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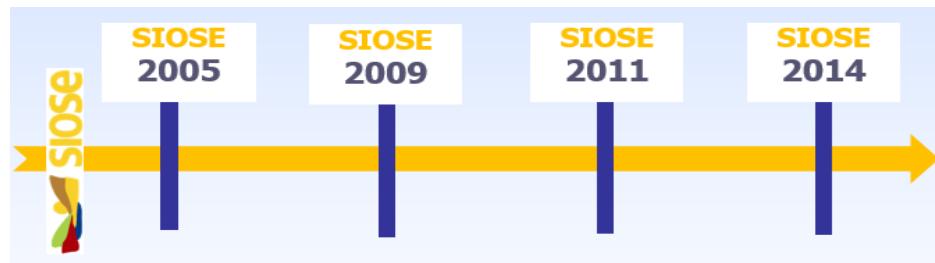
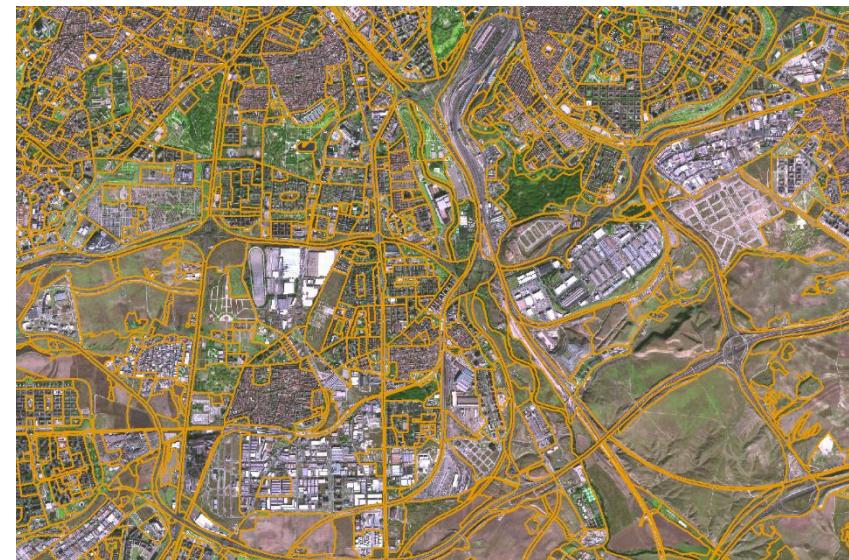


# LAND USE EVOLUTION OVER TIME USING PUBLIC DATA AND A NEW ENVIRONMENTAL INDICATOR APPLICATION TO THE VALENCIA REGION (SPAIN)

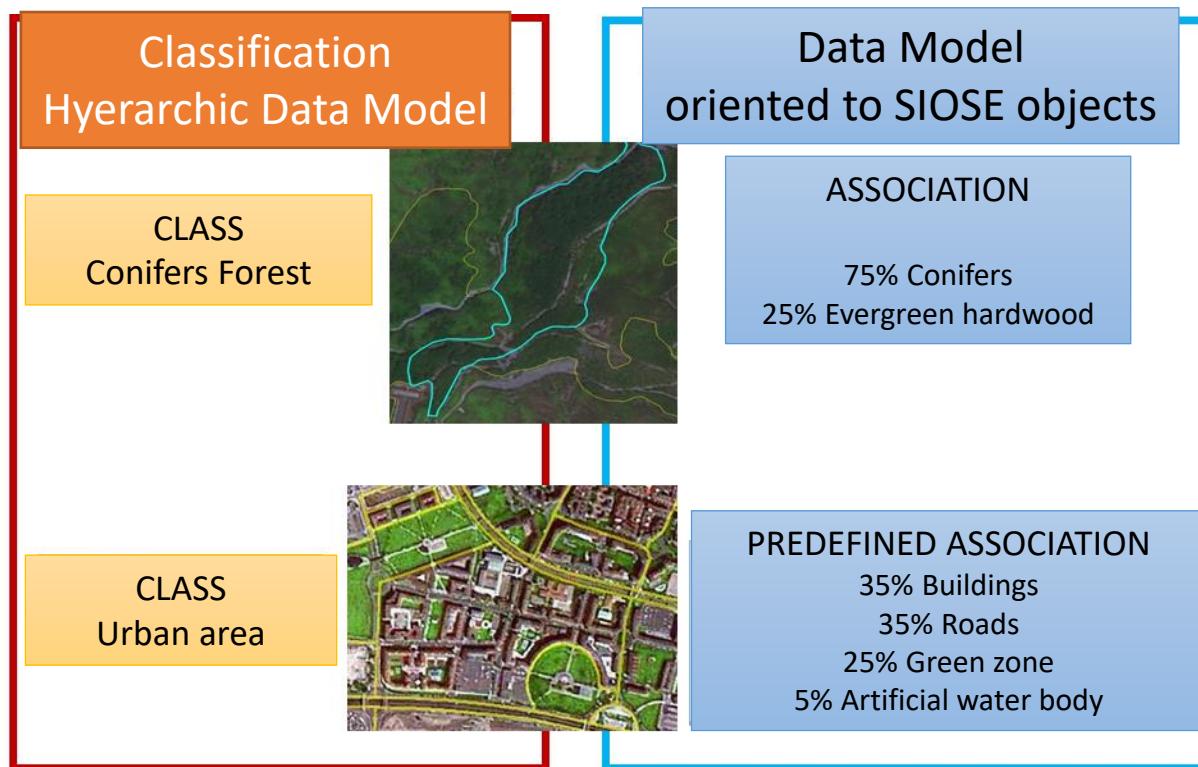
María-Elena Rodrigo-Clavero<sup>1</sup>, Claudia-Patricia Romero-Hernández<sup>1</sup>  
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- **SIOSE** is the Information System on LANDUSE in Spain;
- Its objective is to generate a database of landuse for all Spain at a 1: 25,000 scale.
- It is produced in a decentralized and coordinated manner between the different administrations following the INSPIRE principles, updated periodically.



Currently under development, High resolution SIOSE (scales 1:1000 and 1:5000)



- SIOSE is an object-oriented data model
- Therefore it is multipurpose and extensible
- Its main advantage is that you can customize queries and graphic outputs (maps)
- SIOSE is a database that does not classify the land but describes it by means of coverage or combinations of them with their different occupancy rates and attributes.

## Anthropization Index

SIOSE Index – Ministerio de Fomento, Spain.

Anthropization Index – Three values (-1, 0, 1)



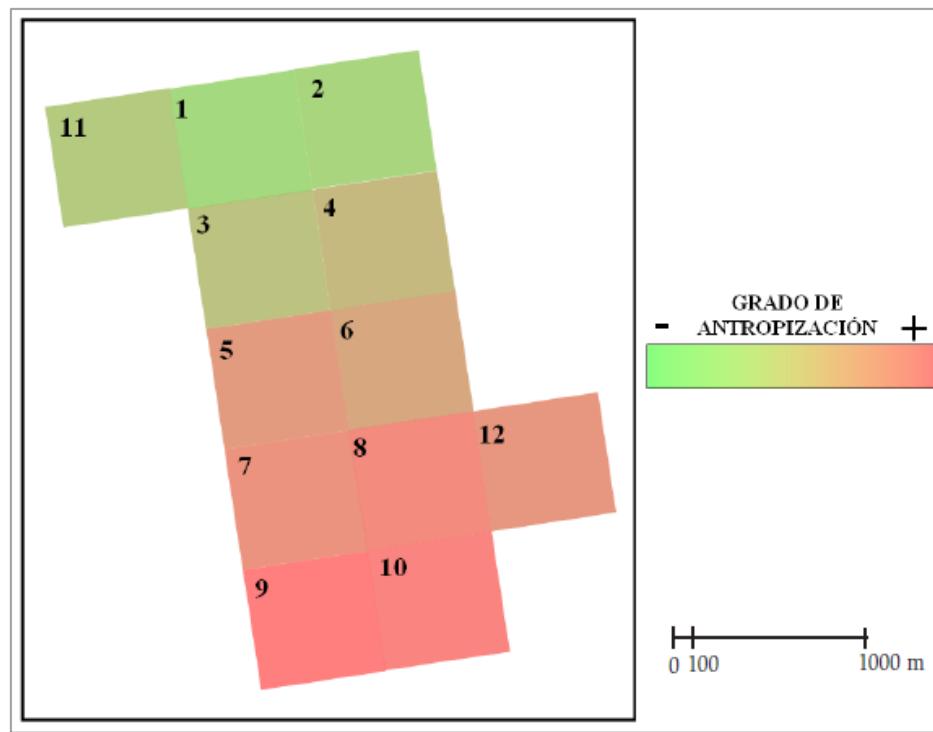
### Land Uses

- 1\_1\_Agriculture
- 1\_2\_Forestry
- 1\_3\_MiningAndQuarryng
- 1\_4\_AquacultureAndFishing
- 2\_SecondaryProduction
- 3\_1\_CommercialServices
- 3\_3\_CommunityServices
- 3\_4\_CulturalEntertainmentAndRecreationalServices
- 4\_1\_TransportNetworks
- 4\_3\_Utilities
- 5\_ResidentialUse
- 6\_1\_TransitionalAreas
- 6\_2\_AbandonedAreas
- 6\_3\_1\_LandAreasNotInOtherEconomicUse
- 6\_3\_2\_WaterAreasNotInOtherEconomicUse
- 6\_6\_NotKnownUse

## Updating the Anthropization Index

Relative Integrated Anthropization Index (INRA) – Martínez Dueñas (2010)

