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Long-term carbon accumulation in tropical peat swamp forests in Indonesia

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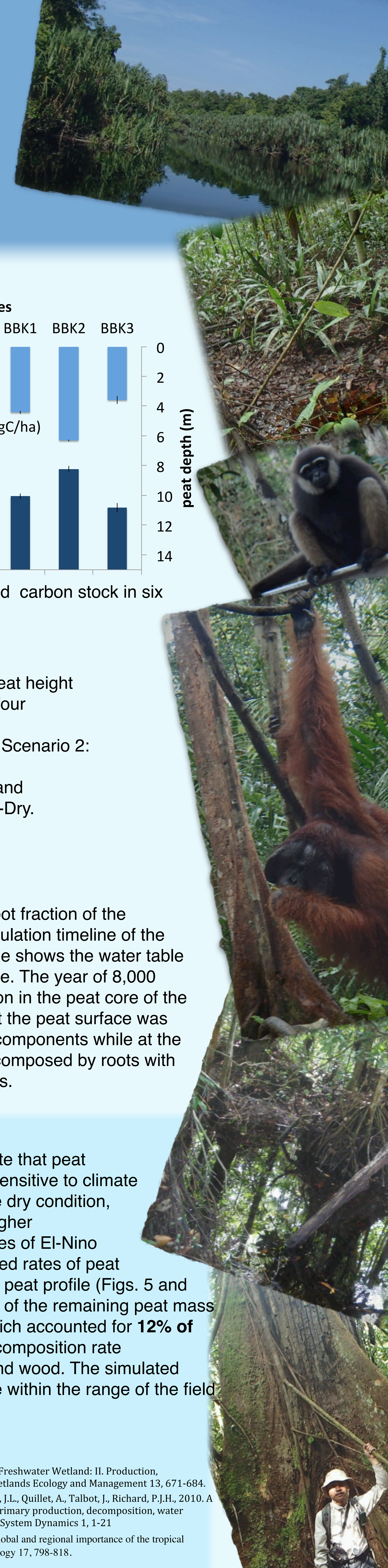


Introduction

Tropical peatlands cover an area of approximately 441,000 km^2 (10-16% of global peatland area) (Page et al. 2011). Southeast Asia contains about 60% of the tropical peat area, with about 0.2M km^2 in Indonesia.

Tropical peatlands vegetation is predominantly lowland evergreen forests, often called peat swamp forests (PSF). They have both high productivity and total carbon stocks. However, intense deforestation pressures and perhaps be followed by lowering of the water table are faced by PSF , leads to large CO_2 emissions.

Objectives:

- Collect and analyze tropical PSF peat cores to estimate peat carbon stocks.
- Modify the Holocene Peat Model (HPM) to be applicable in tropical ecosystems.

Methods

✤Field Study (Cores sampling)

- Sampling was conducted in Tanjung Puting National Park, Kalimantan (**TPG**; 3 sites), and Berbak National Park, Sumatra, Indonesia (**BBK**; 3 sites) in June-July 2012. These sites could be classified as coastal peatlands.
- Peat cores were collected at **50 m** intervals along **250-m transects (6 cores per site).**
- Cores taken from peat surface to basal peat with the systematic depth interval (eg. 0-15cm, 15-30cm, 30-50cm, etc).
- Peat cores were extracted by using Eijkelkamp peat auger. Then, we took of about 8 sub samples per core with the **thickness of 5 cm** for each sample.
- All samples were dried to constant weights at 60°C.
- The dried samples then were ground, homogenized and analyzed for carbon and nitrogen concentration using a LECO TruSpec induction furnace C analyzer.

Figure 1. The map of study area.

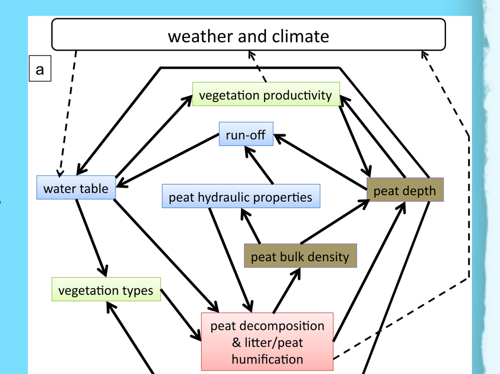
✤Modeling

In this study, we modified the HPM (see Box 1) to be applicable for tropical ecosystems:

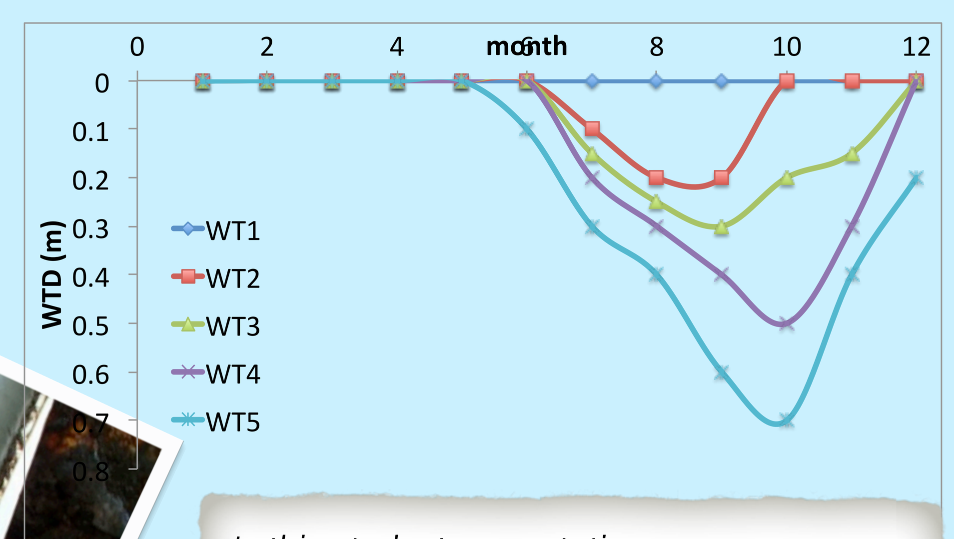
- Running in sub-annual cycle (monthly time step) for capturing the seasonal climate impacts on the peat development

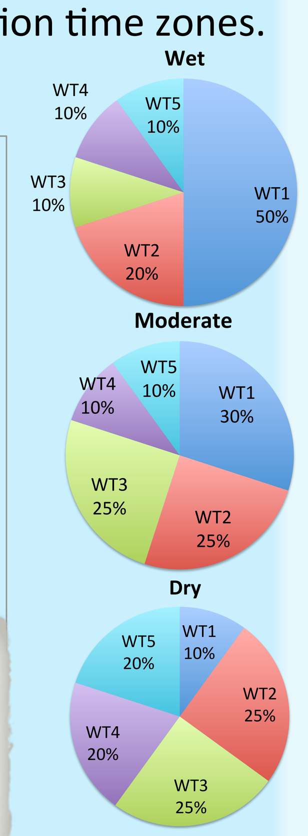
Box 1. Holocene Peat Model (HPM; Frolking *et. al.* 2010)

- Annual time step; 1000 – 10,000 year simulations
- Coupling of carbon and water balance
- 12 plant functional types: mosses, sedges, other vascular
- PFT litter input is a function of peat depth and water table depth
- Calculating total peat height and C content, bulk density, peat water content, and water table
- Evaluated in Canadian peatland



- Using modified Plant Functional Type (PFT), portioned into leaves, woods, and roots (NPP and decomposition rates from Chimner and Ewel 2005).
- Constructing scenarios based on probabilities of wet, moderate, and dry years. We divide the simulation time into three time periods, i.e. 0-3000, 3000-5000, 5000-8000 yrs. The scenario was based on the combination of wetness condition and simulation time zones.





