Who knows best?

The role of stakeholder knowledge in land use models

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Stakeholders in land use change

Land use change is the aggregate effect of all stakeholders' activities.

To understand the variety of possible futures in the territory, a wide range of stakeholders need to be involved

From planning for the people...

To planning BY the people...

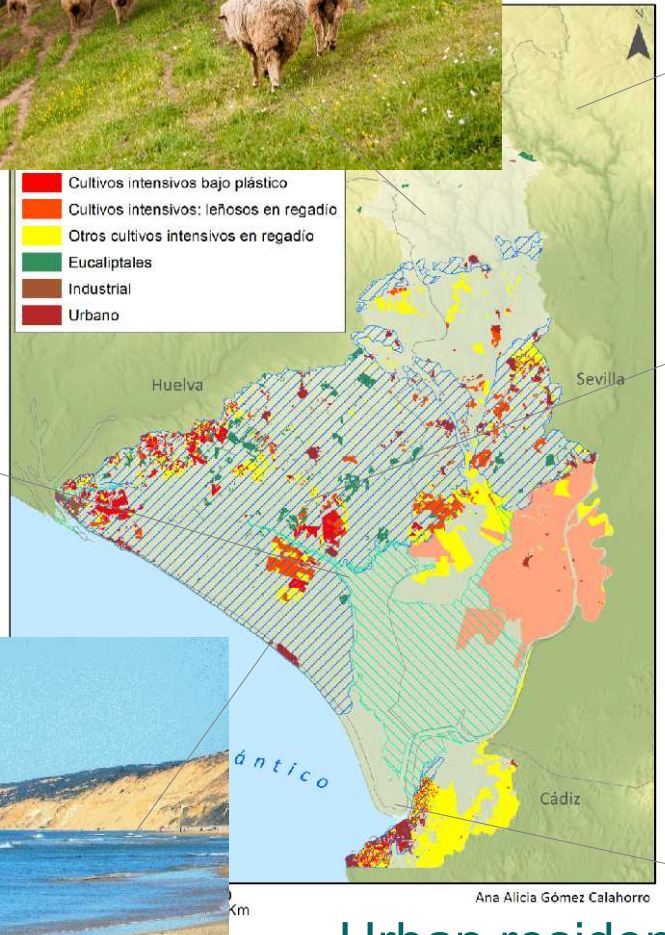
Land use stakeholders

Winemaker
Local businesspeople
Agricultural engineer

Livestock keeper
Rural resident

Ecologist,
conservation scientist
Protected area manager
Visitor

Migrant worker
Farmer
Water committee



Beach tourist
Local tourism
reps

Urban resident
City politician

Discursive vs Analytical approaches

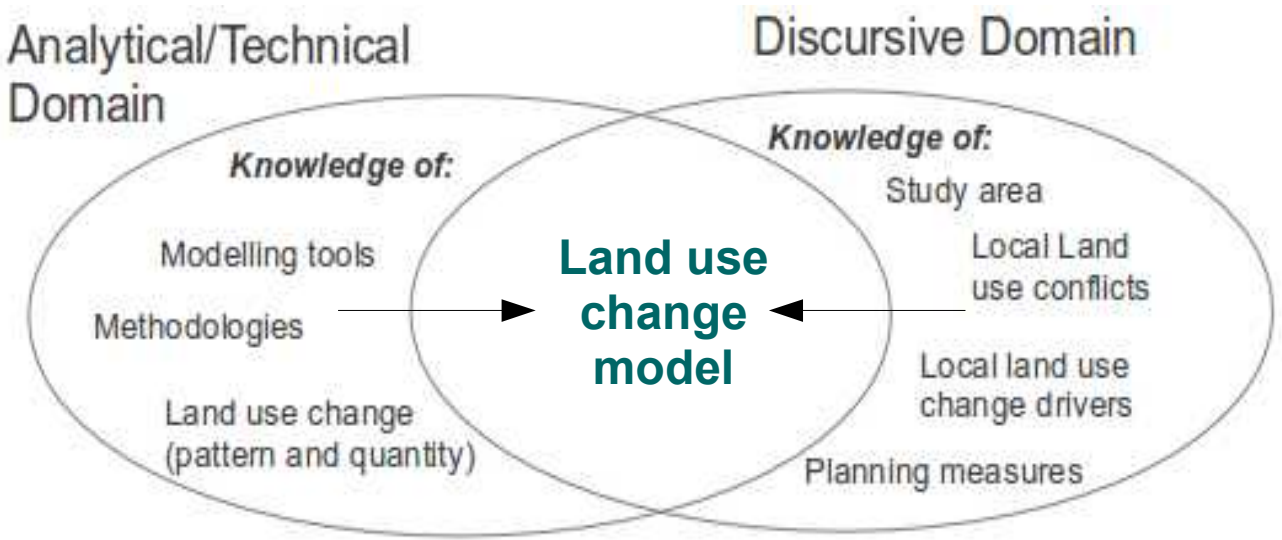
Discursive or "Soft-science" methods are useful in cases where human behaviour or interaction is important (e.g. land use policy)

- may involve participatory techniques for qualitative/approximate information

Analytical or "Hard-science" approaches are relevant to the study of natural phenomena (e.g. degradation of a natural resource), and involve mathematical and quantitative methods which provide precise, numerical data.

In cases of human-environment interaction both kinds of information are necessary....

A land use change model can bring both domains together...



