How do Common Pool natural Resources relate to rural income, poverty and inequality? A multi-country assessment

Abstract: The role of Common Pool natural Resources (CPRs) such as forests, grasslands, rivers, lakes, wetlands and oceans in rural economies has been much debated in the literature, often on the basis of micro-level or provincial-scale analyses and focusing on a single type of CPR, typically forests. This study draws on data from 6,509 households across fifteen regions in nine low and middle-income countries covering Africa, Asia, and Latin America that also cover a diverse set of CPRs, including forests, savannas, grasslands, mangroves and inland and marine fisheries. We estimate the contribution of CPR-based income to total household income and vis-a-vis the poverty line across income classes, and analyse the correlates of CPR-based income and the relationship between CPR income and income inequality within rural settlements.

Our results highlight three important aspects of the CPR-rural income relationship. First, they confirm that CPR-based income makes up a significant portion of the income of the rural poor even across diverse geographies and CPRs. Households below the World Bank $1.9 per capita per day poverty line derive on average one fourth of their household income from CPRs. Second, the regression results highlight the importance of physical resource abundance and social accessibility, household demography, the regional demographic/market context, and most importantly the complementary productive assets owned by households in deriving income from CPRs. Third, there is a distinct correlation between the broad nature of CPR harvest technologies and income-inequality: when the harvest technology is capital-intensive, richer households derive more monetary benefit from CPRs, not only in absolute terms but also in terms of share in household income, leading to a situation where such CPRs exacerbate inequality within settlements. Our results highlight the importance of integrating a diversity of CPRs and CPR availability, access and technological context into CPR studies. They also highlight the need for pro-poor policies that go beyond securing resource access and include support for the poor to access technologies and markets.

Keywords: Common Pool Resources, poverty, inequality, tenure, resource abundance

1. Introduction

Common Pool natural Resources (CPRs)[1] , which include forests, grasslands, rivers, lakes, wetlands and oceans are often important sources of livelihood for rural households, particularly in the Global South. Estimates of the geographic prevalence and nature of livelihood dependence are high. Globally, an estimated 3.5-5.8 billion people use non-timber forest products (Shackleton and de Vos, 2022), 1.2 billion rely on natural resources to meet basic needs (Fedele et al., 2021), 1.3 billion rely on forest products for housing (FAO, 2014), and half a billion depend on wild fisheries (FAO et al., 2021) for their livelihoods.

CPRs are clearly important to rural livelihoods, however, how CPRs contribute to total household income, the links between CPRs (or their restoration) and poverty (or its alleviation) (Fisher et al., 2014), their roles as safety nets (Wunder et al., 2014), and how CPRs relate to inequality (Chetri et al., 2015) have all been topics of longstanding research and debate in development studies (Jodha, 1985; 1986). Even the simple claim that 'the poor are generally more *dependent* on CPRs' is hard to verify, in part because many harvested CPRs are not traded in markets in addition to the challenge in defining 'dependence' vs. 'use' (Shackleton and de Vos, 2022). A number of factors that make the relationship between CPRs, rural poverty, and inequality complicated (Schreckenberg et al., 2018). One clear factor is resource tenure, which enables access to resource (Jagger et al., 2014; DFID, 2007, Dade et al., 2021). ; the magnitude of the accessible resource or its abundance vis-à-vis users is a less studied but equally obvious factor. The evidence is mixed on whether CPRs preferentially benefit the poor or reduce inequities; case studies show some situations where contributions to relative and absolute incomes of poorer households vs more wealthy households is high, and other

[1] We use the term Common Pool Resources, rather than Common Property Resources, to refer to all resources displaying two key biophysical characteristics (Ostrom, 1990, p.295): a) the physical *exclusion* of potential users from CPRs is difficult or costly; b) the consumption or use of the resource is *rivalrous* i.e., increased consumption by one agent implies that less is available for others. Note that excludability is not a binary but a gradient, and hence common-pool resources may be held under a variety of property rights regimes, including private, community, state-property or open-access, or more nuanced versions of property rights regimes, such as intermittently excluded agricultural lands. Our usage thus encompasses a wider array of potentially non-privately accessible resources than the term Common Property Resources.

situations where it is low (Angelsen et al. 2014; Robinson et al. 2019; and only a few of these (Chetri et al. 2014; Fisher, 2004.) explicitly looking at inequality as an outcome.

The reasons behind this variation, apart from the influence of tenurial access, are likely the context-specific nature of the role of factors posited by Ribot and Peluso's (2003) 'Theory of Access', viz. technology, complementary assets, household capacities and social networks. Efforts to look for clearer patterns are hampered by the absence of larger datasets that span regional contexts and variety in CPR types. The Poverty Environment Network (PEN) project was perhaps the first major effort to assess a large, cross-country dataset (CIFOR, 2007; Angelsen et al. 2014; Jagger et al. 2014), but focused on forest-dependent communities.[2] These questions have regained importance in the context of global interest in policies and global agendas to conserve biodiversity, restore ecosystems, and sequester carbon. To anticipate how such policies might affect rural incomes and inequalities requires deeper investigation of CPRs and rural incomes.

We contribute to this literature in three ways. First, we develop a multi-country dataset that also spans multiple ecosystems (forests, savannas, grasslands, mangroves, and inland and marine fisheries). Second, we explicitly include inequality as an outcome to be investigated, in addition to absolute and relative income contribution and poverty line comparisons. Third, we include physical resource abundance and its social accessibility (de facto tenure, which may vary across the resource catchment) along with regional demographic and market variables in understanding the correlates of CPR income. Further with the diversity of CPRs in the dataset, we use the variation in technologies of resource extraction (capital-intensive versus labour-intensive) to tease out patterns relating to income shares and inequality.

We ask three broad questions:

i) How much is the CPR income per adult equivalent across rural households and how does it compare with the global income-based poverty line?

[2] Other networked studies, such as the International Forest Resources and Institutions (IFRI) research programme (Poteete and Ostrom, 2008), have been more specialized, focusing only on forest-based incomes rather than all rural income.

ii) Which factors (including household assets, abundance of CPRs, and resource tenure) are correlated with CPR income?

iii) How does inequality in CPR income and total income at the settlement-level vary and what variables might be related to this variation?

Our analysis is based on a multi-country data set covering 129 settlements from 15 rural regions or sites in nine countries across Africa, Asia and Latin America. Our sample contains 6,509 households representing rural households in quasi-subsistence economies, with some degree of dependence on both CPRs and privately controlled resources such as agriculture. Our dataset pooled a number of existing livelihood-environment studies under Nature4SDGs project (https://www.nature4sdgs.org/).

The remainder of this paper is organized as follows. In section 2, we present a brief review of literature on the relationship between CPRs, rural income, poverty and inequality, followed by our analytical framework in section 3. Data and methods are outlined in section 4 and the results of the analysis are presented in section 5, with distinct subsections for each of the research questions above. Sensitivity analysis is in section 6. In section 7, we discuss the patterns observed and their possible explanations using qualitative data and the limitations of the study. We offer some concluding comments on the policy relevance of our findings in section 8.

2. Common Pool Resources and rural incomes, poverty and inequality

There is a vast and unsettled literature on the links between the use of CPRs and rural incomes, poverty and inequality. At least since Jodha's pioneering work on the contribution of common lands to rural incomes in semi-arid parts of India (Jodha, 1985, 1986), the literature has generated empirical estimates of the contribution of CPRs to total income that range from 6% to 44% (see the overview in Angelsen et al., 2014). This variation in average CPR income shares across regions is explained by access (restricted versus unregulated), resource condition (degraded versus productive), resource value (e.g., high-value timber versus low-value firewood) and market integration (Shackleton and de Vos, 2022; Jagger et al., 2022). While the contribution of CPRs is often found to be substantive (Vedelp et al., 2004;

Razafindratsima et al., 2021), fewer studies compare CPR income with absolute poverty thresholds (Chhetri et al., 2015).

The *variation* in the contribution of CPR income across economic class has also been discussed extensively, and the answers and interpretations vary between absolute and relative contributions. In general, many studies show that wealthier households derive more absolute income while the poorer households are more dependent upon CPRs (i.e., CPR income takes up a higher share of total income) (Vedelp et al., 2004; Chhetri et al. 2015; Jagger et al., 2022). But many scholars, starting with Byron and Arnold (1999) have argued that CPRs are unlikely to lead households out of poverty; answering this question rigorously requires panel data that are rarely available. And while the literature has rarely measured inequality as outcomes explicitly in terms of say Gini coefficients, (but see Chhetri et al., 2015; Fisher, 2004) one may deduce that while CPRs may contribute to poverty reduction, if they contribute higher absolute income to the rich, CPR income may exacerbate inequality.

Why might neighbouring households derive differential income from what is ostensibly a ‘common-pool’ and therefore ‘non-excludable’ resource? Several explanations have been suggested. First, CPRs are never fully non-excludable, and formal (Nadkarni et al., 1989) or informal (Persha and Andersson, 2014) tenure arrangements might favour the rich.[3] A second explanation is that differential ownership of complementary private productive assets play a large role. For example, wealthy households own more livestock and thereby ‘extracting’ more grazing material from the CPR (Adhikari, 2005; Narain et al., 2008a; Lakerveld et al., 2015). Jagger et al. (2022) also suggests income from high-value forest products, such as timber, is captured by richer households because they have access to the technology or capital for engaging in such activities. The ‘Theory of Access’ captures many of these ideas, stating that the degree of benefits derived from CPRs depends not just on the *rights* of access but also the *power* of access that includes “technology, capital, markets, labour, knowledge, authority, identity and social relations” (Ribot and Peluso, 2003, p 165).

[3] An extreme version of this would be when the rich privatize the commons (Jodha, 1986).

In light of these complexities, testing the relationships between CPRs, rural income, poverty and inequality has, not surprisingly, remained challenging. Moreover, there also appears to be limited use of a common framework within which one may hypothesize and test these relationships. We address this gap in the literature by drawing upon data for a diverse set of CPRs including forest, savannas, grasslands, mangroves and inland and marine fisheries, and by providing an analytical framework as given below.

3. Analytical Framework

We use a conceptual framework that builds upon the Sustainable Livelihoods Framework (DFID, 2001), highlighting the importance of the biophysical abundance of the resources (natural capital), the endowments or abilities internal to a household (human capital), the technologies of resource extraction (physical capital), financial capital and social capital, and the institutional context governing resource access. To this, we also add the regional demographic context as explained below.

The implications of using this framework are as follows. First, improved biophysical abundance or supply (extent and quality or productivity) will, *ceteris paribus*, positively influence the magnitude of benefits (e.g., Narain et al., 2008b; Baland et al., 2010). Greater availability will also lead to greater extraction, increasing subsistence or income benefits. While subsistence consumption may eventually saturate, sales can generally increase.

Second, physical resource availability only translates into livelihood benefits when there is accessibility (Miller et. al, 2021). Greater accessibility leads to increased benefits. No doubt unfettered and unregulated access can lead to resource degradation, as Hardin (1968) famously argued, and therefore to reduced future availability. But community control through secured tenure rights can solve or reduce open access issues by establishing boundaries governing the use of resources, excluding outsiders and discouraging resource grabbing (Ostrom, 1990; Zoomers, 2010). Such rights encourage local communities to sustainably manage the resources (Shyamsundar et al., 2020), although they don't always succeed (Rasolofoson et al., 2015). Conversely, state control imposed in the name of conservation usually takes exclusionary forms such as the creation of Protected Areas, which in most cases leads to reduced resource access to the local population.

Third, household characteristics[4] (or capitals) can play important roles in determining the benefits drawn from CPRs. These characteristics include household endowments of labour and education (human capital), ownership of complementary productive assets (e.g. cattle, to convert grass into milk or vehicles to transport charcoal: physical capital), financial capital, and social capital (social networks that might aid in marketing or even harvesting) (Ribot and Peluso 2003)[5]. The physical/financial capital required depends significantly on the nature of the resource and harvesting technology—some may be labour-intensive and some may be capital-intensive.

Finally, the regional context of demand for CPR products that depends on regional population density and proximity to urban centres, can also have complex implications. In general, a more densely populated landscape would imply greater competition in CPR use, possibly reducing availability per capita (Angelsen et.al., 2014). Proximity to urban centres may draw labour into alternative occupations but may also provide better markets for the resources, increasing the incentive to harvest (Angelsen et.al., 2014).

Using the broad factors outlined above, we investigate the correlates of CPR income. For the inequality analysis, instead of a regression approach, we heuristically reduced these factors into a broad categorization of the CPR harvest techniques into capital-intensive and labour-intensive, which also correlates with marketed and non-marketed use of the CPR.

---

[4] We use the term 'household characteristics' as simply referring to features visible at the household level, without implying that the mechanisms that create these characteristics are necessarily internal to a household. E.g., households belonging to a certain ethnic or caste group may have preferential access to certain markets–a social process that manifests in household-level differences.

[5] We have, however, not included social capital in our analysis below as it could not be consistently measured across our sites.

4. Data and Methods

4.1 Sites and sampling

This study draws upon a subset of data from the aggregate Nature4SDGs dataset, which is a compilation of several comparable datasets collected under 7 different research projects funded by the Ecosystem Services for Poverty Alleviation (ESPA) programme and two other projects with similar goals from Robinson et.al. (2019) and Devagiri et. al. (2015). In all original primary surveys, households were selected randomly within each settlement. All sampling aimed to represent the villages or local study population of interest.

All projects collected data on variables at the household as well as settlement scale. Household surveys include data on household demographics and livelihoods. They collected data on household's CPR harvest quantities, cost involved in it, duration of harvests [6] and per-unit values (if sold), as well as income from other sources. All datasets were combined and harmonized, for example creating annual-equivalent measures of harvests and income as some studies differed in the frequency asked or recall period used (see table S1 in the SI).

Primary data gathered at the settlement scale include tenure over CPRs or other institutional arrangements. We have used secondary data for variables such as market access, population density, and resource abundance. The detailed methods of data collection in the original studies and the process of data compilation to create a common dataset can be found in Poudyal et.al. (2024). Within this dataset there are large variations in market access, resource tenure and abundance of CPR (see Table A1 in the Appendix) at the settlement-level and in socio-economic endowments at the household-level (see Table A2 in the Appendix). Table 1 provides an overview of the sample surveyed, the ecological context and the main products collected from CPRs. The geographical distribution of settlements are shown in Figure 1.

[6] CPR harvests is a seasonal activity which is generally carried out for a few months in a year.

