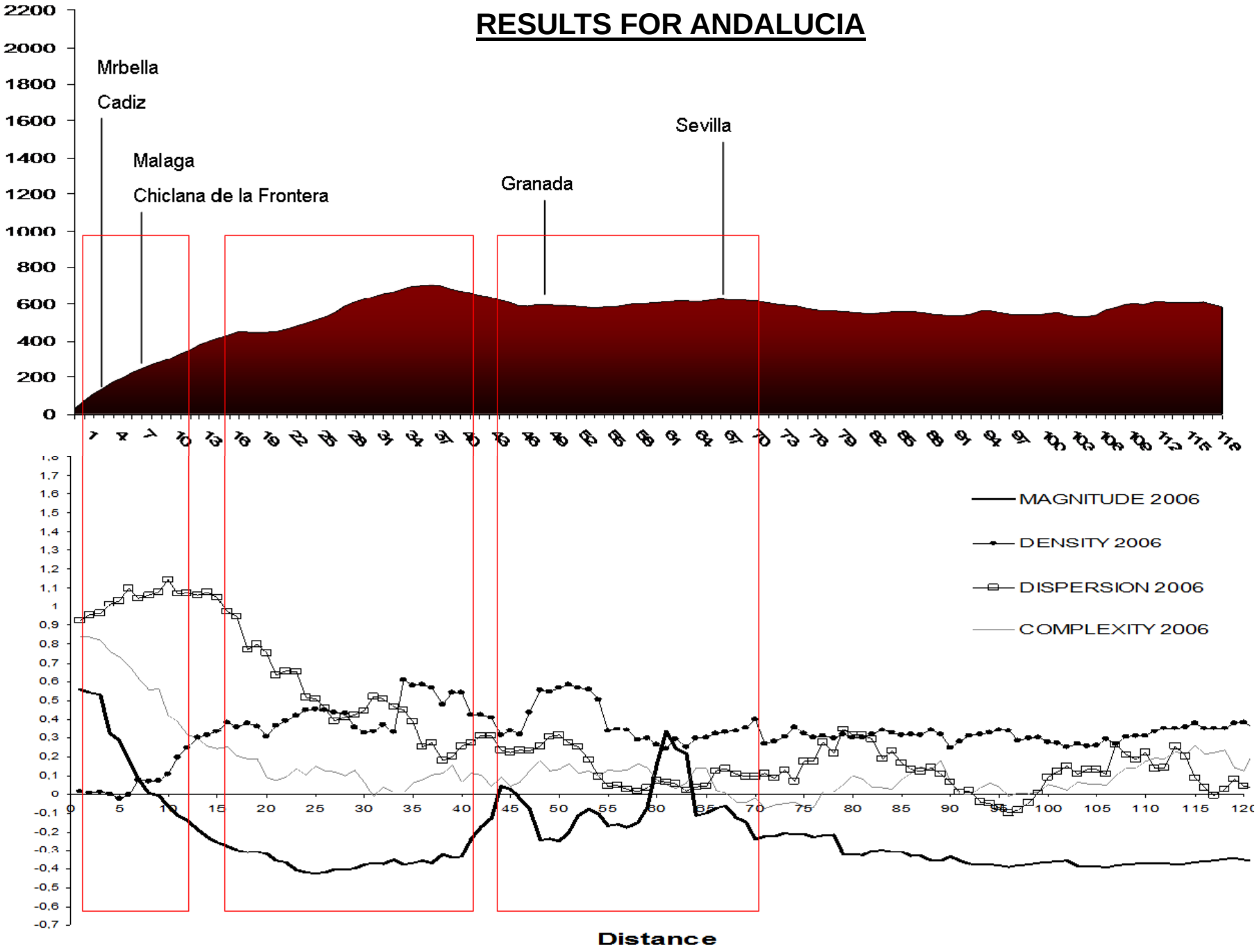
RESULTS


Indices 2000
1
0,8
0,6
0,4
0,2
0
-0,2
-0,4
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Distance
Magnitude
Density
Dispersion
Complexity

RESULTS FOR CATALONIA



RESULTS FOR ANDALUCIA



FINAL REMARKS

• Few limitations of this investigation; population and the change in the administrative boundaries, CORINE Land Cover classification.

• The best goals of the investigation were mostly to propose a methodology for analyzing urban dynamics of growth, by considering the main characteristics of urban patterns.

• The most relevant result of the application of this methodology was to validate the thesis that in almost 20 years of urbanism in Spain, the expansion of artificial land has generally been higher than the population growth rate, meaning that the net density has been reduced over time, and demonstrating that the increase in the rate of building has not been the product of a real demand, nor of proper planning.

• The investigation also showed as the model of land occupation has been changing over time, from a denser and compact model produced of the direct relationship between the percentage of urban land and population growth rate, to a centrifugal model of occupation that tends to spread on the territory.

THANKS FOR YOUR ATTENTION