Community Forestry Management:
Unveiling the success story of Nepal

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IOEA

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What do I would like you to remember?

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   - landscape analysis $\neq$ studies on population $\neq$ ...
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   - ☹ Hardin (1968): The tragedy of the commons
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3. nice stories about the Himalayas but relevant beyond Nepal
   - wood as an important source of energy in developing countries
   - but also (almost) everywhere in a not so distant past
   - long struggle between central power and households (Perron, 2021)

A subcomponent of a larger project

- One part of the results of the **ANR funded project GoLFor-DEEPN "Gouvernance Locale des Forêt: Développement, Environnement et Economie Politique au Népal**
- Other collaborators:
  - Olivia Aubriot, CESAH, CNRS, France
  - Sanjaya Chaudhary, Kathmandu University, Nepal
  - Marine Gueben, CRED, Université de Namur, Belgium
  - Quang Thang Le, LIED, Université Paris-Cité, France
  - Mani Nepal, SANDEE, ICIMOD, Nepal
  - Joëlle Smadja, CESAH, CNRS, France
  - Romain Valadaud, G-EAU, CIRAD, France
- A project that combines
  - statistical approaches relying on survey data and administrative data (some of them being collected by the team in Sunsari, Sarlahi, Chitwan, Kailali, Solukhumbu, Dolakha, Panchhtar, Bhaktapur, Gorkha, Palpa, Pyuthan, Mugu, Jumla, Baitadi)
  - remote sensing
  - repeated field work with qualitative interviews (Palpa, Gorkha, Chitwan, Sunsari, Solukhumbu, Bara, Lalitpur, Kavrepalanchok, Kaski, Nuwakot)

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- UNEP states stresses that *"community forestry has contributed to restoring forest resources in Nepal"* and that it promotes inclusive growth. (Sukhdev and Nuttall, 2010)
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  - Community forestry would generate income, create employment, give loans or scholarships,...
- Forests in the Himalayas have a determinant impact on livelihoods
  - People living nearby forests derive a significant share of their income from forests
  - Forest provide ecosystem services in their vicinity and downstream: watershed services, filtration of water, reduction of nutrient run-off, reduction of air pollution...
  - Forest degradation is one of the causes of climate change.

Research questions

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   - methodology: quasi-natural experiment and staggered dif-in-dif
2. **Which mechanisms are at play?**
   - Institutional change is related to
     1. new management practices
     2. lower fuelwood collection and a diffusion of alternative energy sources such as biogas
   - methodology: quasi-natural experiment and correlational evidence

Contributions

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- Our outcome variable is one of the main stated goal of the decentralization program, namely the change in tree cover
- We are able to dig into the mechanisms behind our results using a combination of household level data, administrative data and remote sensing information.
- This project contributes to the analysis of the pros and cons of decentralization.
  - It is one of the few example of a success (Mookherjee, 2015 and 2022).
  - Community management seems to improve tree biomass.
  - Limited elite capture and local development remain open research questions before concluding to a success of the program.

Related literature in economics: institutional change and forest conservation

Effect of community management regime on forest cover:

- Somanathan et al. (PNAS, 2009): In Indian Central Himalaya, community forestry is shown to conserve forests at least as well as government management but at a lower cost.
- Baland et al. (World Dev., 2010): In Uttarakhand, community forest appear to reduce forest degradation. This is especially true for older groups
- Bluffstone et al. (World Dev., 2018): In Nepal, community forestry would sequester carbon, in community forest plot and provided social capital is high enough
- Oldekop et al. (Nature Sustain., 2019): Using matching, they show that CFUG reduce forest loss
- Desbureaux (FAERE WP, 2017): In Madagascar, the transfer of rights to community has failed to decrease deforestation, maybe even increasing it
- Yang et al. (China ER, 2017) suggests that collective forest tenure has increased fuelwood consumption in Yunnan
- Bowler et al. (FEE, 2011) provide a broader review

Related literature in economics: institutional change and forest conservation

- Privatization of the commons:
  - Relatively dense theoretical literature, with contributions by Weitzman (JET, 1974) ; Brito D. et al. (JPubE, 1997) ; Baland and Bjorvatn (EDE, 2013)
  - Less empirical work, especially on forests (but ongoing work with Maria Cano on pre-industrial metallurgy and forest conservation)
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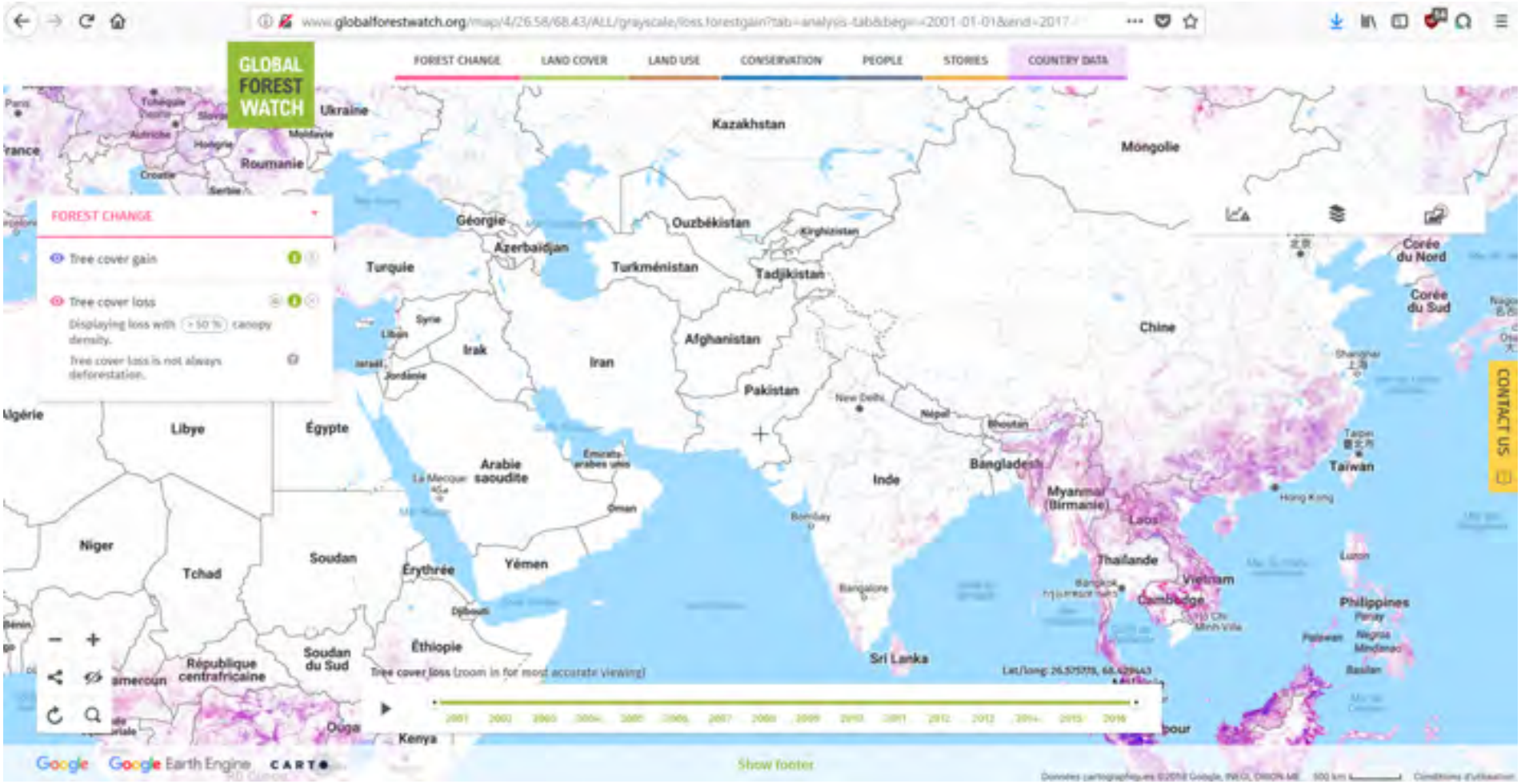
- Many papers discuss the effectiveness of protection status
- See Somanathan (2017) for a review of institutional change and forest management

Roadmap

- Motivation
- Context
- Data
  - Forest conditions
- Community forestry
- Exploration of mechanisms
- Conclusion

Context: forest cover in South Asia

Context: forest cover change in South Asia



Context: why community forestry in Nepal?

- Prior to the 1950s, under the Rana regime, Nepal was feudal-like regime.
  - Local bureaucrats controlled (local) land and forest use.
  - Access by peasants was subject to payments and/or contribution in labour.
- Between the 1950s and Mid-1970s, forest were nationalized.
  - A forest department was created
  - The forest department was responsible of forest management and timber supply to a nascent forest industry.

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- From Mid-1970s to 1980s, the government concern for environmental conservation increased.
  - It created the department of Wildlife and Natural Parks as well as a Department of Soil and Water conservation.
  - Tree felling of valuable species was banned.
  - Despite that, the environmental crisis became more and more visible.
- 1993: Forest Act establishing a legal status of **"Community Forest User Groups (CFUG)"**

Context: community forestry in Nepal

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  - aims at restoring degraded forest land
  - aims at improving livelihoods
  - generates income by selling timber and non-timber forest products
  - has to invest 25% of its budget in forest management
  - has to invest 75% in local development, public good provision and improved livelihoods
  - would have an aggregate budget 4 times larger than village development committee in the early 2010's,

Data: village level information

- **Leaf Area Index (LAI) by Verger et al. (2014), BioPar algorithm based on SPOT images** by Verger et al. (2014). Variable of interest: spatial average of LAI for each Village Development Committee in November or December

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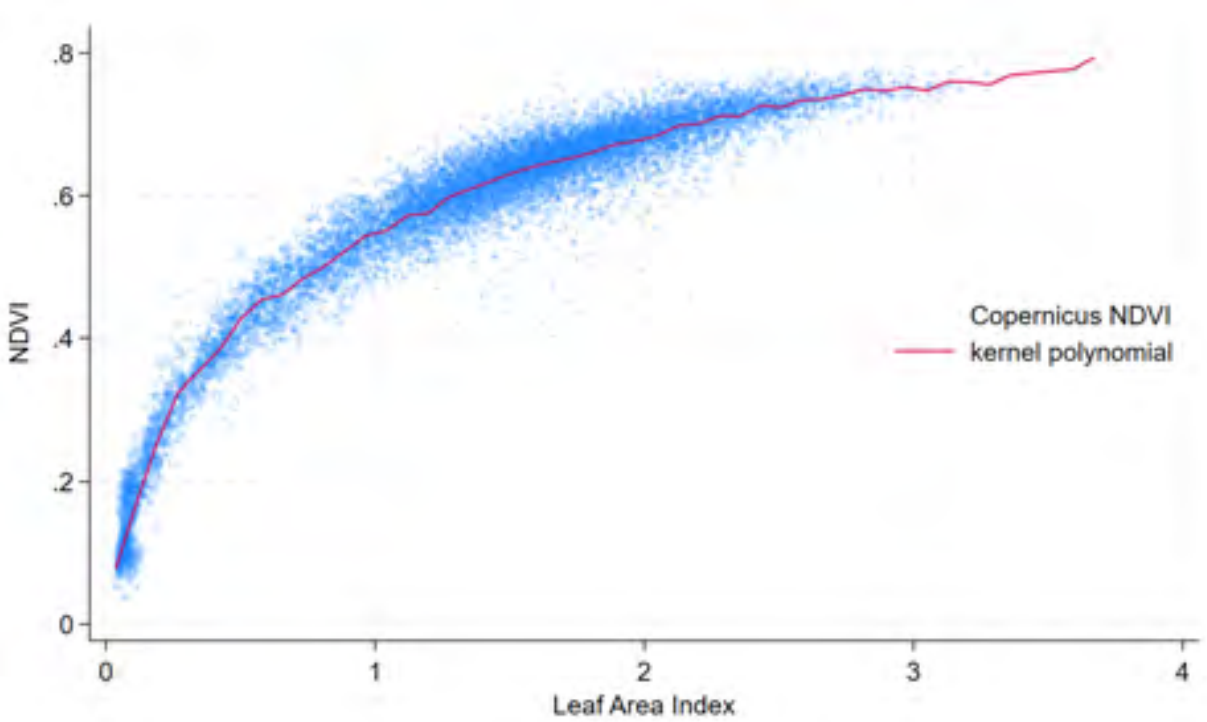
- **Land cover, based on MODIS images, 250m resolution**. Variable of interest: share of a given land cover type for each Village Development Committee by year
- **Land cover map by ICIMOD** (30m resolution) in 1990 and 2010, with a land cover classification in 8 classes.

Why the Leaf Area Index ?

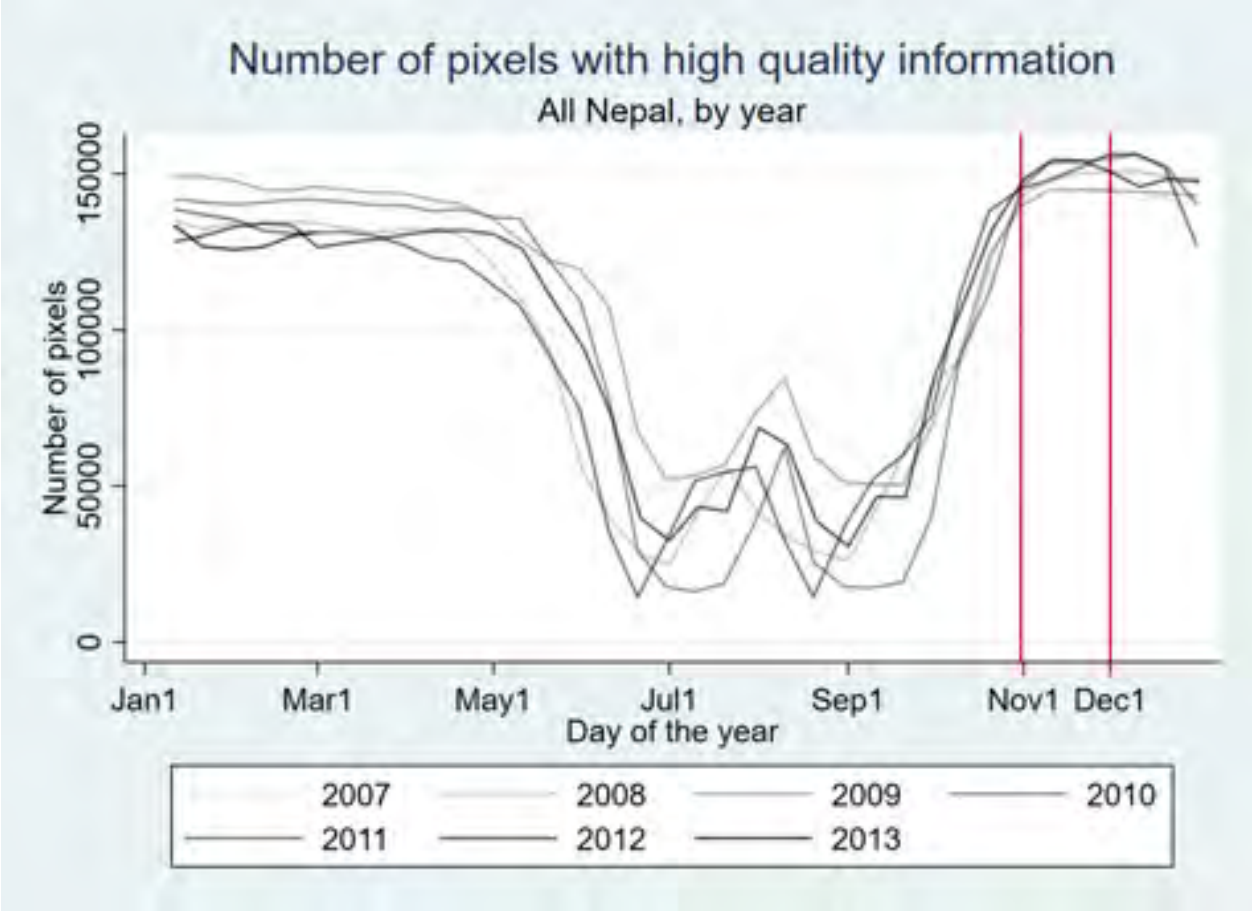
- The leaf area index is half the surface of leaves above each m^2 of ground
- We use BIOPAR Geo-V2. (Baret et al. 2013 ; Camacho et al. 2013)
- Neural networks trained with other datasets (MODIS and CYCLOPES) $\rightarrow$ reflectance based smooth and unsaturated LAI

Why the Leaf Area Index ?



- The NDVI and the LAI are very much correlated
- The LAI contains more information about dense forests and forest degradation
- The NDVI reacts more at deforestation

Why the Leaf Area Index in November ?

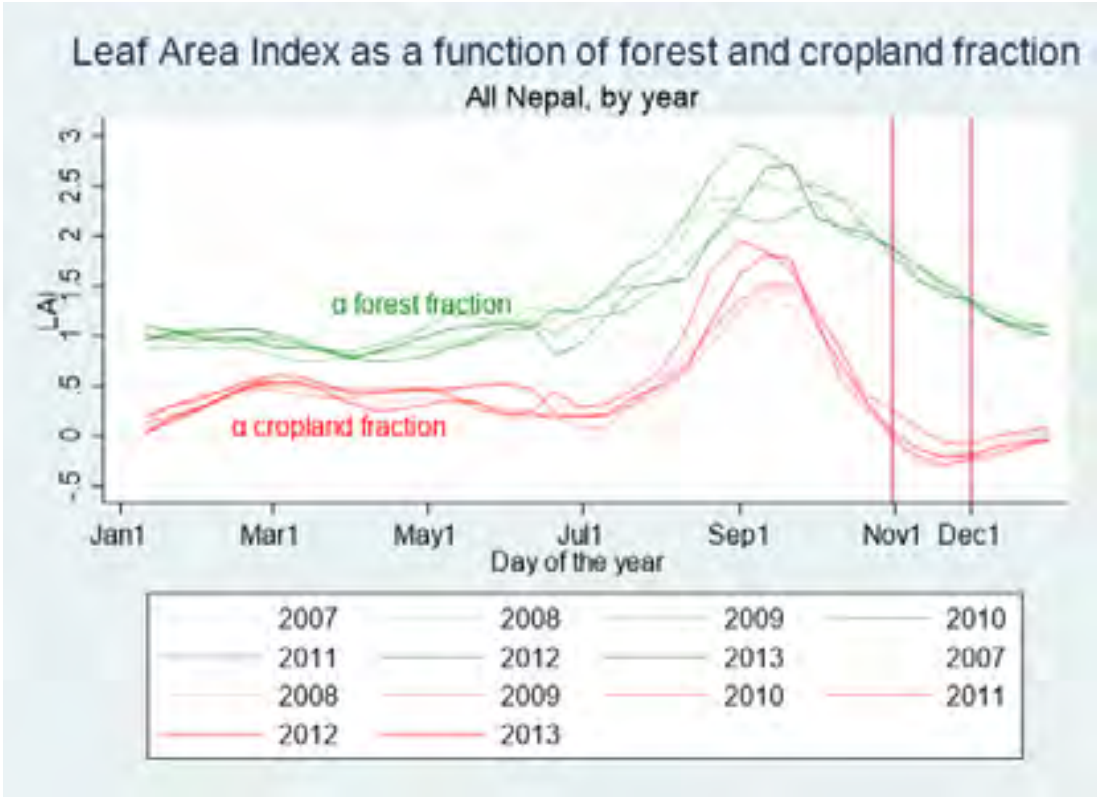


- Between May and November, less than half of the pixels contain high quality information
- Good data coverage from November to April

Why the Leaf Area Index in November ?

For every period of 10 days t, let's regress the leaf area index of 1km pixel p on the fraction of this pixel classified as forest or cropland in the 2010 30m-resolution land cover map by ICIMOD.

$$LAI_p^t = \alpha_0^t + \alpha_1^t ForestFraction_p^t + \alpha_2^t CroplandFraction_p^t + X_p^t \mathbf{B}^t + \varepsilon_p^t \quad \forall t \quad (1)$$



- Forest land (46%) and cropland (35%) do constitute the main land cover classes in 2010
- Reference category: snow (1.3%), **barren land** (6%), water (.5%) buildup area (.5%), **grassland** (8%) and bushes (2%)

Why the Leaf Area Index in November ?

- November because
  1. It's a month where we have a high quality of information
  2. It's the month that maximizes the difference between cropland and forest land in the leaf area index.
  3. It's also a good indicator of variations across time more

Data: village level information

- **Community Forest User Group census data 1988 - 2016 (DoF)** : creation date, municipality and area of all CFUG of Nepal. Source: Department of Forest, Nepal. Variable of interest: share of village area managed by CFUG in year t
- **Alternative Energy diffusion: census of biogas installations 1992 - 2011 (AEPC)**: Number of biogas installations constructed by year and Village Development Committee

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- **Digital Elevation Model from ASTER (NASA)**: allows to compute walking distance from district headquarters

Data: village level information

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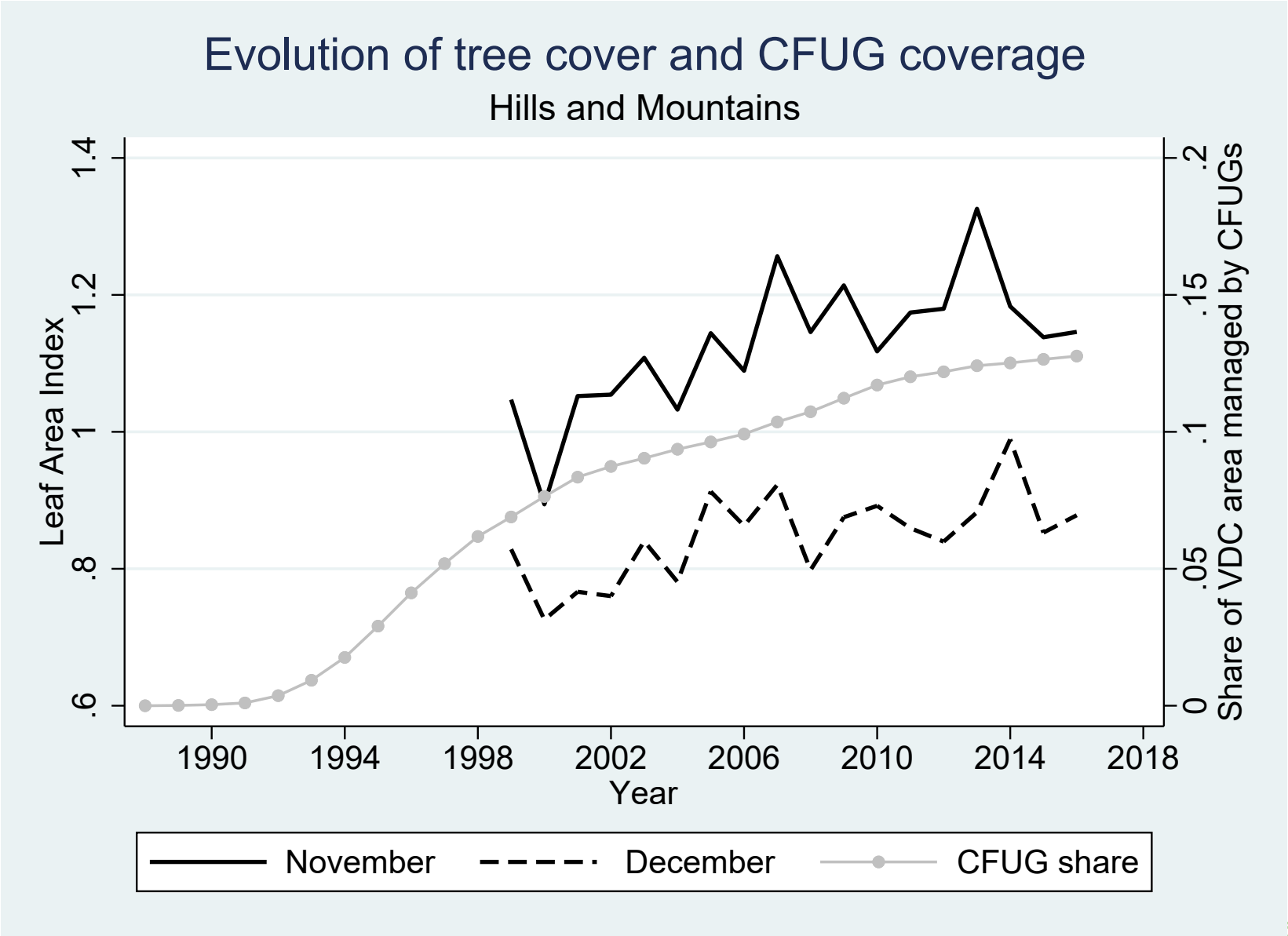
- Historical land cover based on US army maps (1950's)
- Rainfall data from TRMM from NASA and JAXA
- Land Surface Temperature (LST) from MODIS (NASA)
- Snow cover data from MODIS (NASA)
- Nighttime light data (DMLP)
- Conflict data by village and by month 1996-2006 (INSEC)

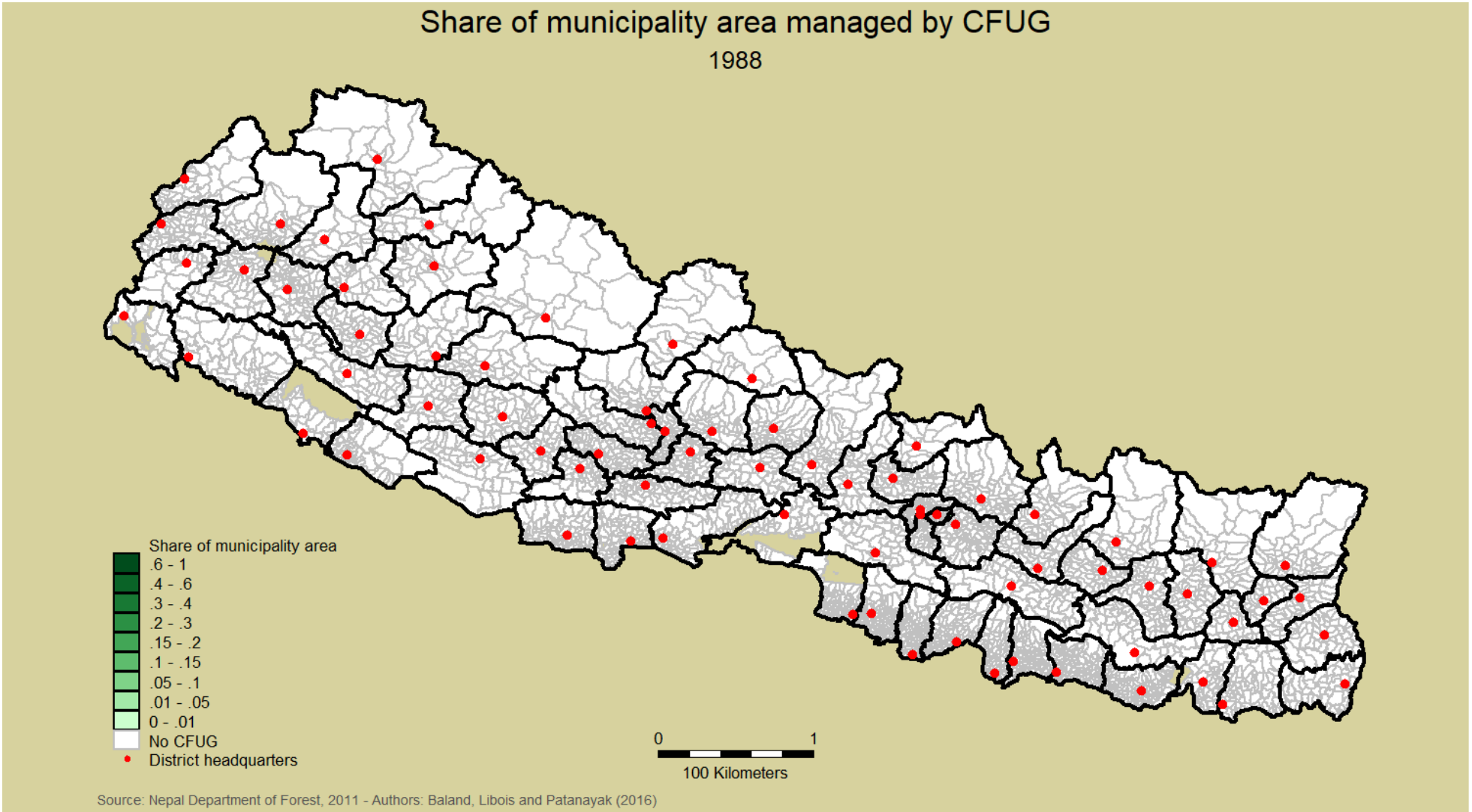
Data: household level information

- Nepal Living Standard Survey 1995/6 - 2003/4 - 2010/1
  - World Bank "LSS-type" survey
  - Repeated cross-sections

Forest conditions and creation of Community Forest User Groups



Diffusion of Community Forest User Groups



By the end of 2016, 19824 CFUGs managed 1.9 million hectares of forest in Nepal, one eighth of the country, around half of countries' forest.

