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Geosimulation modelling

Judith Verstegen

Institute for Geoinformatics, University of Münster

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ifgi
Institut für Geoinformatik
Universität Münster

Outline

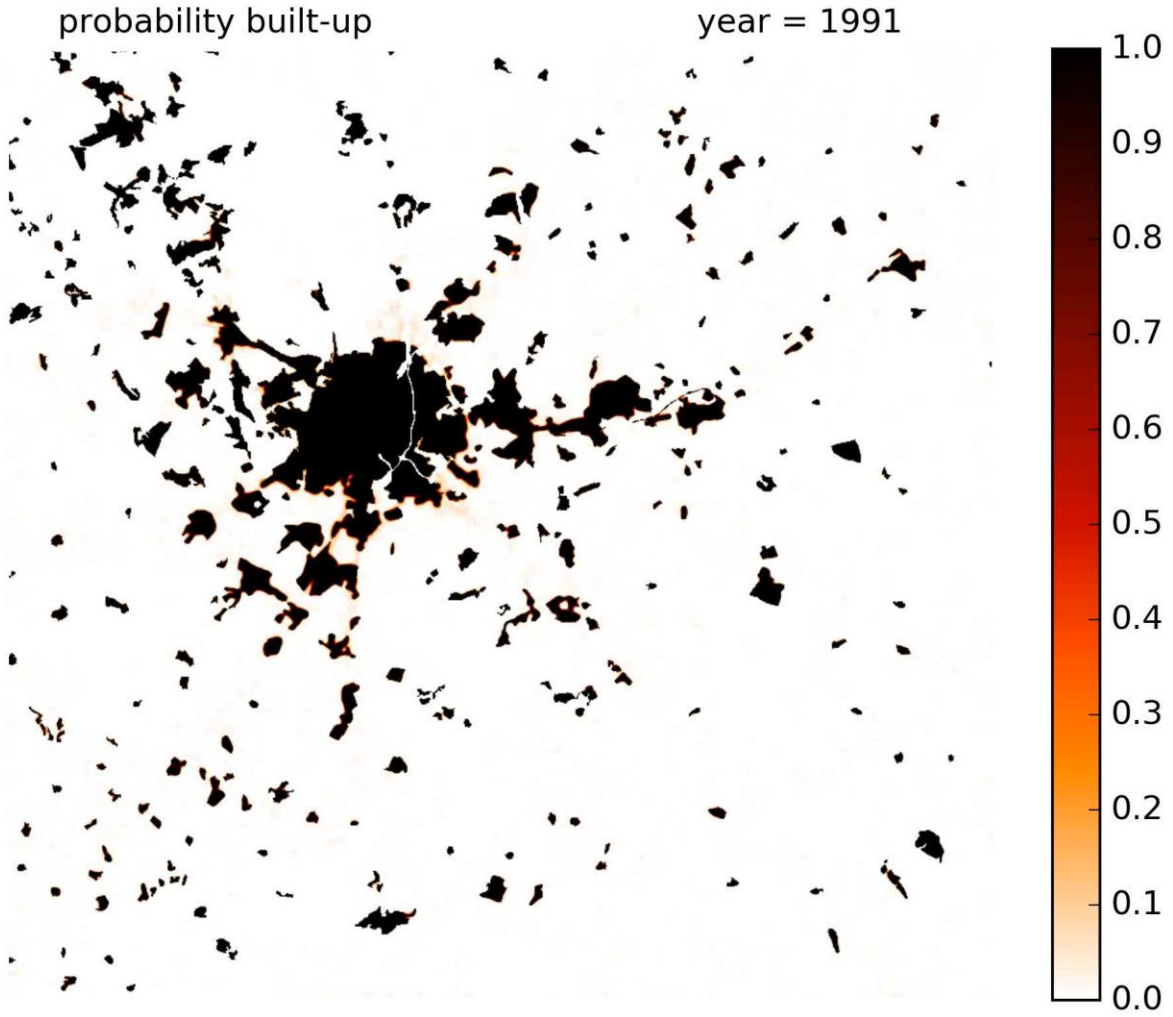
1. Introduction: geosimulation models
2. Example of agent based modelling: pedestrians
3. Example of field-based modelling: land use change
4. PCRaster Python tutorial

