Forest degradation and the role of the state: the case of Himalayan forests in Nepal and India

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Forest degradation is a major issue in the Himalayas

- Most unstable and fragile mountain region in the world, where forests in the middle and low altitude areas are degrading rapidly
- Non-local externalities: erosion, landslides, siltation of Ganges and Brahmaputra river basins, water salination, flooding in Bangladesh
- Local externalities: local populations collect firewood, fodder, leaf-litter, timber

Project Objectives

1. Measure and characterize nature of deforestation and degradation using ground-level forest ecology studies

2. Investigate relative importance of commonly alleged causes:
    a)Poverty, inequality
    b)Growth and commercialization
    c)Demographic changes
    d)Property Rights and Local Collective Action

Project Objectives

3. Assess impact of declining forests on living standards of neighboring populations

4. Assess need for external policy interventions and effectiveness of alternative policy options

Plan of the presentation

1. Characterize the extent of forest degradation and deforestation

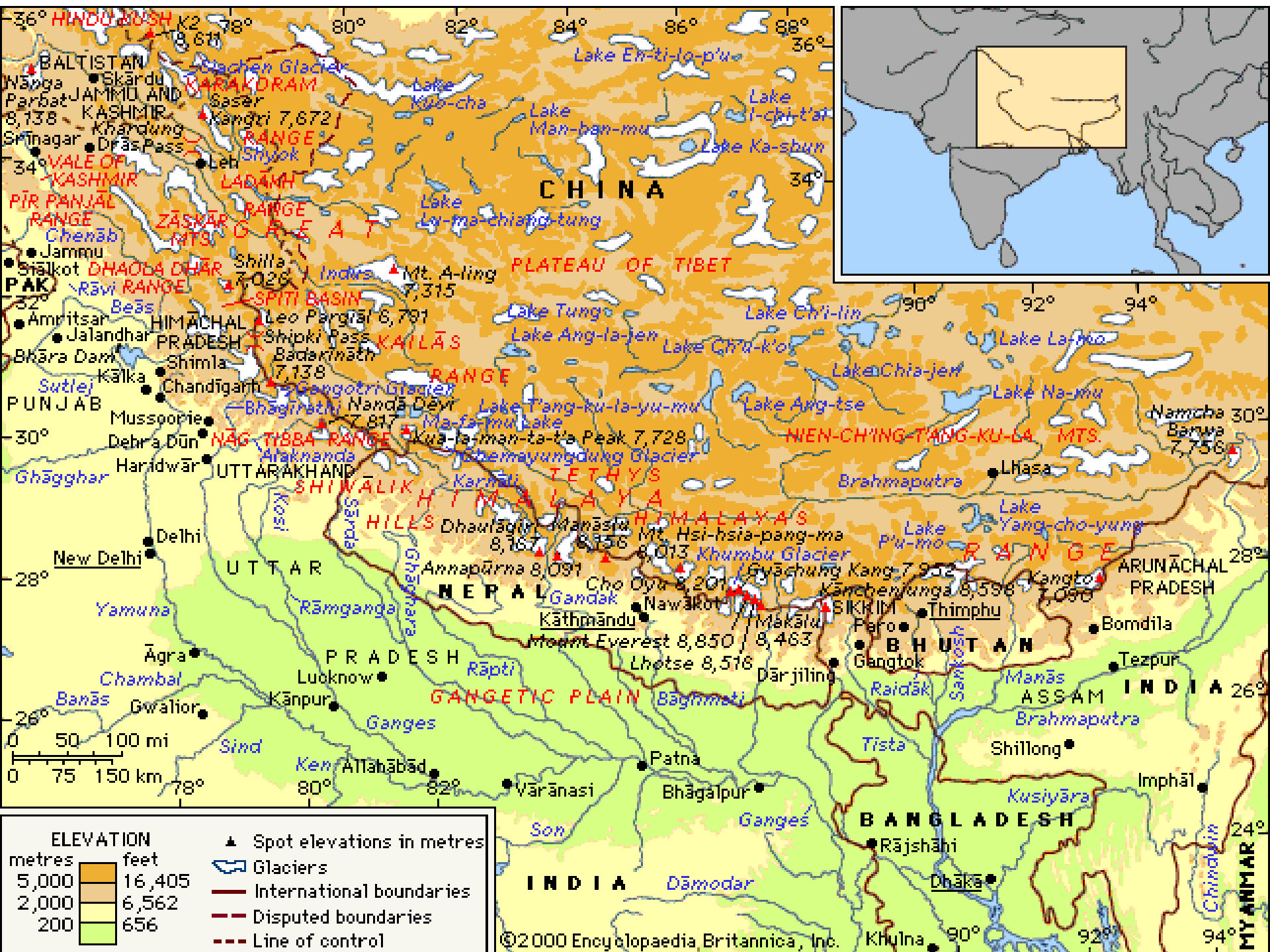
2. Develop an empirical approach to measure human impact

3. Evaluate the effects of alternative policies

The extent of forest degradation

Three major data sources:

- The Nepal LSMS (World Bank) in 1995-6 and in 2002-3, in 275 villages, with no information on forest conditions, and more recently the 2010-11 LSMS.
- A moving panel on about 650 households in the hills and mountains of the Nepal LSMS
- Our own survey (2002-3) in two Northern Indian states (Himachal Pradesh and Uttaranchal) covering 185 villages and their 619 forests in the alpine zone (about 2000 sample units).