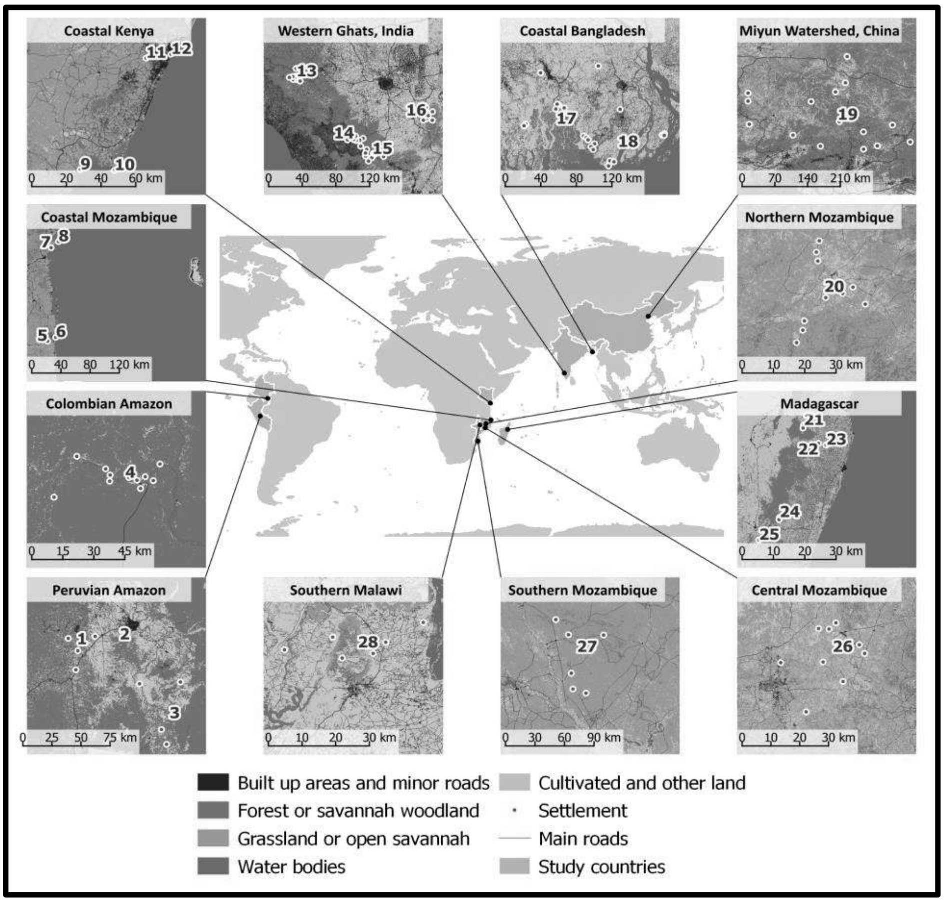

Figure 1: Locations of our study sites and settlements within them
Sources: i) Land use-land cover: Gong. et al., 2019, ESA 2016, NRSC 2016; ii) Roads: OpenStreetMap contributors (2015) iii) Settlements: https://data.humdata.org/

Table 1: Data coverage

Country	Sites	Settle ments	Households	Landscape type	Common Pool Resources	
					Labour-intensive	Capital-intensive
Bangladesh	1.Marine and Coastal periphery	3	67	Coastal, marine, mangroves, agriculture		Fish from marine and coastal fisheries (3 settlements)[7]
	2. Sundarban dependent zone	9	227	mangroves, agriculture	Fuelwood, crab, honey, wax from Mangrove (2 settlements)	Fish from marine and coastal fisheries (7settlements)
China	Miyun watershed	15	1644	Forest, agriculture	Fuelwood, NTFP (15 settlements)	Grazing in common pasture
Colombia	Colombian Amazon	11	193	Forest, agriculture, riverine	Fuelwood, bushmeat	Fish (11 settlements)
India	Western Ghats	40	1099	Forest, agriculture	Fuel wood, medicinal plants, edible insects, fodder, fish from rivers & lakes (35 settlements)	Grazing in common pasture (5 settlements)
Kenya Coastal	1.Rural	3	409	Coastal, marine, mangroves, agriculture	Fuelwood and other products from mangroves, cowry shells from seashore (2 settlements)	Fish from marine fisheries, grazing in common lands (1 settlements)
	2.Peri-Urban	1	280	Coastal, marine, agriculture	Fuelwood from built environment, cowry shells from seashore (1 settlement)	Fish from marine fisheries, grazing in common lands
Madagascar	Madagascar rural	5	167	Forest, agriculture	Fuelwood, building wood, wild vegetables, honey (5 settlements)	Grazing in common lands
Mozambique	1.Charcoal Production	7	246	Grassland pasture, savanna	Forest products (bamboo, pole, grass, etc), processed forest products (mat, basket, wooden chairs), fish (7 settlements)	Charcoal, grazing in common lands
	2.Commercial Crop Production	10	702	Grassland pasture, savanna	Forest products (bamboo, pole, grass, etc), processed forest products (mat, basket, wooden chairs), fish	grazing in common lands (10 settlements)
	3.Subsistence Crop Production	10	643	Grassland pasture, savanna	Forest products (bamboo, pole, grass, etc), processed forest products (mat, basket, wooden chairs), fish	Charcoal, grazing in common lands(10 settlements)
Malawi rural	Malawi rural	6	590	Forest, agriculture	Fuelwood, bushmeat, fish (6 settlements)	Grazing
Peruvian Amazon	1. Indigenous	3	101	Forest, agriculture, riverine	Fuelwood, hunting	Inland fishing, Grazing (3 settlements)
	2. Land-based Colonist	4	105	Forest, agriculture, riverine	Fuelwood, hunting (4 settlements)	Inland fishing, Grazing
	3. Riverine Colonist	2	36	Forest, agriculture, riverine	Fuelwood, hunting	Inland fishing, Grazing (2 settlements
Total	**15**	**129**	**6,509**			

[7] settlements are capital-intensive when most households get more than 50% of their CPR income from CPR characterised as capital intensive and the opposite is true for labour intensive.

4.2 Key variables and their estimation

4.2.1 Household Income

We consider household income as income (both cash and imputed) drawn during the survey year from (i) agriculture, (ii) livestock rearing, (iii) common-pool resource collection, (iv) household enterprise, (v) wage employment, (vi) transfers, and (vii) remittances. Following prior literature, we calculate agricultural, livestock rearing (e.g., Liu, Barrett et al 2020), CPR, and own-enterprise income (e.g., Lopez-Feldman 2014, Cotta 2015, Angelsen et al 2014) as the difference between total revenue obtained and total input (paid-out) costs incurred. Paid-out cost include all the running costs and the purchase cost of assets in annualised form.

To make inter-household comparison more accurate, we considered income per adult equivalent unit.[8] To make the income estimates comparable across countries and over time, we used World Bank indices of Purchasing Power Parity (PPP) (World Bank, 2020) for the year in which that survey was conducted.

4.2.2 CPR Income

CPR income is the combination of (a) direct CPR harvest income and (b) the portion of livestock income attributable to commons. This estimation is based on both qualitative and quantitative assumptions, given the complexities of differentiating commons from private land, notably:

1. We consider fallowed private lands as commons, as data from across all sites indicated that during fallow periods, even private lands were accessible to all.
2. The ratio of duration of grazing in commons to that in private land (or stall feeding) determines livestock income attributable to CPRs. The ratios representing our best estimates from household surveys and qualitative data are given in table S5 in the SI.

[8] We follow the simple formula used in many World Bank analyses to calculate adult equivalent units: children below 15 years and adults above 65 years are assigned a weight of 0.5, while all other household members (15–65 years) are assigned a weight of 1 (Angelsen et. al. 2014).

We estimated direct CPR harvest income by multiplying the quantity harvested (including self-consumed or gifted harvests) by its estimated unit price and subtracting any paid-out costs. We estimated local prices by using the median value from all households in the settlement that reported a price for the same product. When no households reported a price for a product, we used the median price from nearby (and qualitatively similar in socio-ecological context) settlements. Costs included payments such as wages for hired labour, purchasing cost of chainsaws and other equipments , food/feed, cost of licences and bribes/tips. Fishing costs included payments for purchasing or repairing boats or fishing nets, fuel cost, food or lodging expenses (during fishing activities), and cost of permits. Costs for durable goods (e.g., boats, chainsaws) were annualized. Following the literature (Singh et.al, 1986, PEN 2007, Narain et.al., 2008b), we did not deduct the value of household's own labour since our goal is to estimate the contribution of the CPR to total household income (rather than the net value of the *environment* attributable to the CPR, in which case household labour is an input).

To estimate the imputed value of the portion of livestock income attributable to CPRs, we estimated the total income from livestock as the total value of livestock products and livestock sold (quantity times price) minus the paid-out costs for feed and fodder[9] . To get the livestock income attributable to CPR, we then multiply this total livestock income with the ratio of duration in months of grazing in commons to total duration of grazing in a year. For households which collect fodder from commons to stall-feed their livestock, livestock income was calculated net of imputed value of the fodder (quantity times the price of replacement feed). That imputed value of fodder is included in the direct income from CPRs.

[9] Paid-out cost does not include the purchase value of livestock in annualised form, as it is occasional. Most households produce the animals themselves.

4.2.3 Resource Abundance

We represented resource abundance as the relative extent of uncultivated land or open water body around each settlement. We first estimated the total physically accessible landscape or "resource-shed" around each settlement by drawing a circular buffer, whose radius represented the best estimate of the distance up to which CPR harvest occurred in that region, on the basis of qualitative and household survey data (travel time). This varied from 3 km in the more densely populated and hilly Indian site to 8 km in the sparsely populated and relatively flat African sites. Within this buffer, we estimated the CPR area after excluding cultivated lands, settlements and roads, whose areas were estimated from land use-land cover data (for more details refer to Poudyal et.al. 2024). The ratio of the extent of CPR to the total area of the buffer was used as a proxy for relative resource abundance. Similar spatial variables have been widely used in the absence of robust localised data on resource stocks and quality (Walz, 2011).

4.2.4 Accessibility of CPR

While the Resource Abundance variable represents the potentially accessible CPR, actual access depends upon the *de facto* tenure regime. This regime may vary within the CPR resource-shed, as different rules may apply to different parts of the resource-shed. To capture the variations in CPR access, we first developed a three-level classification of tenure that indicates zero-access (weighted 0), regulated access (weighted 0.5) and unregulated access (weighted 1) (see section 2 in SI for details). We then drew upon site-specific data (participatory rural appraisals and maps, interviews, field notes, and mentions of areas accessed in the household surveys) to estimate the fraction of the CPR resource-shed around each settlement that may fall under each of these tenurial classes *de facto* (for more details, refer to Poudyal et.al., 2024). From this we generated an area-weighted average Tenurial Access Index for each settlement to capture the average access that the settlement has to the CPRs within its resource-shed.

4.2.5 Population Density and Distance to Market

At the settlement-level, two socio-economic variables were estimated using additional secondary data: population density and distance to markets. To capture the potential demand from nearby settlements on CPRs, we estimated a regional population density considering 5km buffer around settlement centroid from the Gridded Population of the World (GPWv4) dataset (CIESIN 2018). For consistency across datasets, we calculate distance to the nearest city of 50,000 population using the settlement location information and global data on travel time to cities (Weiss et al., 2018).

4.2.6 CPR harvest techniques

We heuristically created a “CPR harvest technique” variable to capture the technology involved in the harvest and sale of products from CPRs. Our qualitative data indicates that the harvest of terrestrial CPRs often involves labour-intensive techniques, while fishing in both inland and marine fisheries is associated with capital-intensive techniques (motorized boats being capital-intensive) and commercial sale of the product. For livestock grazing in commons and charcoal production, although these activities involve much more labour, households still need financial capital to purchase livestock or procure technologies required for charcoal production including chainsaws, harvesting licences, and access to marketing channels and transport facilities (Baumert et al., 2016). Hence, we characterised livestock grazing in commons and charcoal production also as capital-intensive. We identified households’ broad nature of the harvest techniques (labour versus capital-intensive) involved in the harvest of the most important CPRs (as defined as those contributing the largest share of CPR income) across settlements. We then categorised the settlements as capital-intensive where most households get more than 50% of their CPR income from CPR characterised as capital intensive and labour-intensive where most households get more than 50% of their CPR income from CPR characterised as capital intensive.

4.3 Poverty Analysis

To understand the contribution of CPRs relative to rural poverty levels, we compared households' average daily income and CPR income per adult equivalent with the 2015 World Bank Poverty line of $1.90 per capita per day. We used 2015 poverty line as it is comparable with our data that were collected in 2014-15.

4.4 Regression Analysis

To assess households' dependence on CPRs, we examine which variables are associated with household CPR income per adult equivalent. However, 27% of households derive no CPR income. Thus, we used a two-part regression framework (Cragg 1971) to understand CPRs' contribution to livelihoods. A first model, the "participation" equation, focused on participation in extraction from commons (a dichotomous choice to harvest or not). A second model, the "amount" equation, focused on factors that relate to the amount of income derived from CPR, conditional on being a household that participates in the harvest.

Within this two-part framework, we estimated three sets of models: a site-level fixed effect model, a settlement-level fixed effect model, and a multilevel (hierarchical or mixed-effects) model (Gelman and Hill, 2006) with settlements as random intercepts. The fixed effects models focus strictly on within-unit variation, controlling for all time-invariant unobservable at the site and settlement levels, respectively. The multilevel model uses the strength of the data's settlement-level clustering to determine how much variance is explained by within- versus between-settlement effects. This allows for estimates to reveal correlations for both settlement- and household-level factors, while also accounting for settlement 'random' effects. The multilevel approach, however, assumes unobserved settlement characteristics are uncorrelated with household-level predictors. For example, if larger households tend to cluster in settlements with higher population density, this assumption fails and can lead to endogeneity bias. Therefore, we evaluate the consistency of multilevel estimates with those from fixed effects models that more strictly control for endogeneity from time-invariant unobserved variables (comparative results are in Table A4 in the Appendix).

In the multilevel model, we used a generalised linear multilevel logit model for the participation equation. The amount equation includes households whose CPR income is greater than zero, and the dependent variable (CPR income) is heavily right skewed (Fig S1 in the SI). We therefore used a generalised linear mixed model, specifying the distribution of the dependent variable as Gamma since the dependent variable is continuous, positive and right-skewed (Perraillon, forthcoming, Ng and Cribbie, 2017). The model can be written as

Participation Equation

$$logit(\pi_{ij}) = \ln\left(\frac{\pi}{1-\pi}\right) = \beta_{0j} + \sum_1^K \beta_k x_{kij} + e_{ij} \quad (1)$$

$$\pi_{ij} = P(y_{ij} = 1) \quad (2)$$

$$\beta_{0j} = \beta_0 + u_{0j} \quad (3)$$

$$e_{ij} \sim N(0, \sigma_e^2) \quad u_{0j} \sim N(0, \sigma_{u_o}^2) \quad (4)$$

Where logit (π_{ij}) is the log odds of outcome, x_{kij} are a set of *K* household- and settlement-level independent variables, β_{0j} is the random intercept for settlement *j,* and e_{ij} is the error term. β_{0j} can be further separated into average intercept β_0 and a settlement-level error term u_{0j}.

