Beyond Ostrom:

Randomized experiment of the impact of individualized tree rights on forest management in Ethiopia

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Conservation of forest resources

- Critically important for developing countries (Sunderlin et al. 2005; Reed et al. 2017)
- Increasing stock of forest resources for both income generation and poverty reduction (Takahashi and Todo 2014; Otsuka et al. 2015)

Securing property rights on forestlands

- Fundamental for sustainable forest resource management (Arnot et al. 2011; Owubah et al. 2001; Tucker 1999)
- Not reaching consensus on which type of property regime leads to recovery of forests and their sustainable management

Community Forest Management (CFM)

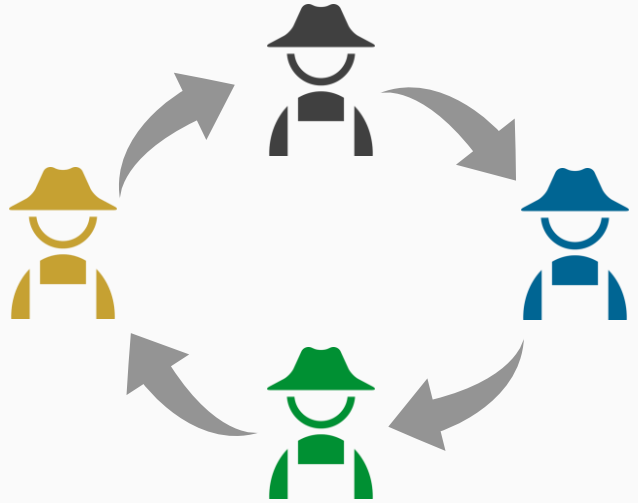
- Commonly adopted in developing countries (Agrawal et al. 2008; Hajjar & Oldekop 2018)
- Primarily due to the contribution of Ostrom and her colleagues

Efficient in developing countries

- Ostrom's (1990, 2010) principles for successful CFM
- Preventing excessive resource extraction through the innate ability of the community (Hayami and Godo 2005; Baland and Platteau 1997; Agrawal 2001)

Advantage: Low protection cost

- Protection is essential in areas with high demand for forest resources to avoid illegal logging or theft
- Monitoring cost is more like fixed cost
- Private: Covered by individual
- Community: Shared by all members
- Cost: Private > CFM (Sakurai et al., 2004)



Rotation monitoring

"Low incentive for tree management"

- To recover timber forests, intensive management is needed: planting, thinning, pruning, weeding, & watering
- Private: High incentive (providing efforts for profit maximization)
- CFM: **No-incentive for properly management of resources** under equal sharing system
- **Importance of providing incentive for tree management is typically overlooked**

News article on tree plantation in Bhutan

From 1951 to 2012, Bhutan planted trees on 54,782 acres
62% died or couldn't be traced

Av survival rate: 58%
Particularly low for timber species (e.g., mixed conifer = **8%**)

Responses from participants
"Most of the saplings did not survive mainly due to a lack of care"

Difficult to regenerate forests

- CFM cannot provide incentives to community members for intensive tree management: planting, thinning, pruning, weeding, & watering

Evidence is mixed (Baynes et al. 2015; Arts and De Koning 2017)

- Less effective than private property systems
  (Araujo et al. 2009; Kijima et al. 2000; Godoy et al. 1998; Nelson et al. 2001; Takahashi & Otsuka 2016)

Optimal institutions for forests

- Consider characteristics between timber and non-timber forests
- Propose **mixed management system** as the optimal system for timber forests in developing countries

Empirical investigation

- Investigate the short-term impact of the mixed management system on forest resource management compared with that of conventional community management

Optimal Institutions

Characteristics of timber & non-timber forests and optimal institutions

Forest Type	Management Intensity	Protection Cost	Optimal Institution
Non-timber	Low	Low	???
		High	???
Timber	High	Low	???
		High	???

Optimal Institutions

Characteristics of timber & non-timber forests and optimal institutions

Forest Type	Management Intensity	Protection Cost	Optimal Institution
Non-timber	**Low**	Low	???
		High	???
Timber	**High**	Low	???
		High	???

