Vegetation Restoration on Degraded Tropical Peatlands: Opportunities and Barriers

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Tropical peatlands: From degradation …

- Indonesia: largest area of tropical peatlands
- Last 15 years, Indonesia has lost 30MHa, or 25%, of its forest
- Annual rates of loss: 1.9%
- A quarter of this land is tropical peatlands, degraded through fires, drainage, logging and conversion
- Degradation leads to peat oxidation, risk of fires and flooding, and loss of forest resources

Tropical peatlands:
… to restoration

Attitudes are changing:

Governor of Central Kalimantan made a public pledge in 2005 to sustainably manage the tropical peat swamp forests (TPSF) of his province

At Bali COP 2007 parties agreed positive incentives to reduce emissions from degradation of forests in developing countries

The ecology of peatland restoration

DEGRADATION

Changes to environmental conditions

Alterations to environmental conditions after degradation lead to REGENERATION BARRIERS that must be overcome

Human-assistance in creating RESTORATION METHODS can remove or find ways round these barriers.

NATURAL REGENERATION

e.g. seed death in harsh conditions
e.g. seedling transplants

e.g. repeat fires
e.g. fire prevention

Implementing restoration

Need to know:

- Thorough understanding of conditions for natural regeneration
- Which environmental conditions have altered
- Which have become active regeneration barriers
- How they can be alleviated

Knowledge is very limited

Few published SE Asian restoration projects, even fewer on TPSF

Successful, transferable restoration methods yet to be developed

Work to be presented:

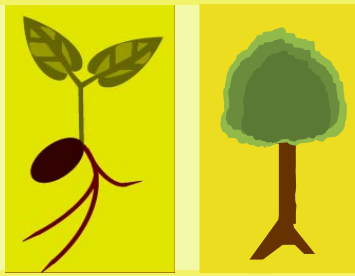
Review of:

- the main **drivers of degradation** in tropical peatlands
- how these **affect the environmental conditions**
- how they develop into **regeneration barriers**

Discussion of new **ecological and social TPSF restoration** research:

- determine and alleviate the regeneration barriers
- develop an achievable restoration action plan
- determine in what way these results are transferable

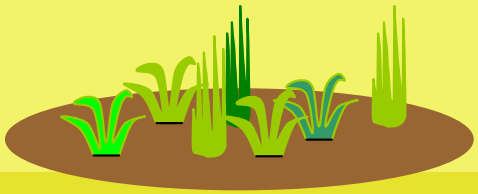
Drivers of degradation: fire



Primary forest

Secondary forest can return

No. of trees, seedlings, saplings and species reduced



Shrubs, fern and sedge. No woody vegetation

Fire leaves forest in a more susceptible state to repeat fire, creating positive feedback

Drivers of degradation: floods

Primary forest

Shallow flooding, short duration

Secondary forest can return

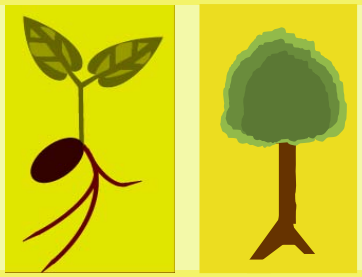
Deeper flooding, medium duration

No. of trees, seedlings, saplings and species reduced

Deep flooding, long duration

Shrubs, fern and sedge. No woody vegetation

Regeneration barriers



Fire and flooding: most important ecological barriers

Ameliorated through fire-prevention and blocking canals with dams

After fire and flooding reduced, many secondary barriers to be dealt with:

- lack of seed sources and dispersers
- competition with non-woody vegetation
- harsh germination and growth environment for seedlings
- social, political and economic barriers…