HINDU KUSH
K2 28,611
BALTISTAN
Nānga Parbat 8,138
Skārdu
JAMMU AND KASHMIR
Srīnagar
Khardung
Drās Pass
Leh
Siachen Glacier
KARAKORAM RANGE
Saser Kangri 7,672
Shyok
VALE OF KASHMIR
LADĀKH RANGE
PĪR PANJĀL RANGE
ZĀSKAR MTS.
GREAT
Chenāb
Jammu
Siālkot
DHAOLA DHĀR RANGE
Rāvi
Beās
Amritsar
Jalandhar
Bhākra Dam
Kālka
Chandīgarh
Sutlej
PUNJAB
Mussoorie
Dehra Dūn
Haridwār
Ghāgghar
Delhi
New Delhi
UTTAR PRADESH
Yamuna
Rāmganga
Ganges
Chambal
Banās
Gwalior
Ken
Sind
Āgra
Kānpur
Lucknow
Allahābād
Vārānasi
Patna
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Son
Rāpti
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Sarda
Kosi
Shilla 7,026
Indus
Mt. A-ling 7,315
SPITI BASIN
Leo Pargīāl 6,791
Shipki Pass
Badarīnāth 7,138
HIMACHAL PRADESH
KAILĀS RANGE
Gangotri Glacier
Bhāgirathi
Nandā Dēvī 7,817
NĀG TIBBA RANGE
Alaknanda
UTTARAKHAND
SHIWALIK HILLS
Karnali
HIMALAYA
Dhaulāgiri 8,167
Manāslu 8,156
Annapūrna 8,091
NEPAL
Gandak
Nawākot
Kāthmāndu
Mount Everest 8,850 / 8,463
Lhotse 8,516
Cho Oyu 8,201
Mt. Hsi-hsia-pang-ma 8,013
Khumbu Glacier
Gyāchung Kang 7,952
Kangto 7,090
Kanchenjunga 8,598
SIKKIM
Thimphu
Paro
Gangtok
Dārjiling
Makālu
BHUTAN
Bomdila
ARUNĀCHAL PRADESH
Tezpur
Manās
ASSAM
INDIA
Raidāk
Sankosh
Brahmaputra
Tista
Shillong
Imphāl
Kusiyāra
BANGLADESH
Rājshāhi
Dhāka
Khulna
Chindwin
MYANMAR
Dāmodar
Ganges
Bāghmati
GANGETIC PLAIN
Lake En-ti-lo-p'u
Lake Kuo-cha
Lake Man-pan-mu
Lake Ka-sbun
Lake I-chi-t'ai
CHINA
Lake La-ma-chiang-tung
PLATEAU OF TIBET
Lake Tung
Lake Ang-la-jen
Lake Ch'i-lin
Lake Ch'u-k'o
Lake Chia-jen
Lake La-mo
Lake Na-mu
Lake Ang-tse
T'ang-ku-la-yu-mu Lake
Ma-ta-mu Lake
Kua-la-man-ta-t'a Peak 7,728
Chemayungdung Glacier
NIEN-CH'ING-T'ANG-KU-LA MTS.
Namcha Barwa 7,756
Lhasa
Brahmaputra
TETHYS HIMALAYAS
Lake P'u-mo
Lake Yang-cho-yung
RANGE
0 50 100 mi
0 75 150 km
ELEVATION
metres
feet
5,000
16,405
2,000
6,562
200
656
Spot elevations in metres
Glaciers
International boundaries
Disputed boundaries
Line of control
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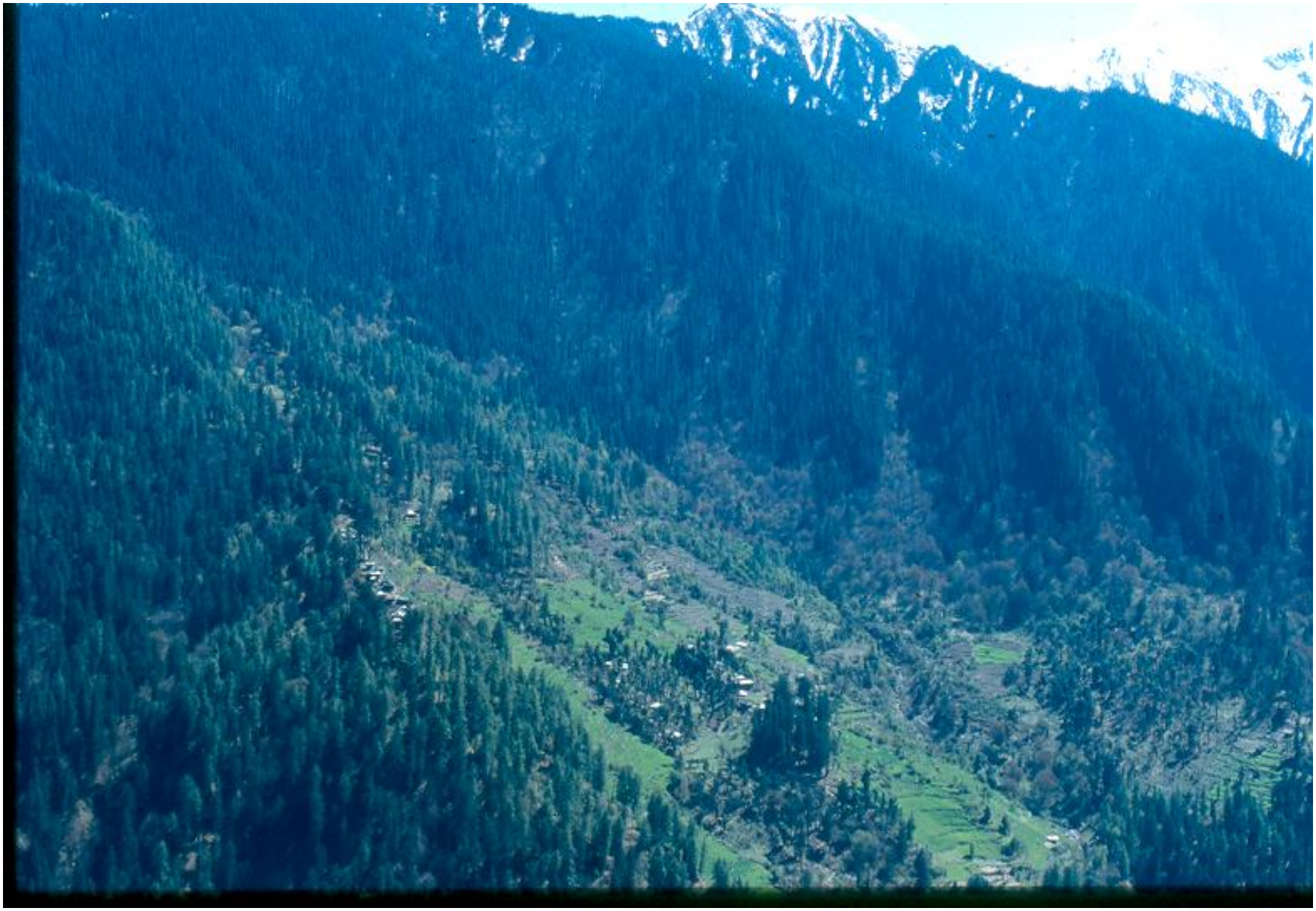


Forest Conditions: Previous Evidence

- Till 1980, deforestation in Nepal: forested area shrunk from 57% to 23% of total area between 1947 and 1980.

- In Indian forests, extensive evidence of degradation: aerial satellite images show 61% of Uttaranchal forests have a crown cover below 40% (Prabhakar et al, 2006).

Forest Conditions: Previous Evidence, contd.

- Foster and Rosenzweig (2003): aerial satellite-based evidence of reforestation in all-India village sample: proportion of land covered by forests *increased* from 1970-1999

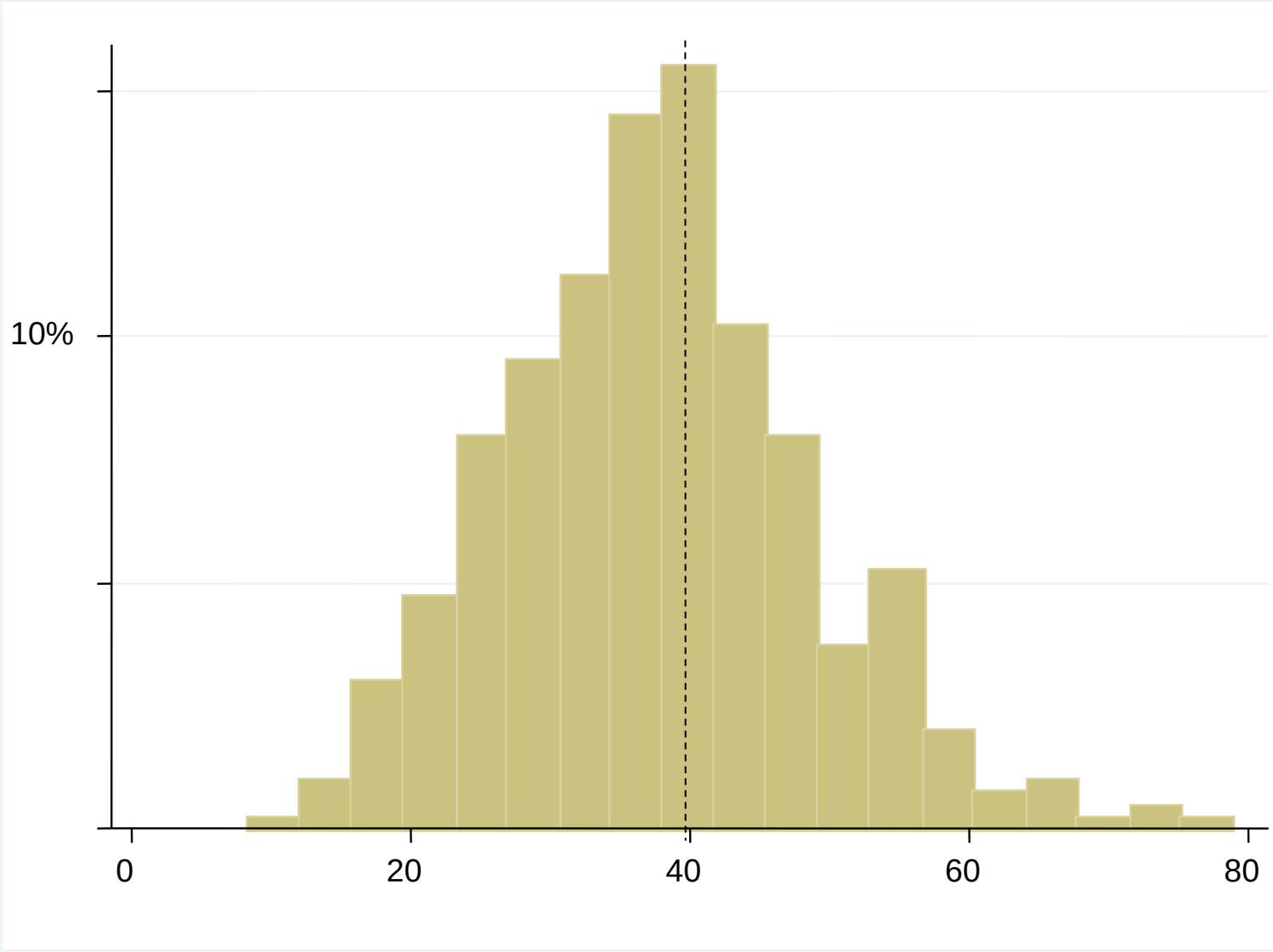
- Raises question concerning forest quality, many dimensions of which are difficult to measure from aerial satellite images

