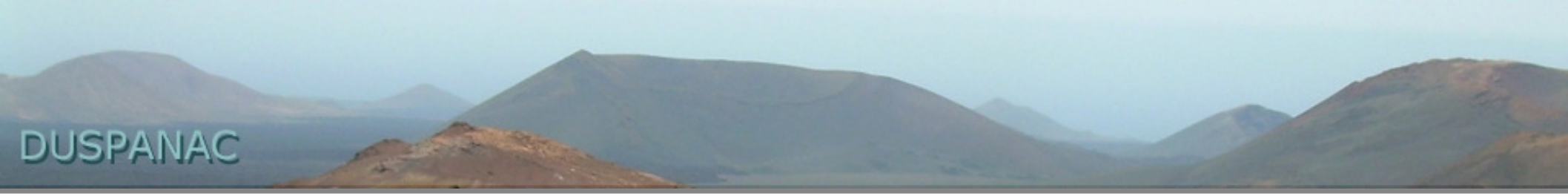
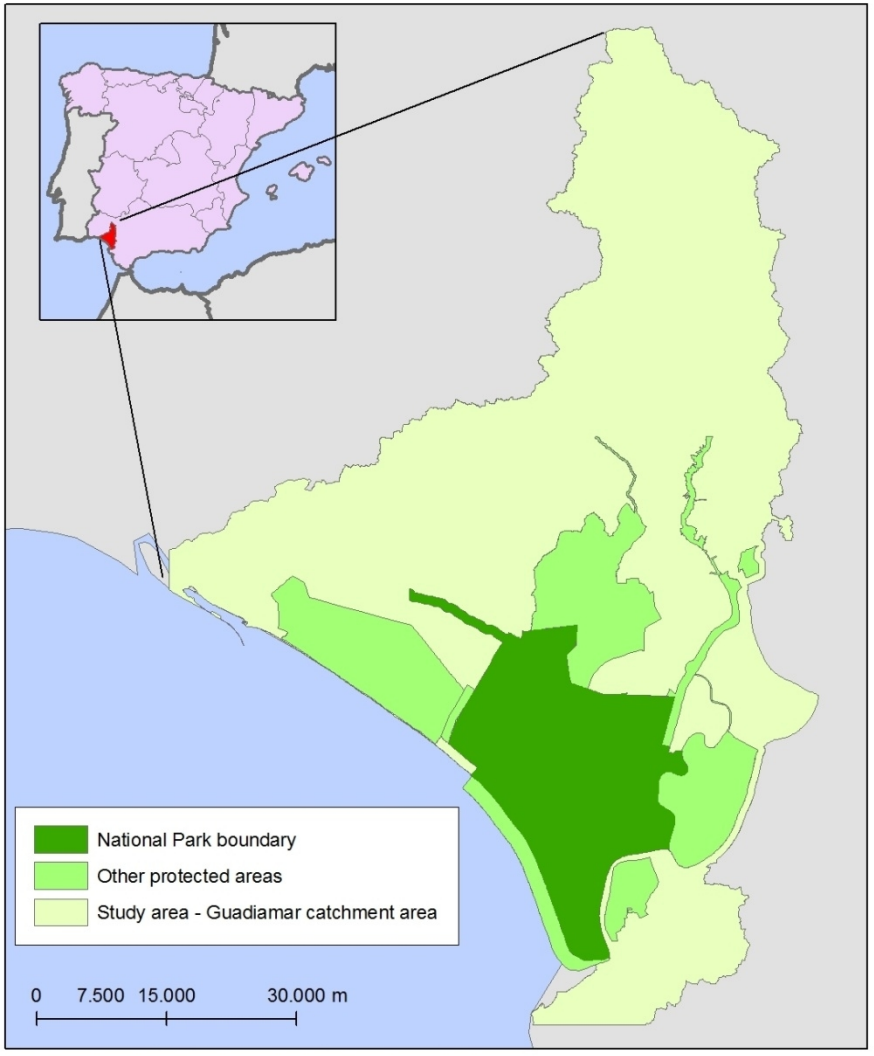
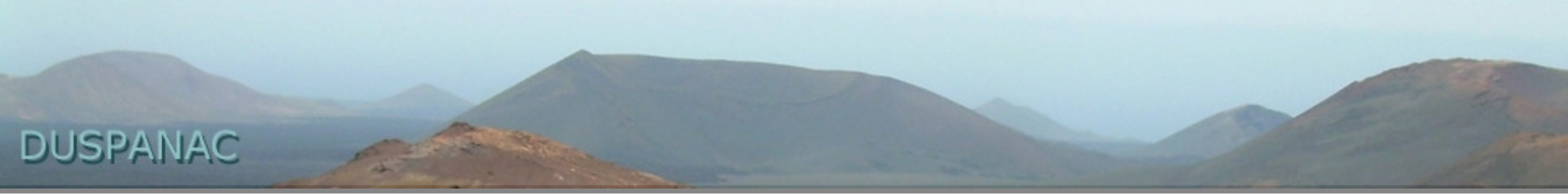


Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

Richard Hewitt[1]

1. University of Alcalá, Madrid, Spain





Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

1. Application of CA-type models to non-urban areas.

2. Modelling procedure - approach useful for future CA land use modelling in non-urban areas?

3. To review the lessons learnt & future steps to improve the model & its applicability as DSS for Doñana natural area.

Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

DOÑANA:

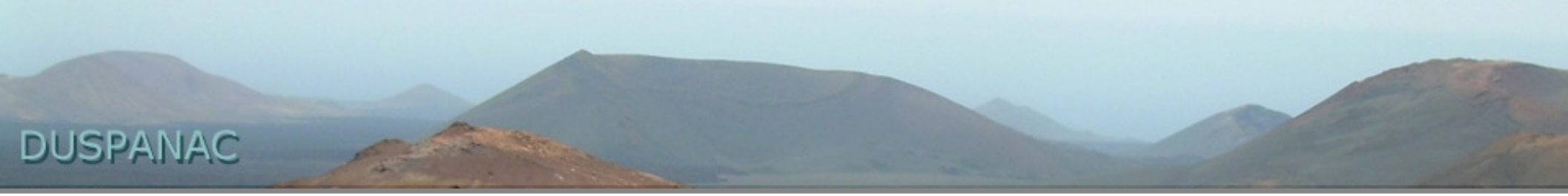
Interconnected coastal dune and wetland ecosystems - Unique in terms of its biodiversity

Socio-economic development has raised GDP dramatically over 60 years -
but deterioration of natural area

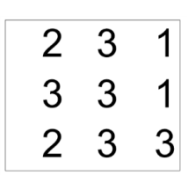
increased awareness NP 1969, UNESCO 1993, among others..

