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Land use changes in the urban area of Montpellier (2010-2040): Scenarios of the impact of urban sprawl on agricultural land and protection of agricultural land from urban sprawl

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Introduction

Montpellier large urban area, south of France, with periurban and rural communes (2,200 km²) has an important population growth for several decades (707,000 inhabitants in 2010 ; and between +114,000 and +118,000 inhabitants more in 2040). Urban sprawl is an important phenomenon which is a set of challenges for public land policy, development of economic activities and natural heritage management. The French law of modernization of agriculture and fisheries, adopted in July 2010, includes a section that defines the goal of halving the loss of farmland in 2020. To do this, a "National Observatory of Agricultural Land Consumption" was established in June 2011. Lands with high production potential (especially due to the soil nature) would be priority excluded areas to be urbanized.

Materials and Methods

Principle: Land use change modeling using the 'Spacelle' software (Cellular Automata), on the large urban area of Montpellier for the years 2010-2040, by considering different scenarios: (i) a baseline scenario (BAU) as a vision of the urban sprawl and consumption of agricultural land, (ii) an alternative scenario with protection of agronomic potential for crops (national strategic issue), and (iii) a scenario about protection of vineyard (regional issue).

The spatial model uses land use states, spatial constraints (slopes, risk areas, urban planning types), accessibility by transport networks and soil data (Quality soil index, from INRA). Outputs are analyzed with GIS and spatial analysis methods: description of dimensions (areas, patches, relative positions), definition of types of urban sprawls according to the scenarios constraints.