Intensive management is mandatory

to maximize profits from timber products

(planting, thinning, pruning, & weeding)

Optimal Institutions

Characteristics of timber & non-timber forests and optimal institutions

Forest Type	Management Intensity	Protection Cost	Optimal Institution
Non-timber	Low	**Low**	???
		High	???
Timber	High	**Low**	???
		High	???

If the demand for forest products is high,
protection is essential to avoid the risk of illegal logging and theft
Often the case in many developing countries

Optimal Institutions

Characteristics of timber & non-timber forests and optimal institutions

Forest Type	Management Intensity	Protection Cost	Optimal Institution
Non-timber	Low	Low	**Any**
		High	**Community management**
Timber	High	Low	???
		High	???

Advantage of CFM = Low protection cost

Works well for non-timber forests in developing countries

Optimal Institutions

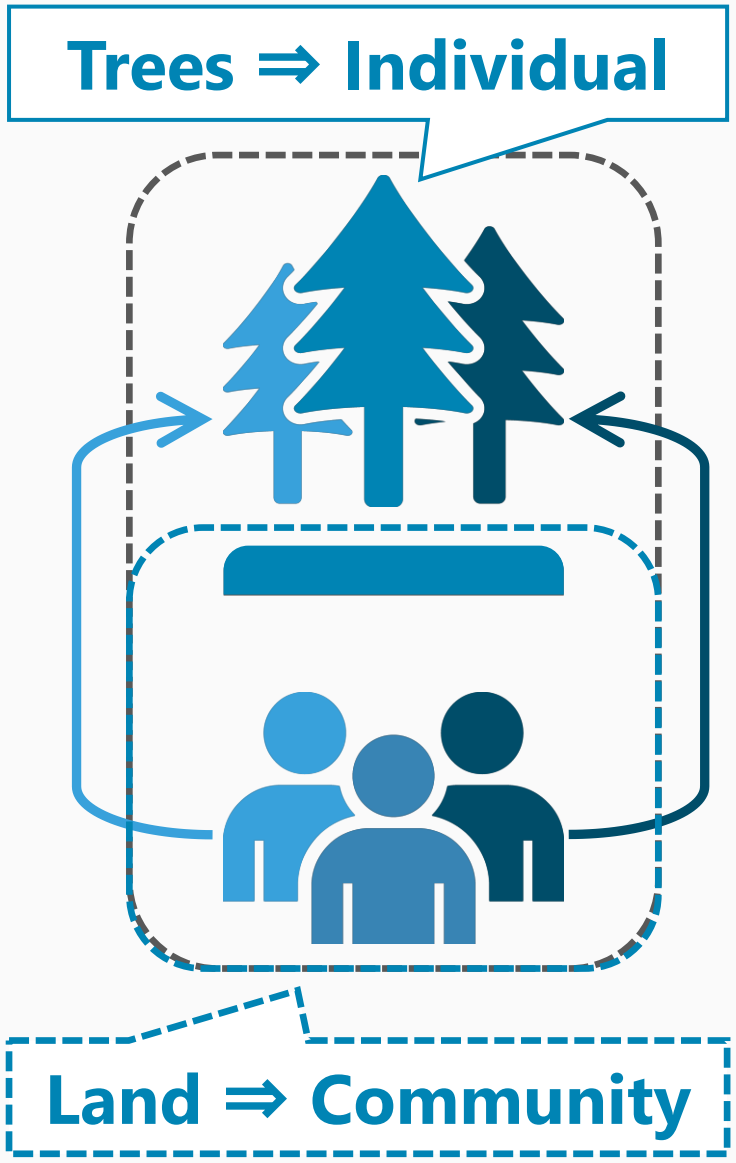
What is the optimal institution for each forest type?