- We therefore rely on ground-level surveys

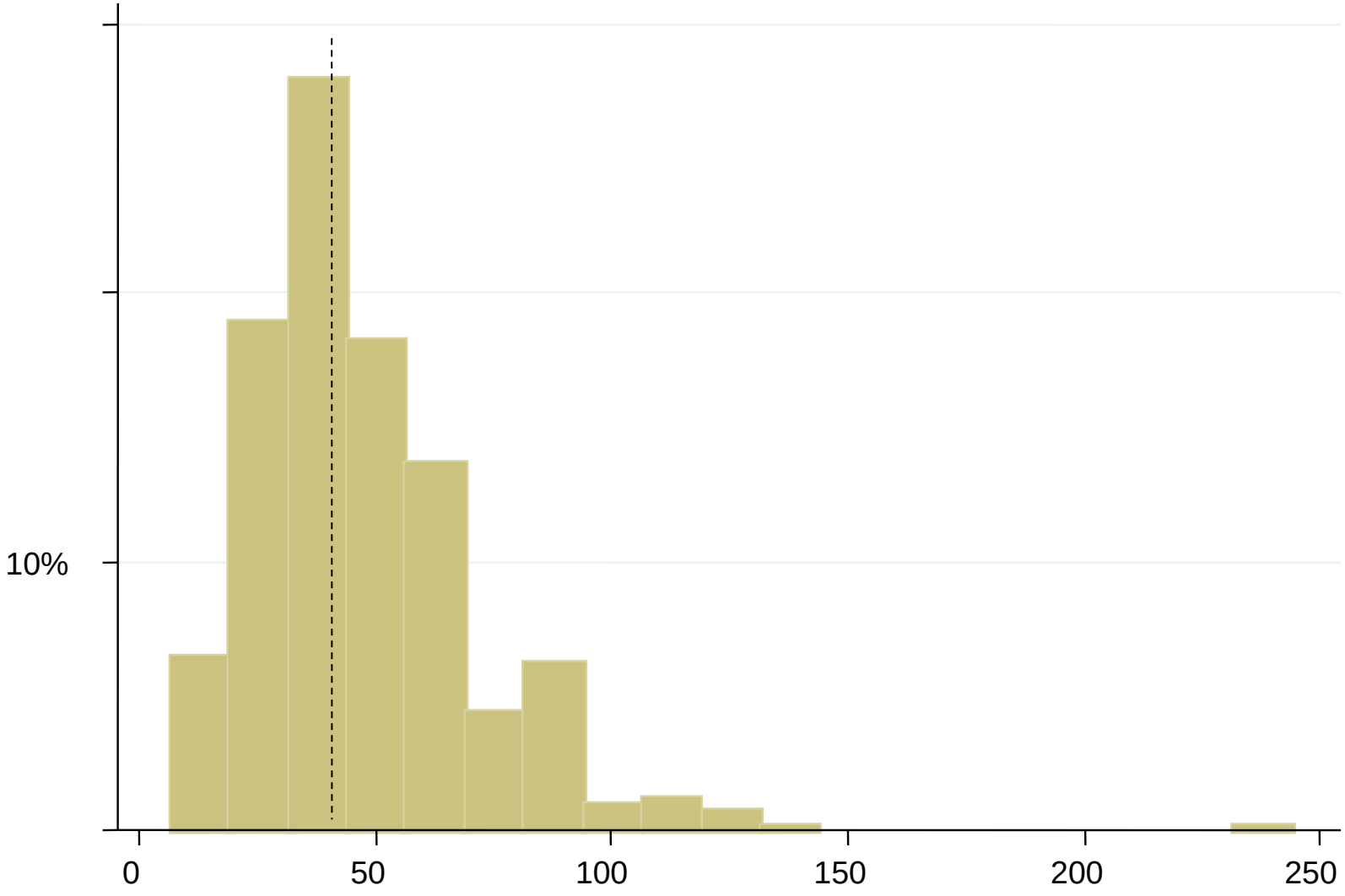
Forest quality measurements

- Forest specialists
  - Identify forest areas accessed by villagers
  - take measurements at randomly chosen transects
- Focus here on three main measures: Canopy cover, basal area and lopping grade.
- Other measures: biodiversity, sapling growth, impact of human activity,…

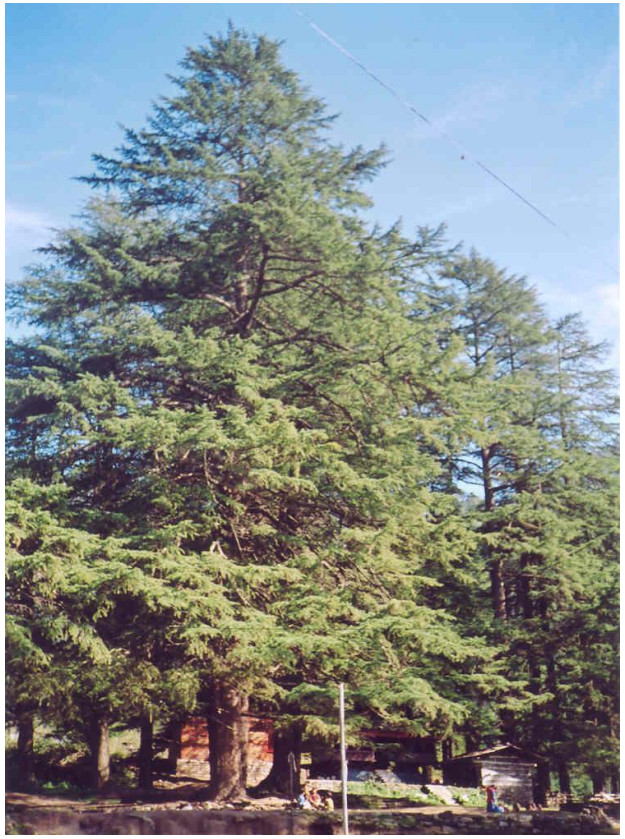
Forest degradation: Canopy cover (%)