1. Introduction:
Geosimulation models

Different ways of dynamic modelling

Data-driven model	Theory-driven model
Start with empirical data	Start with a theory i.e. system description
Based on correlations between drivers and the system state	Based on known cause-effect relations in-between drivers and between drivers and system state
Top-down	Bottom-up
Also called: empirically-based model, statistical model, extrapolation model, machine learning model	Also called: process-based model, physically-based model (not the same), geosimulation model

Example of a geosimulation model

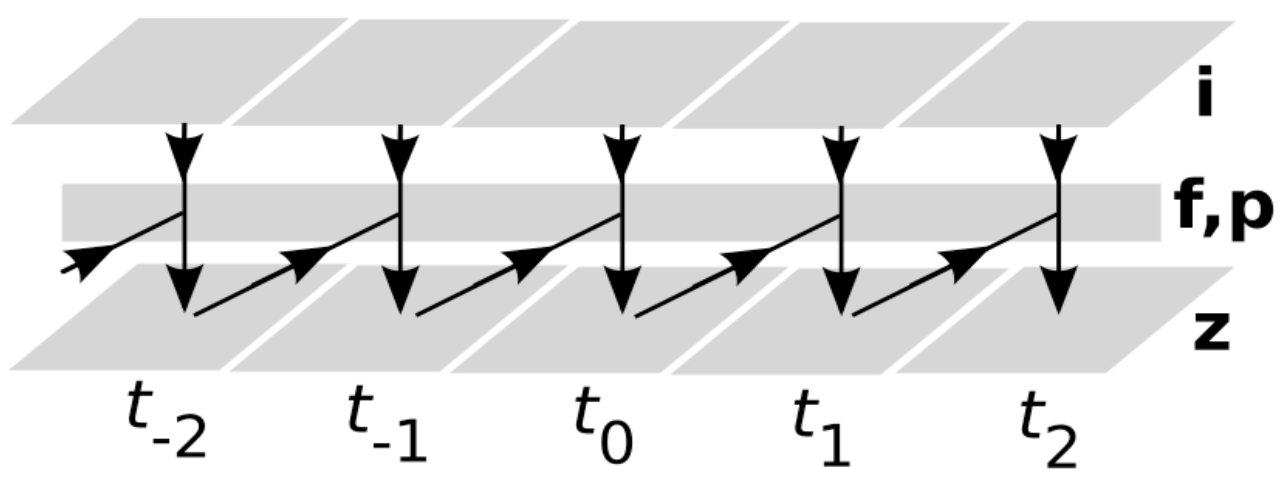


What is a geosimulation model?

A **system** is a set of interacting entities forming an integrated whole.

A **model** is a **purposeful and simplified representation** of a system.

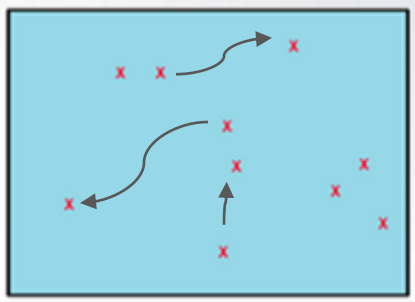
A **geosimulation model** is a **spatially explicit, process-based, dynamic** model, often with a focus on human or animal behavior.