Leaf Area index & CFUG

Table: Main trends related to forests in Nepal 2001 - 2013

	FUG share in VDC			MODIS share forested area		
	overall	$<$ median 1990 forest cover	$>$ median 1990 forest cover	overall	$<$ median 1990 forest cover	$>$ median 1990 forest cover
2001	0.083	0.048	0.119	0.231	0.083	0.379
2013	0.124	0.064	0.184	0.237	0.078	0.397
relative change	49%	34%	55%	3%	-6%	5%

	Leaf Area Index			Copernicus NDVI		
	overall	$<$ median 1990 forest cover	$>$ median 1990 forest cover	overall	$<$ median 1990 forest cover	$>$ median 1990 forest cover
2001	1.052	0.527	1.577	0.474	0.337	0.611
2013	1.326	0.650	2.001	0.517	0.369	0.665
relative change	26%	23%	27%	9%	9%	9%

Leaf Area index & CFUG

$$LAI_{vt} = \alpha CFUGshare_{vt-1} + \beta_k X_{kvt} + \eta_v + \delta_t + \varepsilon_{vt}. \quad (2)$$

with

- LAI, the Leaf area index of village v in year t
- $CFUGshare$, the share of village area managed by CFUGs
- X_k, a vector of k village level controls
- η, village fixed effects
- δ, year fixed effects
- ε, the error term

Leaf Area index as a function of CFUG expansion

Table: Vegetation indices as a function of CFUG expansion in the Hills and Mountains

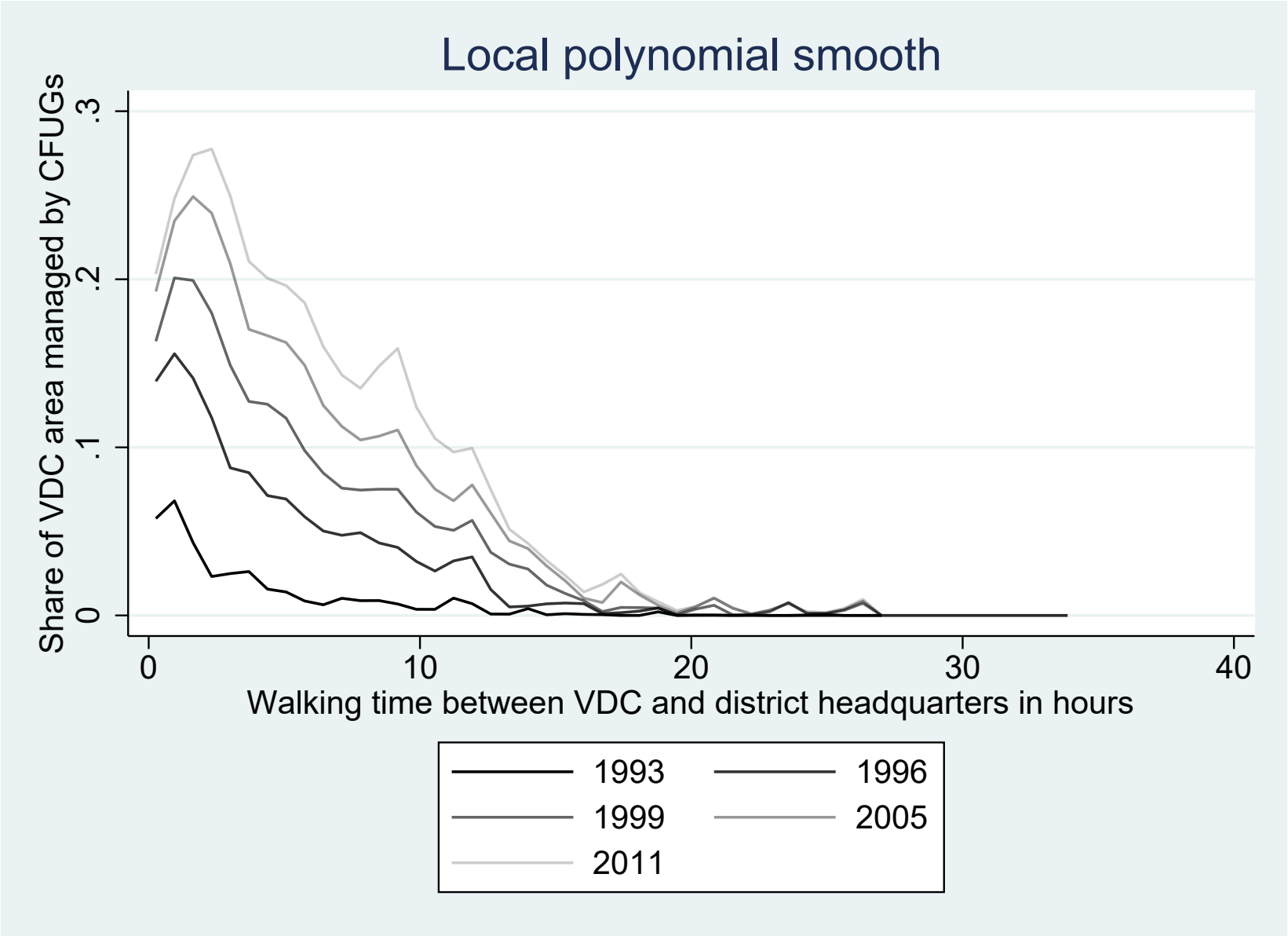
	Leaf Area Index (Verger et al., 2014)			NDVI (Swinnen and Toté, 2017)			NDVI (Pinzon and Tucker, 2014)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FUG share in VDC	0.448***	0.430***	0.365***	0.0176*	0.0172*	0.0125	0.0627***	0.0607***	0.0505***
	[7.36]	[7.25]	[7.29]	[1.93]	[1.89]	[1.52]	[3.56]	[3.48]	[3.13]
Years since FUG in district	0.0136***	0.0135***	0.0123***	-0.000434*	-0.000424*	-0.000506**	0.00351***	0.00352***	0.00321***
	[5.10]	[5.03]	[4.70]	[-1.82]	[-1.77]	[-2.33]	[7.92]	[7.83]	[7.35]
Forest in 1950 ×	-0.000184	0.000757	0.00138	-0.000138	-0.000125	-0.0000800	-0.00129*	-0.00116	-0.00104*
FUG years in district	[-0.05]	[0.21]	[0.46]	[-0.42]	[-0.36]	[-0.26]	[-1.92]	[-1.66]	[-1.70]
Population density		-0.000000916**	-0.00000103**		-0.000000214***	-0.000000230***		-0.000000206***	-0.000000235***
		[-2.55]	[-2.16]		[-4.82]	[-4.15]		[-4.05]	[-4.02]
Biogas per household			0.882***			0.0633***			0.163***
			[6.02]			[5.04]			[4.88]
Lagged Nightlight			-0.00183			-0.000406*			-0.00140***
			[-1.06]			[-1.97]			[-3.13]
Access to road			-0.00109			-0.000352			0.00386
			[-0.10]			[-0.21]			[1.49]
VDC fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Environment controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations (in ha.)	139495824	134635735	134616066	139419180	134559091	134539422	139457591	134597502	134577833
Observations (VDC×year)	2564×13	2483×13	2482×13	2563×13	2482×13	2481×13	2563×13	2482×13	2481×13

Environment controls include rainfall, snow cover, growing degree days and conflict related casualties. We derive population data from the 2011 and 2011 population census and interpolate figures.
Standard errors clustered at the district level, regression weighted by VDC area. t-statistics in brackets, $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

Potential endogeneity of CFUG creation

- Forest conditions may actually affect the creation of CFUGs
  - Villages with high social capital may already have started to manage their forest and get their CFUG before other villages
  - Villages with highly depleted forest may be handed over with less reluctance by the Department of Forests (DoF)
- Predicting CFUG creation based on an exogenous variable
  - The creation of a CFUG requires the intervention of civil servants based in district headquarters.
  - Given the low connectivity in Nepal and the size of the CFUG program, creations and registrations of groups first took place near DoF offices. (This is also the argument of Edmonds (2002) for the Arun Valley)
  - use the interaction between walking time to a given VDC and the number of years since the first creation of a CFUG in the district

Transfer of forest management to CFUGs



Transfer of forest management to CFUGs

$$CFUGshare_{vt} = \beta_1 \text{Proximity}_v \times \text{TO}_{dt} + \mathbf{Z_{vt}\Theta} + \gamma_v + \tau_t + \varepsilon_{vt} \quad (3)$$

with

- $CFUGshare$, the share of village area managed by CFUGs
- $Proximity$, the inverse of the walking time between a village and the district headquarters
- TO, the number of years since the program has started in a given district
- Village v and time t fixed effects, time and space varying controls Z and an error term ε

Leaf Area index as a function of CFUG expansion: IV

Table: Vegetation indices as a function of CFUG expansion in the Hills and Mountains: instrumental variable approach

	Leaf Area Index (Verger et al., 2014)			NDVI (Swinnen and Toté, 2017)			NDVI (Pinzon and Tucker, 2014)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FUG share in VDC	4.594***	4.868***	5.644***	0.291***	0.343***	0.399***	0.531***	0.591***	0.647***
	[4.98]	[5.06]	[4.23]	[3.19]	[3.61]	[2.86]	[3.05]	[3.25]	[2.67]
Years since FUG in district	0.00865***	0.00872***	0.00757***	-0.000760***	-0.000773***	-0.000849***	0.00295***	0.00295***	0.00268***
	[3.36]	[3.39]	[2.89]	[-2.84]	[-2.82]	[-3.24]	[6.25]	[6.32]	[5.69]
Forest in 1950	-0.0198***	-0.0225***	-0.0264***	-0.00143***	-0.00183***	-0.00211***	-0.00350***	-0.00394***	-0.00418***
× FUG years in district	[-3.39]	[-3.46]	[-3.20]	[-2.93]	[-3.22]	[-2.82]	[-3.72]	[-3.69]	[-3.16]
Population density		-0.000000944	-0.000000794		-0.000000216***	-0.000000213***		-0.000000209***	-0.000000208***
		[-1.44]	[-1.28]		[-3.13]	[-3.14]		[-3.47]	[-3.77]
Biogas per household			-0.540			-0.0410			0.00229
			[-1.18]			[-0.97]			[0.04]
Lagged Nightlight			-0.00507			-0.000642*			-0.00177**
			[-1.30]			[-1.75]			[-2.58]
Access to road			0.0514*			0.00350			0.00979**
			[1.77]			[1.15]			[1.97]
First stage results									
Walking distance Hq	0.00547***	0.00563***	0.00414***	0.00547***	0.00563***	0.00414***	0.00547***	0.00563***	0.00414***
× FUG years in district	[4.59]	[4.65]	[4.06]	[4.59]	[4.65]	[4.05]	[4.59]	[4.65]	[4.05]
Years since FUG in district	0.000249	0.000129	0.000203	0.000250	0.000131	0.000205	0.000250	0.000131	0.000204
	[0.53]	[0.28]	[0.51]	[0.53]	[0.28]	[0.52]	[0.53]	[0.28]	[0.52]
Forest in 1950	0.00497***	0.00548***	0.00544***	0.00497***	0.00548***	0.00544***	0.00497***	0.00548***	0.00544***
× FUG years in district	[3.32]	[3.52]	[4.03]	[3.32]	[3.52]	[4.03]	[3.32]	[3.51]	[4.03]
Population density		-0.000000331***	-0.000000283***		-0.000000331***	-0.000000283***		-0.000000331***	-0.000000283***
		[-3.08]	[-2.63]		[-3.08]	[-2.63]		[-3.08]	[-2.63]
Biogas per household			0.245***			0.246***			0.245***
			[3.55]			[3.54]			[3.55]
Lagged Nightlight			0.000730			0.000728			0.000730
			[1.25]			[1.25]			[1.25]
Access to road			-0.00875*			-0.00878*			-0.00875*
			[-1.89]			[-1.89]			[-1.89]
VDC fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Environment controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations (in ha.)	139495824	134635735	134616066	139419180	134559091	134539422	139457591	134597502	134577833
Observations (VDC×year)	2564×13	2483×13	2482×13	2563×13	2482×13	2481×13	2563×13	2482×13	2481×13

Environment controls include rainfall, snow cover, growing degree days and conflict related casualties. We derive population data from the 2011 and 2011 population census and interpolate figures.
Standard errors clustered at the district level, regression weighted by VDC area, t-statistics in brackets, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Change in Leaf Area Index as a function of CFUG creation

- Column (1) indicates that a 10% increase in the share of village area managed by a CFUG is followed by an increase in the LAI of 0.04.
- In terms of magnitude, with an average LAI of 1.3 and 12% of the village area managed by a CFUG in 2013, the contribution of the CFUG program to the increase in tree cover is estimated to be about 4%.

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- We expect selection bias when (and where) forest management gets transferred to communities
- After instrumenting, a 12% increase in CFUG coverage increases the LAI by 0.55, a 40% increase.
- After instrumenting, an hypothetical village that would go from no management by CFUG to full management (100% of its area) would have an increase of its LAI by 4.6, basically the difference between a densely forested pixel in Shivapuri national park and Kathmandu city.

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- Large change BUT the DoF tends to hand over
  - forests plots that are already degraded and under the threat of further degradation
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  - "Community forestry is created to form a buffer protecting state forests" ▸ map

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- robust if we control for night-time light and road network expansion (both are however bad controls)

Longer-term effects

- One may expect that forest regeneration takes time, we therefore estimate following descriptive relation:

$$LAI_{vt} = \sum_{z=0}^{20} \alpha_z \text{Proportion of VDC area managed by FUG}_{vt-z} + \mathbf{X_{vt}\Theta} + \gamma_v + \delta_{dt} + \varepsilon_{vt} \quad (4)$$

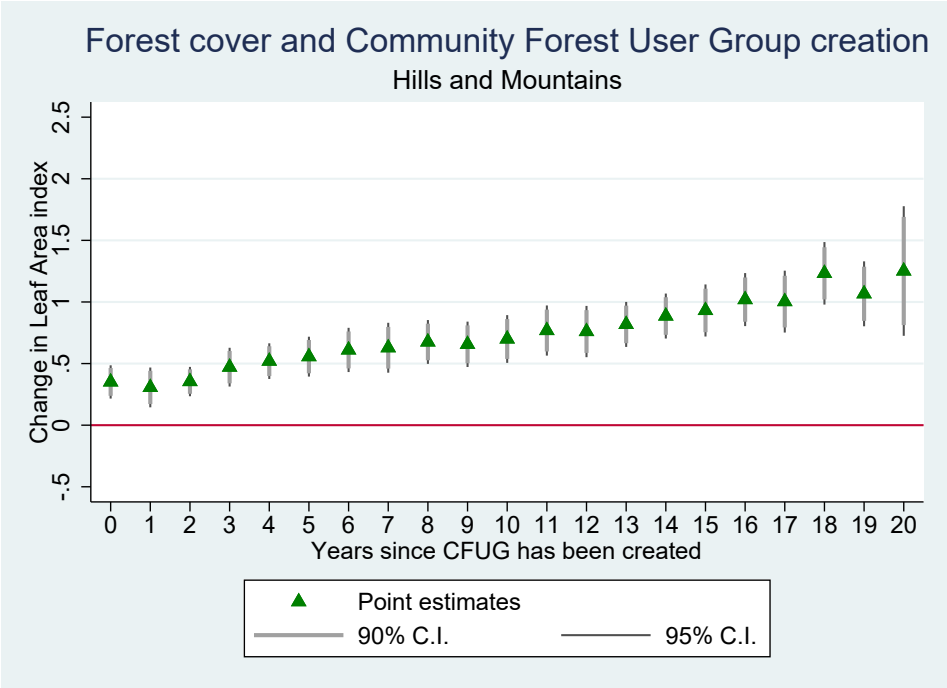
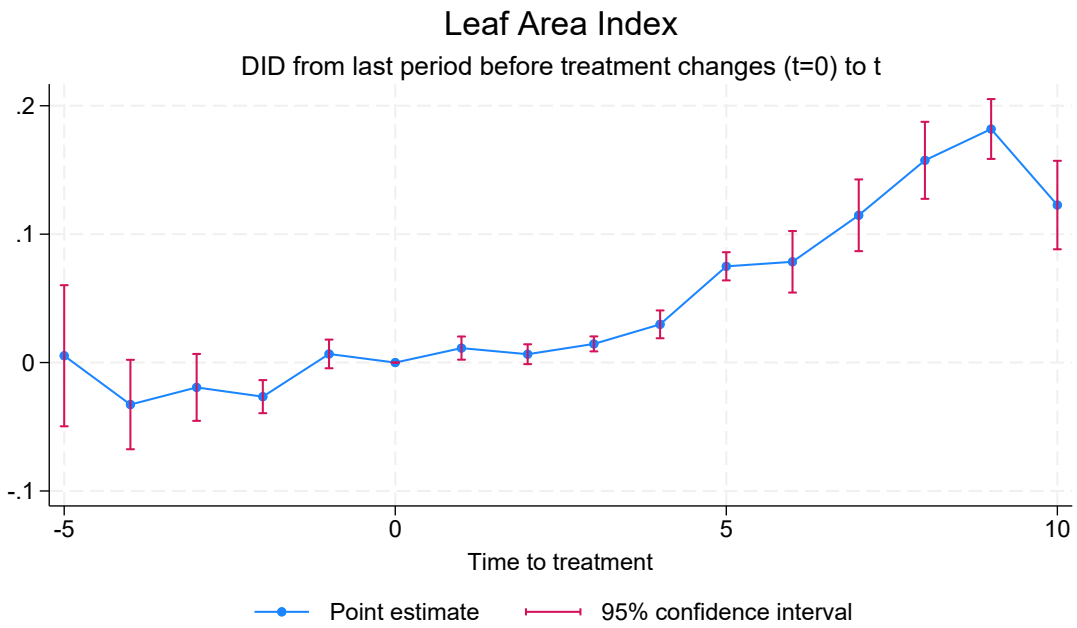


Figure: Forest cover and CFUG creation over time

Longer-term effects: LAI

- An alternative approach is to handle the staggered adoption of community forestry using recently developed estimation techniques (de Chaisemartin and D'Haultfoeuille [REStat, 2024])



- No clear pre-treatment pattern, then consistent upward trend after the creation of a group, with a statistically significant improvement after 3 years of treatment
- Average cumulative total effect per treatment unit: 0.728 (with a 95% Confidence interval given by: [.601; .855]). It can be compared to the average LAI in 2001 of 1.05

Longer-term effects: NDVI

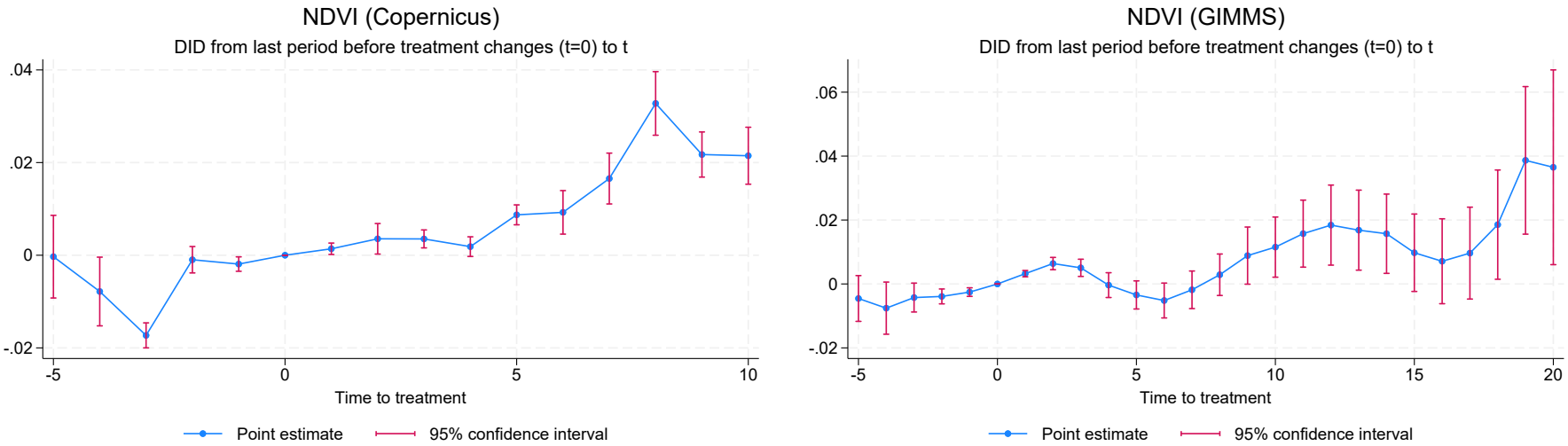


Figure: Short- and long- term effects of CFUG creation on the NDVI

What do CFUGs do?

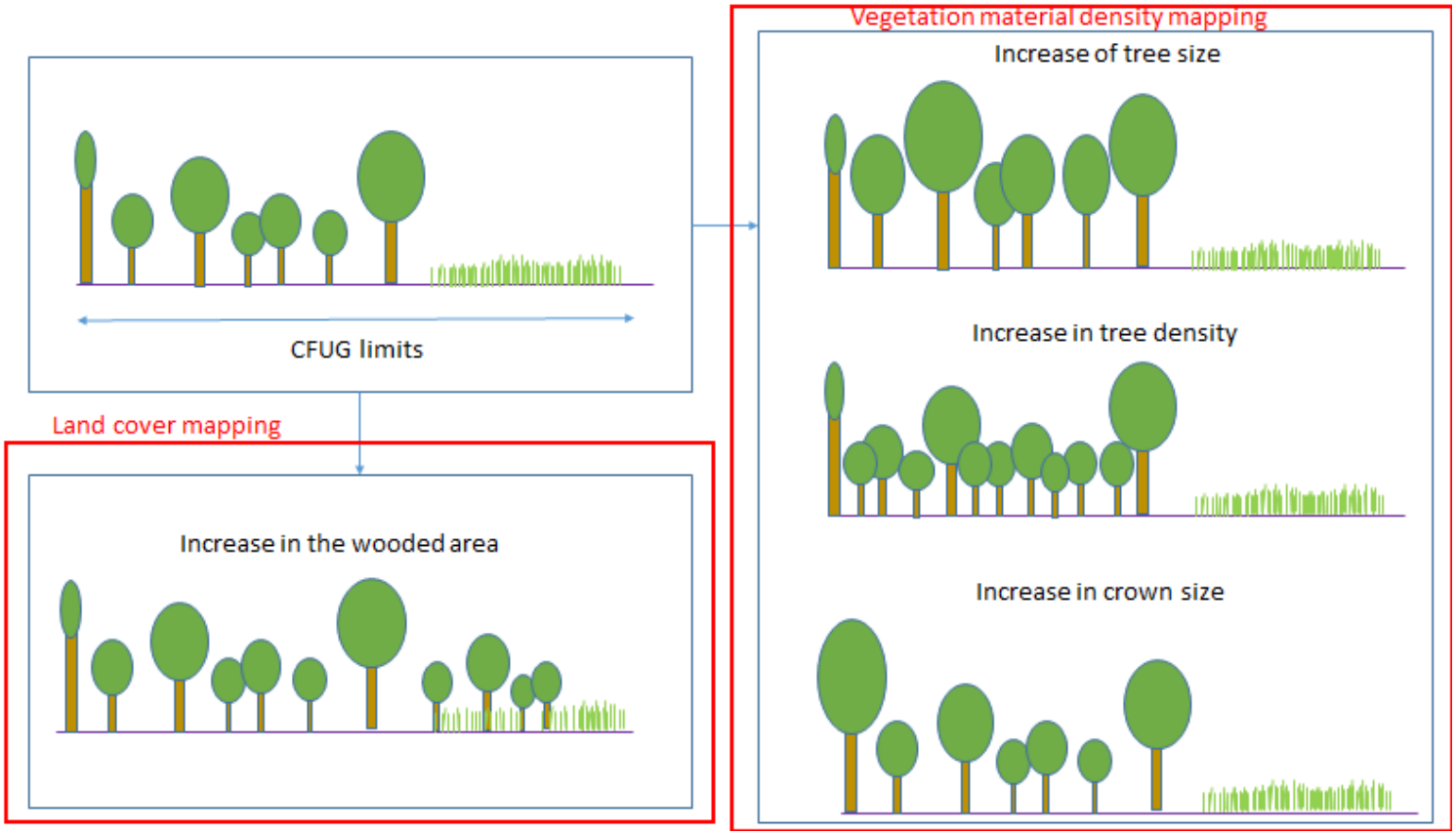
- Two primary reasons may explain why LAI rises with the expansion of community forestry:
  1. CFUGs can contribute to the expansion of forested areas
  2. CFUGs can prevent forest degradation and "densify" forests
- Changes in forest cover by CFUG presence in 2013

Share of village area managed by CFUG in 2013

	Below median	Above Median
Forest cover in 2001	15.9%	30.4%
Forest cover in 2013	15.3%	32.3%
Change in percentage	-3.8%	6.8%

What do CFUGs do?

Figure: Extensive or intensive margin ?



What do CFUGs do: better management and plantations

Table: Land use change as a function of CFUG expansion in the Hills and Mountains

	Forest	Mixed forest	Needle Leaf	Broadleaf	Grassland	Cropland	Shrub-land
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.Share FUG in VDC	0.0764***	0.0661***	0.00821**	0.00203	0.00274	-0.0172***	-0.0735***
	[4.69]	[4.49]	[2.17]	[0.26]	[0.45]	[-2.95]	[-4.32]
L.years since FUG in district	0.00138***	0.00174***	-0.000121*	-0.000230*	-0.000559**	-0.00115***	0.0000642
	[3.12]	[4.23]	[-1.78]	[-1.83]	[-2.58]	[-4.23]	[0.15]
L.Forest in 1950	-0.00258***	-0.00164**	0.0000510	-0.000990***	-0.00114***	0.00136***	0.00170**
× FUG years in district	[-4.00]	[-2.60]	[0.27]	[-3.60]	[-3.23]	[3.25]	[2.18]
VDC fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Environmental controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations (in ha.)	139495824	139495824	139495824	139495824	139495824	139495824	139495824
Observations (VDC×year)	2564×13	2564×13	2564×13	2564×13	2564×13	2564×13	2564×13
Mean in 2001	0.231	0.143	0.029	0.059		0.036	0.348

Environment controls include rainfall, snow cover, growing degree days and conflict related casualties.

Standard errors clustered at the district level, regression weighted by VDC area. t-statistics in brackets, $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

What do CFUGs do: better management and plantations

Table: Land use change as a function of CFUG expansion in the Hills and Mountains, IV approach

	First stage	Forest	Mixed forest	Needle Leaf	Broadleaf	Grassland	Cropland	Shrub-land
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
L.Share FUG in VDC		0.583***	0.405**	0.0686*	0.109	0.0517	-0.390***	-0.494***
		[3.14]	[2.29]	[1.84]	[1.61]	[0.69]	[-3.22]	[-3.02]
L.Walking distance Hq	0.00547***							
× FUG years in district	[4.59]							
L.years since FUG in district	0.000249	0.000781*	0.00133***	-0.000193**	-0.000358**	-0.000618**	-0.000702***	0.000565
	[0.53]	[1.78]	[3.17]	[-2.01]	[-2.40]	[-2.30]	[-2.78]	[1.38]
L.Forest in 1950	0.00497***	-0.00497***	-0.00324***	-0.000234	-0.00149***	-0.00138***	0.00312***	0.00368***
× FUG years in district	[3.32]	[-4.63]	[-3.61]	[-0.78]	[-3.45]	[-3.00]	[3.66]	[3.21]
VDC fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Environmental controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations (in ha.)	139495824	139495824	139495824	139495824	139495824	139495824	139495824	139495824
Observations (VDC×year)	2564×13	2564×13	2564×13	2564×13	2564×13	2564×13	2564×13	2564×13

Standard errors clustered at the district level, regression weigthed by VDC area. t-statistics in brackets, $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

What do CFUGs do: better management and plantations

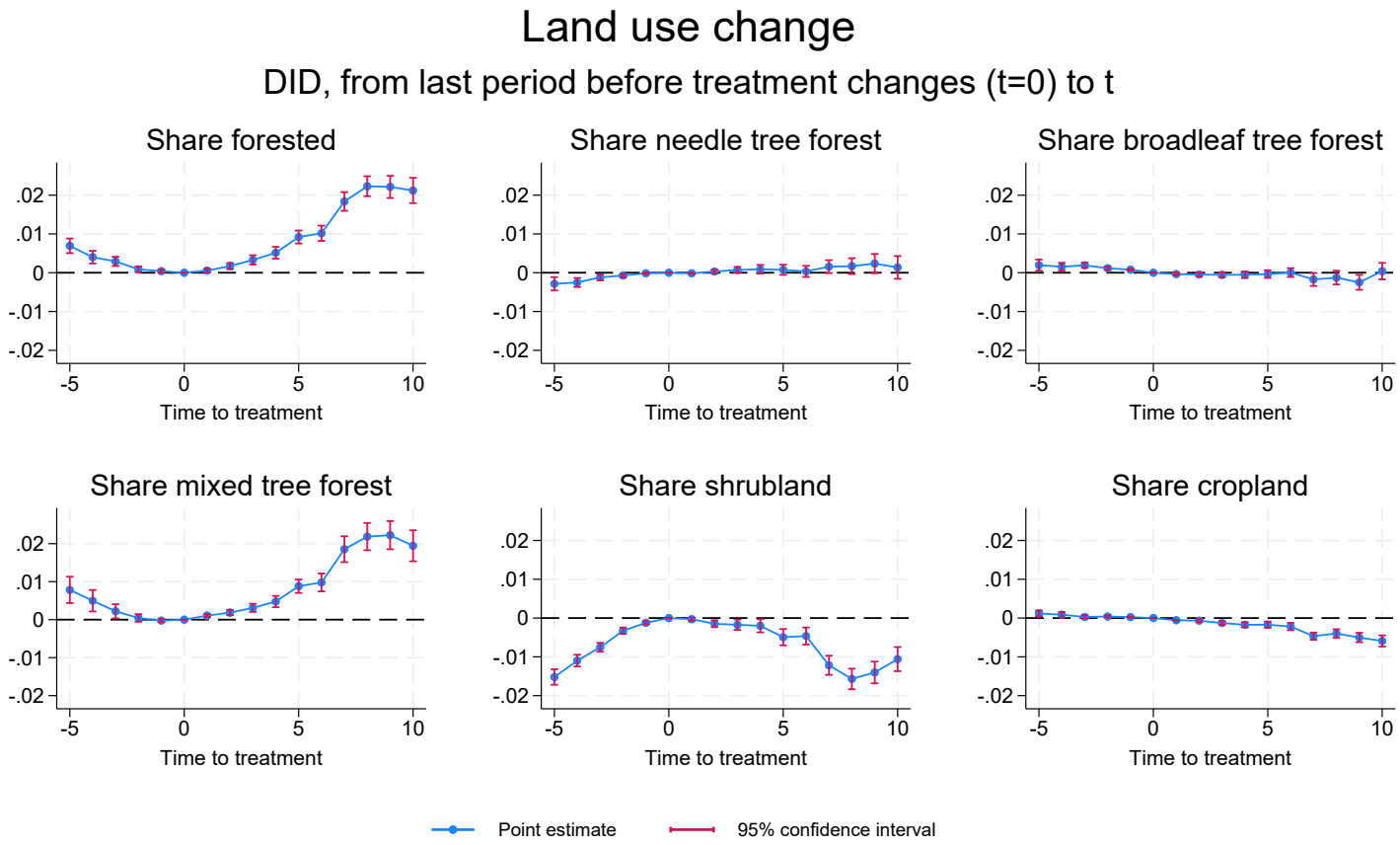
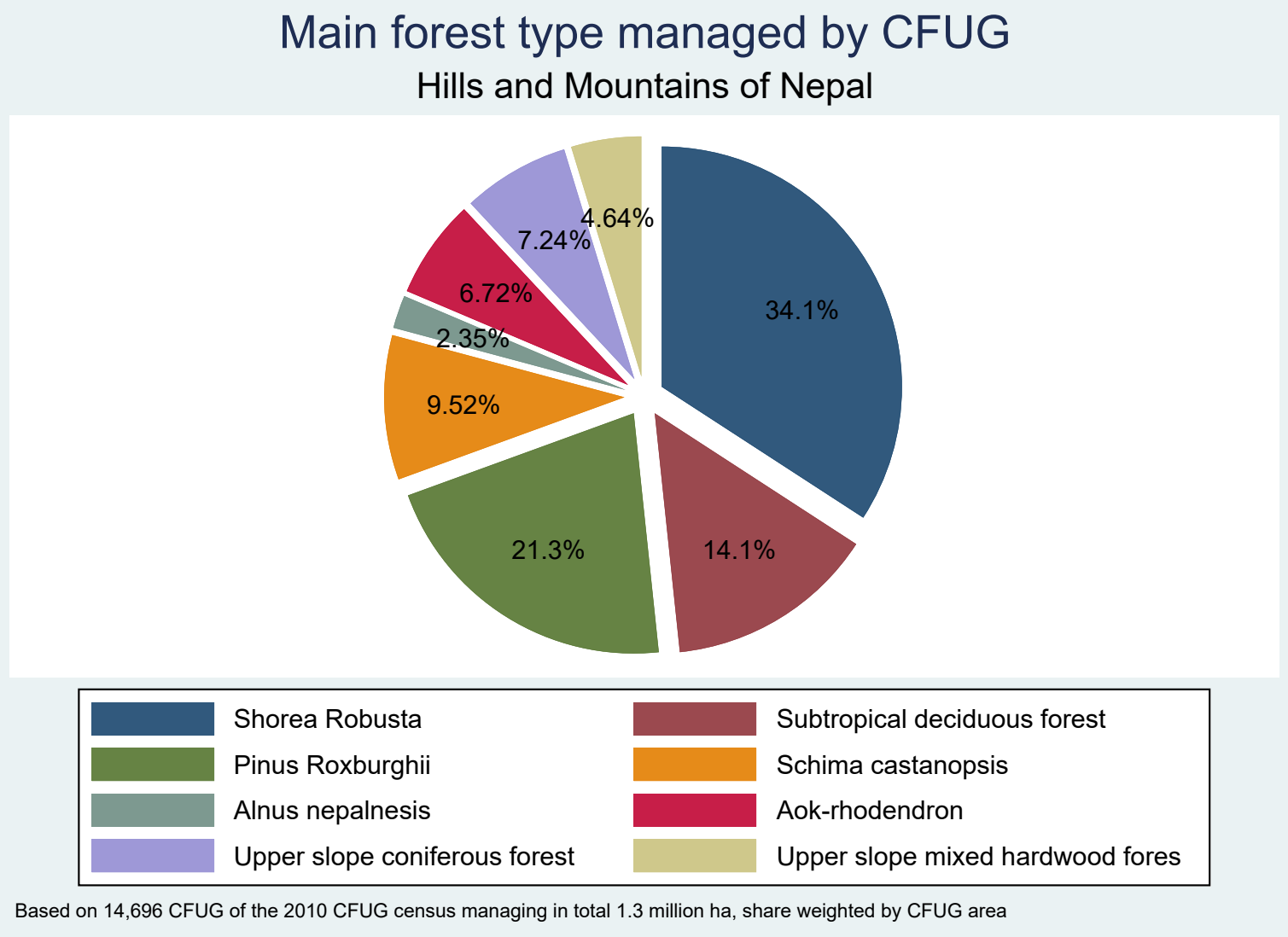


Figure: Dynamic effects of CFUG creation on land use

Estimations based on de Chaisemartin and d'Haultefoeuille (2024), controls include year and village fixed-effects, annual precipitations, snow cover, growing degree days, and conflict casualties.

What do CFUGs do: better management and plantations

Figure: CFUG main forest type



What do CFUGs do: forest extension or forest density ?

Table: Vegetation indices as a function of CFUG expansion in the Hills and Mountains: intensive margin

	Leaf Area Index (Verger et al., 2014)			NDVI (Swinnen and Toté, 2017)			NDVI (Pinzon and Tucker, 2014)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
L.Share FUG in VDC	0.600***	0.312***	-0.324*	0.0322**	0.00873	0.00851	0.0909***	0.0515***	-0.0456
	[7.35]	[6.29]	[-1.78]	[2.53]	[1.07]	[0.36]	[4.06]	[3.02]	[-0.77]
Share of forest land cover in VDC		1.776***			0.116***			0.147***	
		[13.39]			[8.36]			[5.98]	
L.Share FUG in VDC			1.139***			0.0134			0.160*
× Forest share in 1990			[3.70]			[0.34]			[1.78]
L.years since FUG in district	0.00494**	0.0111***	0.0143***	-0.000838**	-0.000595***	-0.000426*	0.00234***	0.00331***	0.00360***
	[2.58]	[5.34]	[5.26]	[-2.56]	[-2.80]	[-1.80]	[4.31]	[8.10]	[8.09]
L.Forest in 1950	0.00997***	0.00440	-0.00148	0.000452	0.000161	-0.000153	0.000644	-0.000914	-0.00148**
× FUG years in district	[3.30]	[1.51]	[-0.41]	[1.02]	[0.51]	[-0.46]	[0.70]	[-1.43]	[-2.26]
VDC fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Environment controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Subsample of VDC with stable forest share	Yes	No	No	Yes	No	No	Yes	No	No
Observations (in ha.)	45139146	139495824	139495824	45084690	139419180	139419180	45100913	139457591	139457591
Observations (VDC × year)	678x13	2563X13	2563X13	678x13	2563X13	2563X13	678x13	2563X13	2563X13

Environment controls include rainfall, snow cover, growing degree days and conflict related casualties.