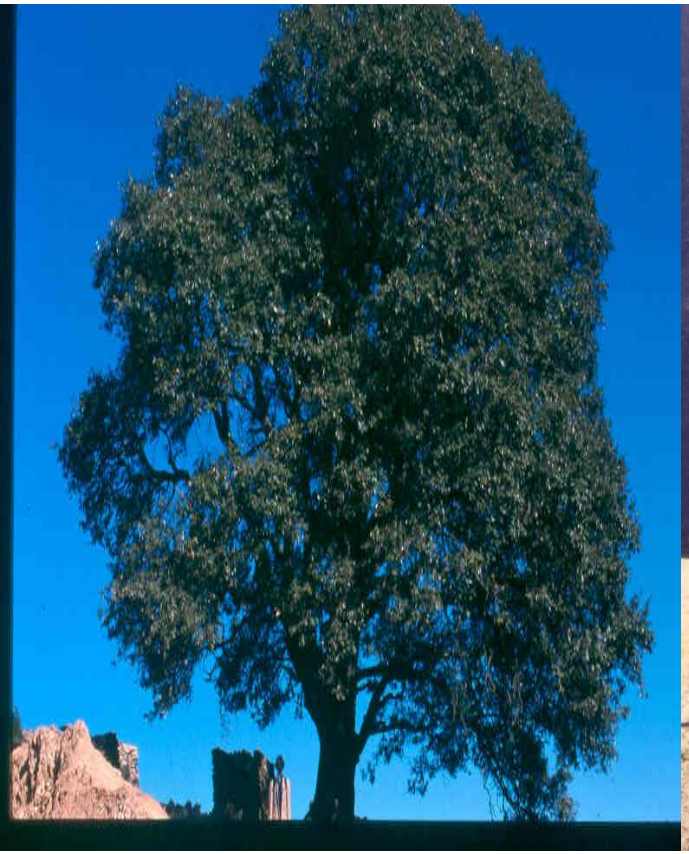
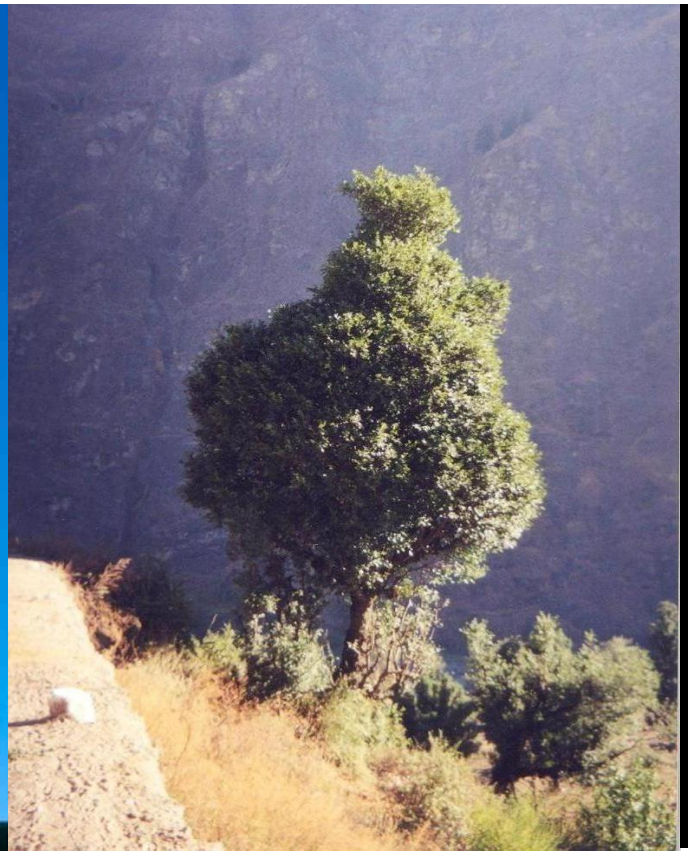
Forest degradation: Basal area (m^2/ha)



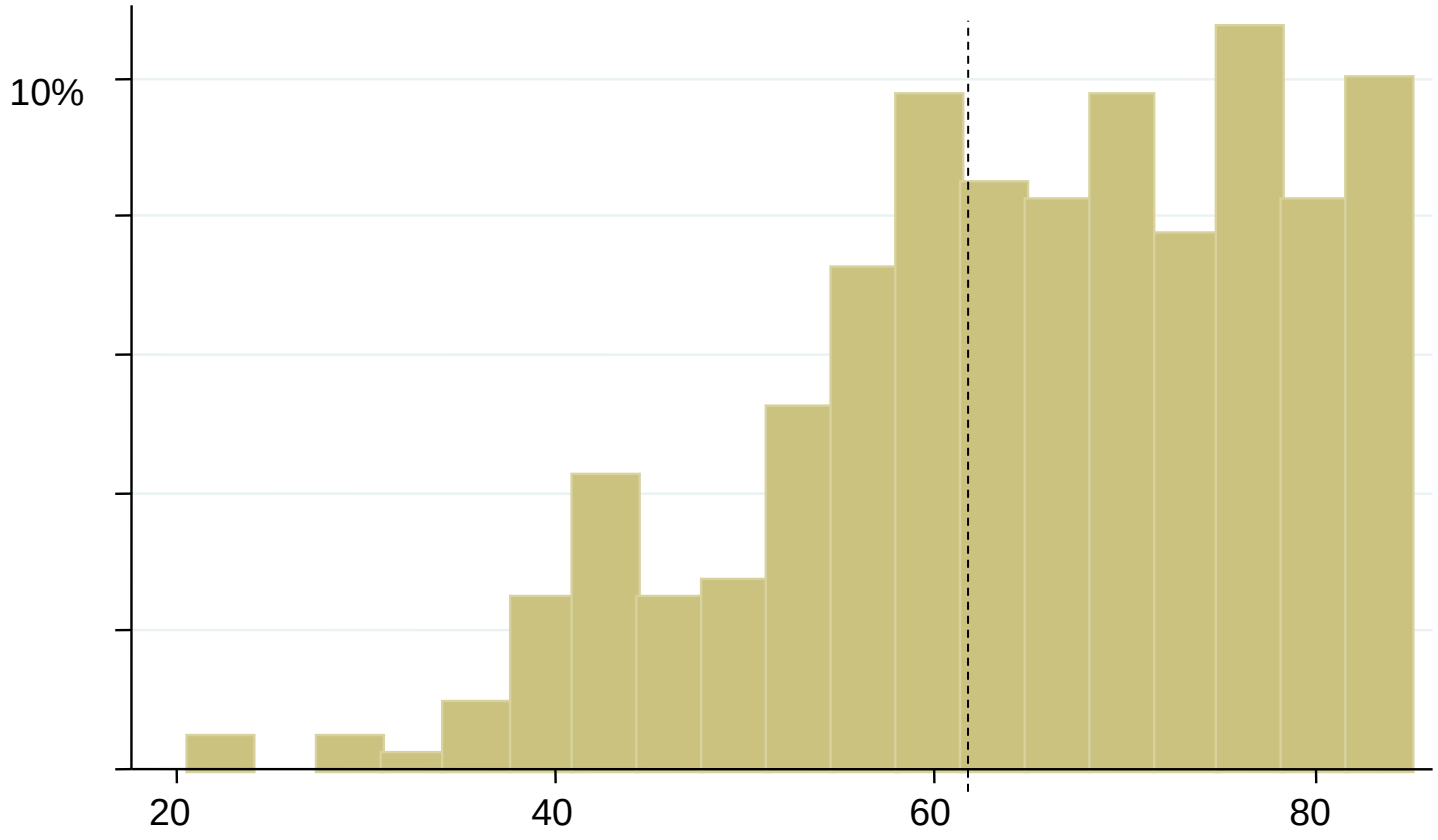
Forest degradation: lopping



Forest degradation:lopping


Forest degradation: lopping (%)



