Linking ecosystem changes to their social outcomes: lost in translation

Description of the peatland model and the outputs

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This document contains a description of how the DigiBog peatland development model works. It is to be used in conjunction with the above titled paper published in Ecosystem Services, 2021. The model was set up and run to generate the peat height and water-table depth outputs in this repository.

1. Introduction

DigiBog (2D/3D) simulates the development of a peatland over millennial timescales, building up layers of peat within hydrologically connected columns. The model is deterministic and therefore will always produce the same output from the same inputs (peatland configuration, peat properties, and climate). Simulations begin with a mineral soil base and individual peat layers are added to each model column on an annual basis (i.e., the peatland is 'grown' up from the mineral base – shown in Fig. 1).

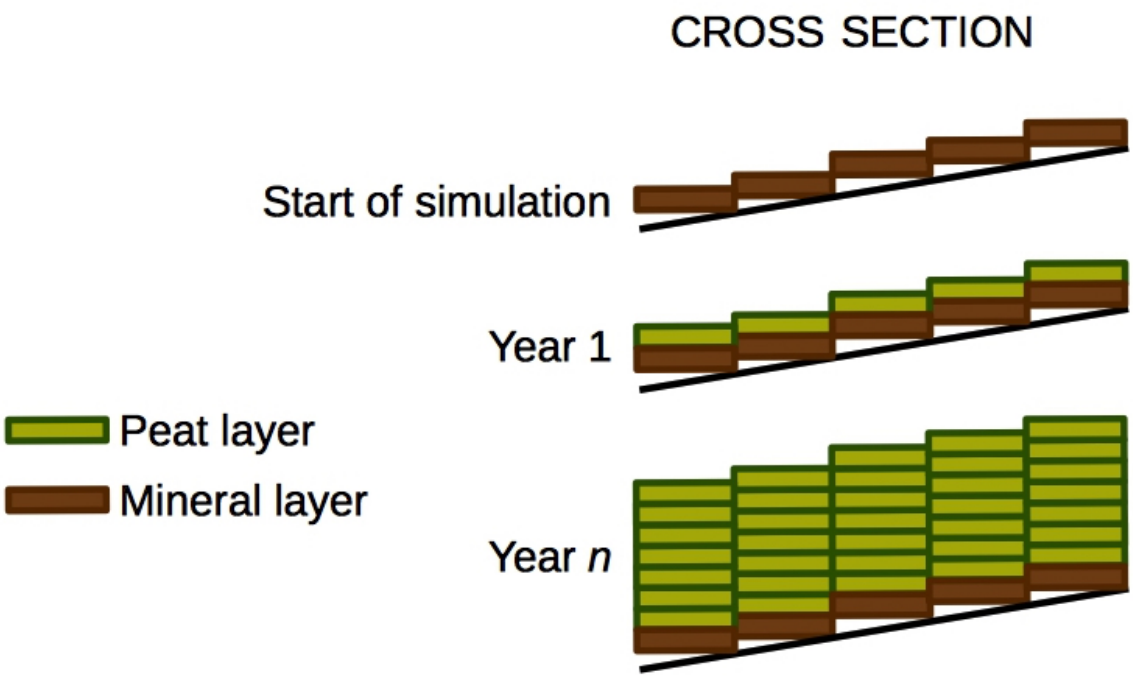

Fig 1. The annual addition of peat layers to a mineral soil base in DigiBog 2D/3D.

The processes of peat formation, peat decomposition, and water movement in the model can be summarised as follows; (1) the mass of each new layer is determined by a plant litter productivity function. Currently, peat formation in DigiBog occurs as an annual addition of new plant litter to the top of each model column, with the thickness of the new layer varying according to annual average air temperature and the annual average water-table depth for the column; (2) on a sub-annual basis, the peat in each layer in each column is decomposed at a rate that depends on its position relative to the water table and the annual air temperature; and, also on a sub-annual basis, (3) water is moved horizontally between columns to simulate water-table behaviour (driven by net rainfall, and the hydraulic properties of the peat).

Therefore, the addition of new peat varies from column to column, and peat decomposition varies both horizontally (between columns) and vertically (within a column). The degree of decomposition of a peat layer determines its saturated hydraulic conductivity, which in turn determines water movement between columns. These interactions mean that there are feedbacks between peat accumulation, decomposition, changes in hydraulic properties, and water movement.

2. Model set up

Model set up includes configuring the peatland (listed below) and defining a set of input parameters (section 3).

- Define the topography of the mineral ground on which the peatland will grow, and the number of peatland columns.
- Define the model input parameters (see section 3), and set the model run time in years.
- Create time series of net rainfall and temperature.
- Set the write out time step for the output files.

3. Inputs

Parameter	Units
Oxic decay (base parameter which is used to calculate the oxic decay parameter along with temperature and Q_{10})	Proportion (yr^{-1})
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Base temperature (used to calculate annual decay parameters)	degree Celsius
Bulk density	g cm^{-3}
Drainable porosity	Proportion
Saturated hydraulic conductivity – initial value that changes (declines) in the model as peat in a layer decomposes.	cm yr^{-1}
Net rainfall (can use annual, monthly, or weekly time series).	cm yr^{-1}
Temperature (mean annual – used in productivity and decomposition calculations)	degree Celsius

4. Outputs

As well as providing a time series of water-table depth, the end-of-simulation depth profiles for each column represent a **virtual core** of peat.

Output	Units
Water table depth (mean annual, and currently mean summer). Can also determine the residence time of ponding water.	cm
Column height (includes mineral soil thickness)	cm