Forest Type	Management Intensity	Protection Cost	Optimal Institution
Non-timber	Low	Low	Any
		High	Community management
Timber	High	Low	**Private management**
		High	**???**

Timber forests with high protection costs:
Mainly observed in developing countries
Neither private nor common ownership works well

Mixed management system of private and common ownership (*MMS*)

- Proposing as a potential solution for developing countries
- Rubber trees are managed by MMS in some areas of Nepal
- Characterized by:
  communal protection of trees and other resources and individual management of these resources
- Granting control rights of forestland to local communities and individual ownership rights of trees to community members



Advantages

Protection cost ⇒ Low

Jointly protecting trees and other resources

Intensive tree management ⇒ High

All the benefits are given to individuals
Fully motivating individuals to carry out management activities

Conversion risk ⇒ Low

Requiring community agreement

Hypotheses

H1: Stimulating tree and forest management activities

- Increasing working efforts for intensive management: thinning, pruning, guarding, watering, and planting seedlings

H2: Increasing the extracted volumes of timber products

- Thinned trees, pruned branches, and timber trees

H3: Not affecting the collection of nontimber forest products unrelated to tree management

- Feed grasses, medicinal plants, honey, mushrooms, and spices

To test hypotheses

Conducting a randomized experiment

Randomly selecting forests under CFM

Providing individual tree rights to members with the official permission from the authority

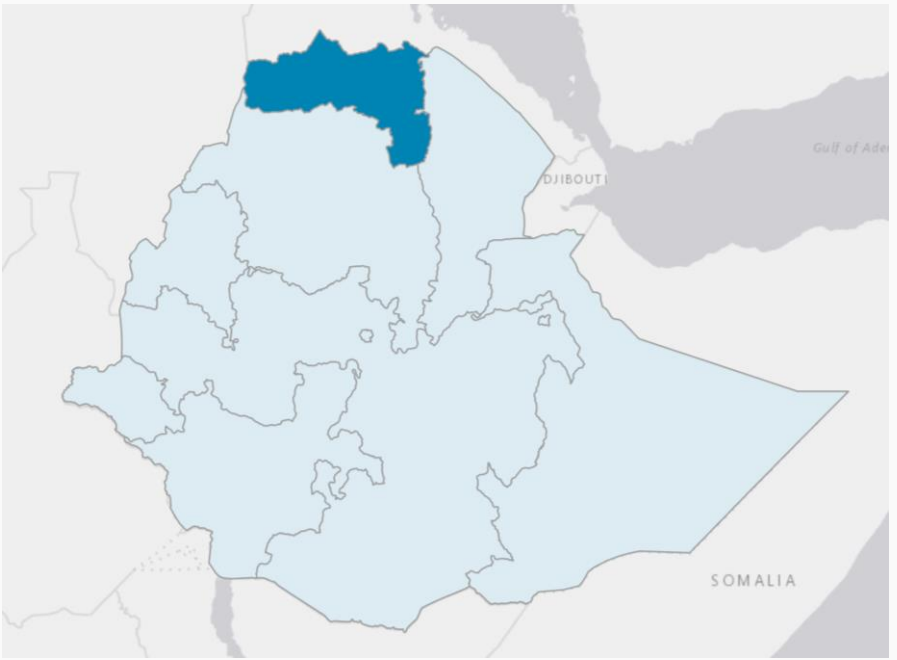
Study area

- Five districts in Tigray region located in Northern Ethiopia

‘Exclosure’ policy

- Restricting access to common lands since 1991 until recently
- 13% of the total land in Tigray (Holden & Tilahun 2018)
- Duration: 5-15 years (Yayneshet et al. 2009)

Tigray, Ethiopia



Allocation of exclosures after rehabilitation

- Groups of landless youth in the community (youth groups)
- Conduct livelihood activities by utilizing common-pool resources: forestry, apiculture, horticulture, mining, and livestock rearing
- Facing high risk of illegal logging by outsiders

Youth groups with forests

- 68 youth groups (Av number of member: 10)
- Dominant tree: Timber trees, including Acacia, Eucalyptus, & etc.
- Following Ostrom's principles (Holden & Tilahun 2018)
  - Rotation monitoring
  - Equal benefit sharing