Forest Degradation: Evidence

	Mean	Median	Proportion degraded forest*
% Canopy Cover	37.79 (11.11)	37.5	100
Basal Area (m^2/ha)	46.79 (24.61)	41.31	47.12
Basal Volume (m^3/ha)	904.59 (867.49)	671.58	na
% Lopped	65.39 (13.17)	67.11	99
Regeneration rate (number of saplings above 0.5m/ha)	440.75 (317.42)	383.33	100
Collection Time (hours)	3.89 (1.23)	4	na

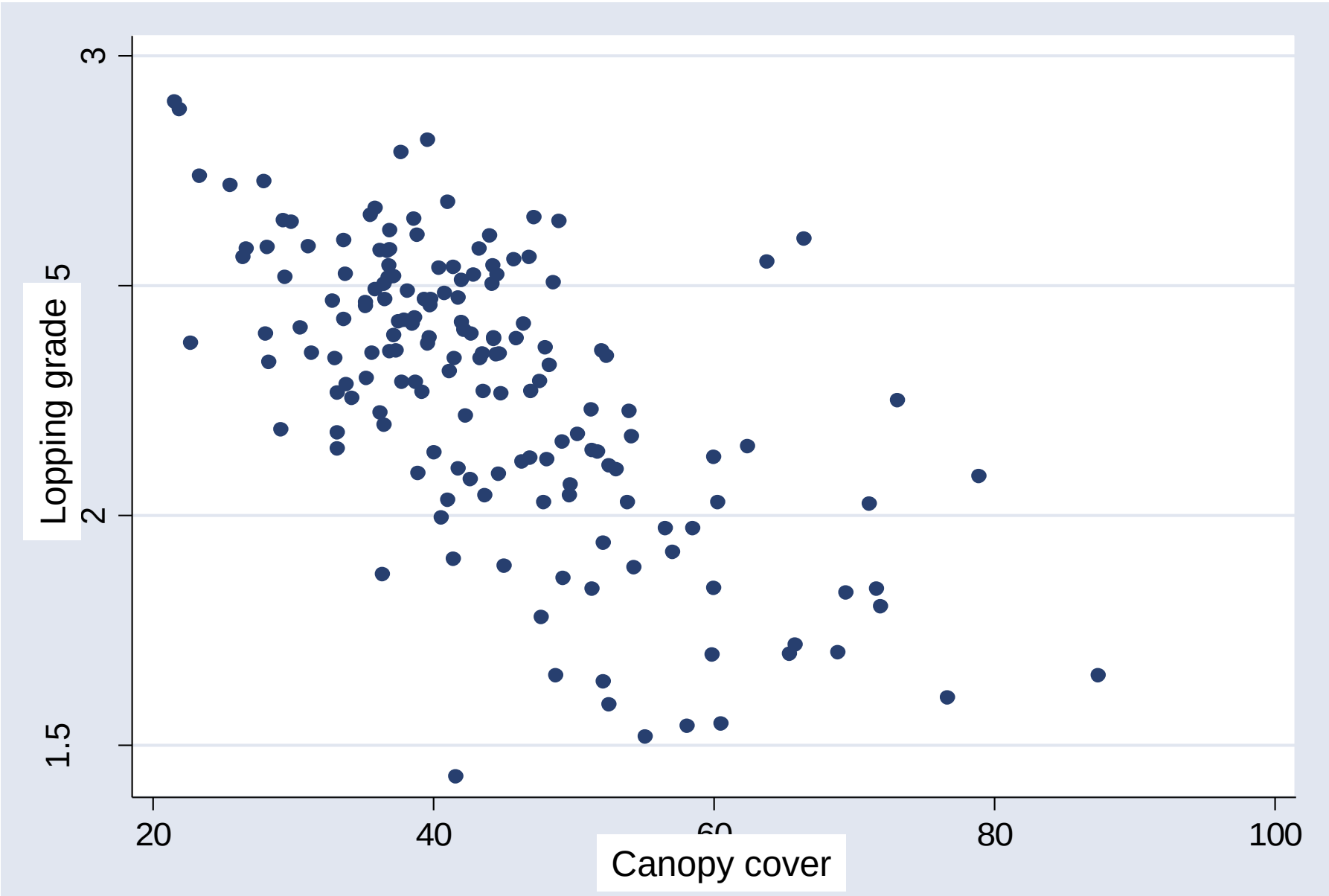
Forest degradation

- Forest biomass and the number of trees (the stock of wood) is satisfactory.

- Lopping rates are alarming. It represents short run overexploitation of branches and leaves. The quality of the trees is very low: stunted growth, low resistance, weak roots, low biomass production.

- Forest regeneration is also very low

Correlation between canopy cover and lopping grades=-0.59



Forest degradation: Implications

- Lopped forests imply villagers have to walk further into the forest to collect firewood and fodder

- Household surveys indicate that mean time to collect firewood increased by 60% over the past 25 years (from 2.4 hrs to 3.8 hrs per bundle)

- Distance to forest increased only by 10% (2.06 to 2.3 km): declining forest quality (degradation) rather than area (deforestation) is the key problem

Forest degradation: Causes

Percentage of parcels in each category		
Cause of degradation	Low incidence %	High incidence %
Grazing	30	70
Lopping	20	80
Timber	57	43
Snow/Fire	70	30

Forest degradation: Timber vs. Firewood

- Household survey evidence used to estimate use of timber as well as firewood/fodder: one tree equivalent for every five years per household

- Implies 48 tons of timber removal in average village per year, compared with 450 tons of firewood use

- Hence we focus on firewood use (also fodder, but results are similar)

Empirical evidence: Poverty and the environment

How does firewood collection vary with income?

Three major views:

- **Poverty-environment hypothesis:** poverty is the cause of degradation. Related to the energy-ladder model
- **Club de Rome**: Development accelerates environmental degradation
- **Environmental Kuznets curve**: development first increases and then decreases pressure on the resources

How to Model Household Firewood Demand?

- Household-level optimization, or dynamic game-theoretic equilibrium of local norms reflecting implicit or explicit collective action in the local community?

- Community surveys and anthropological evidence show near-complete absence of any collective action or any concerted effort by local community to self-regulate use (Exception: Van Panchayats in Uttaranchal)

How to Model Household Firewood Demand?

- Absence in spite of other collective actions: temples, irrigation, credit, women
- Forest guards appointed by the state seemed ineffectual
- Firewood demand can thus be viewed as resulting from socially unconstrained optimization

How to Model Household Firewood Demand?

Given that firewood is collected by the household, one has to distinguish between:

- The direct income effect: for the same collection cost, does firewood consumption increase or decrease with income?
- The cost of collection effect: higher income increases the opportunity cost of time, making firewood more expensive.

The net effect is ambiguous.