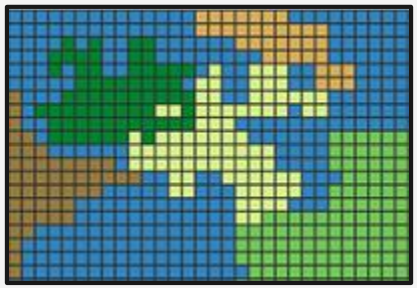


With:
i – inputs
f – transition function
p – parameters in f
z – the system state
t – time step

Geosimulation modelling paradigms

	Agent-based modelling (multi-agent systems)	**Field-based modelling** (cellular automata)
system state	Set of discrete objects	Continuous or discrete
attribute(s)	Is linked to the agent	Has a value everywhere
processes	Behavior of a single agent	Behavior of cells that remain in their location





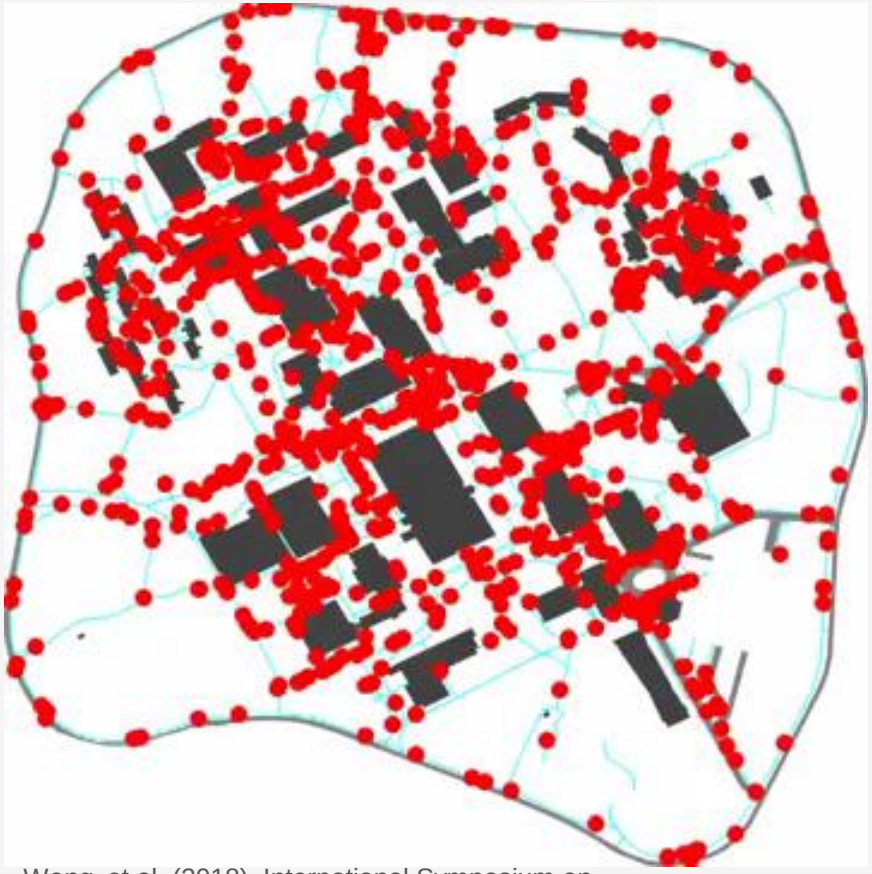
2. Agent-based modelling: Pedestrians

State of the art in pedestrian simulation

Agent-based model

Route choice behavior is simplistic:

- Agents have a ‘perfect’ map
- Streets are only geographic elements
- ‘Optimal’ routes