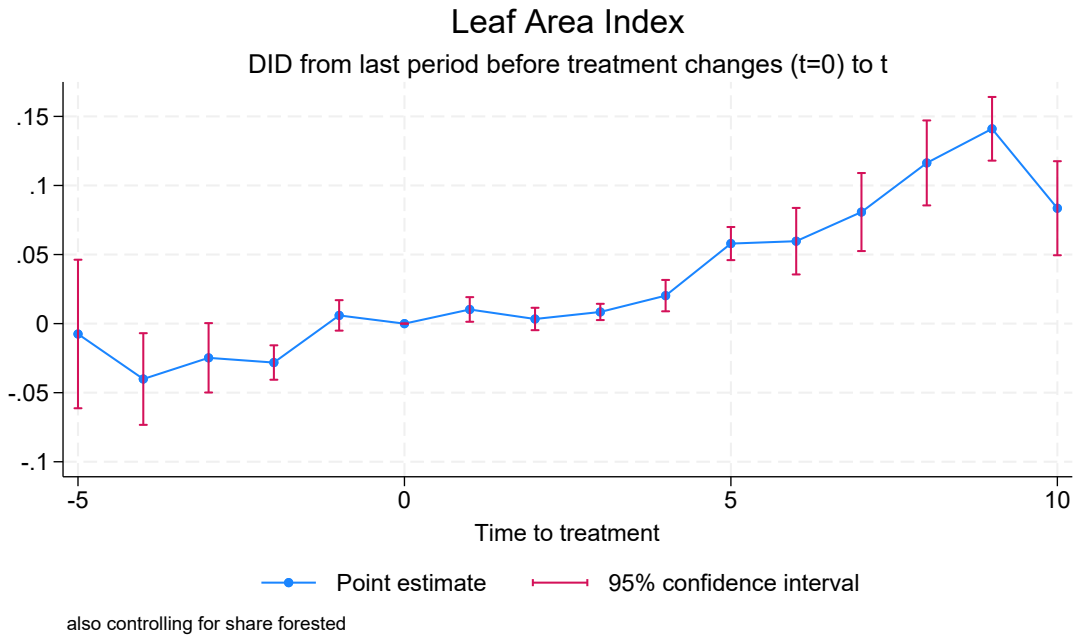
"Stable forest" is defined as the subset of villages whose share of the area forested changes by less than 1%. We compute "Forest share in 1990" based on [?]

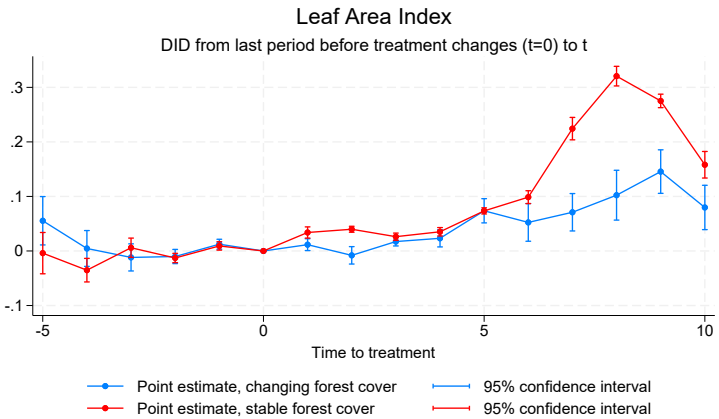
Standard errors clustered at the district level, regression weighted by VDC area

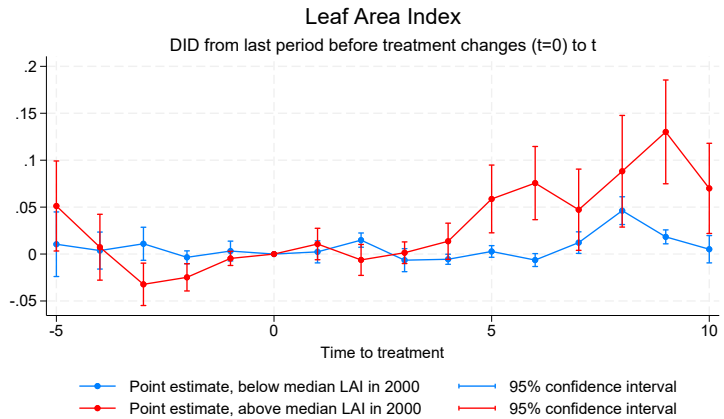
t-statistics in brackets, $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

$\Rightarrow$ Both extension and densification happen, still, with a clear gain in forest density

What do CFUGs do: forest extension or forest density ?







Estimations based on de Chaisemartin and d'Haultefoeuille (2024), controls include year and village fixed-effects, annual precipitations, snow cover, growing degree days, and conflict casualties.

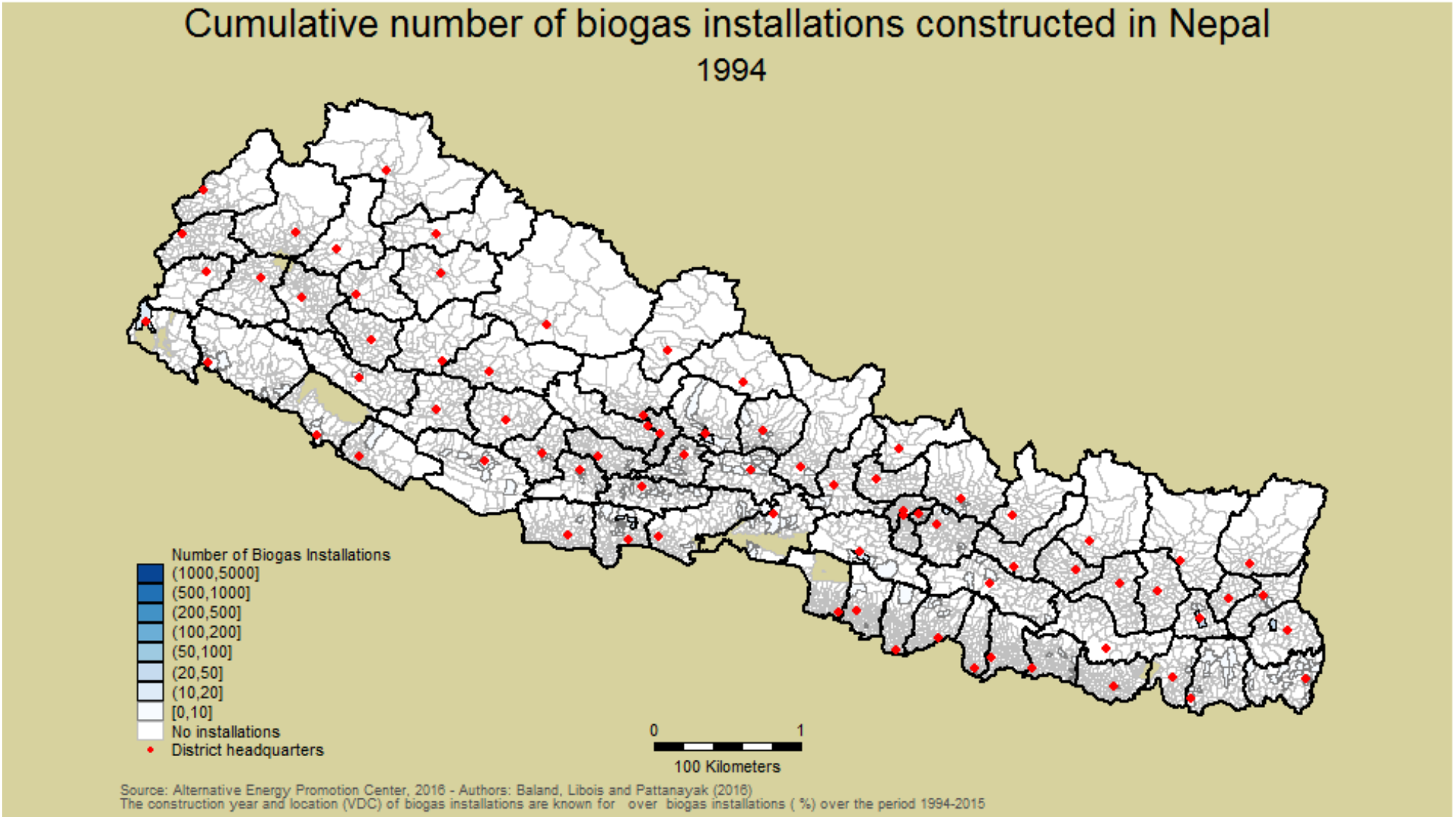
Household response

- CFUGs restrict the access to forest for livestock related activities
  - prohibit grazing
  - reduce and regulate fodder extraction

Household response

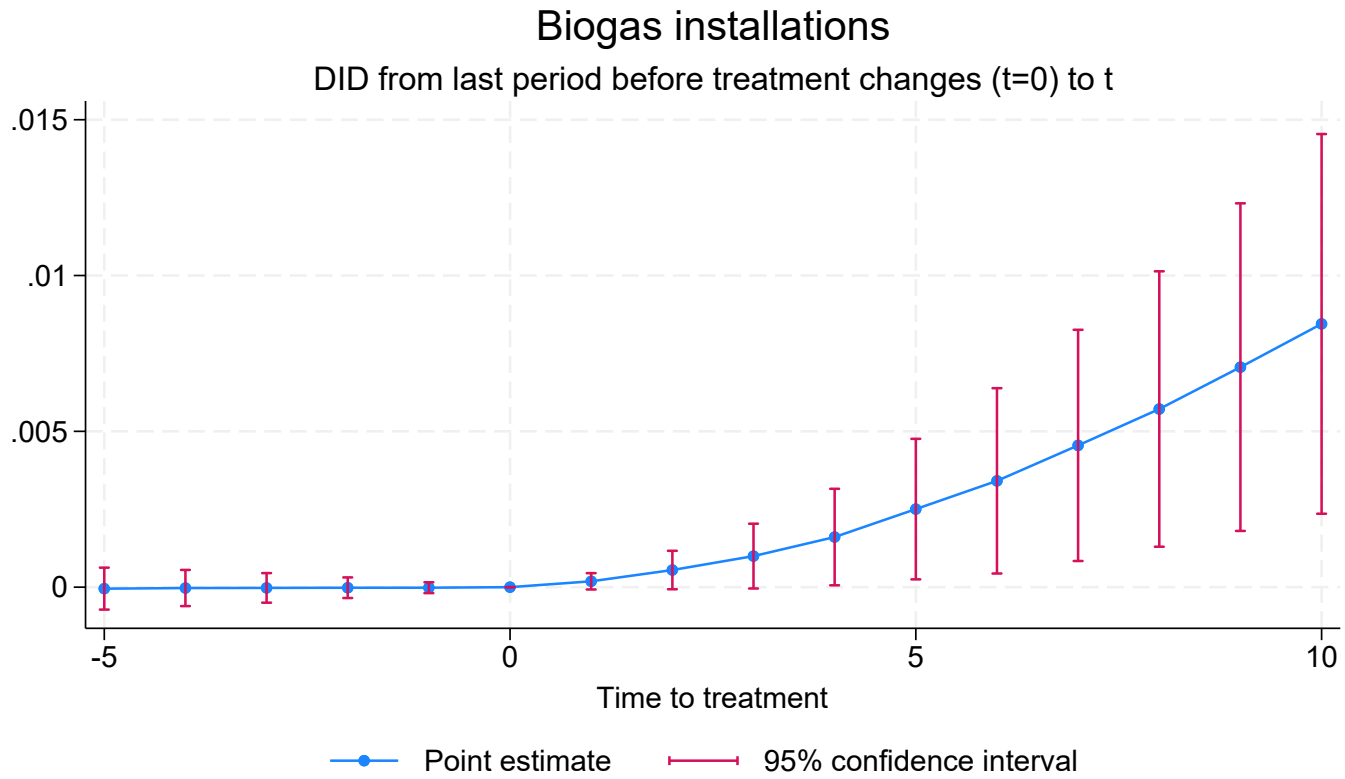
- CFUGs restrict the access to forest for livestock related activities
  - prohibit grazing
  - reduce and regulate fodder extraction
- No quantitative evidence
- See Baland et al. (JAERE, 2018) for a discussion of the link between livestock rearing and firewood collection
- Large qualitative evidence from field visits of the research team in 10 districts

Construction of biogas installations



What do CFUGs do? Reduced degradation

Figure: Biogas adoption (in number of installations per household)



- Effect estimated between 1990 and 2015.
- Given the "average cumulative (total) effect per treatment unit", CFUG creation has contributed to a 15% increase in the construction of biogas installations.

What do CFUGs do: reduced degradation

What do CFUGs do? Reduced degradation

Using the large cross-sectional Nepal Living Standard Survey (2003-4 and 2010-1), let's see how community forestry relates to household energy choices

$$Y_{hvt} = \alpha CFUG_{vt} + \mathbf{X}_{vt}\Phi + \mathbf{W}_{ht}\Gamma + \delta_d + \tau_t + \varepsilon_{hvt} \tag{5}$$

where

- Y stands for energy consumption of household h in village v at time t
- $CFUG$ stands for the share of village area managed by community forest
- $\mathbf{X}$ is a vector of village level controls
- $\mathbf{W}$ is a vector of household level controls
- δ and τ respectively are district and time fixed-effects

What do CFUGs do? Reduced degradation

	collection time (hrs)		Firewood collection (bhari)			
	(1)	(2)	(3)	(4)	(5)	(6)
% of Vil. area in FUG	1.218***	1.471***	-15.29	-27.94**	-9.193	-20.94*
	(0.432)	(0.463)	(11.32)	(11.48)	(11.11)	(11.44)
% of Vil. area in FUG 15 years ago		-1.160		65.47**		58.05**
		(1.064)		(26.11)		(23.75)
Med. collection time					-4.244***	-3.876***
					(1.417)	(1.372)
Years since 1st CFUG in district	-0.0159	-0.0113	1.988	1.736	1.837	1.627
	(0.0428)	(0.0426)	(1.418)	(1.397)	(1.379)	(1.364)
Proximity to district HQ	0.0334	0.0331	1.225**	1.245**	1.311**	1.322**
	(0.0231)	(0.0230)	(0.528)	(0.524)	(0.515)	(0.512)
Forest cover in 1950	-0.00520	-0.0247	3.988	4.834	4.987	5.651
	(0.259)	(0.260)	(7.020)	(7.200)	(6.832)	(6.973)
Household assets	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed-effect	Yes	Yes	Yes	Yes	Yes	Yes
Belt-Zone fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
Village controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3332	3332	3578	3578	3578	3578

Village controls include distance to paved road, war casualties, median elevation and standard deviation, snow cover, rainfall, growing degree days and cooling degree days

Standard errors in parentheses, clustered at the village level, $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

What do CFUGs do? Substitution towards alternative fuel

	Fuel expenditures (NPR)			
	(1)	(2)	(3)	(4)
% of Vil. area in FUG	1581.6*	1756.1*	1044.8	1083.3
	(826.8)	(953.3)	(721.7)	(826.6)
% of Vil. area in FUG, 15 years ago		-902.7		-190.2
		(2043.3)		(1711.8)
Med. collection time			373.6***	372.4***
			(135.2)	(134.7)
Years since	-277.8**	-274.3**	-264.6**	-263.9**
1st CFUG in district	(109.5)	(109.4)	(110.5)	(110.5)
Proximity to district HQ	-86.70*	-86.98*	-94.32**	-94.36**
	(47.30)	(47.37)	(46.52)	(46.55)
Forest cover in 1950	-795.1*	-806.8*	-883.1**	-885.3**
	(436.8)	(440.8)	(443.7)	(445.7)
Household assets	Yes	Yes	Yes	Yes
Year fixed-effect	Yes	Yes	Yes	Yes
Belt-Zone fixed-effects	Yes	Yes	Yes	Yes
Village controls	Yes	Yes	Yes	Yes
Observations	3578	3578	3578	3578

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Standard errors in parentheses, clustered at the village level, $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$

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- **Short- and long-run effects** do differ and public policies promoting community forest should also secure reliable access to substitutes to local products.

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- **Short- and long-run effects** do differ and public policies promoting community forest should also secure reliable access to substitutes to local products.
- Community forestry have **distributional consequences** at the local level, between the elite and others, between men and women...
- more

Discussion

- Community forestry in the Hills and the Mountains **contributes positively to forest regeneration** both by changing management practices and by reducing the energy demand of households addressed to forests, especially in the short-run.
- Net effect at the village level:
  - CFUG may be very well managed and have negative spillovers at the local level
  - CFUG may play the role of buffer area and increase the protection of state forests
  - CFUG may raise environmental awareness and increase tree cover on private plots
  - more
- **Short- and long-run effects** do differ and public policies promoting community forest should also secure reliable access to substitutes to local products.
- Community forestry have **distributional consequences** at the local level, between the elite and others, between men and women...
- more
- **Climate change mitigation ?**

Discussion: beyond Nepal

- Community forestry works in Nepal but it is compared to the pre-existing situation: forest managed by the Department of Forest, notably understaffed

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  - New needs, new skills $\rightarrow$ more human capital to manage forests?

Discussion: beyond Nepal

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- Community forestry as an intermediary step?
  - rural exodus is reducing the reliance on government and community forests
  - New needs, new skills $\rightarrow$ more human capital to manage forests?
- When energy is at stake, the classic measures of deforestation may miss most of the story, whether positive or negative
- Developing (remote sensing) measures of forest quality is important

Discussion: beyond Nepal

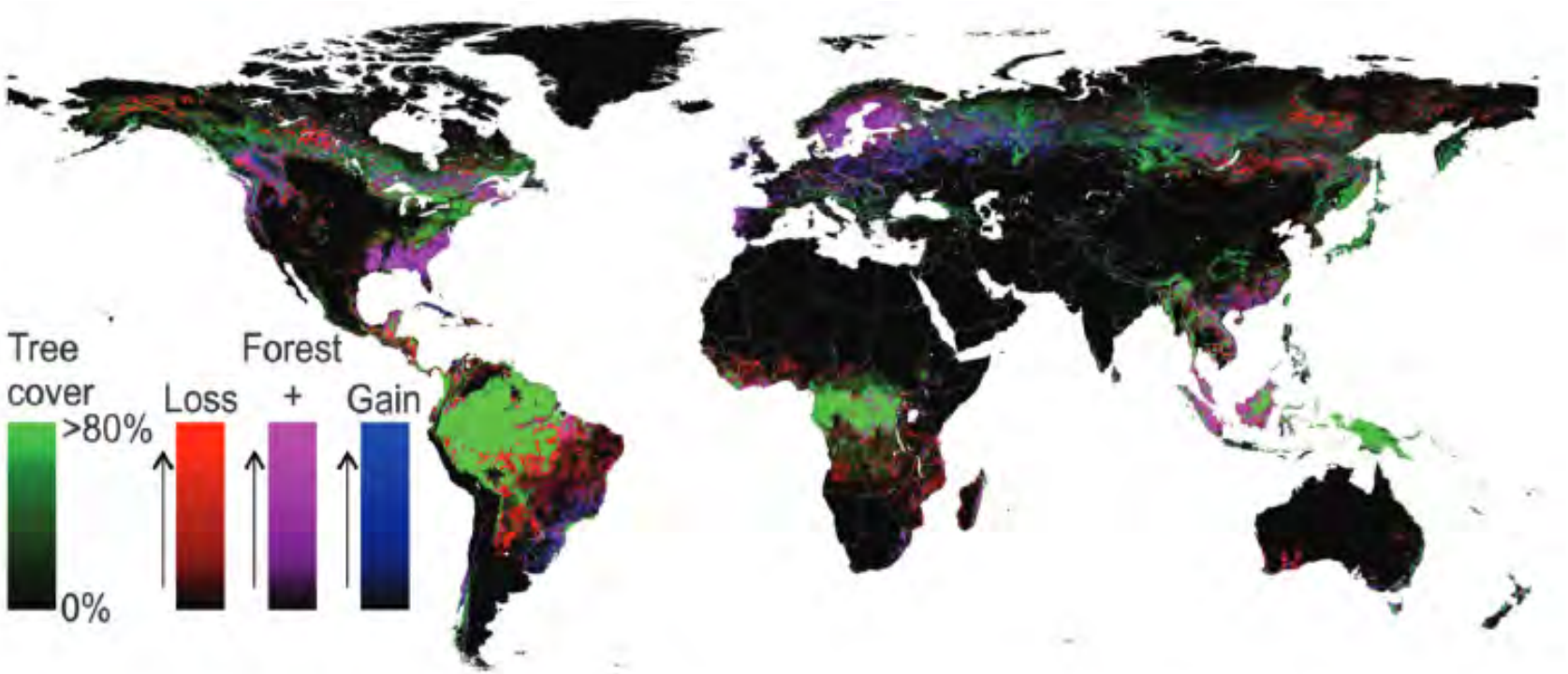
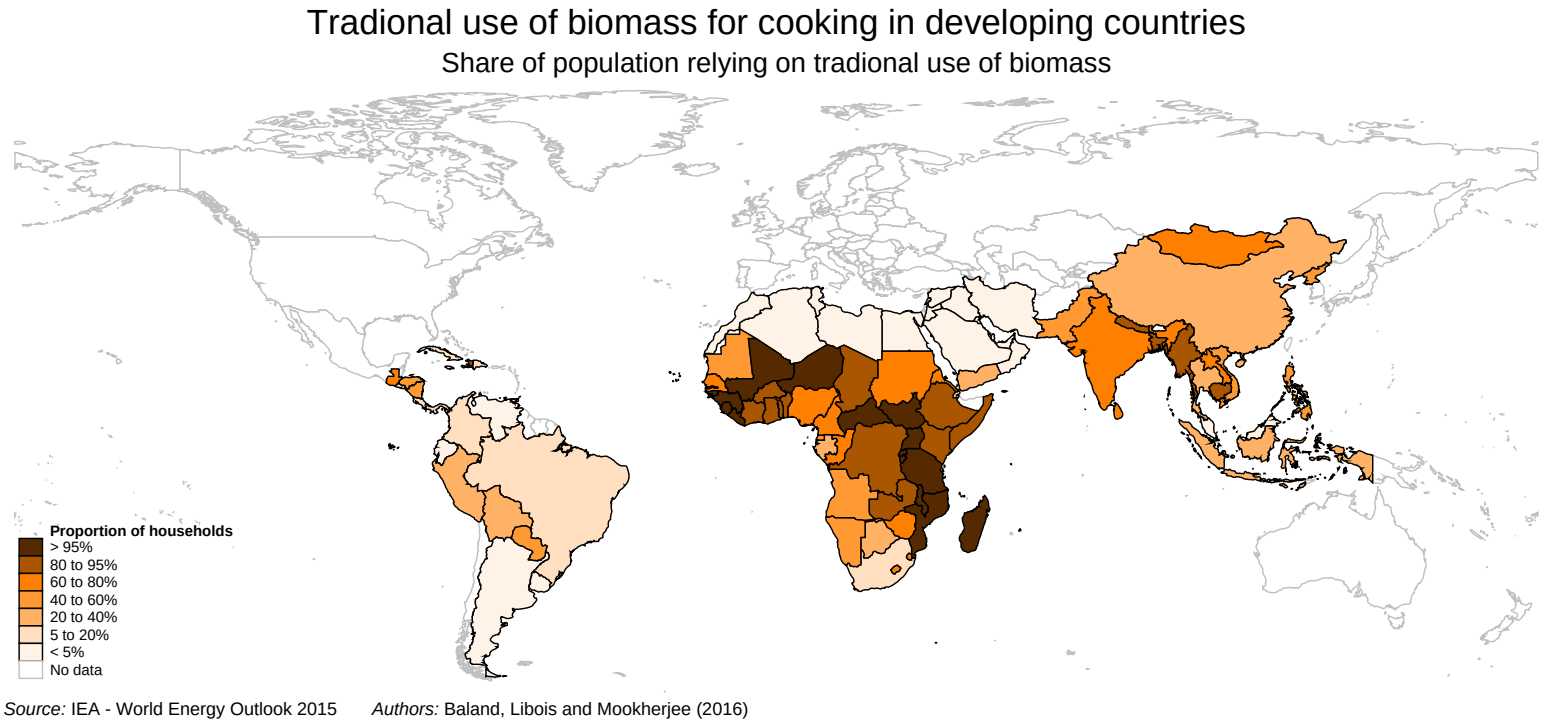


Figure 1: Deforestation (losses), afforestation (gains) and net afforestation between 2000 and 2012, source: Hansen et al. (2013).

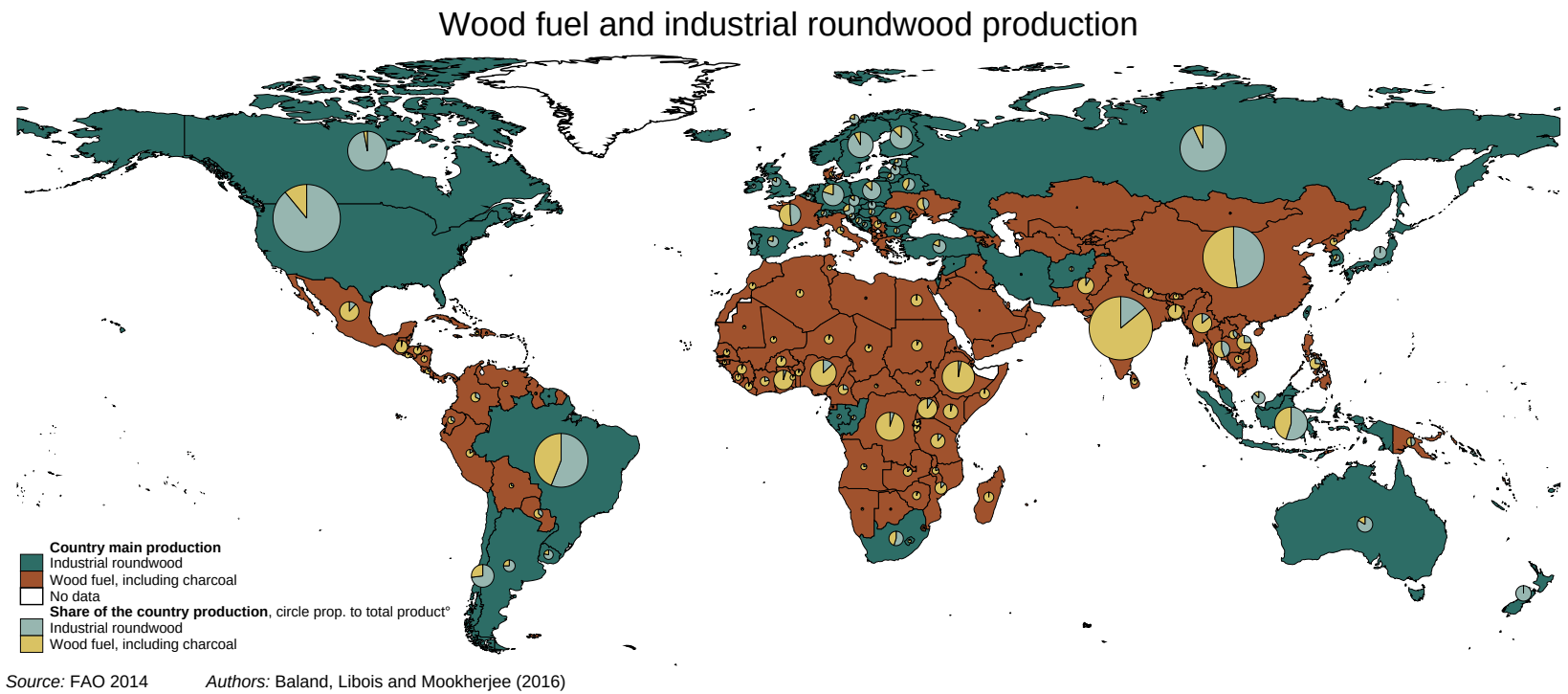
Discussion: beyond Nepal

- Traditional use of biomass is a very important source of energy in many developing countries, especially in rural areas (but not only)



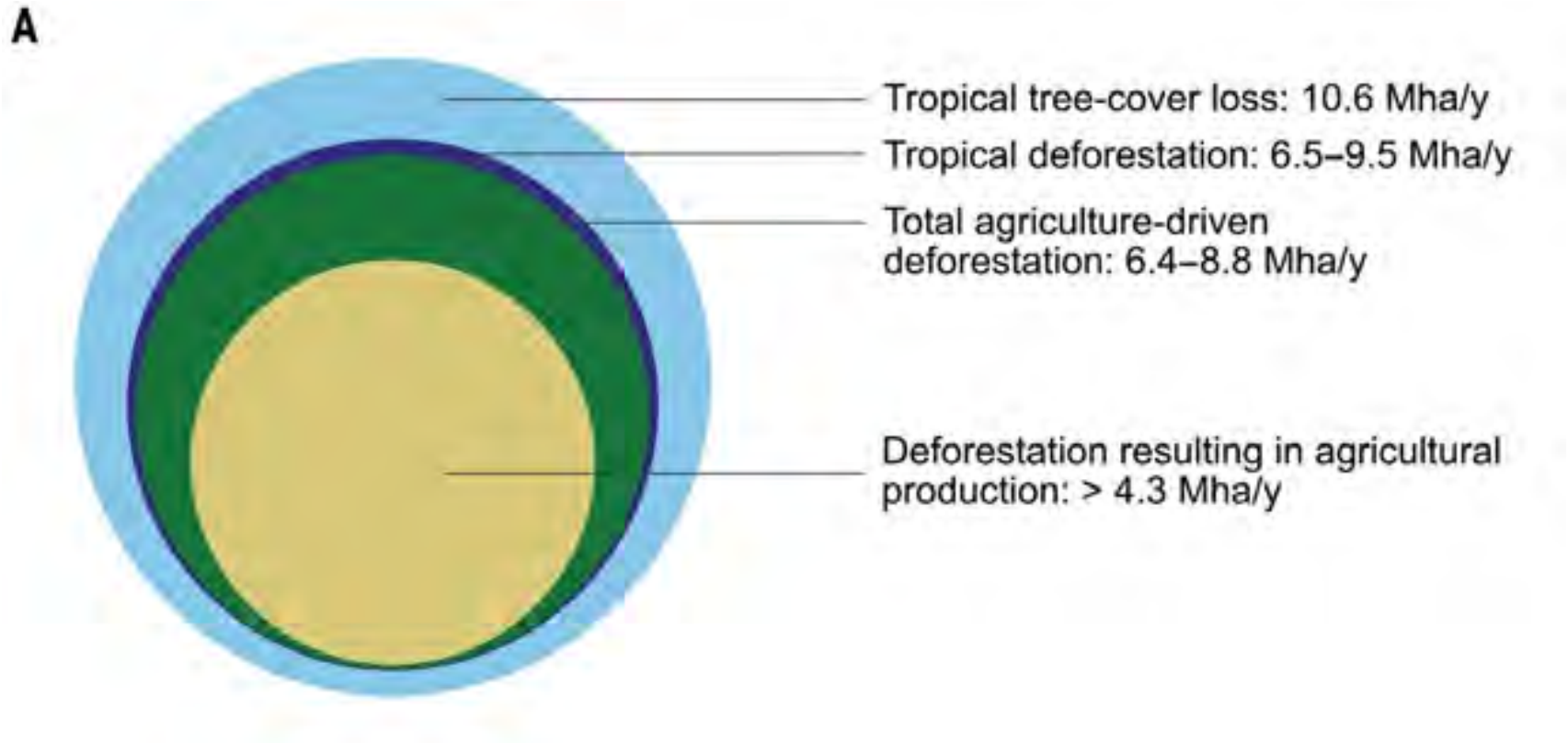
Discussion: beyond Nepal

- Biomass extraction for fuel is an important issue for many forested areas in the world, especially in South Asia and Sub-Saharan Africa



Discussion: beyond Nepal

The deforestation onion: energy, the missing channel?



Source: Pendrill et al. 2022 Science

The end: questions, suggestions and discussion...

The end, but also the beginning...

Local spill-overs

- Suppose now that one group works
- What happens for its neighbours ?