Land value according to degree of anthropization – Values between (0,1)



$$\text{INRA} = (\sum \text{SUA}' / n) \cdot 100$$

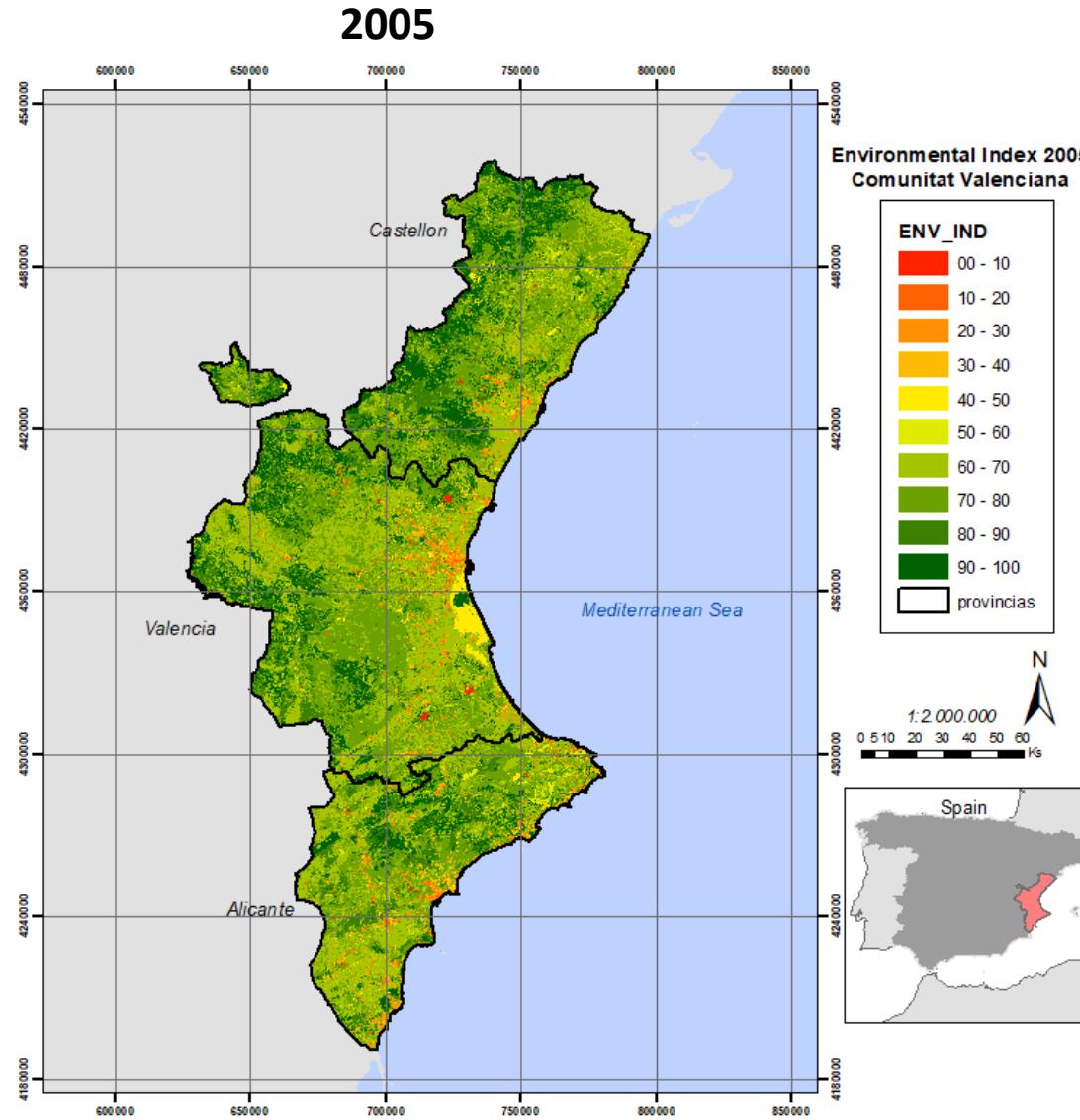
Theoretically based on the landuse Indicators Review - Antón Vallejo (2004)

- Landuse assessment based on occupied land and quantitative classifications
- Landuse assessment based on land production capacity
- Influence that land use will exert on its quality based on biodiversity indicators, life support functions and productivity

|                   |                            |
|-------------------|----------------------------|
| 0 < EnvInd < 39   | Low environmental value    |
| 40 < EnvInd < 69  | Medium Environmental value |
| 70 < EnvInd < 100 | High environmental value   |

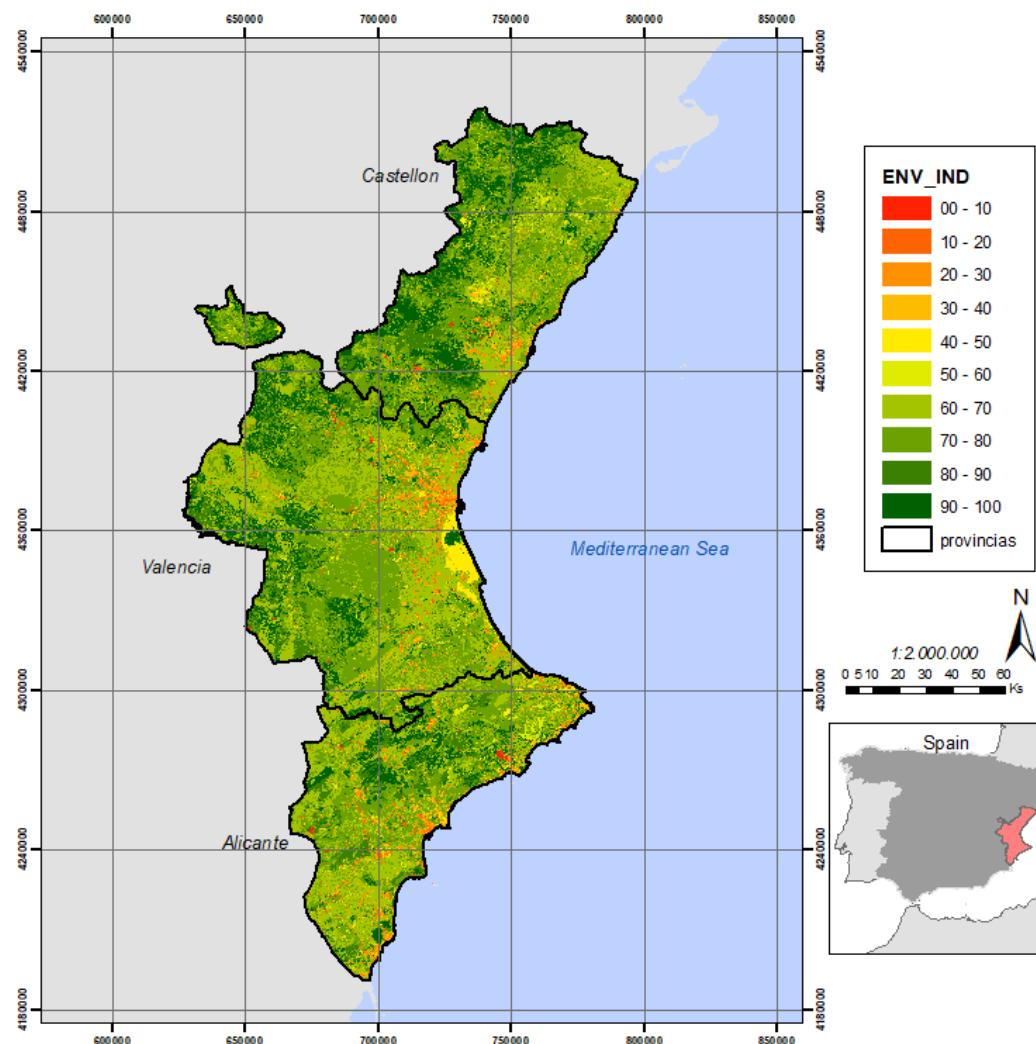
81 different categories of ENV\_IND

| ENV_IND | IND SIOSE ANTHROP | CODE_ABREV | LAND USE DESCRIPTION                                | ENV_IND | IND SIOSE ANTHROP | CODE_ABREV | LAND USE DESCRIPTION                |
|---------|-------------------|------------|---|---------|-------------------|------------|-------------------------------------|
| 0       | 0                 |            |   | 50      | 0                 |            | Non predefined                      |
| 20      | -1                | EDF        | Buildings   | 70      | 0                 | OVD        | Olives and grapes                   |
| 70      | -1                | ZAU        | Artificial Green Zone and Urban Trees               | 50      | 0                 | AAR        | Residential agricultural settlement |
| 70      | -1                | LAA        | Artificial Water Body                               | 70      | 0                 | UER        | Family orchard                      |
| 20      | -1                | VAP        | Road, Parking or Pedestrian Area without vegetation | 20      | -1                | UCS        | Urban center                        |
| 20      | -1                | OCT        | Other constructions                                 | 20      | -1                | UEN        | Urban expansion area                |
| 40      | -1                | SNE        | Soil without edifications                           | 20      | -1                | UDS        | Discontinuous                       |
| 10      | -1                | ZEV        | Extraction zones                                    | 20      | -1                | IPO        | Well sorted industrial area         |
| 50      | 0                 | CHA        | Rice crops  | 20      | -1                | IPS        | Non sorted industrial area          |
| 70      | 0                 | CHL        | Other crops different from rice                     | 60      | -1                | IAS        | Isolated industrial area            |
| 70      | 0                 | LFC        | Citrics   | 100     | -1                | PAG        | Agricultural, livestock             |
| 70      | 0                 | LFN        | Non citrics   | 10      | -1                | PFT        | Primary forest                      |
| 70      | 0                 | LVI        | Grapes  | 50      | -1                | PMX        | Extractive Mining                   |
| 70      | 0                 | LOL        | Olives  | 20      | -1                | PPS        | Fish farm                           |
| 70      | 0                 | LOC        | Other woody crops                                   | 20      | -1                | TCO        | Commercial and offices              |
| 90      | 0                 | PRD        | Meadows   | 20      | -1                | TCH        | Hotels                              |
| 80      | 1                 | PST        | Pastureland   | 40      | -1                | TPR        | Recreational Park                   |
| 100     | 1                 | FDC        | Hardwood deciduous                                  | 20      | -1                | TCG        | Camping                             |
| 100     | 1                 | FDP        | Evergreen hardwoods                                 | 20      | -1                | EAI        | Institutional Administrative        |
| 100     | 1                 | CNF        | Conifers  | 20      | -1                | ESN        | Medical and sanitary                |
| 70      | 1                 | MTR        | Scrub   | 20      | -1                | ECM        | Cemetery                            |
| 90      | 1                 | PDA        | Sandy beaches                                       | 20      | -1                | EDU        | Education                           |
| 40      | 1                 | SDN        | Bare soil   | 20      | -1                | EPN        | Penitentiary                        |
| 10      | 1                 | ZQM        | Burned areas  | 20      | -1                | ERG        | Religious                           |
| 40      | 1                 | RMB        | Ravines   | 20      | -1                | ECL        | Cultural                            |
| 80      | 1                 | ACM        | Marine cliffs                                       | 50      | -1                | EDP        | Sport                               |
| 50      | 1                 | ARR        | Rocky soil  | 70      | -1                | ECG        | Golf Course                         |
| 50      | 1                 | CCH        | Stone quarry  | 10      | -1                | EPU        | Urban Park                          |
| 50      | 1                 | CLC        | Lava flow   | 10      | -1                | NRV        | Streets and roads                   |
| 60      | 1                 | HPA        | Marsches  | 10      | -1                | NRF        | Train                               |
| 60      | 1                 | HSA        | Continental Salines                                 | 30      | -1                | NPO        | Port                                |
| 80      | 1                 | HMA        | Marsches  | 30      | -1                | NAP        | Airport                             |
| 80      | 1                 | HSM        | Marine salines                                      | 0       | -1                | NEO        | Eolic Plant                         |
| 100     | 1                 | ACU        | Water flows   | 0       | -1                | NSL        | Solar Plant                         |
| 100     | 1                 | ALG        | Lakes and lagoons                                   | 0       | -1                | NCL        | Nuclear Plant                       |
| 80      | 1                 | AEM        | Dams and artificial lakes                           | 10      | -1                | NEL        | Electric Plant                      |
| 100     | 1                 | ALC        | Coastal Lagoons                                     | 0       | -1                | NTM        | Thermal Plant                       |
| 100     | 1                 | AMO        | Seas and Oceans                                     | 30      | -1                | NHD        | Hydroelectric Plant                 |
| 100     | 1                 |            |   | 0       | -1                | NTC        | Telecommunications Plant            |
|         |                   |            |   | 0       | -1                | NDP        | Waste and drinking water Plant      |
|         |                   |            |   | 0       | -1                | NCC        | Channels                            |
|         |                   |            |   | 0       | -1                | NDS        | Desalination Plant                  |
|         |                   |            |   | 0       | -1                | NVE        | Landfills                           |
|         |                   |            |   | 0       | -1                | NPT        | Treatment Plants                    |