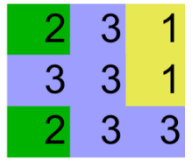
SUSTAINABLE DOÑANA?

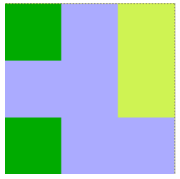
Conservation as a partner of development



Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

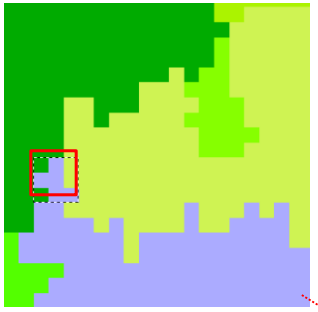






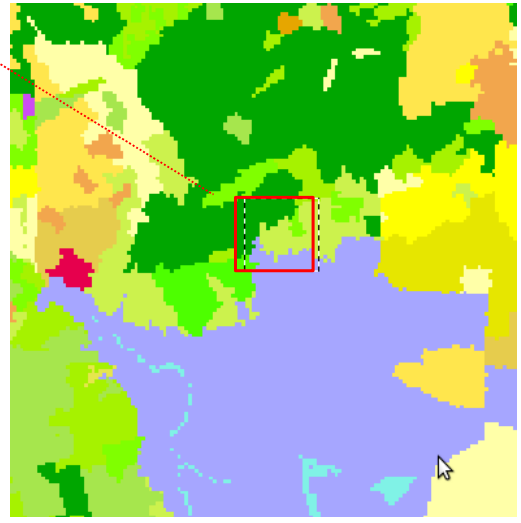
METHODS:

Land use models of historical and future change



cell by cell evolution of landscape in response to land change drivers and constraints

Scenarios for future management of the natural area in context of its region



<u>Models developed together with stakeholders</u>

Land use modelling and the role of stakeholders in natural protected areas: the case of Doñana, Spain

METRONAMICA™ software, a constrained cellular automata model (White and Engelen 1993)

step by step cell evolution controlled by Transition Potential (TP) algorithm:

MS2 → M1*n*a*s*z*ά

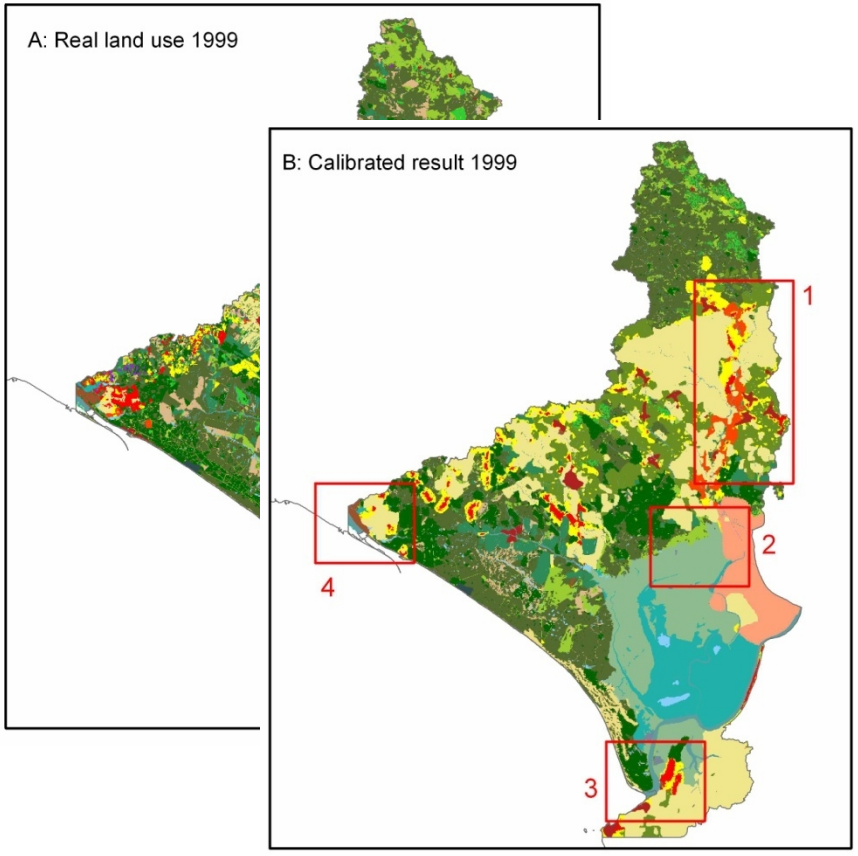
n = cell neighbourhood rules

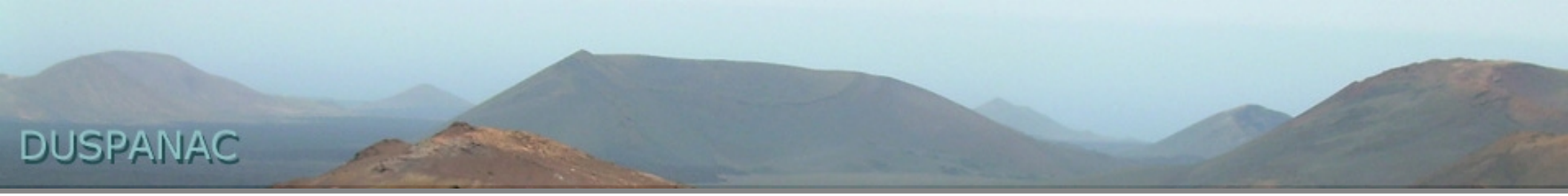
a = accessibility

s = (biophysical) suitability

z = zoning (planning or policy actions)