Local spill-overs

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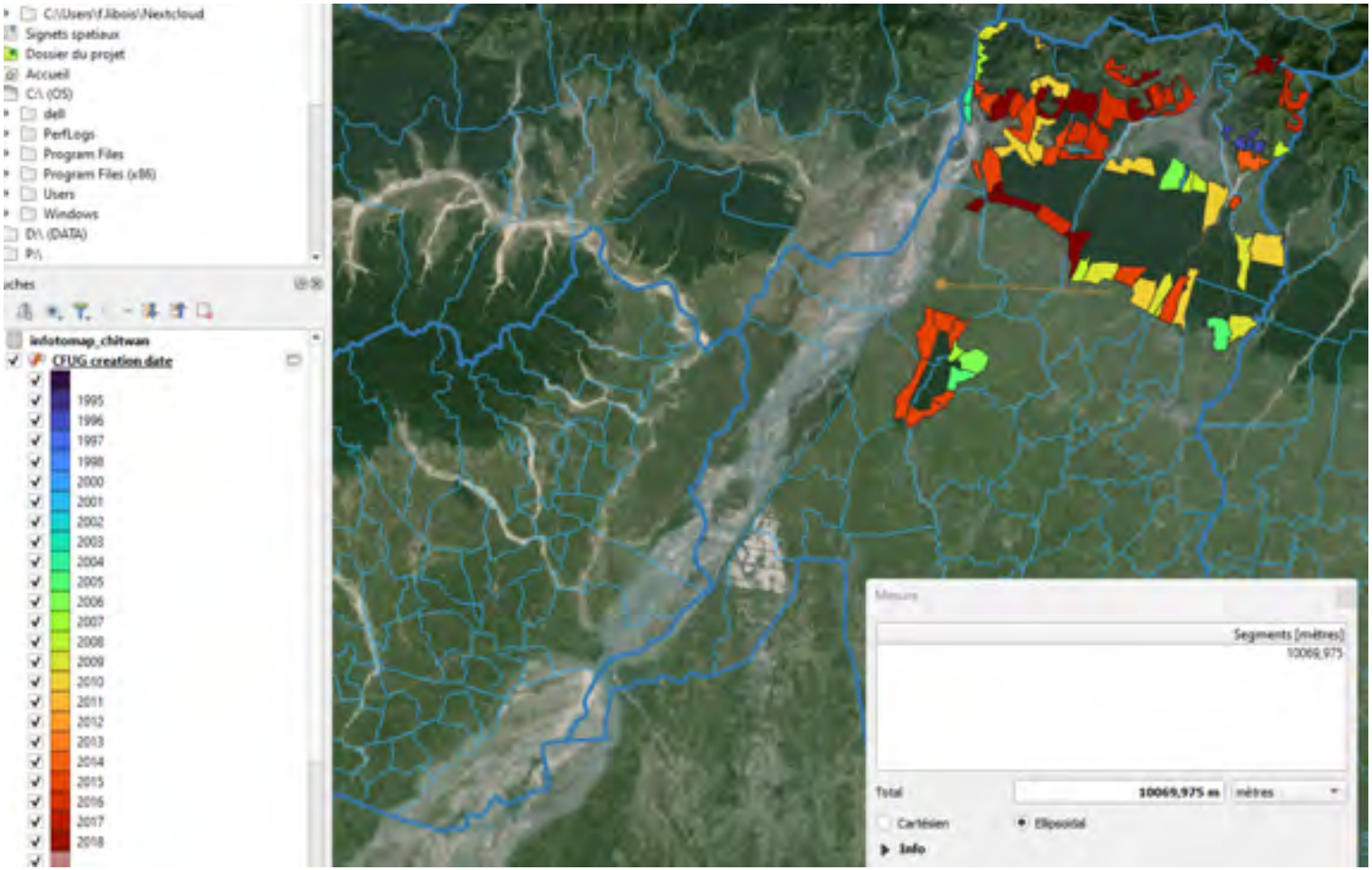
- What happens for its neighbours ?

Local spill-overs

Figure: Districts of Nepal

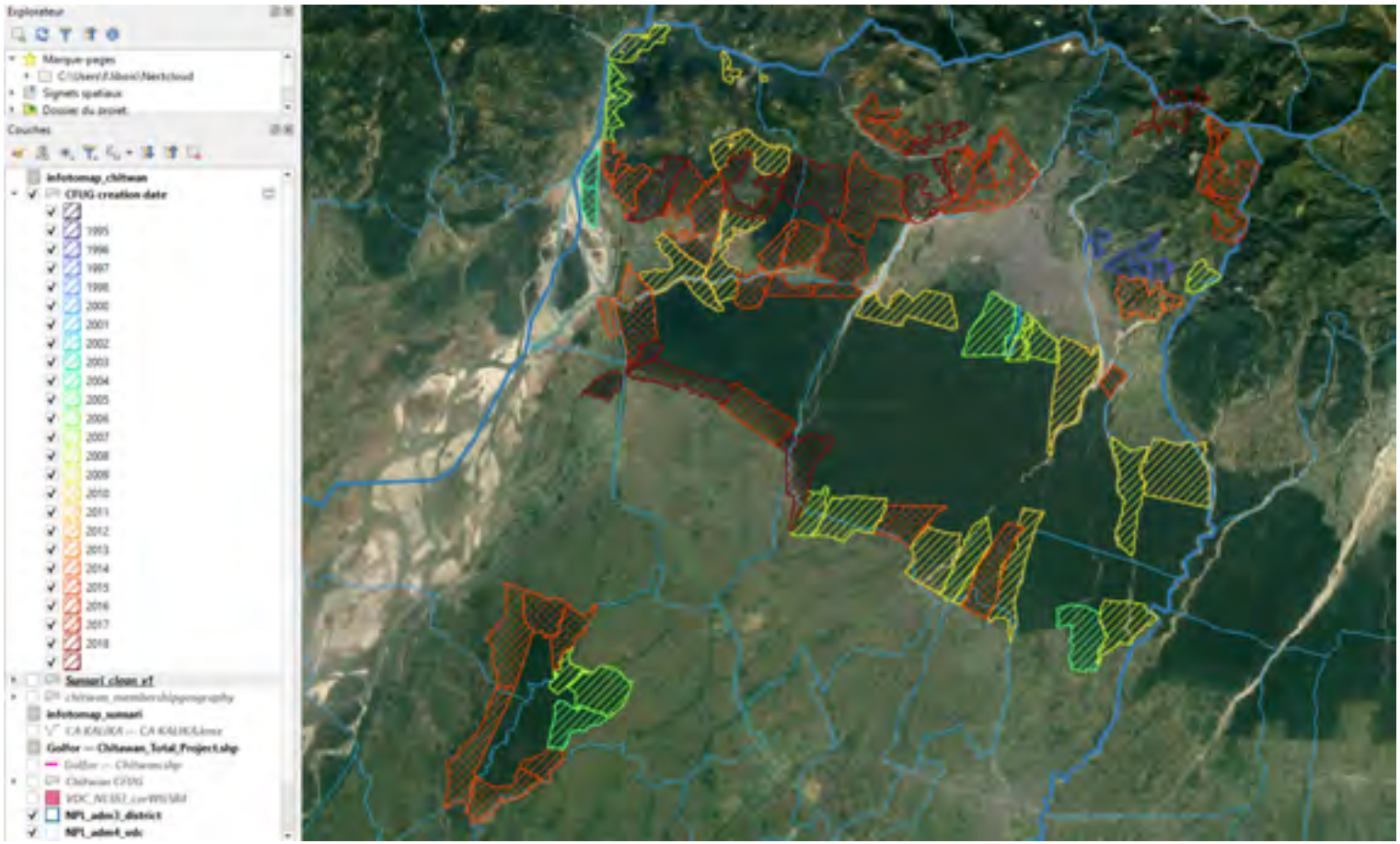
Local spill-overs

Figure: CFUG in Sunsari districts



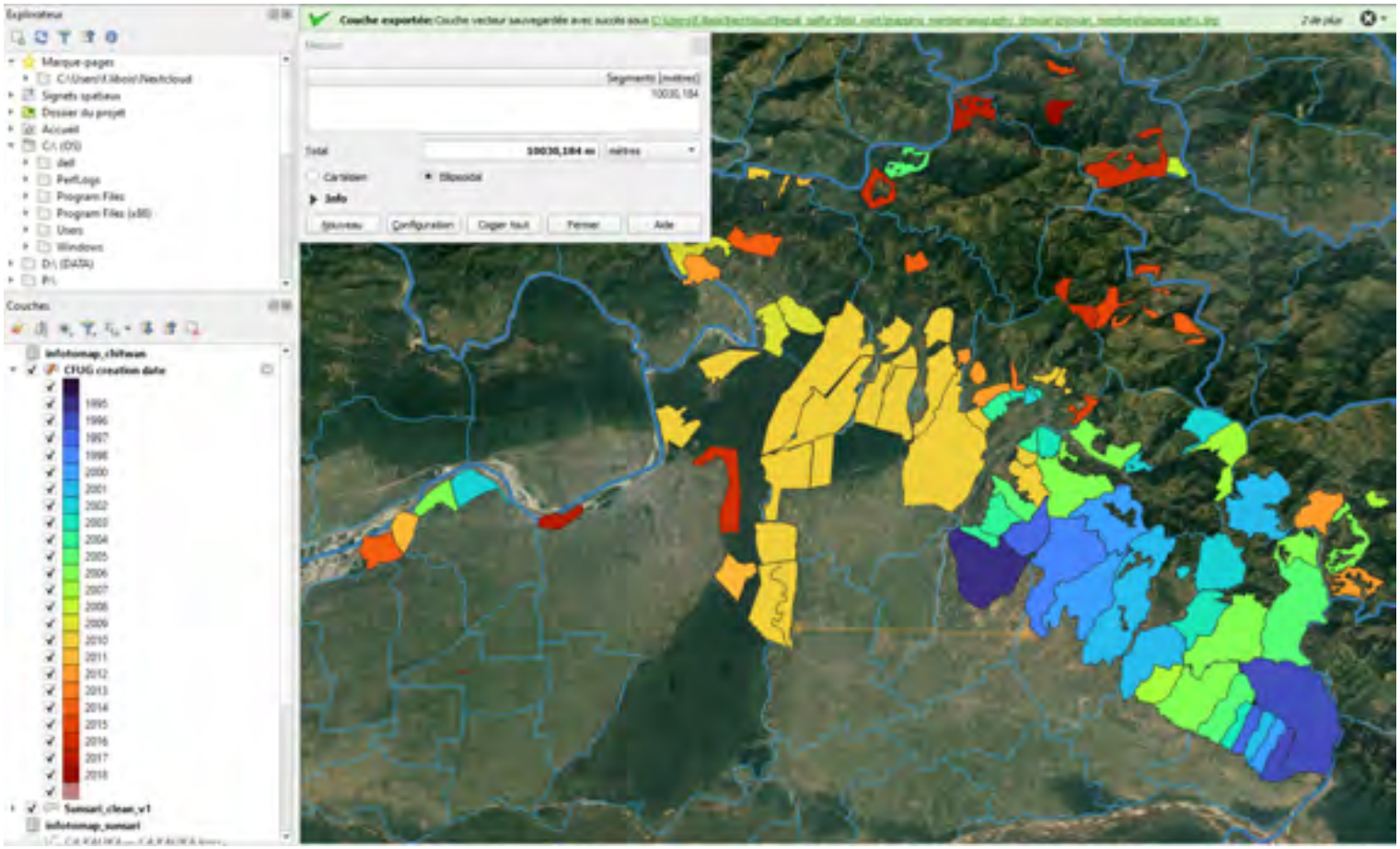
Local spill-overs

Figure: CFUG in Sunsari districts



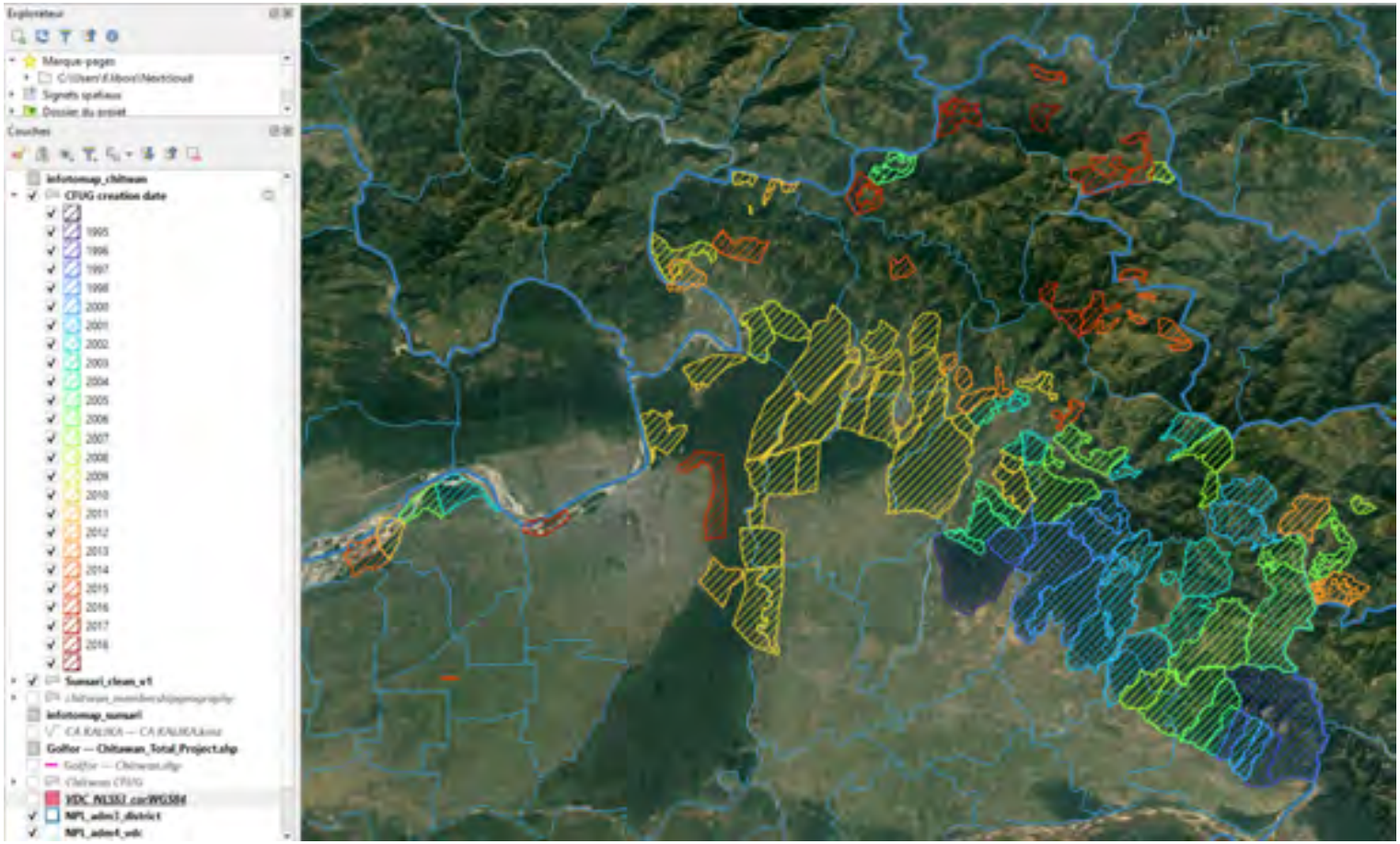
Local spill-overs

Figure: CFUG in Chitwan districts



Local spill-overs

Figure: CFUG in Chitwan districts



back to main result

Local spill-overs

- Our ongoing work with the boundaries of more than 1500 CFUG in 14 districts of Nepal aims at
  - separating the effect of community forestry on managed areas from the net effect at the landscape level
  - delving into the short-term versus long-term effects
  - understanding how environmental (negative) spill-overs may induce (positive) institutional spill-overs

back to conclusion

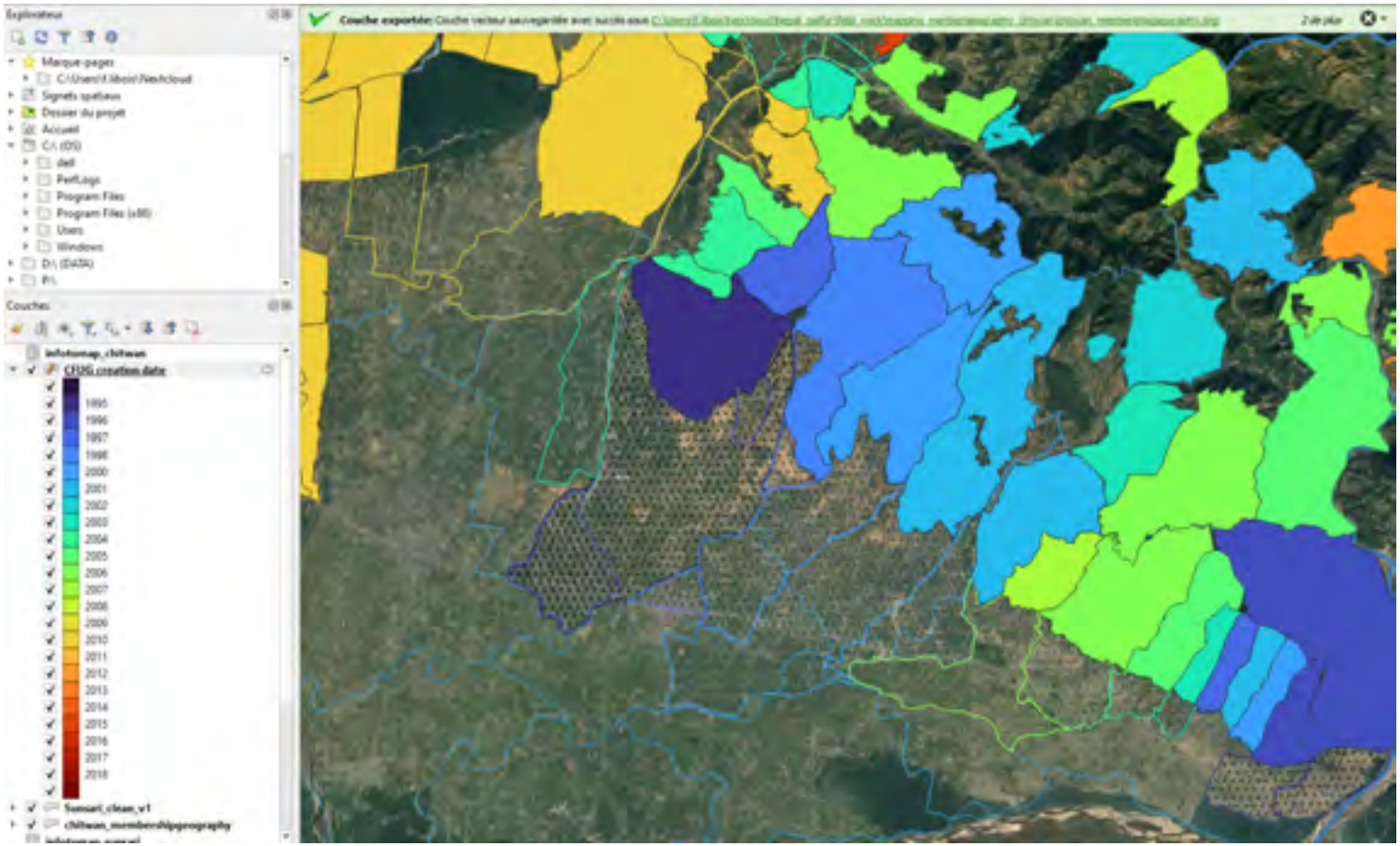
Towards the political economy of resource management

- Well-managed forests create value
- Benefits are distributed in various ways and group leaders play a large role in these allocation decisions
  - sell timber at subsidized prices
  - build school, roads, temples
  - subsidize solar panels, biogas installations...
  - fight against poverty - including by buying a 4-wheeler for the chief of the group

Towards the political economy of resource management

Given these benefits, and the density of groups, how is membership defined ? How are boundaries of forest defined ?

Figure: CFUG "social territories" : membership geography

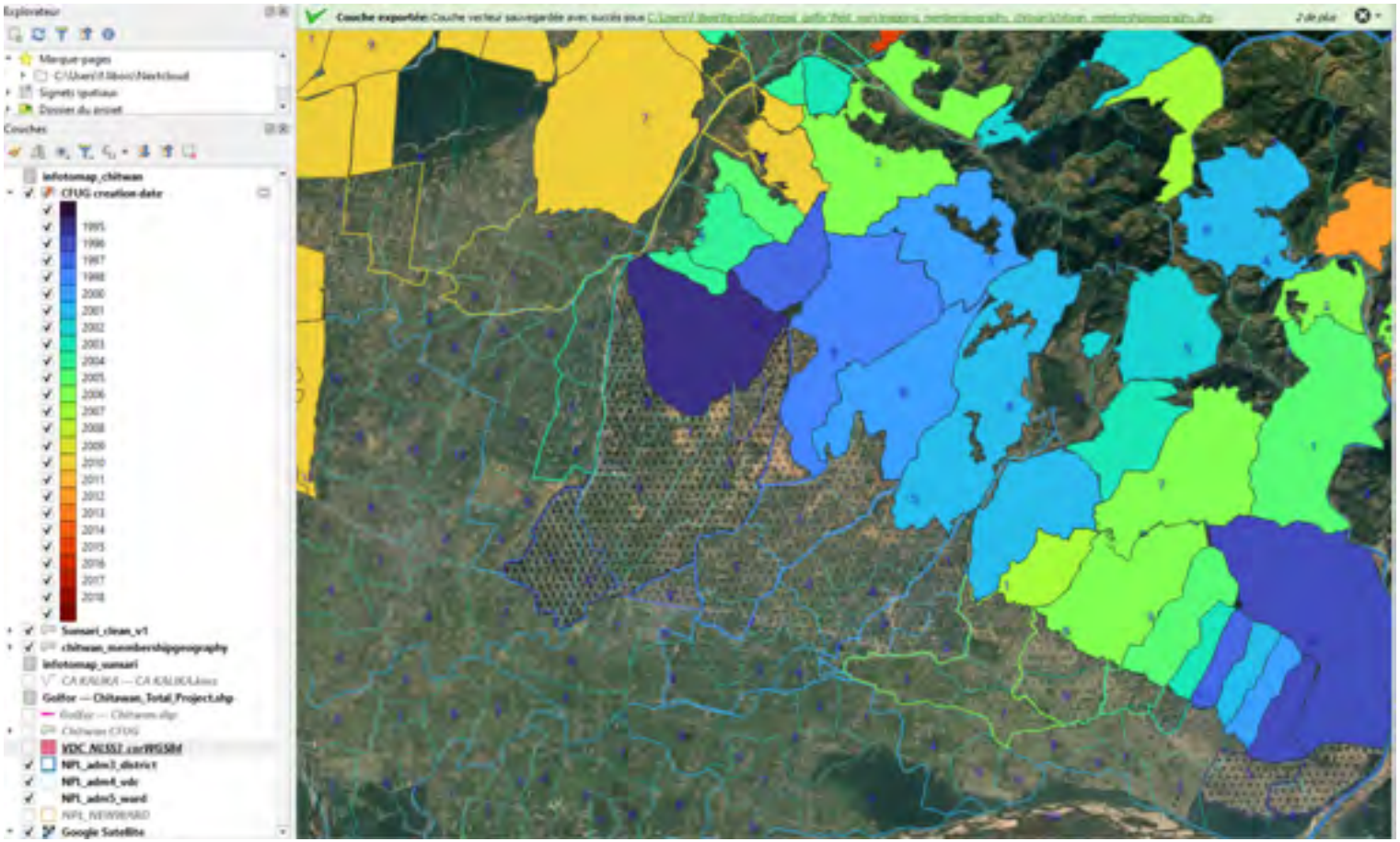


See Mahato and Valadaud (2023) for more details

Towards the political economy of resource management

Given these benefits, and the density of groups, how is membership defined ? How are boundaries of forest defined ?

Figure: CFUG "social territories": membership geography and census wards



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Towards the political economy of resource management

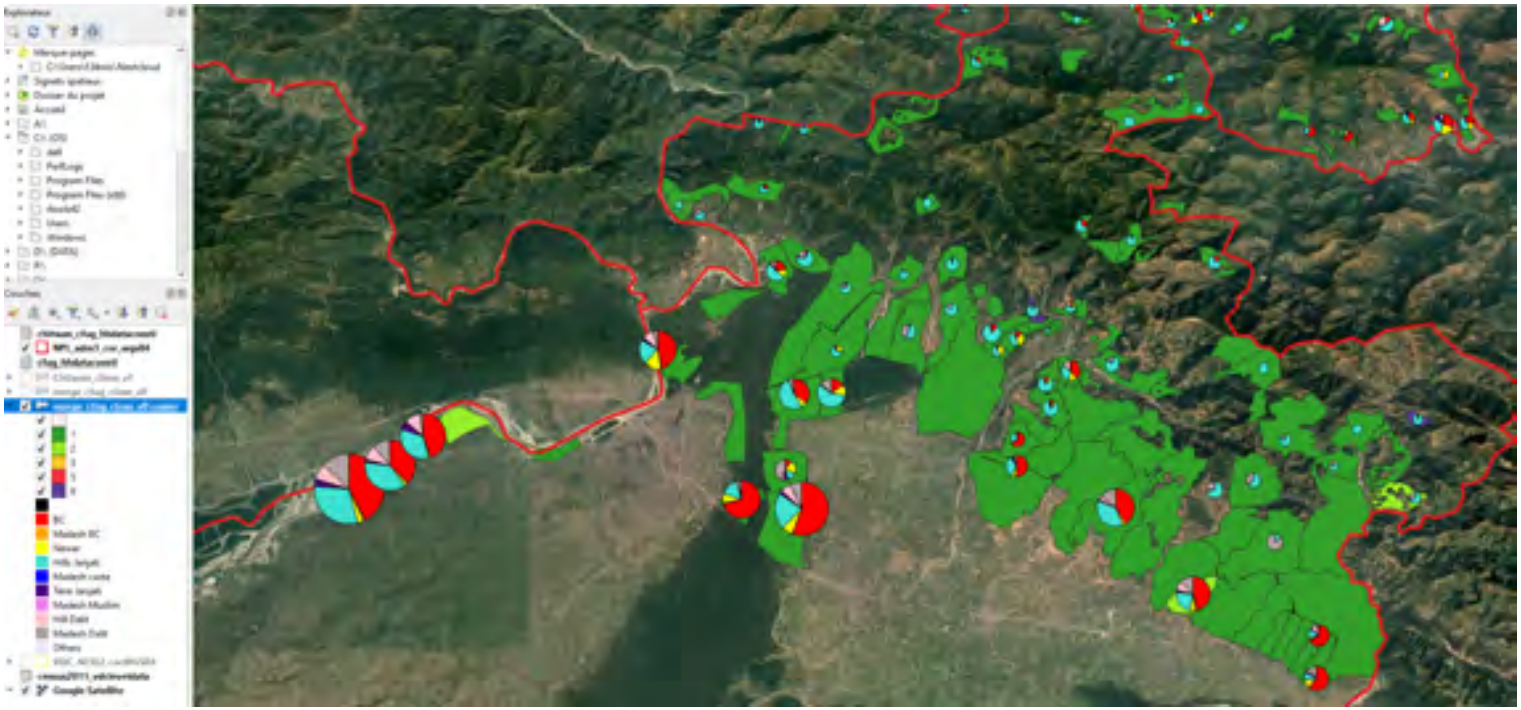
Who are the members, compared to neighbouring populations ?

Figure: CFUG mapping in Chitwan

Towards the political economy of resource management

Who are the members, compared to neighbouring populations ?

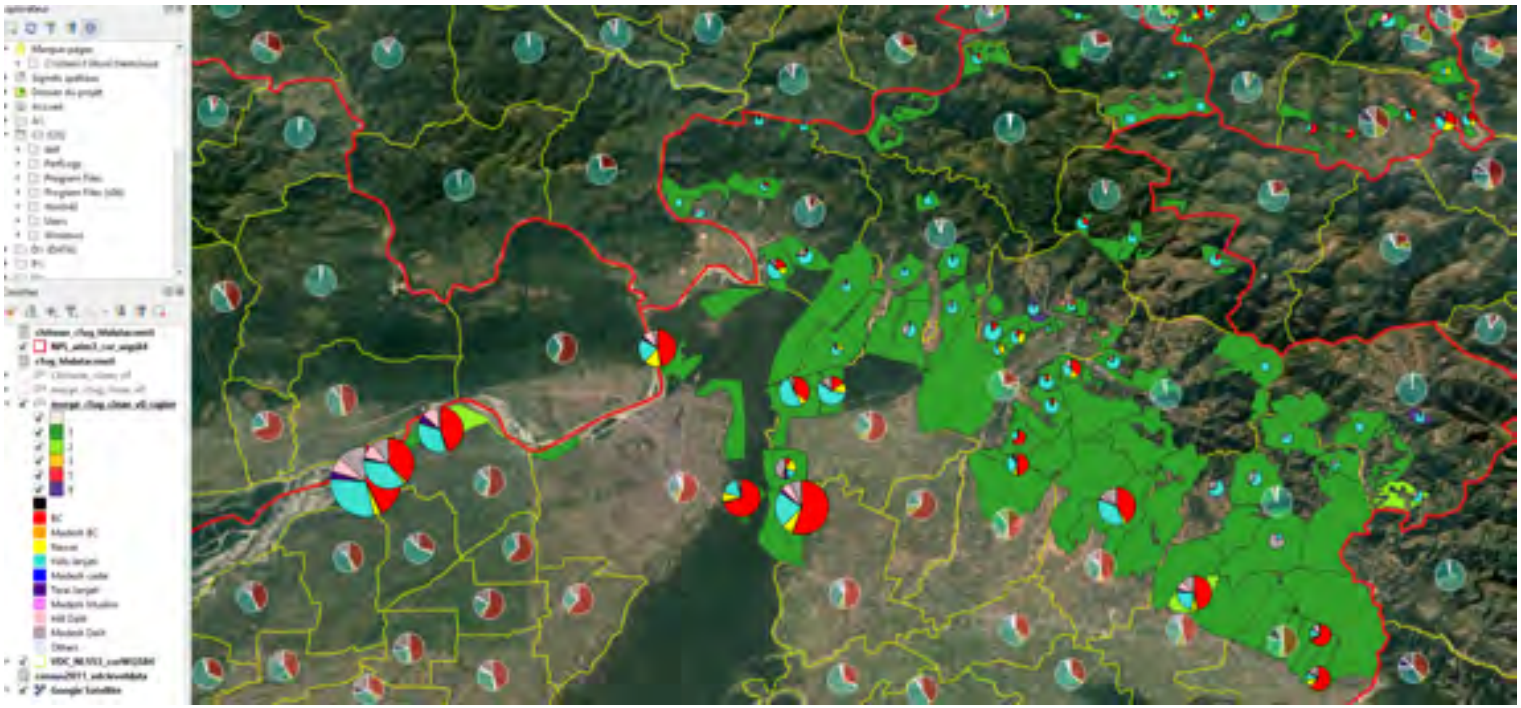
Figure: CFUG mapping in Chitwan: membership



Towards the political economy of resource management

Who are the members, compared to neighbouring populations ?

Figure: CFUG mapping in Chitwan: membership and neighbouring populations



Towards the political economy of resource management

Which group end up being ruled by women ?

Figure: Positions in the executive committee by gender (3000+ groups in 14 districts)

position	sex		
	Male	Female	Total
Chair	2,798	415	3,213
Vice-chair	2,137	966	3,103
Secretary	1,898	1,300	3,198
Vice-Secretary	1,501	658	2,159
Treasurer	2,028	1,157	3,185
Vice-treasurer	4	5	9
Member	9,991	8,880	18,871
Immediate past chair	1	0	1
Council head	0	1	1
Vice council head	1	0	1
Advisor	49	10	59
Forest guard	3	1	4
Coordinator	6	1	7
Legal advisor	1	0	1
Other	8	1	9
Not specified	19	20	39
Total	20,445	13,415	33,860

Towards the political economy of resource management

- From CFUG membership to CFUG leadership, there is a step...
- ... but maybe also a path to political leadership.

Towards the political economy of resource management

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Towards the political economy of resource management

- From CFUG membership to CFUG leadership, there is a step...
- ... but maybe also a path to political leadership.

- **How far can the local management of natural resources help to select leaders who will be in charge of much broader public good provision ?**
- After 20 years without local elections, the 2017 elections set a milestone for Nepal
  - More responsibilities (and more budget) at the local level
  - New boundaries of local constituencies
  - New positions for local leaders

Towards the political economy of resource management

- Do CFUGs play a role in selecting "good" leaders in a nascent local democracy ?
- Given that political parties did select a lot of CFUG executive committee members, which characteristics of these groups do influence the odds of being elected?

Towards the political economy of resource management

- Do CFUGs play a role in selecting "good" leaders in a nascent local democracy ?
- Given that political parties did select a lot of CFUG executive committee members, which characteristics of these groups do influence the odds of being elected?
- is a matter of
  - group size ?
  - good management of the resource ?
  - value of the resource that is managed ?
  - felling the trees before the elections to buy votes ?
  - the composition of the group being a "fair" representation of the new constituency ?
  - ...