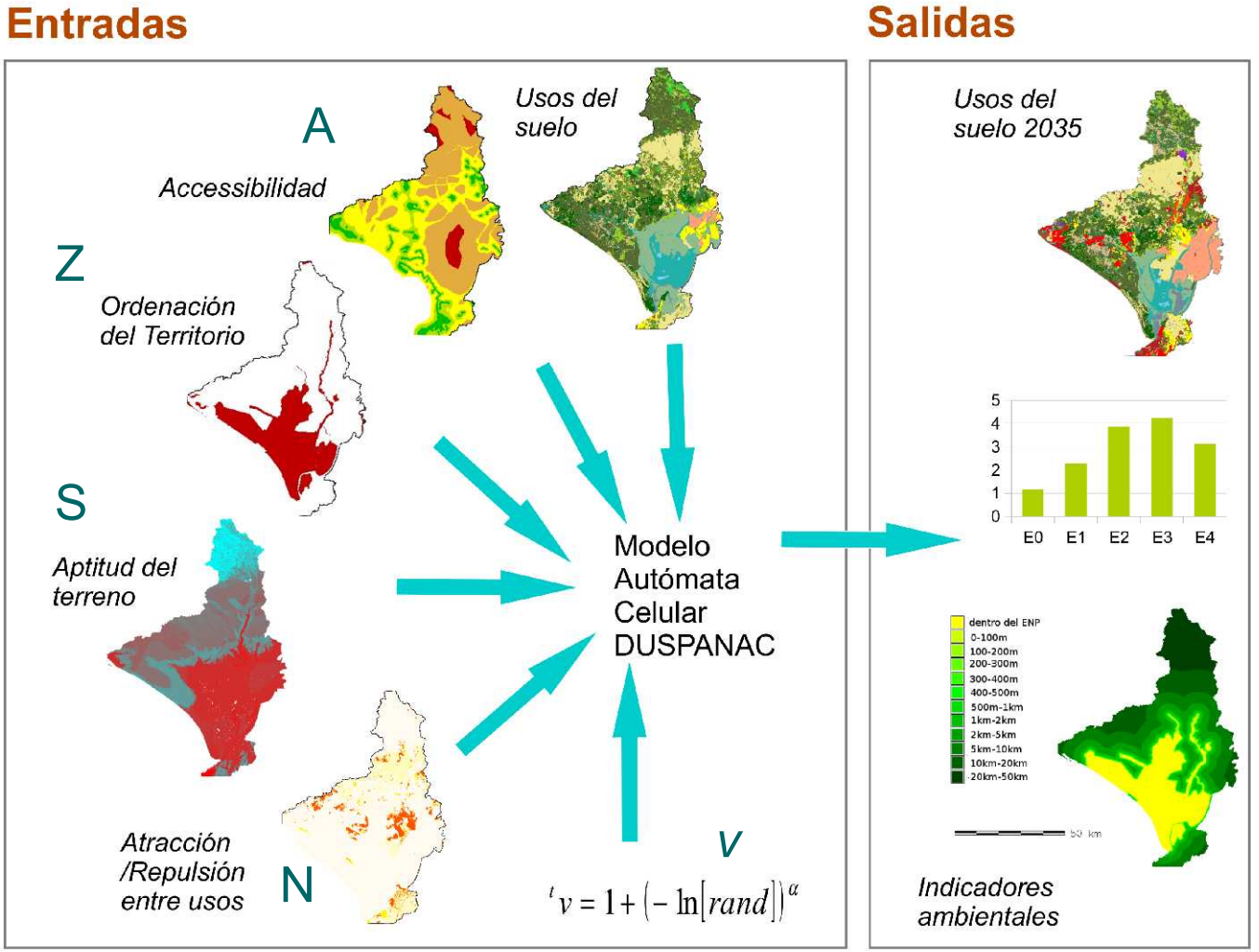
Modelling land use change

The study of *change* implies a dynamic approach (i.e. that includes time).

If the drivers of LUCC (e.g. road network expansion drives urban sprawl) can be found, then land use change over time....

T0, T1, T2 ... Tn

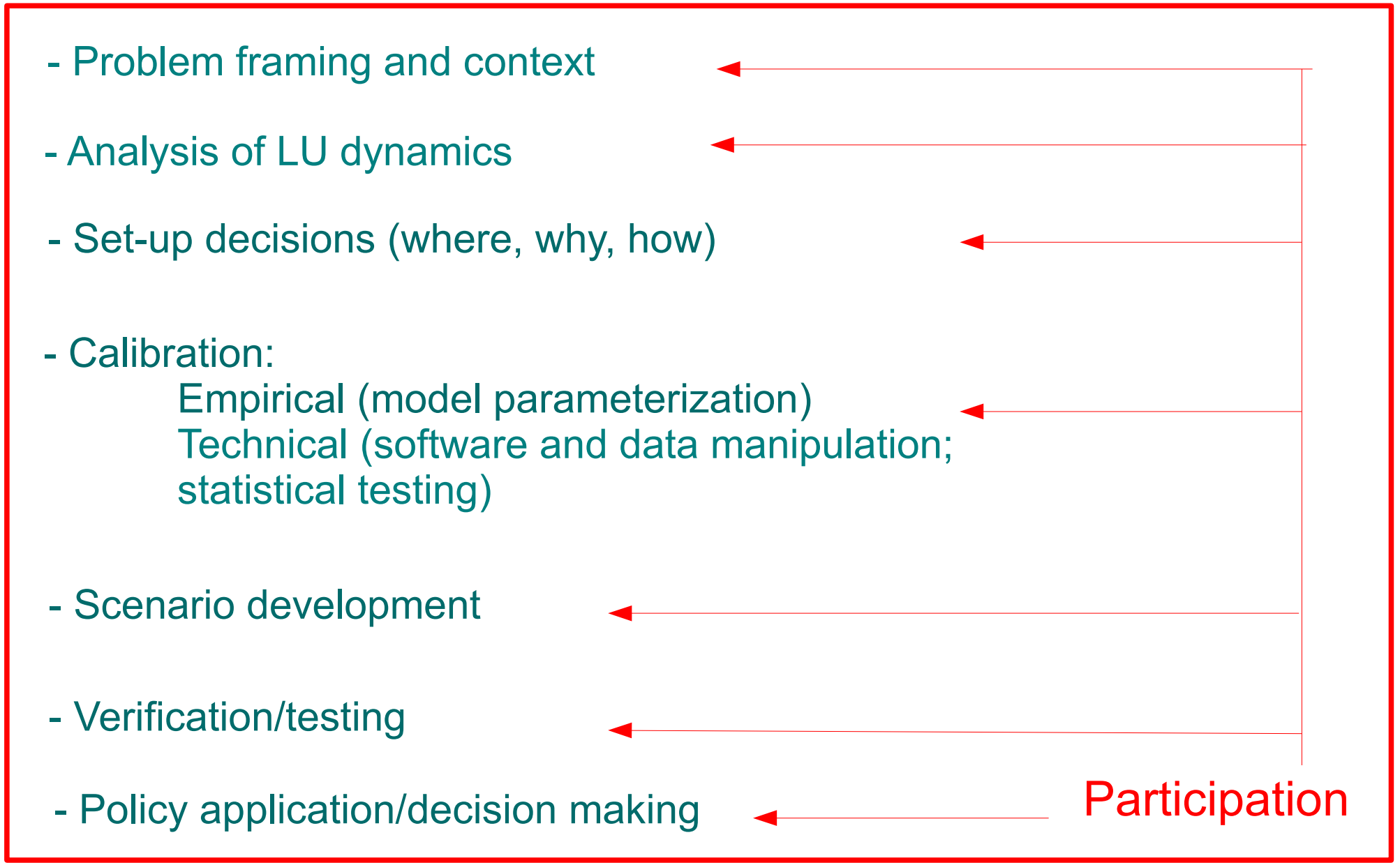
...can be replicated artificially through *transition rules.*



The NASZ model of White and collaborators (White and Engelen 1993, White et al 2000 etc)

By applying transition rules to current land use patterns (NASZ + *v*)
It may be possible to approximate future land use configurations

Modelling steps and involving stakeholders



Participatory land use modelling in practice - case studies

1. Doñana Natural Area (DUSPANAC, SIGEOMOD 2020) – DUSPANAC model

Cellular Automata-based land use model (Metronamica)

5 future scenarios to 2035 (Eco-Futures)

Participatory input to parameterization, calibration, scenario development, indicators and model/process evaluation

Actor behaviour **implicitly** modelled through main model parameters. Transition potential for each cell calculated for every T by:

$$TP = N*A*S*Z*v$$

2. Navarre, Spain and Overijssel, NL (COMPLEX) – the ApoLUS model

Cellular Automata-based land use model (R platform)

4 scenarios to 2050 (low-carbon economy)

Participatory input as above but also around actor dynamics

Actor behaviour **explicitly** modelled through main model parameters and one additional actor dynamics parameter