ά = stochastic factor





Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

PILOT MODEL:

Test input data (corine land cover)

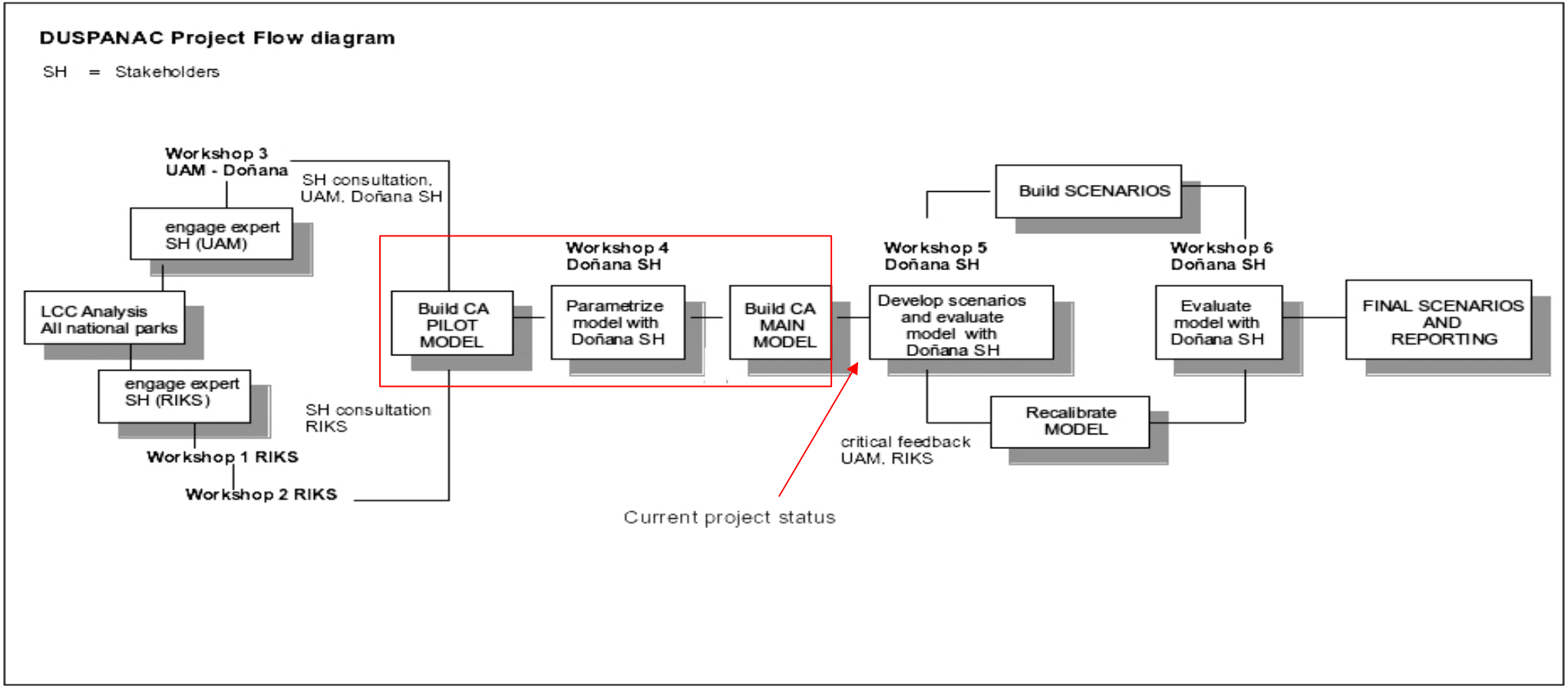
Test researcher's assumptions (participatory workshops)

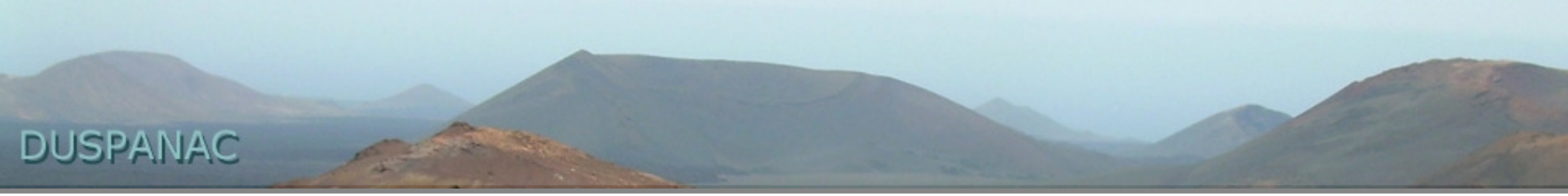
Test appropriateness of software for natural/non-urban areas

Pilot model prior to commitment of extensive resources, allowing time to change direction early within the project cycle

Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

The modelling chain:





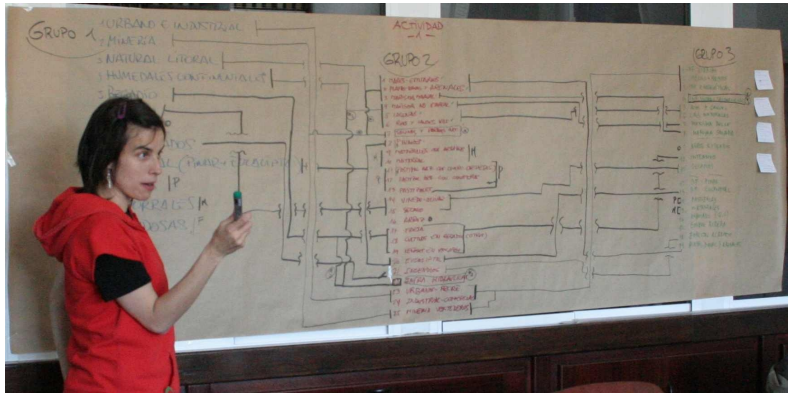
Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