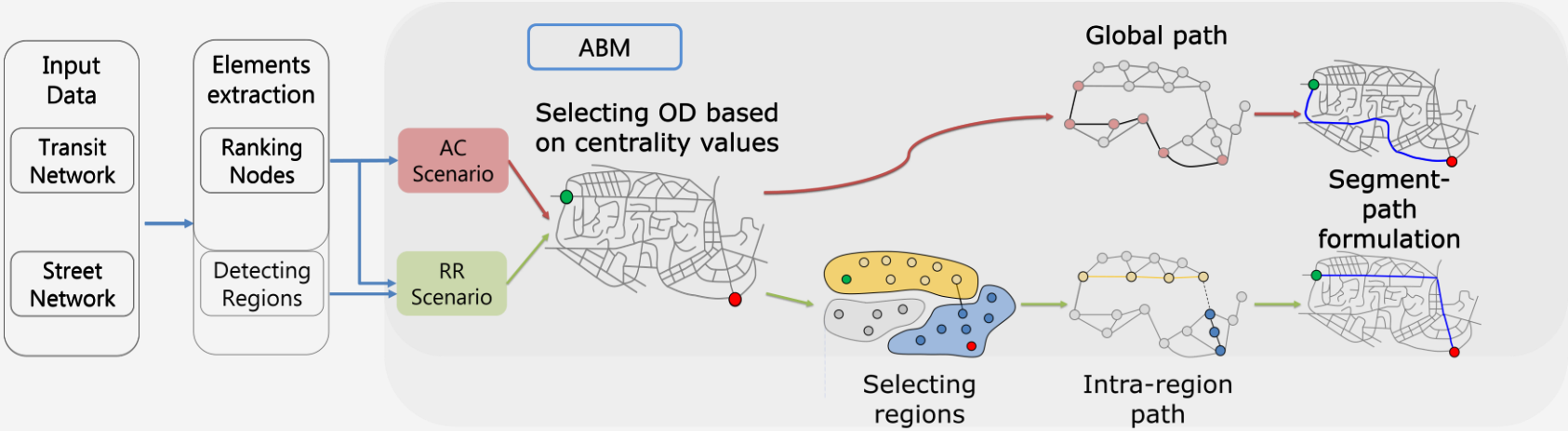


Wang, et al. (2018), International Symposium on Distributed Simulation and Real Time Applications

Pedestrians - conceptual model

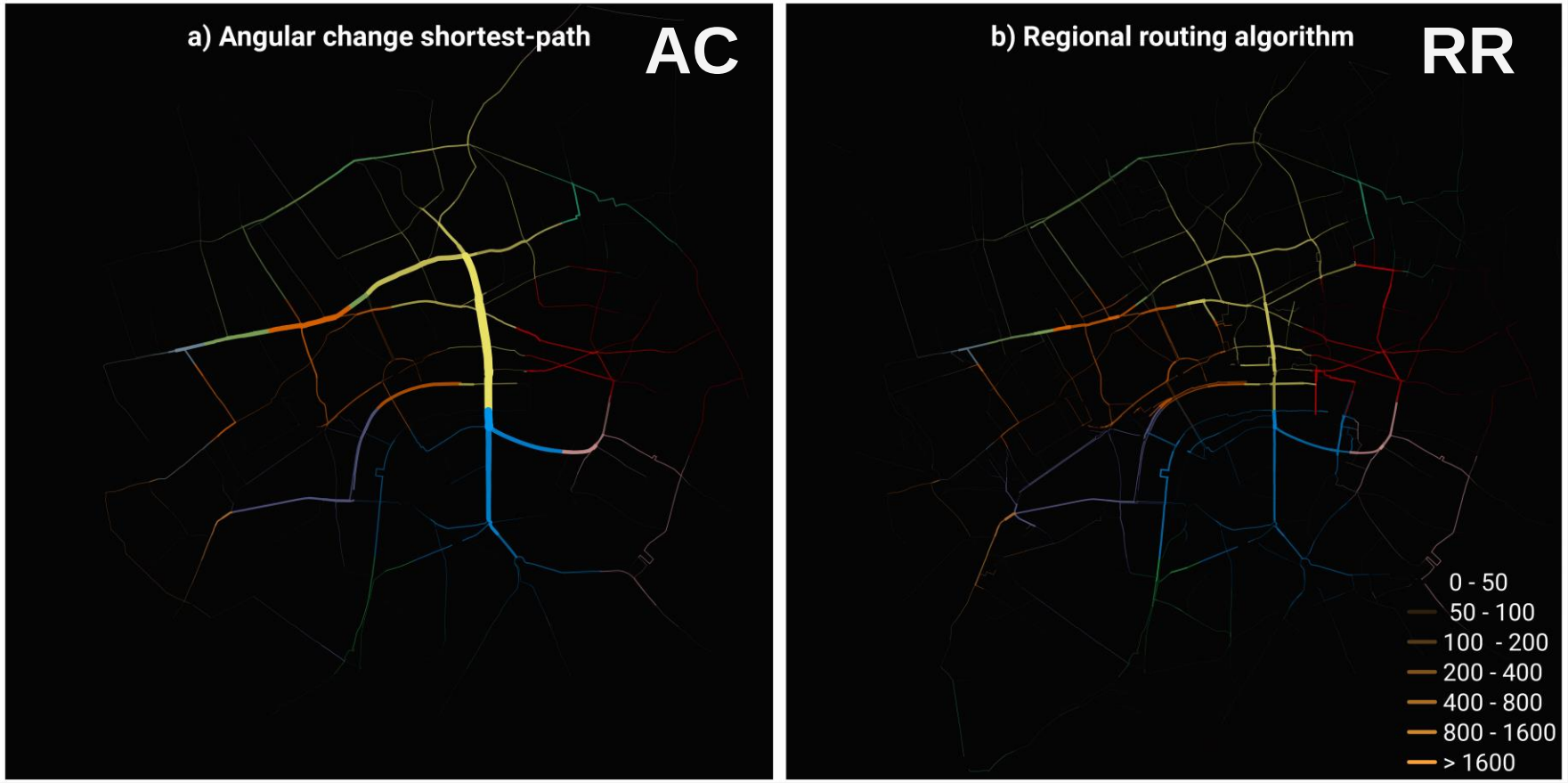
We implement:

- Other geographical elements, here nodes and regions, based on Lynch theory
- Hierarchical route choice



Filomena, Manley and Verstegen (2019), COSIT

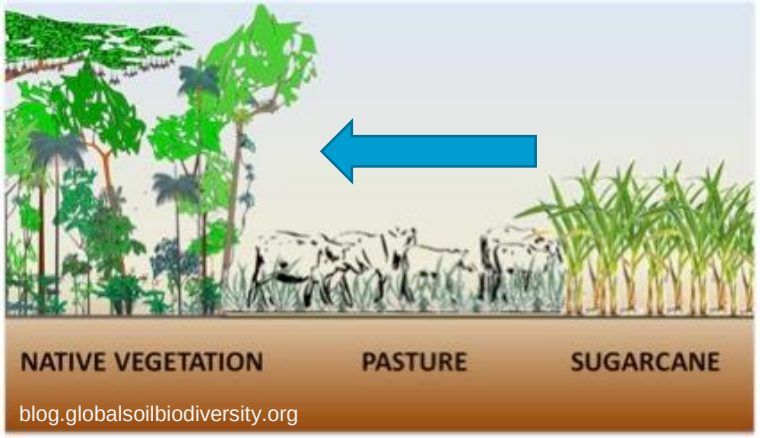
Street segment usage for 1000 trips



Filomena, Manley and Verstegen (2019), COSIT