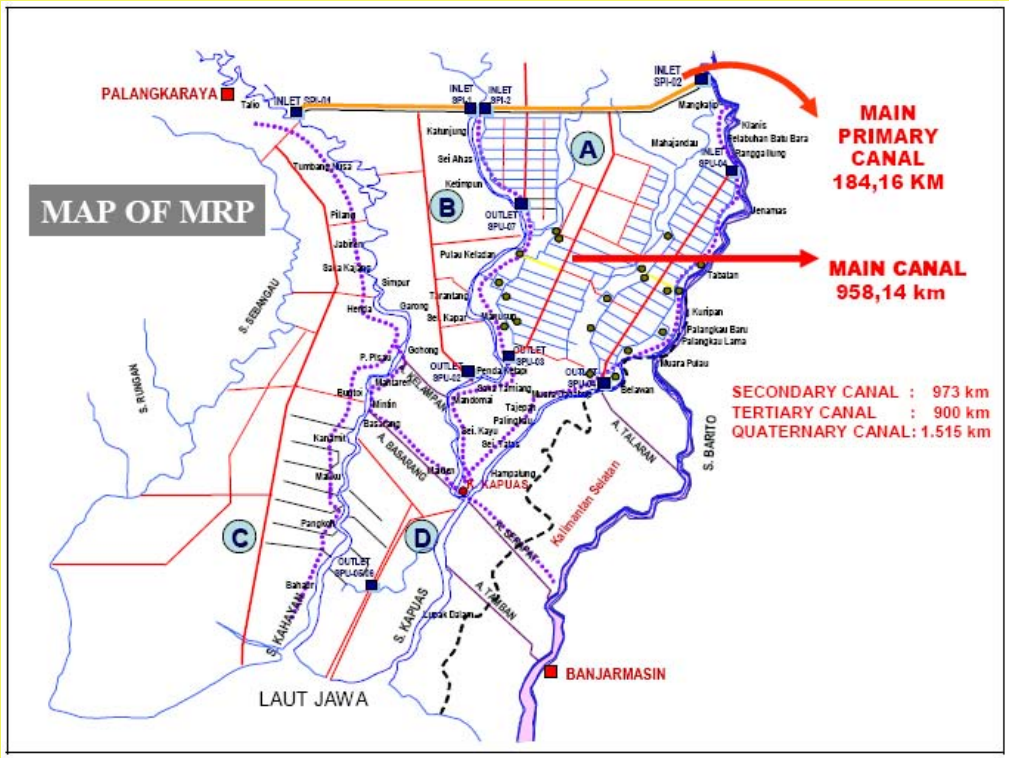
Work to understand and alleviate these barriers is in the early stages, and is the primary focus of this research