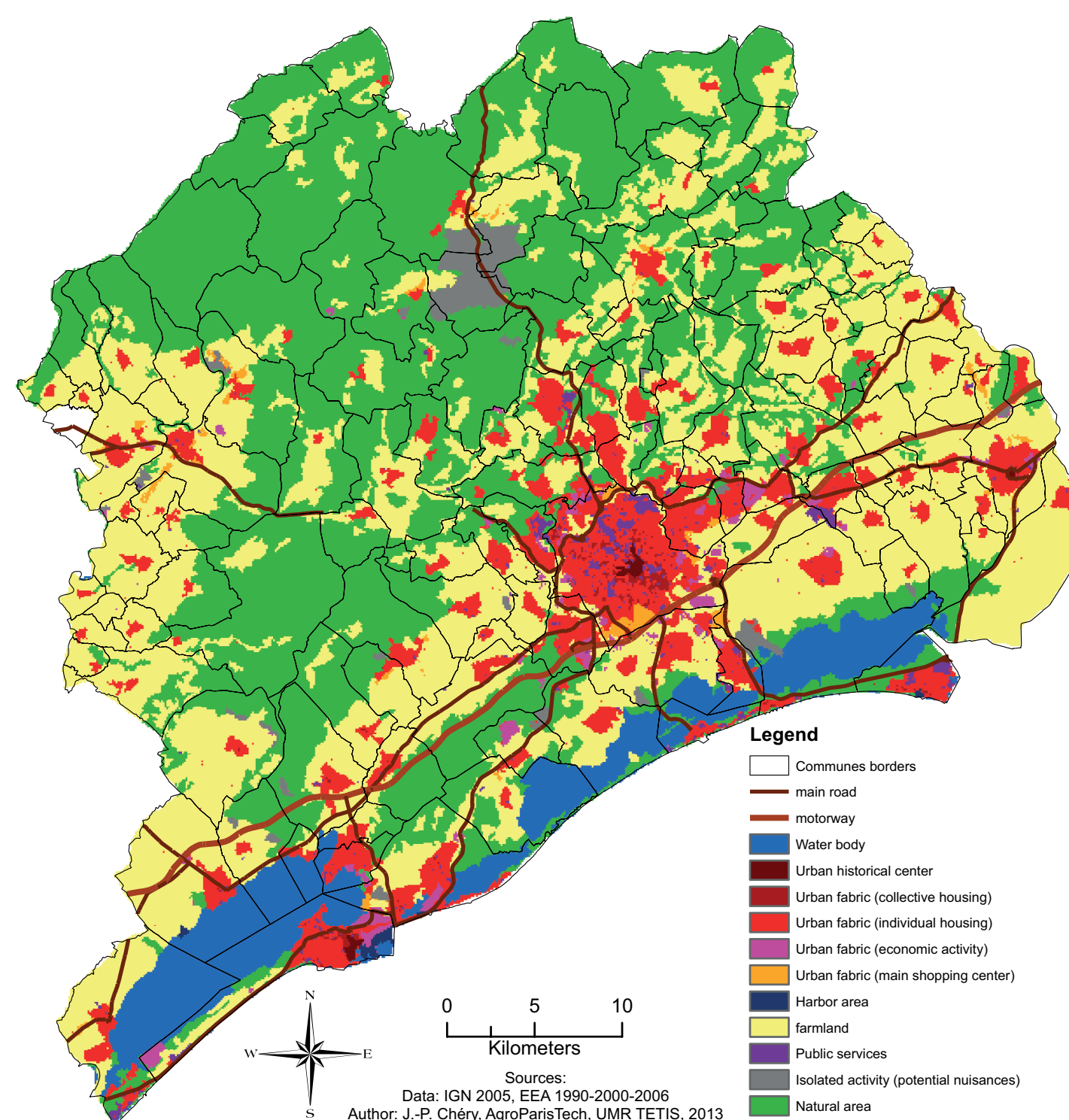


Fig. 2: A land use data for the 'Spacelle' modelling: Corine Land Cover (EEA, 2006) and added informations (public services, transport networks, IGN, 2005). Application of Montpellier case study.