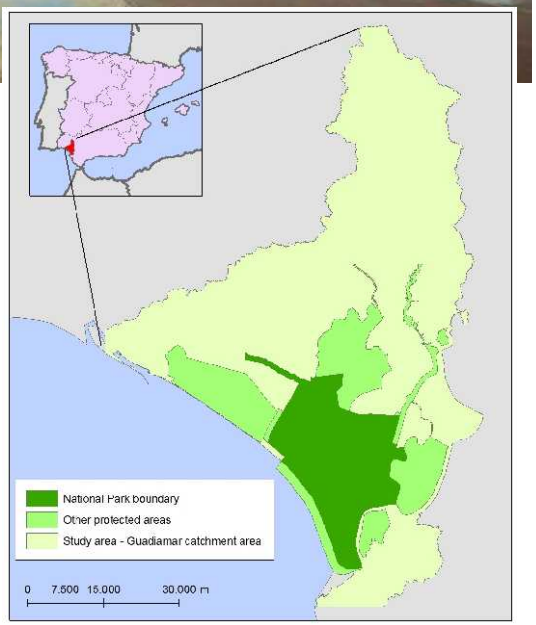
$$TP = D*N*A*S*Z*v$$

Case 1: Participatory modelling in Doñana (DUSPANAC)

Series of interconnected coastal dune and wetland ecosystems, Huelva, SW Spain

Outstanding importance for biodiversity

Socio-economic development of the region in the last 60 years has increased per-capita income but led to environmental deterioration – agricultural intensification, urban sprawl, infrastructures etc.



Growing awareness of the importance of the natural area - PN 1969, UNESCO 1993, and others....

A SUSTANABLE FUTURE FOR DOÑANA?

Spatial modelling to explore future land change tendencies, raise awarness and involve stakeholders

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DUSPANAC – stakeholder engagement

Stakeholder, by sector	WS1	WS2	WS3
SCIENCE			
Researcher, Autonomous University of Madrid	yes	yes	yes
Researcher and University Lecturer, University of Seville	yes	yes	yes
Researcer, Doñana Biological Station (National Scientific Institute)	yes	yes	yes
AGRICULTURE			
Director, federation of rice farmers, Seville	yes	yes	yes
Representative, young farmers agricultural association (ASAJA)	yes	yes	yes
Representative, Andalusian Farmers and Livestock keepers union, Huelva division.	no	yes	yes
TOURISM			
Tourism representative, Doñana natural area	no	yes	yes
LOCAL POLICY MAKERS			
Moguer Municipal council, Environment technician	yes	no	yes
Representative Doñana 21 Foundation	yes	yes	yes
Almonte Municipal council, Environment technician	no	no	yes
REGIONAL POLICY MAKERS			
Regional administration, environmental research division	no	yes	yes
Regional administration, environmental research division	no	yes	yes
NATURAL AREA MANAGERS			
Autonomous Body for National parks, head of project monitoring	yes	yes	no
Director, Doñana Natural Area	yes	yes	si
Sub-director, Doñana Natural Area	yes	no	?
Director of Conservation, Doñana Natural Area	yes	no	?
Director of Public Use, Doñana Natural Area	yes	yes	yes
Guide, Doñana Natural Area	no	no	yes
Monitoring division, Doñana Natural Area	yes	yes	yes
ENVIRONMENTALISTS			
Ex- Ecologistas en acción (Environmental group)	yes	no	yes
World Wildlife Fund	no	no	yes

3 workshops average of 12 participants from:

Science
Agriculture/Livestock
Tourism
Policy makers
Local, Regional Natural Protected Area managers (national, regional, local)
Environmentalists' groups

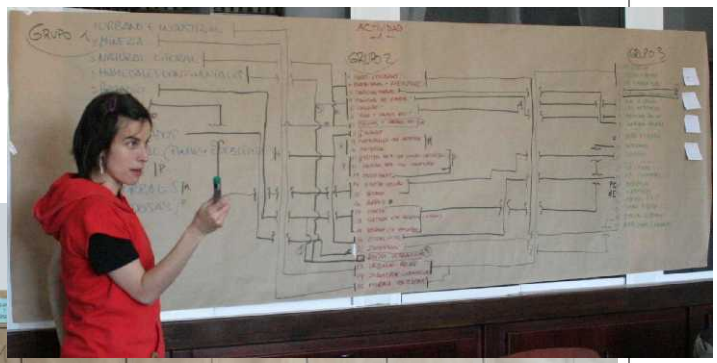
DUSPANAC – Model parametrisation

See http://www.geogra.uah.es/duspanac/)

1. Deciding model study area – PN or watershed

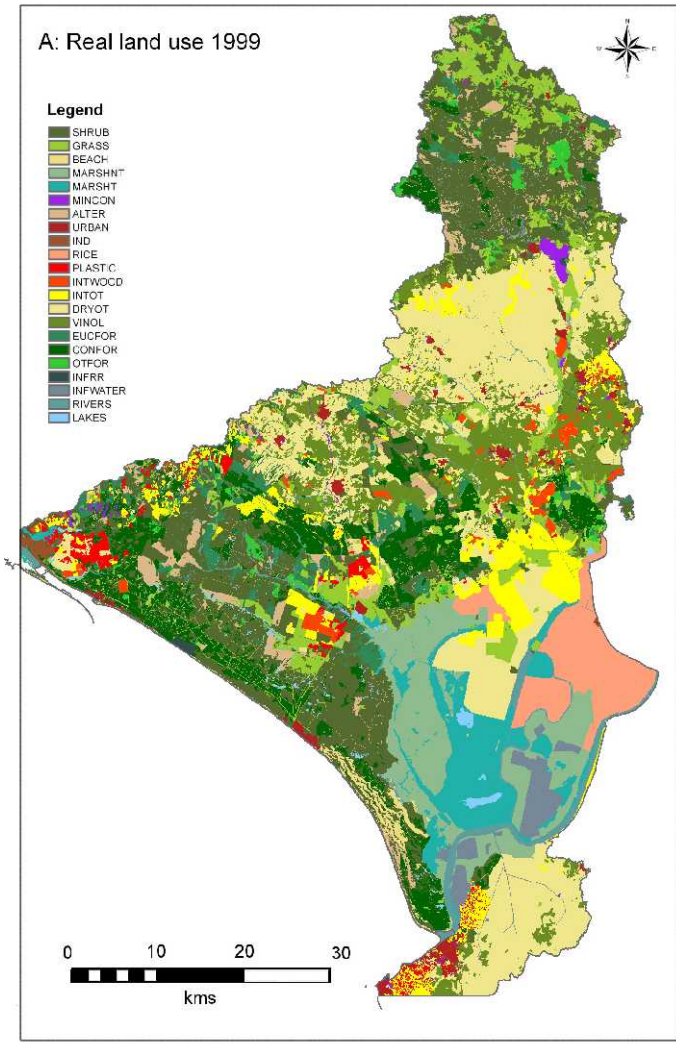
2. Participatory reclassification of land use categories for modelling

