Land use change and forest degradation in Sumatran orangutan habitats and the opportunity cost of CO_2 emissions

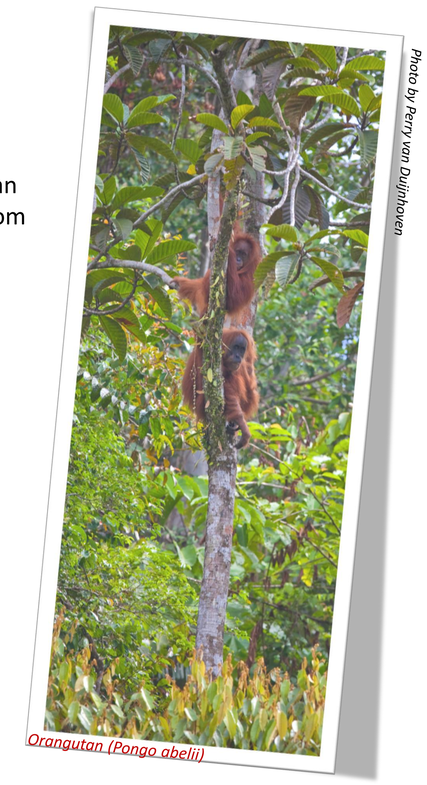
Atiek Widayati, Andree Ekadinata and Hesti Lestari Tata
With contributions from: Subekti Rahayu, Zuraidah Said, Feri Johana, Elok Mulyoutami and Yuliana Cahya Wulan

Background

Landscape arrangements for biodiversity preservation and human livelihood recognise "segregate" and "integrate" approaches. Segregation approach has issues of boundaries that in many cases are contested among stakeholders. The more integrated and gradual transition from natural forest to human habitat has survived through the maintenance of the ecosystem services, like regularity of water flow and other services that the forest provides. Such bundled services may strengthen the arguments to conserve forest flora and fauna habitats, but yet remain unassessed.

Problem statements and objective

- The habitats of red ape of Sumatran Orangutan (*Pongo abelii*) have long been at stake from human impacts through forest extraction and conversion. The population has decreased towards extinction and become one of IUCN Red List species.
- There is a need for analyses of the options for supporting human livelihoods and development agenda as well as for conserving the habitats.
- A study was conducted to observe forest and land use dynamics in the vicinity of Sumatran Orangutan habitats and the consequences on the opportunity costs for CO_2 emissions from the conversion / degradation.

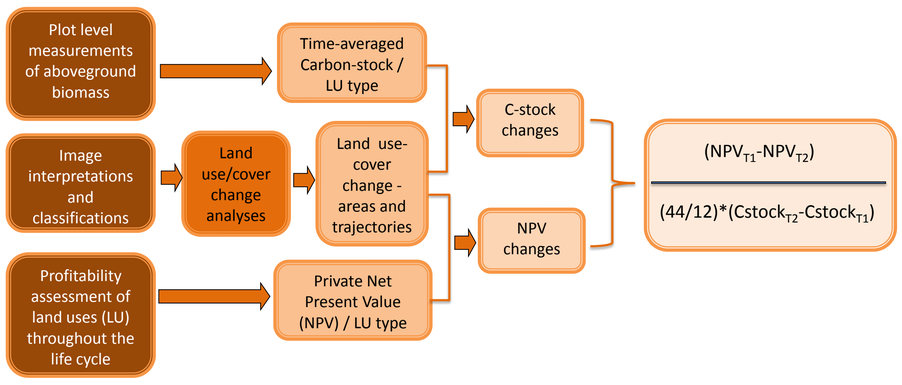

Photo by Perry van Duijnhoven
Orangutan (Pongo abelii)

Study area

Assessments were conducted in two Sumatran Orangutan (OU) habitats and the vicinity: (1) Tripa – peatswamp forest in Aceh coastal area (102,000 ha) and (2) Batang Toru – low montane forest in North Sumatera (247,000 ha)