Econometric Issues

- Lack of exogeneity of income, consumption, prices, lack of good instruments
- `Price' of firewood=shadow wage*collection time (hh-specific, endogenous)
- Large measurement errors in income, consumption, collection time

Econometric Issues

- Disparate assets: how to aggregate into a single measure of wealth?
- Cross-section data, cannot control for unvarying household unobservables
- Functional Form: nonlinearities in direct income effect to be expected
- Endogenous censoring in Nepal: about one-fifth use no firewood (mainly in *terai)*

Semi-Structural Approach

- Assume assets (household size, composition, land, livestock, education, non-farm business assets) are exogenous, in the short-run BUT labor choices are endogenous

- Semi-Structural (SS) Form: first aggregate assets into a measure of *potential income:* estimate a C-D household production function *a la* Jacoby (RES, 93), using household composition as an instrument for labor, and then estimate how much income this household could make by using fully its labor endowments

- Use this to estimate income and shadow wage

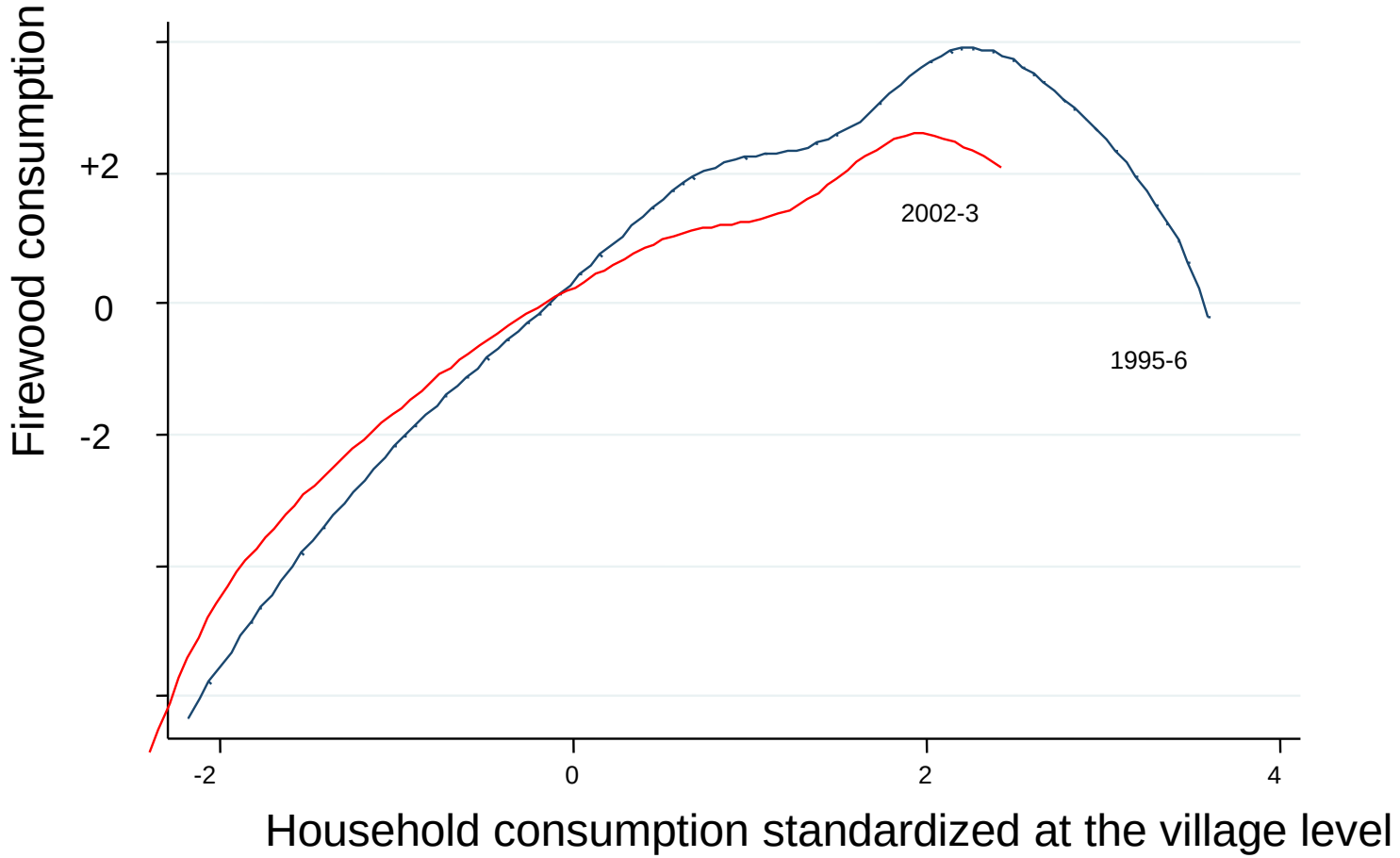
Semi-Structural Approach

- Second Stage: Regress firewood use on:
  - estimated potential income (and its square)
  - estimated shadow wage*collection time (village median)
  - Interacted with all assets
  - Also includes separately household size because of returns to scale in firewood consumption

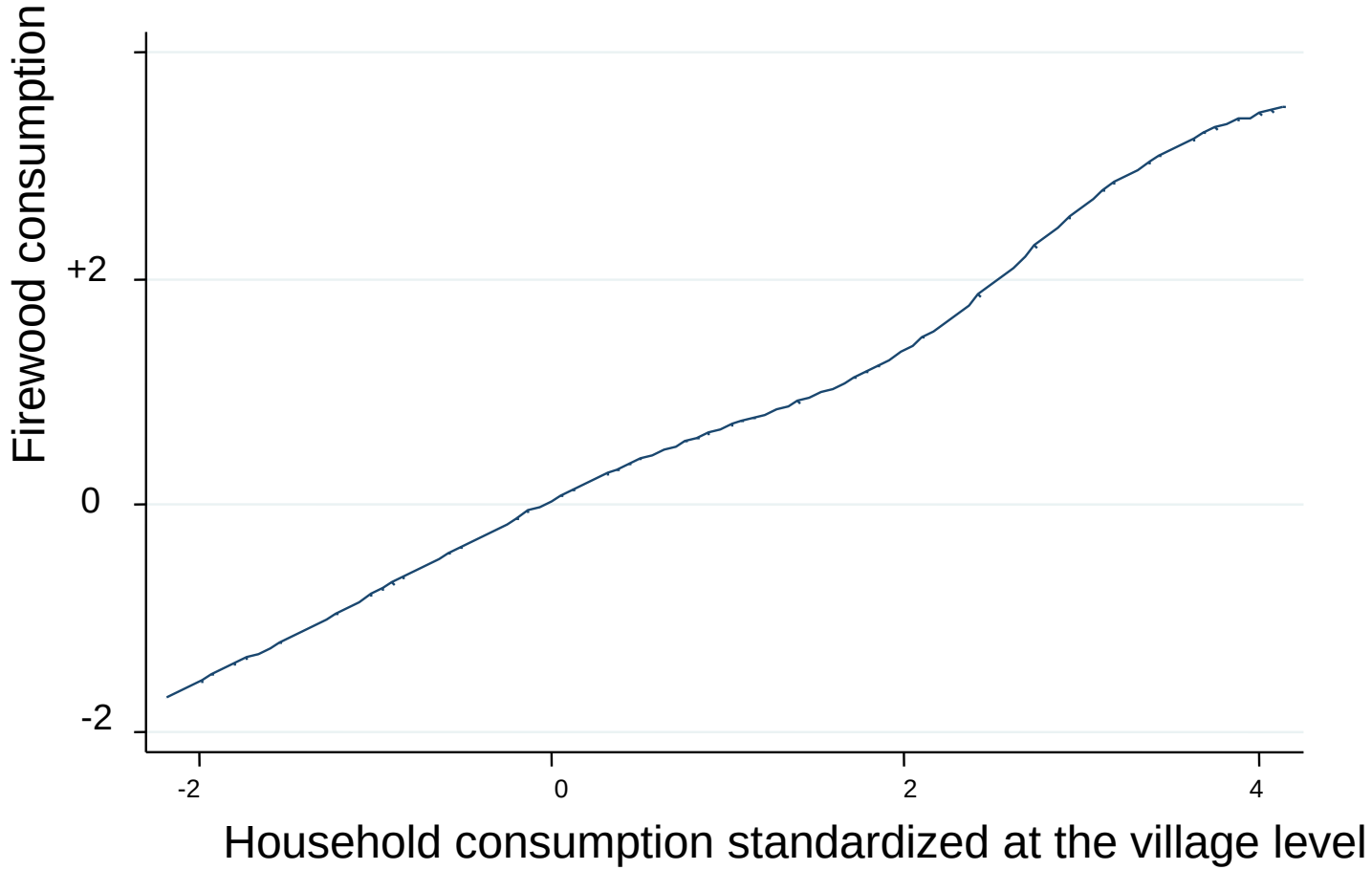
Controls

- Village fixed effects: focus mainly on variations across households in the same village
- Also examine variations across villages and extent to which these are associated with availability/prices of LPG; proportion forest areas managed by Van Panchayats, land inequality, population, altitude