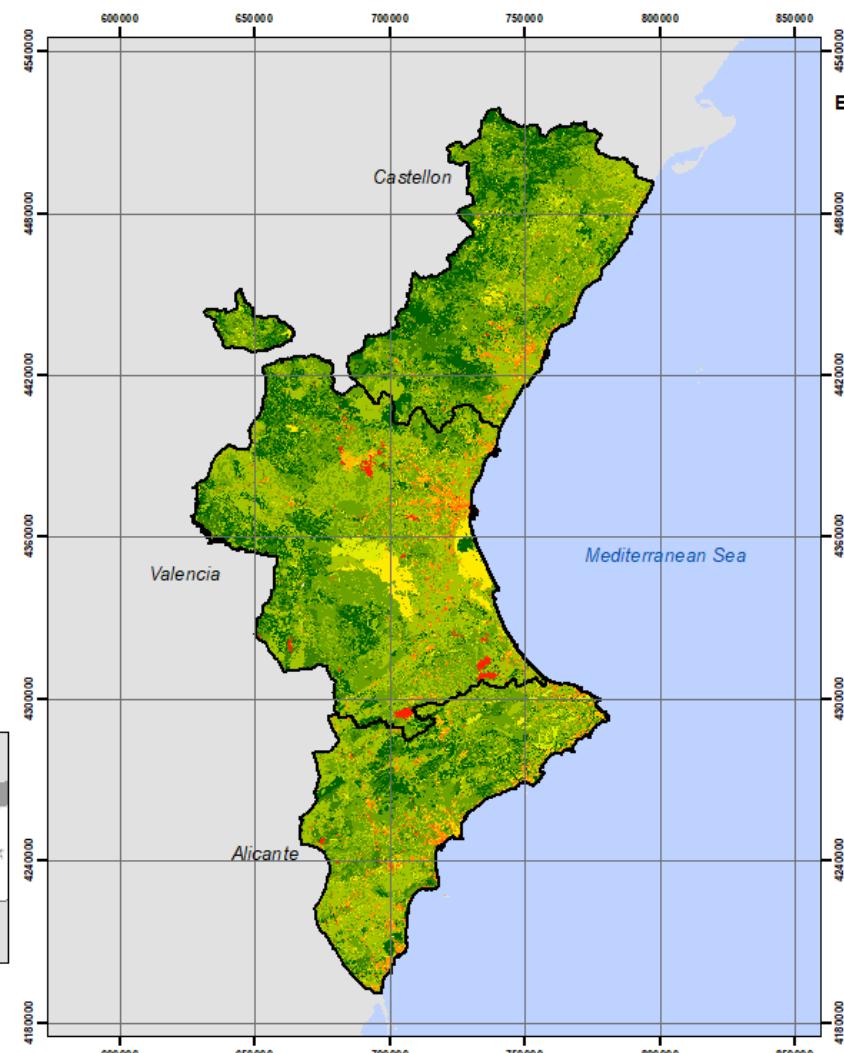


Land use evolution over time using public data and a new environmental indicator. Application to the Valencia region (Spain)