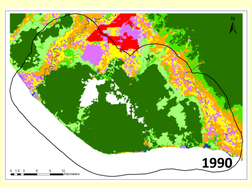


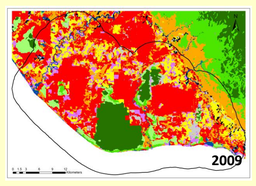
Methods and framework

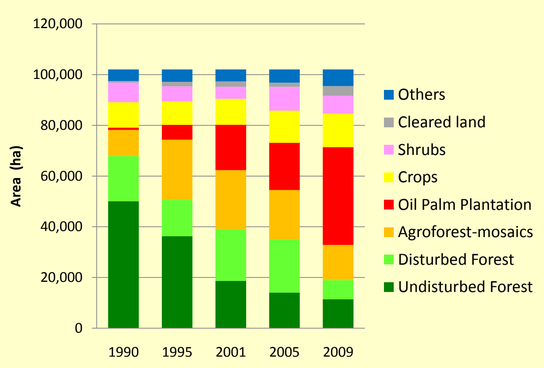


Tripa highlights

Land use and cover changes and carbon stock dynamics- 1990-2009



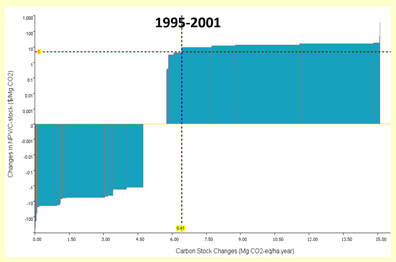


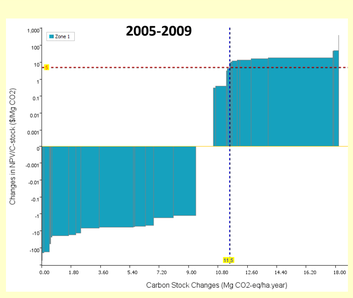


Peatswamp forest area decreased substantially, from 67,000 ha (65%) in 1990 to 19,000 ha (18%) in 2009, with annual rates of 5 -11 % yr^{-1}. Dominant land use conversion, esp. since 1995, has been towards oil palm plantation. Highest forest loss to oil palm plantation occured in 2005-2009, i.e. 1,770 $ha.yr^{-1}$ in average.

Average aboveground carbon stock (C-stock) density in the study area was 114 Mg ha^{-1} in 1990 and decreased into 48 Mg ha^{-1} in 2009 due to land use/cover changes.

CO_2 emissions and the abatement cost curve



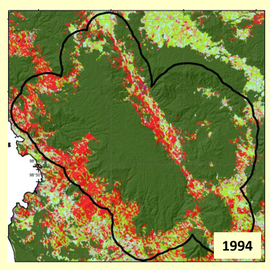


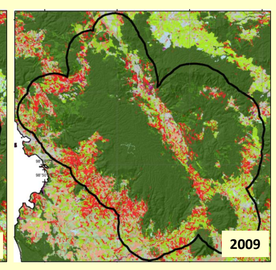
- Land-use based emissions throughout the observation periods ranged between 9 to 21 Mg CO_2 eq. $ha^{-1}yr^{-1}$, while the net emissions(*) were between 7 to 20 Mg CO_2 eq. $ha^{-1}yr^{-1}$
- Opportunity cost for the dominant forest-to-oil-palm conversions is one of the highest (US$ 10.5 per Mg CO_2).
- Between 1995 to 2001, percentage of CO_2 emission that could have been avoided was 40 % , i.e. up to 6.4 Mg CO_2 ha^{-1} yr^{-1} (**) (top picture).
- In the most recent observation (2005-2009), higher percentage could have been avoided (61 %), i.e. up to 11.5 Mg CO_2 ha^{-1} yr^{-1} (**) (below picture).
- Based on 19 years of observation period, 36 % of land- use based emission could have been avoided with the assumed market price of US$ 5 per $MgCO_2$.

