



Defaunation and forest degradation: how to measure the impacts of hunting?

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THINKING beyond the canopy

Selective logging in Congo Basin





- Major land use in humid forests
 - Logging concessions: 51M ha
 - Protected areas: 23M ha
- Major economic activity
 - Major income earner for countries
 - Main rural employer
- As all other extractive activities, induces damage to the ecosystem



THINKING beyond the canopy



Typology of logging impacts

Impacts	Directs	Derived
Unavoidable	<ul style="list-style-type: none"> Damage to residual stand Disturbances (noise, light) Fragmentation Changes in C stocks 	<ul style="list-style-type: none"> Increased human presence (both temporary and permanent) Increased access to remote forests
Avoidable	<ul style="list-style-type: none"> Soil erosion Water course pollution Reduced regeneration ... 	<ul style="list-style-type: none"> Increased deforestation Increased fire risks Favor invasive species Increased hunting




THINKING beyond the canopy

Bushmeat hunting in Congo Basin





- Estimates of the value of the bushmeat trade range from US\$42 to US\$205 million per year in West-Central Africa.
- Current harvest in Central Africa alone may well be in excess of 2 million tons annually, equivalent of over 1.3 billion chickens or 2.5 million cows!
- 30 to 80% of the protein intake of many rural populations



THINKING beyond the canopy

Consequences of hunting




- Direct**
 - Depletion of hunted populations
 - Animal-man transmissions
 - ...
- Indirect**
 - Changes in vegetation structure and regeneration patterns
 - Increase in un hunted species
 - Change in predation and herbivory patterns
 - Food crisis
 - ...



THINKING beyond the canopy

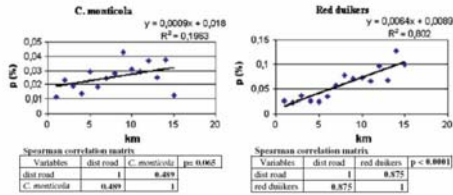
Indicators of defaunation

- Direct:**
 - Hunted populations
 - Large mammals (e.g. duikers)
 - Blue duiker
 - Red duiker
 - Yellow back duiker
- Indirect:**
 - Road network
 - Hunter surveys
 - Hunting profiles
 - Hunting effort
 - Household surveys
 - Meals with meat
 - Sales/consumption
 - Market surveys
 - Fresh/smoked
 - Quantities



THINKING beyond the canopy

Effect of roads...



Surveys of mammal populations



- Direct observations
 - Line transects, RECCE
 - Direct sightings (day/night)
 - Dung counts or trails
 - Capture/recapture
 - Net hunts
- Indirect observations
 - Line transects
 - Hunting signs
 - Market, household, hunter surveys

Classic methods

Line transect with measure of perpendicular distances

- Direct observations during the day or night



Recent innovations

- Call method (van Vliet et al., in press)

Classic methods

Line transect with the measure of perpendicular distance

- Direct observations during the day or night

- Dung counts



Recent innovations

- Call method (van Vliet et al., in press)

- Capture recapture methods with non invasive genetic methods
- Capture recapture using camera traps

Surveys of indirect indicators

- Resource mapping
- Sharing hunters' life
- Understanding household economies
-

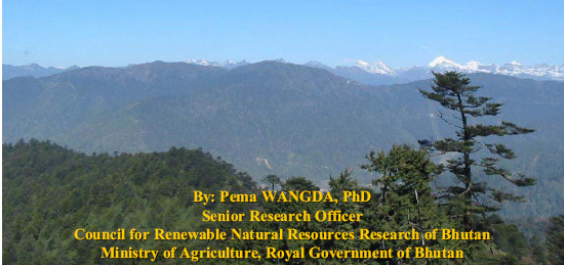


In guise of conclusion

- Lack of basic knowledge of natural ecosystem processes
- No ideal method is available
- Trends matter!
- Comparability matters too! (almost impossible to compare between studies)
- Basic research is still needed
- A good survey must combine several methods (direct, indirect) and approaches (synchronic, diachronic)
- Intelligent use of modelling
- Design and use survey comparable across sites

Forest Degradation in Bhutan: A case of Wasabi Pilot Project

(Methods to Assess Forest Degradation)