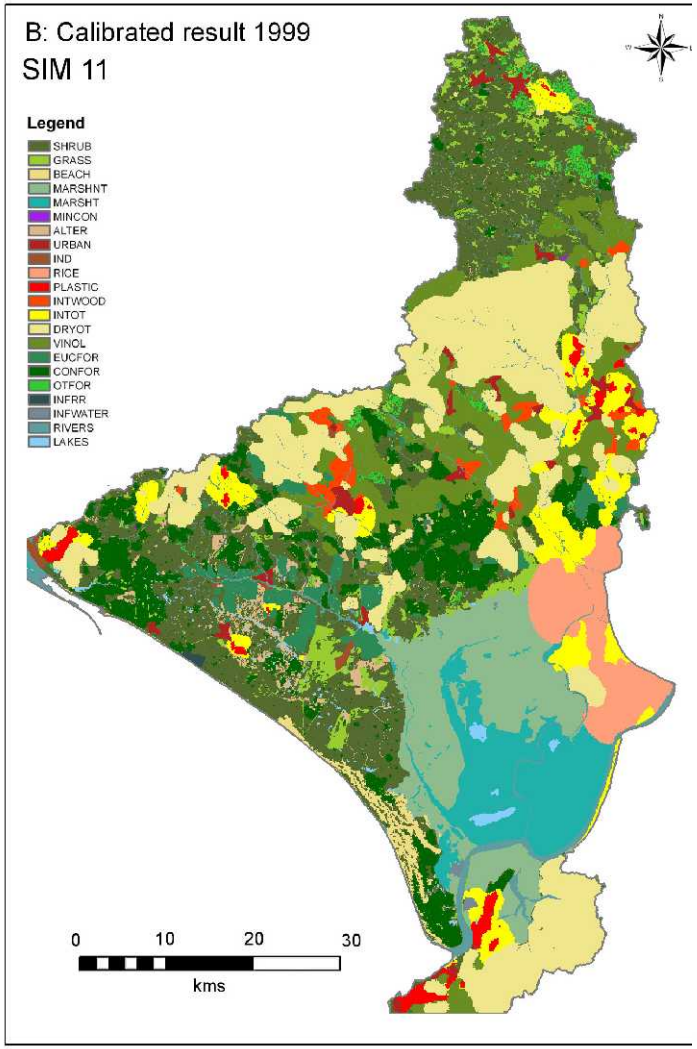
3. Participatory analysis of land change dynamics and identification of land change drivers

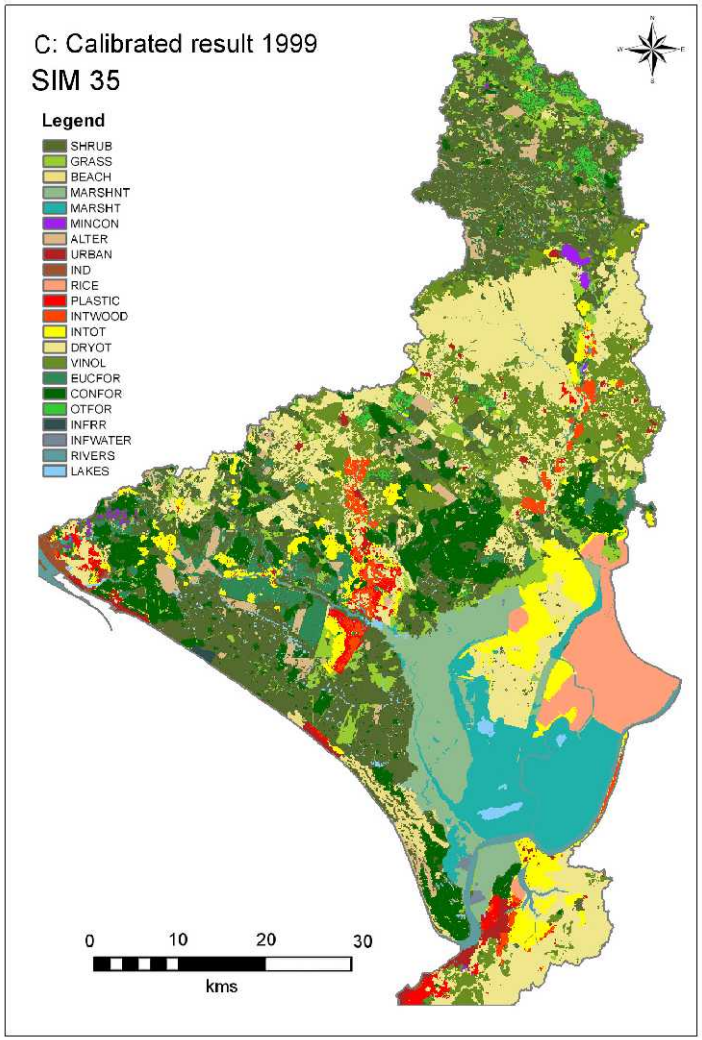


Dynamic (clc) 1990-2006	drivers of change (see key to locations)	gains/losses	reliability of dynamic as presented	group
3. Increase in artificial surfaces, 1990-2006	1. Mining 2. Periurban expansion on the outskirts of Seville 3. Periurban expansion of Sanlúcar de la Barrameda 4. Urbanisation of Matalascañas tourist resort	1: not specified 2: gains in terms of economic growth of municipalities. losses to agriculture, landscape and water (quality and quantity) 3-4:Gains to tourism industry losses to water and landscape	High	1
	1. Residential areas, some due to the influence of Seville. 2. Industrial estates 3. Port areas	The builders got their boots on! (they won). Losses to natural areas, Loss of environmental quality (waste, rivers, purification plants can't keep up)	OK	2
	Agricultural and urban policy, regional and municipal level.	Losses to agricultural areas, due to building of accommodation for temporary workers and agricultural labourers and construction of fruit processing areas.	The map does not properly represent the changes due to isolated construction in agricultural areas.	3

DUSPANAC – 4a: Visual inspection of calibration results







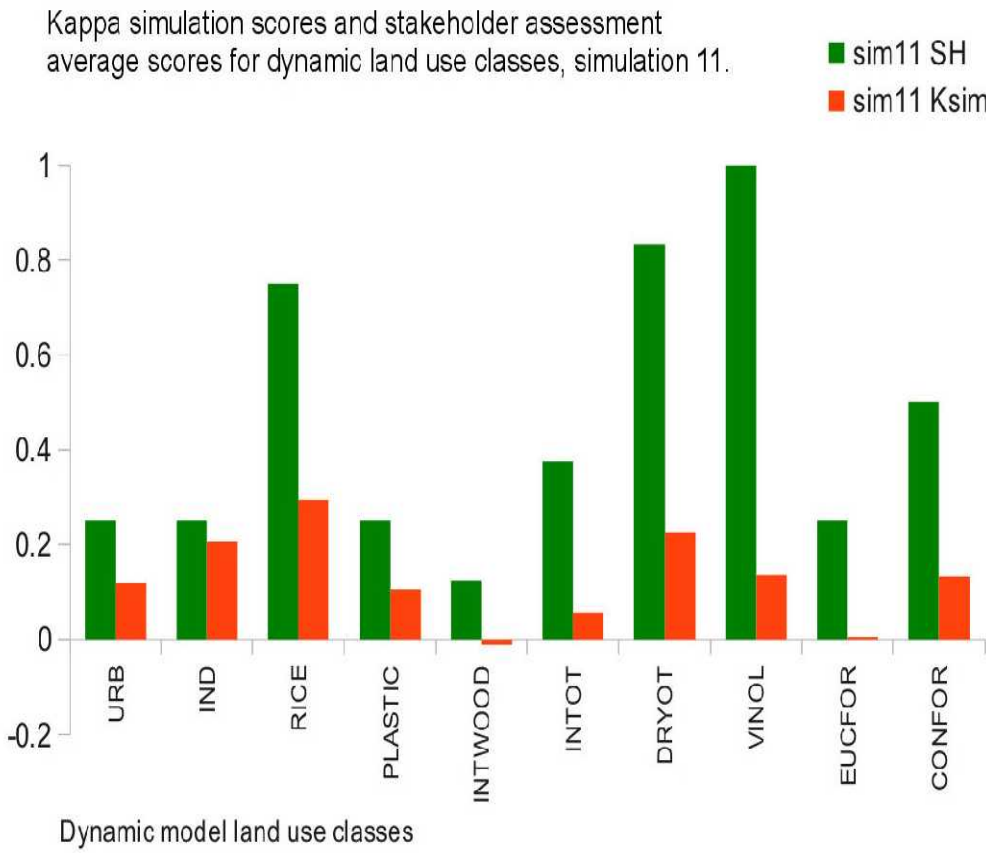
Real map 1999 (calibration date)