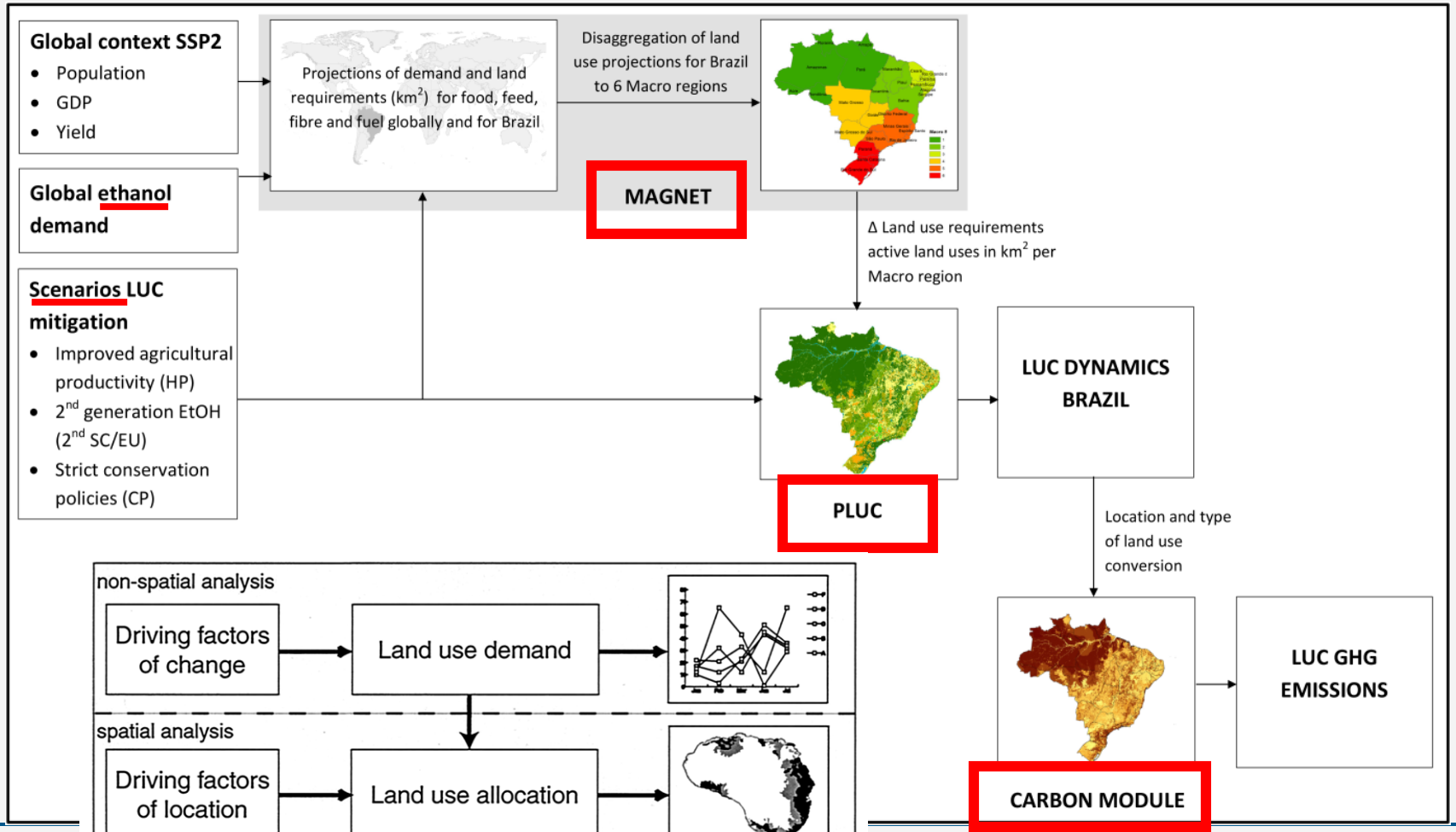
3. Field-based modelling: Land use change

Land use change dynamics in Brazil



Sociedade Nacional de Agricultura (2017)

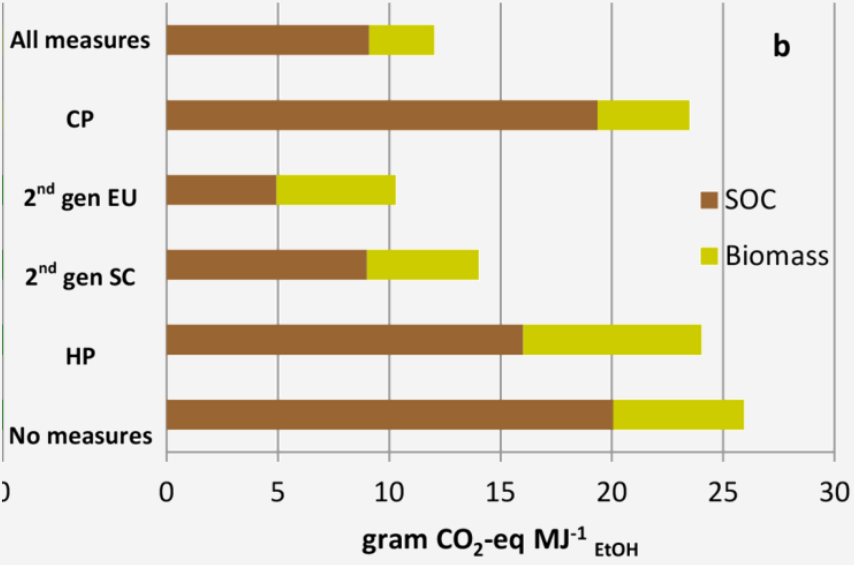
MAGNET (CGE) and PLUC (spatial LU)