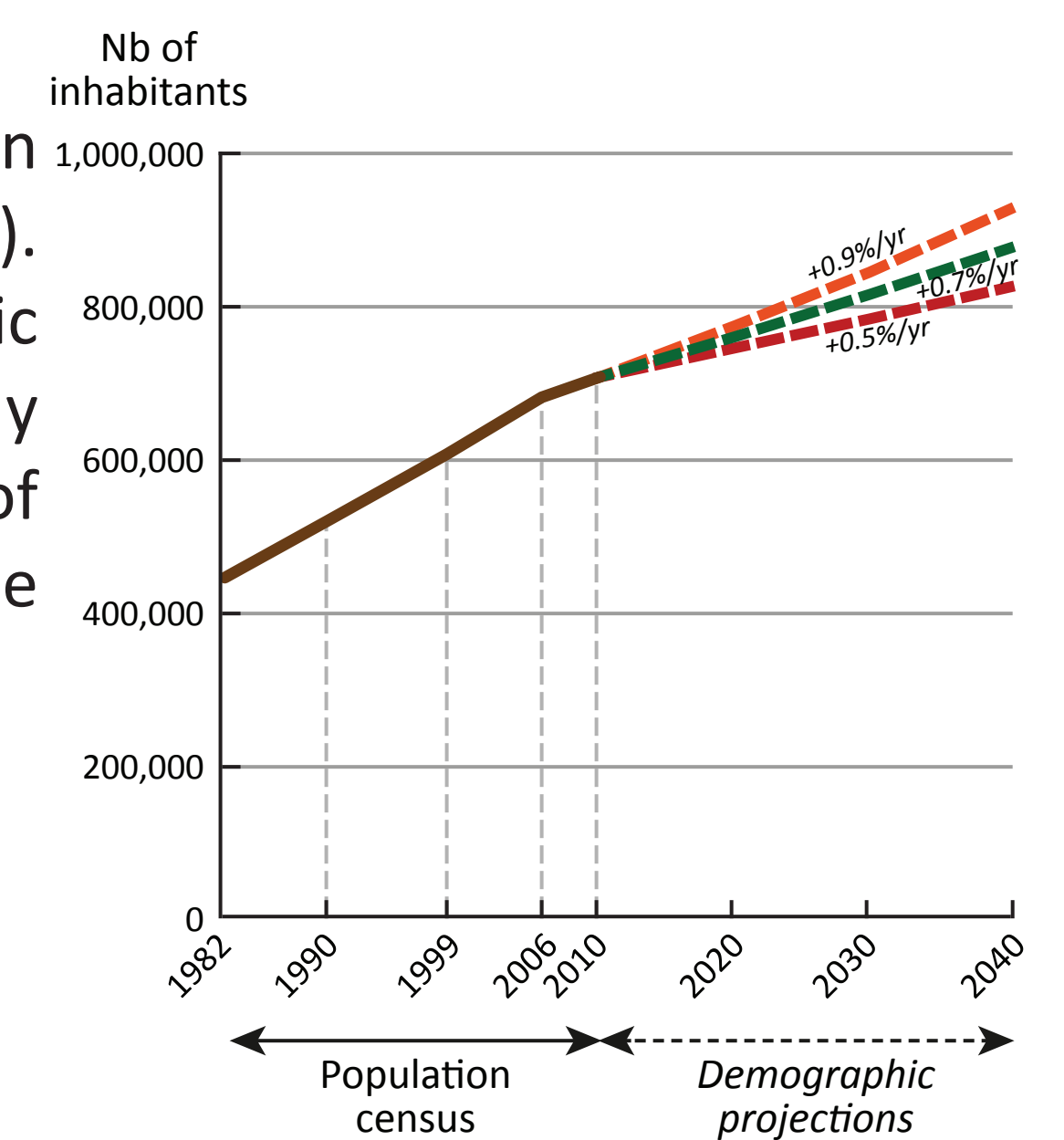


Fig. 1: The demographic growth in the Montpellier large urban area (134 communes), main cause of the urban sprawl (source: INSEE, 2010)

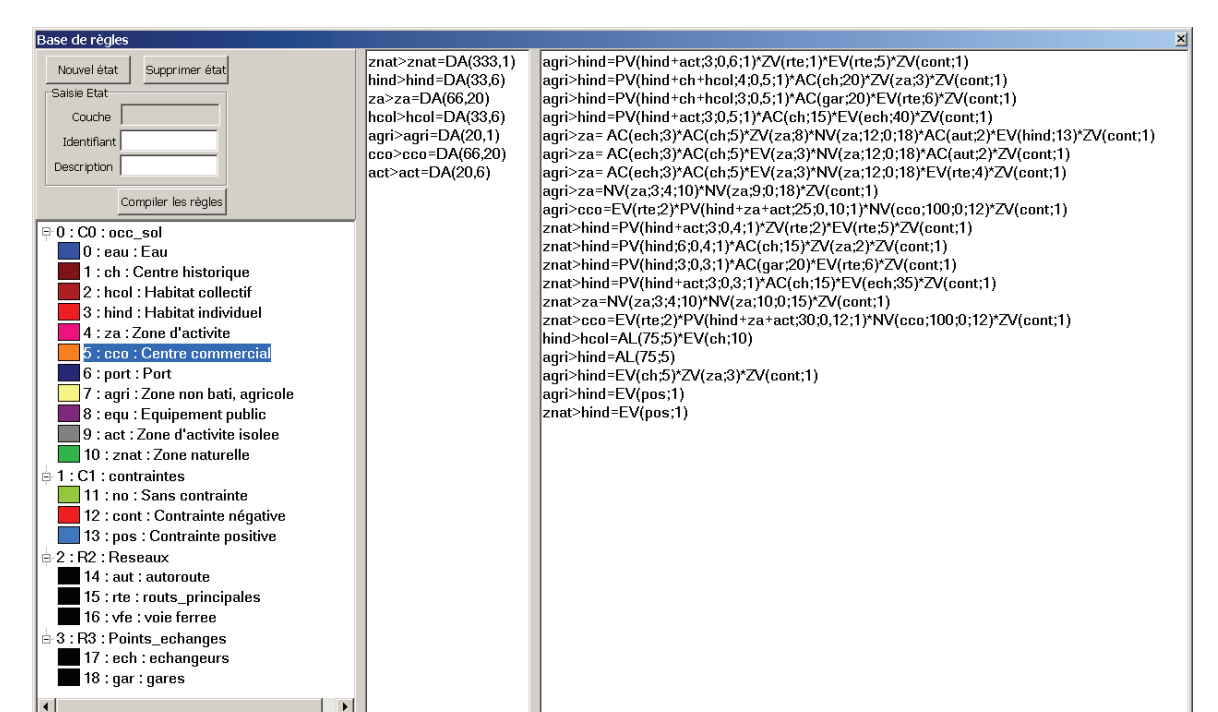


Fig. 3: 'Spacelle' cellular automata interface (v. 5.1.8): Definition of states and rules. Application of Montpellier case study. Spacelle is developed by P. Langlois, University of Rouen

Fig. 4: Map of simulation outputs, according to the three scenarios (year 2040): types of evolutions by combination of results

