Decision support tool for sustainable management of chemical forest soil fertility

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BACKGROUND AND CHALLENGES

The demand for fuel-wood is increasing. Up to now little attention has been paid to harvesting residues, which have been considered as waste and left on the soil after harvesting. But now, interest in harvesting residues is increasing. However it has been shown that these thin branches have a greater nutrient concentration than trunks, and, although they represent a small proportion of forest biomass, they can contain a significant fraction of the ecosystem nutrients. Exporting them can be harmful, especially on acid soils where recycled organic matter is the main source of nutrients.

In 2006, ADEME published the "Sustainable harvesting of forest residues guidelines" as a decision-making tool for forest managers. This identifies three major classes of soil sensitivity. Unfortunately, these guidelines are often too simplistic to be used at national level. Because the recommendations do not take account of the variability of French soil and climate conditions, tree species and forestry practices.

MATERIALS, METHODS AND RESULTS

Within the FORGECO project, an Excel spreadsheet was produced as a decision-making tool for foresters, focusing on silviculture schemes and intensity and focusing on the sustainability of soil fertility.

This system is based on an analysis of biogeochemical cycles in forest ecosystems (figure 1, p. 190) and on data from the literature or from previous FCBA projects. The data concern climate (rainfall, evapo-transpiration), soil, biomass and nutrient content of the main compartments (stem, bark, branches, foliage) of the main tree species, etc.

The user enters information about the forest stand, its management (number of thinnings, age at harvest) and the main soil characteristics. The system uses these data with four integrated models to calculate the inputs (atmospheric deposition, flows of nutrients from the weathering of soil minerals) and outputs (nutrients exported with biomass, losses by drainage) for the five main nutrients (N, P, K, Ca, Mg). The resulting nutrient balance (inputs-outputs) is calculated for the whole

Figure 1 **INTERNAL FLUXES, INPUTS AND OUTPUTS IN A FOREST ECOSYSTEM**

(Legout, 2008)

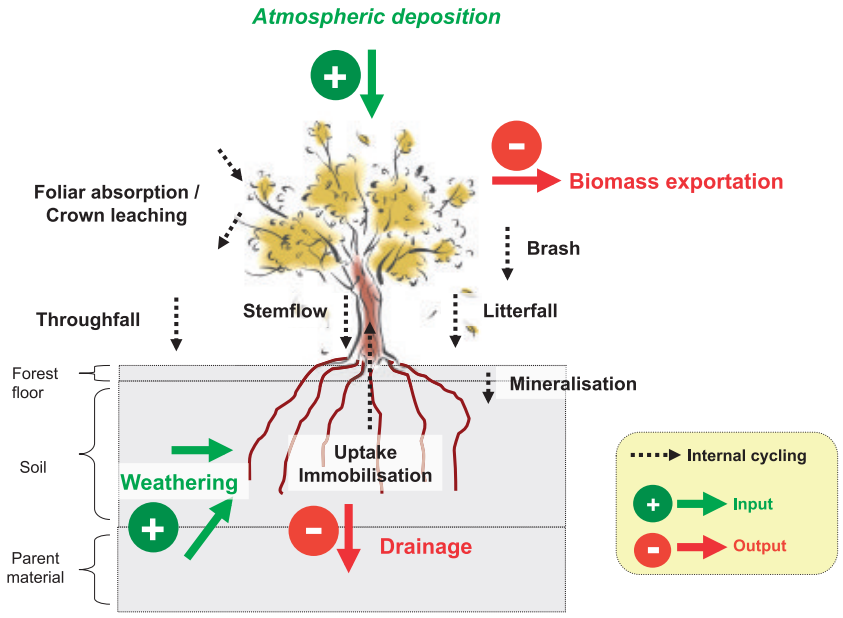
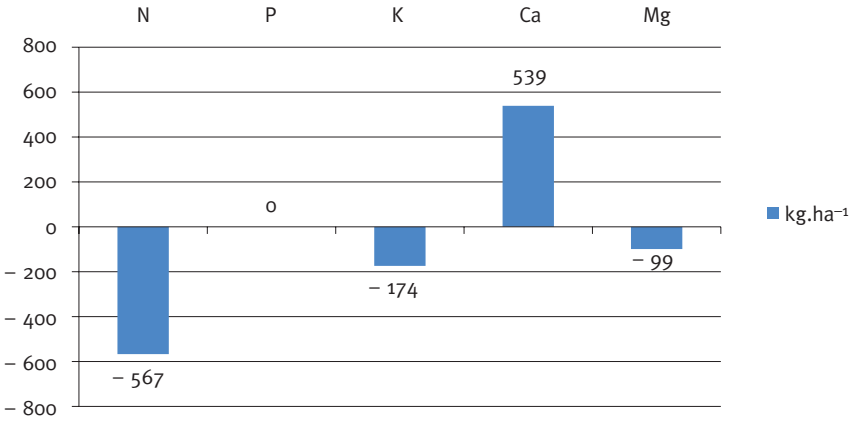


Figure 2 **NUTRIENT BUDGET CALCULATED FOR THE WHOLE STAND ROTATION FOR N, P, K, Ca AND Mg**

(data in kg.ha^{-1})



stand rotation (example on figure 2). It indicates whether the forest ecosystem will be depleted or enriched by the forest management practices applied. If the balance is negative (nutrient loss), the system suggests what amendments have to be applied in compensation. It can also propose changes in the forestry practices and the intensity of harvesting (with or without residues).

LIMITATIONS AND POTENTIAL IMPROVEMENTS

The system was presented to forest managers, potential users, and soil science experts. The resulting discussions showed the need to improve the system and the presentation of the results:

— Emphasis should be placed on the many uncertainties surrounding the measurement of biogeochemical flows on which the system is based; the results only represent orders of magnitude which generally indicate if the nutrient budgets are positive, negative or close to equilibrium.

— A more detailed explanation of the results should be provided to guide forest management choices (whether or not to collect harvesting residues, whether to increase the rotation period, etc.).

— The presentation should be more didactic (more detailed graphics, especially on an annual scale).

This system only covers chemical aspects of soil fertility in relation to biomass harvesting. Other parameters must also be taken into account to guide forestry management decisions, *e.g.* maintenance of biodiversity and soil physical properties.

CURRENT AVAILABILITY, USEABILITY

This is the first version of the system and it is currently parameterized for the Orléans and Vercors French regions, the two study areas of the FORGECO project. Before it can be used for other parts of France, it must be configured with data for the particular area to which it will be applied: soil type, tree species (biomass nutrient content), rainfall and ETP, atmospheric deposits, etc.

A manual is already available for the current version describing the standard setup and specific parameterization.

It is important to emphasize that this system requires knowledge of soil science (description of a soil) and forestry and, has therefore been designed to be used by forest technicians and managers.

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