BRAIN-be
Belgian Research Action through Interdisciplinary Networks

MASC

Modelling and Assessing Surface Change impacts on Belgian and Western European climate

DURATION
01/01/2014 – 31/12/2017

BUDGET
1.196.978 €

PROJECT DESCRIPTION

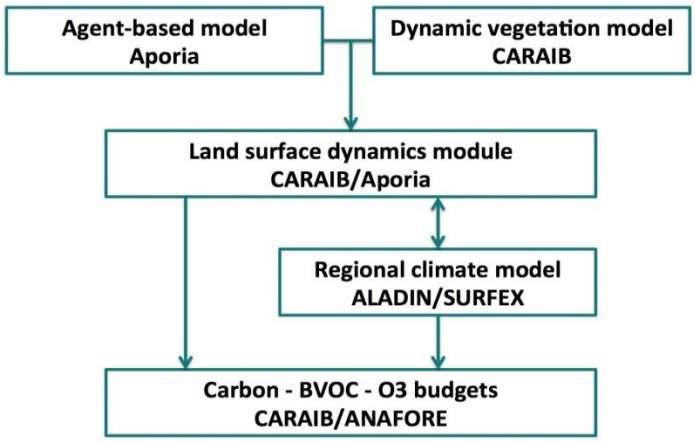
The overall objective of this project is to **study the feedbacks between climate changes and land surface changes** in order to improve regional climate model projections at the decennial scale over Belgium and Western Europe and thus to provide better climate projections and climate change evaluation tools to policy makers, stakeholders and the scientific community.

The interactions between land surface and climate are complex. Climate changes can affect ecosystem structure and functions, by altering photosynthesis or inducing thermal and hydric stresses on plant species. These changes then impact socio-economic systems, through e.g. lower farming or forestry incomes. Ultimately, it can lead to permanent changes in land use structure, especially when associated with other non-climatic factors, such as urbanization pressure. These interactions and changes have consequences [feedbacks] for the climate system, in terms of changing: (1) surface properties (albedo, roughness, evapotranspiration, etc.) and (2) greenhouse gases emissions (mainly CO_2, CH_4, N_2O). The first type of feedbacks alters directly the local/regional atmospheric circulation, whilst the second feedback affects the global system in the long run, through the atmospheric greenhouse gas budget. This project will address the first type of feedbacks.

Current studies remain quite limited in their assessment of the interactions between climate and land surface dynamics, because:

1) they do not fully couple the climate, the land surface and the socio-economic system, implying that the strength of the feedbacks existing between these three systems cannot really be evaluate;

2) they usually use low resolution models, so that atmospheric processes like regional winds, thunderstorms or other local convective systems cannot be represented, while these meso-scale circulation features are probably central in governing the land surface-climate feedbacks at the scale of a region or a country.



Feedbacks between land use change and climate change : an interdisciplinary modelling challenge

MASC

For those reasons, we suggest to build in this project a country-scale assessment tool using high-resolution coupled models of climate, land surface dynamics and socio-economic processes. This tool will be specifically designed for Belgium and applied over its whole territory. A simplified version will be applied at lower spatial resolution over Western Europe.

With this assessment tool, we will:

1) produce **high resolution projections of climate and land use/land cover changes at the decennial scale (2013-2030) over Belgium and Western Europe**, taking the **feedbacks** between all these changes into account (Objective 1),
2) assess the **impacts of expected land surface changes** related to ecosystem cover and socio-economic use **on the future climate** of Belgium and Western Europe (Objective 2), and
3) evaluate **the impacts** of the resulting climate and land surface dynamics **on the carbon budget of land ecosystems** (Objective 3).

Our work will start by adapting a land surface dynamics (LSD) module composed of a dynamic vegetation model, calculating the productivity and growth of natural ecosystems, forests, pastures and crops, and an agent-based model, determining the shifts in land use and land cover resulting from decision rules applied to a set of agents. These two models will be integrated and up-scaled to be applicable to the whole Belgian territory, using various spatial environmental data together with socio-economic and policy information. This LSD module will be validated over the recent period. It will be made consistent with SURFEX, the surface scheme of the ALARO regional climate model that will be used in the project, as well as with the ECOCLIMAP II surface database used by SURFEX.

Then, we will develop a coupler for the exchange of information between the LSD module and SURFEX to allow simulations of ALARO with a fully dynamic land surface. These simulations will be run over Western Europe at 20 km and over Belgium at 4 km, for the period 2000-2030 (first objective). Over Belgium, the LSD module will be used in concert with the regional climate model, using synthetic agents in the agent-based model defined specifically for the Belgian territory.

The simulation results will be analysed in order to identify and quantify the feedbacks linking the climate and the land surface systems, e.g., by comparing separate simulations with and without land surface changes. An assessment of the impacts of projected land use/cover changes on regional climate (second objective) and terrestrial ecosystem carbon cycle (third objective) evolution will also be undertaken.

The objectives of MASC are highly relevant in the framework of the *Joint Programming Initiative (JPI) Climate*. The research deliverables produced by the network will contribute to the provision of climate services for scientists, policy makers and any stakeholder related to climate policy. These deliverables will consist of (1) high resolution climate and land use change dynamic projections at the horizon 2030, covering Belgium and Western Europe, and (2) an assessment of the impacts on land ecosystems and their carbon budget.

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