PREDICTING NITROGEN AVAILABILITY ON A REGIONAL SCALE:

On the necessity to include intricate interactions with local hydrology in a SOM model

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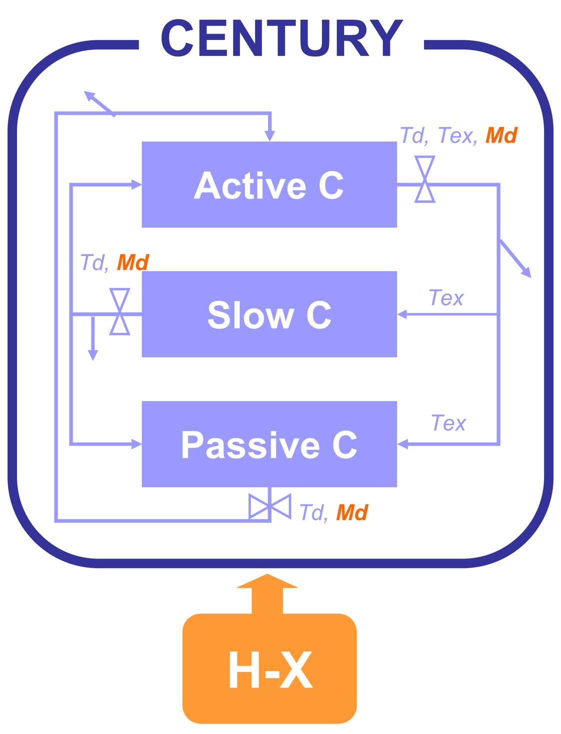
1. Introduction and objectives

The availability of soil nutrients, especially nitrogen (N), strongly influences the functioning and biodiversity of terrestrial ecosystems. Making a robust prediction of N availability on a regional level is a challenge, because of its sensitivity to local conditions such as soil moisture. To that end, a number of previous studies coupled soil organic matter (SOM) models with a hydrological module to make regional predictions of N availability. Nevertheless, whether and how such coupling improves the model predictability has never been tested. Here we investigate:

- **If coupling of a SOM model with a hydrological module improves the prediction of N mineralization rates on a regional scale**
- **Whether the type of hydrological modules matters for the model predictability**