Back to Chitwan

- 80 CFUGs in the census and 75 operational plans
- 2203 candidates in 105 constituencies

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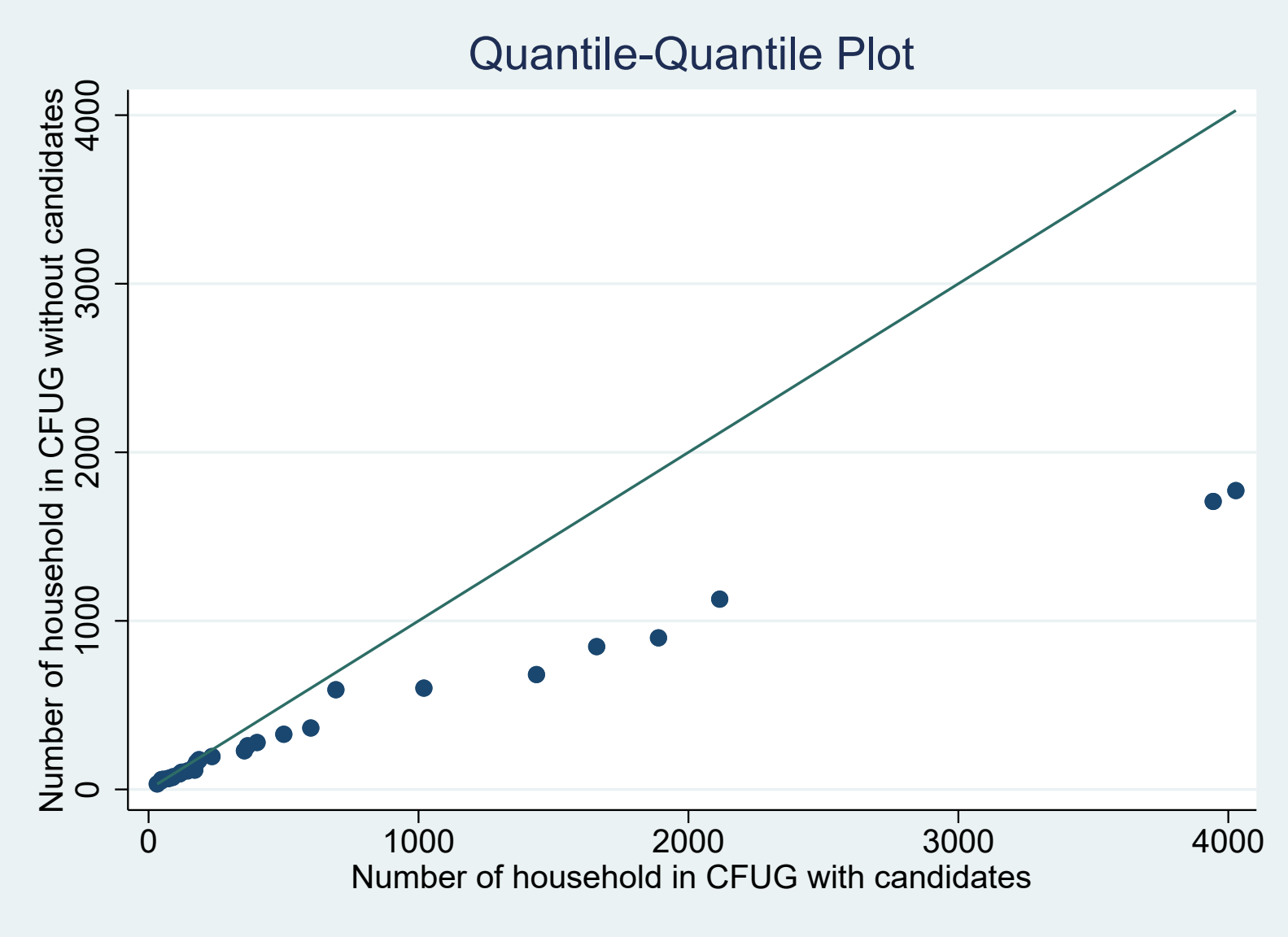
- 80 CFUGs in the census and 75 operational plans
- 2203 candidates in 105 constituencies
- 82 executive committee members coming from not less than 40 CFUGs were running for the local elections in 44 constituencies
- 3.7% of candidates
- 24 executive committee members got elected (30%), among which 9 out 24 female
- it represents 5% of elected officials

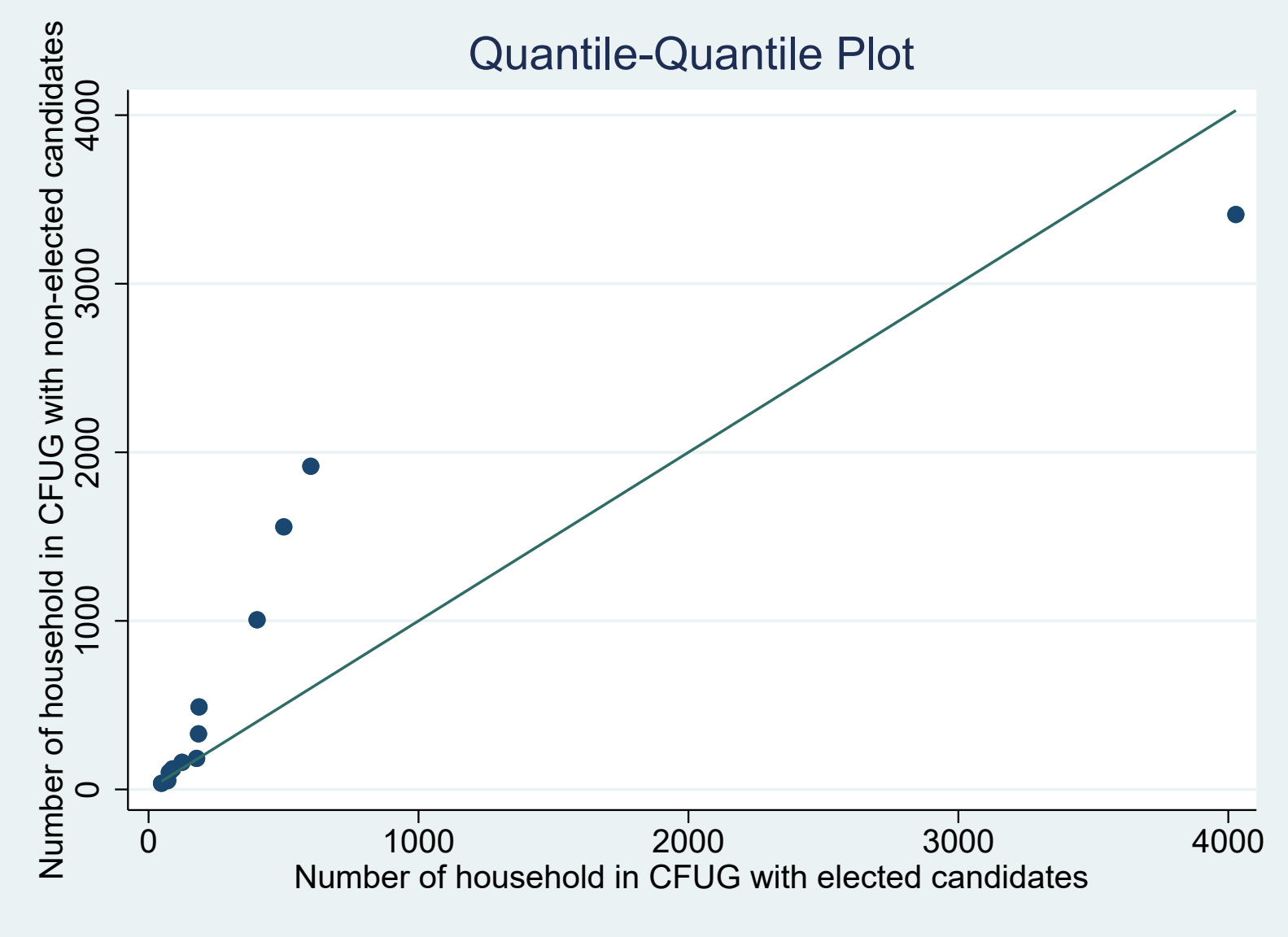
Back to Chitwan

First insights on the number of CFUG members: more candidates from large CFUG



Back to Chitwan

First insights on the number of CFUG members: but more elected candidates in smaller CFUG



Towards the political economy of resource management

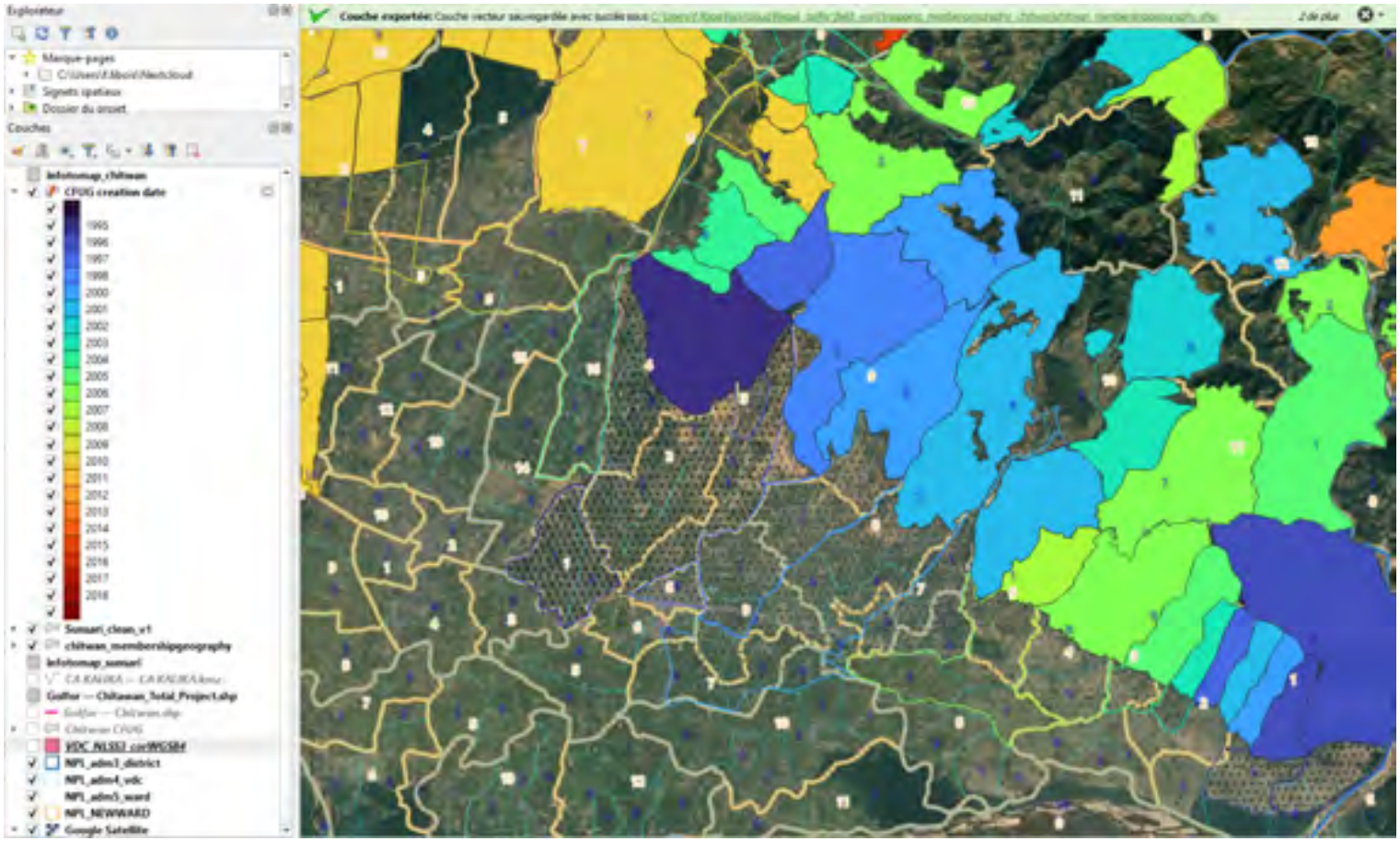
- As forest conditions improve, the value of standing trees increases
- As monetary stakes become more important "new" stakeholders get interested by forests

Towards the political economy of resource management

- As forest conditions improve, the value of standing trees increases
- As monetary stakes become more important "new" stakeholders get interested by forests
  - Political parties play an increasingly larger role in the selection of executive committee members
  - Different levels of government (wards, palikas, provinces, central...) are willing to tax CFUGs and partially take over some of their tasks

Towards the political economy of resource management

Figure: CFUG "social territories": membership geography and old census and new political wards



Towards the political economy of resource management

From 3972 "Village Development Committee" to 6806 "Wards" (new ones) following some boundaries of 36288 "old census wards" ▸ Conclusion

Figure: The new political boundaries: scope for identification

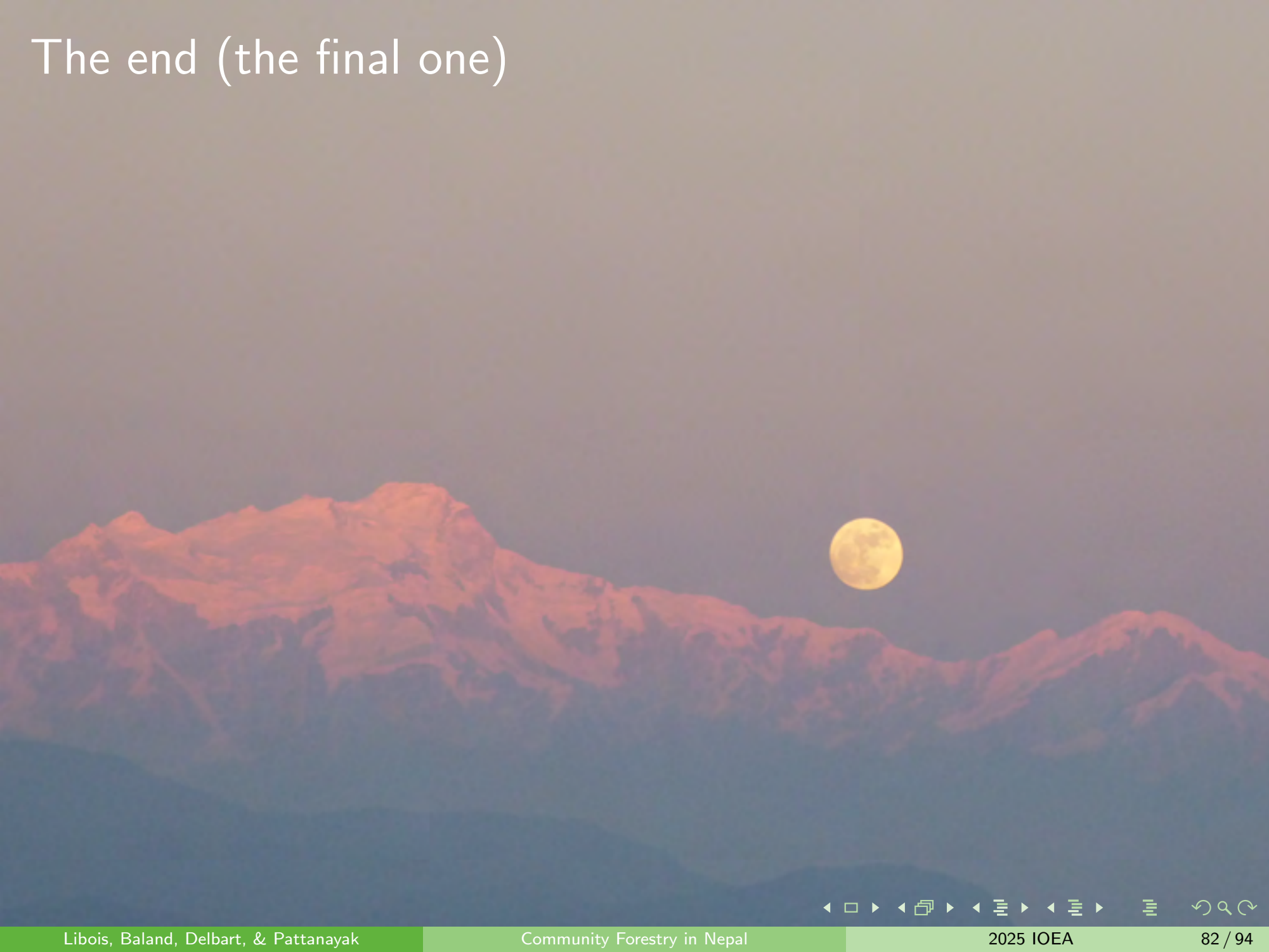
Conclusion

- This project contributes to the analysis of the pros and cons of decentralization.

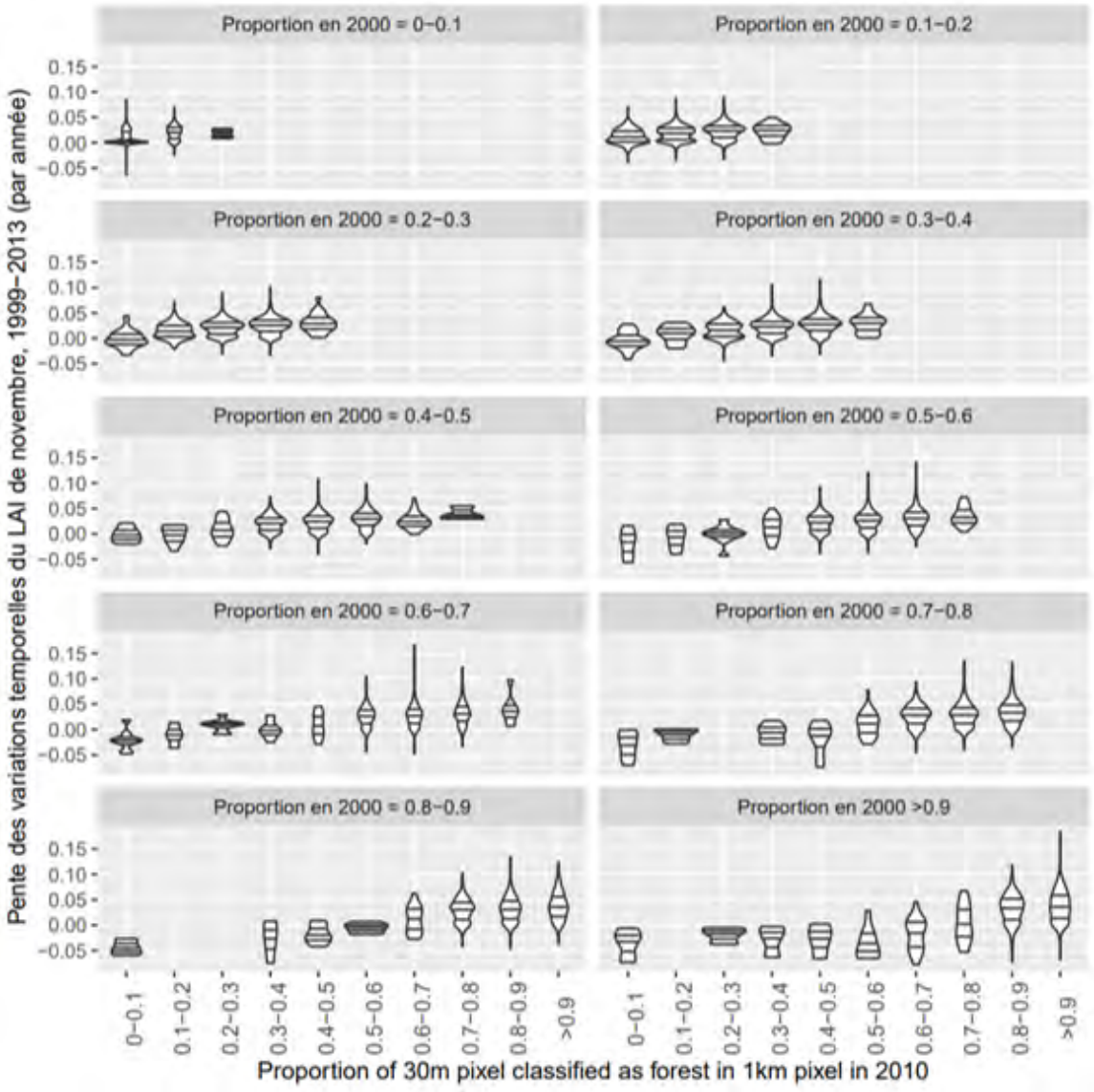
Conclusion

- This project contributes to the analysis of the pros and cons of decentralization.
- It is one of the few example of a success (Mookherjee, 2015 and 2022).
- Community management seems to improve tree biomass.
- Limited elite capture and local development remain open research questions before concluding to a long term success of community forestry in Nepal.

The end (the final one)



Leaf Area Index: variation across time



back LAI

Analysis: what do we measure?

The classic approach is to estimate

$$LAI_{vt} = \alpha CFUGshare_{vt-1} + \eta_v + \delta_t + \varepsilon_{vt} \qquad with \quad t = 2001, 2011 \qquad (6)$$

$$LAI_{dt} = \alpha CFUGshare_{dt-1} + \eta_d + \delta_t + \varepsilon_{dt} \qquad with \quad t = 2001, 2011 \qquad (7)$$

with

- LAI, the Leaf Area Index in village development committee v or district d in year t
- $CFUGshare$, the share of the administrative unit managed by Community Forestry User Groups
- Village or district level fixed-effects η, time-fixed effects δ and an idiosyncratic term

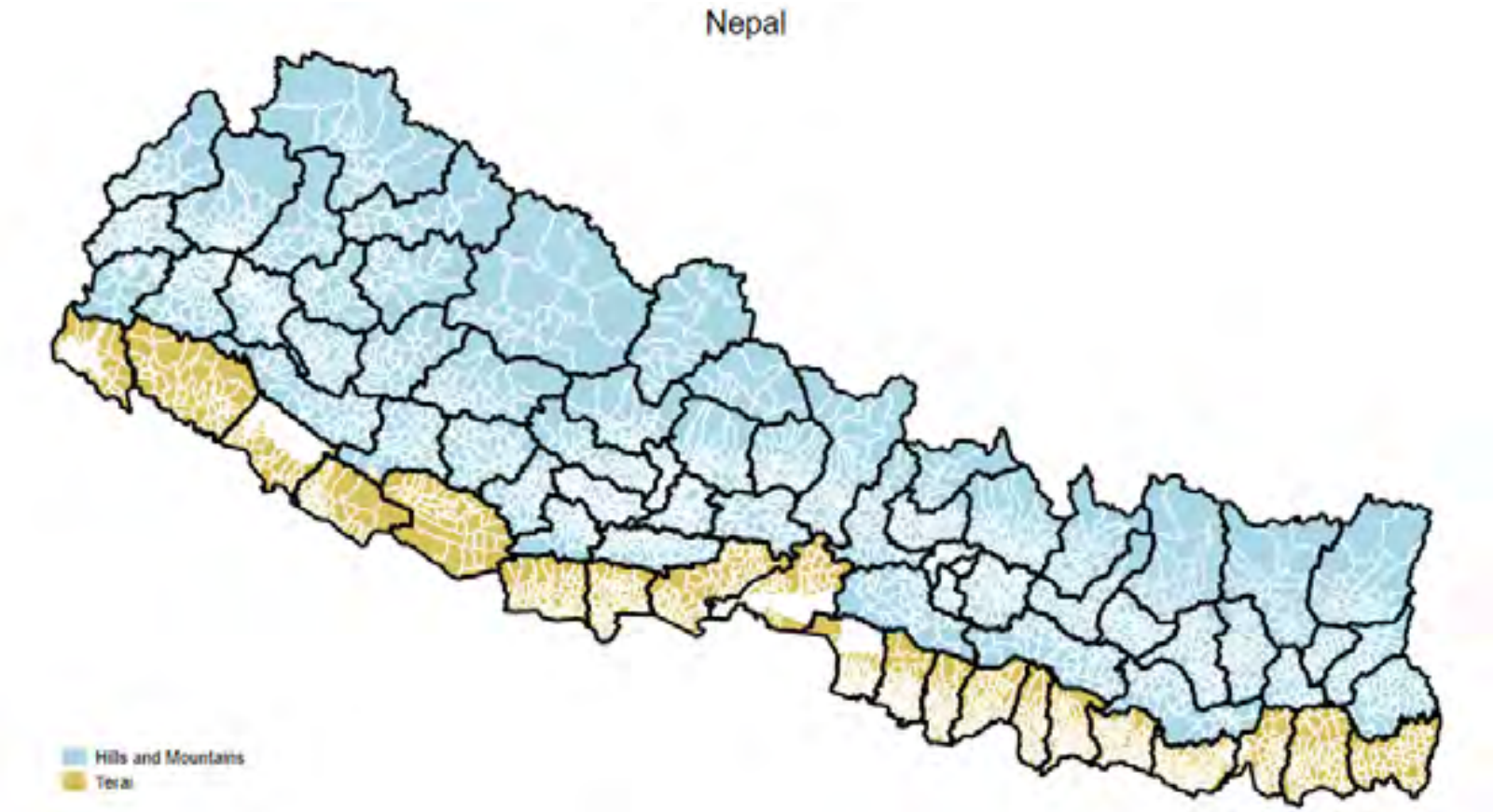
Analysis: what do we measure?

	(1) Leaf Area Index	(2) Share forested	(3) Leaf Area Index	(4) Share forested
Share CFUG area	0.0150	0.0210*	0.843**	0.198***
	(0.31)	(2.11)	(2.92)	(3.98)
Year 2011	0.200***	0.00806**	0.123***	-0.00479
	(15.18)	(3.01)	(5.73)	(-1.09)
Fixed-effects	VDC	VDC	District	District
Observations	7944	7944	150	150

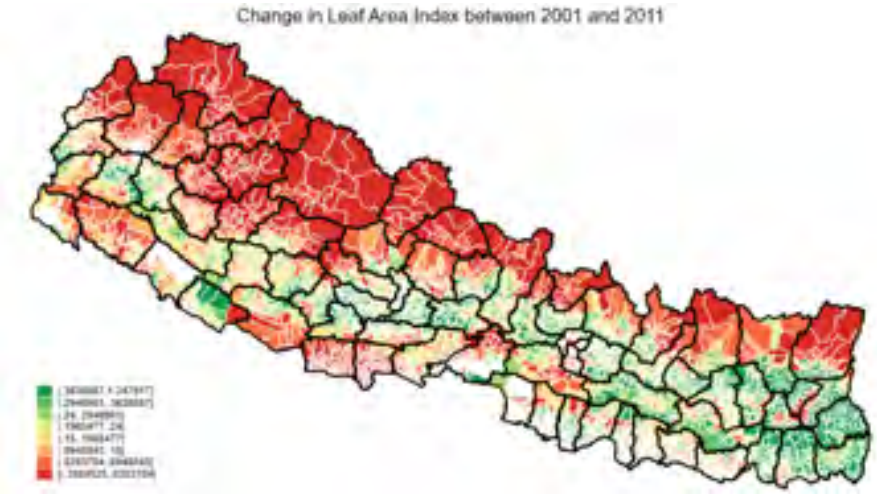
t statistics in parentheses

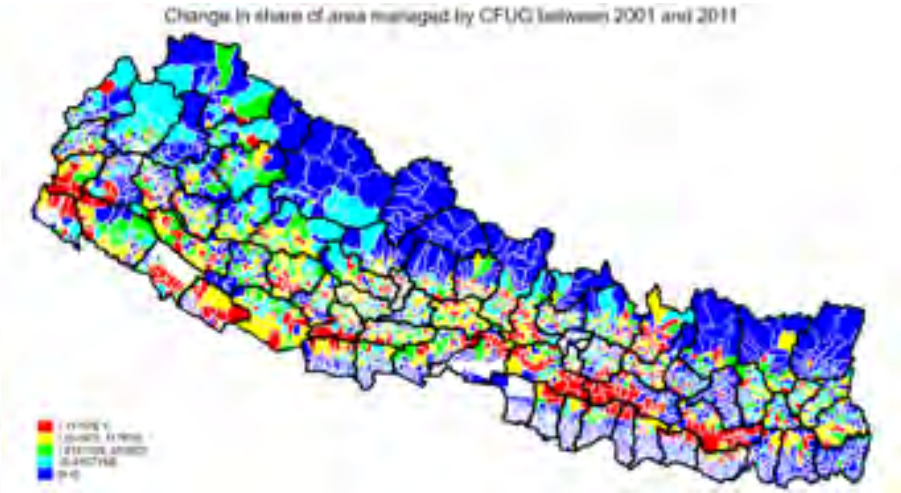
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Analysis: village development committees and districts



What we expect to estimate...





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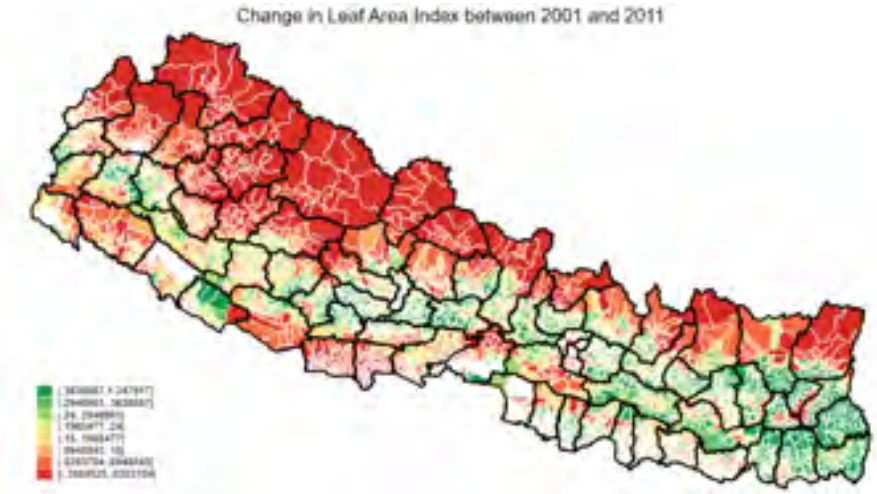
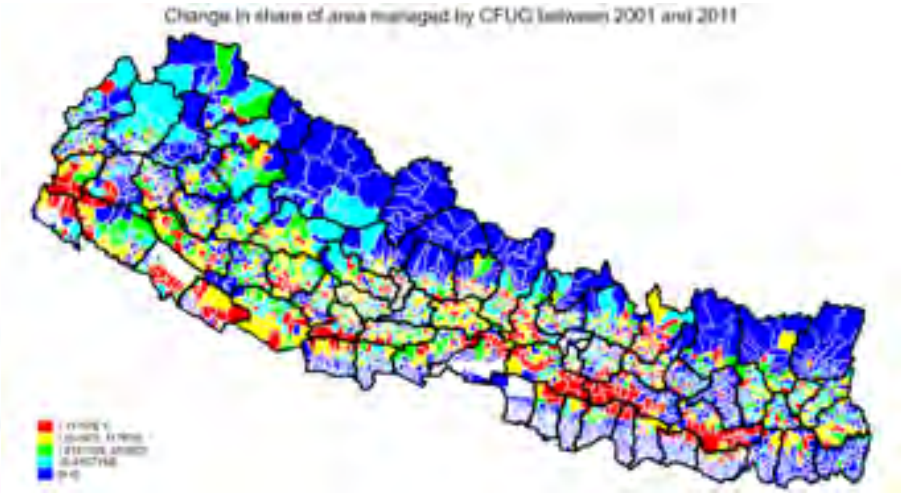
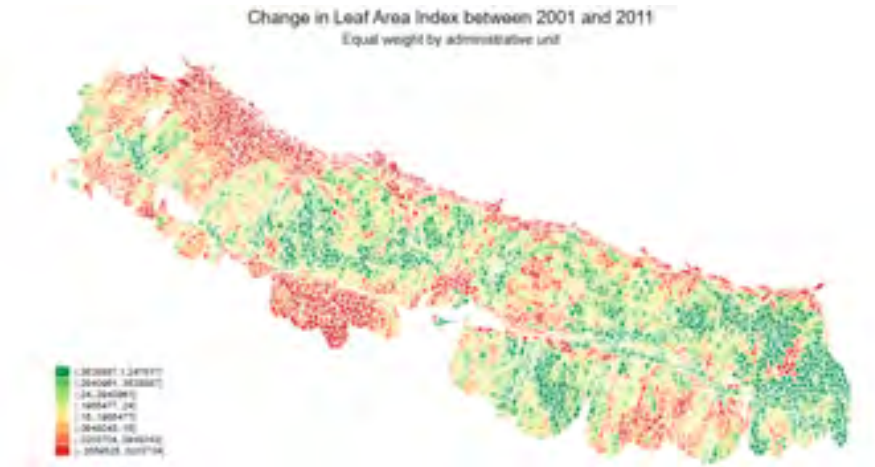
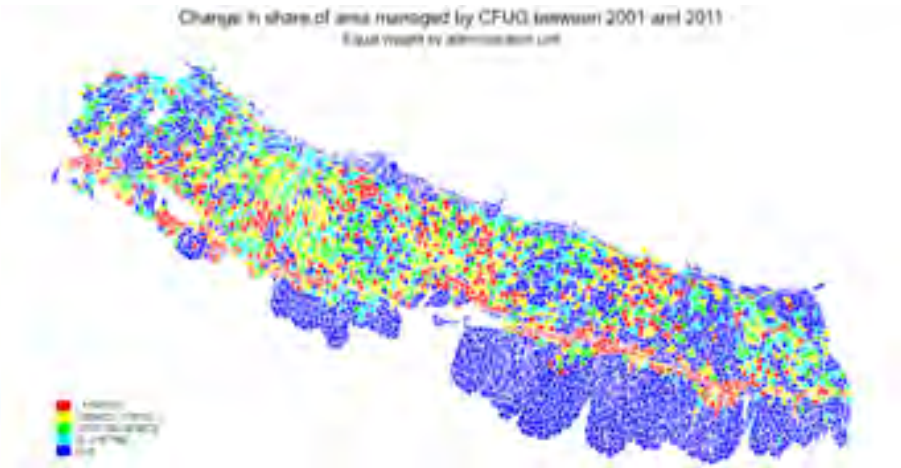




- but here is what we estimate...





