Simulating Soil Organic Matter Transformations with the New Implementation of the Daisy Model

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Daisy is a well-tested deterministic, dynamic soil-plant-atmosphere model, capable of simulating water balance, nitrogen balance and losses, development in soil organic matter and crop growth and production in crop rotations under alternate management strategies. Originally it was developed as a system of single models describing each process involved, but recently it has been developed into a framework, which can be used for implementation of several different models of each of the different processes. Thus, for example a number of different models for simulating soil water dynamics can be chosen depending on the purpose of the simulation and the availability of data for parameterisation.

Behind the Structure of a Daisy Simulation

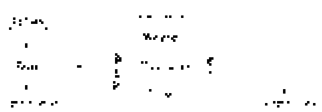

Fig 1. Running a Daisy Simulation

Figure 1 introduces the top level components of the simulation. Figure 2 shows the major component of the simulation, that is the column.

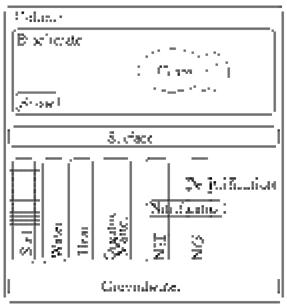

Fig 2. Components of a Column

The sub-model simulating soil organic matter is still a fixed component in the Daisy terminology. This means that there is currently only one model, which can be used to simulate soil organic matter transformations. However this sub-model can be changed considerably.

Behind the Structure of Soil Organic Decomposition in Daisy

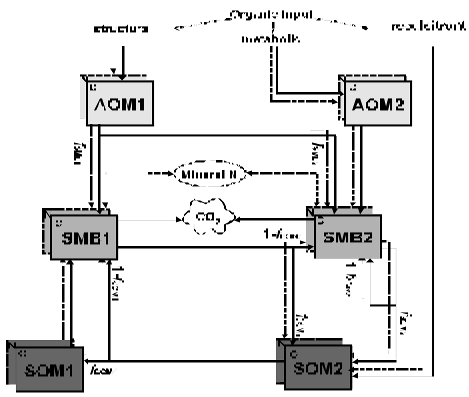

Fig. 3. Structure of the model describing organic C and N transformations of Daisy.

The default structure of the model describing organic C and N transformations in the soil is illustrated in Fig 3. It consists of 3 different types of organic matter: added organic C (AOM C), soil microbial biomass C (SMB C) and soil organic matter C (SOM C=Total organic C - AOM C - SMB C). Each of these types has been divided into a pool of fast (2) and a pool of slow (1) turnover. The turnover of each pool is determined by first order kinetics, with rate constants modified by modifiable functions of temperature, water pressure potential and for some pools clay content and tillage. Each pool of organic matter has a fixed C/N-ratio and thus the dynamics of the N pool is governed by C dynamics. The N balance determines net immobilisation or net mineralisation of N. Furthermore, a soil mineral N model, describing nitrification, denitirification and immobilisation (a maximum rate can be set) is coupled with the SOM model as well as with a solute transport model describing leaching of soil mineral N.

Behind the Soil Organic Matter Component in Daisy

Initialisation

C..: each — A sequence containing the C content of the pool in soil interval.

C_per_N. each — A sequence containing the C/N-ratio of the pool in soil interval.

Parameters

fractions — the fraction of the decay of the current pool to SMB1, SMB2, SOM1 and SOM2, respectively. This can represent the partioning coefficients, f_{SOMx} in Fig. 3, but can be used to modify the flow pattern of organic C and N completely

efficiency — The efficiency with which this pool can be digested by each SMB pool, the remainder lost as growth respiration.

maintenance: — The fraction used for maintenance (only relevant for SMB pools) and thus respired.

turnover_rate: — The turnover rate of the pool.

Each input of added organic matter can either be incorporated by tillage or via a special bio-incorporation sub-model to mimic the action of soil fauna.

Example of a Daisy simulation

In Figure 4 two Daisy simulations are showed. The rotations are both non-stop wheat, in Scenario 1 (SC1) the straw is removed, and in Scenario 2 (SC2) the straw is incorporated at harvest. Both scenarios received 140 kg N/ha in spring.

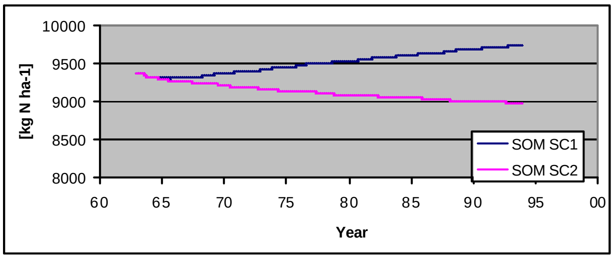

Fig. 4, Daisy simulation soil organic N (kg N/ha to 100 cm) for a continuous wheat rotation on a Danish sandy loam soil. Simulation starts in 1963. SC1: Straw removed after harvest, SC2: Straw incorporated after harvest.

The new implementation and the source code are available at the URL: http://www.dina.kvl.dk/~daisy

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