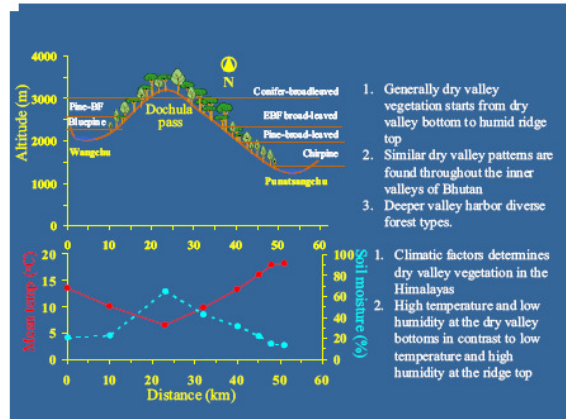
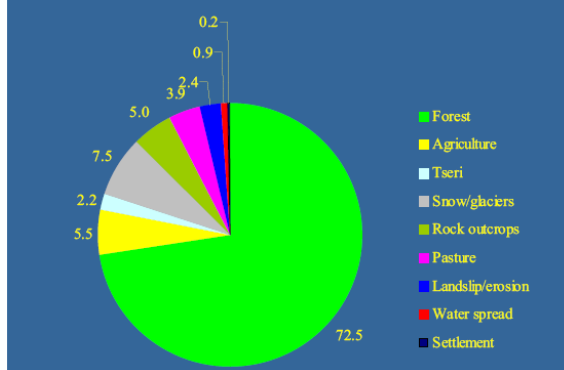


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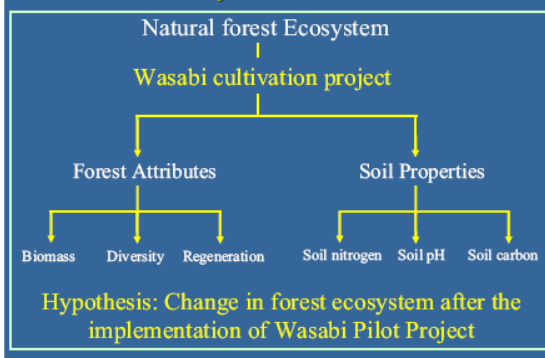
Chronology of Forest Degradation

Period (Year)	Forest for what (concept)	Forest institutions/ infrastructure	Forest degradation process
Before 1950	Forest for basic needs of people.	Forest uses administered by the community (<i>maang, reccups, meccups</i>)	Extensive forest fire damage (shifting cultivation)
1950-1960	Forest as potential resource for revenue generation	Civil Administration and Forest Department established (1952).	Accessible forests at the foothills degraded.
1960-1970	Forest for sustainable production	Nationalization of Forest through Bhutan Forest Act 1969.	Forests near roads degraded.
1970-1980	Forest for timber. Scientific management plan (silviculture).	Preparation of scientific management plan bringing experiences of American, European and Indian foresters.	Forest Management Units (FMU) established.
1980-1990	Forest for wood (wood based industry development)	Wood based industries (Firmwood, particle board) established. Forest Research Division established (1988)	Fast growing tree species for industrial purposes introduced.
1990-2000	Forest for nature conservation and people	A network of Protected Areas established. Forest and Nature Conservation Act 1995.	Forests near settlements and critical watersheds degraded.
2000-to date	Forest for integrated natural resources and environment services	Social Forestry Division in DoF and participatory forestry field programs implemented.	Quality of forest in FMU, plantations and community forests decreasing.

Major land use types of Bhutan



Study Framework



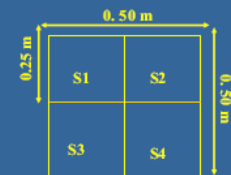
Method I: Soil and Climate measurement

A. Litter and soil

1. L layer (4 replicates)
2. F-H layer (4 replicates)
3. Surface soil (4 replicates)

Nutrients analysis

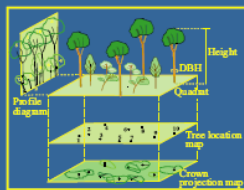
pH, C, N, Ca, Mg, P



B: Meteorological data measurement

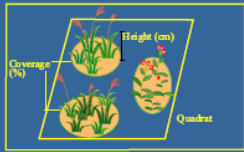
1. Temperature & relative humidity (HOBO Onset data logger)
2. Soil moisture content measured by Hydro-sense