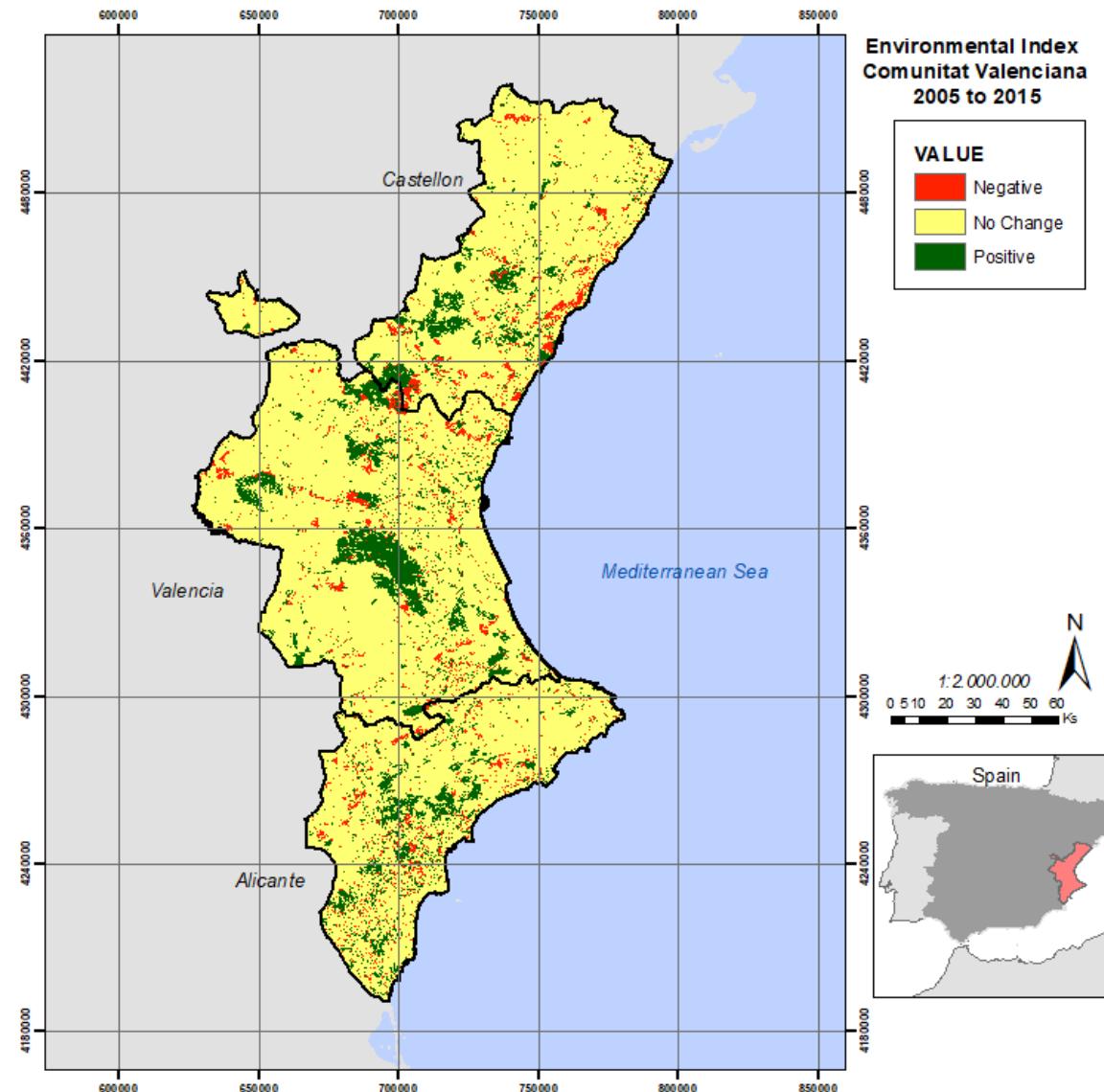
2009



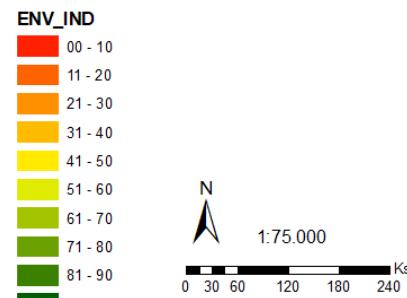
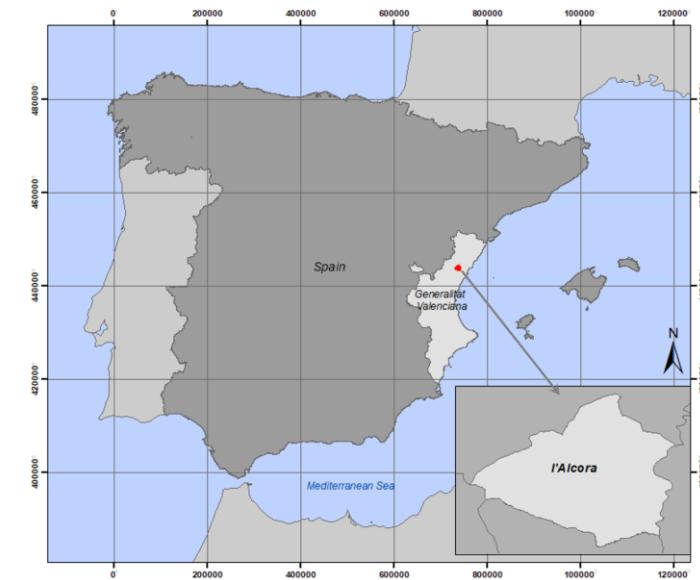
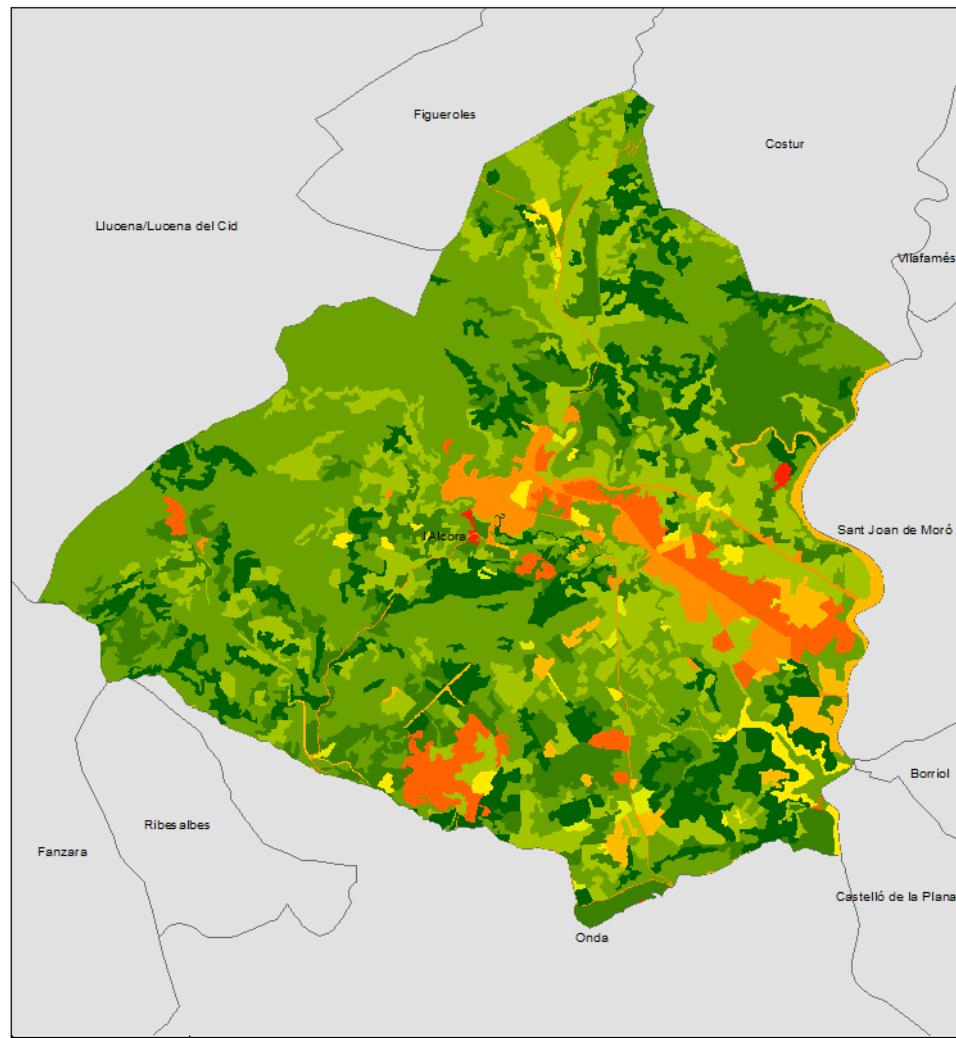
2015



Land use evolution over time using public data and a new environmental indicator. Application to the Valencia region (Spain)

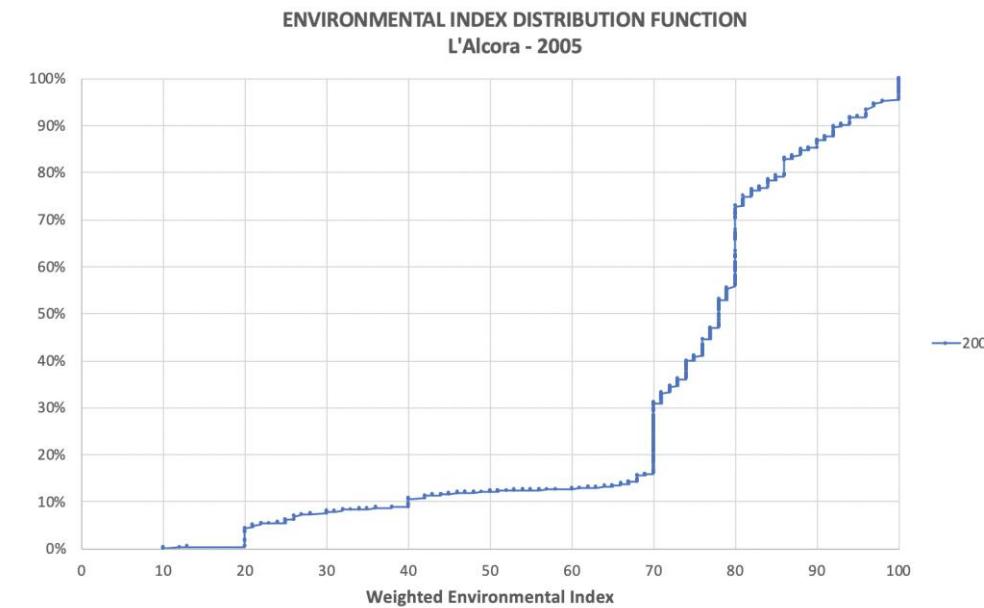
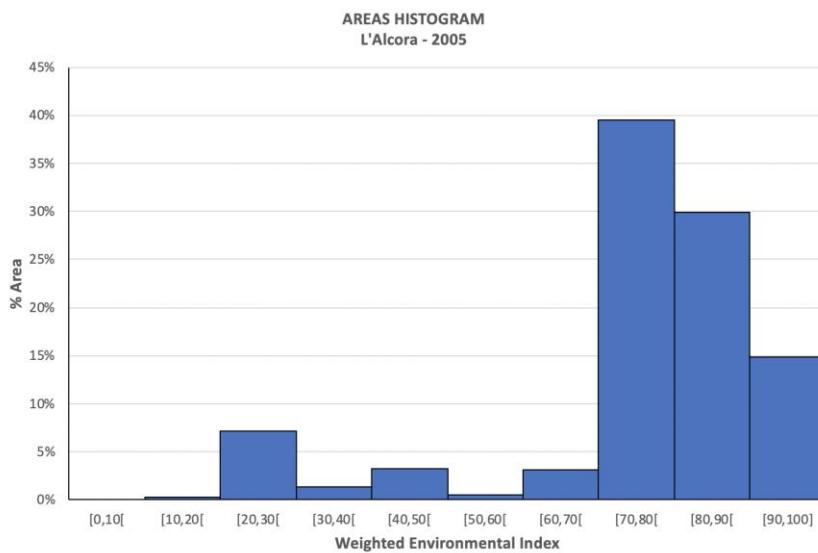


2005

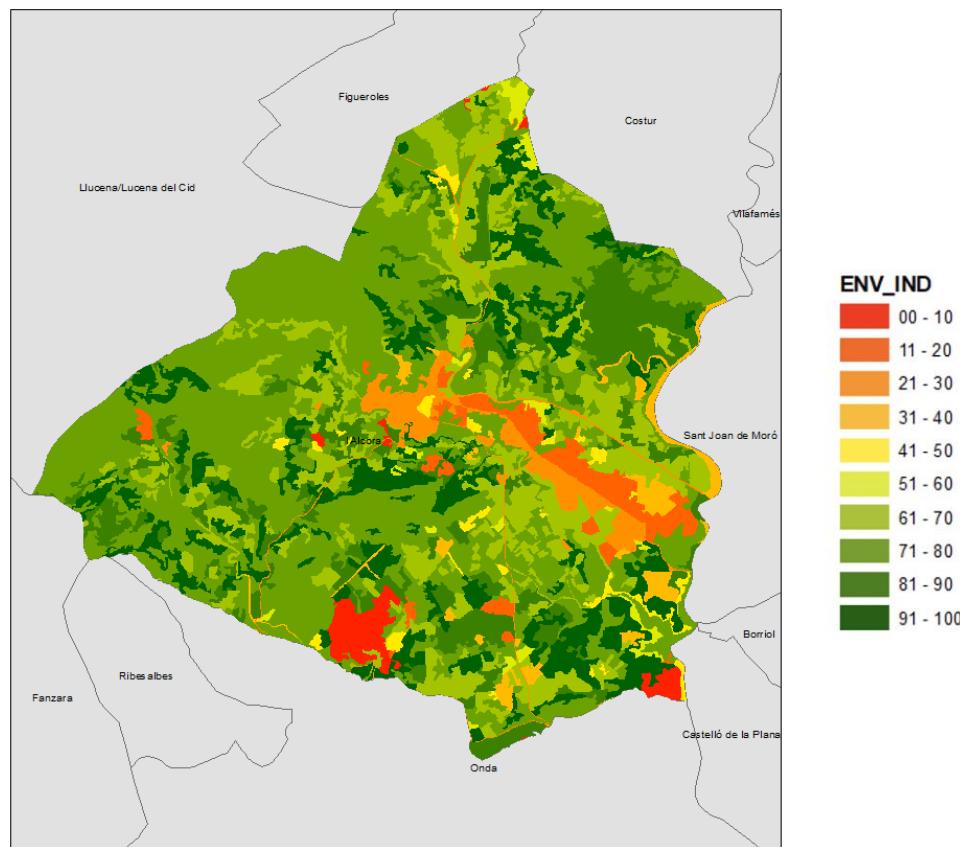


| IND_AMB<br>INTERVALOS | Frecuencia<br>absoluta<br>fi | Marcas de<br>clase<br>Xi | Frecuencia<br>acumulada<br>Fi | Frecuencia<br>relativa | Superficie<br>clase<br>(Has) | %Superficie<br>clase |
|-----------------------|------------------------------|--------------------------|-------------------------------|------------------------|------------------------------|----------------------|
| [0,10[                | 0                            | 5                        | 0                             | 0.00%                  | 0.00                         | 0.00%                |
| [10,20[               | 6                            | 15                       | 6                             | 0.67%                  | 29.86                        | 0.31%                |
| [20,30[               | 38                           | 25                       | 44                            | 4.23%                  | 676.94                       | 7.11%                |
| [30,40[               | 20                           | 35                       | 64                            | 2.22%                  | 129.38                       | 1.36%                |
| [40,50[               | 36                           | 45                       | 100                           | 4.00%                  | 310.85                       | 3.26%                |
| [50,60[               | 20                           | 55                       | 120                           | 2.22%                  | 53.15                        | 0.56%                |
| [60,70[               | 47                           | 65                       | 167                           | 5.23%                  | 302.21                       | 3.17%                |
| [70,80[               | 417                          | 75                       | 584                           | 46.38%                 | 3762.61                      | 39.51%               |
| [80,90[               | 202                          | 85                       | 786                           | 22.47%                 | 2846.46                      | 29.89%               |
| [90,100]              | 113                          | 95                       | 899                           | 12.57%                 | 1411.71                      | 14.82%               |
|                       | 899                          |                          |                               |                        | 9523.18                      | 100%                 |