Amount Equation

$$y_{ij} = \beta_{0j} + \sum_1^K \beta_k x_{kij} + e_{ij} \quad (5)$$

$$\beta_{0j} = \beta_0 + u_{0j} \quad (6)$$

$$e_{ij} \sim N(0, \sigma_e^2), u_{0j} \sim N(0, \sigma_{u_o}^2) \quad (7)$$

where y_{ij} is the absolute CPR income (>0) per adult equivalent for household *i* in settlement *j*. The representation of other symbols in the equations 5, 6 and 7 are already mentioned above. We estimate the models using meglm command in STATA 17.

Both the participation and the amount equations include the same independent variables, selected a priori based on the relevant literature. Household-level variables include demographics (household size in adult-equivalent units, gender of household head, education) and ownership of assets. Settlement-level variables include abundance of CPR, regional population density, travel time to the nearest city, and tenurial access index. We used the Variance Inflation Factor to check for multicollinearity among the hypothesised independent variables (no VIF is greater than 2, indicating little concern for multicollinearity). The results of the VIF test are given in the SI in Table S4. The variables used in regression analysis and their hypothesised influence on household income from CPRs are presented in table S2 in the SI.

4.5 Inequality Analysis

To analyse distributional aspects of CPR income, we used the ratio T10/B50 (Chancel et.al., 2022) of CPR income and its share in total household income, as well as the Gini-decomposition method (Lopez-Feldman, 2006). We conducted these analyses separately for the two categories of settlements based on their broad nature of CPR harvest techniques, capital-intensive versus labour-intensive, to explore whether and how CPR-inequality relationships vary across these settlements.

We calculated the ratioT10/B50 of each settlement as the ratio between the average CPR income of the top 10% and the average CPR income of the bottom 50% of households in the income distribution at the settlement. We then compared the mean ratio across two the types of settlements categorised based on broad nature of CPR-harvest techniques (capital-intensive versus labour-intensive). We also did the same analysis for the share of household income from CPR and for the total household income.

Further, we conducted Gini-decomposition analysis to understand the relationship between CPR income and rural income distribution. We decomposed household income inequality at the settlement by sources of household income, categorised into CPR and non-CPR (Lerman and Yitzhaki, 1985, Lopez-Feldman, 2006). This enabled us to estimate the percentage change in Gini-coefficient due to a 1% increase in CPR income across households (Lopez-Feldman, 2006). We calculated the mean of the percentage changes in Gini-coefficients for the two types of settlements (capital-intensive vs labour-intensive) to explore how the relationship between CPR income and inequality varies across these two types of settlements.

5. Results

The descriptive statistics for the independent and dependent variables are reported in the Appendix: the descriptive statistics of settlement level variables aggregated at the site level are presented in table A1, and the descriptive statistics of household level variables per income decile for the whole population in our sample as well as for the subset of the population that have CPR income are presented in table A2. The descriptive statistics of household income from different sources across our study sites are presented in table A3. Here, we outline the results of the analyses vis-à-vis our main questions.

5.1 How much is the CPR income derived by rural households and how does it compare with the global income-based poverty line?

We first compared total daily income per adult equivalent and the contribution of CPRs with the World Bank's $1.90 poverty line. The decile-level mean daily income per adult equivalent and the CPR and non-CPR portions of the same are presented in Figure 2.

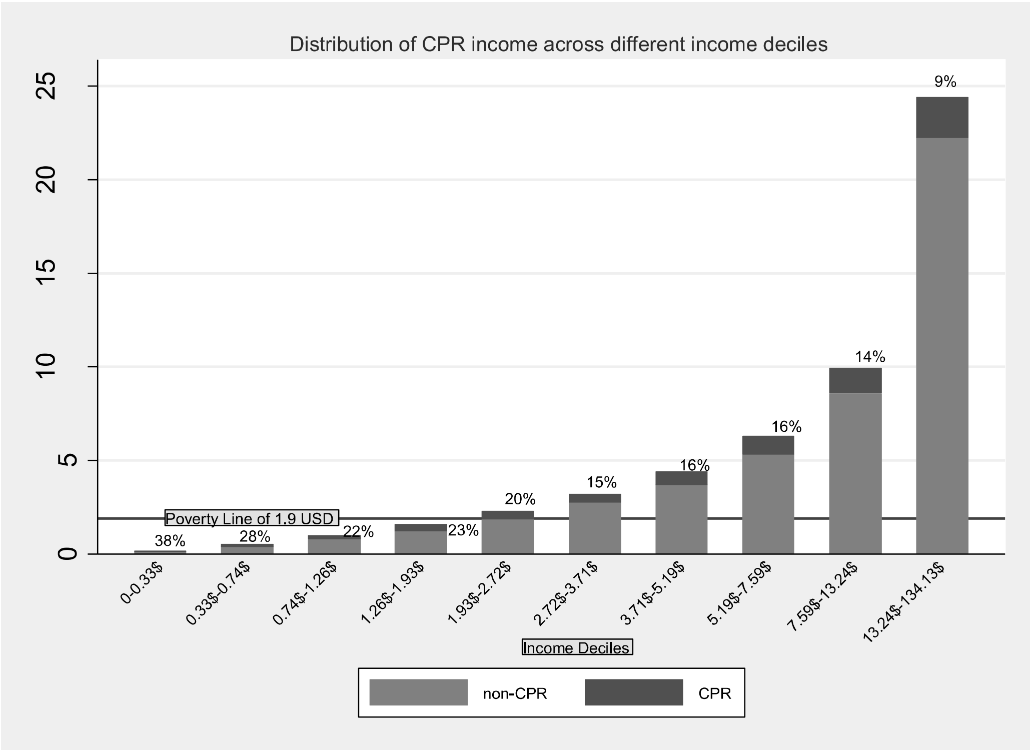

Figure 2: The distribution of CPR income across different household income deciles (The mean percentage share of CPR income is reported on the top of each bar)

We find that 38% of the sampled households are below the poverty line. CPR harvests contributes to a large share of income for these poor households: households in these four deciles derive more than 1/4th of their income from CPRs. In contrast, households above the poverty line derive ~1/6th of their income from CPRs on average.[10] However, in absolute terms, the average CPR income per adult equivalent is much higher in the households above the poverty line. At the extremes, the richest households (10^{th} decile) earns 33 times higher CPR income than the CPR income of the poorest households (1^{st} decile).

[10] From Figure 2, it might be tempting to conclude that households in the 5th decile stay out of poverty because of CPR income (following Chhetri et al., 2015), but this would assume that in the absence of CPRs, they would have no other income. To the extent that CPRs complement and do not substitute employment opportunities, this may be true, but is hard to estimate.

5.2 Which factors are correlated with the household CPR income per adult equivalent?

Given the contribution of CPR income to the income of poor households, it becomes crucial to examine factors that are correlated with the *participation* in extraction from CPRs, and then those factors correlated with the *amount* of CPR income derived. As noted in section 4.4, we compared three different modelling approaches to examine variation in participation and the amount extracted from the commons. Table A4 in the Appendix shows broad agreement between the two fixed effect approaches and results from the multilevel model estimated. Having little concern for undue endogeneity bias, we refer to the multilevel estimates in interpreting our results. The main results (multilevel estimates) are presented in Table 2 and explained in the two sections below.

5.2.1 The Participation Equation

The results of the participation model indicate that of the household demographics and human capital (household size, gender of household head, and education) and the ownership of complementary productive assets (such as livestock, fishing net, boat, chainsaw) are significantly correlated with participation in CPR harvest. Households with greater number of adult equivalent household members are more likely to participate in CPR harvest. Female-headed households (16% of our sample) are less likely to participation in the extraction from CPR than their male counterparts. Households with educated members are less likely to participate. Households with

Table 2: Multilevel regression model

	Participation in extraction from commons	**Amount of CPR income** per adult equivalent derived by households
Household size (# adult equivalent family members)	0.15**(0.06)	-0.29***(0.04)
Gender of the household head (0-female, 1-male)	0.36***(0.12)	-0.10 (0.19)
Household with educated members (0-no, 1-yes)	0.48***(0.13)	-0.11 (0.09)
Ownership of productive assets (0-no, 1-yes)	0.62***(0.19)	0.61***(0.12)
Ownership of farmland (0-no, 1-yes)	0.10 (0.17)	0.31**(0.14)
Abundance of CPR (% uncultivated land w/i resource-shed)	0.48***(0.16)	0.28***(0.08)
Tenurial Access Index (0 - 1)	-0.18 (0.18)	0.16**(0.07)
Regional Population density (people/km^2)	-0.89***(0.13)	0.43***(0.07)
Travel time to nearest city of 50000 population (minutes)	0.23* (0.13)	0.21***(0.04)
Constant	1.24*** (0.25)	4.99***(0.16)
Random Intercept variance	2.60(0.44)	0.76 (0.13)
Log pseudolikelihood	-2,243.78	-25,907.81
N (household)	5,590	4,136
N (settlements)	128	128

Notes: 1) Clustered standard errors at the settlement level are in parentheses.
2) Asterisks indicate the degree of statistical significance (*=p<0.1, **=p<0.05, *** = p < 0.01).
3) Variables are standardised.
4) One settlement from Colombia does not have asset holding data, hence for these estimates the total number of settlements is 128 instead of 129.

CPR-relevant productive assets such as livestock or fishing vessels are more likely to participate in CPR harvest.

Of the four settlement-level variables- the proportion of CPR area within the buffer, population density, travel time to the nearest city, and tenurial access index; all except the tenurial access index were significantly correlated and with expected signs. While CPR proportion in buffer was positively correlated, as is remoteness (distance from town), population density is negatively correlated.

5.2.2 The Amount Equation

Among those households that do participate in CPR harvest, household size, ownership of productive assets and the ownership of farm land are statistically significant correlates of the CPR income they derive. Households with greater number of adult equivalent household members tend to have less CPR income, possibly because the labour supply effect is counterbalanced by the fact that the dependent variable is CPR income per adult equivalent. Both ownership of productive assets and the ownership of farm land are positively correlated with higher CPR income.

All the settlement-level variables are statistically significant. The extent of physically available CPR is positively correlated with CPR income. Degree of access to CPRs is also positively correlated with the CPR income, unlike in the case of participation. Interestingly, households in densely populated settlements are likely to derive more CPR income, unlike in the case of the participation outcome. Households from remote settlements tend to derive more CPR income.

5.3. How does CPR income relate to rural income inequality?

To explore the distribution of CPR income, we used both the ratio T10/B50 and the Gini coefficient. The former is the ratio between the average CPR income of the top 10% and the average CPR income of the bottom 50% of the households in a settlement. We then estimated the mean ratio for two categories of settlements: where CPR-harvest techniques were capital-intensive and where they were labour-intensive. The results are presented in Table 3. This disaggregation of settlements provides more insights than the aggregate analysis of the relationship between CPR income and total income reported in section 5.1, which hides some stark differences between capital-intensive and labour-intensive harvest situations.

In the settlements where CPR harvest techniques are more capital-intensive, the average ratio T10/B50 of CPR income (column 2 of Table 3) is 9.81, suggesting that richest households on average derive almost 10 times more CPR income than the poorer households. The ratio T10/B50 of CPR income is higher than that of total income, indicating that CPR income is more unequally distributed than the total income in these settlements. The ratio T10/B50 of the share of CPR income being more than 1 suggests that richest households derive more CPR income than the poorer households even in the relative terms. In other words, CPR income share in total income rises with total income in settlements engaged in capital-intensive CPR harvest techniques, unlike the overall trend seen in Figure 2.

In settlements where CPR harvest techniques are more labour-intensive (column 3 of Table 3), CPR income is less unequally distributed than the total income, indicated by a lower ratio of T10/B50 of CPR income than that of total income. More importantly, the ratio T10/B50 of share of CPR income is less than 1, suggesting that CPR income plays a more important role in the livelihood of the poorer households in these settlements.

Table 3: Mean Ratio of CPR income of top 10% and bottom 50% of the households		
	Categories of Settlements based on broad nature of CPR harvest technique	
	Capital- intensive	Labour- intensive
Share of CPR income	1.11(1.43)	0.35 (3.31)
CPR income	9.81 (13.19)	6.86 (11.65)
Total income	5.06(4.33)	13.28 (13.97)
N(settlements)	39	90

Standard deviations are in parenthesis

A decomposition of Gini-coefficients at the settlement level also confirms the above findings. Gini-decomposition gives the percentage change in the Gini-coefficient due to a 1% increase in CPR income in a settlement. We presented the mean of the percentage changes in Gini-coefficient in the two types of settlements in Table 4. The results indicate that in settlements where CPR-harvest techniques are more labour-intensive, CPR income disproportionately flows to the poorer households. This is indicated by a negative mean percentage change in Gini-coefficients due to 1% increase in CPR income. On the other hand, CPR income is associated with increased inequality in a settlement where CPR-harvest techniques are more capital-intensive. This is shown by a positive mean percentage change in Gini-coefficient due to 1% increase in CPR income.

Table 4: Gini-Decomposition by Income Sources		
	Mean of the percentage changes in Gini-coefficient due to 1% increase in CPR income in two types of settlements categorised based on broad nature of CPR harvest technique	
Sources of Income	Labour-intensive	Capital-intensive
CPR	-0.03	0.001
N (settlements)	90	40

6. Sensitivity Analysis

Our estimate of CPR income requires both qualitative and quantitative assumptions outlined in section 4.2.2. We carried out sensitivity analysis to assess robustness to the ratios of duration of grazing in commons to that in private land, the extent of the resource catchment, and the weights assigned to each level of access. We did not change the assumption regarding fallows as fallow land is common land during the time of survey and the products collected from fallow land is considered as CPR harvests. We check for changes in the regression results as well as the inequality analysis. The detailed results are presented in the SI in section 5. Broadly, our qualitative conclusions remain the same. Some particular notes include:

i) Reducing the contribution of grazing to CPR income (the dependent variable), in both the participation and the amount of CPR income regression model, results in some changes in the magnitude of coefficient estimates, although the direction and significance of the variables remain same.