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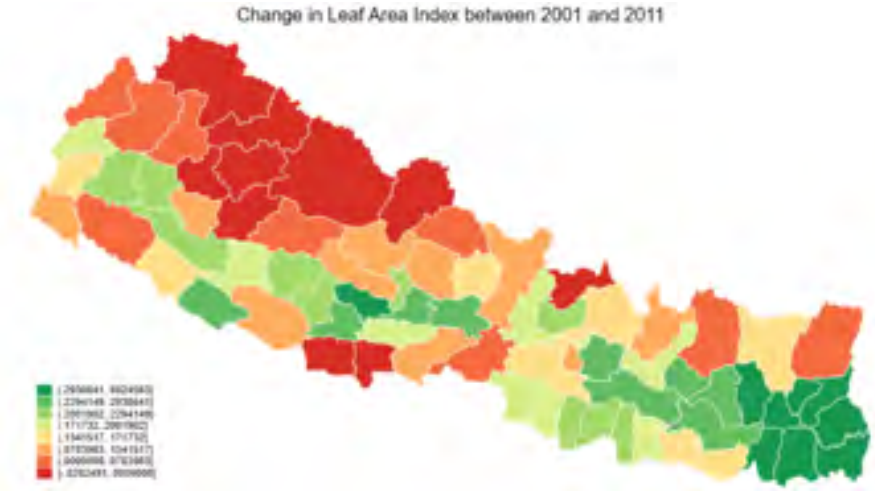

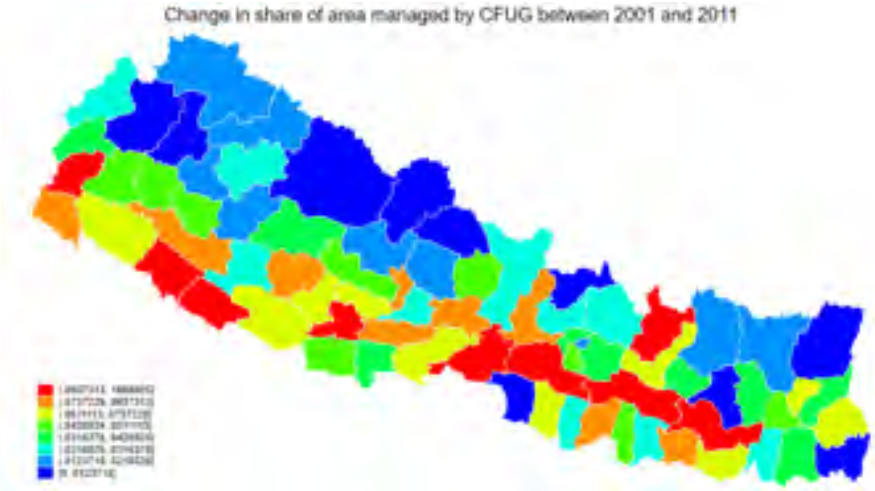

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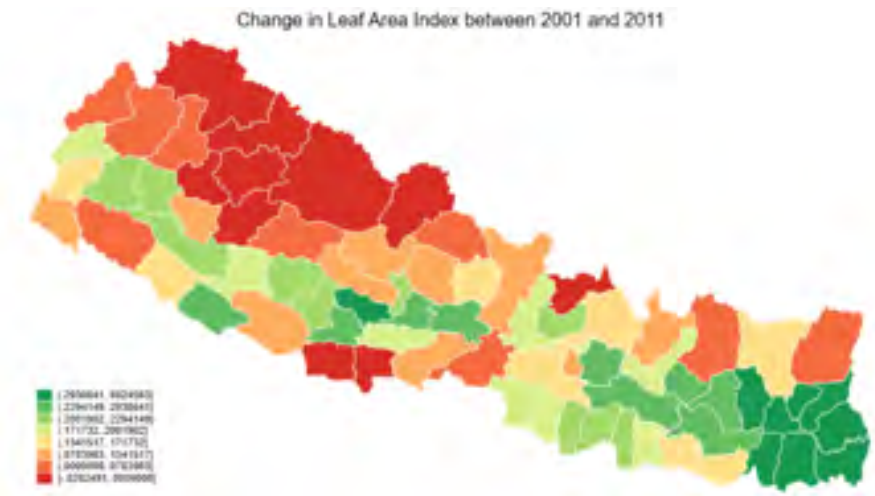

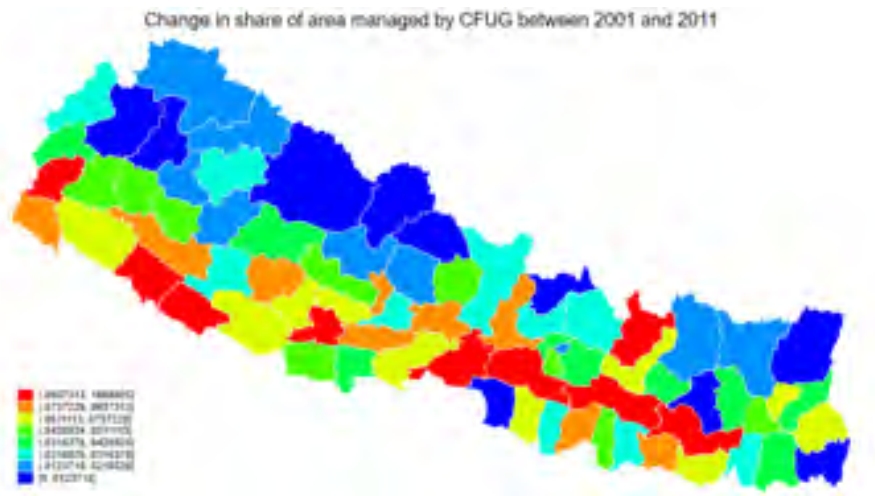

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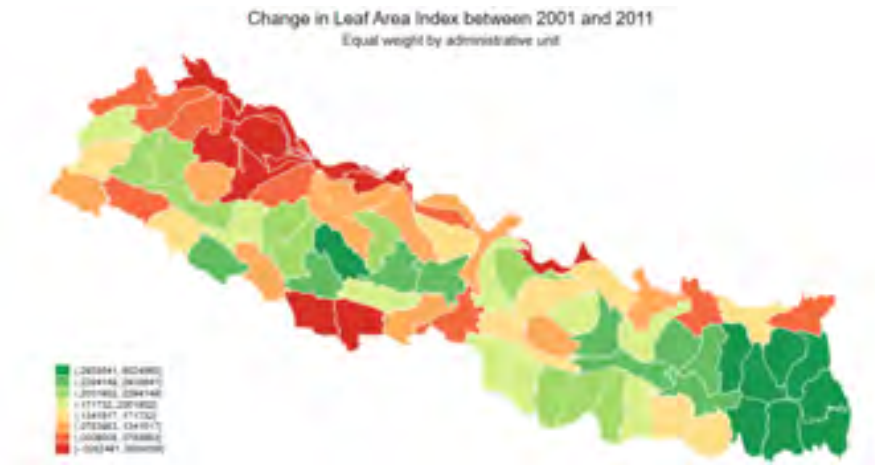
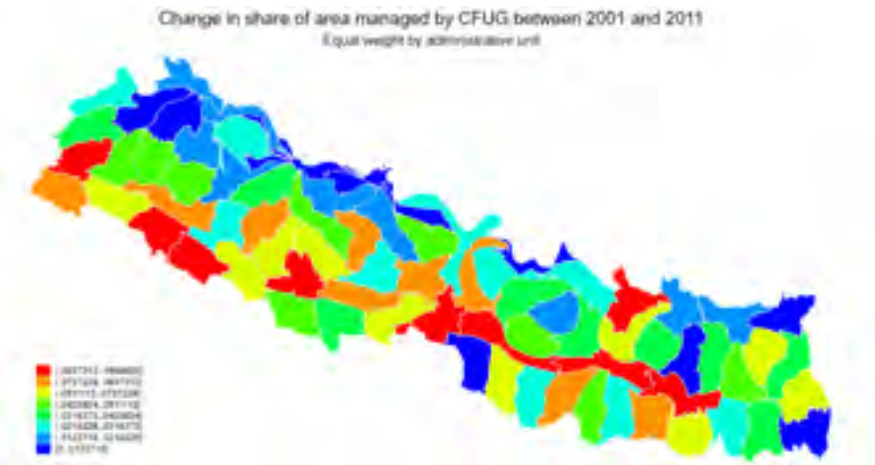




Analysis: what do we measure?

We have to weight regressions by the area of administrative units

	(1) Leaf Area Index	(2) Share forested	(3) Leaf Area Index	(4) Share forested
Share CFUG area	0.331***	0.0564***	1.247***	0.237***
	(3.87)	(4.28)	(4.37)	(5.54)
Year 2011	0.118***	-0.00155	0.0767***	-0.00962**
	(7.11)	(-0.53)	(3.85)	(-2.69)
Fixed-effects	VDC	VDC	District	District
Observations	28948234	28948234	28948234	28948234

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Analysis: But what about the people?

- One may also want to know if Community forestry has positive consequences on livelihoods

Analysis: But what about the people?

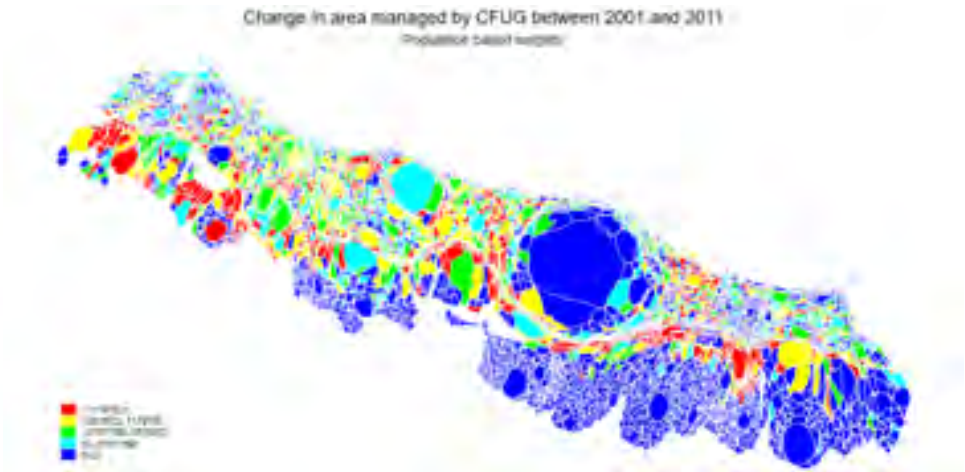
- One may also want to know if Community forestry has positive consequences on livelihoods
- then it is the number of people who benefit that matters !
- weighting by population (here number of households) makes more sense
- So, assuming that nightlight tell us something about livelihoods

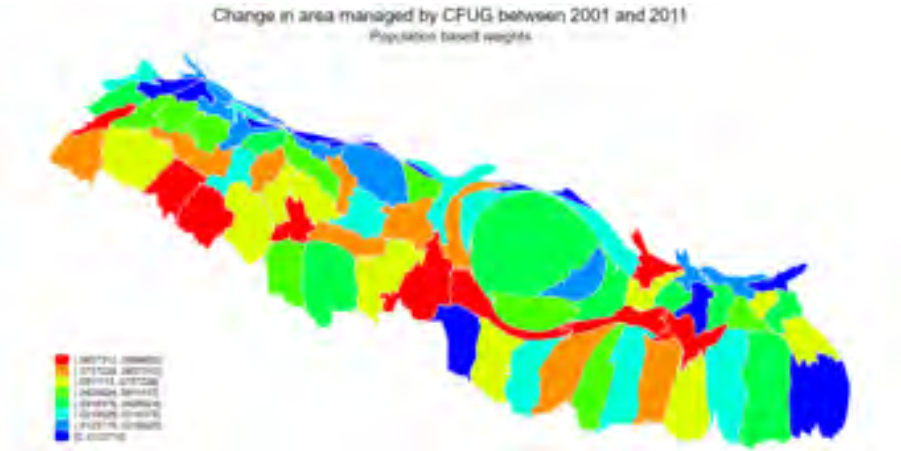
	(1)	(2)	(3)
	Avg. Nightime light		
Share CFUG area	0.0821	0.407	3.541*
	(0.53)	(1.16)	(1.97)
Year 2011	-0.0523**	-0.172**	-0.849**
	(-2.10)	(-2.27)	(-2.05)
Weights	VDC area	no	Households
Fixed-effects	VDC	VDC	VDC
Observations	28948234	7944	10846594

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

What we want to estimate looks more like:





Shall we abandon weights by administrative units?

- Sometimes the focus may be on administrative units
- Just think about
  - turnover of district forest officers
  - budget of municipalities or districts
  - electoral dynamics

Some people may recommend to weight by forest area

- This puts, by construction, a lot of emphasis on administrative units with large patches of already existing forests...
- ... and neglects areas with lower forest cover that may get reforested

$\Rightarrow$ for sure not an option in a project about forest restoration

back main OLS back staggered DiD

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- ... and neglects areas with lower forest cover that may get reforested

$\Rightarrow$ for sure not an option in a project about forest restoration

- When is it relevant?
  - probably when the dependant variable captures average forest conditions (for instance species richness or other biodiversity measure) in a context where forest area is stable.
  - relatively endogenous (as is population weighting) $\Rightarrow$ a predetermined variable is important!
  - tricky interpretation if forest area is changing

▸ back main OLS ▸ back staggered DiD

Summary of staggered DiD estimates

Average cumulative (total) effect per treatment unit

Figure	Dependent Variable	Mean in 2001	Avg. cum. effect	SE	LB CI	UB CI	N	Switch X Periods
Fig. **??**	LAI	1.052	.728	.065	.601	.855	4864	1342
Fig. **??**	LAI (December)	.766	.379	.052	.277	.482	4864	1342
Fig. **??**	NDVI (Copernicus)	.474	.109	.015	.080	.137	4852	1342
Fig. **??**	NDVI (GIMMS)	.512	.068	.033	.004	.133	55365	39482
Fig. 4	Share Forest	.231	.104	.009	.086	.123	4864	1342
Fig. 4	Share needle forest	.029	.010	.007	-.005	.024	4864	1342
Fig. 4	Share broadleaf forest	.059	-.008	.006	-.019	.004	4864	1342
Fig. 4	Share mixed forest	.143	.102	.011	.081	.124	4864	1342
Fig. 4	Share shrubland	.348	-.060	.010	-.080	-.040	4864	1342
Fig. 4	Share cropland	.036	-.026	.004	-.035	-.018	4864	1342
Fig. 43	LAI (contr. Forest)	1.052	.535	.069	.400	.670	4864	1342
Fig. 43	LAI (Changing Forest share)	1.265	.477	.108	.264	.689	3147	982
Fig. 43	LAI (Stable Forest share)	.669	2.015	.055	1.908	2.122	1717	360
Fig. 43	LAI (Low initial LAI)	.471	.151	.098	-.040	.342	1859	348
Fig. 43	LAI (High initial LAI)	1.634	.319	.113	.098	.540	3005	994
Fig. **??**	Biogas	.006	.021	.017	-.011	.053	4864	1342

Estimations following de Chaisemartin and d'Haultefoeuille (2024)

▸ back main result ▸ back Land Use ▸ back Biogas

Decentralized management of Natural Resources

Preserving the Environment to the Benefit of People?

François Libois°

°INRAE and Paris School of Economics, France

IOEA
Cargèse, France, May 2025

Main questions

1. Can we find guidelines or sound theoretical principles for an optimal long-term exploitation of local resources ? (Baland and Platteau, 1996)
2. Can local governance be a way to improve human welfare and preserve the environment ?
3. What are the distributional consequences of institutional change ?

Plan

- 2 examples about mining
- Managing commons: theoretical insights
  - Some illustrations related to forest and fisheries management
- Forest management in Nepal
  - success of community forestry
  - who are the beneficiaries ?
  - challenges

Natural resource: a curse or a blessing?

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- Natural capital can be used to accumulate physical and human capital

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  - The presence of coal would be instrumental for the industrial revolution in England (Pommeranz, 2000)
  - Possible collapse of Easter Island because of an insufficient growth rate of trees on this island (Brander and Taylor, 1998, AER)

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  - But the advantage of the winners may be overemphasized because we accumulate more knowledge about the value of the natural resources on which winner relies

  - Shortages may spur conflict as stressed by the literature on negative shocks in agriculture and conflict (see for instance Harari and La Ferrara, ReStat, 2018)

Natural resource: a curse or a blessing?

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Natural resource: a curse or a blessing?

- Being resource rich has also drawbacks
  - Abundant literature in economics about the resource curse, especially stressing that mineral abundance fuels conflict in Africa (Berman et al., AER, 2017)
- Some theory to reconcile structure these facts
  - Abundance of labour intensive resources reduces conflict while abundance of capital intensive resources increases conflict (Dal Bo and Dal Bo, JEEA, 2011)
  - Complementarity between the groups' resources lowers the stakes of political conflict and increases the incentives to commit (Silve, JCR, 2017)
  - Dickson et al. (2021) argues that both scarcities and abundance can fuel conflict, depending on the endogeneity of relative prices

Natural resource: a curse or a blessing?

- What about institutions?
  - this literature often looks at countries' institutions, less so at the specific organization of natural resource extraction

Industrial gold mining, artisanal mining and conflict

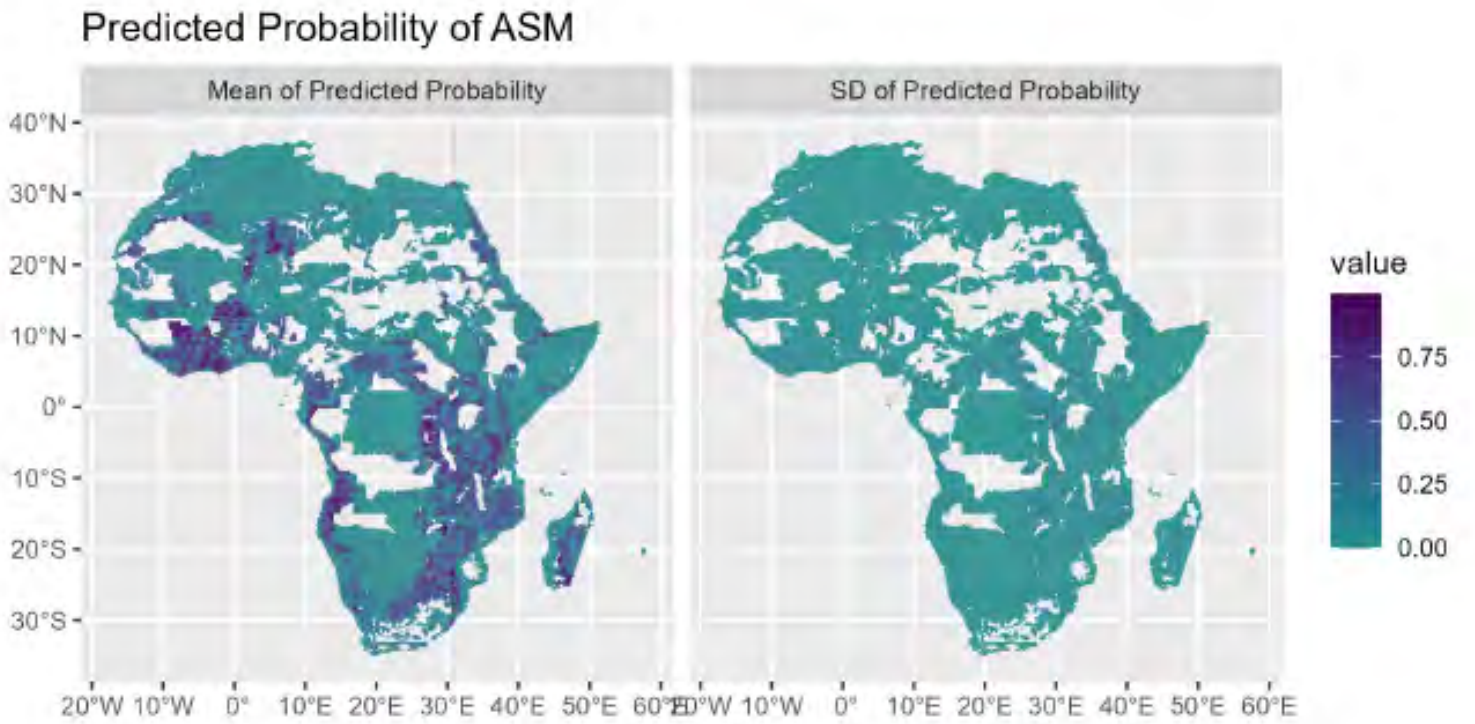
- A substantial share of conflict associated with natural resource extraction happens in locations with no observed conflict over government or territorial control (Rigtering et al., 2023, based on ACLED data)
- (Rigtering et al., 2023) argues that conflict between industrial mining operations and artisanal miners are an important source of mining-related conflict
  - Qualitative case study in DRC and Zimbabwe
  - Quantitative findings in Africa
- Back-of-the-envelope calculations suggest that between 31 to 55% of conflict events estimated to be caused by price shocks are in places where industrial and artisanal mining overlap.

Industrial gold mining, artisanal mining and conflict

- Main testable hypothesis of the paper:
  - as international price of commodity increase, violence increase around industrial sites extracting that commodity **where the site is also suitable for artisanal mining**
  - This increase will be smaller when the area is unsuitable for artisanal mining
- Competition between artisanal mining and industrial mining drives conflict
  - artisanal miners increase their extraction effort?
  - previous arrangements do not seem fair anymore?

Industrial gold mining, artisanal mining and conflict

Figure A.6: The left panel shows the average predicted probability of ASM across the 50 models, and the right panel shows the standard deviation of the predicted probabilities.



Industrial gold mining, artisanal mining and conflict

Table 3: Main results

	(1) acled>0	(2) acled>0	(3) acled>0	(4) acled>0	(5) acled>0	(6) acled>0
ln LSM price × LSM	0.021***	0.023***	0.012***	0.012***	0.015***	0.012***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
ln ASM price × ASM				0.002	0.002	0.002
				(0.002)	(0.002)	(0.002)
ln LSM price × LSM × ASM			0.024***	0.024***		
			(0.007)	(0.007)		
ln ASM price × LSM × ASM					0.019***	
					(0.006)	
ln ASM price × LSM × diff. ASM						0.012
						(0.009)
ln LSM price × LSM × diff. ASM						-0.001
						(0.011)
ln price × LSM × same ASM						0.032***
						(0.008)
Country-year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Grid FEs	Yes	Yes	Yes	Yes	Yes	Yes
Control mean	0.039	0.039	0.039	0.039	0.039	0.039
Total stand. effect	0.432	0.487	0.763	0.813	0.880	0.969
Sample	All	\w geo data	\w geo data	\w geo data	\w geo data	\w geo data
Observations	1080328	825583	825583	823469	823469	823469

Notes: Dependent variable in all columns is an indicator equalling one if there is one or more ACLED violent events in a cell-year. "ln LSM price" ("ln ASM price") is the natural log of the price of the modal LSM (ASM) commodity in the a cell, and equals zero if there is no LSM (ASM) in the cell. Modal LSM commodity is defined as per Berman et al. (2017). Modal ASM commodity is the commodity (gold, diamonds, 3t or 2c) with the highest predicted ASM suitability. For 3t and 2c minerals, price is the simple average of prices of tin, tantalum and tungsten, and copper and cobalt respectively. "LSM" is an indicator equalling one if there was ever LSM in a cell, and "ASM" equals one if the cell is predicted to be suitable for ASM mining of one or more of gold, diamonds, 3t or 2c minerals. "diff. ASM" ("same ASM") is an indicator equalling one if ASM mines a different (the same) modal commodity than LSM. "Total stand. effect" is the effect of a one standard deviation increase in commodity price on the probability of conflict in cells with LSM and ASM (in cells with LSM for columns 1 and 2), expressed in standard deviations of the probability of conflict in cells without mining. This aggregates effects captured by all coefficients in each regression, except for column 6, which aggregates the effects captured by "ln LSM price × LSM", "ln ASM price × ASM" and "ln price × LSM × same ASM". Columns 2-5 restrict the sample to cells with geological data, allowing prediction of ASM suitability. Number of observations in columns 4, 5 and 6 differ from other columns, as more cells are assigned a commodity price, which is missing for some commodities and some years. Conley standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01.

Gold mining in Burkina Faso

Gold mining in Burkina Faso

- Artisanal and large-scale mining have different implications for local populations

Gold mining in Burkina Faso

- **The gold digger and the machine: Evidence on the distributive effect of the artisanal and industrial gold rushes in Burkina Faso** (Bazillier and Girard, JDE, 2020)

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- The authors use a boom in gold prices to analyse the distributive impacts of private versus common property management of gold, namely under the form of artisanal versus industrial gold mining
- artisanal gold mines are labour intensive and quite unproductive
- industrial gold mines are highly capital intensive and very productive

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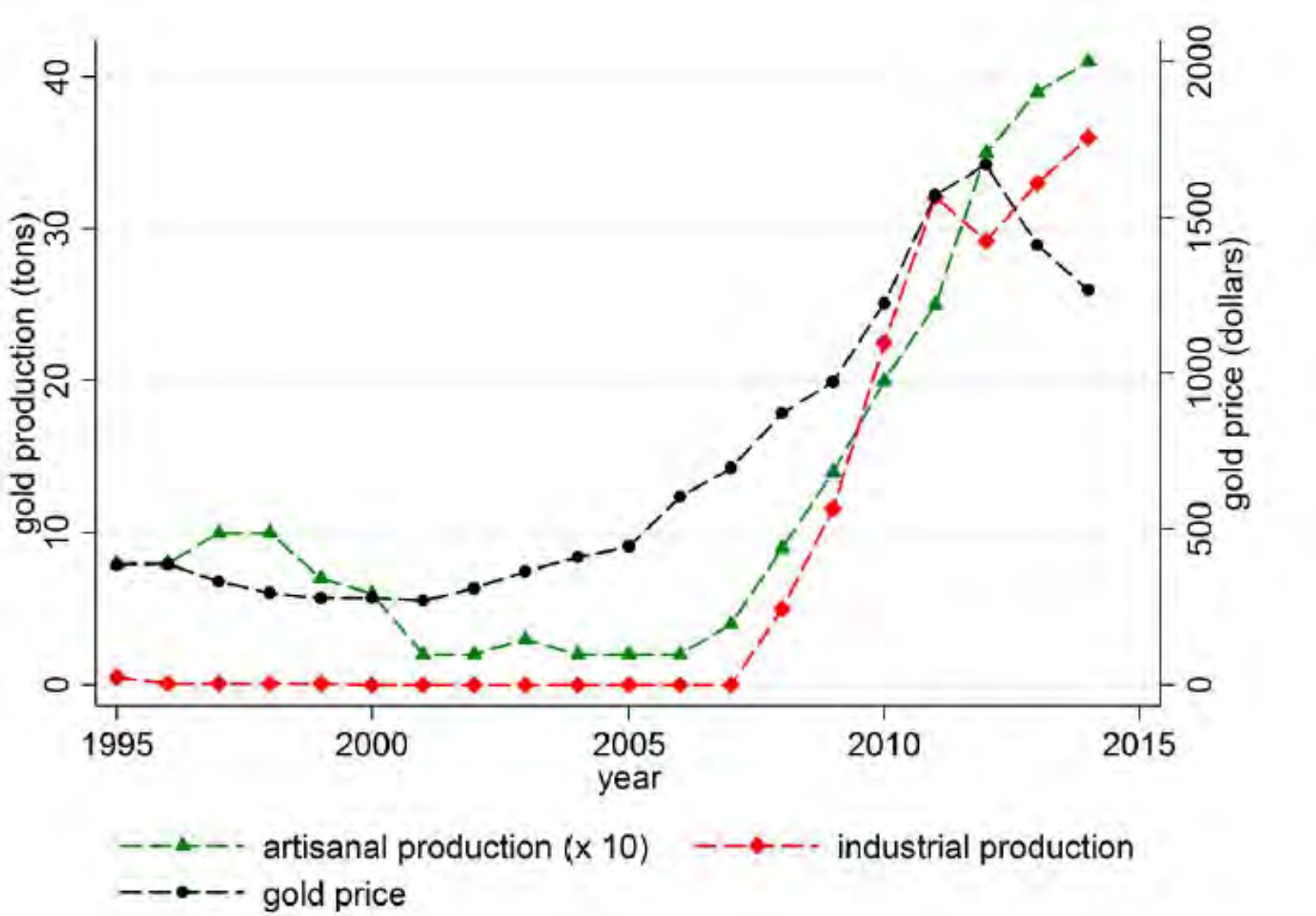
- artisanal gold mines are labour intensive and quite unproductive
- industrial gold mines are highly capital intensive and very productive

- The authors show that a 1% increase in the gold price increases consumption by 0.2% for households neighbouring artisanal mines
- They do not find any effect for households neighboring industrial mines.
- Despite the huge efficiency gains in production, the distributive impact of industrial gold mines is not sufficient to raise local livelihoods

Gold mining in Burkina Faso



Gold mining in Burkina Faso

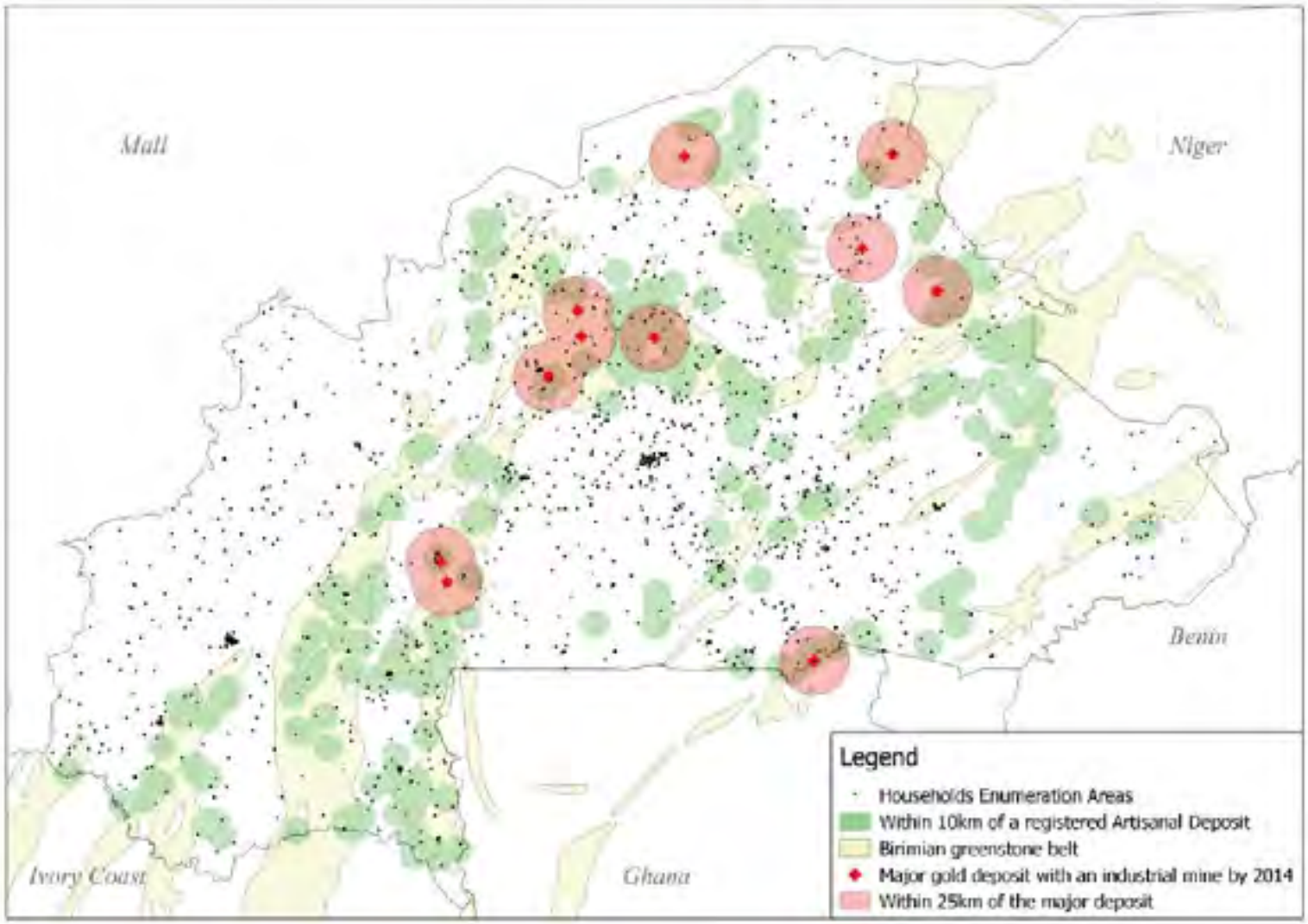
Table 1: Major industrial gold mines in Burkina Faso, producing and about to produce in 2014

name	cumulated production in 2014	Estimated gold reserves	production started	Country controlling compagny
Bissa	15.698	34,00	2013	Russia
Essakane	46.885	100,00	2010	Canada
Inata	20.035	22,50	2010	UK
Kalsaka	10.201	20,00	2008	UK
Mana	35.956	35,00	2008	Canada
Taparko	23.058	35,00	2007	Russia
Youga	16.074	25,00	2008	Canada
Karma	0,00	29,00	2016	Canada
Gryphon	0,00	20,00	2016	Australia