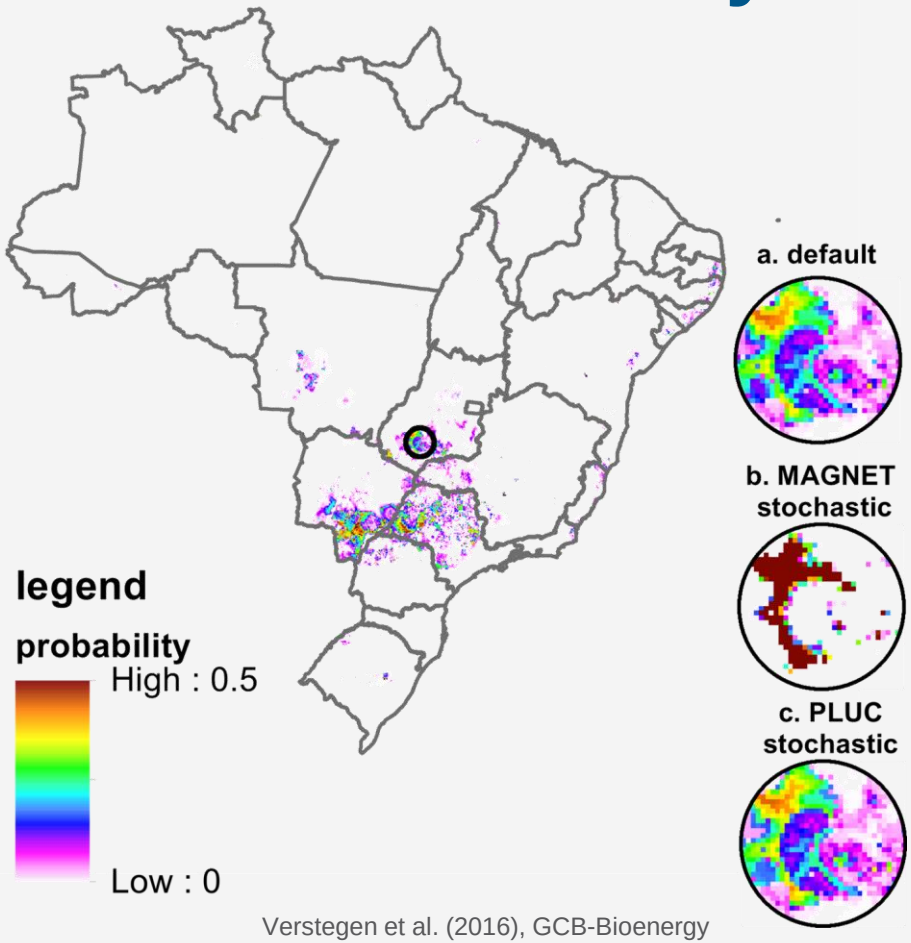
Verburg et al. (2002), Environmental Management