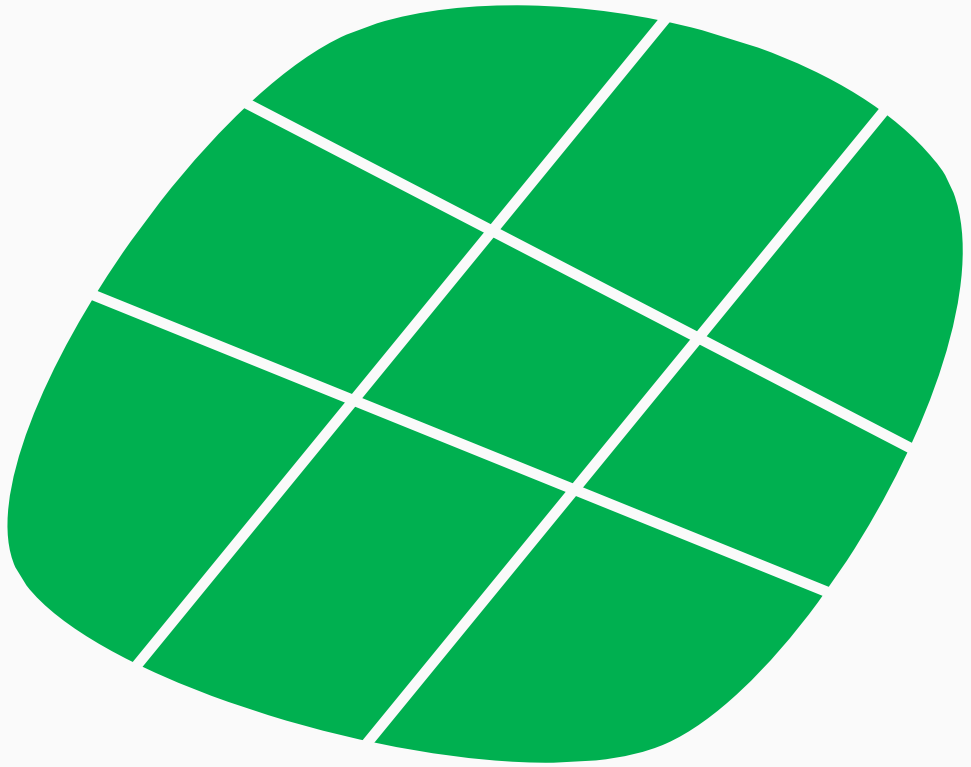
Random selection of the treatment

- Equitably dividing communal lands into smaller parcels based on the vegetation conditions
- Giving property rights only for trees in each parcel to individual members

	Groups	Obs	Right holders	Non-accepters
Treatment	26	197	172	25 (12.7%)
Control	42	262		

Implementation of *MMS*

1. Dividing forests into parcels based on environmental conditions
2. Allocating tree rights for each parcel to members
3. Allowing them to extract their allocated trees
4. Granting tree rights for newly planted trees
5. Securing their rights



Individual tree rights

- Av number of allocated trees for each individual: **81** trees
- Short trees with 5cm diameter at breast height: **63**%
- Providing a document indicating the permission w/o any time limitation from the Bureau of Agriculture and Natural Resources

After the provision

- Allowing to extract their owned trees at any time
- Continuously owning trees if they newly plant tree seedlings at the same allocated parcel

Intervention and surveys

- Baseline survey: Jan – Feb 2018
- Intervention: June – July 2018
- Endline survey: Dec 2019

Data

- Work efforts for tree management
- Extracted volume of resources

Summary Statistics | Demographic Characteristics

	Treatment	Control
Average area (ha)	5.97	5.51
	(4.18)	(4.24)
Age	30.00	27.82**
	(9.97)	(8.57)
Education year	5.63	5.15
	(3.74)	(4.06)
Annual income (USD)	199.26	179.69
	(321.59)	(194.50)
Distance to the community land from residence (km)	2.60	2.18**
	(2.63)	(1.74)

Note. Standard deviations in parentheses; ** indicates statistical significance at the 5% level.