Note: data from the Ministere des Mines et de l'Energie of Burkina Faso

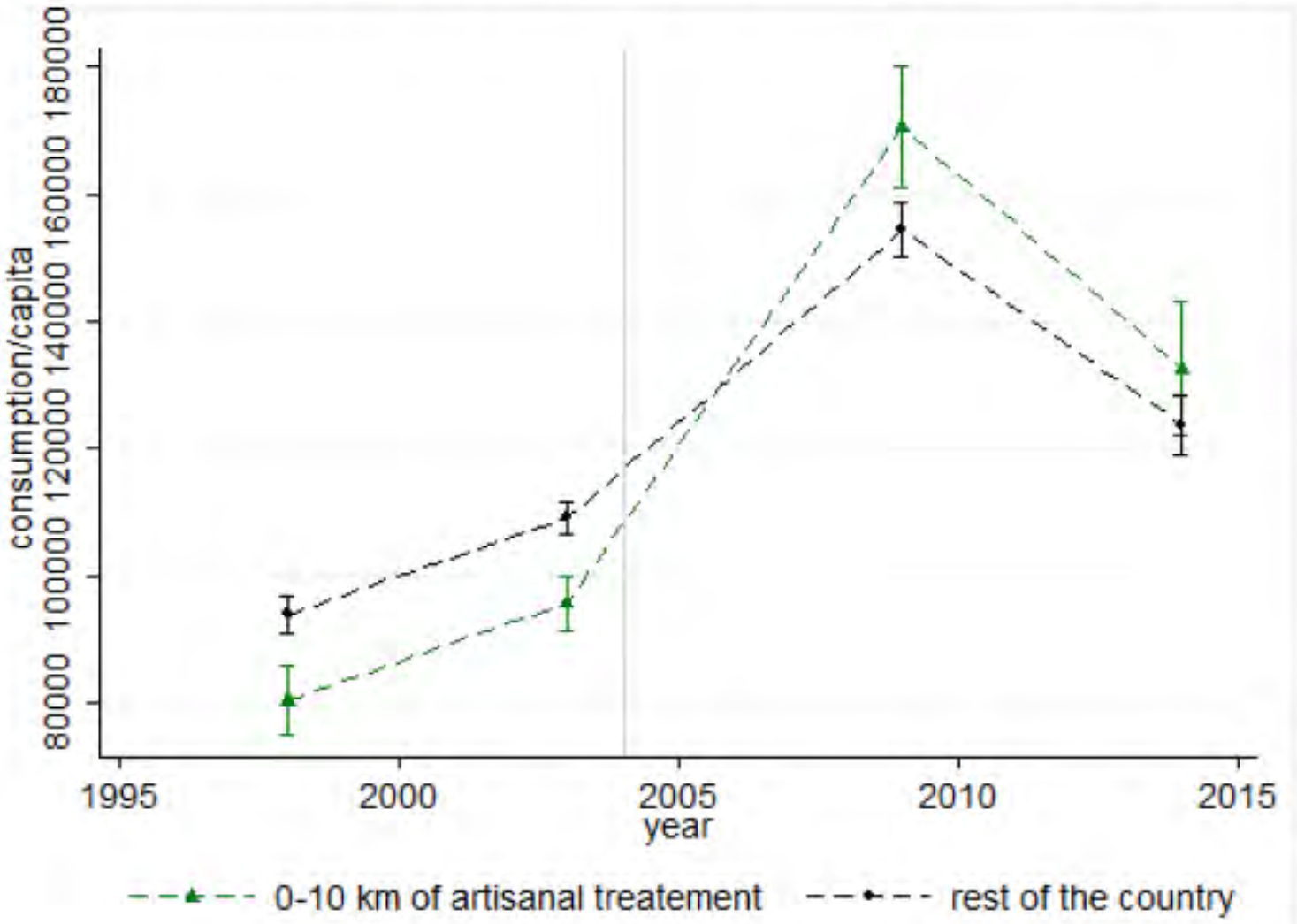
Gold mining in Burkina Faso

Figure 3: Location of enumeration areas for household surveys and mines (both industrial and artisanal)



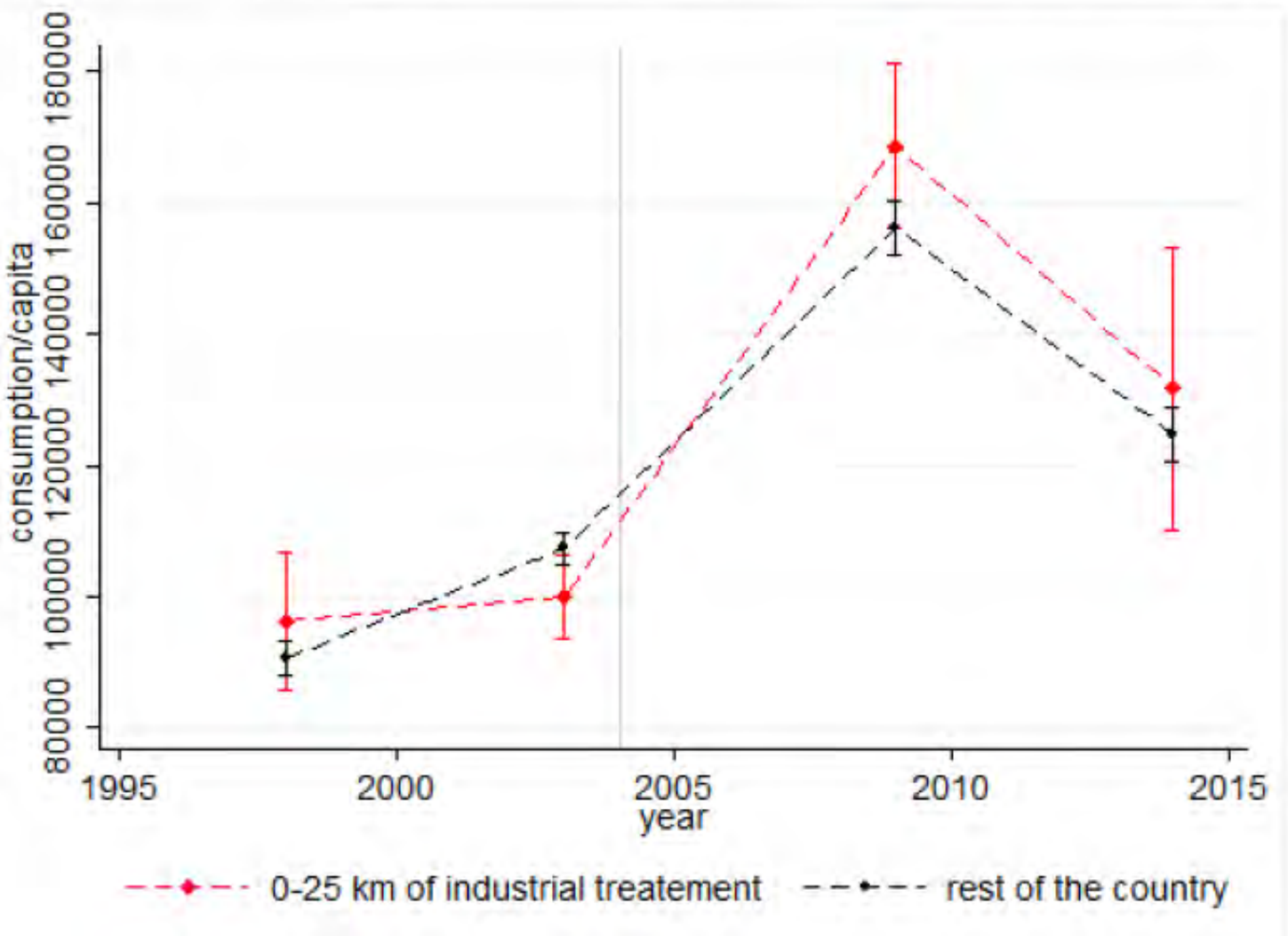
Gold mining in Burkina Faso

Figure 4: The evolution of household consumption before and after the gold price boo



Gold mining in Burkina Faso

Figure 5: The evolution of household consumption before and after industrial mines opening



Gold mining in Burkina Faso

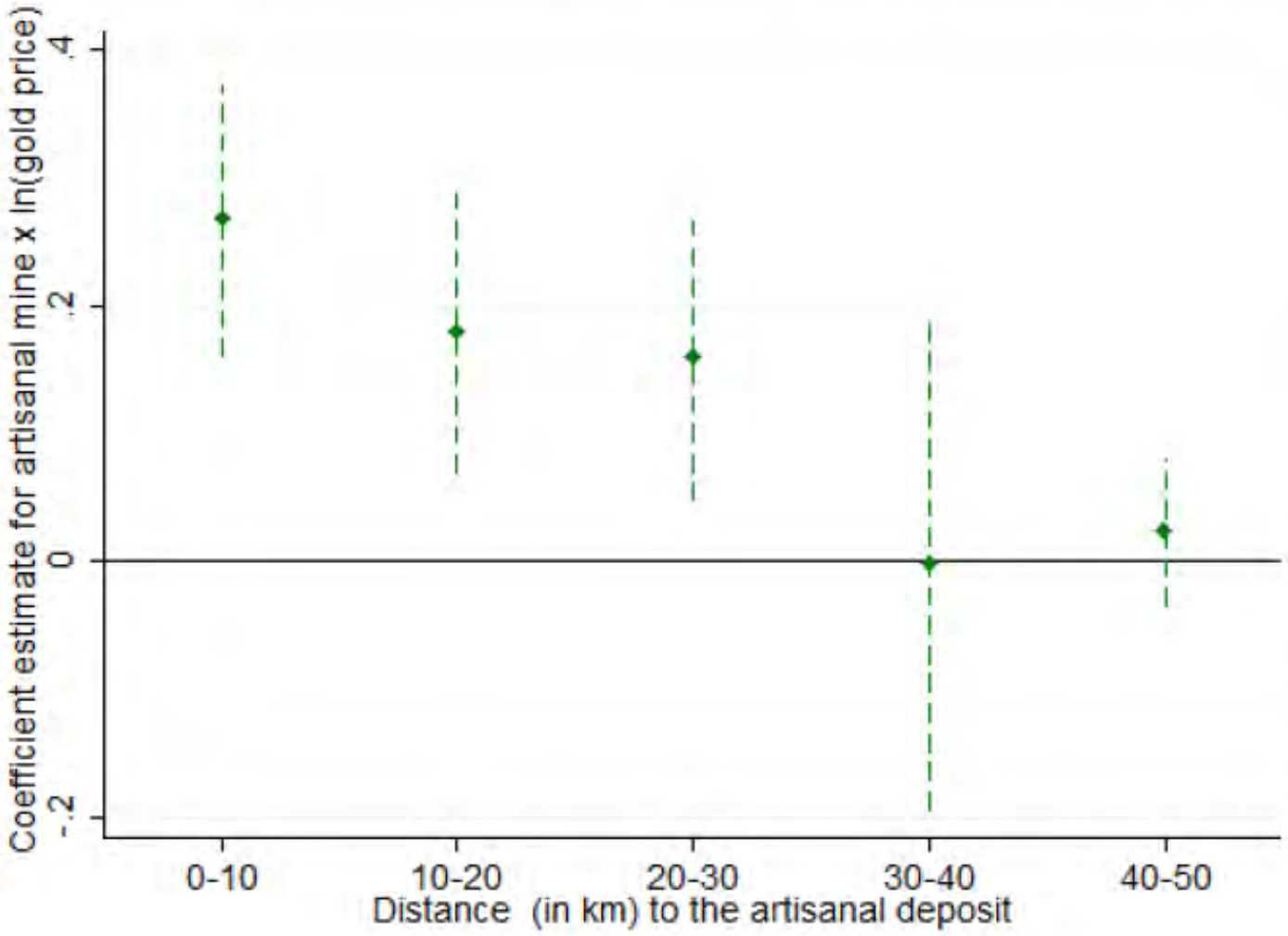
Table 3: The effects of artisanal mines on households' consumption: Baseline estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.: ln pc Cons.						
Artisanal deposit 10km	0.190***				0.167***	
* ln(gold price)	(0.0495)				(0.0465)	
Artisanal 10km		0.242***				0.211***
* gold price boom		(0.0660)				(0.0634)
Artisanal deposit 10km	-1.225***	-0.133***			-1.076***	-0.113**
	(0.325)	(0.0496)			(0.301)	(0.0464)
Birimian belt			0.116**		0.0463	
* ln(gold price)			(0.0477)		(0.0427)	
Birimian belt				0.152**		0.0654
* gold price boom				(0.0627)		(0.0573)
Birimian belt			-0.751**	-0.0827*	-0.293	-0.0268
			(0.310)	(0.0444)	(0.274)	(0.0406)
Observations	34,308	34,308	34,308	34,308	34,308	34,308
R-squared	0.412	0.412	0.411	0.411	0.412	0.412
P(artisanal+boom=0)		0.0100				0.0315
P(Birimian+boom=0)				0.0934		0.375

Note: All columns include municipality fixed effects, year fixed effects, and household level controls (age, sex, ability to read, the sector of occupation and nature of work of the household's head, number of household member and adult members, the electricity connection and main source of drinking water of the household), and a control for urban areas. Robust standard errors are clustered at the municipality level. *** p<0.01, ** p<0.05, *p<0.1.

Gold mining in Burkina Faso

Figure 6: Impact of artisanal mines on consumption by distance to the deposit



Gold mining in Burkina Faso

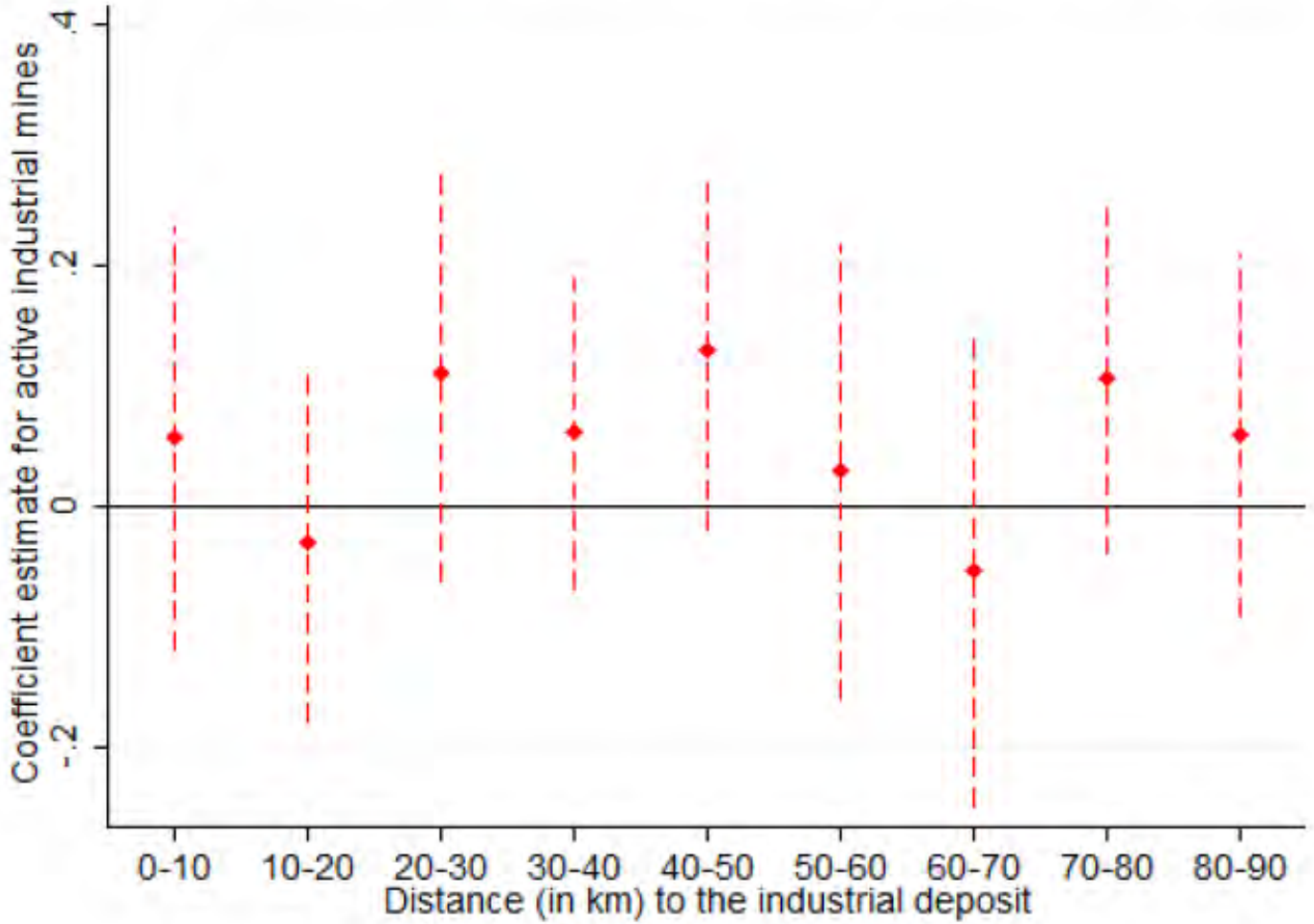
Table 4: The effects of artisanal and industrial mines on households' consumption

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.: ln pc Cons.						
Artisanal deposit 10km	0.191***	0.192***	0.193***	0.193***	0.191***	
* ln(gold price)	(0.0491)	(0.0491)	(0.0492)	(0.0493)	(0.0490)	
Artisanal deposit 10km	-1.238***	-1.240***	-1.248***	-1.249***	-1.238***	
	(0.322)	(0.322)	(0.323)	(0.323)	(0.322)	
Industrial deposit 25km	0.124*	0.124*	0.124*	0.124*	0.123*	0.123*
	(0.0707)	(0.0707)	(0.0720)	(0.0719)	(0.0626)	(0.0659)
Industrial mine 25km	-0.0595				-0.0590	-0.0326
	(0.0696)				(0.0680)	(0.0664)
Industrial mine 25km		-0.00875				
* ln(gold price)		(0.0100)				
Major industrial mine 25 km			-0.0557			
			(0.0799)			
Minor and semi-mechanized mine 25km			-0.118			
			(0.134)			
Major industrial mine 25 km				-0.00821		
* ln(gold price)				(0.0112)		
Minor and semi-mechanized mine 25km				-0.0164		
* ln(gold price)				(0.0192)		
Mine construction 25 km					0.00412	
* ln(gold price)					(0.0986)	
Observations	34,308	34,308	34,308	34,308	34,308	34,308
R-squared	0.412	0.412	0.412	0.412	0.412	0.410
P(deposit=industrial mine)	0.352					
P(industrial deposit=mine)					0.341	0.169
P(industrial deposit=construction)					0.339	
P(industrial construction=mine)					0.607	
P(deposit= major mine)			0.349			
P(deposit= semi mechanized mine)			0.968			

Note: All columns include municipality fixed effects, year fixed effects, and household level controls (age, sex, ability to read, the sector of occupation and nature of work of the household's head, number of household member and adult members, the electricity connection and main source of drinking water of the household), and a control for urban areas. Robust standard errors are clustered at the municipality level. *** p<0.01, ** p<0.05, *p<0.1.

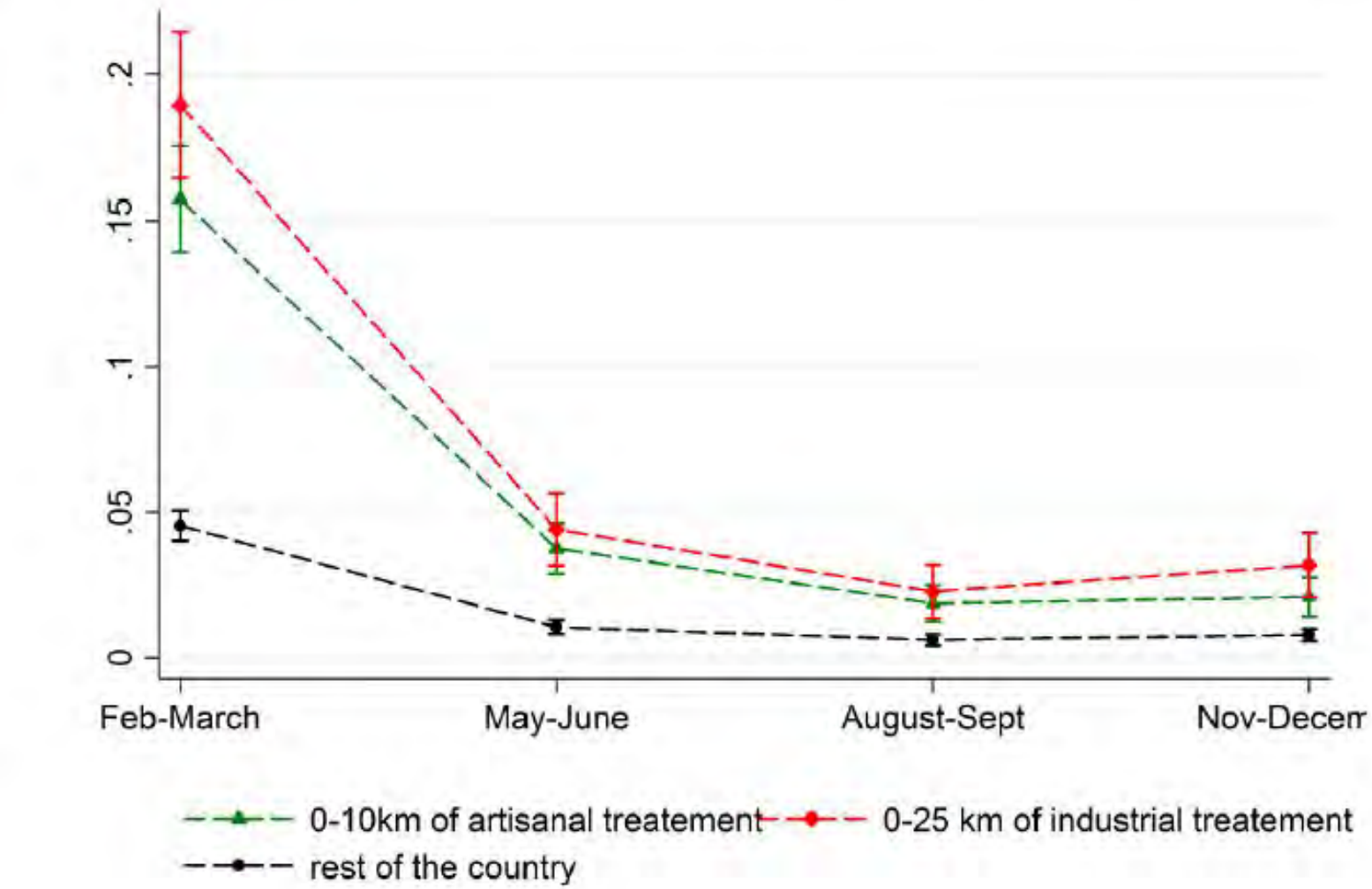
Gold mining in Burkina Faso

Figure 7: Impact of industrial mines on consumption by distance to the mine



Gold mining in Burkina Faso

Figure 8: Share of workers in the extractive sector during the different quarters of 2014



Gold mining in Burkina Faso

Table 10: Education effects: the probability to be at school

	(1)	(2)	(3)	(4)	(5)
Sample	household head	above 16 years old	11 to 16	6 to 10	0 to 5
Dep. Var: education ongoing					
Artisanal 10 km	0.00390	-0.00810**	0.0237	0.0221	-0.0324
* ln(gold price)	(0.00270)	(0.00362)	(0.0285)	(0.0227)	(0.0216)
Artisanal deposit 10 km	-0.0249	0.0540**	-0.168	-0.133	0.184
	(0.0177)	(0.0236)	(0.188)	(0.150)	(0.143)
Industrial mine 25km	0.00533	-0.00574	0.0378	0.0639**	-0.0463
	(0.00592)	(0.00919)	(0.0427)	(0.0316)	(0.0289)
Industrial deposit 25km	-0.00573	-0.00579	-0.0122	-0.00246	0.0174
	(0.00386)	(0.00652)	(0.0316)	(0.0252)	(0.0214)
Observations	34,533	118,536	35,964	39,984	7,433
R-squared	0.030	0.066	0.194	0.203	0.188
P(deposit=mine)	0.951	0.158	0.489	0.0555	0.313

Note: All columns include municipality fixed effects, year fixed effects, and a control for urban areas. Robust standard errors are clustered at the municipality level. *** p<0.01, ** p<0.05, *p<0.1.


Managing commons: theoretical insights

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- The industrial mine: an example of centralized extraction of natural resource extraction (whether the mine is private or government-owned).
- Small-scale miners are typically numerous
  - they take their extraction decisions independently
  - eventually influenced by informal or formal institutions coordinating their actions.
- Why does it make a difference?
- Why are (very) efficient industrial mines raising tensions?

Managing commons: theoretical insights

Managing commons: theoretical insights

- What about renewable natural resources?
  - renewable
  - typically non-point resources
  - often labour intensive exploitation

The problem of open-access (Baland and Platteau, 1996)

- Let's consider a fishery with S, the stock of fish and let's neglect dynamic aspect at this stage
- Suppose that there are n active fishermen and catches are divided equally among them, provided they hire a boat at price p

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- A fishermen has to choose between getting nothing, at no cost or catching $\frac{S}{n}$ at cost p
- It is easy to show that the equilibrium number of fishermen if such that

$$n_O = \frac{S}{p}$$

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- The rent is totally dissipated, as the fish stock, by assumption
- If there is only one fishermen, the entry of the second one reduces the profit of the first one from $S - p$ to $\frac{S}{2} - p$. The aggregate loss for this small economy is p

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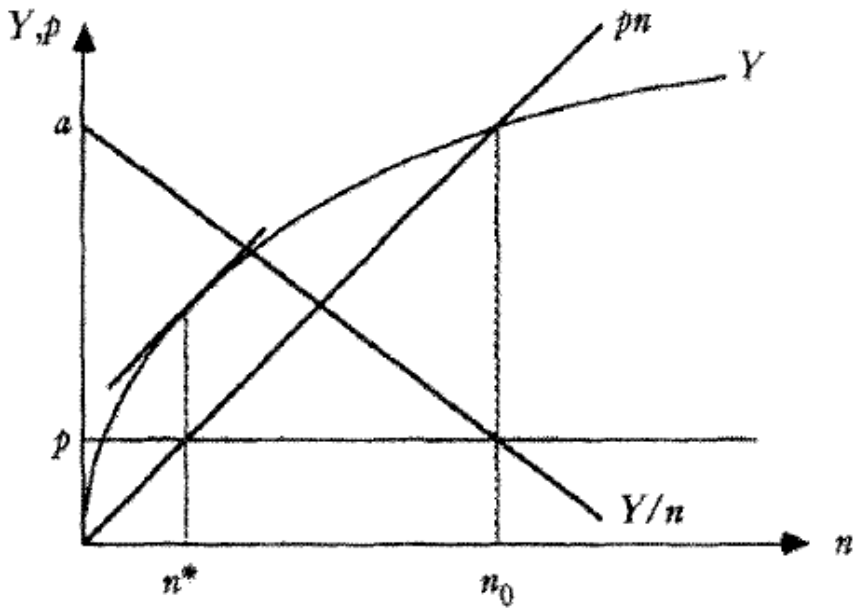
- Let's now suppose that the total number of catch does depend on the number of boats and consider the production function $Y = an - bn^2$
- The open-access equilibrium will be such that $\frac{Y}{n} = p$
- It is easy to show that, under open-access,

$$n_O = \frac{a - p}{b}$$

- while, under private property, it would be

$$n^\star = \frac{a - p}{2b}$$



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- there is no way in which, by refraining from fishing today, the agents can be assured that, in the next period, they will receive the amount of fish they have left untouched, augmented by its natural growth

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- Agents are myopic...

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  - **Regulated common property** where, on top of exclusion, norms of behaviour and rules of use can be imposed to members

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  - **Unregulated common property** where outsiders can be excluded
  - **Regulated common property** where, on top of exclusion, norms of behaviour and rules of use can be imposed to members
- In common property resources, we enter in a world of strategic interactions
- Let's consider two herdsman watching for their cows over a pasture and the following payoff matrix

Nb animals	1	2
1	5,5	6,3
2	3,6	4,4

The problem of common property (Baland and Platteau, 1996)

- Let's assume that two fishermen own a lake in common. They can decide on the number of boat n_i they operate on the lake, knowing that operational costs are equal to p
- Let's further assume that total catches are a function of the number of fishing boats operating

$$Y = a\sum_i n_i - b(\sum_i n_i)^2$$

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$$Y = a\sum_i n_i - b(\sum_i n_i)^2$$

- we can therefore write the individual profit functions as

$$\Pi_i = \frac{n_i}{n_i + n_j}\left[a(n_i + n_j) + b(n_i + n_j)^2\right] - pn_i$$

The problem of common property (Baland and Platteau, 1996)

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- by symmetry, we can show that the equilibrium number of boats is

$$n_i^{Nash} = n_j^{Nash} = \frac{a - p}{3b}$$

The problem of common property (Baland and Platteau, 1996)

- This solution can be compared to the open access and the to the common property situation:
  $1 \times n^{\star} < n_i^{Nash} + n_j^{Nash} < N \times n^0$
- with a larger rent dissipation as N increases

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- Let's now generalize and compute the equilibrium with N fishermen and a more general production function, increasing and concave.

The problem of common property

- Harvest/catch function

$$h_i(e_i, e_{-i}) = \frac{e_i}{\sum_{j=1}^{N} e_j} F\left(\sum_{j=1}^{N} e_j\right) \tag{1}$$

with $F' > 0$, $F'' < 0$ and $h_i(0,0) = 0$

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- Profit function

$$\Pi_i(e_i, e_{-i}) = h_i(e_i, e_{-i}) - c(e_i) \tag{2}$$

with $c'(.) > 0$ and $c''(.) \geq 0$

The problem of common property

- The maximization of problem of fisherman i can be written as

$$\max_{\Pi_i} \quad \Pi_i \quad = \quad \max_{e_i} \quad \frac{e_i}{\sum_{j=1}^{N} e_j} F\left(\sum_{j=1}^{N} e_j\right) - c(e_i) \tag{3}$$

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- It yields the first order condition

$$\frac{\partial \Pi_i}{\partial e_i} = \frac{\left(F(.) + F'(.)e_i\right)\sum_{j=1}^{N} e_j - e_i F(.)}{\left(\sum_{j=1}^{N} e_j\right)^2} - c'(.) = 0 \tag{4}$$

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- This can be rewritten as

$$\frac{\partial \Pi_i}{\partial e_i} = \frac{\sum_{j=1}^{N} e_j F(.)}{\left(\sum_{j=1}^{N} e_j\right)^2} - \frac{e_i F(.)}{\left(\sum_{j=1}^{N} e_j\right)^2} + \frac{e_i F'(.)}{\sum_{j=1}^{N} e_j} = c'(.) \tag{5}$$

The problem of common property

- and even, in a simpler version

$$\frac{\partial \Pi_i}{\partial e_i} = \frac{\sum_{j \neq i}^{N-1} e_j}{\sum_{j=1}^{N} e_j} \frac{F(.)}{\sum_{j=1}^{N} e_j} + \frac{e_i}{\sum_{j=1}^{N} e_j} F'(.) = c'(.) \tag{6}$$

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$$\frac{\partial \Pi_i}{\partial e_i} = \frac{(N-1)e}{Ne} \frac{F(.)}{Ne} + \frac{e}{Ne} F'(.) = c'(.) \tag{7}$$

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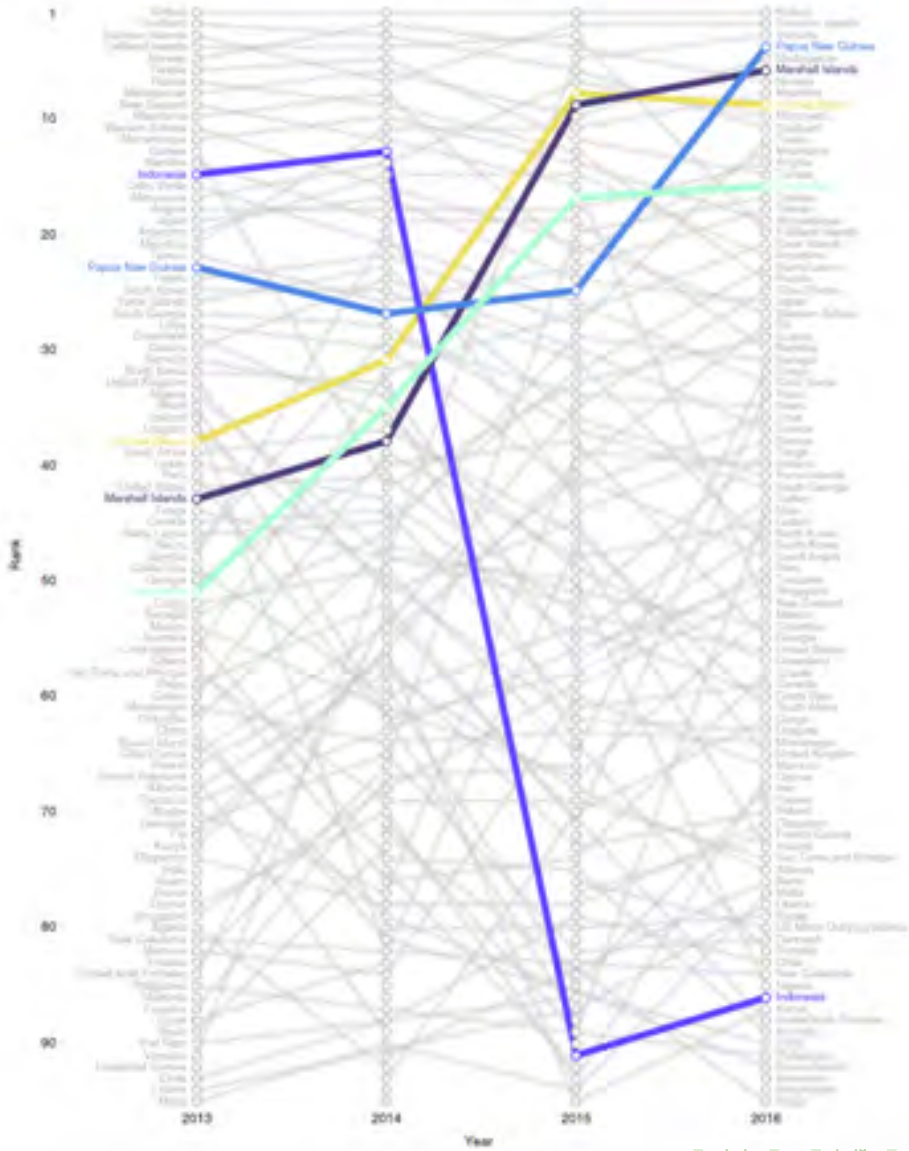
- If $N = 1$, then e is such that $F'(e) = c'(e)$, the socially optimal level of extraction
- If $N = \infty$, then e is such that the marginal cost of effort is equal to the average productivity. This is the open access equilibrium where all rents are dissipated
- If $1 < N < \infty$, the Nash equilibrium is located somewhere between the marginal and the average productivity curves. The equilibrium is such that there is over-use of the resource and lower profits

The problem of common property

- The intuition behind this result can easily be understood by thinking to the situation of a newcomer when there are already a lot of fishermen.
- The newcomer will compare the cost of his effort to what he will earn: the average product of effort (and not the marginal)
- the larger the number of users, the higher the rent dissipation and the overextraction of the resource.

