Income and wildlife hunting in the Anthropocene Evidence from Cambodia

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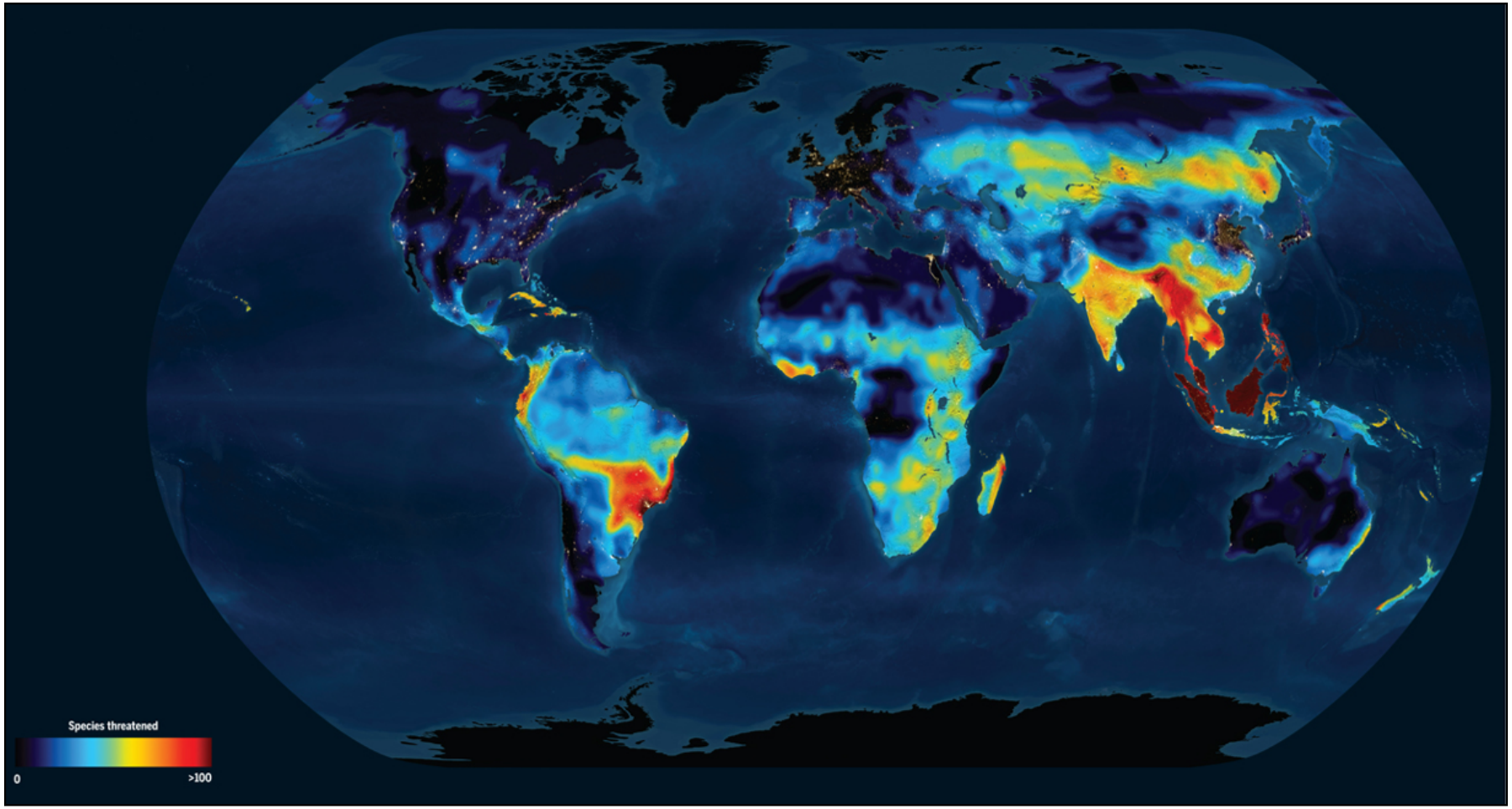
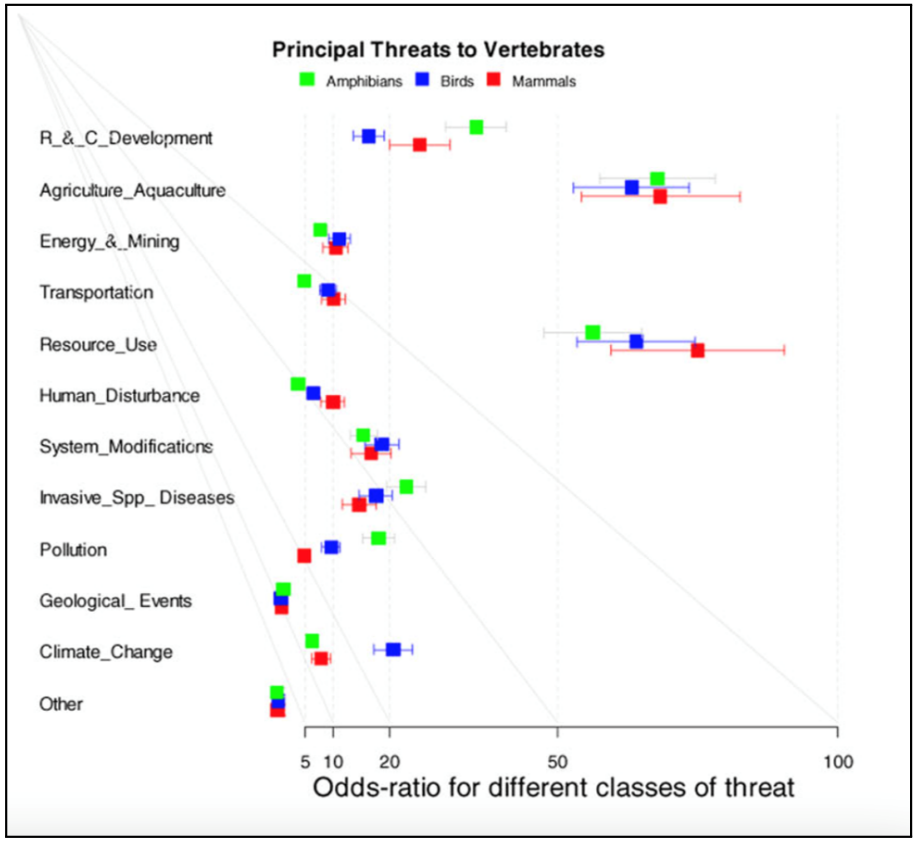
Biodiversity losses and poverty