Sim 11

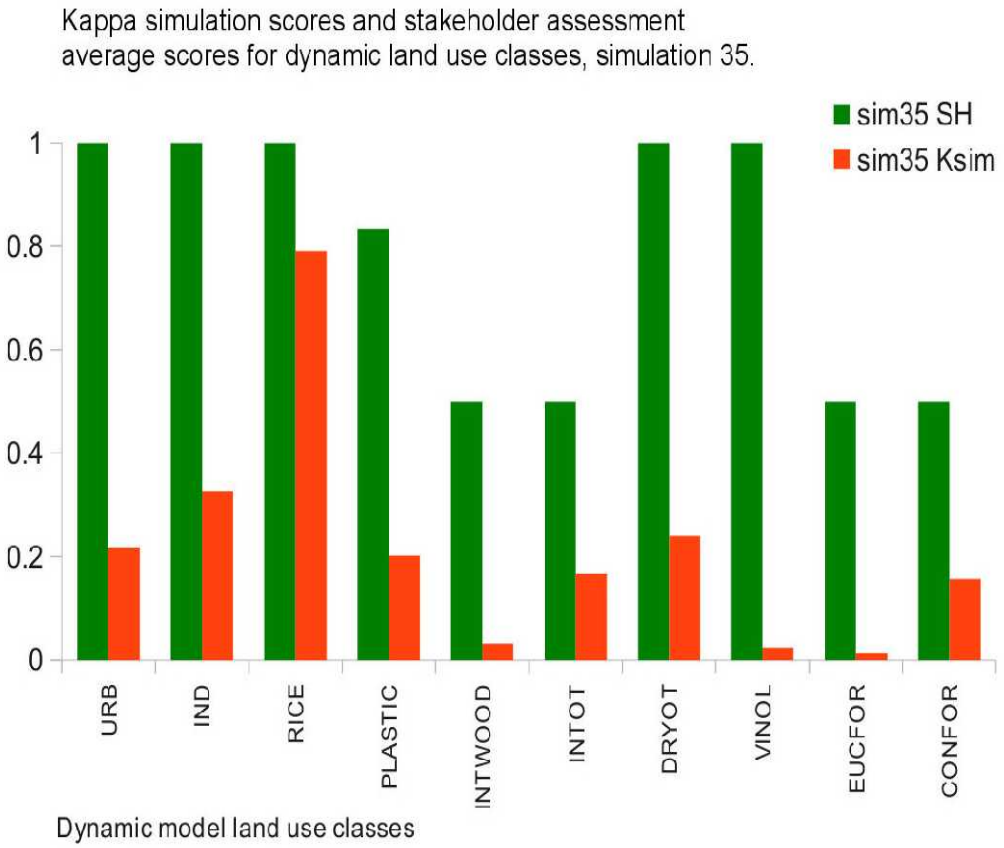
Sim 35

DUSPANAC – 4b: Visual inspection of calibration results

Sim 11



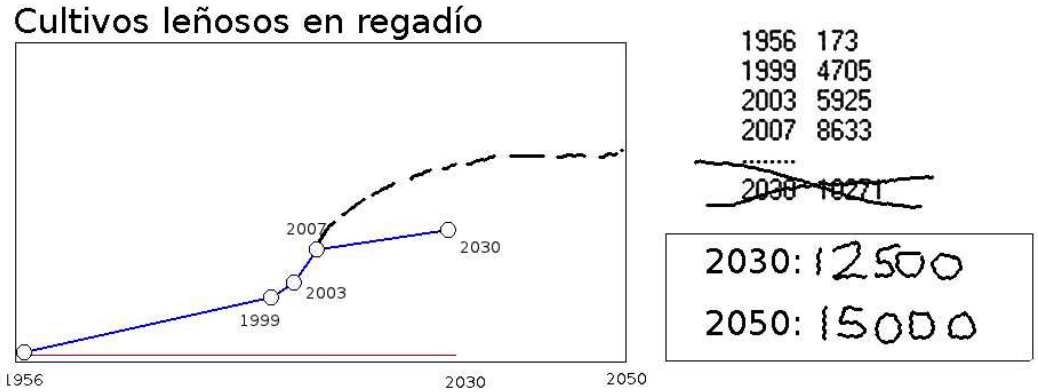
Sim 35



Stakeholder evaluation scores broadly supported by Ksim and clumpiness statistics

DUSPANAC – 5: Scenario development

Stakeholder estimation of land use demand for future scenarios:



Activity 2a, estimating the demand in ha for each scenario

Activity 2b, locating the estimated demand on the map

Scenario 1, Doñana Global knowledge (Palomo et al 2012)

Land use demand estimated by stakeholders used as direct model input

DUSPANAC – 6: Indicator development from scenario outputs

Stakeholders have prioritized a series of indicators ...

Grupo 1	Grupo 2
✔ Superficie zonas protegidas / Superficie total. ✔ Superficie zonas urbanas / Superficie total. ✔ Evolución masas forestales. ✔ Abandono. ✔ Situación de la costa y núcleos costeros. ✔ Sellado. ✔ Evolución de las masas de agua superficial e interna. ✔ Evolución de suelos urbanos, concentrado y disperso. ✔ Evolución de cultivos agrícolas tradicionales y ecológicos. ✔ Indicadores paisajísticos. ✔ Evolución del turismo. ✔ Evolución de cultivos en regadío. ✔ Cambio de localización de usos del suelo/Estabilidad espacial.	✔ S ✔ S n tr e ✔ A d ✔ S c a ✔ S m ✔ D (r ✔ S e ✔ L b ✔ Ír ✔ P te

Nº	Indicadores por orden de importancia
1	¿Existen indicadores que vinculen los procesos sociales y culturales (incremento de niveles educativos, alfabetización tecnológica, servicios culturales y sociales disponibles, bibliotecas, centros de salud...) con los usos del suelo?
2	Superficie de ecosistemas naturales y agricultura tradicional fuera de los espacios protegidos.
3	¿Existe un indicador que vincule la participación y gestión democrática del territorio con los usos del suelo? (Plan Corona Forestal por ejemplo)
4	Servicios de los ecosistemas.
5	índice de conectividad.
6	Superficie de marisma mareal.
7	Longitud o superficie de bosques de ribera.
8	Consumo de agua (agrícola, doméstica).
9	Calidad de agua.
10	Producción de residuos (Toneladas producidas)
11	Presencia de industria tecnológica.

vinculen los procesos sociales y culturales (incremento de niveles educativos, alfabetización tecnológica, servicios culturales y sociales disponibles, bibliotecas, centros de salud...) con los usos del suelo?