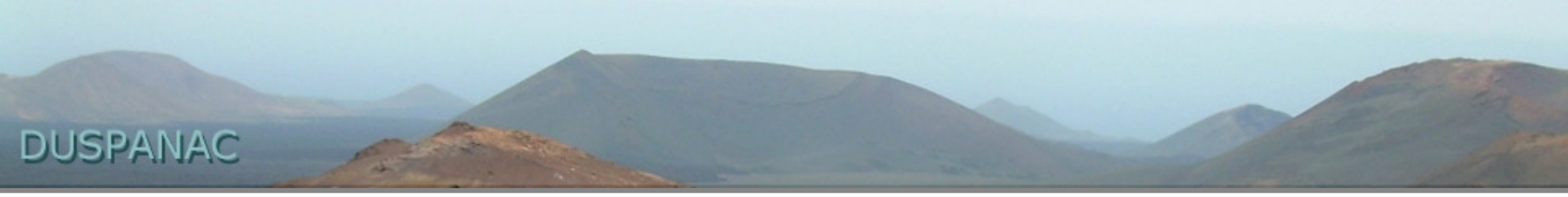
STAKEHOLDERS:

1. Why model?
2. Who is the model for?
3. Improved acceptance
4. Social learning/shared learning

PARAMETERS

1. Model study area
2. Land use datasets and classes to use in the model
3. Land use dynamics to represent





Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

KEY LAND USE DYNAMICS 1990-2006 (CLC)

- Significant expansion of fruit and berry plantations (F) (Intensive cultivation of citrus and strawberry).

- Increase in other types of irrigated crops (TRP)

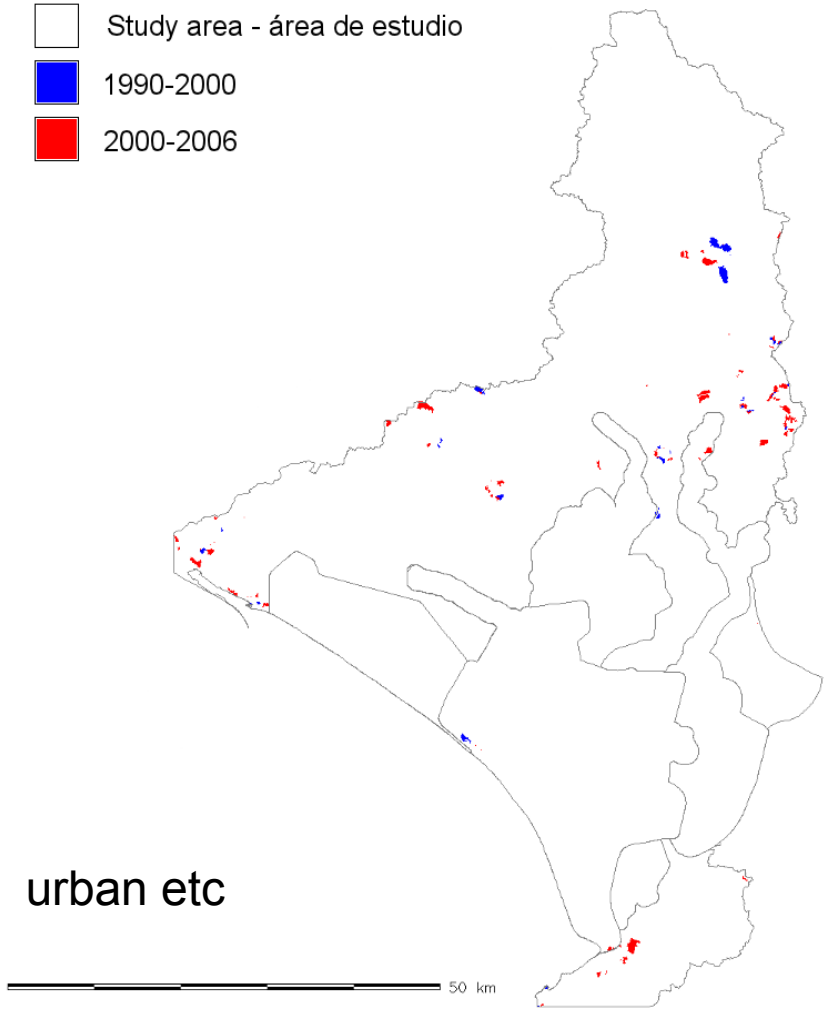
- Loss of natural areas (shrubland, grassland, wetland)