Results

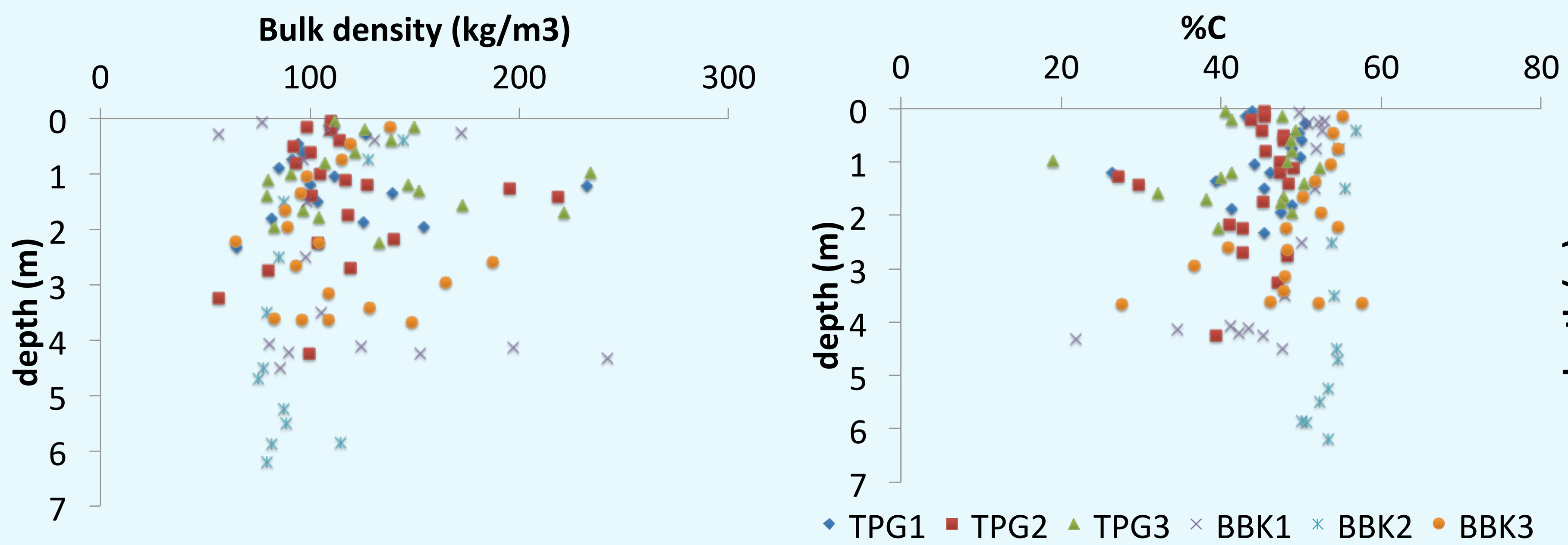


Figure 2. Peat properties on the six pristine forests sites in Tanjung Puting and Berbak NP. The bulk densities are **120+/-5.3** (mean+/-s.e.) and **109 +/- 7.7 kg/m³**; C-concentrations are **44.1+/-0.5 and 49.5+/-2.2%**; and C-densities are **50.3+/-1.4 and 52.1+/-0.8 kgC/m²**, for Tanjung Puting and Berbak NP, respectively.

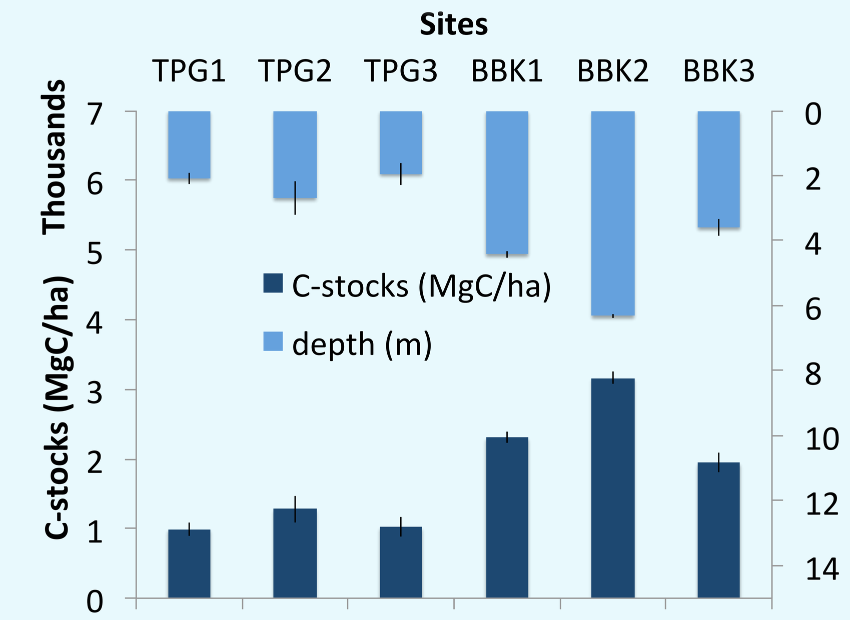


Figure 3. Peat depth and carbon stock in six sites.