Poverty and the environment: the Engel curve in Nepal



Poverty and the environment: the Engel curve in India



Dependent Variable: Firewood Collection (log of number of bharis per year)	Using Potential income	Consumption	Actual Income
Log Potential Income	1.961	___	___
	(1.599)		
Square of Log Potential income	-0.083	___	___
	(0.076)		
Log Consumption Expenditures	___	2.289**	___
		(1.138)	
Square of Log Consumption	___	-0.118**	___
Expenditures		(0.056)	
Log Actual Income	___	___	0.959*
			(0.482)
Square of Log Actual Income	___	___	-0.049*
			(0.025)
Log(Collection	-0.165**	-0.150**	-0.134*
Time)*Log(Shadow Wage)	(0.079)	(0.070)	(0.071)

Household size and triple interactions between collection time, shadow wage and productive assets are included. Village Fixed Effects are included. Standard errors are given in parentheses. *: significant at 10%, **: significant at 5%, ***: significant at 1%. The number of observations is 2190 households in 201 villages.

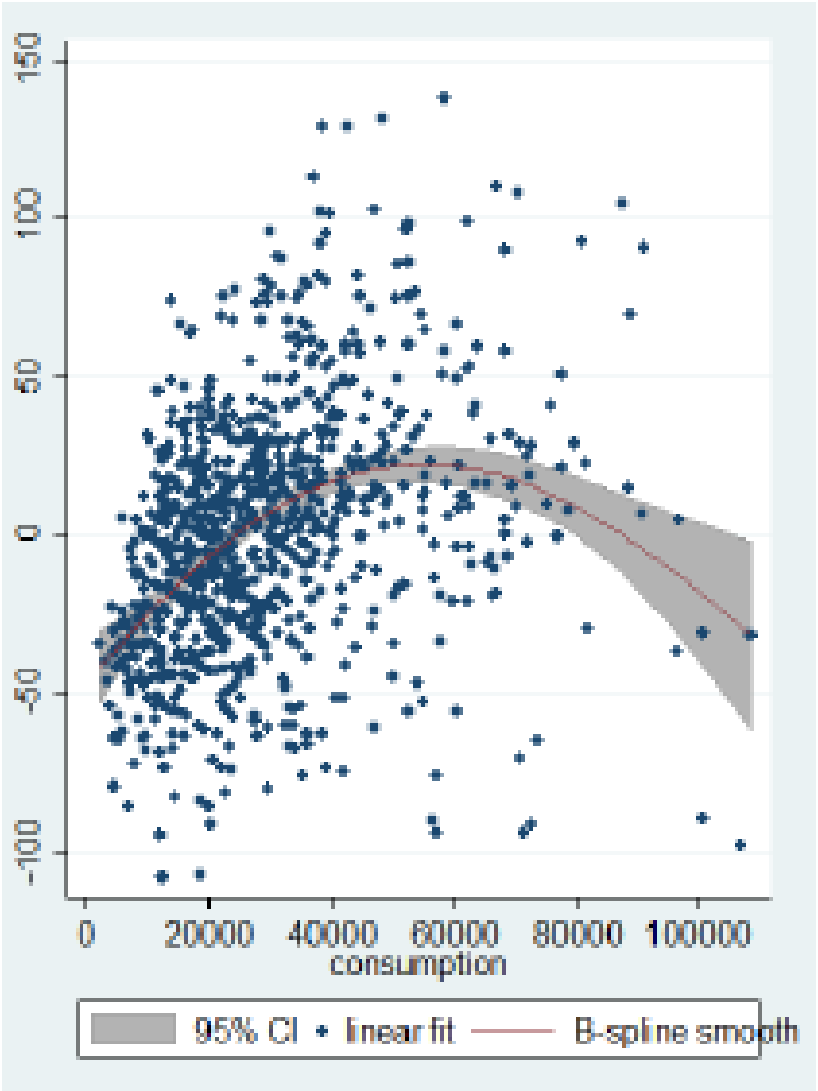
Table 3: Firewood Collection: Semi-Structural estimates for Nepal (1995-6 LSMS)

Source: Baland et al (2010a)

Nepal panel

- New data set: 400 households in the LSMS in the hills and moutains that are matched as a panel for the years 1995/6 and 2003.
- Major changes: Conflicts in 2003, Large increase in the number of FUGs, Migration of men.
- Allows us to control for village and household fixed characteristics.

Engel curve Nepal panel



Poverty and the environment: the direct income effect

- The income effect is largely positive and exceeds the substitution effect. Average elasticity = +0.4

  => firewood increases by 4% if income rises by 10%

- Possible turning point but at top income levels (around the 95 percentile)

Poverty and the environment: the cost of collection effect

- The cost of collection effect has three components: time to collect, shadow wage, price of gas (the closest alternative energy)

- Time to collect: elasticity is not high. An increase of collection time by one hour is associated with a 0-20% (best estimate:14%) decline in collections.

Poverty and the environment: the cost of collection effect

- Welfare impact is computed using the enveloppe theorem:

  Δ Utility=sh.wage * Δ coll.time

- Welfare impact is low: the monetary cost of an increase in collection time by one hour per headload corresponds to 1-2% of annual income.

The Local Externality

- These estimates imply that size of local externality is small (at least for collection times observed so far)

- May explain why there is so little collective action in the local community to regulate firewood and fodder collections

- Argument for policy interventions therefore rest on non-local externalities, and raise complex issues of equity between local and non-local populations

The local externality

- Low sensitivity of collections to collection costs implies that there is little chance of converging toward a ‘stationary’ forest, as there are no built-in stabilization mechanisms.

- In particular, population growth (#hh) translates immediately in increased collections, with little counteracting effects.

- Caveat: could not measure adequately how degradation reacts to aggregate collections.

Reduced Form (RF) Approach

- SS approach makes assumptions about aggregation of direct income effects from different assets, also associated with measurement error in estimated pot. income and shadow wage
- RF avoids these problems, at the cost of increased complexity: include entire vector of assets instead of associated potential income and shadow wage
- RF approach generates more precise estimates; aggregation assumptions in SS approach are rejected
- Implies difficulty in generalizing about growth effects: source of growth matters

Poverty and the environment: shadow wage

- In the reduced form, shadow wage is expressed as a function of occupational structure, which itself depends on assets:
  - Modern assets (education, non farm business assets) tend to reduce collections.
  - Farm based assets (livestock) tend to increase collections, particularly livestock which is a complementary activity.
- Much depends on the type of growth in the future. In the case of India, with the reduced form approach, we have:

Predicted % change in firewood collection for an average household resulting from:	
Increase in Potential Income by 10%	-0.06
Increase in Land by 10 %	-0.08
Increase in Big Livestock by 10%	0.15
Increase in Small Livestock by 10%	0.01
Increase in Education by 10%	-0.19
Increase in Non-Farm Business Assets by 10%	-0.01

Table 4: Predicted Effects of 10% Asset Growth on Yearly Per-Capita Firewood Use of Average Household in Indian mid-Himalayan Region

Source: Baland et al (2007a)

RF estimates for Nepal: collection times

- Using the Nepal panel, there is an added difficulty: there is some evidence of endogeneity of collection times, at the village level. One of the major change during the period is the maoist guerilla, the location of which was not random (Mani et al, 2012; Iyer et al, 2010).