   This is also true for reducing the size of the CPR resource buffer by 10% and increasing the weight for 'regulated access' from 0.5 to 0.6 in the tenure index (the independent variables). We estimated two models, one corresponding to the change in the CPR area and the other to the tenure index.

ii) Even when we combine modifications in the estimation of income and in the independent variables (size of resource catchment and tenurial access index), the direction and significance of the variables remain the same in both the regressions, with only slight changes in the values of the coefficients.

iii) The mean ratio T10/B50 of both CPR income and its share (see table S11 in the SI) reduce when the ratio of grazing duration in CPR to that in private land was reduced (see table S5 in the SI).

6. Discussion

Our study provides cross-continent and cross-ecosystem evidence on the contribution of CPRs to household income and its interactions with poverty and inequality. The key findings are as follows. First, CPR-based income makes up a significant portion of the income of the rural poor. Second, the correlates of participation in CPR harvests are household size adult equivalent (positive), gender of household head (less for women), education (negative), ownership of productive assets (positive), the abundance of CPRs (positive), population density and travel time to the nearest town (negative). Third, the correlates of the amount of CPR income derived by households who engage in harvest are household size adult equivalent (negative), ownership of productive assets (positive), ownership of farmland (positive), the abundance of CPRs (positive), the tenure of resource access (positive), population density (positive), and travel time to the nearest ton(positive). Fourth, the nature of resource harvest technology (capital-intensive versus labour-intensive) makes a very significant difference in the inequality in the distribution of CPR income within a settlement. We discuss each finding in detail below.

Households below the poverty line constitute 38% of the sample, which itself is a high fraction, and these households on average derive more than 25% of their income from CPRs highlighting the importance of CPRs for the poor. This finding, across ecosystem types and technology types, confirms and extends the findings of regional forest-focused studies such as Font and Ayuk (2013) in South-Eastern Nigeria and Damania et al. (2020) in India. At the same time, richer households obtain more CPR income than the poor in absolute terms, extending the findings of Angelsen et al. (2014) and Robinson et al. (2019) across ecosystem types and technology types. In other words, while households below the poverty line appear to be more ‘dependent’ on CPRs for critical livelihood support, higher-income households derive more absolute benefits from CPRs across a wide range of ecosystem types and technology contexts.

Digging into the factors that correlate with the participation in CPR harvest and the factors that correlate with the amount of CPR income derived by those households that engage in harvest, the regression analysis revealed a number of interesting relationships. At the outset, our results show that the biophysical availability/abundance of the CPR seems important, both for participation and for income derived from CPRs, extending the findings of Narain et al. (2008b) and Jagger et al. (2014) to multiple ecosystem types. Field data show that, in the Malawi site, villages with higher forest cover had higher proportions of households engaged in NTFP trade (and traded more products) while at the same time they have fewer households resorted to purchasing NTFPs. Whereas the reverse was true in the villages with the least forest cover (Mahonya et al., 2019). A more comprehensive estimate of biophysical abundance, including resource quality or productivity, would help nuance the results further, but the enormous diversity of resource types (fisheries, savannas, forests) would still limit comparability.

Beyond biophysical abundance, however, tenure expectedly plays a key role. Households are likely to derive higher income from more open CPR, confirming the findings of Miller et al. (2021). Jagger et al. (2014) found higher CPR income coming from state forests, which may actually be in line with our result also, because they use *de jure* tenure as a categorical variable, whereas we reduced 'tenure' to an index of (*de facto*) access. Even in our sample, most of the accessible forests were state-owned, but were largely accessible. One of the limitations of our dataset, however, was that more than half the settlements had fully open access to the resource, and the number of cases where communities themselves regulate the resource (so as to ensure its sustainability) were very few. So, we can infer that access matters, but cannot examine whether regulating access to ensure sustainable use comes at a cost.

The 'demographic' variables show a complex relationship with participation and income. households with higher number of adult equivalent members are more likely to participate in CPR harvest, presumably to fulfil higher demand for resources (confirming the findings of Munonde and Zegeye, 2025, Adhikari et al., 2004; Appiah et al., 2009; Sunderland et al., 2014) but tend to derive less CPR income per adult equivalent due to the reason that the income is being calculated per adult equivalent. Following the findings of Angelsen et.al., (2014), larger households tend to have higher consumer to worker ratios, hence income per adult equivalent is likely to be lower, which means having more 'hands' for CPR harvest does not by itself become human capital. Female-headed households are less likely to participate in CPR harvest (supporting the findings of Sunderland et al., 2014). This may be a result of constraints faced by women in certain CPR-related activities. For instance, in the India Western Ghat site, although there is no restriction for women in the Soliga community on entering the forest, they have limited involvement in the NTFP harvest activities as they are restricted from climbing tall trees to harvest gooseberry, soapberry or tree lichens, and rock cliffs to harvest honey. Or it may be a reflection of the greater workload faced by women in female-headed households. Similarly in Colombia, cultural norms mean that hunting and fishing - the main income-generating CPR activities - are predominantly undertaken by men (Cruz-Garcia et al., 2019). However, the gender of the household head did not significantly correlate with the *amount* of CPR income derived by households in our study, suggesting that if the household did engage, then they had overcome the barrier and obtained similar incomes. Finally, households with educated members are less likely to participate in CPR harvest (supporting the findings of Adhikari et al., 2004; Fisher, 2004) as educated members have other employment opportunities. Even in the case of CPR income, education has a negative.

Households' asset holding, on the other hand, is an important positive correlate of whether and how much income households can derive from CPRs. The ownership of assets that are related to CPR harvest, such as livestock or fishing vessels, is positively correlated with the participation in resource extraction from CPR as well as with CPR income, confirming the finding of Adhikari(2005) and Escobal and Aldana (2003). Ownership of farmland is not significantly correlated to participation but is correlated to the amount of CPR income. A possible explanation is that in certain kinds of CPR harvest, such as grazing of livestock, those with private lands can provide supplementary inputs, such as agricultural residue. This is supported by the findings of Adhikari, 2005 and Chopra et. al. 1990. Overall, private property resources appear to largely complement CPRs, which of course has implications for inequality (below).

Regional demographics and market distances also seem to influence CPR-based activities and incomes in complex ways. The results for market distance (distance to nearest town) are mixed: Households from remote settlements are more likely to participate in the harvest, which fits with the intuition that they would lack other employment opportunities. But the fact that remote households also tend to derive more CPR income (which is in contrast to the findings of Angelsen et.al., 2014) suggests that, although product markets become more distant, the quantum of harvest may more than compensate. In the case of demographic pressure, again we have a mixed result: Households in densely populated regions are less likely to participate in CPR harvest; this may be because they tend to have more off-farm employment opportunities in such situations. But among households that do harvest, CPR income is higher in more densely populated regions. For instance, the Kenya coastal site is densely populated. But households from this site tend to earn fairly high CPR income from marine fishing. The dynamics of marine CPRs could be different from those of terrestrial CPRs. Previous studies have not consistently included such regional demographic and market distance variables; our results suggest including them in future analyses would be important.

Our inequality analysis went beyond simply looking at variations in absolute and relative contributions of CPRs to income, which has been *de rigueur* in most studies. Using two indicators of inequality and drawing from the ‘Theory of Access’, we found that the type of resource and the technology of resource harvest (firewood versus charcoal or artisanal fishing versus mechanised boat fishing) are correlated with distinct outcomes: capital-intensive technologies, owned almost inevitably by richer households, increase income inequalities. This was most clearly visible in the

Kenya coastal site, where fishing is now carried out through mechanised boats and other fishing gear that requires high investments, and then generates very high returns for the owners. Other variables, such as social capital, which were not captured in our analysis, also tend to correlate with wealth. For instance, in the Mozambique charcoal production site, qualitative data from the field indicated that only those with access to funds and social networks could obtain charcoal making licenses. Only where the resource is low-value (per unit of labour input) and the extraction process cannot be capitalized and then marketed, do CPRs preferentially benefit the poor.

When combined with the finding regarding ownership of productive assets, this finding of capital-intensive CPRs exacerbating rural inequalities points to the need for highly nuanced policies and efforts if the benefits of a commons are not to be preferentially appropriated by the rich. The common policy approach to ensure sustainable use of and better incomes from CPRs has been to decentralize control (Agrawal et al., 2008), and the results have clearly been positive at a gross level (especially in terms of resource sustainability) (Chhatre and Agrawal, 2009). While decentralized control is certainly necessary, and normatively dictated by a commitment to recognizing rights of indigenous peoples (RRI, 2021), it will not be sufficient to meet the social objective of improving livelihoods equitably. Improvement in returns typically involves increasing the productivity of harvesting labour, improved marketing, post-harvest value-added processing, or accessing and selling newer/higher-value products. But most of these strategies require financial, physical and social capital, raising the possibility that, even 'collectively governed' resources may exacerbate inequalities. Expanding the 'Theory of Access', one would then argue that ensuring a fair distribution of (higher) returns would require collective management/ownership of not just the resource but also of the capital-intensive technologies and other productive assets involved in resource harvest, processing and transport. We believe this is an important insight that our analysis of diverse CPRs has provided, in addition to highlighting the need to look at inequality as outcome explicitly.[11]

Finally, we would like to acknowledge several limitations of this study. First, the limited data on resource quality limits our ability to say more about the influence of resource condition on CPR incomes; however, we note that capture resource quality across forests, grasslands and marine fisheries may be difficult. Second, the lack of a set of consistent measures for a number of variables such as education, assets, landholding size, etc. across the sites forced us to come up with minimalistic variables where details were lost. For instance, we converted all education and asset holding variables into binaries, because scale variables were not available for all sites. Third, our analysis is based on observational data and therefore, the regression analysis we have carried out does not establish causal effects in the way that experimental or quasi-experimental approaches might. Fourth, the absence of panel data meant that we could not test the safety net or insurance aspect (Baland and François, 2003). Finally, the use of quantitative methods, necessary for large datasets such as ours, also means that much of the nuance captured in qualitative data is lost. We tried to overcome this by using some qualitative information from individual sites when looking for 'explanations' for our results, but a more consistent approach in both quantitative and qualitative data would have helped. Perhaps this points to the need for another PEN study covering multiple CPR types with a stronger focus on inequality as outcome.

7. Conclusion

This large-scale multi-country and multi-CPR study confirms the important contribution of CPRs to the income of rural poor across diverse contexts. Households below the World Bank $1.9 poverty line derive almost one fourth of their household income from CPRs. This is, of course,

[11] Several studies, including the PEN one, have used measures of inequality as *explanatory variables*, sometimes to explain the presence of collective action, but the only very few we found using Gini coefficients to characterize outcomes were Chhetri et al. (2015) and Fisher (2004).

critically dependent upon the physical availability of and social access to CPRs, highlighting the crucial role of tenure. At the same time, returns from CPRs are distributed unequally, and when the technology and market context is such as that capital investments in CPR harvest or sale are viable, the inequality sharpens dramatically.

These findings are highly pertinent at a time when several policies pertaining to CPRs are being implemented. On the one hand, land 'restoration' for biodiversity conservation and carbon sequestration is getting much attention from governments and funding agencies, and researchers. CPRs are often easily mistaken for 'unused' or 'degraded' lands/waterbodies that are 'available' for restoration in a top-down manner without consulting local communities (especially poorer households) as to their preferred uses and forms (Löfqvist et al., 2023). As the poor continue to be dependent on CPRs for their livelihood, such fortress conservation to meet say the "30x30" conservation target would lead to immense livelihood loss. On the other hand, policies to decentralize the governance of common-pool resources (in effect making them common *property* resources) are being rolled out for the past several decades (RRI, 2021). But there has been little discussion of what measures are required to ensure that the rich do not benefit disproportionately from such 'commons'. Our study suggests that, if one major goal is to improve the livelihoods of the rural poor, then special attention needs to be paid not only to prevent the takeover of the commons by top-down 'restoration' but also to strengthen both resource tenure and market/technology access for marginalised groups.

Data References

Das, Anamika; Wells, Geoff; Attiwilli, Suman; Poudyal, Mahesh; Kraft, Franziska; Lele, Sarachchandra; Daw, Tim; Schreckenberge, Kate; Robinson, Brian E; Setty, Siddappa; Ryan, Casey; Fisher, Janet; Jones, Julia; Adams, Helen. J. (2025), *Common Pool Resources, Rural Poverty and Inequality: A multi-country Study*. (Mendeley Data, V1, 2025) doi: 10.17632/zt725sr9jc.1

Wells, G., Das, A., Attiwilli, S., Poudyal, M., Kraft, F., Lele, S., Daw, T., Schreckenberg, K. *Nature's Contribution to Poverty Alleviation, Human Wellbeing and Sustainable Development Goals, 2019-2022*. (UK Data Service, Essex, 2022) https://dx.doi.org/10.5255/UKDA-SN-856560

References

Adhikari, B., Di Falco, S., and Lovett, J. C., 2004. Household characteristics and forest dependency: evidence from common property forest management in Nepal. *Ecological Economics*, 48(2), 245-257. https://doi.org/10.1016/j.ecolecon.2003.08.008

Adhikari, B., 2005. Poverty, property rights and collective action: understanding the distributive aspects of common property resource management. *Environmen tand Development Economics*, 10, 7–31. https://doi.org/10.1017/S1355770X04001755

Adhikari, B., and Di Falco, S.. 2009. Social Inequality, Local Leadership and Collective Action: An Empirical Study of Forest Commons. *European Journal of Development Research*, 21, 179–94. doi:10.1057/ejdr.2008.16

Agrawal, A., A. Chhatre and R. Hardin., 2008. Changing governance of the world's forests. *Science*, 320 (5882): 1460. https://doi.org/10.1126/science.1155369

Anderson, D., Bratsberg, S., Ringsmuth, A. K., de Wijn, A. S., 2021. Dynamics of collective action to conserve a large common-pool resource. Scientific Reports, 11, 9208. https://doi.org/10.1038/s41598-021-87109-x

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N.J., Bauch, S., Börner, J., Smith-Hall, C., Wunder, S., 2014. Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. *World Development,* 64, S12–S28. https://doi.org/10.1016/j.worlddev.2014.03.006

Appiah, M., Blay, D., Damnyag, L., Dwomoh, F. K., Pappinen, A., Luukkanen, O. (2009). Dependence on forest resources and tropical deforestation in Ghana. *Environment, Development and Sustainability*, 11(3), 471-487. https://doi.org/10.1007/s10668-007-9125-0

Baland, J.M., Bardhan, P., Das, S., Mookherjee, D., Sarkar, R., 2010. The Environmental Impact of Poverty: Evidence from Firewood Collection in Rural Nepal. *Economic Development And Cultural Change*, 59, 23–61. https://doi.org/10.1086/655455