Number of threatened species in the World (Vignieri (2014))

Drivers of biodiversity losses

- Land use change & extraction (not climate change) are currently the main drivers
- What we know about wildlife hunting is mostly based on case-studies, making it difficult to understand the relation between income and environmental degradation
- Relation between poverty and environmental degradation is unclear: cash transfers have both increased (Alix-Garcia et al, 2013) and reduced (Ferraro and Simorangkir, 2022) deforestation
- If a negative relation exists, then cash transfers may both reduce poverty and biodiversity losses



Drivers of defaunation (Caro et al., 2022)

Context & Data

- Cambodia, one of the most biodiverse countries in Southeast Asia
- Cambodia Socio-Economic Survey (CSES), 2014 & 2019: nationally representative income and expenditure surveys that, unusually, ask questions about value of wildlife consumed and sold
- Household location allows us to link household data with several rich datasets of environmental datasets - biodiversity, conservation areas, soil quality, weather
- Over 90% of hunters and over 95% of value of hunted wildlife are in rural areas, the focus of our analysis
- Economy of rural Cambodia: heavily dependent on rainfed rice production, concentrated in one main season (May-October), while the importance of irrigation is almost negligible - weather shocks, particularly at the start of the rainy season, matter.

Context & Data

- Consumption $>$ sales for 90% of hunting households
- Hunting in 2019 is 3$\times$ more important than in 2014, but value of hunted wildlife per household does not change
- Small absolute value ($\sim$ 25 USD), but a large importance in terms of meat consumption
- Caveat: no data on species hunted

Table 1: Hunting in rural Cambodia

	2014	2019
Hunts wildlife (%)	0.031	0.091
	(0.17)	(0.29)
Sells wildlife (%)	0.007	0.010
	(0.09)	(0.10)
Consumes wildlife (%)	0.030	0.089
	(0.17)	(0.29)
If household hunts:		
Hunted wildlife	191	200
(1000 riels)	(282)	(510)
Hunted wildlife	0.14	0.17
(share value of meat)	(0.20)	(0.44)
N	8333	6092

Context & Data

- Lower income
- Greater specialization on agricultural production ...
- ... not reflected in higher rice productivity

Table 2: Who hunts (2014 & 2019)?