- Change in the time required to collect one unit of firewood across the two panels: -1.17 hours

- Main Factors
  - Current conflict:-0.86
  - Past Conflict: -0.25
  - Average Village Household Size: +0.18
  - Presence of a FUG: -0.09

RF estimates for Nepal: collections

- Change in the average amounts of firewood collected:
  -12.28 bharis

- The gross apparent elasticity of collections to time is positive. With proper controls, coefficient is positive, small, and insignificant.

- Main Factors behind the fall in collections:
  - Village **Livestock**: -6.99
  - Household **Livestock**: - 3.11
  - Household Size: +3.14
  - Prop. of Men in the Houhehold: + 0.51

Policy options

- Based on two observed policies: gas prices and community forest management.

- Cannot be done on non-observed policies.

  Example: improved cook-stoves have been heavily promoted by NGOs in Nepal. In the Nepal LSMS, only 50 out of 3500 households had one. Reasons for low adoption are not yet clearly understood.

Policy option 1: the price of gas

- In the Indian sample, a 33% subsidy on LPG reduces wood collection by 22%.
- The cost is relatively low, and corresponds to a tax of about 1.2% on consumption expenditures.
- However, mostly cooking energy, ‘full’ substitution is unlikely.

Policy option 2: local property rights

- Nepal: FUGs started in 1993: local management of forests, with plantation programs, controlled access,... In 2007, 38% of rural population is involved in a FUG; 25% of forest area.

- Edmonds (2001) shows that, in the initial stage, the creation of a FUG is associated with a fall in firewood collection by 10-15%.

  Method: compares collections from FUG villages to villages with FUG forests created within the next 2 years with Nepal 95-6 LSMS.

Decentralization in Uttarankhand

- In India, long tradition (back to the British Rule) of local forest management in Uttarankhand, known as ‘Van Panchayats’ (forest village committee). It is based on voluntary participation of villagers, and gives exclusive use rights (except for timber) to the local community.

- Rapid increase over the past years of the number of van panchayats, with mixed evaluations. Van Panchayat forests represent 11% of total forest area in Uttaranchal

- In our sample, 45 out of 83 Uttaranchal villages had a Van Panchayat (formal village forest management committees with control over use of specified Van Panchayat forests)

Decentralization in Uttarankhand

- Somanathan et al (2005) use satellite imagery to evaluate crown cover comparing van panchayats forests to open access forests and state reserve forests, which are protected and managed by the state administration.
- Methodology: compare neighboring forests with different property status, or control for topography.

- Result: Crown cover in VP forests is similar to state forests, and better than in open access forests (about 12% for broad-leaved trees).

- Concludes that decentralization is worth it: same efficiency at a much lower fiscal cost.

Decentralization in Uttarankhand

- We do the same thing with our forest survey data in Uttarankhand, on the three main measures of forest quality

- Methodology: compare forests with different status within the same village, controlling for topography.

Methodological issues

- Unobserved village characteristics: we use village fixed effects

- Spillover problems: protecting one forest may increase degradation on others: VP have no spill-over effects on neighboring forests.

- Endogenous selection: (1) VP may have been placed in forests with more/less potential. Using aspect or slope, VP tend to be created on more degraded forests and on less favorable soils. (2) Villages with Van Panchayats are themselves not random (voluntary application).

- VP are heterogeneous: Distinguish beween new and old VPs

Comparison with state forests

	Canopy cover	Basal area	Lopping
Van Panchayats	5.27 (3.42)	-4.14 (4.32)	**-13.18***** **(3.98)**
New Van Panchayats	0.06 (2.86)	**-12.56**** **(5.68)**	**-6.70*** **(3.55)**
Old Van Panchayats	9.35** (4.30)	2.47 (5.24)	**-18.30***** **(4.56)**

Decentralization in Uttarankhand

- Van Panchayat forests exhibit a much lower lopping. Alternative estimates suggest a 10-20% reduction in firewood use in both Nepal and India

- New Van Panchayats are less effective: they may be too new or they may be less genuine/effective. May be the result of recent top-down approach by the state. But the effects found are consistent.

Table 10. *Forest quality regressions with village fixed effects, and separate effect of old and new Van Panchayats*

	Canopy cover	Basal area	Basal volume	Lopping	Regeneration	Collection time
New Van Panchayat	0.06	−12.56**	−288.75	−6.70*	−8.34	−0.12
	(2.86)	(5.68)	(227.27)	(3.55)	(66.83)	(0.23)
Old Van Panchayat	9.35**	2.47	194.33	−18.26***	43.89	−0.25
	(4.30)	(5.24)	(141.72)	(4.56)	(116.12)	(0.30)
Dummy civil soyam forest	3.68	1.72	93.80	−9.76**	174.67*	−0.34
	(3.50)	(6.39)	(151.65)	(4.58)	(100.90)	(0.28)
Distance to the forest	1.04**	3.67***	117.25***	−1.24*	−12.67	0.47***
	(0.48)	(1.11)	(33.45)	(0.65)	(11.88)	(0.08)
Percentage broad-leaf	0.04*	−0.20***	−11.15***	0.06*	0.86*	0.00
	(0.02)	(0.04)	(1.44)	(0.03)	(0.45)	(0.00)
Aspect	2.38	6.82**	218.97**	−0.61	113.02**	−0.09
	(1.53)	(2.64)	(87.14)	(2.36)	(50.78)	(0.15)
Altitude	0.00	0.03***	0.81**	−0.01	0.26**	0.00
	(0.00)	(0.01)	(0.39)	(0.01)	(0.11)	(0.00)
Slope	0.14	0.05	1.09	−0.25	11.90**	0.02
	(0.14)	(0.35)	(11.01)	(0.17)	(4.60)	(0.02)
Competing Van Panchayat forest area (ha)	0.01	−0.04	−0.65	0.00	0.33	0.00
	(0.02)	(0.03)	(0.81)	(0.03)	(0.48)	(0.00)
Competing state protected forest area (ha)	−0.04*	0.03	0.19	0.06**	−0.60	−0.004**
	(0.02)	(0.04)	(1.23)	(0.03)	(0.56)	(0.00)
Competing civil soyam forest area (ha)	0.14	0.32	3.36	−0.14	8.61*	−0.01
	(0.15)	(0.28)	(5.50)	(0.20)	(5.02)	(0.01)
Number of observations	399	399	399	399	399	346
Number of villages	83	83	83	83	83	83
R^2	0.13	0.26	0.30	0.13	0.12	0.45

Note: Robust standard errors, clustered at village level.

Decentralization in Uttarankhand

- Distributive impact is less clear, as local elite may tend to dominate the commitees (see Banerjee et al 2001 for sugar cooperatives, Pokharel 2011 for Nepal FUGs).

- Agarwal (2007) argues that women got dispossessed of their traditional access rights to the forests, bear most of the costs of the 'decentralized regulations', with little benefits:

  'If you were to attend meetings, the men will say, oh, you haven't cooked my meal on time! What happened to my tea? (…)

  People don't like it when we speak (at the meetings), they think that women are becoming very smart.'

Why should decentralization work?

- Remember: welfare losses are low at the local level. So why should local property rights be effective?

- Four explanations:
  - Sense of property
  - Coordination device, at very small cost even if benefits are small
  - Costs of collection go beyond ‘collection time’ and may include several coordination problems (when and where to go, how to cut, disputes…) that are solved by joint management
  - Timber sales and wood control is important and prohibited in other types of property regimes… (but weakens empirical strategy)

Forest degradation in the Himalayas: conclusions

- Public intervention is needed. Pressure on the resource will increase due to increases in income and in the number of households in the villages.
- There is little feedback effect from increase in collection time (following the reduction in the resource base) on the amounts collected.
- Subsidies on gas, and decentralization have positive effects, at relatively low cost.