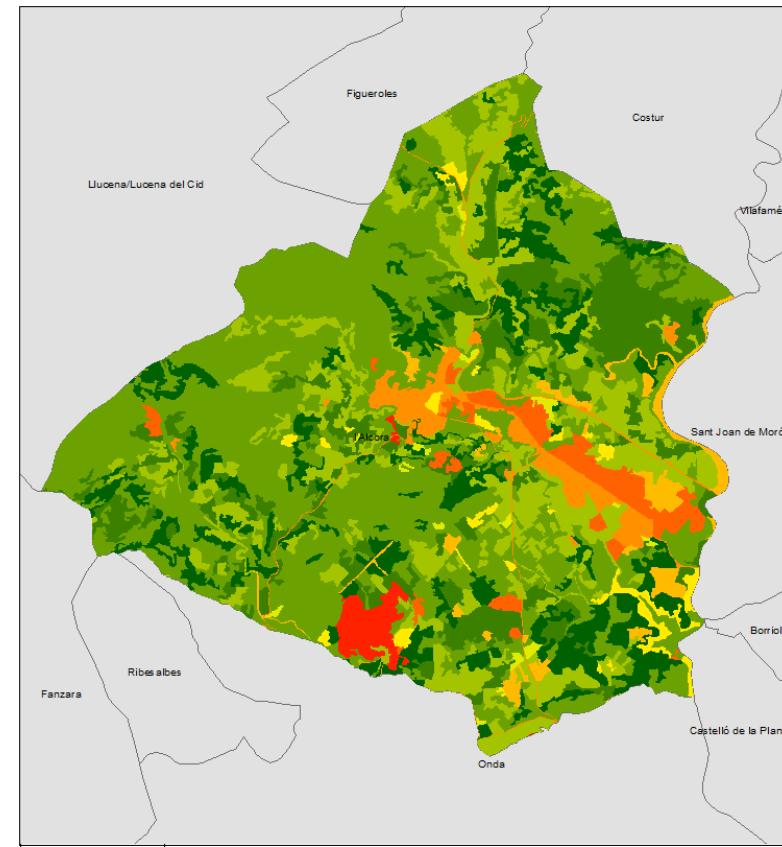
| L'Alcora 2005  |      |
|----------------|------|
| Number of data | 899  |
| 1st Quartile = | 70   |
| Median =       | 75,5 |
| Mean =         | 78   |
| 3rd Quartile = | 80   |
| IQR =          | 10   |



2009

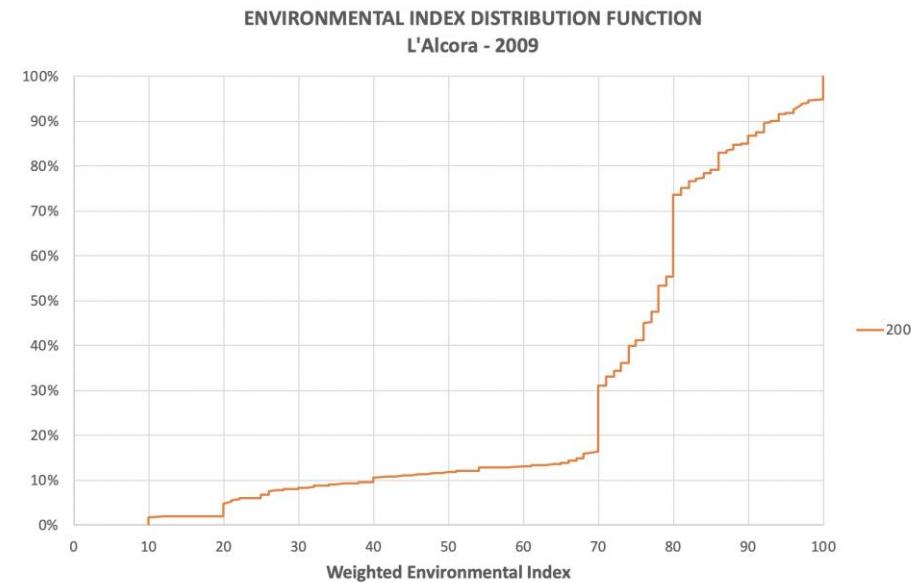
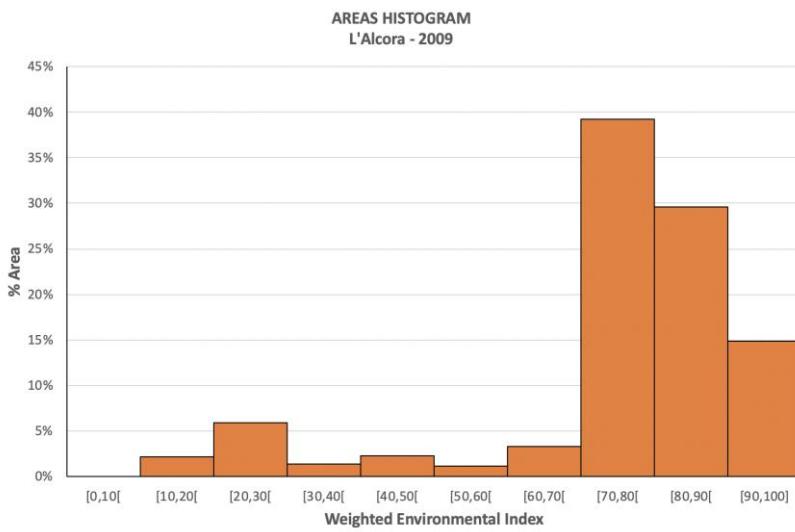


2015



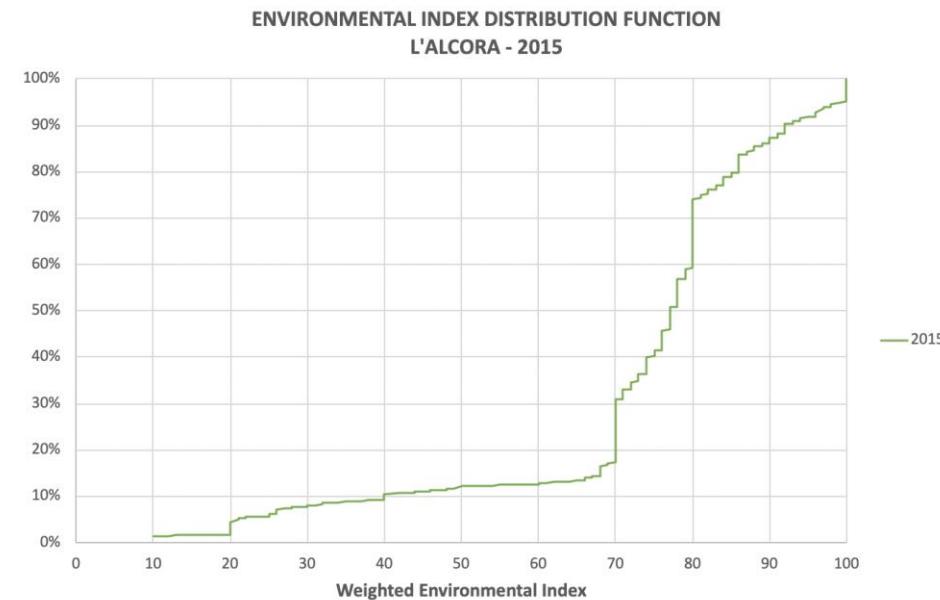
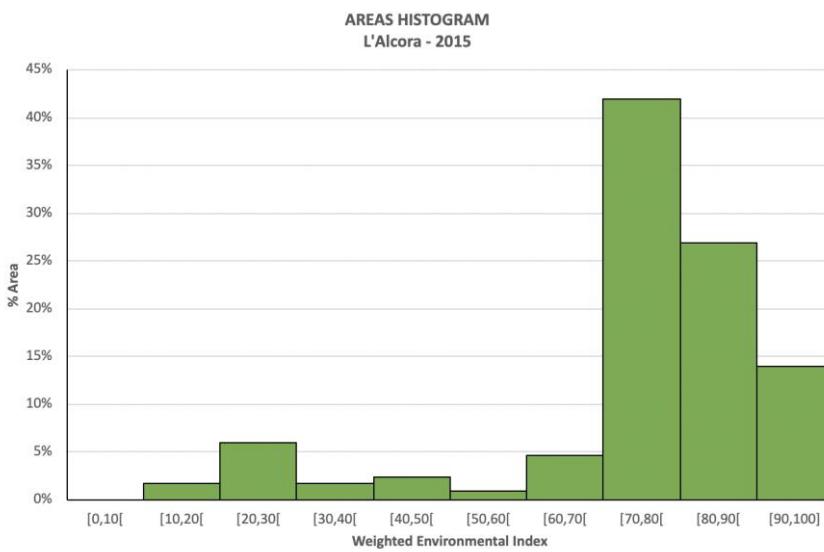
| IND_AMB    | Frecuencia absoluta | Marcas de clase | Frecuencia acumulada | Frecuencia relativa | Superficie clase (Has) | %Superficie clase |
|------------|---------------------|-----------------|----------------------|---------------------|------------------------|-------------------|
| INTERVALOS | fi                  | Xi              | Fi                   |                     |                        |                   |
| [0,10[     | 0                   | 5               | 0                    | 0.00%               | 0.00                   | 0.00%             |
| [10,20[    | 11                  | 15              | 11                   | 1.21%               | 202.28                 | 2.12%             |
| [20,30[    | 39                  | 25              | 50                   | 4.29%               | 565.99                 | 5.94%             |
| [30,40[    | 23                  | 35              | 73                   | 2.53%               | 136.45                 | 1.43%             |
| [40,50[    | 32                  | 45              | 105                  | 3.52%               | 213.98                 | 2.25%             |
| [50,60[    | 20                  | 55              | 125                  | 2.20%               | 114.38                 | 1.20%             |
| [60,70[    | 50                  | 65              | 175                  | 5.50%               | 313.94                 | 3.30%             |
| [70,80[    | 417                 | 75              | 592                  | 45.87%              | 3732.63                | 39.20%            |
| [80,90[    | 200                 | 85              | 792                  | 22.00%              | 2822.30                | 29.64%            |
| [90,100]   | 117                 | 95              | 909                  | 12.87%              | 1421.22                | 14.92%            |
|            | 909                 |                 | 9523.18              |                     | 100%                   |                   |

