Methods

Objectives

Methods

Field Study (Cores sampling):
- Sampling was conducted in Tanjung Puting National Park (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 using Eijkamp peat auger. Then, we took of about 12 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 were then ground, homogenized and analyzed for carbon and nitrogen concentration using a LECO TruSpec induction furnace C analyzer.

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.

Results

Figure 2. Peat properties on the six pristine forests sites in Tanjung Puting and Berbak NP. The bulk densities are 44±6.5 and 49±6.2 kg/m³, and C-densities are 59±1.4 and 52±0.8 kgC/m³, 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 peat surface was dominated by non-roots components while at the depth of 3-5 m mostly comprised by roots with the age of about 2,000 yrs.

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

- 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 depth
- Evaluated in Canadian peatland

- Using modified Plant Functional Type (PFT), portioned into leaves, woods, and roots (NPP and decomposition rates from Chinner 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.

Figure 6. Final simulated peat profile after 8000 yrs, 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. Final simulated depth vs age of the final peat core.

Abstract Reference Number: 1471840; Paper Number: PP11D-2042

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

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Peatland carbon has accumulated over millions of years in tropical peat swamp forests (PSF). Peatland carbon is considered the third largest terrestrial carbon pool. The peat has a high carbon content (50% of the total mass) and is an effective carbon sink, particularly during the wet phases or sub-optimal plant growth condition. Peatland carbon is sensitive to climate change and human activities, such as deforestation, wildfires, and peat mining. Since peat is a slow-turning substrate, peatland carbon is stored over thousands of years, leading to large CO₂ emissions. Tropical peatlands are 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 CO₂ emissions.

Introduction

Figure 1. The map of study area.