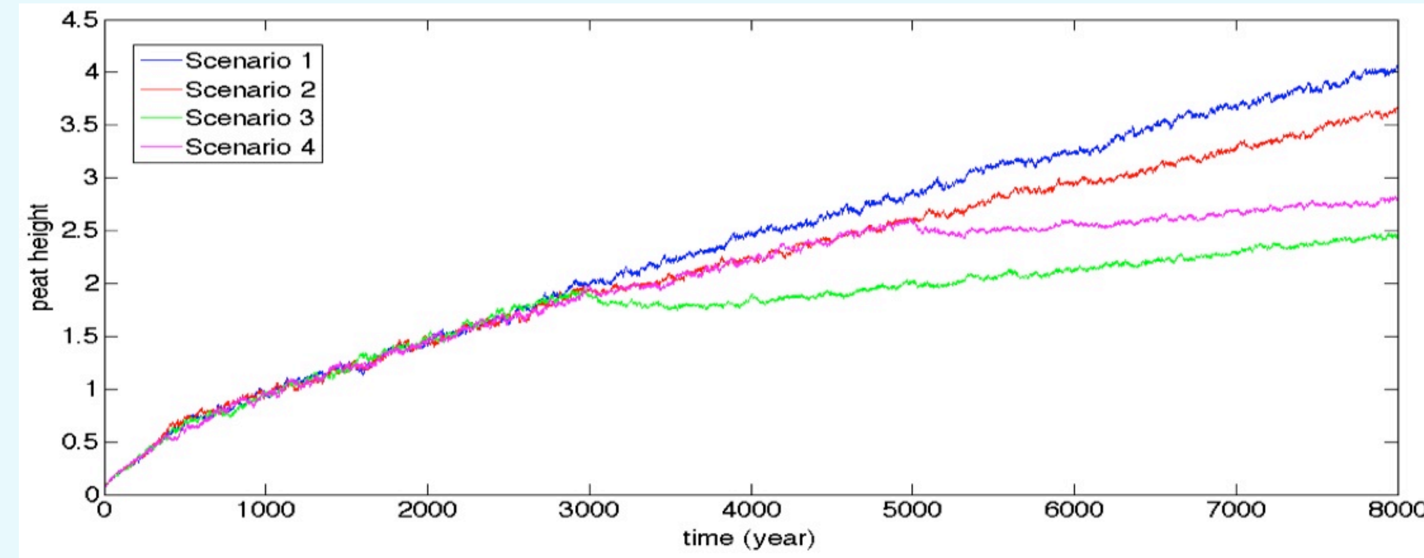


Figure 4. The simulated peat height along 8,000 yrs based on four scenarios.
Scenario 1: Wet-Wet-Wet; Scenario 2: Wet-Moderate-Moderate;
Scenario 3: Wet-Dry-Dry; and
Scenario 4: Wet-Moderate-Dry.

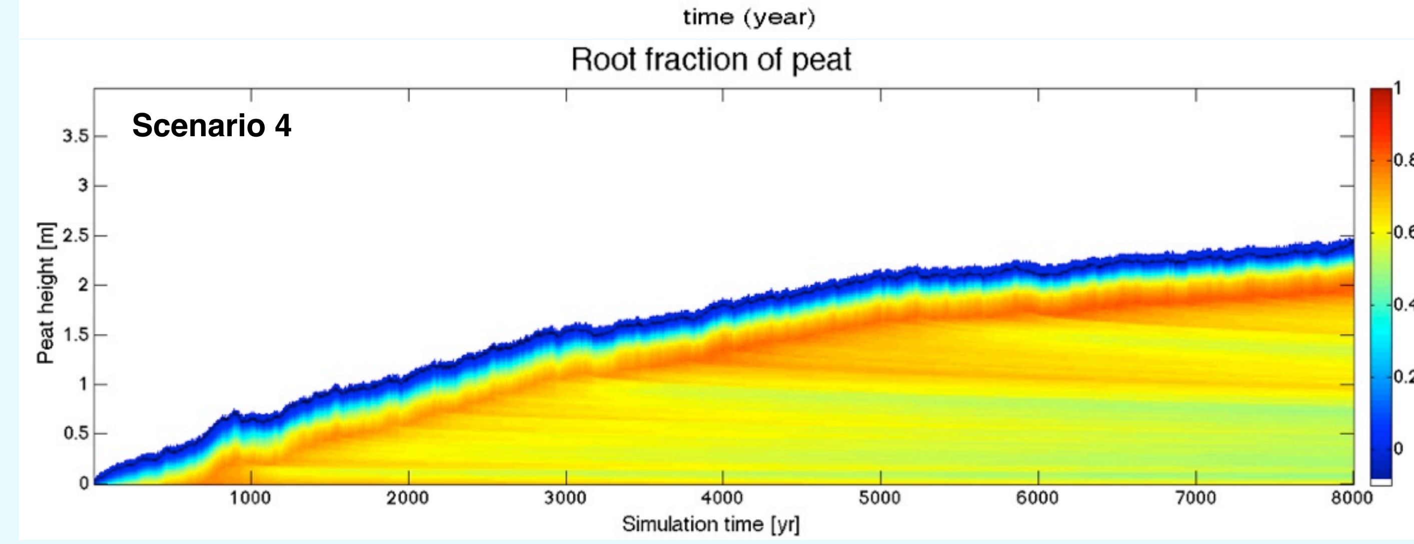


Figure 5. Profile of the root fraction of the remaining peat along simulation timeline of the Scenario 4. The black line shows the water table position on the peat profile. The year of 8,000 represents the root fraction in the peat core of the modern era. It shows that the surface was dominated by non-roots components while at the depth of 0.5-1 m mostly composed by roots with the age of about 2,000 yrs.