The next step is to use the model to output indicators under each scenario ... SIGEOMOD 2020

COMPLEX FP7 – Realising climate mitigation strategies

http://spcomplex.wordpress.com/

Aims:

1. Increase knowledge about renewable energy installations and land use
2. Identify possible future routes for RE implementation that allow EU roadmap 2050 objectives to be acheived

3. Facilitate decision making around climate change mitigation and RE in the territory

A land use model incorporating actor dynamics to test RE implementation under future scenarios

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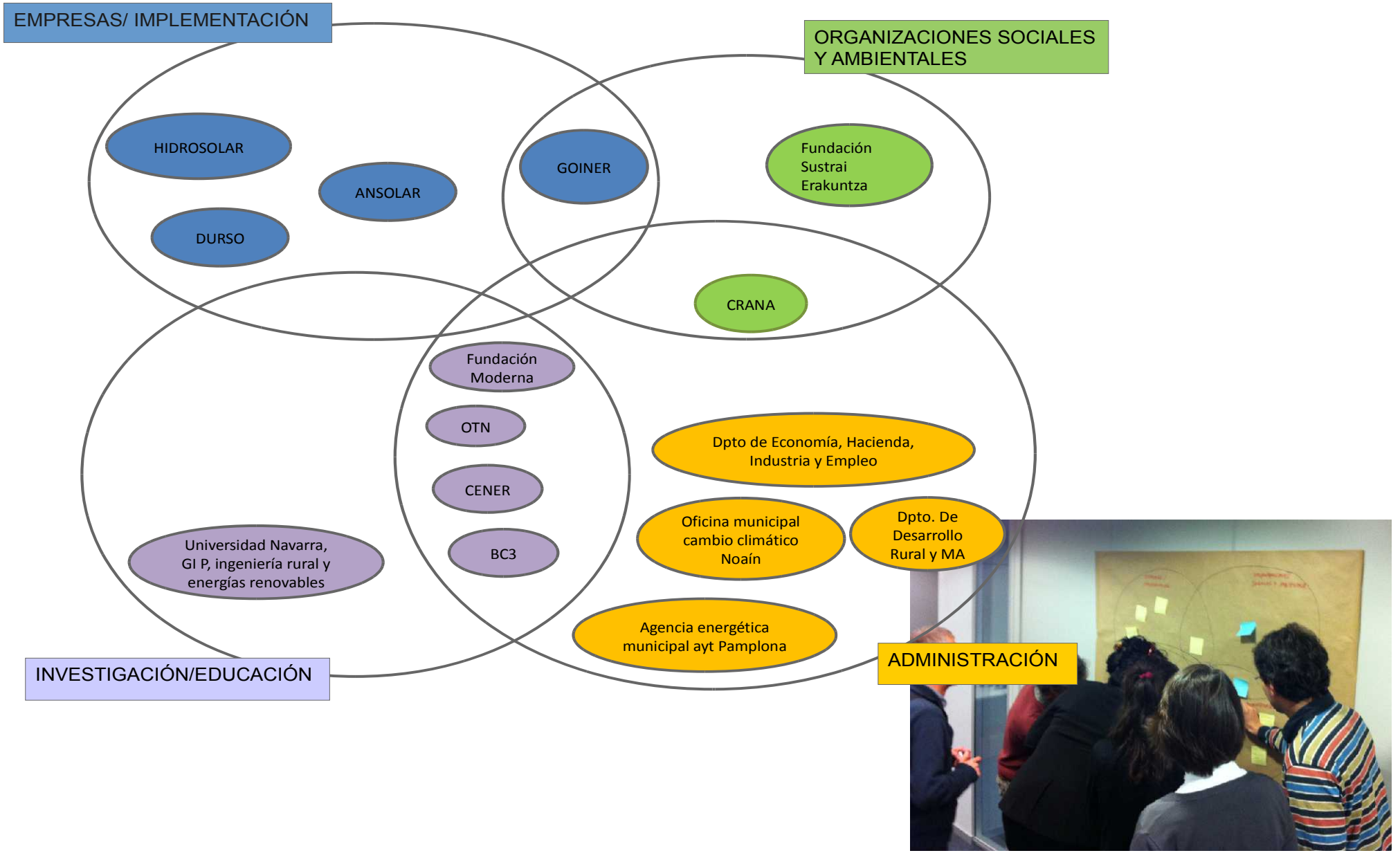
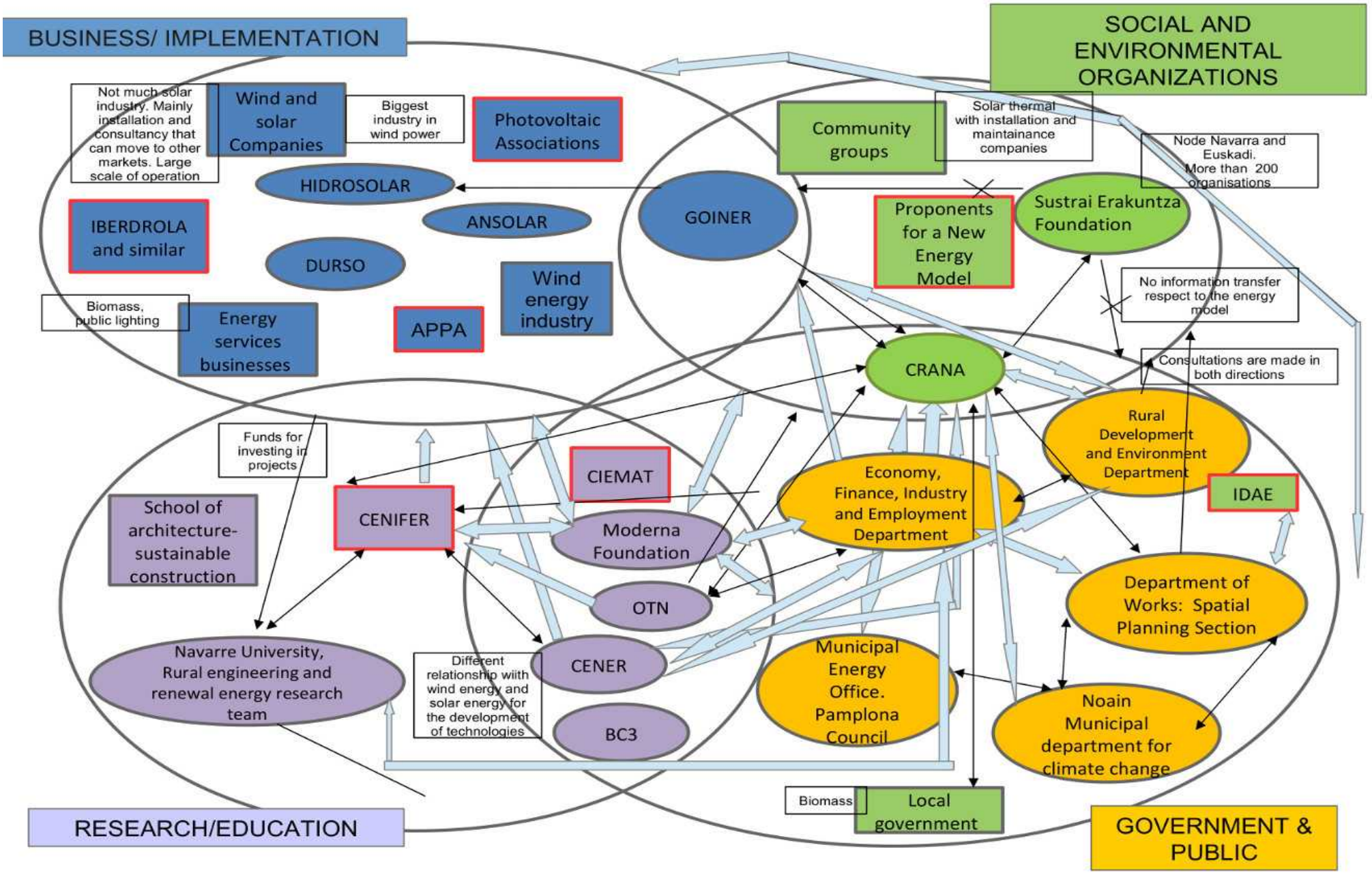
COMPLEX – Incorporating actor dynamics