- Increase in urban fabric, leisure areas, areas in construction

ALL TAKING PLACE ON THE FRINGE OF THE PROTECTED AREA

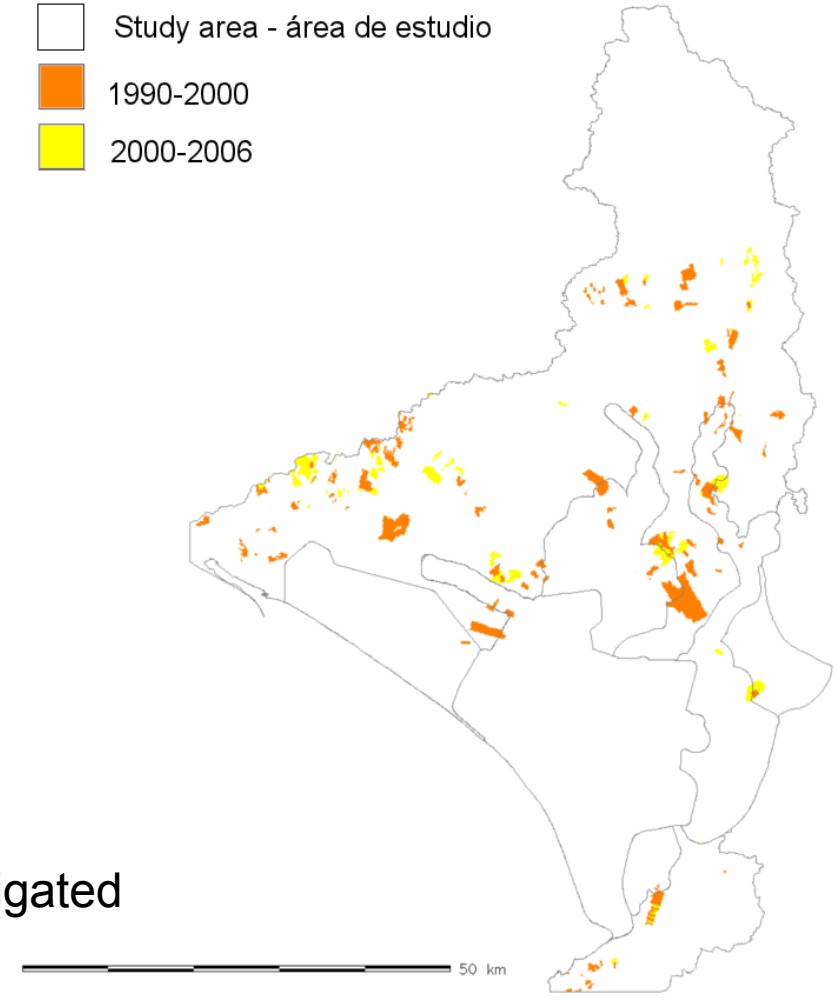
Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

Nuevas superficies artificiales, 1990-2006, según corine land cover



urban etc

Aumento de cúltivos en regadío 1990-2006, según corine land cover



irrigated

Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

Model calibration

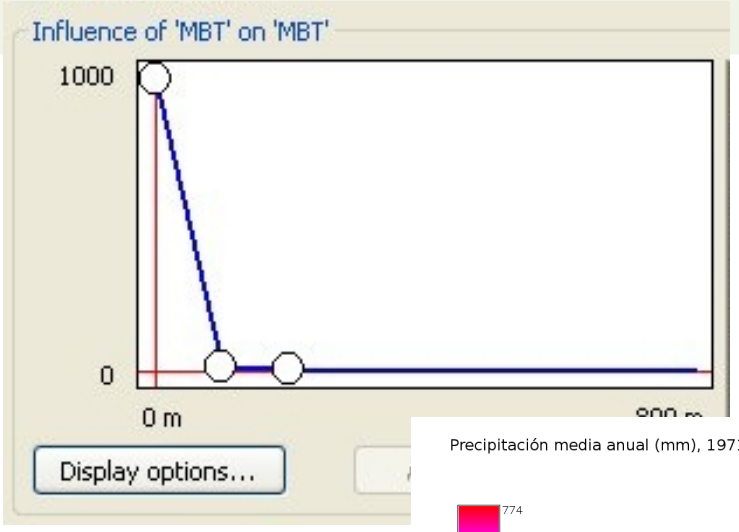
1. introduce demand (cells) for each FUNCTION land use

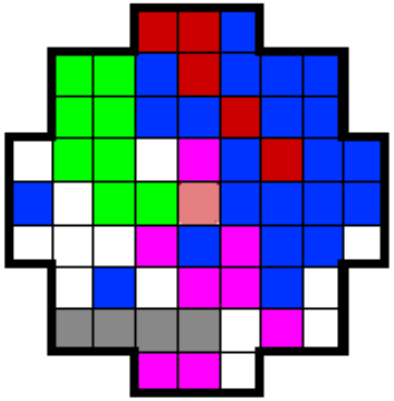
2. Set neighbourhood rules (attraction and repulsion) (n=197)

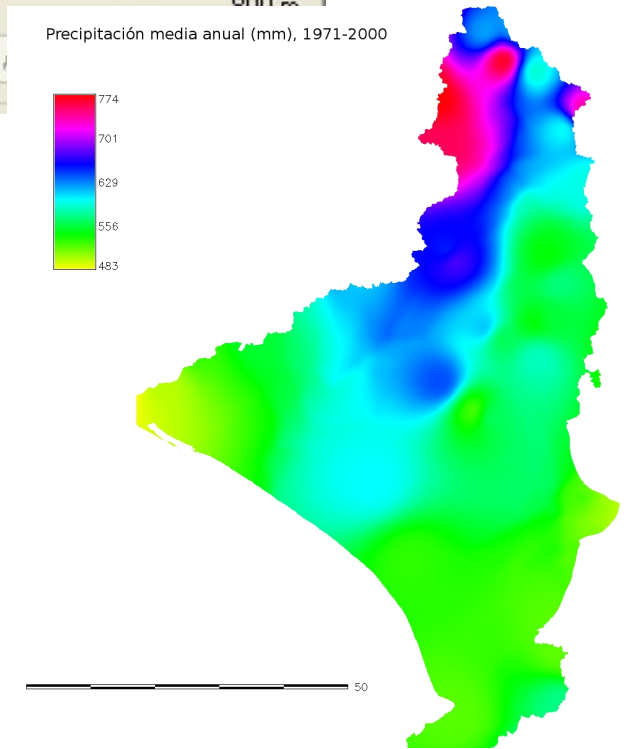
3. Introduce accessibility, suitability, zoning.