Baland, J.M. and Francois, P., 2005. Commons as insurance and the welfare impact of privatization. *Journal of Public Economics*, *89*(2-3), pp.211-231. https://doi.org/10.1016/j.jpubeco.2004.02.002

Baumert, S., Luz, A.C., Fisher, J., Vollmer, F., Ryan, C.M., Patenaude, G., Zorrilla-Miras, P., Artur, L., Nhantumbo, I., Macqueen, D., 2016. Charcoal supply chains from Mabalane to Maputo: Who benefits? *Energy For Sustainable Development*, 33, 129–138. https://doi.org/10.1016/j.esd.2016.06.003

Belcher, B.M., 2005. Forest product markets, forests and poverty reduction. *International Forest Review*, 7, 82–89. https://doi.org/10.1505/ifor.2005.7.2.82

Byron, N. and M. Arnold. 1999. What futures for the people of the tropical forests? *World Development*, 27 (5): 789- 805. https://doi.org/10.1016/S0305-750X(99)00025-X

Chen J., Roth J. 2024. Logs with Zeros? Some Problems and Solutions, *The Quarterly Journal of Economics,* 139, 891–936, https://doi.org/10.1093/qje/qjad054

Chhetri, B. B. K., Larsen, H. O., Smith-Hall, C., 2015. Environmental resources reduce income inequality and the prevalence, depth and severity of poverty in rural Nepal. *Environment,* *Development and Sustainability*, 17(3), 513-530. https://doi.org/10.1007/s10668-014-9557-2

Chhatre, A. and Agrawal, A. (2009) Trade-Offs and Synergies between Carbon Storage and Livelihood Benefits from Forest Commons. Proceedings of the National Academy of Sciences of the United States of America, 106, 17667-17670. https://doi.org/10.1073/pnas.0905308106

Chancel, L., Piketty, T., Saez, E., Zucman, G. et al., 2022. World Inequality Report 2022, World Inequality Lab. https://wir2022.wid.world

CIESIN, 2018. *Gridded Population of the World, Version 4 (GPWv4): Population Density, Revision 11*. https://doi.org/10.7927/H49C6VHW

CIFOR, 2007. Poverty Environment Network (PEN) technical guidelines, version 4. Available at: https://www2.cifor.org/pen/the-pen-technical-guidelines/

Cotta, J. N. 2015. Contributions of local floodplain resources to livelihoods and household income in the Peruvian Amazon. *Forest Policy and Economics*, 59, 35-46. https://doi.org/10.1016/j.forpol.2015.05.008

Cragg, J. G. (1971). Some statistical models for limited dependent variables with application to the demand for durable goods. *Econometrica: journal of the Econometric Society*, 829-844. http://dx.doi.org/10.2307/1909582

Cruz-Garcia, G.S., Vanegas Cubillos, M., Torres-Vitolas, C., Harvey, C.A., Shackleton, C.M., Schreckenberg, K., Willcock, S., Navarrete-Frías, C., Sachet, E., 2019. He says, she says: Ecosystem services and gender among indigenous communities in the Colombian Amazon. *Ecosystem Services*, 37, 100921. https://doi.org/10.1016/j.ecoser.2019.100921

Dade, M. C., Bennett, E. M., & Robinson, B. E. 2022. Property rights play a pivotal role in the distribution of ecosystem services among beneficiaries. *Ecosystems and People*, *18*(1), 131-145. https://doi.org/10.1080/26395916.2022.2037715

Damania, R., Joshi, A., Russ, J., 2020. India's forests – Stepping stone or millstone for the poor? *World Development,* 125, 104451. https://doi.org/10.1016/j.worlddev.2018.11.

Davis, B., Winters, P., Carletto, G., Covarrubias, K., Quin˜ones, E. J., Zezza, A., et al. 2010. A cross-country comparison of rural income generating activities. *World Development*, 38(1), 48–63. doi:10.1016/j.worlddev.2009.01.003

Devagiri, G.M., Kushalappa, C.G., Ravikumar, D., Anilkumar, K., Siddappa, S., Javed, R., Pal, S., Tomar, S., Gurav, M., and Anand, M. 2015. *Western Ghats Household Baseline (ATREE, Bengaluru).*

DFID, 2001. Sustainable livelihoods guidance sheets. Department for International Development, London, U.K.

DFID (2007). Land: Better access and secure tenure for poor people. London, UK: Department for International Development.

Escobal, J., Aldana, U., 2003. Are non-timber forest products the antidote to rainforest degradation? Brazil nut extraction in Madre De Dios, Peru. *World Development*, 31 (11), 1873–1887. https://doi.org/10.1016/j.worlddev.2003.08.001

ESA, 2016. *Tanzania Sentinel 2 Land Use Land Cover 2016. European Space Agency Climate ChangeInitiative*.http://geoportal.rcmrd.org/layers/servir%3Atanzania_sentinel2_lulc2016 #more.

FAO, 2014. State of the World's Forest: Enhancing the socioeconomic benefits from forests. Food And Agriculture Organization of The United Nations, Rome.

FAO, Duke University, World Fish, 2021. Illuminating Hidden Harvests: The contribution of small-scale fisheries to sustainable development. FAO, Rome, Italy.

Fedele, G., Donatti, C.I., Bornacelly, I., Hole, D.G., 2021. Nature-dependent people: Mapping human direct use of nature for basic needs across the tropics. *Global Environmental Change*, 71, 102368. https://doi.org/10.1016/j.gloenvcha.2021.102368

Fisher, J. A., Patenaude, G., Giri, K., Lewis, K., Meir, P., Pinho, P., Rounsevell, M. D. A., Williams, M. (2014). Understanding the relationships between ecosystem services and poverty alleviation: A conceptual framework. *Ecosystem services*, 7, 34-45. https://doi.org/10.1016/j.ecoser.2013.08.002

Fisher, M., 2004. Household welfare and forest dependence in Southern Malawi. *Environment and Development Economics*, 9(2), 135-154. https://www.jstor.org/stable/44379151

Fonta, W. M., and E. T. Ayuk. 2013. "Measuring the Role of Forest Income in Mitigating Poverty and Inequality: Evidence from South-Eastern Nigeria." *Forests, Trees and Livelihoods* 22(2): 86–105. doi:10.1080/14728028.2013.785783.

Gatiso, T., Kulik, L., Bachmann, M., Bonn, A., Bosch, L., Freytag, A., Heurich, M., Wesche, K., Winter, M., Ordaz-Németh, I., Sop, T., Kuhl, H., 2022. Sustainable protected areas: Synergies between biodiversity conservation and socioeconomic development. *People and Nataure*, 4, 893–903. https://doi.org/10.1002/pan3.10326

Gelman, A., Hill, J., 2006. Data analysis using regression and multilevel/hierarchical models. Cambridge University Press, Cambridge (USA).

Gong, P. *et al.,* 2019. Stable classification with limited sample: transferring a 30-m resolution sample set collected in 2015 to mapping 10-m resolution global land cover in 2017. *Scientific Bulletin*, 64, 370–373

Hardin, G., 1968. The Tragedy of the Commons. *Science*, 162, 1243–1248. 10.1126/science.162.3859.1243

Harris, T., Hardin, J.W., 2013. Exact Wilcoxon signed-rank and Wilcoxon Mann–Whitney ranksum tests. *Stata Journal*, 13, 337–343. https://doi.org/10.1177/1536867X1301300208

Heltberg, R., Arndt, T.C., Sekhar, N.U., 2000. Fuelwood consumption and forest degradation: a household model for domestic energy consumption in rural India. Land Econ. 76 (2), 213–232. https://doi.org/10.2307/3147225Iversen, V., Chhetry, B., Francis, P., Gurung, M., Kafle, G., Pain, A., 2006. High value forests, hidden economies and elite capture: evidence from forest user groups in Nepal's Terai. *Ecological Economics*, 58 (1), 93–107. https://doi.org/10.1016/j.ecolecon.2005.05.021

Jagger, P., Luckert, M. (Marty) K., Duchelle, A.E., Lund, J.F., Sunderlin, W.D., 2014. Tenure and Forest Income: Observations from a Global Study on Forests and Poverty. *World Development*, 64, S43–S55. https://doi.org/10.1016/j.worlddev.2014.03.004

Jagger, P., Cheek, J.Z., Miller, D., Ryan, C., Shyamsundar, P., Sills, E., 2022. The Role of Forests and Trees in Poverty Dynamics. *Forest Policy and Economics*, 140, 102750. https://doi.org/10.1016/j.forpol.2022.102750

Jodha, N.S., 1985. Population growth and the decline of common property resources in Rajasthan, India. *Population and Development Review,* 11, 247–264. https://doi.org/10.2307/1973488

Jodha, N.S., 1986. Common Property Resources and Rural Poor in Dry Regions of India. *Economic and Political Weekly*, 21, 1169–1181. https://www.jstor.org/stable/4375858

Jodha, N., and Bhatia, A., 1998. Community management of commons: re-empowerment process and the gaps. Paper presented at the ”Crossing Boundaries: The Seventh Common

Property Conference” organised by the International Association for the Study of Common Property (IASCP) at University of British Columbia, Vancouver, Canada. June 10-14. https://dlc.dlib.indiana.edu/dlc/items/e7f9f81f-a8f3-4bcf-a2e4-81c640075429

Kemkes, Robin J. 2015. The Role of Natural Capital in Sustaining Livelihoods in Remote Mountainous Regions: The Case of Upper Svneti, Republic of Georgia. *Ecological Economics,* 117: 22–31. https://doi.org/10.1016/j.ecolecon.2015.05.002

Lakerveld, R.P., Lele, S., Crane, T.A., Fortuin, K.P.J., Springate-Baginski, O., 2015. The social distribution of provisioning forest ecosystem services: Evidence and insights from Odisha, India. *Ecosystem Services*, 14, 56–66. https://doi.org/10.1016/j.ecoser.2015.04.001

Lerman, R.I., Yitzhaki, S., 1985. Income Inequality Effects by Income Source: A New Approach and Applications to the United States. *The Review of Economics and Statistics,* 67, 151–156. https://doi.org/10.2307/1928447

Liu, Y., Barrett, C. B., Pham, T., Violette, W. 2020. The intertemporal evolution of agriculture and labor over a rapid structural transformation: Lessons from Vietnam. *Food Policy*, 94, 101913. https://doi.org/10.1016/j.foodpol.2020.101913

Löfqvist, S., Kleinschroth, F., Bey, A., Bremond, A. de, DeFries, R., Dong, J., Fleischman, F., Lele, S., Martin, D.A., Messerli, P., Meyfroidt, M., Pfeifer, S.O., Rakotonarivo, N., Ramankutty, V., Ramprasad, P., Rana, P., Rhemtulla, J.M., Ryan, C.M., Vieira, I.C.G., Wells, G.J., Garrett, R.D., 2023. How Social Considerations Improve the Equity and Effectiveness of Ecosystem Restoration. *BioScience*, 73, 134–148. https://doi.org/10.1093/biosci/biac099

L´opez-Feldman, A., 2006. Decomposing inequality and obtaining marginal effects. *Stata Journal*, 6, 106–111. https://doi.org/10.1177/1536867X0600600107

Lopez-Feldman, A. 2014. Shocks, income and wealth: do they affect the extraction of natural resources by rural households?. *World development*, 64, S91-S100. https://doi.org/10.1016/j.worlddev.2014.03.012

Mahonya, S., Shackleton, C.M., Schreckenberg, K., 2019. Non-timber Forest Product Use and Market Chains Along a Deforestation Gradient in Southwest Malawi. *Frontiers in Forest and Global Change*, 2. https://doi.org/10.3389/ffgc.2019.00071

Miller, D.C., Rana, P., Nakamura, K., Irwin, S., Cheng, S.H., Ahlroth, S., Perge, E., 2021. A global review of the impact of forest property rights interventions on poverty. *Global Environmental Change*, 66, 102218. https://doi.org/10.1016/j.gloenvcha.2020.102218

Mugido, W., and Shackleton, C. M.,2018. Price determination of non-timber forest products in different areas of South Africa. *Ecological Economics*, *146*, 597-606. https://doi.org/10.1016/j.ecolecon.2017.12.010

Munonde, K. D. and Zegeye, E. W.,2025. Evaluating non-timber forest product dependence of peri-urban households in a payment for ecosystem service scheme in durban, South Africa. *Trees, Forests and People*, 101128. https://doi.org/10.1016/j.tfp.2025.101128

Nadkarni, M.V., Pasha, S.A., Prabhakar, L.S., 1989. Political Economy of Forest Use and Management. Sage Publication, New Delhi.

Narain, U., Gupta, S., van't Veld, K., 2008a. Poverty and resource dependence in rural India. *Ecological Economics*, 66, 161–176. https://doi.org/10.1016/j.ecolecon.2007.08.021

Narain, U., Gupta, S., van't Veld, K., 2008b. Poverty and the environment: Exploring the relationship between household incomes, private assets, and natural assets. *Land Economics*, 84, 148–167. https://doi.org/10.3368/le.84.1.148

NRSC, 2016. LULC Map of India 2014-15. National Remote Sensing Centre. https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php

Ng, V. K., and Cribbie, R. A. (2017). Using the gamma generalized linear model for modeling continuous, skewed and heteroscedastic outcomes in psychology. *Current Psychology*, 36(2), 225-235. https://doi.org/10.1007/s12144-015-9404-0

Ostrom, E., 1990. Governing the commons: The evolution of institutions for collective action. Cambridge University Press, Cambridge (U.K.).

OpenStreetMap contributors, 2015. Planet dump [Data file from $date of database dump$]. Retrieved from https://planet.openstreetmap.org

Persha, Lauren, and Krister Andersson. 2014. Elite Capture Risk and Mitigation in Decentralized Forest Governance Regimes. *Global Environmental Change*, 24, 265–76. doi:http://dx.doi.org/10.1016/j.gloenvcha.2013.12.005.

Perraillon, Marcelo Coca and Donald Hedeker. Health Services Research and Program Evaluation: Causal Inference and Estimation. Cambridge University Press, Cambridge, U.K., forthcoming.