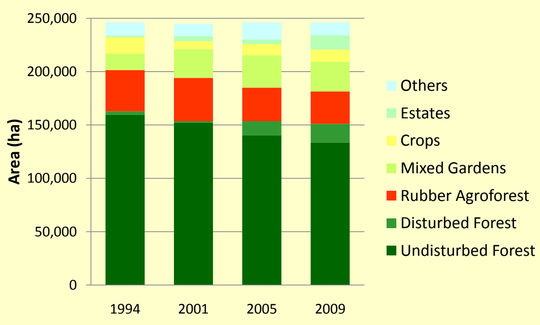
(*) taking into account carbon sequestration
(**) assumed market price is US$5 per Mg CO_2

Batang Toru highlights

Land use and cover changes and carbon stock dynamics- 1994 -2009

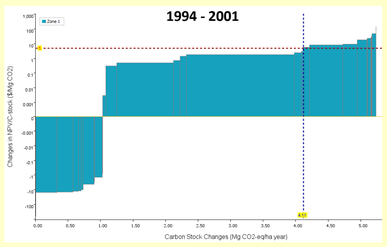


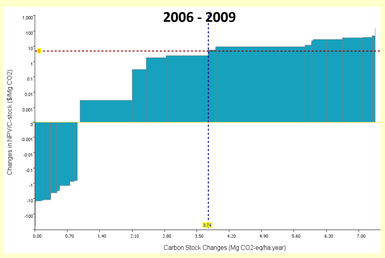




Forest cover was 162,000 ha in 1994 and 151,000 in 2009, located in the core of the study area. In 15 years (1994-2009) , 11,000 ha forest were converted (7 % of forest area), while degradation reached 14,000 ha (9 % of forest area). Anthropogenic land uses have been stable since 1994, dominated by rubber agroforest and mixed gardens, covering areas of 12-16 % and 6 - 12 % of the study area respectively. Mixed gardens are dominated by *kemenyan* (*Styrax benzoin*) and fruit trees . The average density of aboveground carbon stock (C-stock) was 185 Mg ha^{-1} in 1994 and decreased into 174 Mg ha^{-1} in 2009.

CO_2 emissions and the abatement cost curve





- CO_2 emissions triggered by land use changes ranged between 5.4 to 7.4 Mg CO_2 eq. $ha^{-1}yr^{-1}$ throughout the observation periods, and the net emissions(*) ranged between 0.9 to 4.8 Mg CO_2 eq. $ha^{-1}yr^{-1}$
- The highest emission source is forest degradation, which has been due to timber extraction and small scale encroachments. The opportunity cost of timber extraction is US$ 8.3 per Mg CO_2, which is the highest compared to other forest-based activities or conversions taking place in the study area.
- Between 1994 to 2001, percentage of CO_2 emissions that could have been avoided was highest (73 %), i.e. up to 4.1 Mg CO_2 $ha^{-1}yr^{-1}$. The most recent observation (2006-2009) shows that approximately 50 % of emissions could have been avoided, i.e. up to 3.7 Mg CO_2 ha^{-1} yr^{-1} (*).
- Based on 14 years of observation period, approximately 50 % of the emissions could have been avoided with the assumed market price of US$ 5 per $MgCO_2$.

Summary and conclusion


Photo by Feri Johana
Swamp forest in Tripa

For Sumatran orangutan habitats and the vicinity, threats from forest conversion and degradation show different magnitudes and patterns. In Tripa, the threat is more alarming and comes primarily from oil palm plantation expansion. In Batang Toru, pressures of timber extraction and encroachments mostly occur around the edges, while the core areas are relatively intact. Land-use-change based emission is much higher in Tripa, which has been attributed to the types and magnitudes of land use changes and the trajectories. The consequence on the opportunity cost is highest for the conversion of forest to oil palm, which occurs in Tripa; while the cost is much lower for the forest extraction dominant in Batang Toru. Percentage of emission that could have been avoided through the potential carbon market was much lower in Tripa than in Batang Toru.

Conserving the habitat where forest has been converted into profitable land use system like oil palm plantation entails very high opportunity cost. With the observed NPV (US$ 10.5 per Mg CO_2) and under the assumed market price of US$ 5 per Mg-CO_2 it is a non-feasible pathway. For cases with 'unaffordable opportunity cost', more tangible and direct conservation efforts are needed by targeting preservation of the leftover forest and in combination with forest restoration. Such efforts might include 'land swap' which requires 'conservation goodwill' from the pertinent stakeholders.

For habitat vicinity with lower opportunity cost, carbon market mechanism is more potential. In addition, locally managed tree-based land use systems , like in Batang Toru, function as buffer zones which can help maintain the bundled ecosystem services that forest provides.

More info: **Atiek Widayati** (a.widayati@cgiar.org)
World Agroforestry Centre
Southeast Asia Regional Office