4. Run model

5. Iterations (modify parameters 1-3)







Agentes, escenarios y autómatas celulares; modelización espacial para la toma de decisiones en Doñana y su entorno

Scenario development with the CA model

E1 : Business as usual (BAU)

E2: Expansion of urban areas and tourist infrastructures

E3: Massive Expansion of fruit trees and berry plantations

USO	ha 1990	ha 2000	ha 2006	E1 2030	E2 2030	E3 2030
TUC	407	407	451	517	781	517
TUD	6	6	6	6	6	6
ZC	53	53	38	15,5	15,5	15,5
IDR	13	65	65	143	455	143
TRP	419	369	351	249	249	249
F	100	241	241	452,5	452,5	2000
MC	0	50	50	125	125	125
MBT	3307	4464	4939	7387	7387	7387

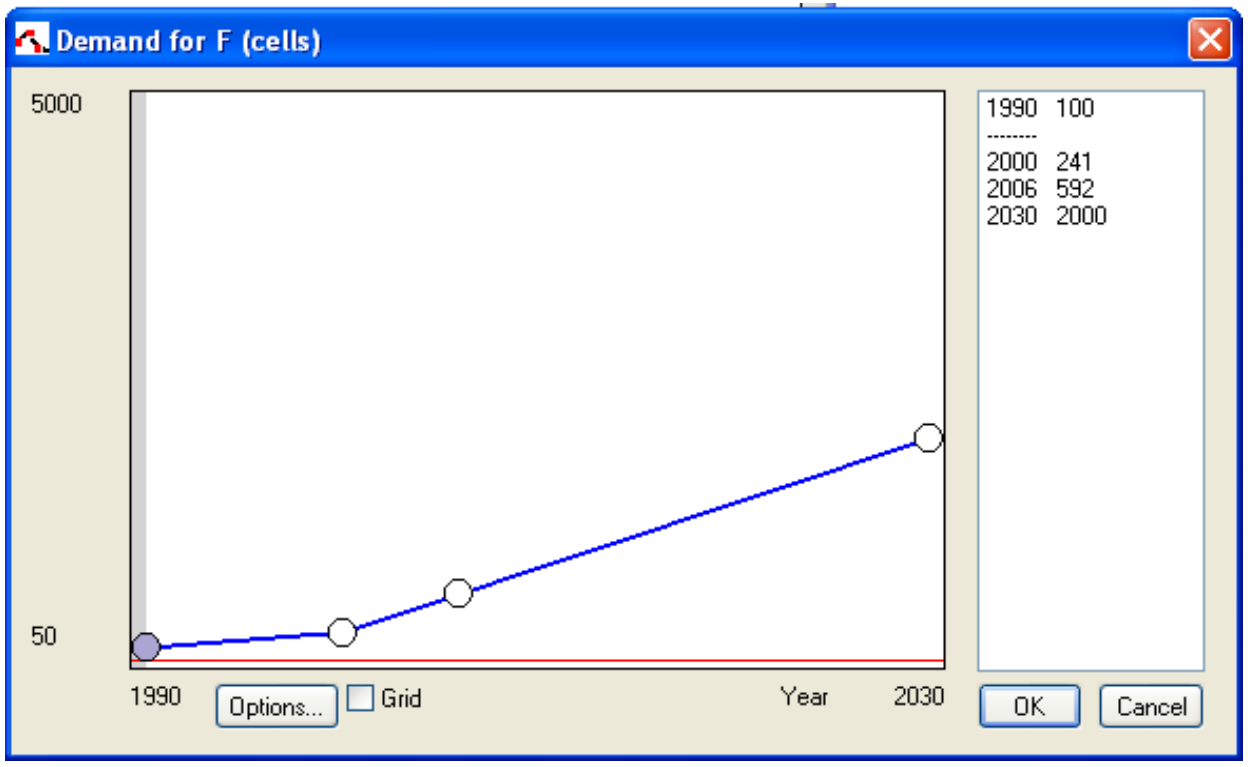
Agentes, escenarios y autómatas celulares; modelización espacial para la toma de decisiones en Doñana y su entorno

E3: Massive Expansion of fruit/berry crops up to 2030

Between 1990 and 2006, the surface area occupied by F increased by 141 ha.

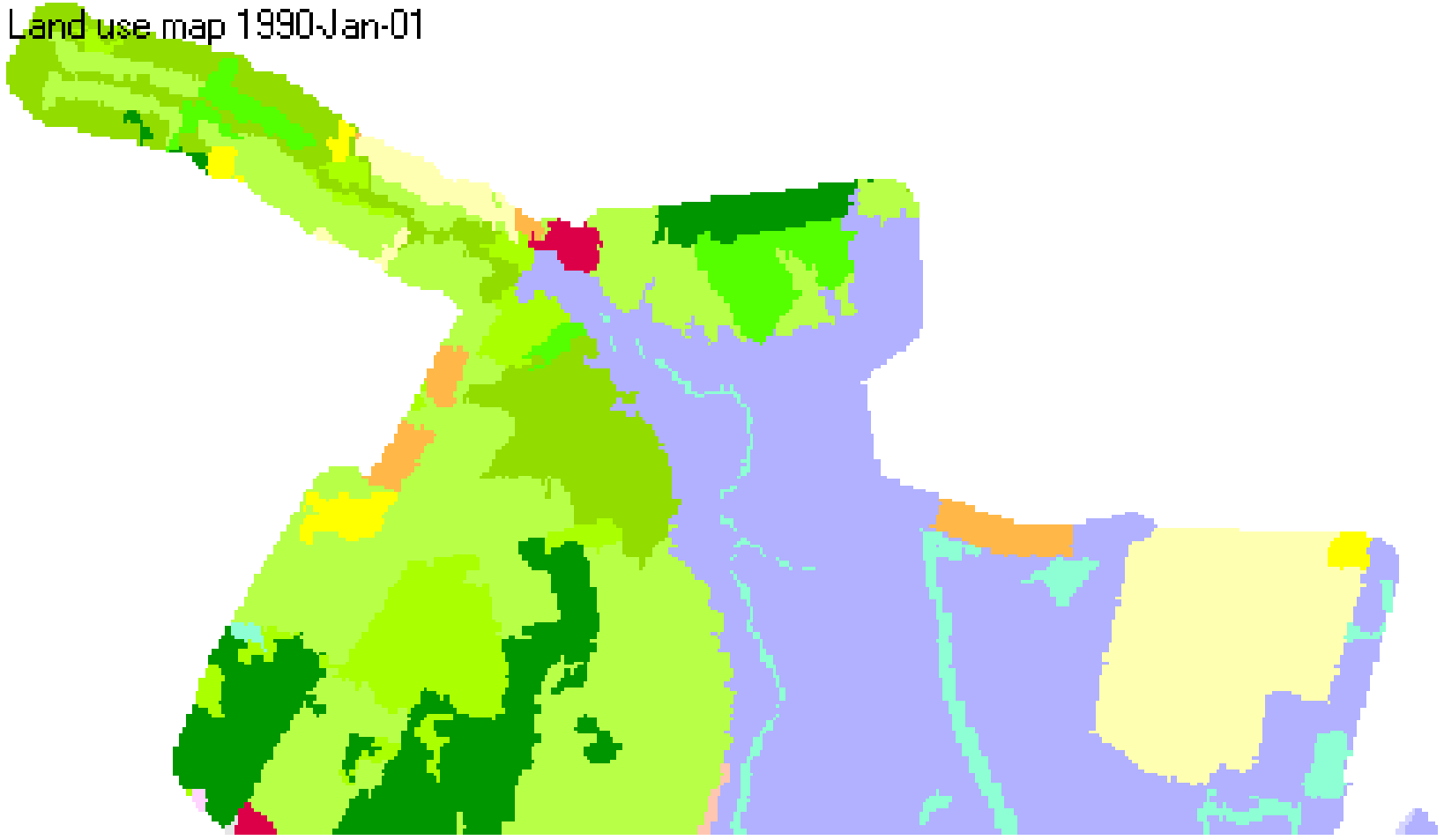
En scenario E1, F increases at the pace observed1990-2006