Summary Statistics | Pre-treatment

Annual work-days

	Treatment	Control
Thinning	0.29 (1.38)	0.15 (0.90)
Pruning	0.72 (2.87)	0.41 (1.02)
Guarding	19.92 (22.79)	18.21 (19.53)
Watering	4.73 (11.40)	7.69 (26.57)
Planting	2.87 (5.80)	2.78 (4.90)

Planting & extracted volume (kg)

	Treatment	Control
Number of planted seedlings	189.43 (425.66)	177.61 (482.57)
Thinned trees	0	0
Pruned branches	48.22 (237.95)	76.57 (198.84)
Timber	0	0
Fodder	34.00 (81.74)	29.85 (50.01)
Honey	2.45 (5.07)	2.35 (3.72)

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Pl		

Av 18-20 days per member

Approximately 180-200 days per group per year

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Thinning and pruning activities are limited

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Sizable number of trees were planted

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To address endogeneity due to non-accepters

1. Instrumental Variable (IV) method (Panel A)
2. Intention-To-Treat (ITT) model (Panel B)
3. Youth-group-level analysis (Panel C)

Panels A, B: Individual level (n=459)
Panel C: Group level (n=68)

Employing a Difference-in-differences (DID) approach for all models

Methodology

IV (1st): $$Rights_i = \alpha_0 + \alpha_1 Treat_i + \alpha_2 Time_t + \alpha_3 Treat_i * Time_t + \theta X_i + u_i, \quad (1)$$

IV (2nd): $$\log Y_{ijt} = \beta_0 + \beta_1 Treat_i + \beta_2 Time_t + \beta_3 \widehat{Rights}_i + \theta X_i + \varepsilon_i, \quad (2)$$

ITT: $$\log Y_{ijt} = \gamma_0 + \gamma_1 Treat_i + \gamma_2 Time_t + \gamma_3 Treat_i * Time_t + \theta X_i + \omega_i, \quad (3)$$

Group: $$\log \bar{Y}_{jt} = \delta_0 + \delta_1 Treat_j + \delta_2 Time_t + \delta_3 Treat_i * Time_t + \theta \bar{X}_i + \mu_j \quad (4)$$

Y_{it}: Outcome of interest (i.e., the number of work-days for tree management, the extracted volume of natural resources, and the number of planted trees)

$Rights_i$: Individual tree rights dummy that takes the value 1 if individual i actually receives the individual tree rights

$Treatment_i$: Treatment dummy that takes the value 1 if individual i is offered individual tree rights

Results | Number of Work-days

	Management index	Thinning	Pruning	Guarding	Watering
Panel A: IV (n=459)					
Tree rights provision	1.586***	0.009	0.348**	1.053**	0.641*
	(0.543)	(0.127)	(0.149)	(0.494)	(0.359)
Panel B: ITT (n=459)					
Offered tree rights	1.382***	0.008	0.304**	0.918**	0.559*
	(0.482)	(0.111)	(0.126)	(0.435)	(0.325)
Panel C: Group (n=68)					
Offered tree rights	1.300**	0.016	0.188*	0.764*	0.579*
	(0.580)	(0.082)	(0.109)	(0.447)	(0.332)

Note: Standard errors are clustered at the group level in parentheses; *, **, and ***: p<10%, p<5%, and p<1%

Results | Number of Work-days

	Management index	Thinning	Pruning	Guarding	Watering
Panel A: IV (n=459)					
Tree rights provision	1.586***	0.009	0.348**	1.053**	0.641*
	(0.543)	(0.127)	(0.149)	(0.494)	(0.359)
Panel B: ITT (n=459)					
Offered tree rights	1.382***	0.008	0.304**	0.918**	0.559*
	(0.482)	(0.111)	(0.126)	(0.435)	(0.325)
Panel C: Group (n=68)					
Offered tree rights	1.300**	0.016	0.188*	0.764*	0.579*
	(0.580)	(0.082)	(0.109)	(0.447)	(0.332)

Note: Standard errors are clustered at the group level in parentheses; *, **, and ***: p<10%, p<5%, and p<1%