Poudyal, M., Kraft, F., Wells, G., Das, A., Attiwilli, S., Schreckenberg, K., Lele, S., Daw, T., Carlos, V., Setty, S., Adams, H., Ahmad, S., Ryan, C., Fisher, J., Robinson, B., Jones, J., Homewood, K., Bluwstein, J., Keane, A., Macamo, C., Mugi, L. M. 2024. Nature's contribution to poverty alleviation, human wellbeing and the SDGs. *Scientific data*, 11, 229. https://doi.org/10.1038/s41597-024-02967-0

Poteete, A.R., Ostrom, E., 2008. Fifteen Years of Empirical Research on Collective Action in Natural Resource Management: Struggling to Build Large-N Databases Based on Qualitative Research. *World Development*, 36, 176–195. https://doi.org/10.1016/j.worlddev.2007.02.012

Razafindratsima, O.H., Kamoto, J.F.M., Sills, E.O., Mutta, D.N., Song, C., Kabwe, G., Castle, S.E., Kristjanson, P.M., Ryan, C.M., Brockhaus, M., Sunderland, T., 2021. Reviewing the evidence on the roles of forests and tree-based systems in poverty dynamics. *Forest Policy and Economics*, 131, 102576. https://doi.org/10.1016/j.forpol.2021.102576

Rasolofoson, Ranaivo A., Paul J Ferraro, Clinton N. Jenkins, and Julia P.G. Jones. 2015. Effectiveness of Community Forest Management at Reducing Deforestation in Madagascar. Biological Conservation 184, 271–77. doi:10.1016/j.biocon.2015.01.027.

Ribot, J.C., Peluso, N.L., 2003. A Theory of Access. *Rural Sociology*, 68, 153–181. https://doi.org/10.1111/j.1549-0831.2003.tb00133.x

Robinson, B.E., Zheng, H., Peng, W., 2019. Disaggregating livelihood dependence on ecosystem services to inform land management. *Ecosystem Servics*, 36. https://doi.org/10.1016/j.ecoser.2019.100902

RRI. 2021. Status of Legal Recognition of Indigenous Peoples', Local Communities' and Afro-descendant Peoples' Rights to Carbon Stored in Tropical Lands and Forests. Rights and Resources Initiative, Washington, D.C.

Shackleton, C.M., de Vos, A., 2022. How many people globally actually use non-timber forest products? *Forest Policy and Economics*, 135, 102659. https://doi.org/10.1016/j.forpol.2021.102659

Schreckenberg, K., Mace, G., Poudyal, M. (Eds.), 2018. Ecosystem Services and Poverty Alleviation: Trade-offs and Governance. Routledge, London and New York.

Shyamsundar, P., Ahlroth, S., Kristjanson, P., Onder, S., 2020. Supporting pathways to prosperity in forest landscapes – a PRIME framework. *World Development*, 125, 104622. https://doi.org/10.1016/j.worlddev.2019.104622

Singh, I., Squire, L., Strauss, J., 1986. A survey of agricultural household models: Recent findings and policy implications. *The World Bank Economic Review*, *1*(1), 149-179.

Sunderland, T., Achdiawan, R., Angelsen, A., Babigumira, R., Ickowitz, A., Paumgarten, F., Reyes-García, V., Shively, G., 2014. Challenging Perceptions about Men, Women, and Forest Product Use: A Global Comparative Study. *World Development,* 64, S56–S66. https://doi.org/10.1016/j.worlddev.2014.03.003

Vedeld, P., Angelsen, A., Sjaastad, E., Berg, G. K. (2004). Counting on the environment: Forest incomes and the rural poor. Environment Department Papers, Paper No. 98, Environmental Economics Series. Washington, DC: The World Bank.

Walz, U., 2011. Landscape Structure, Landscape Metrics and Biodiversity. Land Rev. Landsc. Res. 5.

Weiss, D.J., Nelson, A., Gibson, H.S., Temperley, W., Peedell, S., Lieber, A., Hancher, M., Poyart, E., Belchior, S., Fullman, N., Mappin, B., Dalrymple, U., Rozier, J., Lucas, T.C.D., Howes, R.E., Tusting, L.S., Kang, S.Y., Cameron, E., Bisanzio, D., Battle, K.E., Bhatt, S., Gething, P.W., 2018. A global map of travel time to cities to assess inequalities in accessibility in 2015. Nature 553, 333–336. https://doi.org/10.1038/nature25181

World Bank, 2020. World Development Indicators database. PPP conversion factor, GDP (LCU per international $). International Comparison Program, World Bank.

Wunder, S., Börner, J., Shively, G., Wyman, M., 2014. Safety nets, gap filling and forests: a global-comparative perspective. *World development*, 64, S29-S42. https://doi.org/10.1016/j.worlddev.2014.03.005

Zoomers, A., 2010. Globalisation and the foreignisation of space: seven processes driving the current global land grab. *Journal of Peasant Studies*, 37, 429–447. https://doi.org/10.1080/03066151003595325

Appendix

Table A1: Descriptive Statistics of settlement-level Independent Variables by site[a]					
Country	**Site**	**Market Access(Travel time to the nearest town in minutes)**	**Tenure Index**	**Abundance of CPR (Proportion of CPR area within the buffer)**	**Population Density**
		Mean	Mean	Mean	Mean
Bangladesh	Marine and Coastal periphery	21 (11)	1 (0)	0.32 (0.11)	700 (115)
	Sundarbans dependent zone	20 (10)	0.4 (0.2)	0.01 (0.03)	330 (252)
China	Miyun watershed	86 (64)	1 (0)	0.8 (0.2)	45 (38)
Colombia	Colombian Amazon	4189 (323)	0.5 (0.1)	0.9 (0.03)	0.4 (0)
India	Western Ghats	21 (15)	0.7 (0.2)	0.5 (0.3)	296 (114)
Kenya Coastal	1.Rural	52 (24)	0.7 (0.1)	0.6 (0.3)	155 (44)
	2.Urban	0 (0)	0.5 (0)	0.5 (0)	7617 (0)
Madagascar	Madagascar rural	693 (351)	0.7 (0.3)	0.4 (0.3)	43 (30)
Mozambique	1.Charcoal Production	227 (39)	1 (0)	0.96 (0.02)	5 (3)
	2.Commercial Crop Production	49 (28)	1 (0)	0.6 (0.05)	45 (0)
	3.Subsistence Crop Production	135 (22)	1 (0)	0.7 (0.1)	8 (0)
Malawi rural	Malawi rural	34 (15)	0.8 (0.2)	0.2 (0.2)	198 (133)
Peruvian Amazon	Indigenous	798 (76)	1 (0)	0.6 (0.2)	1 (0.5)
	Land-based Colonist	48 (16)	1 (0)	0.001 (0)	8 (2)
	Riverine Colonist	203 (84)	1 (0)	0.1 (0.01)	2 (0.3)

[a]Standard deviations are in parentheses

A2: Descriptive Statistics Across Household Income Deciles, Standard Deviations in parenthesis

	Mean of CPR income per adult equivalent in USD		Mean household size adult equivalent		Mean proportion of male headed household		Mean Proportion of Households with educated members		Mean proportion of households owning productive assets		Mean proportion of households owning farm land	
Income Deciles	Considering overall sample size	For the subset of the sample that have CPR Income	For the overall sample size	For the subset of the sample that have CPR Income	For the overall sample size	For the subset of the sample that have CPR Income	considering the overall sample size	For the subset of the sample that have CPR Income	considering the overall sample size	For the subset of the sample that have CPR Income	considering the overall sample size	For the subset of the sample that have CPR Income
1st	34.04 (67.25), N=647	50.17 (76.55), N=439	3.50 (1.59), N=652	3.52 (1.62) N=439	0.74 (0.44), N=651	0.76 (0.43), N=439	0.29 (0.45), N=652	0.28 (0.45) N=439	0.31 (0.46), N=513	0.25 (0.43), N=365	0.69 (0.46), N=619	0.66 (0.47) N=430
2nd	58.85 (105.9), N=651	79.64 (116.42), N=481	3.50 (1.63), N=652	3.62 (1.53) N=481	0.75 (0.44), N=652	0.76 (0.43) N=481	0.21(0.40) N=652	0.17 (0.37) N=481	0.35(0.48) N=498	0.37 (0.48) N=364	0.81 (0.39), N=605	0.84 (0.37) N=439
3rd	93.66 (177.6), N=651	129.72 (197.52), N=470	3.47 (1.69), N=652	3.61 (1.70) N=470	0.82 (0.38), N=652	0.86 (0.35), N=470	0.25(0.43), N=252	0.2 (0.4) N=470	0.39 (0.49), N=537	0.42 (0.49) N=381	0.81 (0.39) N=615	0.83 (0.38) N=439
4th	132.23 (242.7), N=649	178.79 (267.06), N=480	3.55 (1.75), N=651	3.58 (1.76) N=480	0.83 (0.38), N=651	0.84 (0.37), N=480	0.27 (0.44), N=651	0.21 (0.41) N=480	0.37 (0.48) N=542	0.36 (0.48) N=403	0.80 (0.40) N=617	0.8 (0.40) N=459
5th	192.9 (364.7), N=652	260.52 (402.52), N=483	3.50 (1.67), N=652	3.48 (1.65) N=483	0.85 (0.35), N=652	0.85 (0.36), N=483	0.28 (0.45), N=652	0.19 (0.39) N=483	0.38 (0.49), N=572	0.37 (0.48) N=416	0.79 (0.41), N=633	0.82 (0.39) N=465
6th	170.3 (320.5), N=650	225.88 (351.76), N=490	3.71 (1.73), N=652	3.78 (1.73) N=490	0.87 (0.33), N=652	0.88 (0.33), N=490	0.33 (0.47), N=652	0.26 (0.44) N=490	0.33 (0.47), N=581	0.34 (0.48) N=439	0.73 (0.44), N=634	0.73 (0.44) N=476
7th	284.6 (535.5), N=649	357.30 (578.07), N=517	3.79 (1.67), N=651	3.87 (1.64) N=517	0.87 (0.33), N=651	0.88 (0.33) N=517	0.32 (0.47), N=651	0.28 (0.45) N=517	0.36 (0.48), N=580	0.37 (0.48) N=460	0.73 (0.44) N=642	0.76 (0.43) N=509
8th	361.7 (936.9), N=648	476.34 (1049.85), N=492	3.90 (1.78), N=652	4.02 (1.79) N=492	0.87 (0.33), N=652	0.88 (0.32) N=492	0.33 (0.47), N=652	0.28 (0.45) N=492	0.36 (0.48), N=590	0.40 (0.49) N=453	0.78 (0.41), N=641	0.80 (0.40) N=484
9th	515.1 (1149.2), N=650	666.93 (1268.58), N=502	3.92 (1.95), N=652	4.04 (1.98) N=502	0.86 (0.35), N=652	0.87 (0.33), N=502	0.30 (0.46), N=652	0.25 (0.44) N=502	0.36 (0.48) N=573	0.41 (0.49) N=437	0.82 (0.38), N=632	0.84 (0.37) N=485
10th	708.7 (2062.8), N=640	1010.14 (2400.82), N=449	3.91 (1.80), N=651	4.13 (1.84) N=449	0.88 (0.32), N=651	0.88 (0.32) N=449	0.31 (0.46), N=651	0.30 (0.46) N=449	0.32 (0.47) N=590	0.39 (0.49) N=405	0.84 (0.36), N=650	0.86 (0.35) N=448

Table A3: Mean Household Income ($US PPP) (Standard deviations are in parentheses)

Country	Site	CPR	Agriculture	Non-farm enterprise	Non-CPR Livestock income	Wage and Other	Total	Percentage Share of CPR income in household income
Bangladesh	Marine and Coastal periphery	527.0 (1,754.6)	413.3 (932.9)	2,899.9 (3,041.2)	276.9 (1,380.7)	116.4 (461.4)	4,238.9 (3,753)	14 (29)
	Sundarbans dependent zone	258.3 (603.6)	143.9 (432.5)	2,741.1 (2,749.5)	77.4 (399.0)	581.8 (1,167.6)	3,708.2 (3,001.2)	10 (20)
China	Miyun watershed	454.9 (1,010.2)	111 (437.9)	-	116.7 (795.2)	9,018.2 (9,840.2)	9,436.8 (9,987.5)	11 (19)
Colombia	Colombian Amazon	2,517.8 (3,296.8)	1,692.9 (3,050.8)	53.6 (234.6)	175.9 (438.9)	2,403.2 (2,484.1)	6,843.5 (5,575.4)	33 (28)
India	Western Ghats	466.3 (1,514.1)	1,640 (4,288.4)	213.1 (1,725.1)	93.8 (400.2)	3,605.3 (3,729.9)	6,024.6 (5,708.5)	9 (15)
Kenya Coastal	1.Rural	2,496.4 (4,901.2)	275.4 (853.1)	2,565.6 (4,746.1)	31.0 (175.2)	-	5,355.1 (6,379.1)	43 (49)
	2.Peri-Urban	42.3 (427.3)	108.7 (1,810.7)	5,152.6 (5,162.1)	14.12 (88.9)	-	5,316.9 (5,225.8)	1 (7)
Madagascar	Madagascar rural	180.9 (423.9)	809.9 (756.3)	294.8 (469.4)	80.7 (191.6)	-	1,373.4 (1,083.2)	12 (15)
Mozambique	1.Charcoal Production	6,247.86 (7,717.71)	1,176.27 (2,374.28)	321.30 (1,953)	38.90 (129.21)	169.08 (830.32)	7,959.85 (8,697.23)	67 (36)
	2.Commercial Crop Production	523.71 (1,350.67)	2,119.47 (5,234.42)	605.83 (6,866.61)	52.02 (174.11)	124.11 (426.37)	3,424.20 (8,806.98)	19 (80)
	3.Subsistence Crop Production	709.18 (2,828.28)	1,725.57 (5,408.3)	284.24 (1,319.5)	46.71 (107.2)	108.86 (398.32)	2,873.45 (6,232.7)	23 (47)
Malawi rural	Malawi rural	521.0 (2,393.5)	539.5 (1,845.7)	69.6 (312.9)	68.7 (311.9)	247.1 (592.7)	1,439.1 (3,438.3)	35 (32)
Peruvian Amazon	Indigenous	1,469.6 (2,596.9)	2,268.0 (5,170.4)	22.4 (138.9)	117.9 (401.2)	457.2 (633.9)	4,362.7 (6,674.3)	36 (38)
	Land-based Colonist	351.7 (1,345.9)	3,675.8 (9,798.2)	212.5 (1,475.1)	1,809.3 (8,699.2)	702.6 (1,610.1)	6,804.5 (13,128.3)	12 (28)
	Riverine Colonist	3,088.4 (5,814.8)	1,80,596.1 (4,97,196.2)	34.5 (171.9)	188.8 (476.9)	241.8 (354.8)	1,85,286.2 (5,05,940.3)	33 (36)