The study site

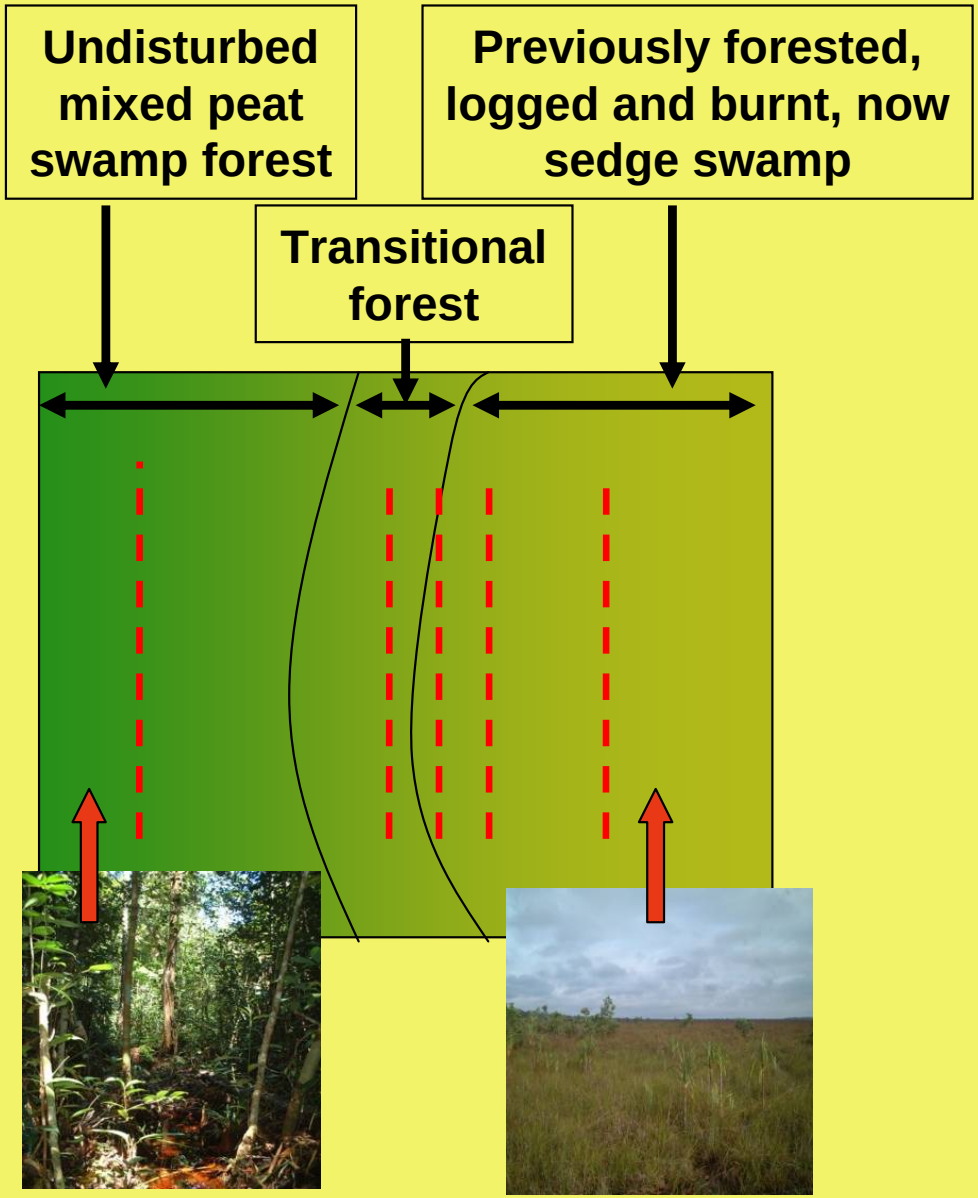
Peat-covered catchment of the river Sabangau, close to Palangka Raya, Central Kalimantan, Indonesia