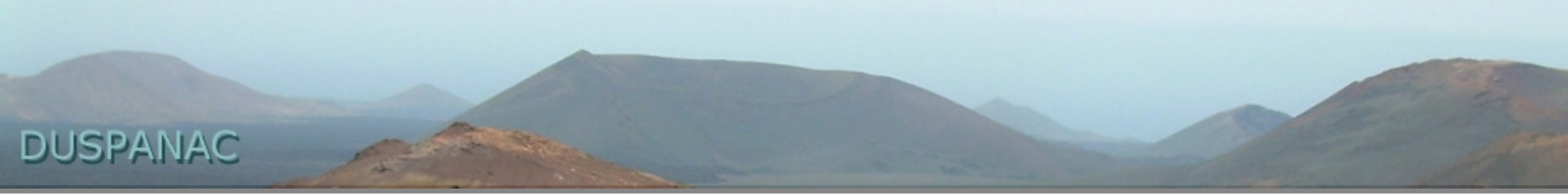
In scenario E3 - F increases much more quickly that 1990-2006 **(approx 8x)**



Agentes, escenarios y autómatas celulares; modelización espacial para la toma de decisiones en Doñana y su entorno

E3: Expansión masiva de frutales hasta 2030





Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

RESULTS: Can CA models like metronamica be applied to non urban areas?

Yes, as long as:

- LU dynamics can be represented through neighbourhood rules

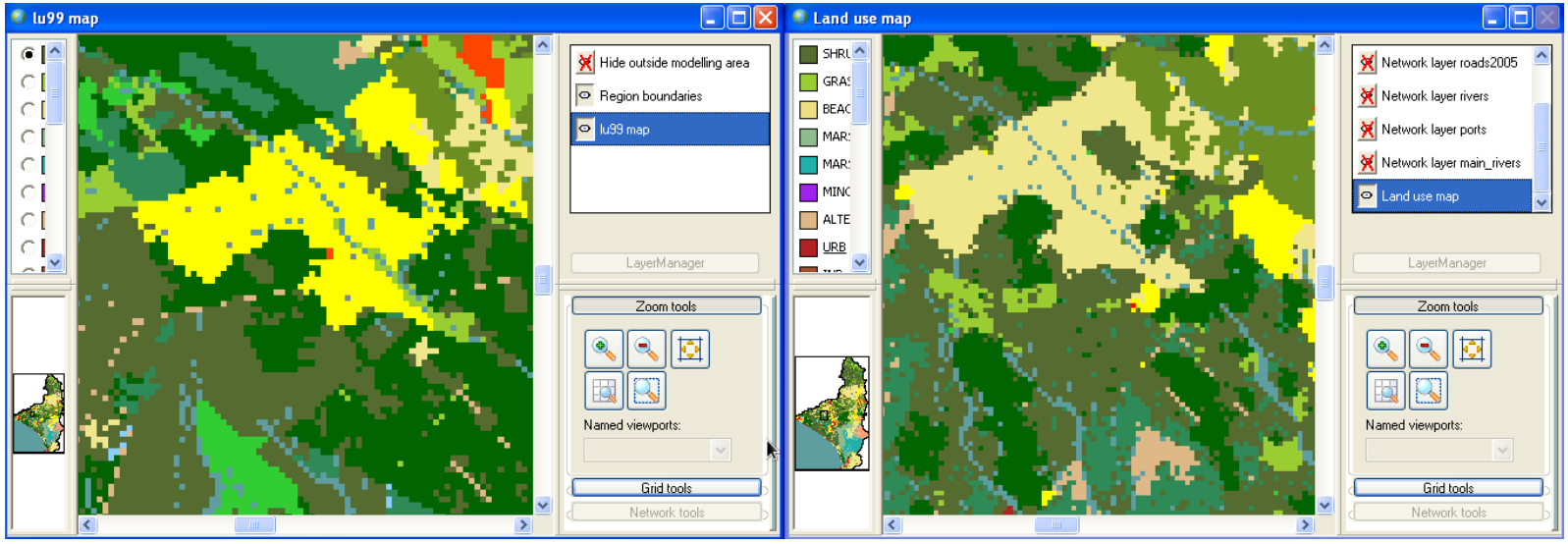
- if the theoretical model of pressure and competition over land uses can reasonably be applied

- at least some areas can be shown to grow incrementally (resolution dependent?)

Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

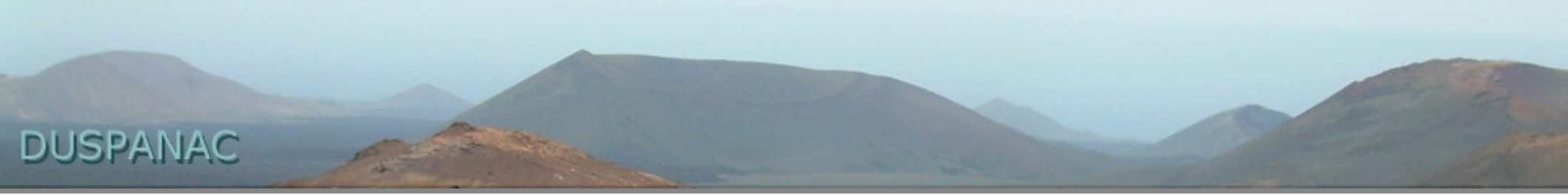
DIFFICULTIES:

- Evolution of vegetation categories
- Non-incremental growth of land areas (e.g. irrigated crops)



RESPONSES:

- inertia effect for vacant vegetation classes
- Create specific suitability maps for large change areas



Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

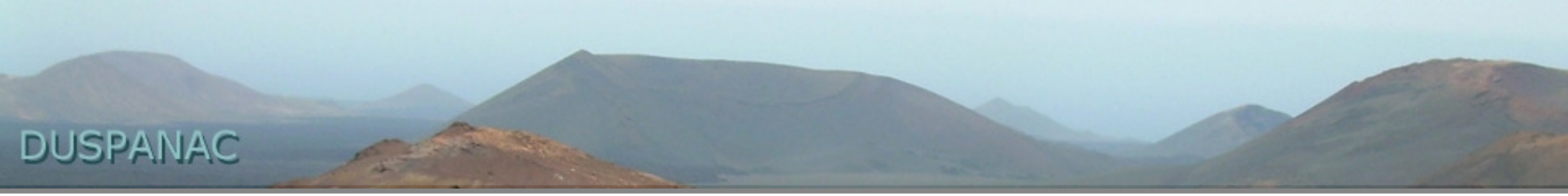
LESSONS LEARNT FROM PILOT MODEL/STAKEHOLDER CONSULTATION

1. CLC data used in the pilot study is over-generalised for the study area

2. Initial study area need to be increased to reflect important influences on NPA from outside

3. Expansion of urban and tourist infrastructures and expansion of irrigated crops is an important dynamic for future scenarios

4. CA model approach adopted (metronamica) is appropriate in this case, even though the most important land use changes are non-urban in origin.

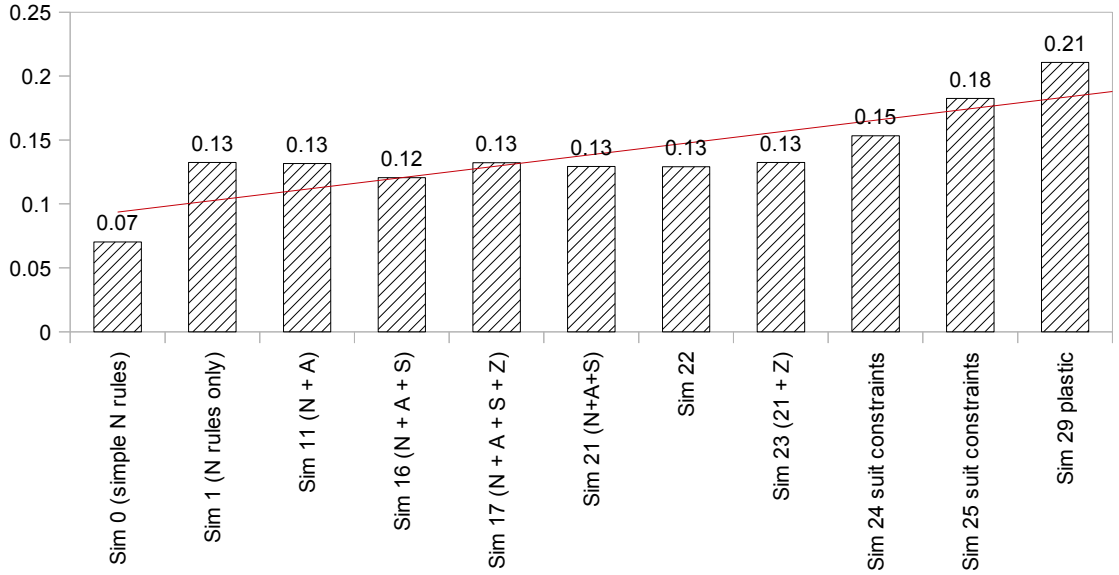


Cells but not cities: building a cellular automata land use model for the Doñana natural area, SW Spain

CONCLUSIONS

Model performs well on basis of cell-by-cell/pattern measures compared with peers

e.g. Diaz Pacheco (Madrid), ongoing research
Wickramasuriya et al (2009)



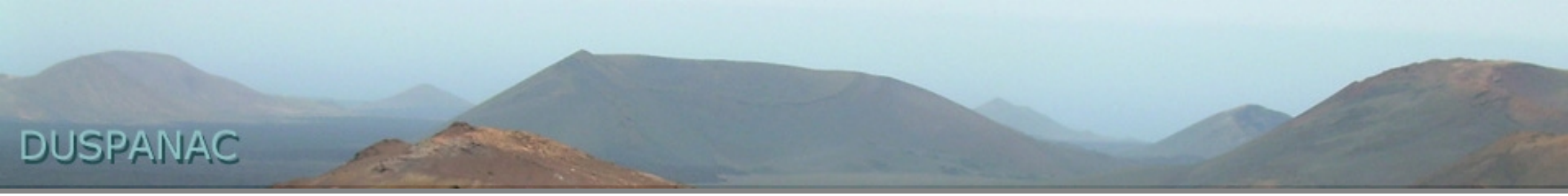
FUTURE WORK

re-calibrate model with larger study area and better LU data (COMPLETE)

validation phase up to third date (ONGOING)

evaluation of model by stakeholders (Dec 11th 2012)

Develop realistic land use scenarios for “ecofutures” (Palomo et al 2011)



Land use modelling and the role of stakeholders in natural protected areas: the case of Doñana, Spain

THANK YOU!

Website: http://www.geogra.uah.es/duspanac

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