Table A4: Regression model

	Regression model with site as fixed effect		Regression model with settlement as fixed effect		Multilevel regression model	
	Participation in extraction from commons	Amount of CPR income (>0) per adult equivalent derived by households(log transformed)	Participation in extraction from commons	Amount of CPR income (>0) per adult equivalent derived by households(log transformed)	Participation in extraction from commons	Amount of CPR income (>0) per adult equivalent derived by households
Household size, (number of adult equivalent family members)	0.01**(0.003)	-0.18**(0.07)	0.01**(0.004)	-0.16***(0.02)	0.15**(0.06)	-0.29***(0.04)
Gender of the household head (0-female, 1-male)	0.04(0.02)	0.18*(0.10)	0.04***(0.02)	0.13(0.09)	0.36***(0.12)	-0.10 (0.19)
Household with educated members (0-no, 1-yes)	-0.04(0.03)	-0.13(0.09)	-.0.05***(0.02)	-0.11*(0.07)	-0.48***(0.13)	-0.11 (0.09)
Ownership of productive assets (0-no, 1-yes)	0.13***(0.04)	0.66**(0.30)	0.09***(0.02)	0.61***(0.13)	0.62***(0.19)	0.61***(0.12)
Ownership of farmland (0-no, 1-yes)	0.01(0.02)	0.32*(0.15)	0.01(0.02)	0.29***(0.10)	0.10 (0.17)	0.31**(0.14)
Abundance of CPR (proportion of uncultivated land cover within the landscape buffer)	0.11(0.07)	0.19(0.16)	0(Omitted)	0(Omitted)	0.48***(0.16)	0.28***(0.08)
Tenurial Access Index (ranges from 0 to 1)	0.04(0.05)	0.04(0.12)	0(Omitted)	0(Omitted)	-0.18 (0.18)	0.16**(0.07)
Regional Population density (People per square km)	-0.03(0.15)	0.17(1.48)	0(Omitted)	0(Omitted)	-0.89***(0.13)	0.43***(0.07)
Travel time from the settlement to the nearest city of 50000 population (in minutes)	-0.14(0.10)	0.20(0.56)	0(Omitted)	0(Omitted)	0.23* (0.13)	0.21***(0.04)
Constant	0.64***(0.04)	4.48***(0.32)	0.64***(0.02)	4.45***(0.15)	1.24*** (0.25)	4.99***(0.16)
Adjusted R-squared	0.25	0.25	0.38	0.33		
Random Intercept variance	-	-	-	-	2.60(0.44)	0.76 (0.13)
Log pseudolikelihood	-	-	-	-	-2,243.78	-25,907.81
N (Household)	5590	4136	5590	4136	5590	4,136
N(site, settlements)	15	15	128	128	128	128

Notes: 1) Clustered standard errors are in parentheses. In column 2nd and 3rd, standard errors are clustered at the site level and in other columns, they are clustered at the settlement levels.
2) Asterisks indicate the degree of statistical significance ((*=p<0.1, **=p<0.05, *** = p < 0.01).
3) Variables are standardised.
4) The qualitative findings across all the models remain more or less similar.

In the participation regression, the results of settlement fixed effect model and multilevel model remain the same in terms of significance of the coefficients of household level variables and the direction of correlation. In the former model, all the settlement level variables get omitted due to multicollinearity. In the case of site as fixed effect model, among the four household level variables, only household size and ownership of productive asset variable are significant as such model absorbs a larger portion of the variation of our data. None of the settlement level variable are significant.

In case of the amount of CPR income regression, the results across the models remain similar in terms of the significance and the direction of the correlation of most household level variables except for the variables- gender of household head and household with educated members. Gender of household head has no significant correlation to the amount of CPR income derived by households in settlement fixed effect and in multilevel model but it is positively significant in site level fixed effect model indicating that households with male head are likely to derive more CPR income than their counterpart. The variable 'household with educated member' is not significant in the case of the site-level fixed effect and multilevel model but has negatively significant correlation with the amount of CPR income in the settlement-level fixed effect model. None of the settlement level variable are significant in site-level fixed effect model and get omitted in settlement-level fixed effect model.

Broadly, the qualitative results remain consistent across the common variables in the different models. The qualitative agreement between the two fixed effect approaches and results from the multilevel model estimated shows little concern for undue endogeneity bias. Thus, in the main text we refer to the multilevel estimates in interpreting our results.

Declaration of Interest statement: Authors declare no conflict of interest regarding this submission.

How do Common Pool natural Resources relate to rural income, poverty and inequality? A multi-country assessment

Figures

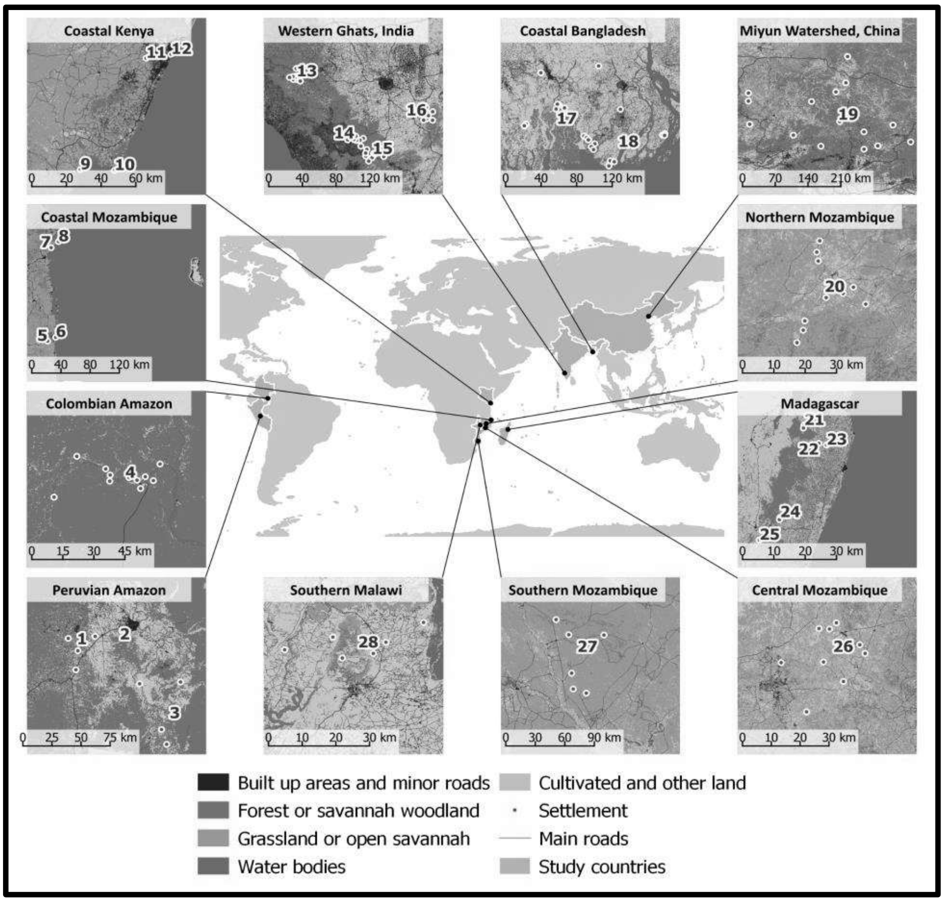

Figure 1: Locations of our study sites and settlements within them

Sources: i) Land use-land cover: Gong. et al. 2019, ESA 2016, NRSC 2016; ii) Roads: OpenStreetMap contributors (2015) iii) Settlements: https://data.humdata.org/

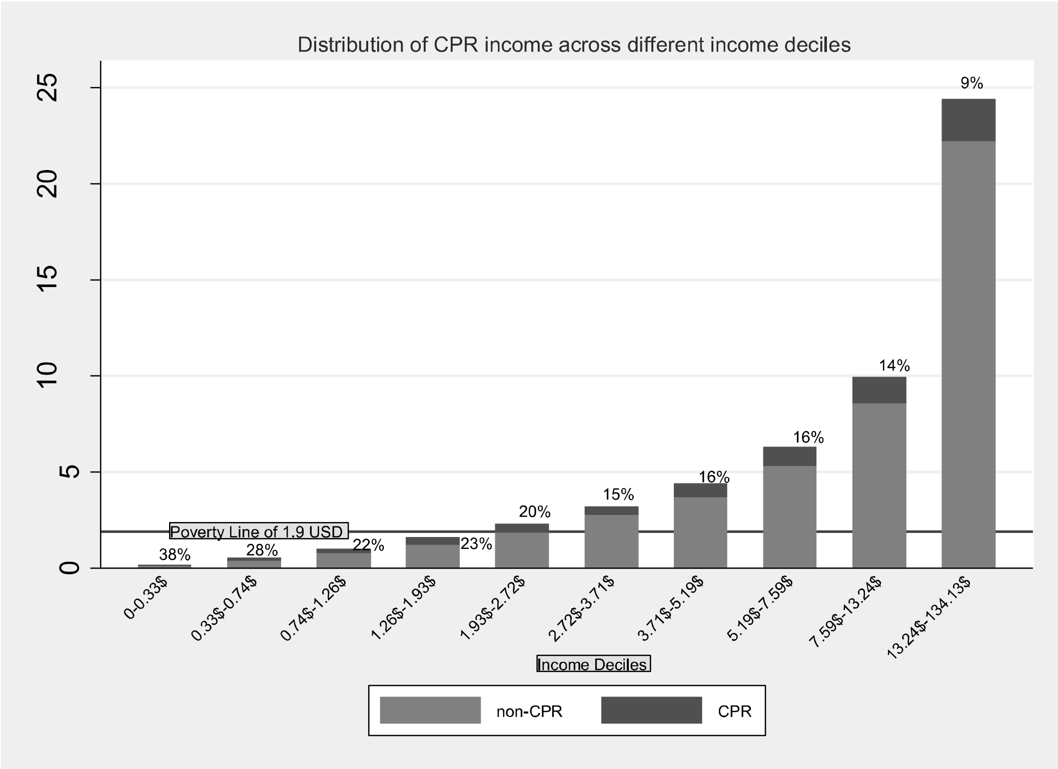

Fig2: The distribution of CPR income across different household income deciles
(The mean percentage share of household income from CPR are reported on the top of each bar)

How do Common Pool natural Resources relate to rural income, poverty and inequality? A multi-country assessment

Tables

Table 1: Data coverage

Country	Sites	Settle ments	Households	Landscape type	Common Pool Resources	
					Labour-intensive	Capital-intensive
Bangladesh	1.Marine and Coastal periphery	3	67	Coastal, marine, mangroves, agriculture		Fish from marine and coastal fisheries (3 settlements)[1]
	2. Sundarban dependent zone	9	227	mangroves, agriculture	Fuelwood, crab, honey, wax from Mangrove (2 settlements)	Fish from marine and coastal fisheries (7settlements)
China	Miyun watershed	15	1644	Forest, agriculture	Fuelwood, NTFP (15 settlements)	Grazing in common pasture
Colombia	Colombian Amazon	11	193	Forest, agriculture, riverine	Fuelwood, bushmeat	Fish (11 settlements)
India	Western Ghats	40	1099	Forest, agriculture	Fuel wood, medicinal plants, edible insects, fodder, fish from rivers & lakes (35 settlements)	Grazing in common pasture (5 settlements)
Kenya Coastal	1.Rural	3	409	Coastal, marine, mangroves, agriculture	Fuelwood and other products from mangroves, cowry shells from seashore (2 settlements)	Fish from marine fisheries, grazing in common lands (1 settlements)
	2.Peri-Urban	1	280	Coastal, marine, agriculture	Fuelwood from built environment, cowry shells from seashore (1 settlement)	Fish from marine fisheries, grazing in common lands
Madagascar	Madagascar rural	5	167	Forest, agriculture	Fuelwood, building wood, wild vegetables, honey (5 settlements)	Grazing in common lands
Mozambique	1.Charcoal Production	7	246	Grassland pasture, savanna	Forest products (bamboo, pole, grass, etc), processed forest products (mat, basket, wooden chairs), fish (7 settlements)	Charcoal, grazing in common lands
	2.Commercial Crop Production	10	702	Grassland pasture, savanna	Forest products (bamboo, pole, grass, etc), processed forest products (mat, basket, wooden chairs), fish	grazing in common lands (10 settlements)
	3.Subsistence Crop Production	10	643	Grassland pasture, savanna	Forest products (bamboo, pole, grass, etc), processed forest products (mat, basket, wooden chairs), fish	Charcoal, grazing in common lands(10 settlements)
Malawi rural	Malawi rural	6	590	Forest, agriculture	Fuelwood, bushmeat, fish (6 settlements)	Grazing
Peruvian Amazon	1. Indigenous	3	101	Forest, agriculture, riverine	Fuelwood, hunting	Inland fishing, Grazing (3 settlements)
	2. Land-based Colonist	4	105	Forest, agriculture, riverine	Fuelwood, hunting (4 settlements)	Inland fishing, Grazing
	3. Riverine Colonist	2	36	Forest, agriculture, riverine	Fuelwood, hunting	Inland fishing, Grazing (2 settlements
Total	**15**	**129**	**6,509**			

[1] settlements are capital-intensive when most households get more than 50% of their CPR income from CPR characterised as capital intensive and the opposite is true for labour intensive.

Table 2: Multilevel regression model

	Participation in extraction from commons	Amount of CPR income (>0) per adult equivalent derived by households
Household size, (number of adult equivalent family members)	0.15**(0.06)	-0.29***(0.04)
Gender of the household head (0-female, 1-male)	0.36***(0.12)	-0.10(0.19)
Household with educated members (0-no, 1-yes)	-0.48***(0.13)	-0.11(0.09)
Ownership of productive assets (0-no, 1-yes)	0.62***(0.19)	0.61***(0.12)
Ownership of farmland (0-no, 1-yes)	0.10(0.17)	0.31**(0.14)
Abundance of CPR (proportion of uncultivated land cover within the landscape buffer)	0.48***(0.16)	0.28***(0.08)
Tenurial Access Index (ranges from 0 to 1)	-0.18(0.18)	0.16**(0.07)
Regional Population density (People per square km)	-0.89***(0.13)	0.43***(0.07)
Travel time from the settlement to the nearest city of 50000 population (in minutes)	0.23* (0.13)	0.21***(0.04)
Constant	1.24*** (0.25)	4.99***(0.16)
Random Intercept variance	2.60(0.44)	0.76(0.13)
Log pseudolikelihood	-2243.78	-25907.81
N (Household)	5590	4,136
N(settlements)	128	128

Notes: 1) Clustered standard errors at the settlement level are in parentheses.
2) Asterisks indicate the degree of statistical significance ((*=p<0.1, **=p<0.05, *** = p < 0.01).
3) Variables are standardised.
4) In one settlement from Colombia does not have asset holding data, hence total number of settlements is 128 instead of 129.