~60,000km^2 of peatland, but land cover has altered dramatically since early 1970s

Large reduction in primary TPSF cover, particularly 1997 onwards; mainly due to repeat fires



Determining the regeneration barriers



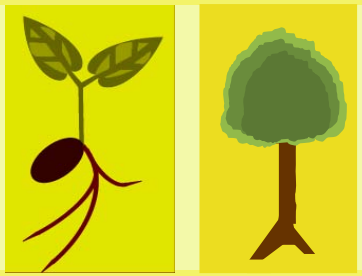
Research set-up:
Transects (dashed red lines) established in forested, transitional and degraded locations.

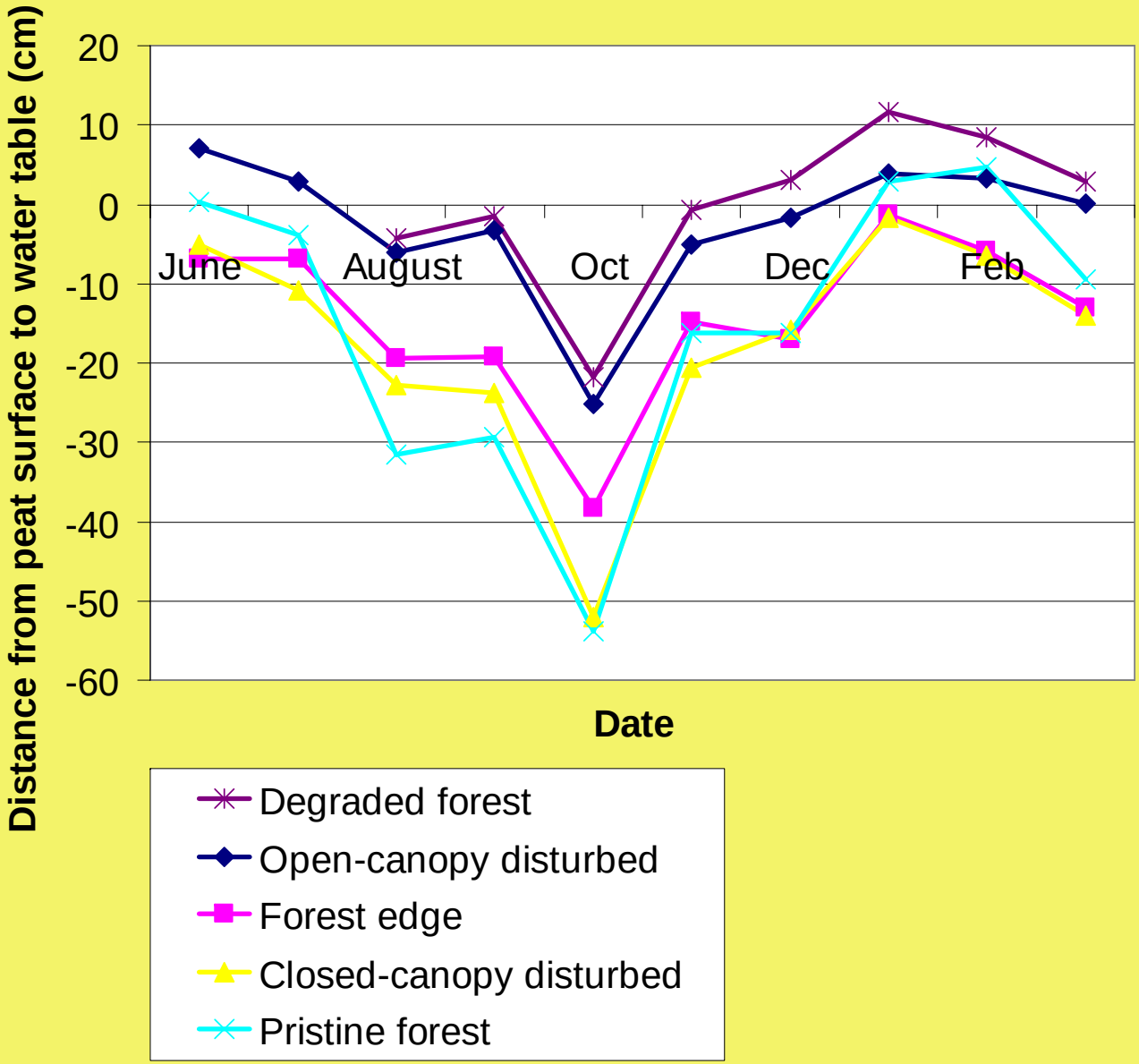
Ecological conditions being assessed, necessary for successful regeneration:

- level of competition
- peat composition
- availability of nutrients
- light intensity
- water level
- mycorrhizae availability
- seed abundance and dispersal

Determine degree of alteration in each zone, and impact on seedling recruitment, abundance, survival and growth

Water level:
a regeneration barrier? Example



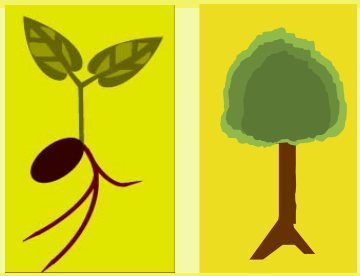


Degraded area wettest through the year

Reduced transpiration rates due to less vegetation?

Flooding may be a barrier for this site, but lack of water through dry season is not

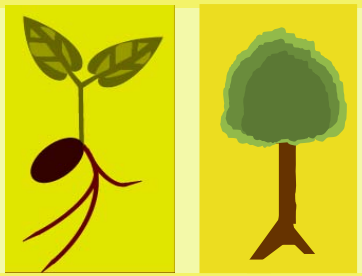
Peat composition: a regeneration barrier? Example