van der Hilst et al. (2018), GCB-Bioenergy

Results error propagation and sensitivity

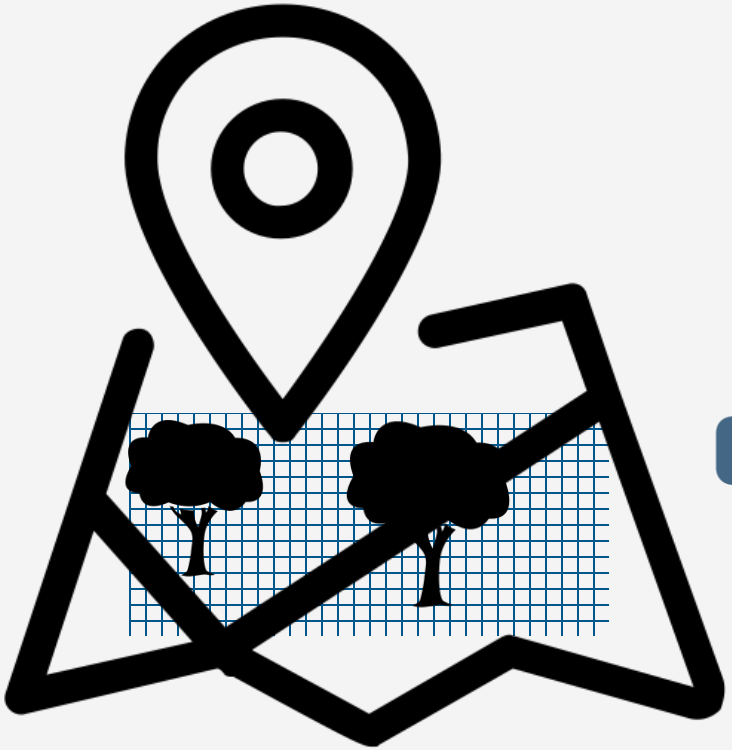


van der Hilst et al. (2018), GCB-Bioenergy



Verstegen et al. (2016), GCB-Bioenergy

4. PCRaster Python tutorial

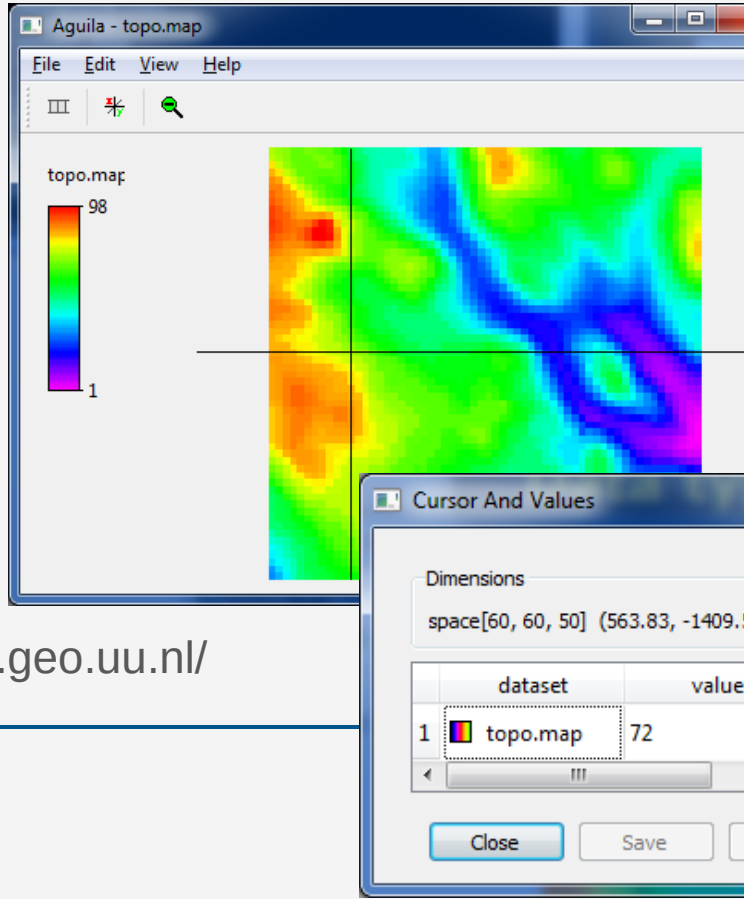


python

What is PCRaster?

PCRaster is:

- software for map algebra and spatio-temporal (or geosimulation) modelling
- stand-alone (PCRcalc) or as a Python library
- PCRaster Python framework



Other properties

- available for Linux and Windows
- comes with the interactive visualization tool Aguila
- map format in gdal
- free and open source, download it at: http://pcraster.geo.uu.nl/