Application: regulating the access to a CPR

- Starting in 2015, Indonesia decided to ban illegal and unreported fishing activities in its exclusive economic zone.



Application: regulating the access to a CPR

Cabral et al. (2018) shows that the ban has been effective

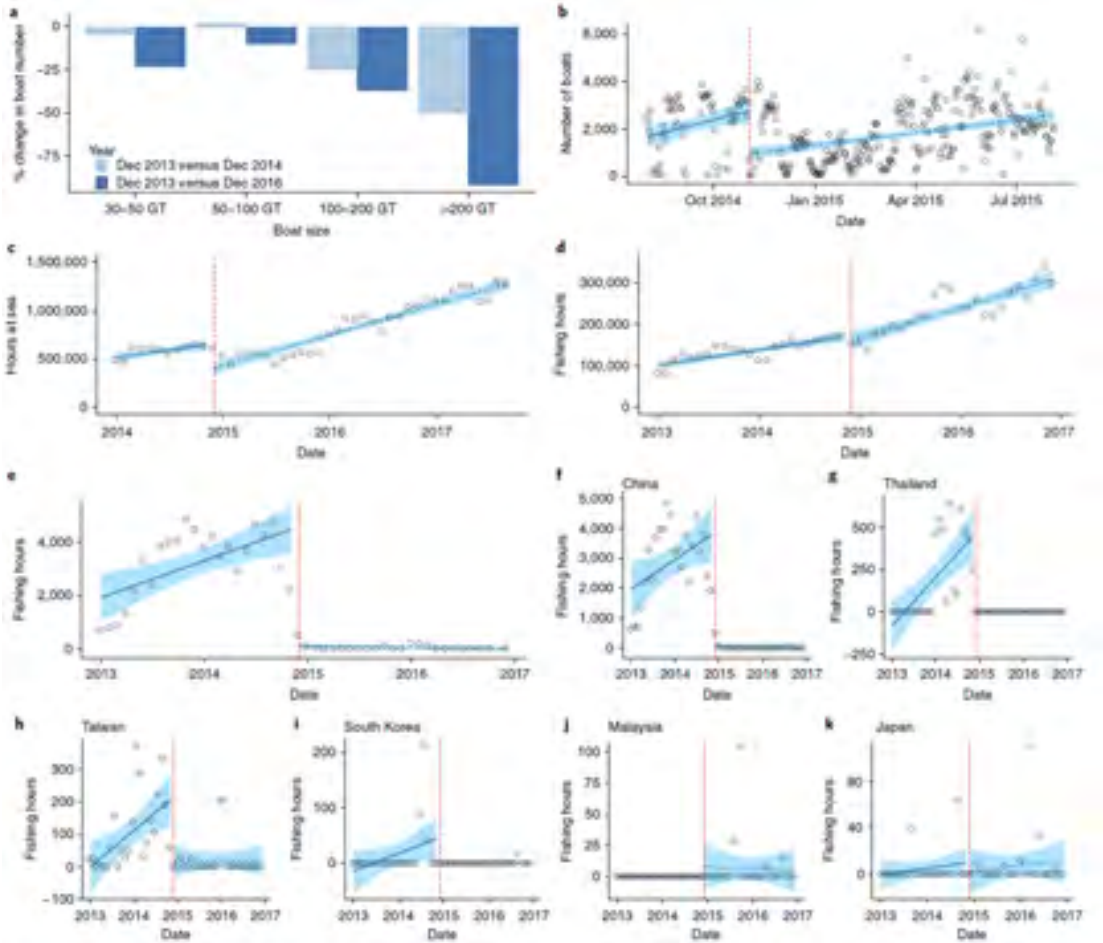


Fig. 3 | Fishing effort before and after the implementation of Indonesia's IUU policies. a, Percent change in boat number by size class before (2013) and after (2014 and 2016) the implementation of moratoria on foreign fleets. Data are derived from Indonesia's boat registration records. **b**, Number of boats detected within Indonesia's EEZ, based on nightlight satellite images. **c**, Total hours at sea per month of fishing boats. Data are derived from Indonesia's VMS data. **d**, Fishing hours per month of all countries fishing in foreign EEZs, using AIS data from the GFW. **e**, Fishing hours per month of foreign boats fishing in Indonesia, using AIS data from the GFW. **f**–**k**, Fishing hours per month of the top foreign nations fishing in Indonesia, using AIS data from the GFW. The vertical dashed red line represents the beginning of the implementation of Indonesia's IUU policies; the solid blue line represents linear regression of data before the IUU policies; the dashed blue line represents linear regression of data during the IUU policies; and the blue shading represents the 95% confidence interval.

Application: regulating the access to a CPR

The paper even estimates that it has raised profits of Indonesian fishermen

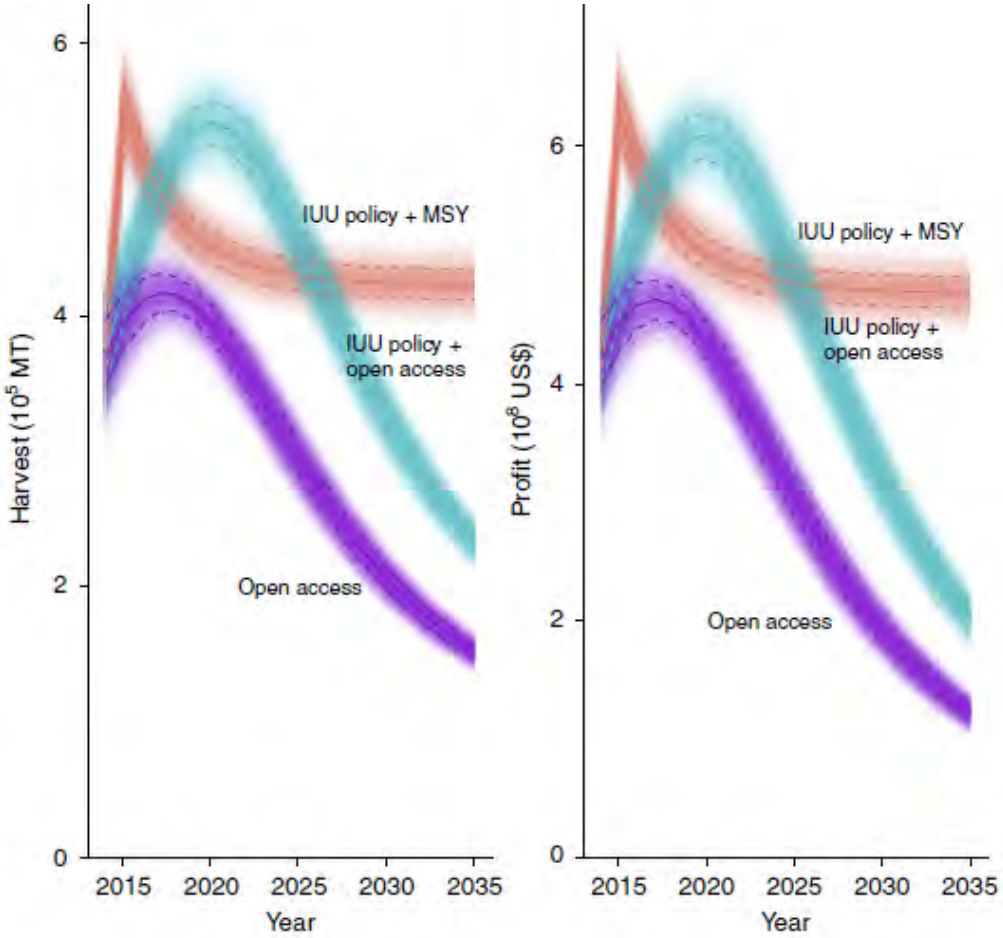


Fig. 4 | Benefits of addressing IUU fishing in Indonesia. Indonesia's local skipjack harvest and profit under the scenarios of an open-access fishery (business as usual), implementation of IUU policies but uncontrolled domestic effort expansion, and implementation of IUU policies and targeting effo expansion at the MSY level. The background shading represents the 1,000 projections derived from bootstrapped population parameters; the solid line are the mean values; and the dashed lines represent s.d. from the mean.

Application: regulating the access to a CPR

it also simulates how it would help world fisheries

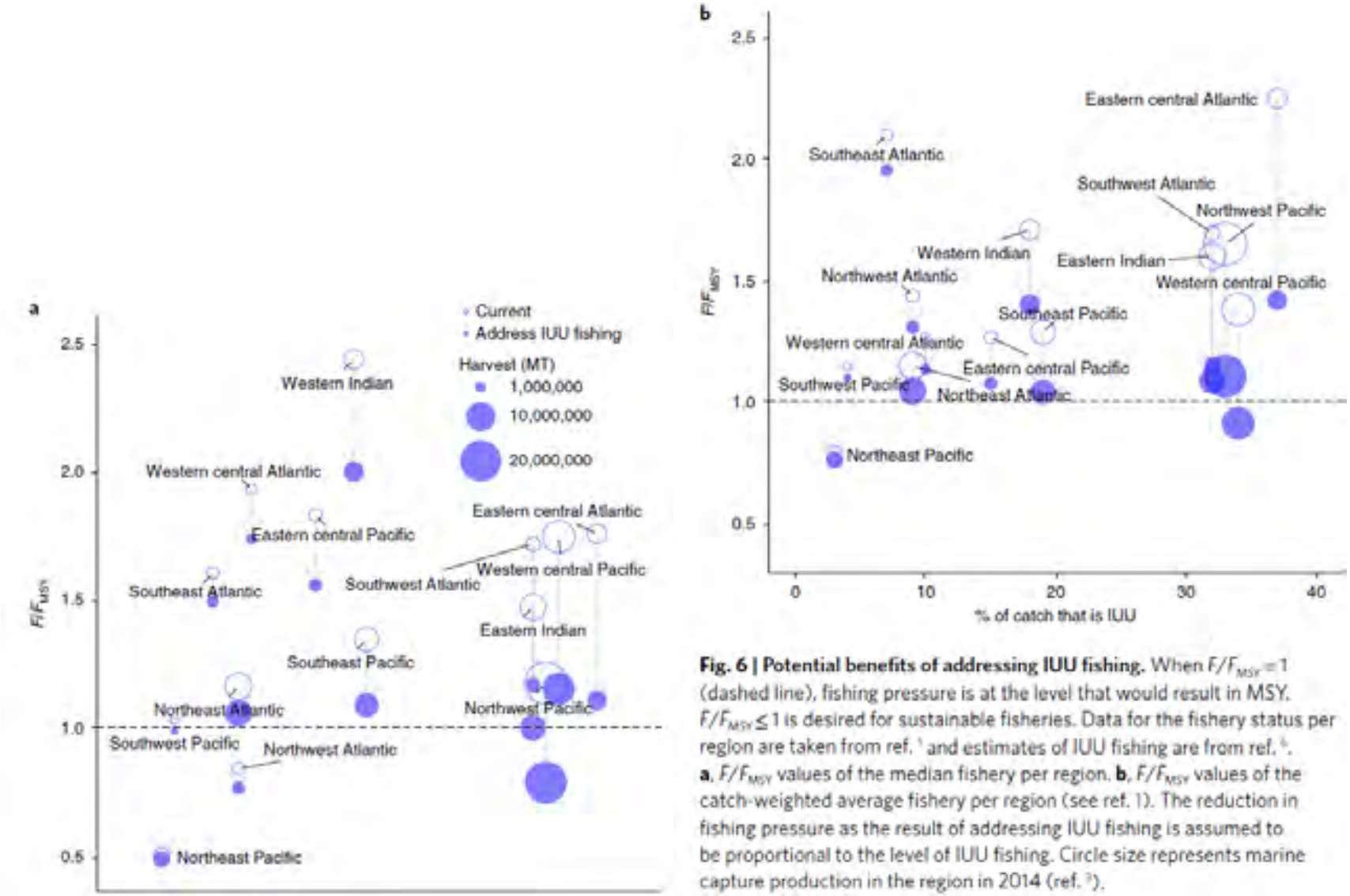


Fig. 6 | Potential benefits of addressing IUU fishing. When $F/F_{MSY} = 1$ (dashed line), fishing pressure is at the level that would result in MSY. $F/F_{MSY} \leq 1$ is desired for sustainable fisheries. Data for the fishery status per region are taken from ref. [1] and estimates of IUU fishing are from ref. [6]. **a**, F/F_{MSY} values of the median fishery per region. **b**, F/F_{MSY} values of the catch-weighted average fishery per region (see ref. 1). The reduction in fishing pressure as the result of addressing IUU fishing is assumed to be proportional to the level of IUU fishing. Circle size represents marine capture production in the region in 2014 (ref. [3]).

The problem of common property: static and dynamic considerations

- The above mentioned model is static in nature
- **Static externalities** occur because the effort of users both allow them to harvest the resource **AND** to appropriate a share of the resource (which could be reframed saying that effort also gives access to the resource)

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- Dynamic externalities are the main issues in environmental problems
  - Climate change
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  - ...
- **Dynamic externalities** occur because the resource is shared with others in the future. The user therefore prefer to overexploit the resource now because he internalizes only a tiny share of the benefits that his self-restraint today creates in the future.
- These dynamic issues can hardly be solved without commitments, across and eventually within periods

The problem of common property: static and dynamic considerations

- A quick illustration based on field work in Udaipur district, Rajasthan, India (August 2012),
- Some community forest user groups refrain from planting teak despite its very high value and moderate growth rate.
- They prefer to plant species like mango or bamboo trees even if teak is planted on private land next to villagers' dwellings.

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- Some community forest user groups refrain from planting teak despite its very high value and moderate growth rate.
- They prefer to plant species like mango or bamboo trees even if teak is planted on private land next to villagers' dwellings.
- Group leaders justify their investment decision by their anticipation of members' future behaviour.
  - users could not be refrained from felling teak before it gets mature, precisely because its value is too large.
  - bamboo trees grow faster and have a lower initial value.
  - even more salient with mango trees.Mango timber in itself is not worth a lot.

The problem of common property: static and dynamic considerations

- Assuming that a community (or a central authority) has limited enforcement capacity, Libois (2022) shows that
  - if the value of the resource growth fast, preserving the resource requires low enforcement
  - if the value of the resource has a low growth rate, it is easier to enforce resource sharing than resource preservation

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  - inequalities decrease static inefficiencies BUT increase dynamic inefficiencies
  - As inequality increases, the "big player" appropriates most of the resource with limited effort and waste of resources but...
  - as inequality increases, it becomes more and more difficult to convince the small player to wait for the second period. The benefit of escaping future conflict gets larger with inequalities.

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  - as inequality increases, it becomes more and more difficult to convince the small player to wait for the second period. The benefit of escaping future conflict gets larger with inequalities.
  - For a given institutional capacity, a positive change in the value of the resource can induce an governance failure and decrease the welfare of extractors.

The problem of common property: property rights

- Given the problem, a traditional answer is to privatize the resource by establishing well defined property rights. Then the owner internalizes the externalities.
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- Traditional users may not be adequately compensated.
- Private management is more efficient, but can the former common property users, now working as wage earners for the private owners, gain from privatization (as their marginal product goes up under privatization)? (Weitzman, JET 1974).

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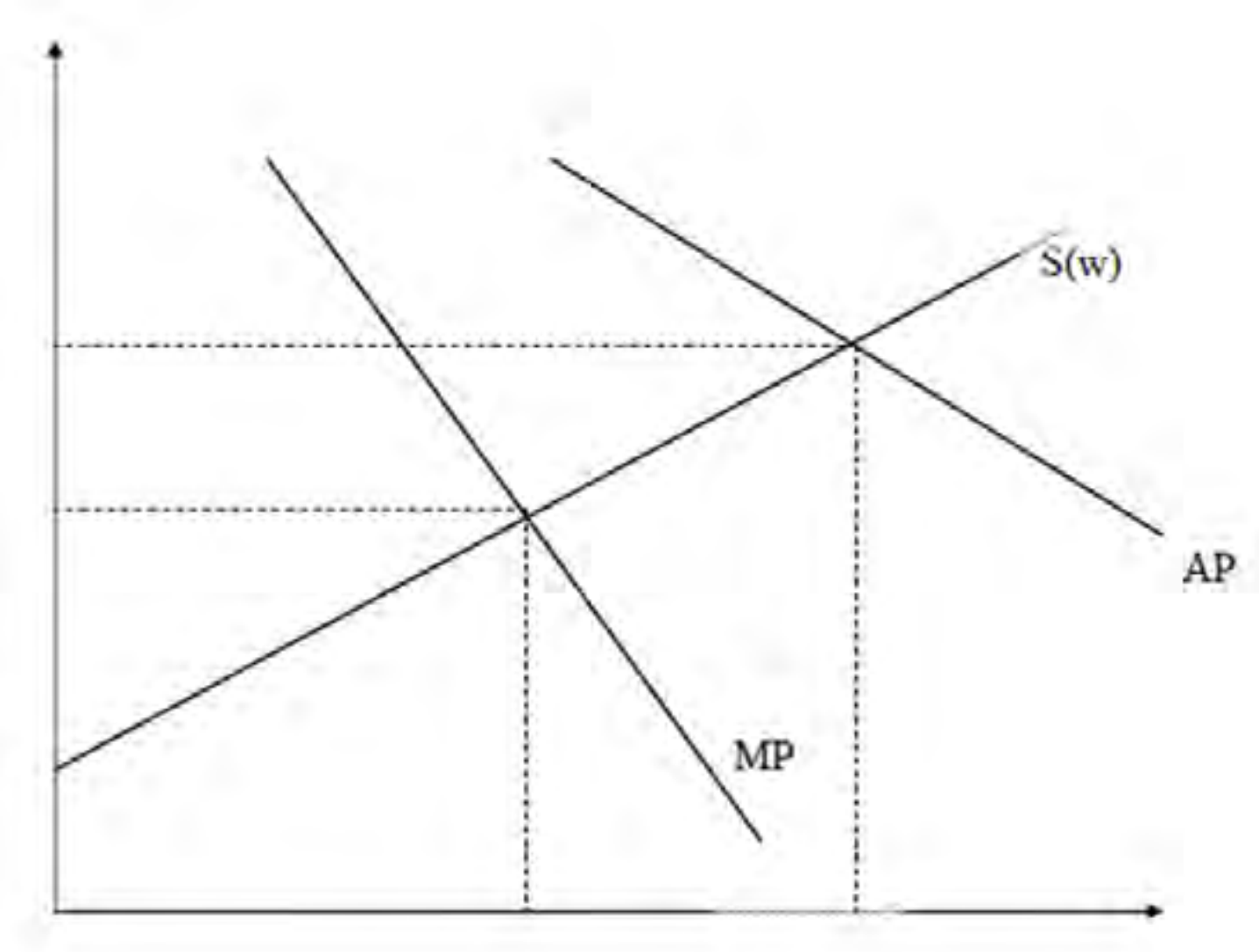
- In this question, all go to the private owner.
- If property shares are not given to the former property users, they can only loose from privatization. They loose twice, in terms of wages and in terms of employment.

The problem of common property: property rights



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- De Meza and Gould (JET 1985) revisit partially the results given by Weitzman, with the following question:
- If the commons consist of pieces of varying quality, can employment rise on some of them after privatization, so that more (but more efficient also) exploitation may locally result?

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- If the commons consist of pieces of varying quality, can employment rise on some of them after privatization, so that more (but more efficient also) exploitation may locally result?
- Under free access:

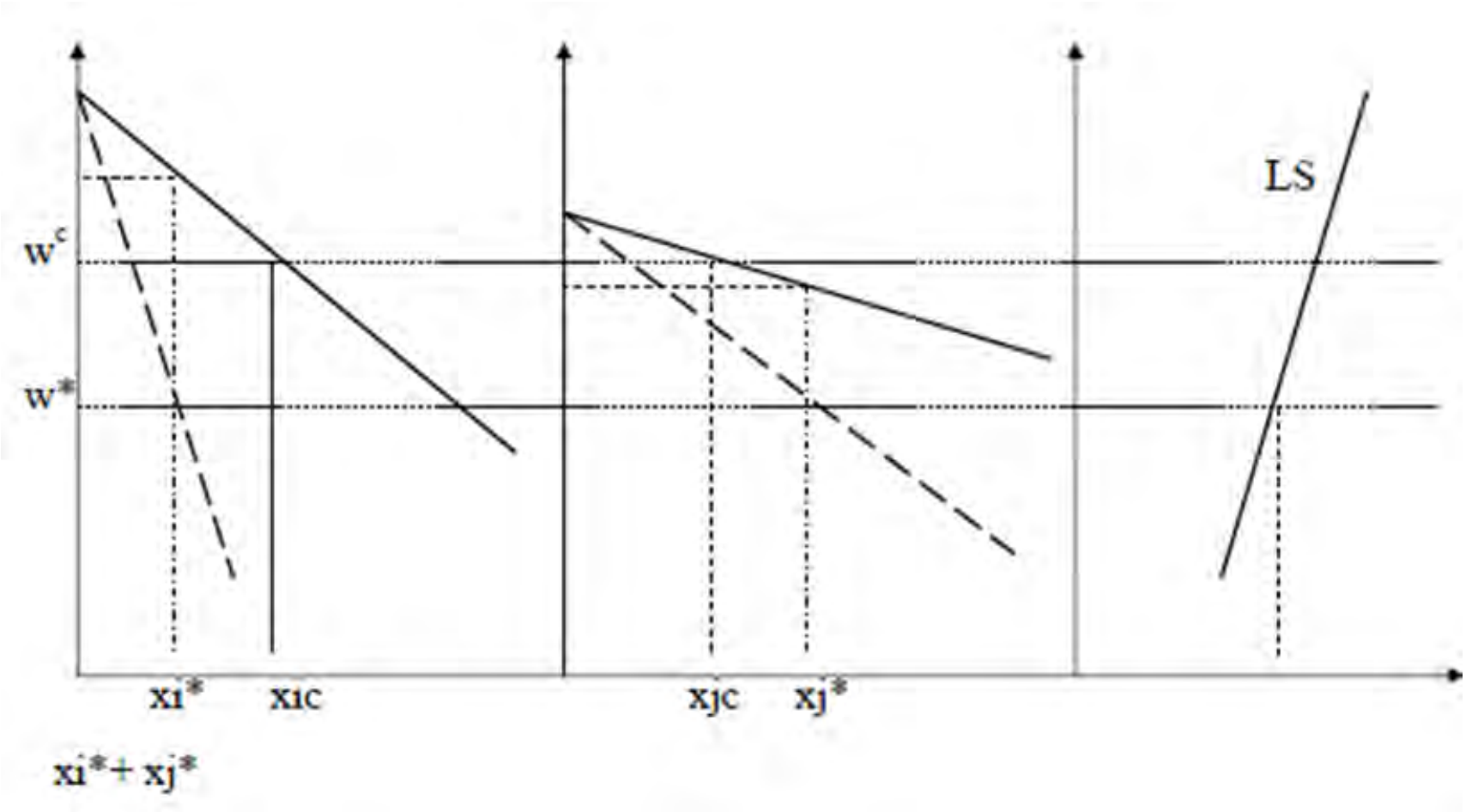
$$AP(x_i^c) = w^c$$

- Under private ownership:

$$AP(x_i^\star) > w^\star = MP(x_i^\star)$$

far al plots i

The problem of common property: property rights



The problem of common property: property rights

- We obtain $x_i^\star < x_i^c$ if $AP(x_i^\star) > w^c$
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- Note also that, globally, equilibrium on the labour market is such that, over all parcels,

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  so that total employment must fall.
- In another paper, De Meza and Gould show that, with more than one input, things get really tricky. Suppose users are cattle herders who use a common pasture. The common pasture is now privatized, and private owner rents out land: the rent proposed to the herders is such that each of them has now an efficient herd size. The net impact is ambiguous, and herders' welfare may actually go up.

The problem of common property: property rights

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The problem of common property: property rights

- But this argument by Weitzman is again a static argument
- Private property implies less use and less employment today but also more preservation and therefore more resource and more employment **tomorrow**
- Because of the inefficiency in the commons, each unit of employment we renounce to today produces more than one unit (even discounted) of employment tomorrow. This is the "dynamic externality".

The problem of common property: property rights

- Baland and Bjorvatn (EDE, 2012) show that, in the context of renewable resources
  1. Privatization necessarily increases employment in the long run, which is positive for labor. This effect is based on the conservation efforts by the private owner, which lead to a larger future stock of the resource. Conservation implies a short-term reduction but a long-term increase in labor demand.
  2. The employment effect may be large enough for privatization to be Pareto improving: traditional users may gain from being excluded from access to the resource, even when they do not receive any direct compensation for this exclusion. These gains are larger the larger the initial stock of the resource and its growth rate.

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  2. The employment effect may be large enough for privatization to be Pareto improving: traditional users may gain from being excluded from access to the resource, even when they do not receive any direct compensation for this exclusion. These gains are larger the larger the initial stock of the resource and its growth rate.
- Of course, if property rights are given to the former users, proportionately to their former use (the "proportional" solution), then all users are better off. The question arises mostly because resource rents or profits are appropriated away by an external agency.

The problem of common property: property rights

- Commons provide more than just income, they may play a role of **insurance** against adverse income shocks
- Typically, for those commons that are mostly used by the poor, one may think that people with good shocks consume less of the resource, and people with bad shocks consume more of it. As a result, the commonly owned resource plays the role of an informal insurance mechanism, which is incentive compatible.

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- Following Baland and Francois (JPubE, 2005), let's assume that everyone is ex ante identical, and privatization consists in giving to each former user an equal share
- Then
  1. In the absence of an insurance mechanism, privatization may reduce expected utility in the absence of a compensating insurance scheme.
  2. A compensating insurance scheme may not exist, unless shocks are observable

The problem of common property: property rights

- Suppose that after privatization, the shock is not observable, but only the amount of work spent on the commons. Then an insurance scheme transferring income from outside workers to inside workers may not be enforceable, as outside workers may then prefer to work on the resource and not transfer income (incentive compatibility problem).
- Consider the largest punishment that can exist, which is that when an agent does not abide by his obligations, he is cut from the community, cannot hire anyone, and won't receive nor give transfers. It is possible that, if he has to transfer income to poorly hit agents, the good shock agents prefer autarky than insuring the others. Once again, insurance may not be feasible (enforcement problem).

The problem of common property: property rights

TABLE 1
Household per-capita income (total and from natural resources), resource dependence and participation by income quintile

	Lowest 20%	*20-40%*	*40-60%*	*60-80%*	*Top 20%*
Participation in natural resource extraction (percentage)	65	63	54	50	39
Average total income (pesos)	2 271	5 963	10 358	17 609	50 530
Average natural resource income (pesos)	333	453	465	508	363
Average natural resource income for households that participate in extraction (pesos)	512	717	860	1 019	927
Average natural resource dependence (ratio)	0.16	0.08	0.05	0.03	0.01

Note: sample size for each quintile is 329 households.
Source: own estimation based on ENHRUM.

Figure: Lopez-Feldman 2011 in Mexico

The problem of common property: property rights

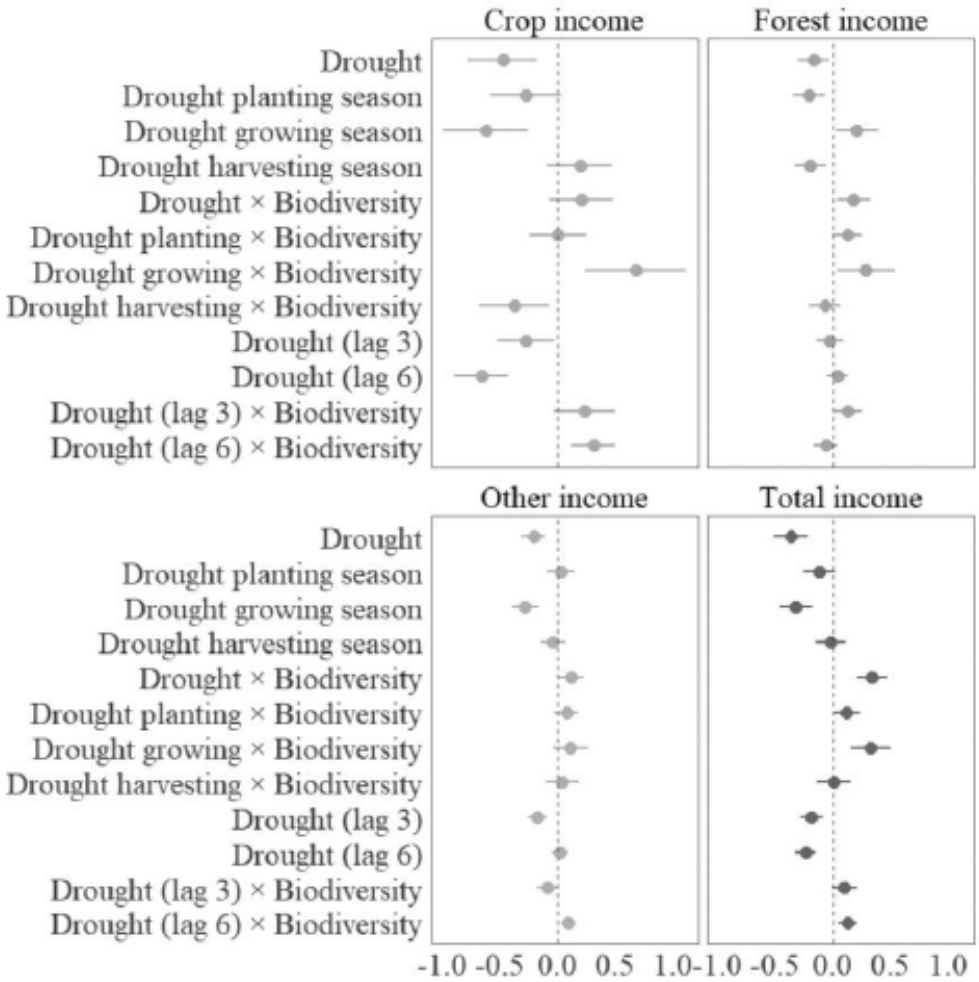

Figure 5. Marginal effects of droughts and biodiversity on sector and total incomes. The coefficients represent semi-elasticities, that is, the relative change of incomes in response to a one standard deviation increase in the drought or biodiversity level. The size of the marginal effects multiplied by 100 approximates the percentage change of income. Color version available as an online enhancement.

Governing the commons

- As of now, we have just spoken about access regulation.
- Access regulation is the weakest form of common property management
- Regulated CPR can have very complex rules on how and when use what resources

Governing the commons

- In her famous book *Governing the commons*, Elinor Ostrom (1990) somehow rehabilitates the commons
- Her book came out in an era putting forward "participatory development"
- She emphasizes that common management may actually be efficient and stresses 8 conditions easing up a successful governance of the common pool resources (CPR)

Governing the commons

The 8 principles of stable local common pool resources management:

1. Clearly defined CPR
2. Appropriation and provision of CPR are adapted to local conditions
3. Participation of most users to the decision process
4. effective monitoring
5. graduated sanctions for violators of community rules
6. cheap mechanisms of conflict resolution (accessible to all)
7. self-determination of the community recognized by the "central" authority
8. if the CPR is large, organization in multiple layers

Governing the commons

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Governing the commons

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- Based on a panel of 233 irrigation systems in Nepal, surveyed twice, once by Ostrom and her team and once by the author, Pokharel (OUP, 2024) investigates the determinants of successful long lasting collective management
- The main findings stress the importance of **fairness and perceived fairness** as a determinant of sustained cooperation
- Pokharel (OUP, 2024) finds little evidence that the 8 principles listed by Ostrom matter significantly for cooperation in the long-run.

The problem of common property: wrap up

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- This is however not always feasible
- It may also not be desirable
- This is typically the case when regulated common property with small transaction costs exists and when fencing costs are high
- Unregulated (and regulated) common property resources have also insurance properties and redistributive properties

The end...

of the first part and the beginning of the second one...