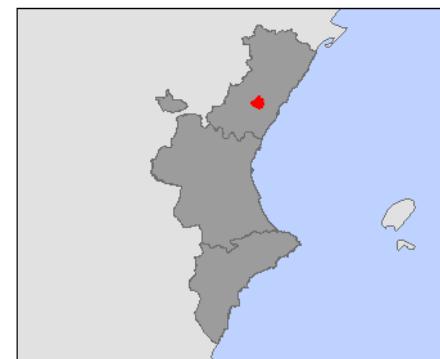
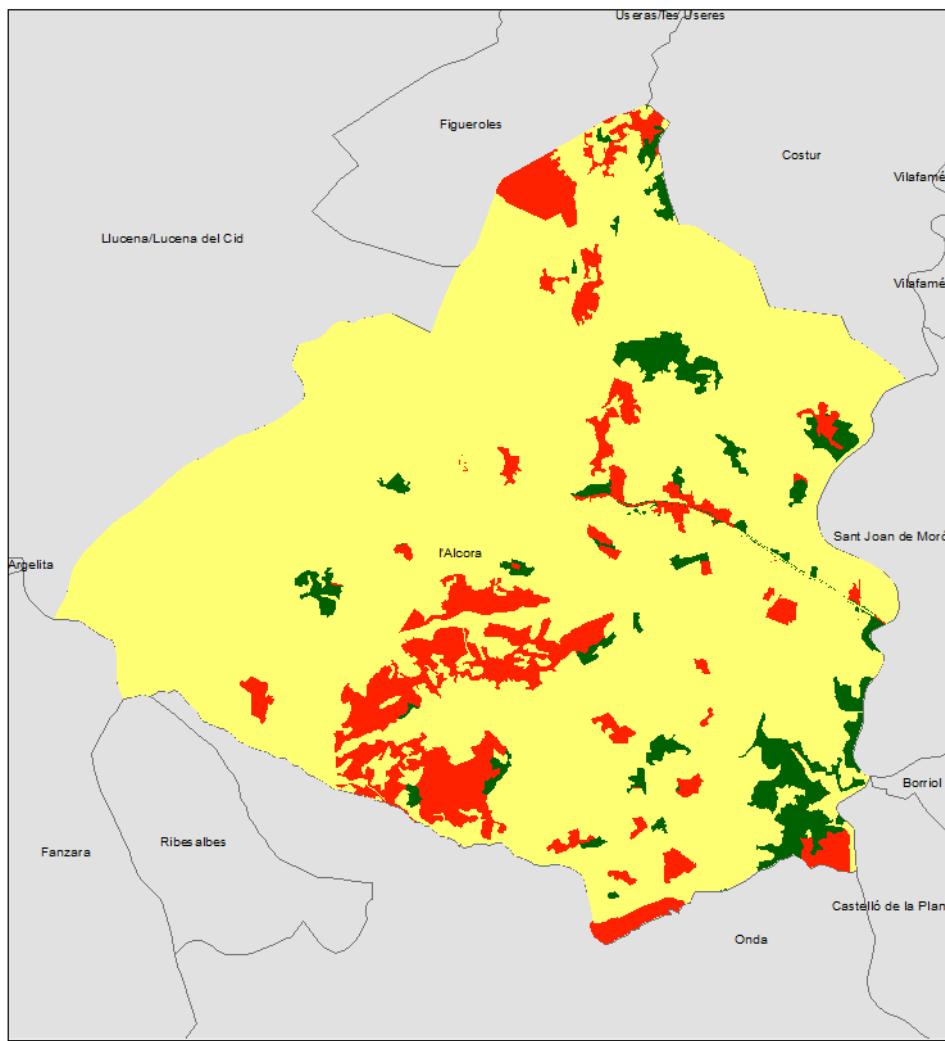
| L'Alcora 2009  |      |
|----------------|------|
| Number of data | 909  |
| 1st Quartile = | 70   |
| Median =       | 75,5 |
| Mean =         | 78   |
| 3rd Quartile = | 80   |
| IQR =          | 10   |



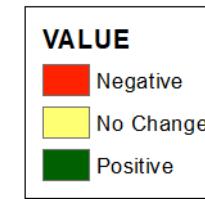
| IND_AMB    | Frecuencia absoluta | Marcas de clase | Frecuencia acumulada | Frecuencia relativa | Superficie clase (Has) | %Superficie clase |
|------------|---------------------|-----------------|----------------------|---------------------|------------------------|-------------------|
| INTERVALOS | fi                  | Xi              | Fi                   |                     |                        |                   |
| [0,10[     | 0                   | 5               | 0                    | 0.00%               | 0.00                   | 0.00%             |
| [10,20[    | 7                   | 15              | 7                    | 0.77%               | 159.77                 | 1.68%             |
| [20,30[    | 39                  | 25              | 46                   | 4.28%               | 567.12                 | 5.96%             |
| [30,40[    | 25                  | 35              | 71                   | 2.74%               | 160.58                 | 1.69%             |
| [40,50[    | 31                  | 45              | 102                  | 3.40%               | 220.96                 | 2.32%             |
| [50,60[    | 16                  | 55              | 118                  | 1.75%               | 85.15                  | 0.89%             |
| [60,70[    | 56                  | 65              | 174                  | 6.14%               | 442.93                 | 4.65%             |
| [70,80[    | 421                 | 75              | 595                  | 46.16%              | 3992.15                | 41.92%            |
| [80,90[    | 201                 | 85              | 796                  | 22.04%              | 2558.72                | 26.87%            |
| [90,100]   | 116                 | 95              | 912                  | 12.72%              | 1335.81                | 14.03%            |
|            | 912                 |                 |                      |                     | 9523.18                | 100%              |

| L'Alcora 2015  |     |
|----------------|-----|
| Number of data | 912 |
| 1st Quartile = | 70  |
| Median =       | 76  |
| Mean =         | 77  |
| 3rd Quartile = | 80  |
| IQR =          | 10  |