COMPLEX – Incorporating actor dynamics

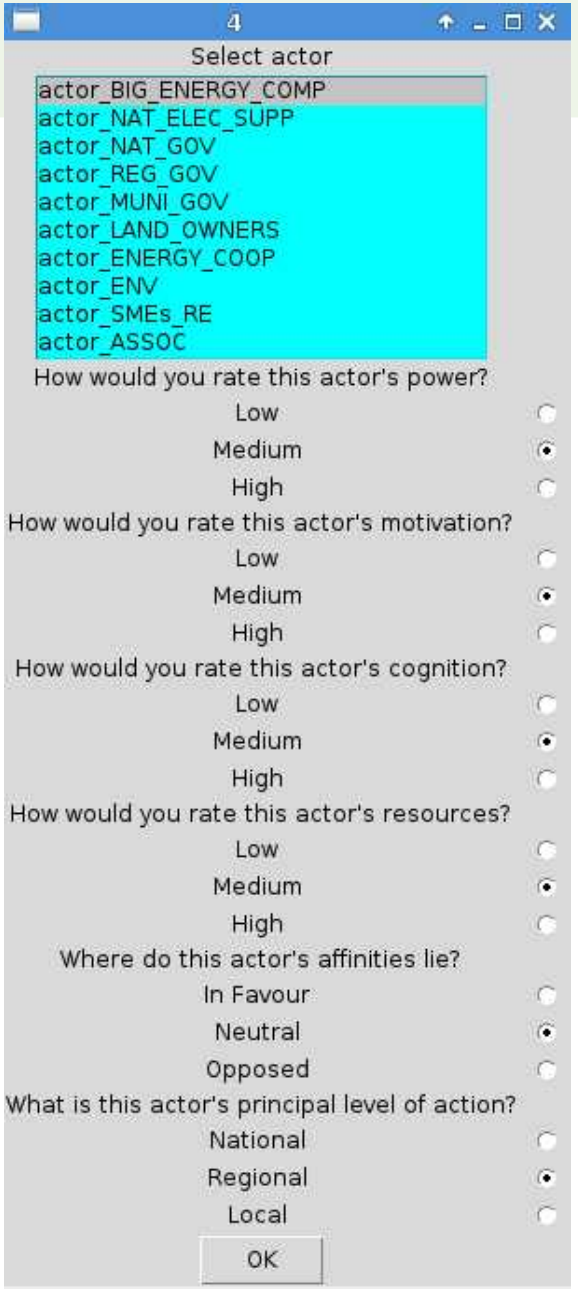


COMPLEX – Incorporating actor dynamics

WS1 – problem framing, definition actor characteristics

Policy implementation context and power relations

Motivation, cognition, resources, power, affinity, and level of action.



Motivation, Cognition, Resources
Low = 0.1
Medium = 0.5
High = 0.9

Power
Low = 1
Medium = 2
High = 3

Affinity
In Favour = 2
Neutral = 1
Opposed = -2

Level of action
National, Regional, Local

COMPLEX – Quantifying actor dynamics for the spatial model

TP = D*N*A*S*Z*v (applied only to RE land uses)

For each actor, a map is created at that actor's level of action, having values equal to **D**:

D = C*P [Eqn.1]

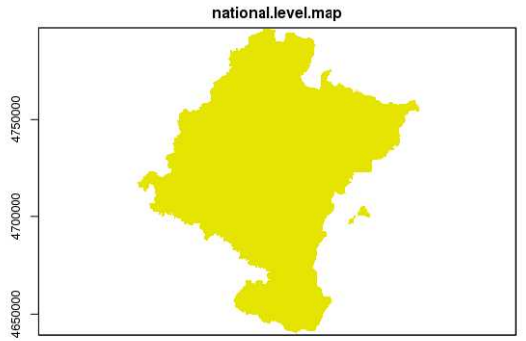
where:

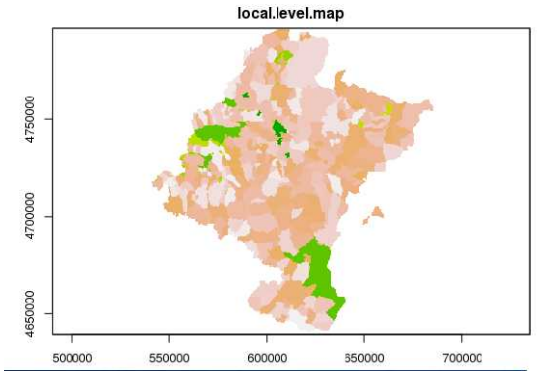
C = ∑[m,c,r] [Eqn. 2]

and

P = p*a [Eqn. 3]

where p,m,c,r,a are scores for power, motivation, cognition, resources and affinity.





	actor	motivation	cognition	resources	power	affinity	level	result
1	actor_BIG_ENERGY_COMP	0.1	0.5	0.9	3	-2	1	-9
2	actor_NAT_ELEC_SUPP	0.1	0.5	0.1	3	-2	1	-4.2
3	actor_NAT_GOV	0.1	0.9	0.9	3	-2	1	-11.4
4	actor_REG_GOV	0.5	0.9	0.9	3	1	2	6.9
5	actor_MUNI_GOV	0.5	0.5	0.5	2	2	3	6
6	actor_LAND_OWNERS	0.5	0.5	0.5	2	1	2	3
7	actor_ENERGY_COOP	0.9	0.5	0.5	1	2	2	3.8
8	actor_ENV	0.9	0.5	0.9	3	2	2	13.8
9	actor_SMEs_RE	0.5	0.5	0.5	2	1	2	3
10	actor_ASSOC	0.5	0.5	0.5	1	1	2	1.5
11	actor_SCI_and_UNIV	0.9	0.9	0.5	1	2	2	4.6
12	actor_MEDIA	0.5	0.5	0.9	2	1	1	3.8

COMPLEX – ApoLUS simulations

Simulation of the effect of actor dynamics in the municipality of Pamplona on solar panel iinstallation (yellow)

Actor_muni_gov (pamplona)