Table 3: Mean Ratio of CPR income of top 10% and bottom 50% of the households		
	Categories of Settlements based on broad nature of CPR harvest technique	
	Capital-intensive	Labour-intensive
Share of CPR income	1.11(1.43)	0.35 (3.31)
CPR income	9.81 (13.19)	6.86 (11.65)
Total income	5.06(4.33)	13.28 (13.97)
N(settlements)	39	90

Standard deviations are in parenthesis

Table 4: Gini-Decomposition by Income Sources		
	Mean of the Percentage changes in Gini-coefficient due to 1% increase in CPR income in settlements categorised based on broad nature of CPR-harvest techniques-Capital- and Labour-intensive	
Sources of Income	Labour-intensive	Capital-intensive
CPR	-0.03	0.001
N (settlements)	90	40

Table A1: Descriptive Statistics of settlement-level Independent Variables by site (Standard Deviations in parenthesis)					
Country	**Site**	**Market Access(Travel time to the nearest town in minutes)**	**Tenure Index**	**Abundance of CPR (Proportion of CPR area within the buffer)**	**Population Density**
		Mean	Mean	Mean	Mean
Bangladesh	Marine and Coastal periphery	21 (11)	1 (0)	0.32 (0.11)	700 (115)
	Sundarbans dependent zone	20 (10)	0.4 (0.2)	0.01 (0.03)	330 (252)
China	Miyun watershed	86 (64)	1 (0)	0.8 (0.2)	45 (38)
Colombia	Colombian Amazon	4189 (323)	0.5 (0.1)	0.9 (0.03)	0.4 (0)
India	Western Ghats	21 (15)	0.7 (0.2)	0.5 (0.3)	296 (114)
Kenya Coastal	1.Rural	52 (24)	0.7 (0.1)	0.6 (0.3)	155 (44)
	2.Urban	0 (0)	0.5 (0)	0.5 (0)	7617 (0)
Madagascar	Madagascar rural	693 (351)	0.7 (0.3)	0.4 (0.3)	43 (30)
Mozambique	1.Charcoal Production	227 (39)	1 (0)	0.96 (0.02)	5 (3)
	2.Commercial Crop Production	49 (28)	1 (0)	0.6 (0.05)	45 (0)
	3.Subsistence Crop Production	135 (22)	1 (0)	0.7 (0.1)	8 (0)
Malawi rural	Malawi rural	34 (15)	0.8 (0.2)	0.2 (0.2)	198 (133)
Peruvian Amazon	Indigenous	798 (76)	1 (0)	0.6 (0.2)	1 (0.5)
	Land-based Colonist	48 (16)	1 (0)	0.001 (0)	8 (2)
	Riverine Colonist	203 (84)	1 (0)	0.1 (0.01)	2 (0.3)

A2: Descriptive Statistics Across Household Income Deciles, Standard Deviations in parenthesis

	Mean of CPR income per adult equivalent in USD		Mean household size adult equivalent		Mean proportion of male headed household		Mean Proportion of Households with educated members		Mean proportion of households owning productive assets		Mean proportion of households owning farm land	
Income Deciles	Considering overall sample size	For the subset of the sample that have CPR Income	For the overall sample size	For the subset of the sample that have CPR Income	For the overall sample size	For the subset of the sample that have CPR Income	considering the overall sample size	For the subset of the sample that have CPR Income	considering the overall sample size	For the subset of the sample that have CPR Income	considering the overall sample size	For the subset of the sample that have CPR Income
1st	34.04 (67.25), N=647	50.17 (76.55), N=439	3.50 (1.59), N=652	3.52 (1.62) N=439	0.74 (0.44), N=651	0.76 (0.43), N=439	0.29 (0.45), N=652	0.28 (0.45) N=439	0.31 (0.46), N=513	0.25 (0.43), N=365	0.69 (0.46), N=619	0.66 (0.47) N=430
2nd	58.85 (105.9), N=651	79.64 (116.42), N=481	3.50 (1.63), N=652	3.62 (1.53) N=481	0.75 (0.44), N=652	0.76 (0.43) N=481	0.21(0.40) N=652	0.17 (0.37) N=481	0.35(0.48) N=498	0.37 (0.48) N=364	0.81 (0.39), N=605	0.84 (0.37) N=439
3rd	93.66 (177.6), N=651	129.72 (197.52), N=470	3.47 (1.69), N=652	3.61 (1.70) N=470	0.82 (0.38), N=652	0.86 (0.35), N=470	0.25(0.43), N=252	0.2 (0.4) N=470	0.39 (0.49), N=537	0.42 (0.49) N=381	0.81 (0.39) N=615	0.83 (0.38) N=439
4th	132.23 (242.7), N=649	178.79 (267.06), N=480	3.55 (1.75), N=651	3.58 (1.76) N=480	0.83 (0.38), N=651	0.84 (0.37), N=480	0.27 (0.44), N=651	0.21 (0.41) N=480	0.37 (0.48) N=542	0.36 (0.48) N=403	0.80 (0.40) N=617	0.8 (0.40) N=459
5th	192.9 (364.7), N=652	260.52 (402.52), N=483	3.50 (1.67), N=652	3.48 (1.65) N=483	0.85 (0.35), N=652	0.85 (0.36), N=483	0.28 (0.45), N=652	0.19 (0.39) N=483	0.38 (0.49), N=572	0.37 (0.48) N=416	0.79 (0.41), N=633	0.82 (0.39) N=465
6th	170.3 (320.5), N=650	225.88 (351.76), N=490	3.71 (1.73), N=652	3.78 (1.73) N=490	0.87 (0.33), N=652	0.88 (0.33), N=490	0.33 (0.47), N=652	0.26 (0.44) N=490	0.33 (0.47), N=581	0.34 (0.48) N=439	0.73 (0.44), N=634	0.73 (0.44) N=476
7th	284.6 (535.5), N=649	357.30 (578.07), N=517	3.79 (1.67), N=651	3.87 (1.64) N=517	0.87 (0.33), N=651	0.88 (0.33) N=517	0.32 (0.47), N=651	0.28 (0.45) N=517	0.36 (0.48), N=580	0.37 (0.48) N=460	0.73 (0.44) N=642	0.76 (0.43) N=509
8th	361.7 (936.9), N=648	476.34 (1049.85), N=492	3.90 (1.78), N=652	4.02 (1.79) N=492	0.87 (0.33), N=652	0.88 (0.32) N=492	0.33 (0.47), N=652	0.28 (0.45) N=492	0.36 (0.48), N=590	0.40 (0.49) N=453	0.78 (0.41), N=641	0.80 (0.40) N=484
9th	515.1 (1149.2), N=650	666.93 (1268.58), N=502	3.92 (1.95), N=652	4.04 (1.98) N=502	0.86 (0.35), N=652	0.87 (0.33), N=502	0.30 (0.46), N=652	0.25 (0.44) N=502	0.36 (0.48) N=573	0.41 (0.49) N=437	0.82 (0.38), N=632	0.84 (0.37) N=485
10th	708.7 (2062.8), N=640	1010.14 (2400.82), N=449	3.91 (1.80), N=651	4.13 (1.84) N=449	0.88 (0.32), N=651	0.88 (0.32) N=449	0.31 (0.46), N=651	0.30 (0.46) N=449	0.32 (0.47) N=590	0.39 (0.49) N=405	0.84 (0.36), N=650	0.86 (0.35) N=448

Table A3: Mean Household Income ($US PPP) (Standard deviations are in parentheses)

Country	Site	CPR	Agriculture	Non-farm enterprise	Non-CPR Livestock income	Wage and Other	Total	Percentage Share of CPR income in household income
Bangladesh	Marine and Coastal periphery	527.0 (1,754.6)	413.3 (932.9)	2,899.9 (3,041.2)	276.9 (1,380.7)	116.4 (461.4)	4,238.9 (3,753)	14 (29)
	Sundarbans dependent zone	258.3 (603.6)	143.9 (432.5)	2,741.1 (2,749.5)	77.4 (399.0)	581.8 (1,167.6)	3,708.2 (3,001.2)	10 (20)
China	Miyun watershed	454.9 (1,010.2)	111 (437.9)	-	116.7 (795.2)	9,018.2 (9,840.2)	9,436.8 (9,987.5)	11 (19)
Colombia	Colombian Amazon	2,517.8 (3,296.8)	1,692.9 (3,050.8)	53.6 (234.6)	175.9 (438.9)	2,403.2 (2,484.1)	6,843.5 (5,575.4)	33 (28)
India	Western Ghats	466.3 (1,514.1)	1,640 (4,288.4)	213.1 (1,725.1)	93.8 (400.2)	3,605.3 (3,729.9)	6,024.6 (5,708.5)	9 (15)
Kenya Coastal	1.Rural	2,496.4 (4,901.2)	275.4 (853.1)	2,565.6 (4,746.1)	31.0 (175.2)	-	5,355.1 (6,379.1)	43 (49)
	2.Peri-Urban	42.3 (427.3)	108.7 (1,810.7)	5,152.6 (5,162.1)	14.12 (88.9)	-	5,316.9 (5,225.8)	1 (7)
Madagascar	Madagascar rural	180.9 (423.9)	809.9 (756.3)	294.8 (469.4)	80.7 (191.6)	-	1,373.4 (1,083.2)	12 (15)
Mozambique	1.Charcoal Production	6,247.86 (7,717.71)	1,176.27 (2,374.28)	321.30 (1,953)	38.90 (129.21)	169.08 (830.32)	7,959.85 (8,697.23)	67 (36)
	2.Commercial Crop Production	523.71 (1,350.67)	2,119.47 (5,234.42)	605.83 (6,866.61)	52.02 (174.11)	124.11 (426.37)	3,424.20 (8,806.98)	19 (80)
	3.Subsistence Crop Production	709.18 (2,828.28)	1,725.57 (5,408.3)	284.24 (1,319.5)	46.71 (107.2)	108.86 (398.32)	2,873.45 (6,232.7)	23 (47)
Malawi rural	Malawi rural	521.0 (2,393.5)	539.5 (1,845.7)	69.6 (312.9)	68.7 (311.9)	247.1 (592.7)	1,439.1 (3,438.3)	35 (32)
Peruvian Amazon	Indigenous	1,469.6 (2,596.9)	2,268.0 (5,170.4)	22.4 (138.9)	117.9 (401.2)	457.2 (633.9)	4,362.7 (6,674.3)	36 (38)
	Land-based Colonist	351.7 (1,345.9)	3,675.8 (9,798.2)	212.5 (1,475.1)	1,809.3 (8,699.2)	702.6 (1,610.1)	6,804.5 (13,128.3)	12 (28)
	Riverine Colonist	3,088.4 (5,814.8)	1,80,596.1 (4,97,196.2)	34.5 (171.9)	188.8 (476.9)	241.8 (354.8)	1,85,286.2 (5,05,940.3)	33 (36)

Table A4: Regression model

	Regression model with site as fixed effect		Regression model with settlement as fixed effect		Multilevel regression model	
	Participation in extraction from commons	Amount of CPR income (>0) per adult equivalent derived by households(log transformed)	Participation in extraction from commons	Amount of CPR income (>0) per adult equivalent derived by households(log transformed)	Participation in extraction from commons	Amount of CPR income (>0) per adult equivalent derived by households
Household size, (number of adult equivalent family members)	0.01**(0.003)	-0.18**(0.07)	0.01**(0.004)	-0.16***(0.02)	0.15**(0.06)	-0.29***(0.04)
Gender of the household head (0-female, 1-male)	0.04(0.02)	0.18*(0.10)	0.04***(0.02)	0.13(0.09)	0.36***(0.12)	-0.10 (0.19)
Household with educated members (0-no, 1-yes)	-0.04(0.03)	-0.13(0.09)	-.0.05***(0.02)	-0.11*(0.07)	-0.48***(0.13)	-0.11 (0.09)
Ownership of productive assets (0-no, 1-yes)	0.13***(0.04)	0.66**(0.30)	0.09***(0.02)	0.61***(0.13)	0.62***(0.19)	0.61***(0.12)
Ownership of farmland (0-no, 1-yes)	0.01(0.02)	0.32*(0.15)	0.01(0.02)	0.29***(0.10)	0.10 (0.17)	0.31**(0.14)
Abundance of CPR (proportion of uncultivated land cover within the landscape buffer)	0.11(0.07)	0.19(0.16)	0(Omitted)	0(Omitted)	0.48***(0.16)	0.28***(0.08)
Tenurial Access Index (ranges from 0 to 1)	0.04(0.05)	0.04(0.12)	0(Omitted)	0(Omitted)	-0.18 (0.18)	0.16**(0.07)
Regional Population density (People per square km)	-0.03(0.15)	0.17(1.48)	0(Omitted)	0(Omitted)	-0.89***(0.13)	0.43***(0.07)
Travel time from the settlement to the nearest city of 50000 population (in minutes)	-0.14(0.10)	0.20(0.56)	0(Omitted)	0(Omitted)	0.23* (0.13)	0.21***(0.04)
Constant	0.64***(0.04)	4.48***(0.32)	0.64***(0.02)	4.45***(0.15)	1.24*** (0.25)	4.99***(0.16)
Adjusted R-squared	0.25	0.25	0.38	0.33		
Random Intercept variance	-	-	-	-	2.60(0.44)	0.76 (0.13)
Log pseudolikelihood	-	-	-	-	-2,243.78	-25,907.81
N (Household)	5590	4136	5590	4136	5590	4,136
N(site, settlements)	15	15	128	128	128	128

Notes: 1) Clustered standard errors are in parentheses. In column 2nd and 3rd, standard errors are clustered at the site level and in other columns, they are clustered at the settlement levels.
2) Asterisks indicate the degree of statistical significance ((*=p<0.1, **=p<0.05, *** = p < 0.01).
3) Variables are standardised.
4) The qualitative findings across all the models remain more or less similar.

Acknowledgement: We thank the editor and anonymous reviewers for their extensive comments, without which the paper would not have taken its present shape.

We thank Julia PG Jones for commenting on the draft, Casey Ryan and Janet Fisher for providing us all the required field information to clarify our results and Franziska Kraft for making the map used in this paper. We gratefully acknowledge the financial support from the Towards a Sustainable Earth (TaSE) initiative (NE/S012850/1), which is a joint initiative of NERC (UK), FORMAS (Sweden) and DBT (India) (Indian grant number BT/IN/TaSE/73/SL/2018-19).

Research Data

Click here to download Research data(Old)
http://data.mendeley.com/datasets/zt725sr9jc/1