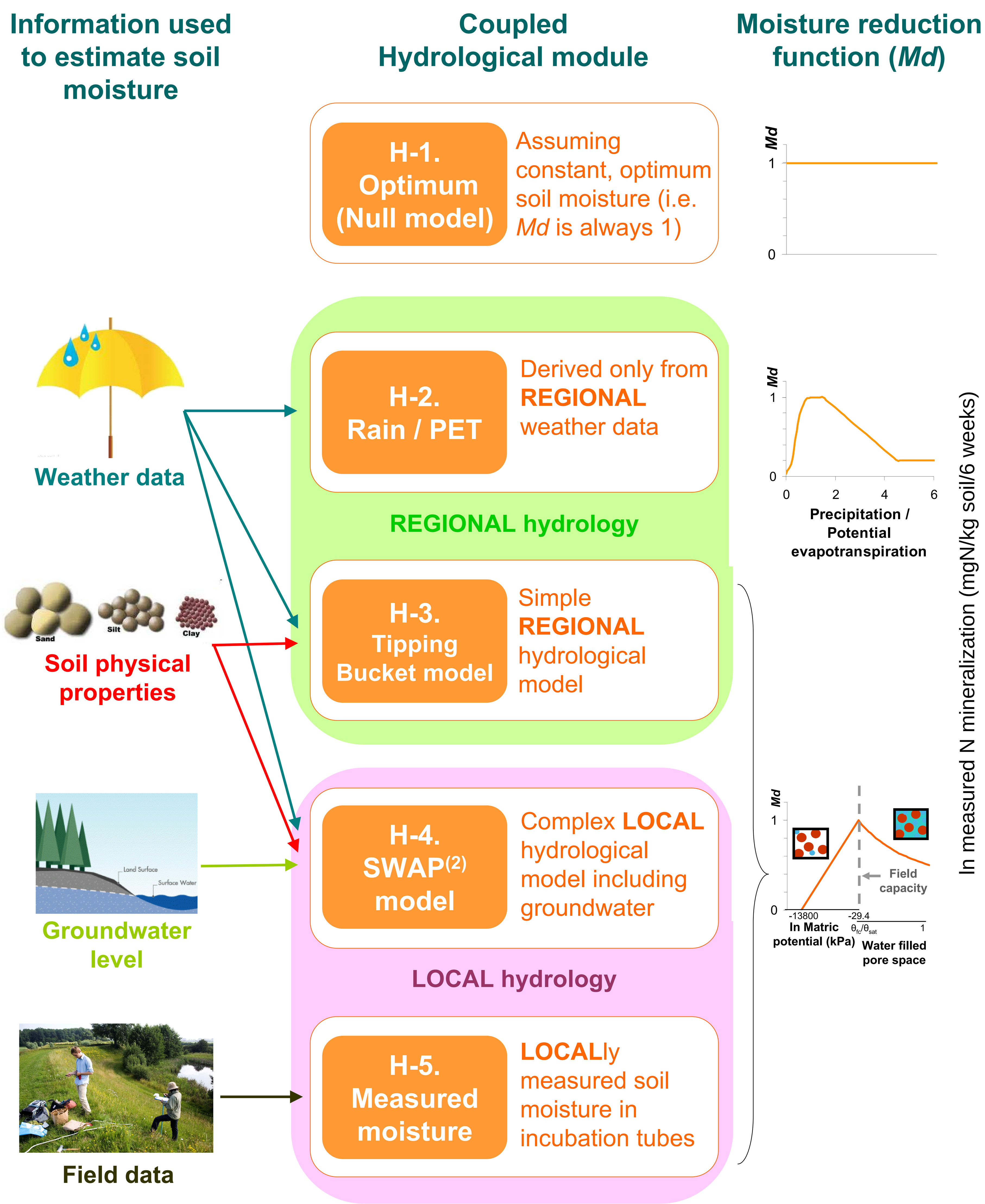
2. Model

Fig 1. CENTURY model coupled with a hydrological module (H-X)



An process-based SOM model, CENTURY[1], is used to simulate carbon and nitrogen dynamics in the soil (Fig 1). The C flows between the pools are controlled by temperature (*Td*), soil texture (*Tex*), and soil moisture (*Md*). The N flows are associated with C pools, but adjusted by C/N ratios of the originating and receiving pool.

We have coupled the CENTURY model with five different hydrological modules which differs in complexity and assumptions in estimating soil moisture (H-1 to H-5).