	non-hunters	hunters	difference
Per capita consumption	4445	4193	-252.32**
(1000 riels/year)	(3402)	(2375)	
Poor	0.263	0.328	0.065***
	(0.44)	(0.47)	
Has low income card	0.163	0198	0.035***
	(0.37)	(0.40)	
Durable goods (1000 riels)	6025	4643	-1382***
	(13987)	(6614)	
Owns livestock	0.680	0.818	0.138 ***
	(0.47)	0.39)	
Owns non-farming business	0.258	0.188	-0.070***
	(0.44)	(0.39)	
Owns a pond	0.025	0.034	0.091
	(0.22)	(0.32)	
Land (ha)	1.31	2.12	0.80***
	(2.39)	(2.69)	
Rice yield (kg/ha)	2866	2101	-764***
	(3692)	(1746)	
Dependency ratio	1.14	1.16	0.02
	(0.93)	(0.88)	
Age household head	47.93	43.43	-4.49***
	(14.03)	(13.22)	
Male household head	0.787	0.905	0.118***
	(0.41)	(0.29)	
N	13847	820	

Context & Data

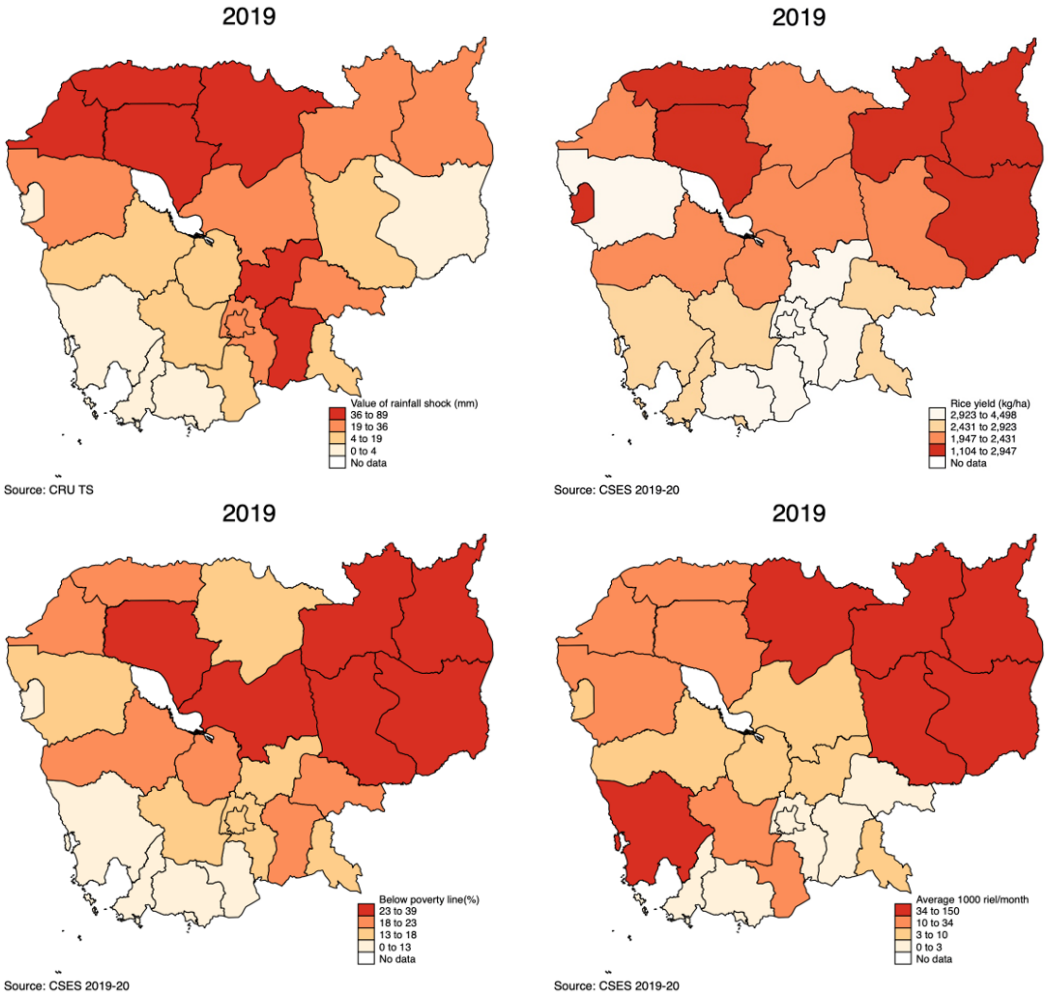
- Availability of wildlife matters
- Hunting is more frequent where rainfall shocks are more important
- and agronomic conditions make rainfed agriculture harder
- Lower rice yields & higher poverty
- Not covered by existing social safety nets
- Conclusion: hunting as a coping strategy

Table 3: Where is hunting concentrated (2014 & 2019)?