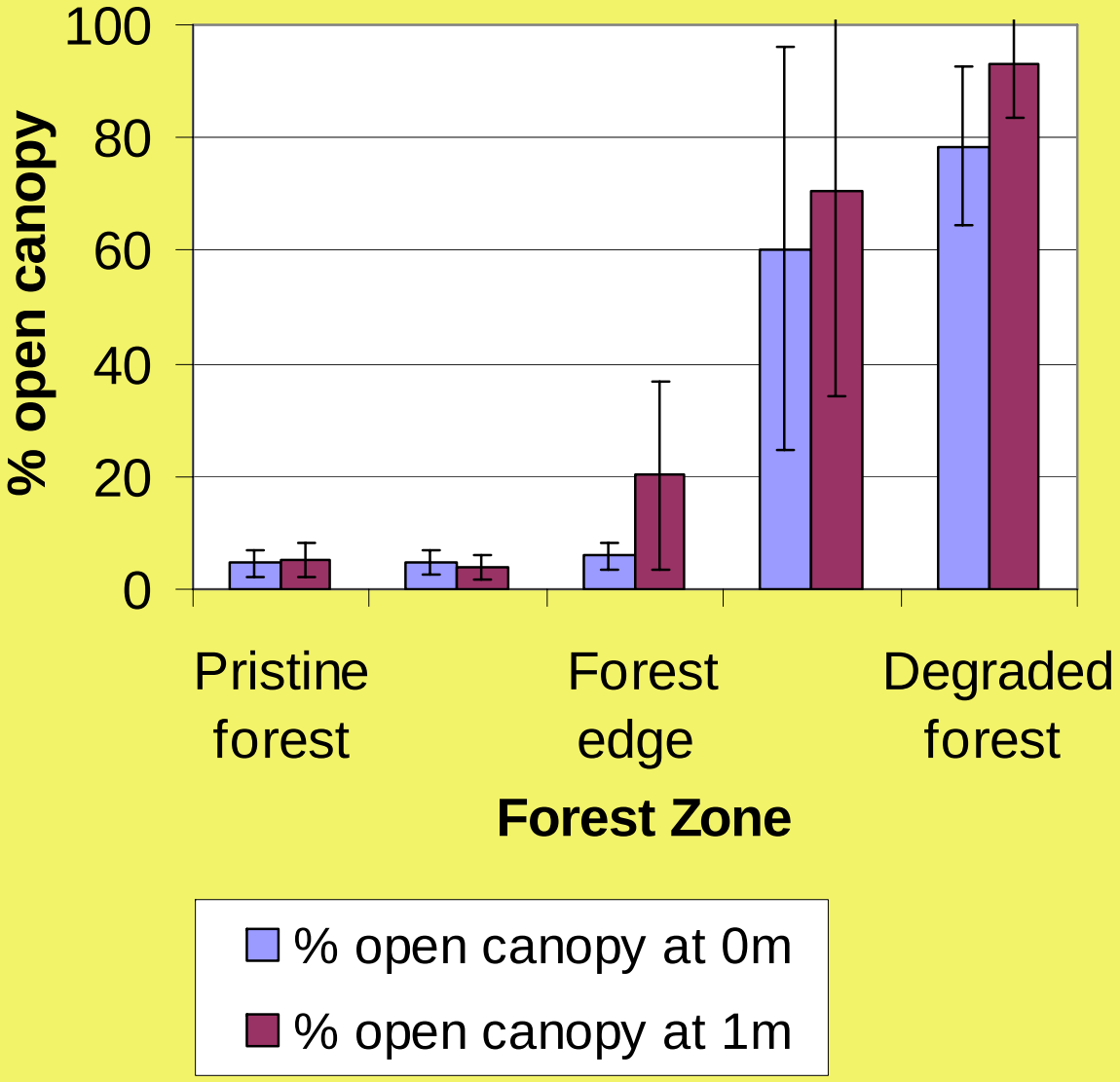


Peat samples were collected from each transect and analyzed:

Analyzed	Result	Potential regeneration barrier?
pH	No sig. diff.	No
% N	Some sig. diff.	Possibly
% org.C	Sig. diff. as move to more degraded zones	Yes
Total-P	Sig. diff. as move to more degraded zones	Yes