4. Result

Model validation

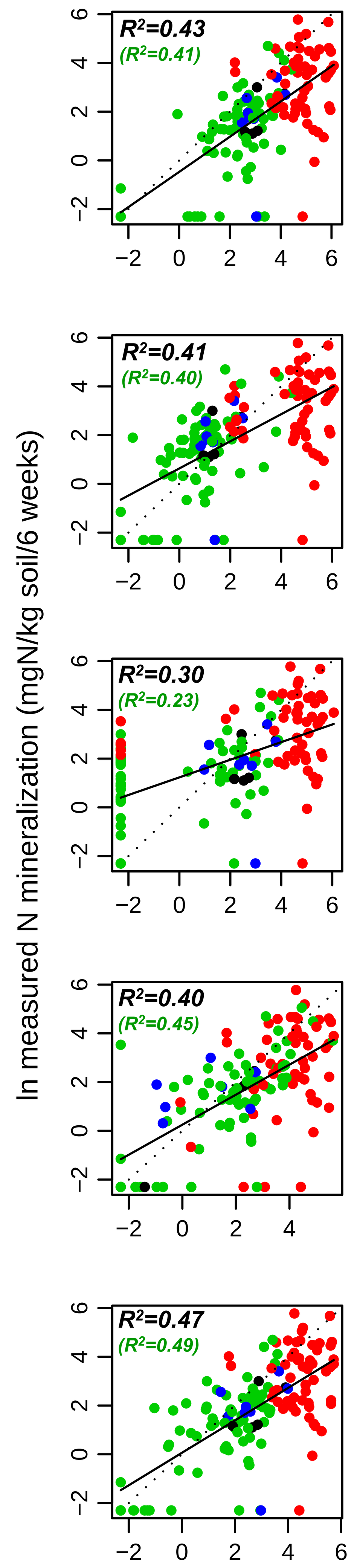
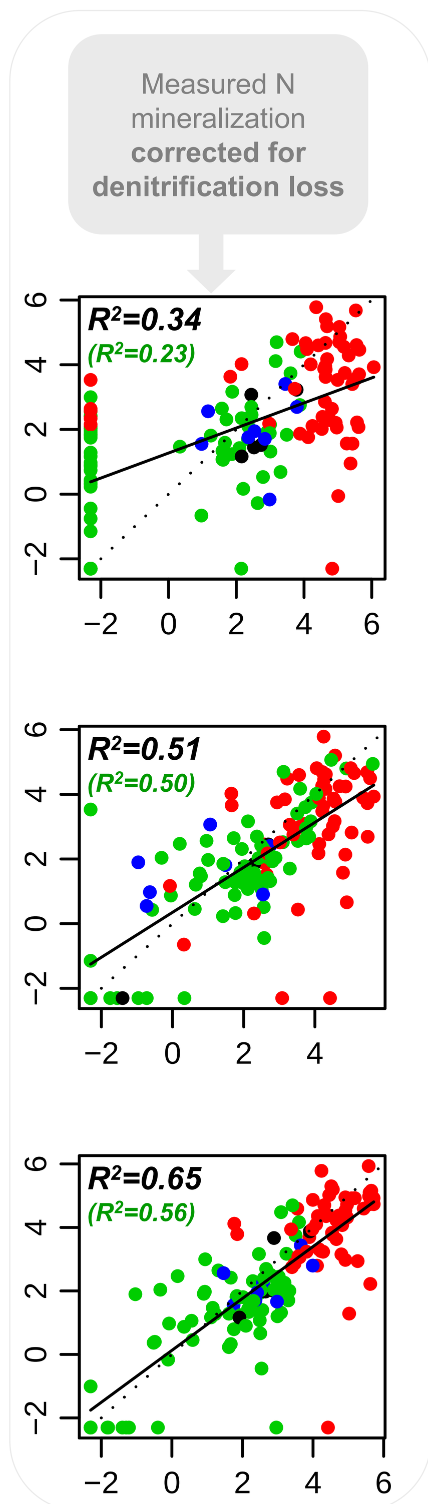
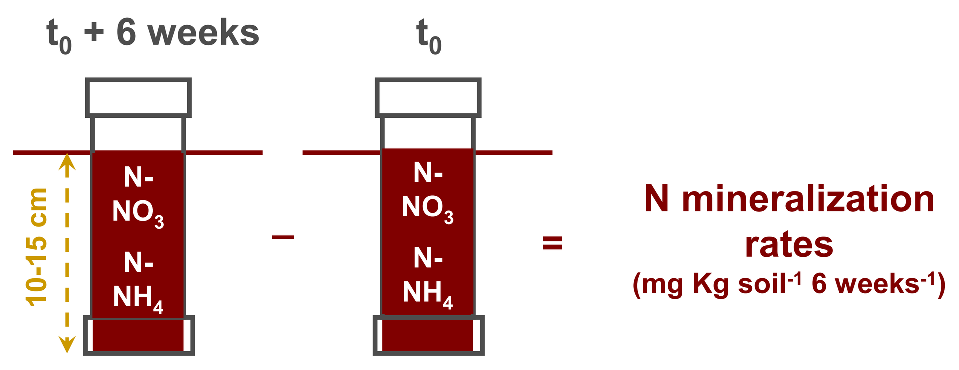


Fig 2. Measured N mineralization compared with N mineralization modeled with different hydrological modules. Measured N mineralization rates were corrected for N loss during incubation by adding modeled denitrification rates for H-3, H-4, and H-5 (right). R^2 values of linear regression analysis are shown for all soil types (N=139) and for sandy soils only (in brackets, N=85).
• sand • sabulous clay
• clay • peat



In modeled N mineralization (mgN/kg soil/6 weeks)

3. In-situ soil incubation experiment



N=139 in NL and BE[(3), (4), (5)], including dry–wet, sand–clay, acid–calcareous, and nutrient poor–rich ecosystems

Literature

(1) Parton *et al.* (1987) Soil Science Society America Journal 51: 1173-1179.
(2) Hong *et al.*(1997) Journal of Membrane Science, 1997. 132(2): 159-181.
(3) Ordonez *et al.* (2010) Ecology 92: 3218-3228.
(4) Olde Venterink *et al.* (2002) Ecological Applications 12: 1010-1026
(5) Fujita *et al.* In preparation

5. Conclusions

- **Coupling with hydrology improves model prediction:** The predictability of N mineralization rates improved from 43% to 47% by using measured soil moisture data, or even to 65 % when N loss via denitrification was corrected.
- **Type of hydrological modules matters:** Coupling a SOM model with regional hydrological module even worsened the model predictability. Coupling with detailed local hydrological module improved the model predictability, as far as sandy soils are concerned.
- **Implication:** SOM models should be coupled with a proper local hydrological module to make regional-scale predictions of N availability.

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