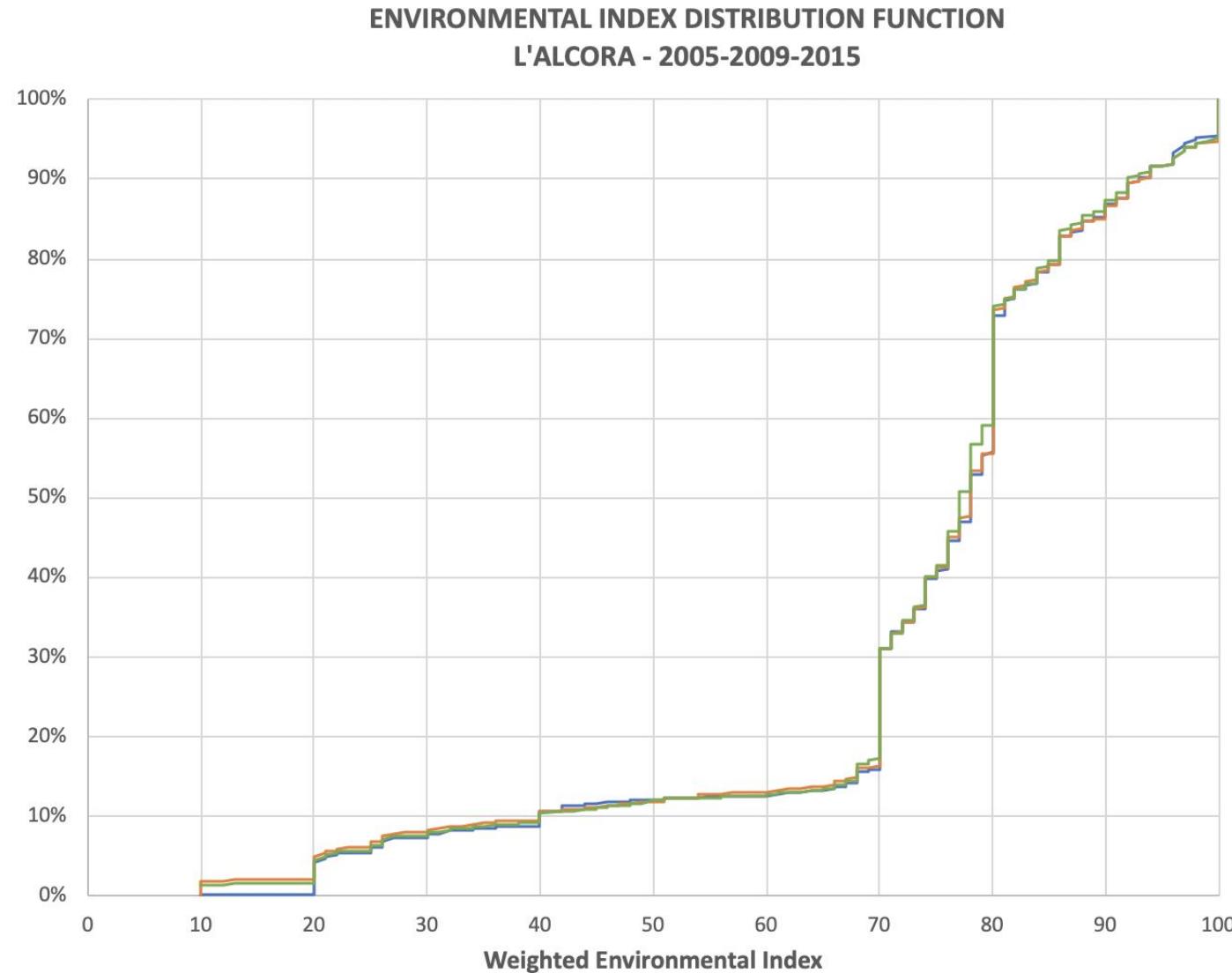


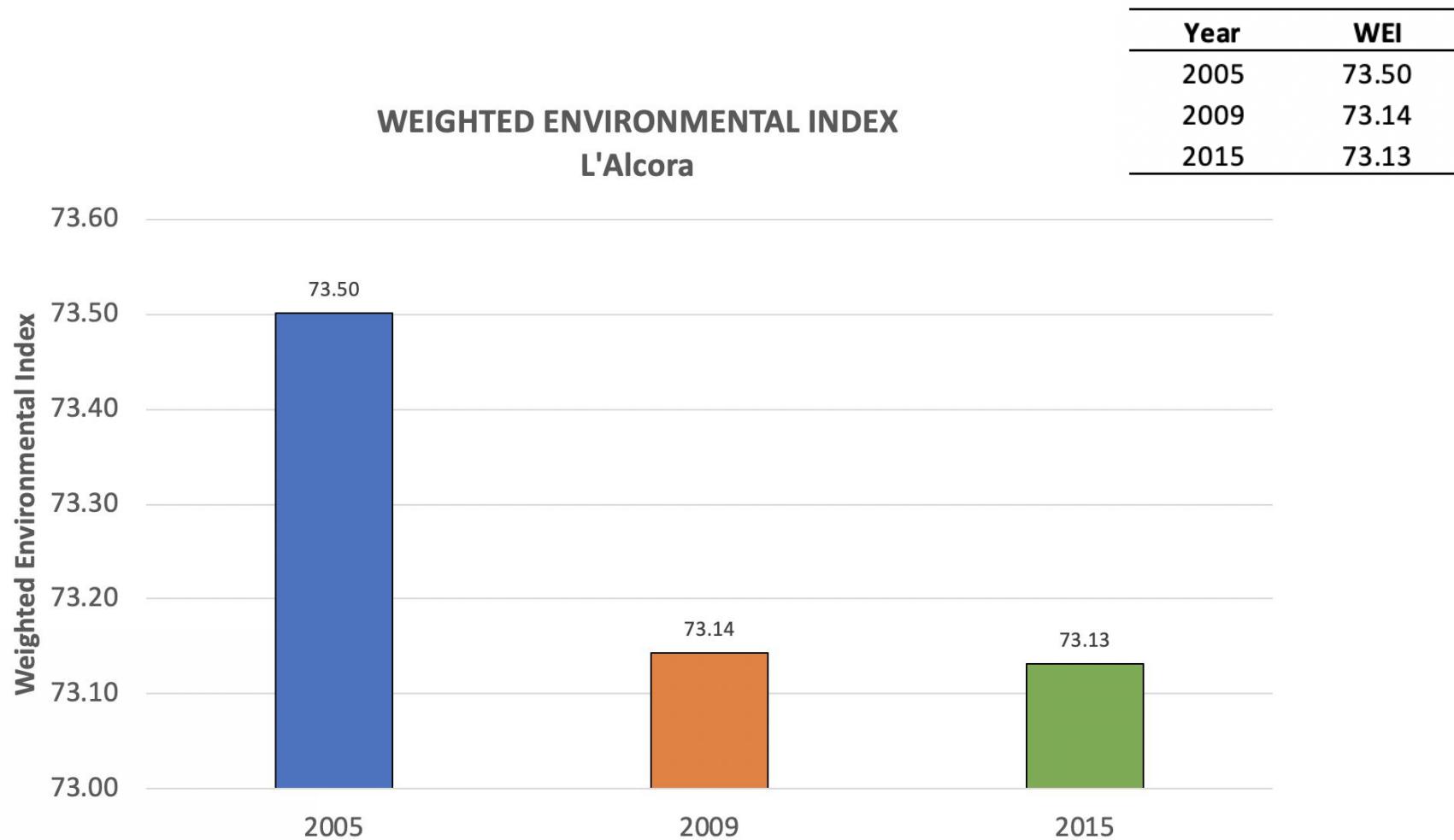


**Environmental Index L'Alcora  
2005 to 2015**

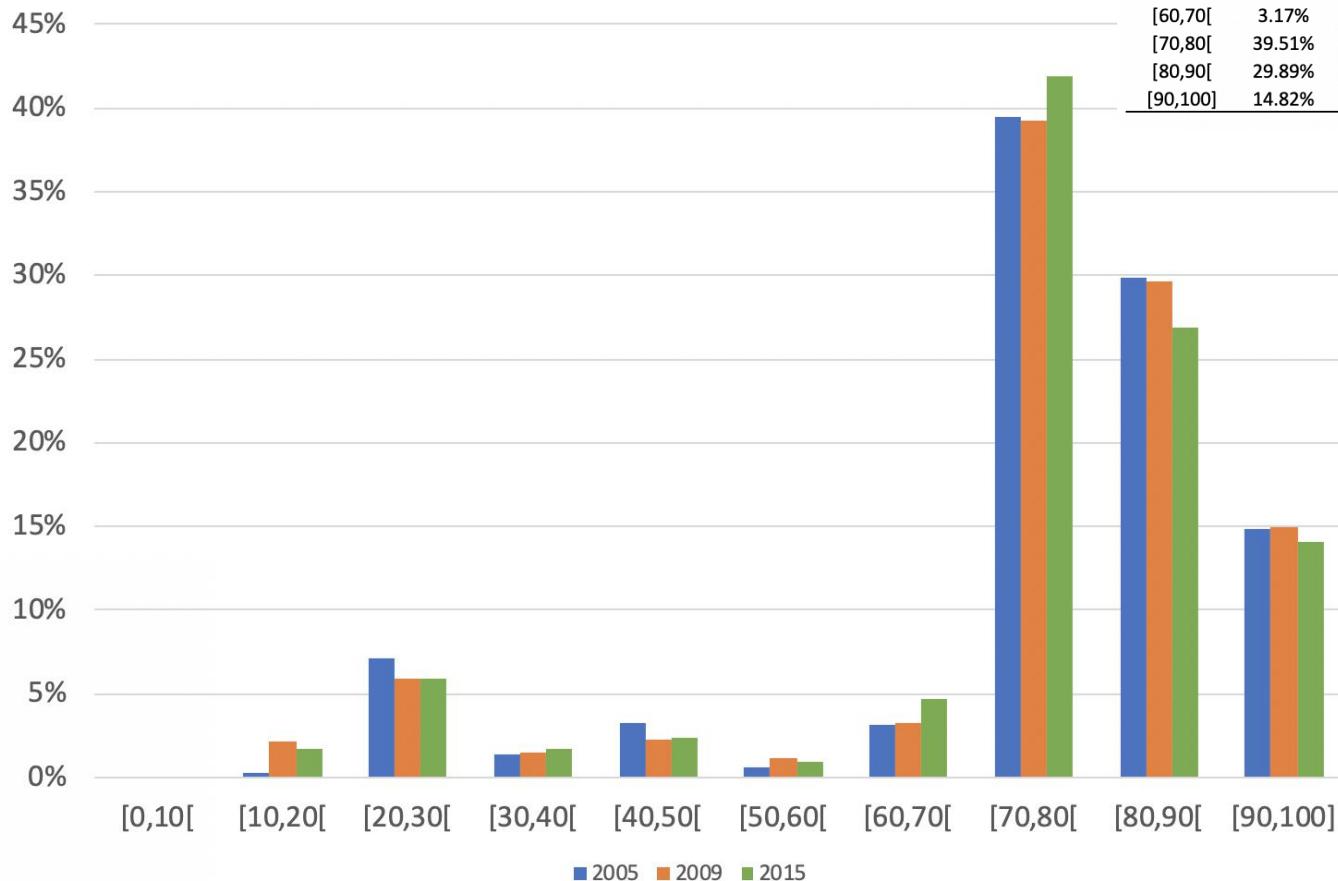


A scale bar and north arrow are located in the top right corner of the map. The scale bar shows distances from 0 to 4 Kilometers. The north arrow points towards the top left.