Light intensity: a regeneration barrier? Example



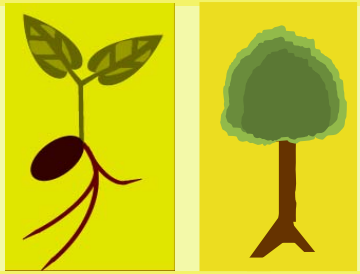


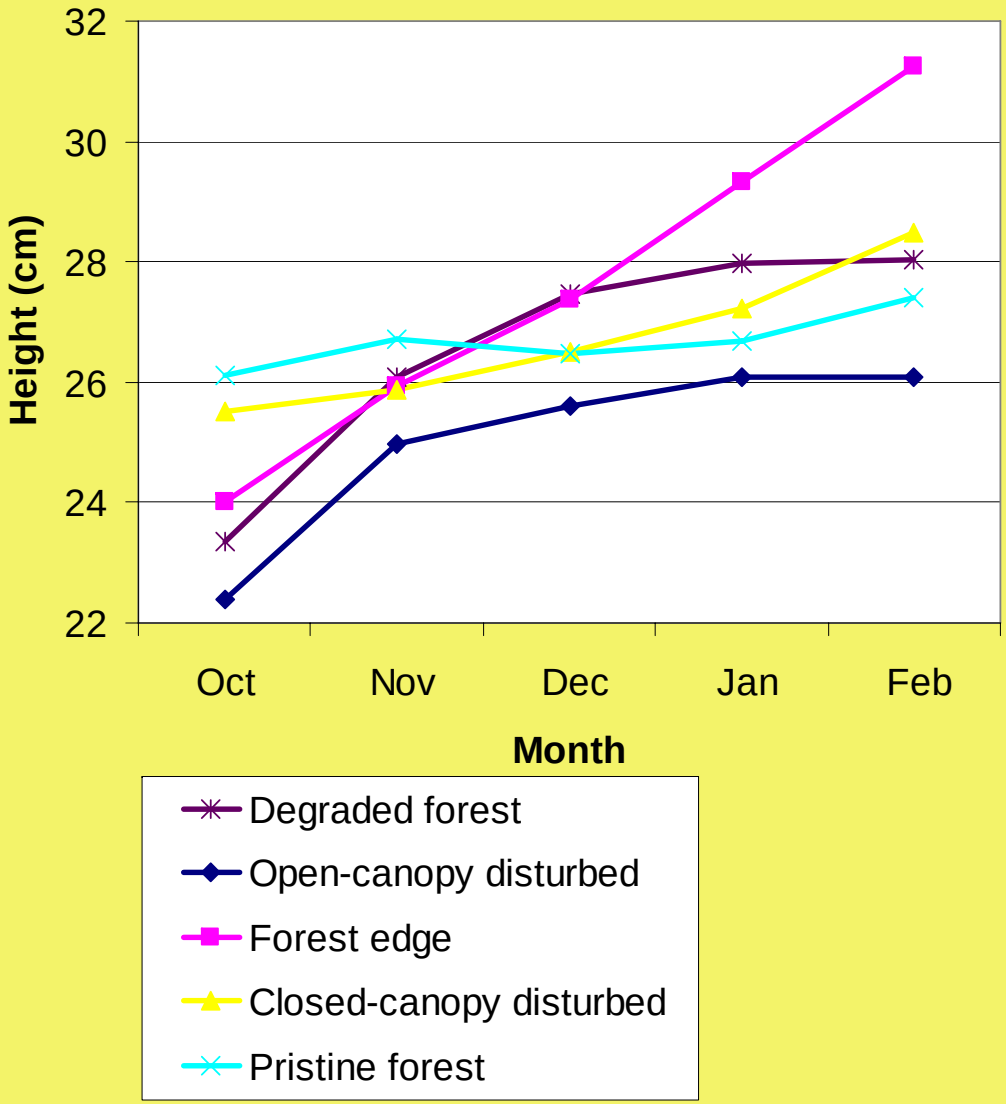
Light intensity significantly increases at ground level as one moves into degraded zones

Ground vegetation (grasses and ferns, 1m height) do not ameliorate this effect

Increased light intensity may have negative impacts on regenerating seedlings (photoinhibition, wilting, drying)

Trial seedling transplants: Example





400 *Shorea balangeran* seedlings (Dipterocarpaceae) planted in 2007, 80 seedlings per forest zone

Height, basal diameter and leaf number recorded monthly

Seedling survival is high, with fatality lower than 2%

Seedling growth and survival not highest in the pristine forest, but in some of the degraded zones

This tree species was selected based on its known tolerance of disturbance and flooding, not a natural pioneer

