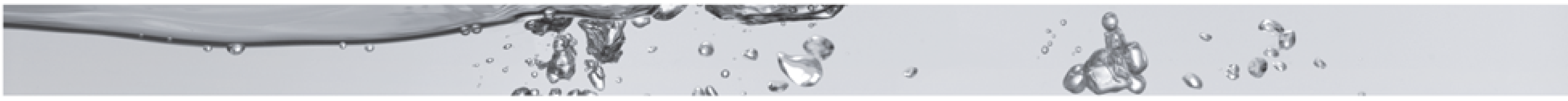

PREDICTING NITROGEN AVAILABILITY ON A REGIONAL SCALE

On the necessity to include local hydrology in a SOM model

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1. Introduction and objectives

The availability of soil nutrients, especially nitrogen (N), determines 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. Here we investigated the effect of local soil moisture conditions. To this end a number of soil organic matter (SOM) models were coupled with a hydrological module to make regional-level predictions of N availability. 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 module matters for the predictability of the SOM model.**

2. Model

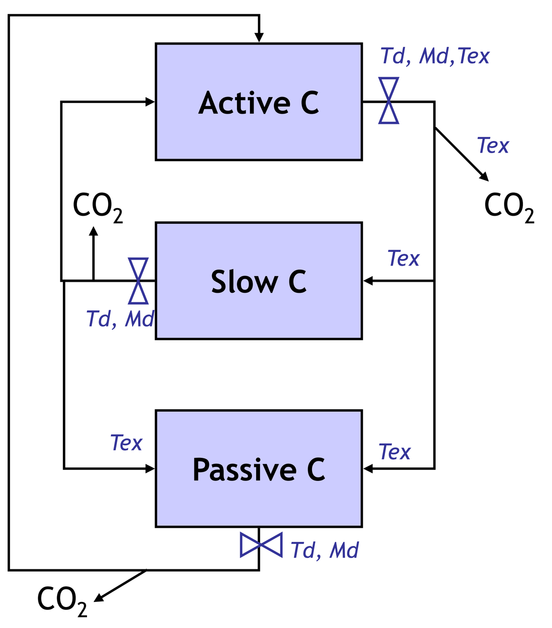

Fig 1. CENTURY model structure

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

We have coupled CENTURY with five different estimates of soil moisture involving contrasting complexity: M1) soil moisture optimal for N decomposition (null model), M2) regional weather data, M3) regional hydrological model (tipping bucket model), M4) local hydrological model including local groundwater data (SWAP[(2)]), and M5) soil moisture measured locally in the field. The reduction function on decomposition, *Md,* is always 1 for M1, a function of rain/PET for M2 (Fig 2 left), and a function of soil water parameters for M3-M5 (Fig 2 right).

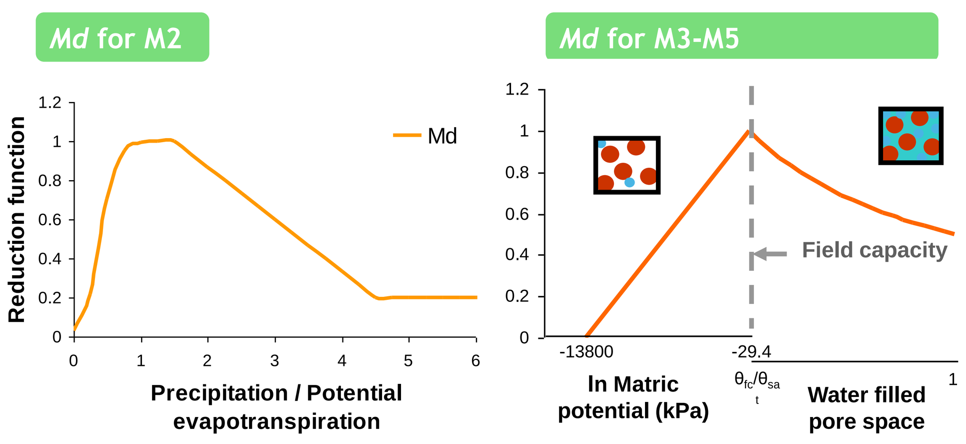

Fig 2. Reduction function of soil moisture on SOM decomposition rate in CENTURY model coupled with M2 (left) and M3, M4, and M5 (right).

3. In-situ incubation experiment

N mineralization rate was measured with in-situ soil incubation experiments in a wide range of Dutch and Belgian natural ecosystems (N=139). Soil samples of 10 or 15 cm depth were incubated for 6 or 8 weeks in summer, and the amount of mineralized N was calculated as the change in $N\text{-}NH_4+N\text{-}NO_3$ [(3,4,5)].

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.

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(5) Fujita *et al.* In preparation

4. Results

The null model (M1) explained 43% of variation in measured N mineralization rates. For all soil types together, inclusion of modeled hydrological information (M2, M3, M4) decreased the model predictability, whereas inclusion of measured soil moisture data improved the model predictability to 47% (M5). When peaty soils were excluded, model predictability improved with local hydrological model (M4) and with measured soil moisture (M5), but not with regional hydrological models (M2, M3). When N loss from incubation tube (via denitrification) was corrected, the model predictability was largely improved, but only with local hydrological information (M4 to 51%, M5 to 65%).