D = 6

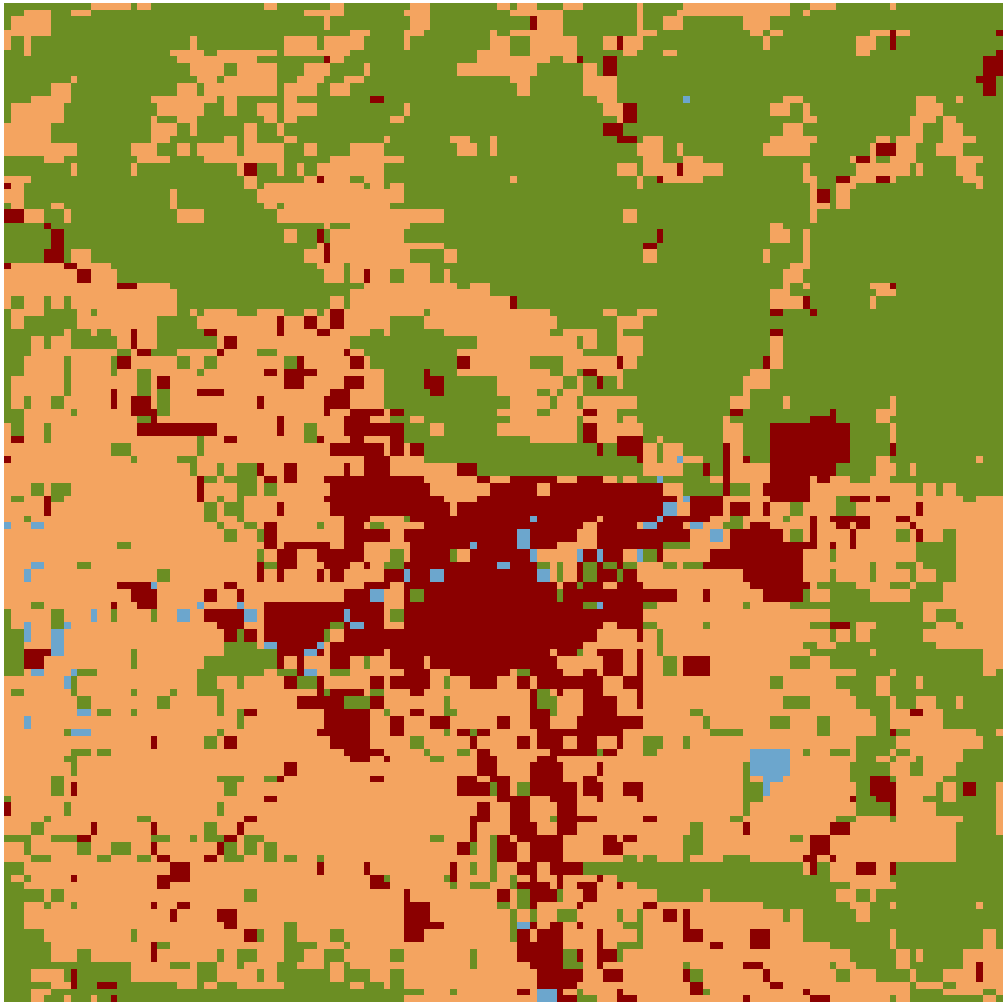
Simulation of the effect of strongly opposed actors at national or regional level

Actor_big_energy_comp

D = -9

Actor_nat_gov

D = -11.4



What effect will these values have on the spatial model?

COMPLEX – APoLUS next steps

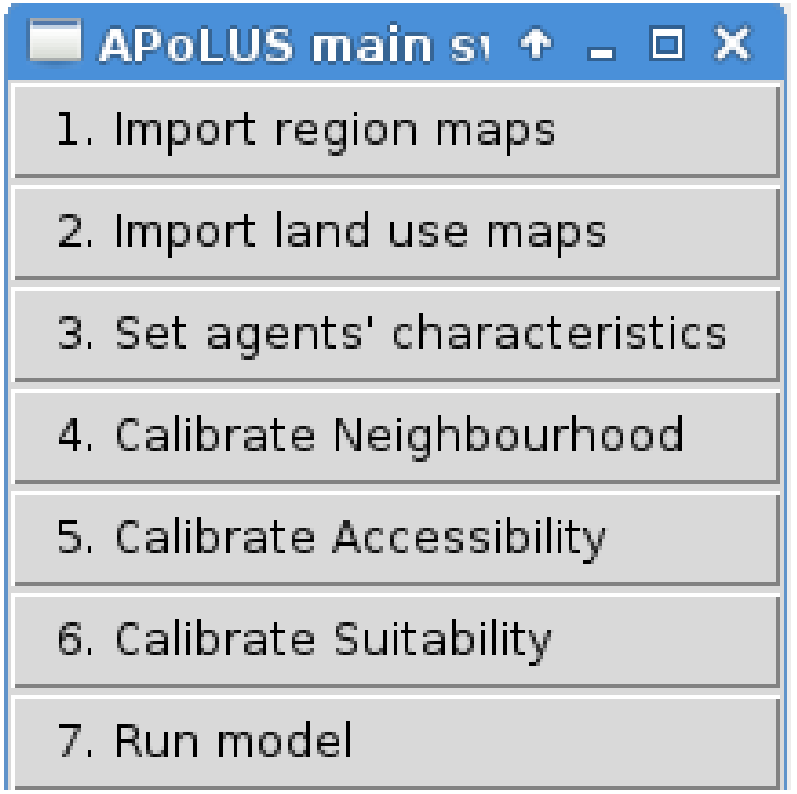
1. Solicit information from stakeholders on actor characteristics at municipal level

(needs strong implication of municipal governments)

2. use actor characteristics to modify demand (D value input to demand)

3. Further work with stakeholders to define scenarios for renewable energy development up to 2050

4, Output land use maps for 2015 under each scenario and test with stakeholders



5. Participatory evaluation of model utility and succes of participatory process

6. Policy briefings and recommendations

7. Release model software and code to community

Conclusions: advantages and disadvantages

Pros	Cons
Better model!	
Wider uptake/more chance the system will be used	Time consuming
Break down barriers between scientist, policy maker and citizen	Success not guaranteed!
Shared learning and appreciation of other perspectives	Adequate fit between stakeholder selection and task very important
Applicable to complex systems and “wicked” problems	False expectations and disappointment in stakeholders (scenarios, model results, science in general)
Move debate on from pure prediction – brackets, boundaries, thresholds, probability ranges, indicators	Harder to fund than conventional studies (though this may be changing)

Conclusions: key characteristics of our approach

Option spaces not “decision support”

Many general tools not a single out-of-the box software “solution”

Facilitation not a turn-key itinerary

Researcher/scientist as one stakeholder among many

Modelling as a process, not a one off activity

Conclusions: what's important? Accuracy? Replicability?

A proposition:

A policy-relevant land use model should be:

1. Analytical/Discursive
2. Cyclical/Iterative
3. Refutable
4. Open to all stakeholders to modify, use and copy (replicable)
5. Useful

Thank you!

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DUSPANAC (2011-13): Spanish national parks authority 2010 research call

SIMULACIONES GEOMÁTICAS PARA MODELIZAR DINÁMICAS AMBIENTALES
AVANCES METODOLÓGICOS Y TEMÁTICOS

SIGEOMOD2020 (2014-16): Spanish ministry of economy, national research plan

COMPLEX (2012-16) EU FP7

Project Ref no. 308601

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