Mycorrhizae – initial results

Non-transferability of *data*

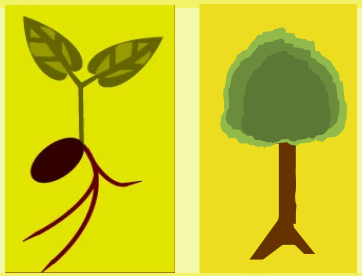
Secondary barriers are **site-specific**:

C**annot** be assumed based on transferred data or ecological principles

Each unique history of disturbance leads to unique barriers for each site: From fire history to political tensions

As move to more degraded zones:	
As expected:	**Unexpected:**
Light intensity ↑	pH, no sig. diff.
Nitrates ↓	Phosphorus, no sig. diff.
Flooding in wet season ↑	Drying in dry season ↑
Potential regen. barrier	**Not a regen. barrier**
Requires human-assistance	**No assistance required**

Transferability of *methods*

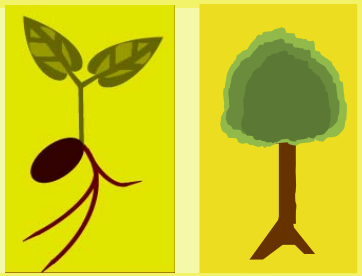


How can we transfer knowledge from one site to another? How can we expand to the landscape scale?

Create transferable methods; site-specific restoration can be streamlined, with appropriate restoration methods being quickly targeted:

Guideline:	**Method:**
Develop list of potentially-altered environmental conditions	Based on natural history of ecosystem and social history of the area
Investigate which have significantly altered	Compare environmental conditions in degraded zone and adjacent forest
Investigate which have become active regeneration barriers	Investigate impact altered conditions have on seedling recruitment, survival and growth
Restoration action planning	Ameliorate barriers with targeted, trialled restoration methods

Traditional Ecological Knowledge

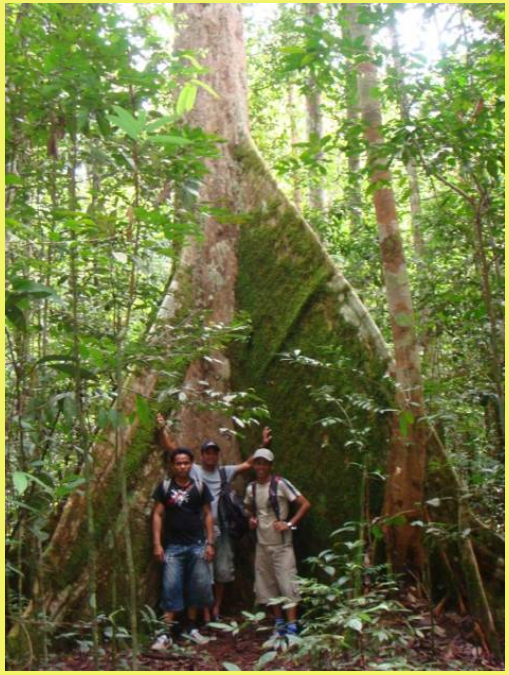


- In addition to investigating ecological barriers to forest restoration
- we also investigate social aspects of restoration ecology
- Restoration action planning will incorporate local TEK as well as data derived from ecological studies
- Two-way process

Summary

- Indonesia’s tropical peatlands, in the last 15 years, have suffered wide-spread levels of degradation. However, political attitude is changing
- Peatland restoration is a complex process; after degradation the altered environmental conditions must be established and over-come
- The natural processes of regeneration, how these have altered and how we can alleviate them must be determined. At present, knowledge is very limited
- The two main regeneration barriers facing tropical peatland restoration are fire and flooding, and work is presently underway to alleviate them
- There are many secondary barriers that must also be alleviated; research is underway to establish what these are
- The most appropriate methods of restoration for a given site are unique to that site; based on its history of disturbance and degradation
- In light of this, data from any given site is non-transferable, however, methods by which we establish these barriers are transferable, and should be streamlined and put into practice

Thank you…



All the field assistants that helped hugely in data collection, particularly Eben Eser and Salahuddin, who continue to plough through the degraded zone even when flood levels reach their waist

Dr. Jenny Pickerill for her advice and supervision on the social aspects of the research

All the staff at CIMTROP for their continued help with our administration