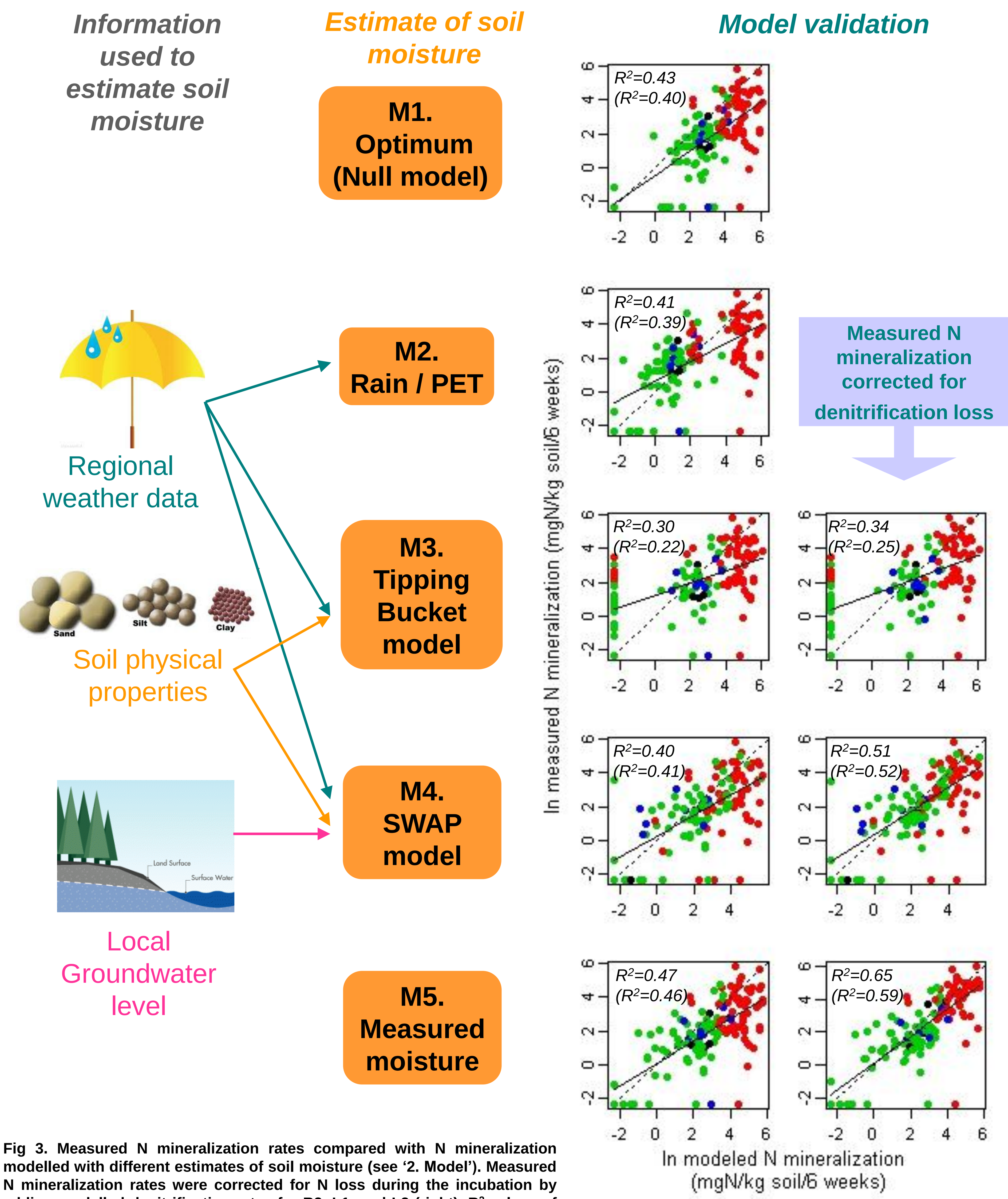

Fig 3. Measured N mineralization rates compared with N mineralization modelled with different estimates of soil moisture (see '2. Model'). Measured N mineralization rates were corrected for N loss during the incubation by adding modelled denitrification rates for R2, L1, and L2 (right). R² values of linear regression model are shown for all soil types and for non-peat soils only (in brackets). Green: sand, blue: sandy clay , black: clay, red: peat.

5. Conclusions

- **Coupling with hydrology improves model prediction:** The predictability of N mineralization rates on a regional scale 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 slightly improved the model predictability if peaty soils were excluded.

- **Implication:** A simple SOM model coupled with a proper local hydrological module can be used for regional-scale predictions of N availability.

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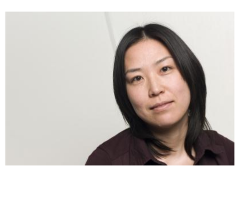

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