	Planting days	Planted seedlings
Panel A: IV (n=459)		
Tree rights provision	0.164	0.197
	(0.319)	(1.471)
Panel B: ITT (n=459)		
Offered tree rights	0.143	0.172
	(0.280)	(1.288)
Panel C: Group (n=68)		
Offered tree rights	0.277	0.829
	(0.295)	(1.238)

Note: Standard errors are clustered at the group level in parentheses; *, **, and ***: p<10%, p<5%, and p<1%

Increasing guarding activity

- 190 days for guarding as a group before the experiment
- Continuing collective monitoring
  - Less incentive if land is fully privatized
- Increasing by 76-105%
  ⇒ Conducting every day throughout the year
- Potential reason: To reduce the risk of illegal harvesting and unauthorized grazing by outsiders
  - 63% of the trees provided were small trees
  - Guarding efforts to prevent damage from livestock

Increasing pruning and watering activity

- Increasing the incentives to take care of planted trees
- Increasing watering days by 56-64%
- Many of the provided trees were still young and small
  - Requiring watering to ensure their survival and growth

No significant impact on planting

- Planting a sufficient number of seedlings : 150 per member
- Prefer to take well care of planted tree seedlings & provided trees
- Expected to increase in the longer run

Hypothesis 1. Stimulating tree and forest management activities

Increasing: Work-days for pruning, guarding, and watering

Largely supporting Hypothesis 1

Results | Extracted Resource Volume

	Thinned trees	Pruned branches	Timber trees	Fodder	Honey
Panel A: IV (n=459)					
Tree rights provision	0.110**	2.345***	0.352*	-0.008	0.154
	(0.051)	(0.541)	(0.196)	(0.560)	(0.164)
Panel B: ITT (n=459)					
Offered tree rights	0.096**	2.044***	0.307*	-0.007	0.134
	(0.045)	(0.453)	(0.172)	(0.489)	(0.145)
Panel C: Group (n=68)					
Offered tree rights	0.073	1.651***	0.237**	0.238	0.038
	(0.049)	(0.530)	(0.102)	(0.616)	(0.312)

Note: Standard errors are clustered at the group level in parentheses; *, **, and ***: p<10%, p<5%, and p<1%

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Offered tree rights	0.096**	2.044***	0.307*	-0.007	0.134
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Panel C: Group (n=68)					
Offered tree rights	0.073	1.651***	0.237**	0.238	0.038
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Note: Standard errors are clustered at the group level in parentheses; *, **, and ***: p<10%, p<5%, and p<1%

Increasing in the extracted volume of timber products

- Thinned trees, pruned branches, & timber trees
- Particularly, pruned branches: 165-235%
- Also increase for timber trees: 24-35%
  - Not necessarily implying excessive extraction or degradation
  - Continuously planting a sizable number of tree seedlings
  - 24 to 35% increase = Less than 500 grams/member (av 1.3kg/member)
  - More like thinning (removing short trees from dense tree areas can be a part of timber forest management)

No significant impact on non-timber products

- Fodder and honey
- Continuing collective activities for non-timber products, probably because our intervention did not change the communal rules of extracting non-timber forest products

H2. Increasing the extracted volumes of timber products

H3. Not affecting the collection of non-timber forest products

Supporting Hypotheses 2 and 3

Mixed management system

- Stimulating intensive forest management activities: pruning, guarding, and watering
- Receiving more timber trees and forest products related to tree management, such as thinned trees and pruned branches
- No change in the extracted volumes of forest products unrelated to tree management (i.e., fodder and honey)

Incentive for intensive tree management

- Difficult to achieve reforestation of timber forests under CFM
- Introducing a mixed management system
  ⇒Motivating members to allocate efforts for forest management
  Maintaining the advantage of CFM in protecting forest

Application of MMS

- Granting individualized property rights for timber trees

Thank you for your attention

Objective	Investigating the impact of the mixed management system on forest resource management
Method	Introducing the mixed system to randomly selected communal forest lands
Findings	① Increasing work-days for pruning, guarding, and watering ② Insignificant for tree planting activities (as expected) ③ Increasing the extracted volumes of thinned trees, pruned branches, and timber trees ④ Not affecting the collection of nontimber forest products unrelated to tree management (fodder & honey)