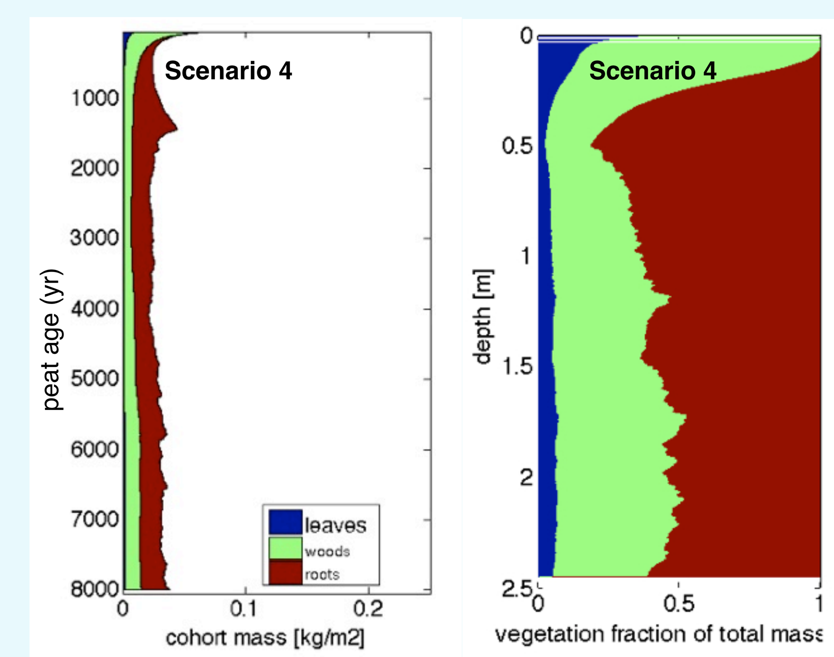


Figure 6. Final simulated peat profile after 8000 years, resulting peat carbon stocks in amount of **1,350 MgC/ha**. **Left**, Simulated peat profile mass by vegetation components as a function of the peat age. **Right**, Simulated peat profile presented as the fractional composition of the vegetation components by depth.

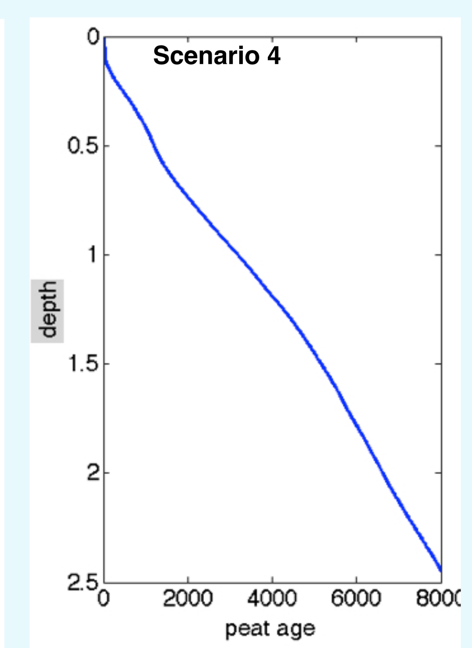


Figure 7. Simulated depth vs age of the final peat core.

Conclusion

The model results indicate that peat accumulation rates are sensitive to climate (moisture) condition. The dry condition, perhaps generated by higher frequencies and intensities of El-Nino conditions, lead to reduced rates of peat accumulation. Simulated peat profile (Figs. 5 and 6) show that the majority of the remaining peat mass is derived from roots, which accounted for **12% of total NPP** and had a decomposition rate intermediate to leaves and wood. The simulated peat mass and depth are within the range of the field measurements.

References

Chimner, R.A., Ewel, K.C., 2005. A Tropical Freshwater Wetland: II. Production, Decomposition, and Peat Formation. Wetlands Ecology and Management 13, 671-684.

Frolking, S., Roulet, N.T., Tuittila, E., Bubier, J.L., Quillet, A., Talbot, J., Richard, P.J.H., 2010. A new model of Holocene peatland net primary production, decomposition, water balance, and peat accumulation. Earth System Dynamics 1, 1-21

Page, S.E., Rieley, J.O., Banks, C.J., 2011. Global and regional importance of the tropical peatland carbon pool. Global Change Biology 17, 798-818.

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