RI/06

ECORISK

A decision support tool to manage climate change risks to forest ecosystems

DURATION OF THE PROJECT
01/06/2012–31/05/2016

BUDGET
916.772 €

KEYWORDS
pollution, nutrients, global climate change, forest, soil, radio-nuclides

CONTEXT

In the global change context, forest ecosystems are key components for successful mitigating strategies, as they are supposed to act through two main avenues: (i) increased carbon storage in biomass following increased productivity and (ii) decreased fossil fuels emissions due to increased wood utilization either as biomass energy or as substitution low energy-inputs materials.

The extent to which forest ecosystems will be able to effectively ensure these roles in the future remains however poorly documented, due to an intricate web of direct and indirect effects of global change.

Direct effects are due to a combination of stress events (e.g. extreme droughts) and of diffuse pollution (contamination, nutritional unbalances). Indirect effects are those generated by alternative energy sources used to mitigate climate change impacts. The impacts of radionuclides on forests are also to be considered as a possible side effect of mitigation strategies.

PROJECT DESCRIPTION

Objective
The objective of this project is to generate a decision support tool (DSS) to analyse risks to forest ecosystems and forest responses as a result of extreme climate events, with a focus on addressing long-term effects on water, carbon and nutrient cycling in Belgian forest ecosystems. By extension, the tool will be able to simulate the enhanced dispersion of certain elements (radionuclides and trace metals) at the biosphere/geosphere interface, through the coupling of element fluxes to the above-mentioned water, carbon and nutrient fluxes. In all, this type of study has an obvious potential for linking climate (extreme droughts) with forest growth (biomass) and element cycling (heavy metal contaminated ground water and sites, nuclear waste disposal) for the better evaluation of environmental solutions.

Methodology
The DSS will be based on a combination of existing models and approaches designed to predict direct ecosystem responses to extreme climate events (i.e. extreme droughts) – including a quantification of the associated risks, as well as associated effects such as the redistribution of pollutants at the soil / vegetation / atmosphere level as they follow the biogeochemical cycles. The following components are at the centre of the DSS system:

- The RMI atmospheric model, which will be used to down-scale Intergovernmental Panel for Climate Change (IPCC) scenarios at higher resolution over Belgium, such as to produce detailed projections of precipitation, temperature, heat waves, wind phenomena and cloud formation affecting incoming radiation as a consequence of extreme events.
- The above climate model will be used as input for the UA ANAFORE forest management model, which is designed to simulate water, carbon and nitrogen exchanges at the ecosystem level for the major forest types of Belgium. The ANAFORE model will also be used to simulate forest yield quantity and quality in function of forest management for the different scenarios.
- The ANAFORE model would be supplemented by the addition of two modules, dealing with nutrients and pollutants, respectively, such that the relative mobility of elements in respect to water and nitrogen within the system is incorporated, by including such factors as retardation and bioaccumulation in the module. In effect, this will imply the mathematical coupling of pollutant and nutrient fluxes to water, carbon and nitrogen fluxes within the ANAFORE model.

Integration of the system will be tested by selection of specific climate extreme scenarios and validation through existing datasets of water, carbon and other substances in Belgian forests. The work on nutrients will focus on P, Ca, Mg and K. The pollutants that will be considered are heavy metals / micronutrients (Cl, Mn, Cu), as well as radioactive elements (36Cl, 41Ca, 94Nb and 126Sn). Including elements relevant to long-term ground radioactive contamination provides added value to the tool for studying enhanced long-term dispersion from underground disposal nuclear sites into the biosphere as a result of severe water table fluctuations (specific risk assessment).

SSD SCIENCE FOR A SUSTAINABLE DEVELOPMENT

RISKS

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INTERACTION BETWEEN THE DIFFERENT PARTNERS

The partners of the project have different modelling expertise (see above). Their models/model results will be integrated into the final DSS as described above. The integration of the data and models into the final DSS is depicted in the following figure:

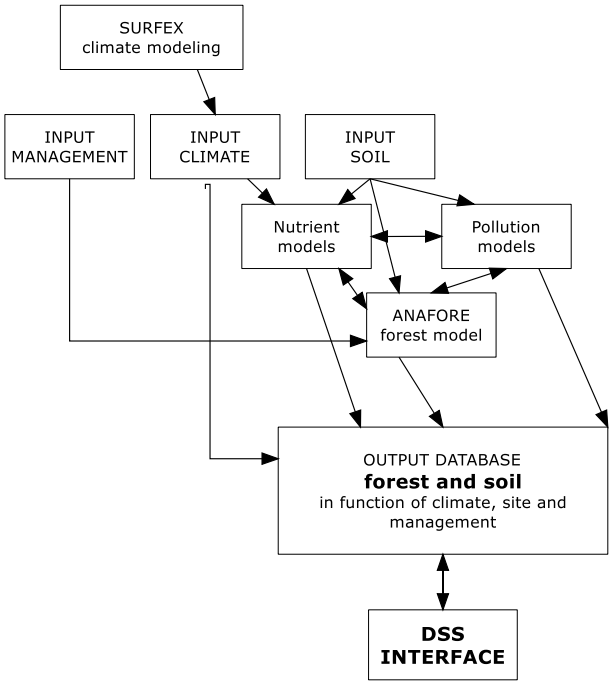

Fig. 1. Model and database coupling

EXPECTED RESULTS

The final goal is a decision support system (DSS) based on a user-friendly interface to query a database containing geospecific data on belgian forest growth, health, soil contamination and soil nutrient status as influenced by climate and forest management. Special emphasis will be on the production of risk maps over Belgium.

Intermediate deliverables will be:

1. Downscaled climate scenario's
2. Input database geospecific forests/soil/pollutants/nutrients over Belgium
3. Nutrient module
4. Pollutant module
5. Integrated forest model

PARTNERS

The research team of Plant and Vegetation Ecology of the **University of Antwerpen (UA)** has a long-term experience with the ecophysiology and functioning of plants, and of trees in particular. In most of the current projects at least part of the role of the research group deals with the integration of experimental results in functional models.

The **Royal Meteorological Institute (RMI)** is the national meteorological service of Belgium, providing an extensive range of weather forecasts, climatological, environmental and other services. The meteorological and hydrological modeling unit is part of the international consortiium ALADIN. The unit has solid experience in numerical model development and regional downscaling of the past climate.

The group Biosphere Impact Studies of **the SCK•CEN** is involved in terrestrial and aquatic radioecology and impact studies, focusing mainly on the mechanistics of radionuclide availability, transfer and biological uptake in the soil-plant environment and biogeochemical cycling of radionuclides in ecosystems.

The general interest of the Earth and Life Institute, **UCL University**, is to understand the reactivity of forest ecosystems, stands and trees to resources (e.g. carbon, nutrients, water) and/or controllers (e.g. light), using an ecosystem approach. The main disciplines are related to ecophysiology and ecology.

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