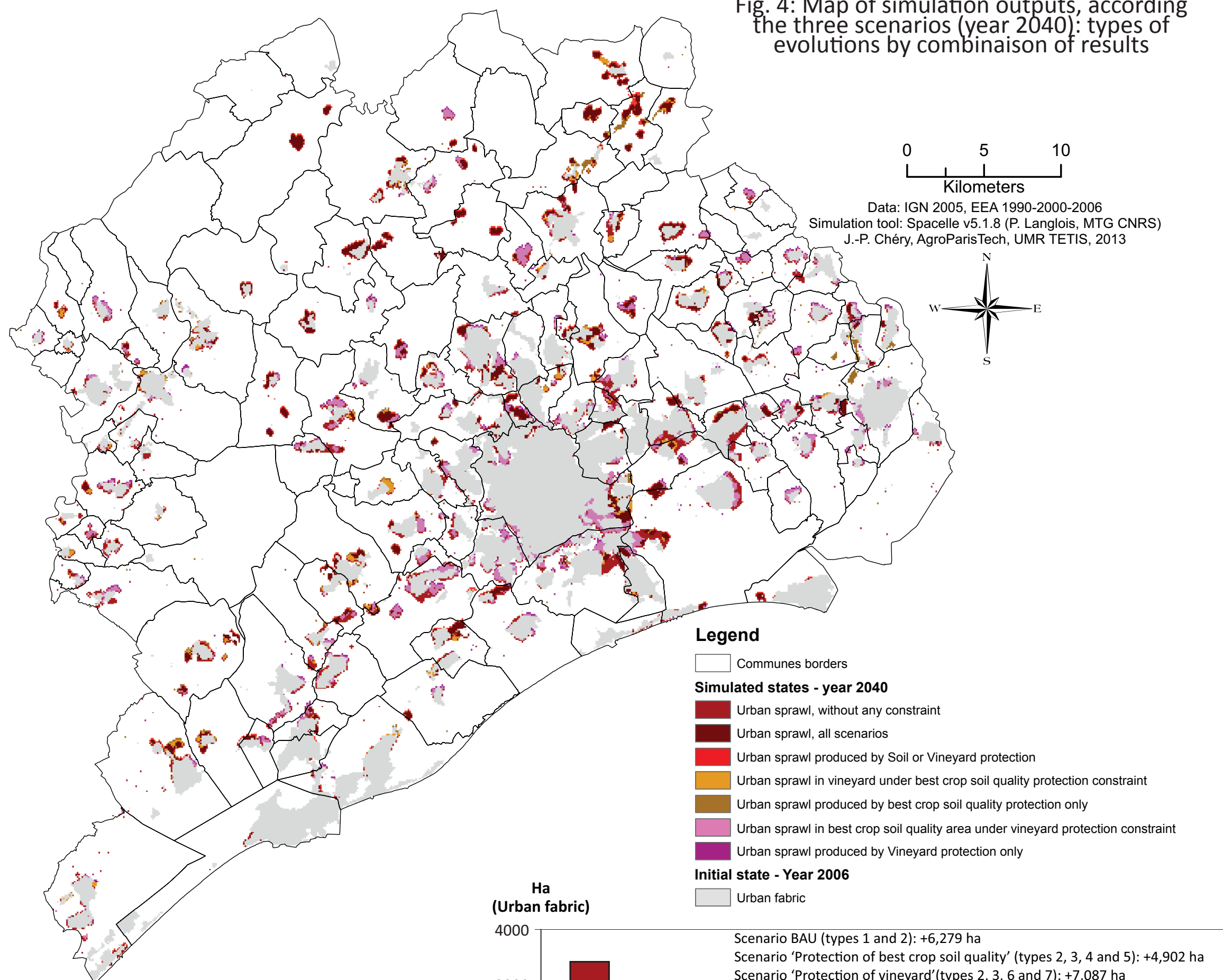
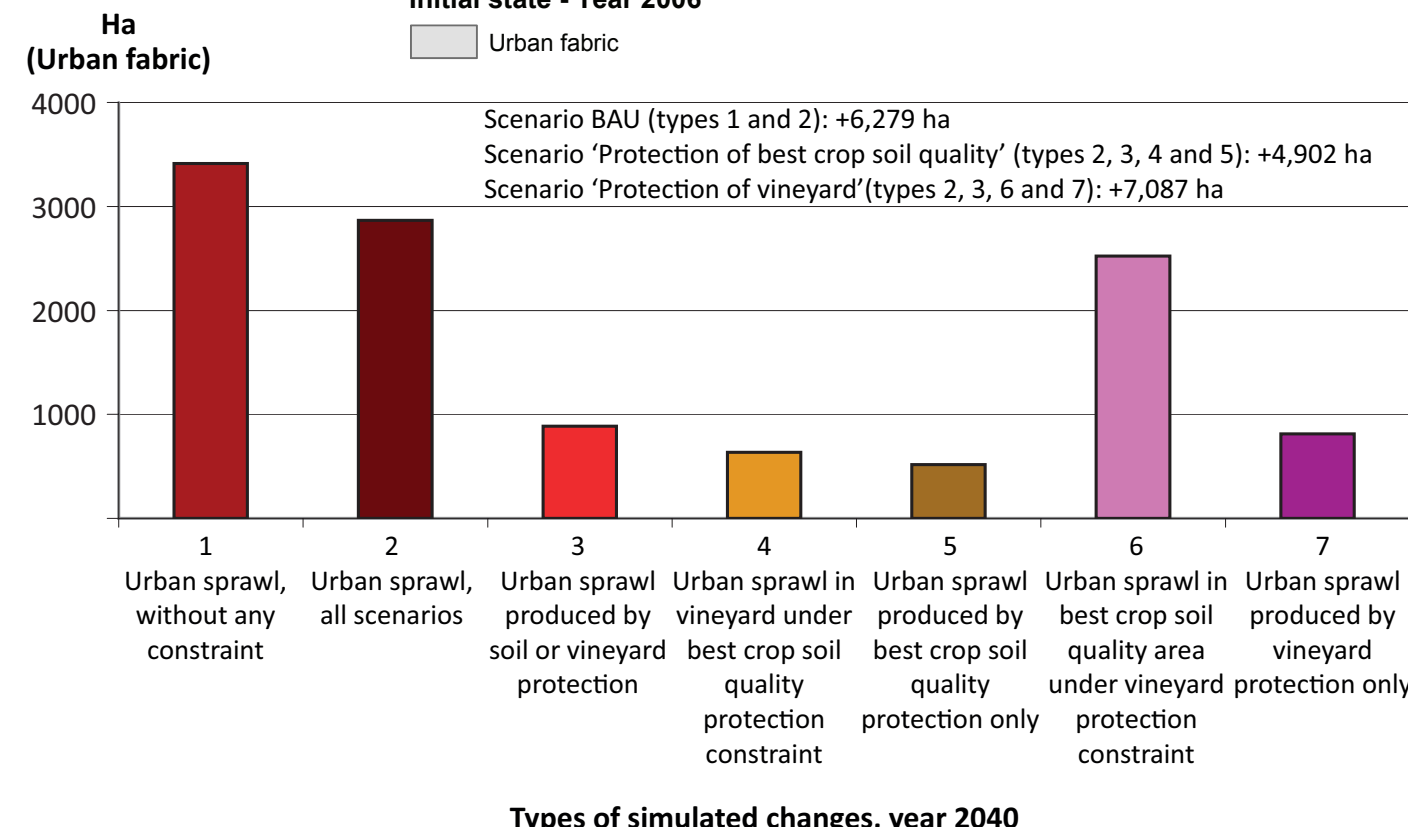


Fig. 5: Graph of simulation outputs: types of evolutions by combination of results, for comparison of areas and analyse of spatial 'evasion' of urban sprawl



Results

Simulation outputs give three states for year 2040, with different areas for urban fabric (between +4,902 ha and +7,087 ha). Spatial analysis with GIS is used to define types of the urban sprawl with the reference to location: each cell is concerned (or not) by the scenarios. The analysis provides a qualification of potential change according to two phenomena: (i) a classic phenomenon of sprawl, which is given by automata rules (contagion by neighborhood, accessibility by networks) and (ii) a capacity to bypass local constraints (protection) and to project urban sprawl with new fragmented patches. This second behaviour is not the expression of dispersed local housing (household decision under local possibilities) but the one of counter intuitive effect of spatial protection of agricultural areas, defined at a regional level.

Conclusions and perspectives

It can be unproductive to compare different outputs of simulations if the local constraints have a random spatial distribution (as potential soil quality for cropland, in a spatial planning issue). Urban planning is strongly constrained by the logic of natural areas - and potentially farmland - protections. The expected benefit of spatial simulation modelling is, in this perspective of blocking land property, to provide counter intuitive visions of the urban sprawl.

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