Analyzing the residuals in predicting Ca^{++} depletion caused by forest logging residuals harvest

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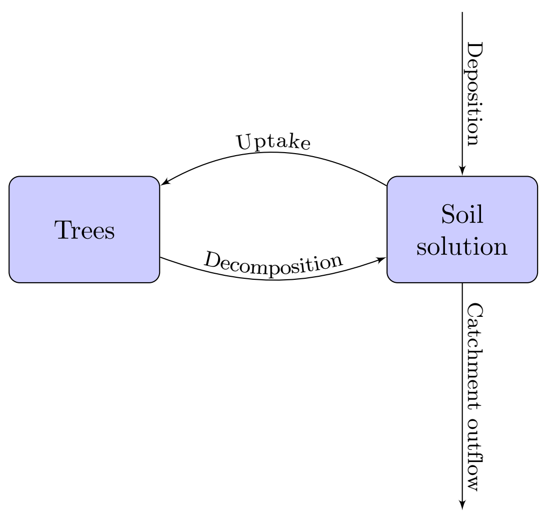
1 Building the model

1.1 The model

The model considers the base cations (BC) in two pools in the ecosystem: the soil solution (B) and the dead and living biomass.



The fluxes of (BC) to and from these pools that will be connected by the model are five. Three of them are at the boundary of the system:

1. Net deposition (D)
2. Exports (with biomass) (E)
3. Water stream outside the catchment (S)

Two of them are internal to the system:

4. Uptake from living biomass (U)
5. Decomposition from dead biomass (C)

The fluxes can be combined together to define the variation of the content of BC in the soil solution (B):

$$B' = +D + E + C - U - S \tag{1}$$

The deposition D is measured in mass per surface unit, as well as the estimated fluxes of biomass exports E and decomposition C as well as uptake U. The stream of Ca^{++} outside the catchment S is instead estimated through the Ca^{++} concentration at the outlet. We connect S with its measured proxy variable S_m through a calibrated coefficient σ. Also the BC concentration is not directly measured but connected with a measured proxy, the acid neutralizing capacity (ANC), and we utilize another calibrated coefficient β to connect it with the Ca^{++} concentration:

$$\beta B'_m = +D + E + C - U - \sigma S_m \tag{2}$$

Each of these fluxes is either measured directly or estimated through simulation.

1.2 The measured variables and conversion

1.2.1 BC in the soil solution, the predicted variable (B)

The ANC concentration in the soil solution (as meq l^{-1}) is part of the variables monitored at the study site [4]. This is the cumulated value of the soil solution pool at a certain time, and not its variation over time (the derivative considered by Equation 2).

1.2.2 Net BC deposition data (D)

The net BC is the balance between the total BC and the deposition of neutralizing acids. At the study sites SO_4^{2-}, NO_3^- and Cl^- are all measured as meq m^{-2} y^{-1}. It represents a flux over time and surface, and must be reported to a flux over the reference area. This can be done just by multipliying it by the surface of the reference area.

This should be converted to meq l-1 over time, to compare with the soil solution pool

1.2.3 Streamwater data (S_m)

The ANC concentration in the streamwater (as meq l^{-1}) is part of the variables monitored at the study site. This is a concentration over time, and must be reported to a flux over the reference area. This can be done by multiplying it by the stream current in liters per time unit (y^{-1}).

This also should be converted to meq l-1 over time, to compare with the soil solution pool

1.3 The modeled variables

1.3.1 Uptake (U) and exports (E)

Uptakes will be modeled considering the biomass growth, which is recorded at the sites. Various reference values expressing the ratio between Ca^{++} ions and (mg g−1) C in different part of biomass are reported in [3].

Is it? Stefan, in which form is biomass recorded, and how often?

We will consider separately needles, fine roots, branches, coarse roots, stem and stem bark. Exports will be modeled based on 3 scenario of forest utilization (no utilization, low intensity, high intensity).

Values are variable in each site, but sites reported here are different from the ones we will use. What should we use? Average all the values with uncertainty?

1.3.2 Decomposition (C)

To model the decomposition of the dead biomass, and its relative release of base cations (mainly Ca^{++}) we will utilize the decomposition model described in [3]. Decomposition material will come from aboveground and belowground. From aboveground we will consider decomposing material from litterfall and from tree death, while from belowground material from coarse and fine roots.

1.3.3 Aboveground - Litterfall

Stefan, do we have measurements or proxies for litterfall?

1.3.4 Aboveground - Tree death

we will assume a death rate of trees from the literature. On top of this we will add the dead biomass coming from the forestry operation in the two commercial forestry scenarios.

To be found

1.3.5 Belowground - Coarse roots

Coarse roots are assumed from aboveground biomass based on coefficients from [**?**].

1.3.6 Belowground - Fine roots

The inputs from fine roots are defined by their mass and their turnover time. The turnover will be assumed based on data from [5]. Their amounts is assumed from Finer2011a.

also all these values have wide variance, I'll "solve" it with uncertainty

1.4 Calibration

The model will be calibrated against the data within a Bayesian framework [2]. Subsequent analyses will utilize the resulting Markov chains Monte Carlo to analyze the residuals in all the model space explored by the search algorithm according to [1].

References

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[3] Riitta Hyvönen, Bengt A. Olsson, and Göran I. Ågren. Dynamics of soil C, N and Ca in four Swedish forests after removal of tops, branches and stumps as predicted by the Q model. *Scandinavian Journal of Forest Research*, 27(8):774–786, 2012.

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