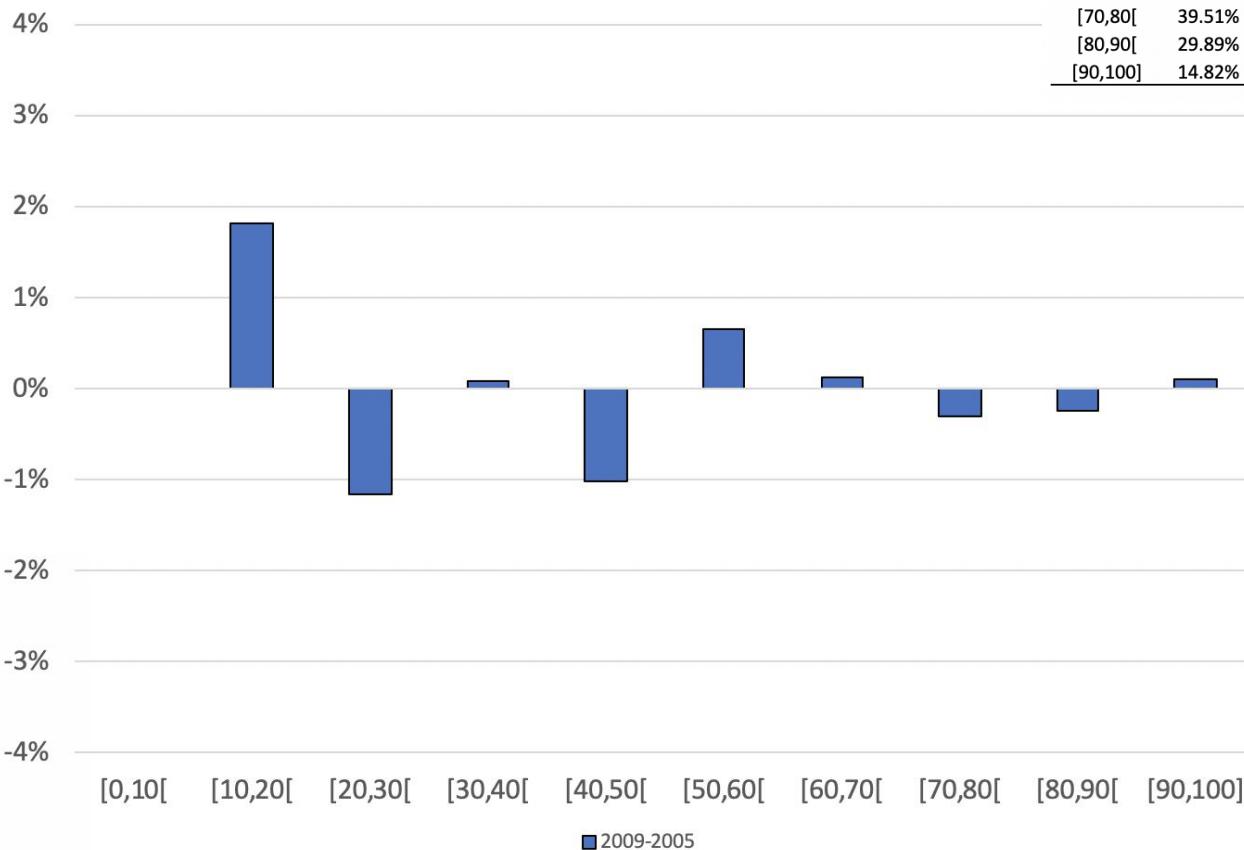


**WEIGHTED ENVIRONMENTAL INDEX**  
**Decile Evolution**



| WEI      | % Superficie de clase |        |        | Diferencias |           |           |
|----------|-----------------------|--------|--------|-------------|-----------|-----------|
|          | 2005                  | 2009   | 2015   | 2009-2005   | 2015-2009 | 2015-2005 |
| [0,10[   | 0.00%                 | 0.00%  | 0.00%  | 0.00%       | 0.00%     | 0.00%     |
| [10,20[  | 0.31%                 | 2.12%  | 1.68%  | 1.81%       | -0.45%    | 1.36%     |
| [20,30[  | 7.11%                 | 5.94%  | 5.96%  | -1.17%      | 0.01%     | -1.15%    |
| [30,40[  | 1.36%                 | 1.43%  | 1.69%  | 0.07%       | 0.25%     | 0.33%     |
| [40,50[  | 3.26%                 | 2.25%  | 2.32%  | -1.02%      | 0.07%     | -0.94%    |
| [50,60[  | 0.56%                 | 1.20%  | 0.89%  | 0.64%       | -0.31%    | 0.34%     |
| [60,70[  | 3.17%                 | 3.30%  | 4.65%  | 0.12%       | 1.35%     | 1.48%     |
| [70,80[  | 39.51%                | 39.20% | 41.92% | -0.31%      | 2.73%     | 2.41%     |
| [80,90[  | 29.89%                | 29.64% | 26.87% | -0.25%      | -2.77%    | -3.02%    |
| [90,100] | 14.82%                | 14.92% | 14.03% | 0.10%       | -0.90%    | -0.80%    |

**WEIGHTED ENVIRONMENTAL INDEX**  
**Decile Evolution 2005-2009**



**WEIGHTED ENVIRONMENTAL INDEX**  
**Decile Evolution 2009-2015**

4%

3%

2%

1%

0%

-1%

-2%

-3%

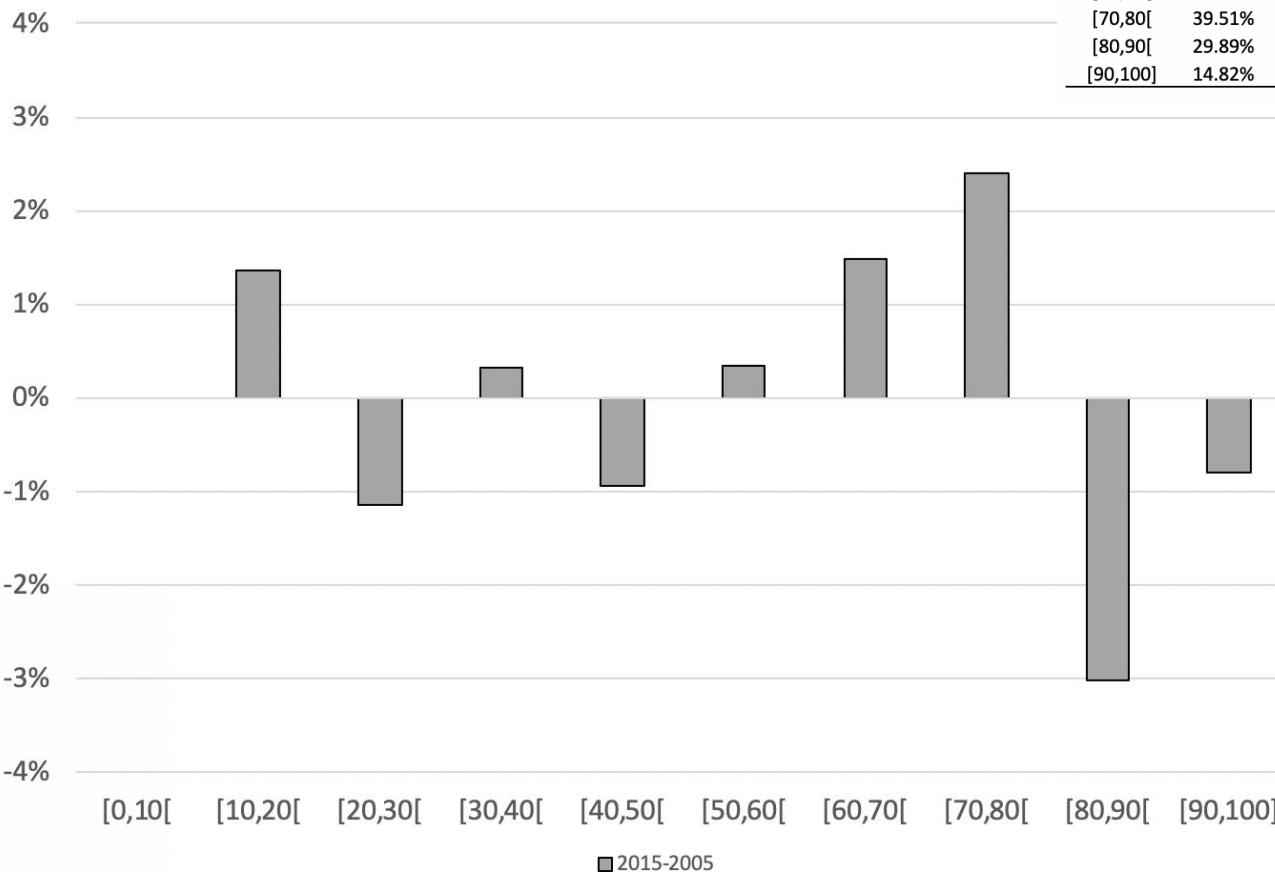
-4%

[0,10[ [10,20[ [20,30[ [30,40[ [40,50[ [50,60[ [60,70[ [70,80[ [80,90[ [90,100]

2015-2009

| WEI      | % Superficie de clase |        |        | Diferencias |           |           |
|----------|-----------------------|--------|--------|-------------|-----------|-----------|
|          | 2005                  | 2009   | 2015   | 2009-2005   | 2015-2009 | 2015-2005 |
| [0,10[   | 0.00%                 | 0.00%  | 0.00%  | 0.00%       | 0.00%     | 0.00%     |
| [10,20[  | 0.31%                 | 2.12%  | 1.68%  | 1.81%       | -0.45%    | 1.36%     |
| [20,30[  | 7.11%                 | 5.94%  | 5.96%  | -1.17%      | 0.01%     | -1.15%    |
| [30,40[  | 1.36%                 | 1.43%  | 1.69%  | 0.07%       | 0.25%     | 0.33%     |
| [40,50[  | 3.26%                 | 2.25%  | 2.32%  | -1.02%      | 0.07%     | -0.94%    |
| [50,60[  | 0.56%                 | 1.20%  | 0.89%  | 0.64%       | -0.31%    | 0.34%     |
| [60,70[  | 3.17%                 | 3.30%  | 4.65%  | 0.12%       | 1.35%     | 1.48%     |
| [70,80[  | 39.51%                | 39.20% | 41.92% | -0.31%      | 2.73%     | 2.41%     |
| [80,90[  | 29.89%                | 29.64% | 26.87% | -0.25%      | -2.77%    | -3.02%    |
| [90,100] | 14.82%                | 14.92% | 14.03% | 0.10%       | -0.90%    | -0.80%    |

**WEIGHTED ENVIRONMENTAL INDEX**  
**Decile Evolution 2005-2015**



| WEI      | % Superficie de clase |        |        | Diferencias |           |           |
|----------|-----------------------|--------|--------|-------------|-----------|-----------|
|          | 2005                  | 2009   | 2015   | 2009-2005   | 2015-2009 | 2015-2005 |
| [0,10[   | 0.00%                 | 0.00%  | 0.00%  | 0.00%       | 0.00%     | 0.00%     |
| [10,20[  | 0.31%                 | 2.12%  | 1.68%  | 1.81%       | -0.45%    | 1.36%     |
| [20,30[  | 7.11%                 | 5.94%  | 5.96%  | -1.17%      | 0.01%     | -1.15%    |
| [30,40[  | 1.36%                 | 1.43%  | 1.69%  | 0.07%       | 0.25%     | 0.33%     |
| [40,50[  | 3.26%                 | 2.25%  | 2.32%  | -1.02%      | 0.07%     | -0.94%    |
| [50,60[  | 0.56%                 | 1.20%  | 0.89%  | 0.64%       | -0.31%    | 0.34%     |
| [60,70[  | 3.17%                 | 3.30%  | 4.65%  | 0.12%       | 1.35%     | 1.48%     |
| [70,80[  | 39.51%                | 39.20% | 41.92% | -0.31%      | 2.73%     | 2.41%     |
| [80,90[  | 29.89%                | 29.64% | 26.87% | -0.25%      | -2.77%    | -3.02%    |
| [90,100[ | 14.82%                | 14.92% | 14.03% | 0.10%       | -0.90%    | -0.80%    |

- ENV\_IND is a powerful tool to analyse landuse
- It covers a whole range of situations as is able to analyse landuse evolution over time at detailed scale
- The evolution of the ENV-IND indicator over time has been obtained for the whole Valencia Region for three different dates (2005-2009-2015)
- A detailed results analysis has been done for L'Alcora municipality.
- The ENV-IND indicator is therefore applicable as a tool to quantify and analyze trends of the environmental quality related with land use change.

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**LAND USE EVOLUTION OVER TIME USING PUBLIC DATA  
AND A NEW ENVIRONMENTAL INDICATOR  
APPLICATION TO THE VALENCIA REGION (SPAIN)**

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