Method II: Vegetation survey



TREE LAYER

Height → Height class distribution
 DBH → DBH class distribution
 Basal area (BA)
 ↓
 = Dominance analysis
 = Dominant species



HERB LAYER

H → Maximum height (cm)
 C → Coverage (%)
 Volume (H*C)
 ↓
 = Dominance analysis
 = Dominant species

Data analysis

$$\text{Diversity } (H') = -\sum_{i=1}^N p_i \log p_i$$

Where N = number of species in a plot, p_i = decimal fraction of a relative basal area

$$\text{Basal area (BA)} = \{(\text{DBH})^2 * \pi\} / 4$$

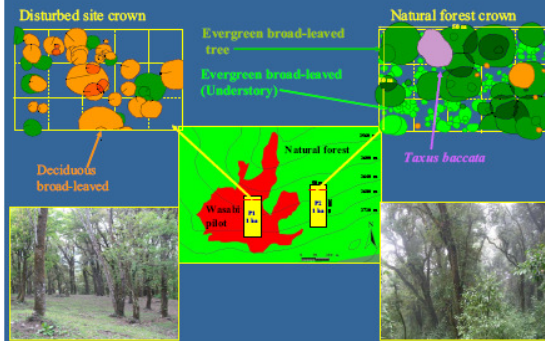
DBH = diameter at basal area

Dominance

$$d = 1/N \{ \sum (x_i - x')^2 + \sum x_j^2 \}$$

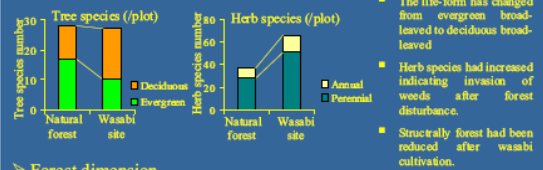
Where, x_i is the actual percent share (RBA%) of the top species (T), i.e., in the top dominant in the one-dominant model, or the two top dominants in the two-dominant model and so on; x' is the ideal percent share based on the model as mentioned above and x_j is the percent share of the remaining species (U). N is total number of species.

Results: 1. Vegetation

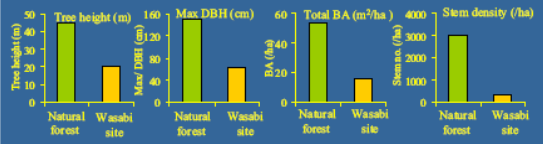


Results: 1. Diversity and forest structures

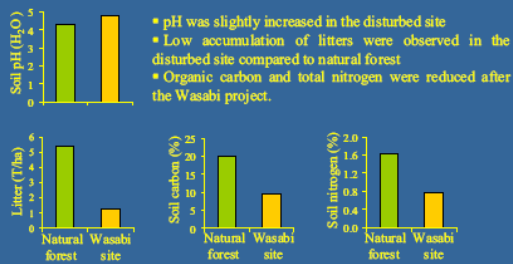
> Species richness



> Forest dimension

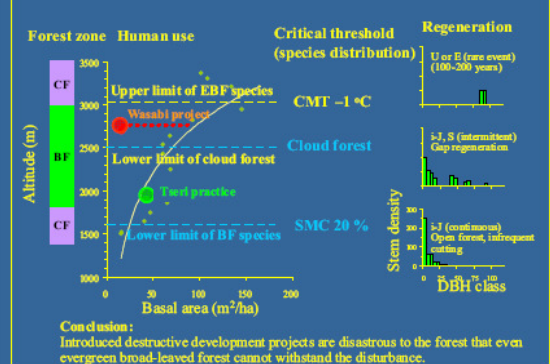


Results: 2. Litter accumulation and soil properties



Based on the quantitative data analysis, the impact of Wasabi project on the evergreen broad-leaved forest was disastrous both floristically and geologically resulting in disturbance to the forest ecosystem.

Conclusion: Evaluation of human impacts on the forest



Conclusion: Introduced destructive development projects are disastrous to the forest that even evergreen broad-leaved forest cannot withstand the disturbance.