	No hunting	Frequent hunting	difference
Biodiversity Intactness Index	0.88	0.95	0.07***
	(0.07)	(0.06)	
Forest cover (km^2)	12.46	37.33	24.87***
	(20.45)	(30.01)	
Rainfall shocks - May & June (mm)	28.26	36.83	6.28***
	(29.05)	(33.76)	
Irrigation	0.083	0.032	-5.85***
	(0.11)	(0.06)	
Topsoil depth (mm)	9950	8766	1282***
	(1284)	(1754)	
Rice yield (kg/ha)	3029	2040	1001***
	(2181)	(909)	
Poverty (share)	0.265	0.374	0.109***
	(0.22)	(0.24)	
Low income card	0.163	0.177	0.014
	(0.17)	(0.17)	
N communes	997	49	
N households	11169	548	

From rainfall shocks & low income to hunting

Rainfall shocks $\rightarrow$ rice yield $\rightarrow$



poverty $\rightarrow$ incidence of hunting

Identification strategy

$$lnWLH_{ict} = \beta_0 + \beta_1 Y_{ict} + \beta_2 X_{ict} + \beta_3 Z_c + \beta_4 T + \epsilon_{ict}$$

- WLH = value of Wildlife Hunting of household i, living in commune c, at time t
- Y = income per capita (100,000 riels)
- X = household characteristics
- Z = commune characteristics
- T = time fixed effect
- s.e. clustered at commune level
- IV: rainfall shocks in previous May & June, local price of fish (alternative source of protein)

Estimates

- OLS estimates: fairly low semi-elasticity of hunting with respect to income
- IV estimates: reduction in income of $\sim$ 100,000 riels ($\equiv$ 24 USD) $\Rightarrow$ increase in hunting of $\sim$ 6.2%
- First stage: 1 mm rainfall deficit in May-June $\Rightarrow$ reduction in income by $\sim$ 0.5 USD/ha

Table 4: Income and hunting

	OLS	IV
Income per capita	-0.006***	-0.062***
(100,000 riels)	(0.000)	(0.020)
Household controls	Yes	Yes
Commune controls	Yes	Yes
Time FE	Yes	Yes
N	14,425	14,425
Kleibergen-Paap F-stat		23.69
Hansen J-stat		0.62
Hansen J-stat p-value		0.43

Defining transfers to reduce wildlife hunting

We consider two types of transfers:

- Conservation Basic Income (CBI) (deLange et al., 2023): a per capita unconditional transfer equal to the rural poverty line to all households; average value of transfer: US$2,484 per household ($\sim 4 \times$ CTP-COVID19, targeted to the poor only)
- Conservation Insurance (CI) (Chantarat el at., 2011): a transfer identical to income loss due to rainfall shock; average value of transfer: US$15

In addition, we consider the possibility of targeting only those households who are most likely to hunt based on observable characteristics & limit all transfers to areas close ($\leq$20km) to NP

There is substantial artificiality in this analysis:

- We assume we can measure rainfall shocks perfectly, rather than through an index (such as NDVI)
- Ignores the acceptability of targeting sub-sets of the population that may not be the poorest of the poor

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Defining transfers to reduce wildlife hunting

Table 5: Transfers & wildlife hunting

Target	N	Cost	Δ Hunting	$/%	Δ poverty
CIns	4,401	$107,274	-2.70%	$39,731	-0.61%
CBI	6,599	$16,396,884	-80.08%	$204,756	-24.10%
CIns & hunter	1,113	$20,730	-1.23%	$16,854	-0.11%
CBI & hunter	1,650	$4,098,600	-54.62%	$75,038	-5.09%

Hunter $\equiv$ top quartile of the probability of engaging in hunting as a function of observable characteristics

Conclusions

- The relation between income and environmental degradation is contested, and probably locally determined.
- We use a nationally representative dataset with information on value of wildlife extracted to quantify this relation in Cambodia
- A negative relation suggests some room for cash transfers to play a role as a complement of traditional conservation policies, based on exclusion of use of resources
- Insurance against rainfall shocks seems cost-effective but the total reduction on value of hunted wildlife is likely to be small
- Targeting hunters substantially increases the effectiveness of transfers, but is unlikely to be socially acceptable
- Planned work in NE Cambodia will test some of these ideas