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Impact of Protected Areas on the Incidence of Infectious Diseases - June 2019

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CESIEP

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Center for the Socioeconomic Impact of Environmental Policies

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Outline

- Research objective
- Human health and the environment
- Chilean context
- Data
- Results and conclusions

Research objective

- To estimate the impact of the Chilean National System of Protected Areas on the incidence of infectious diseases, considering socioeconomic, demographic, biophysical and land use factors.

Human health and the environment

- Nature and its contributions to people are deteriorating worldwide
- Direct and indirect drivers of change have accelerated during the past 50 years
- Sustainability goals for 2030 and beyond may only be achieved through transformative changes across economic, social, political and technological factors
- Little attention has been paid to how changes in the structure of natural systems and their functions can affect human health
- The causal relationships between ecosystem changes and human health are complex, generally indirect, dispersed in time and space and dependent on other factors

Human health and the environment

Nutrition

Water purification

Protection against natural disasters

Incidence of infectious diseases

Mental health

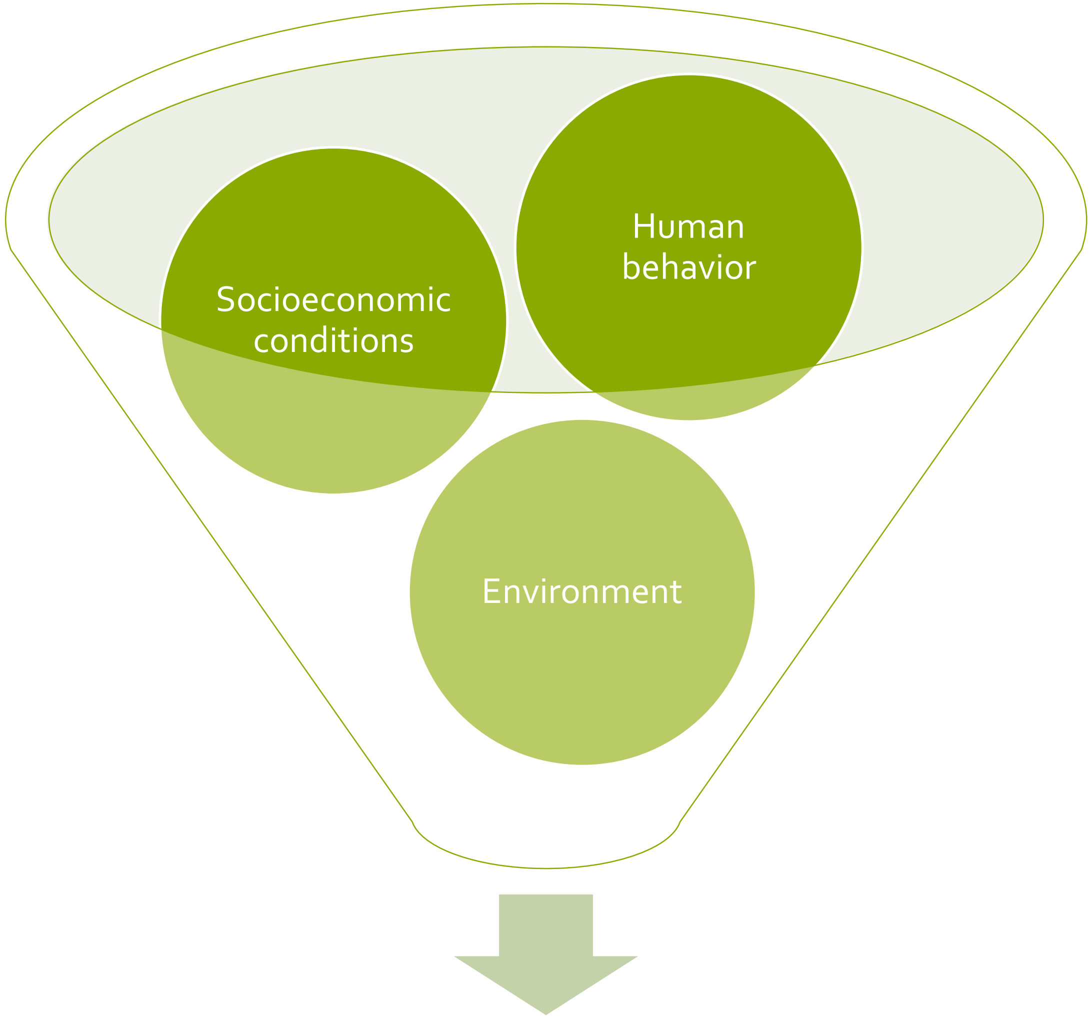
Human health and the environment

Deforestation is considered one of the most important factors in the emergence and re-emergence of infectious diseases

There is little evidence on how forest and ecosystem conservation policies affect human health

Although conservation is the main objective of these policies, it becomes evident to link them with other components of well-being

Ecology of Infectious Diseases

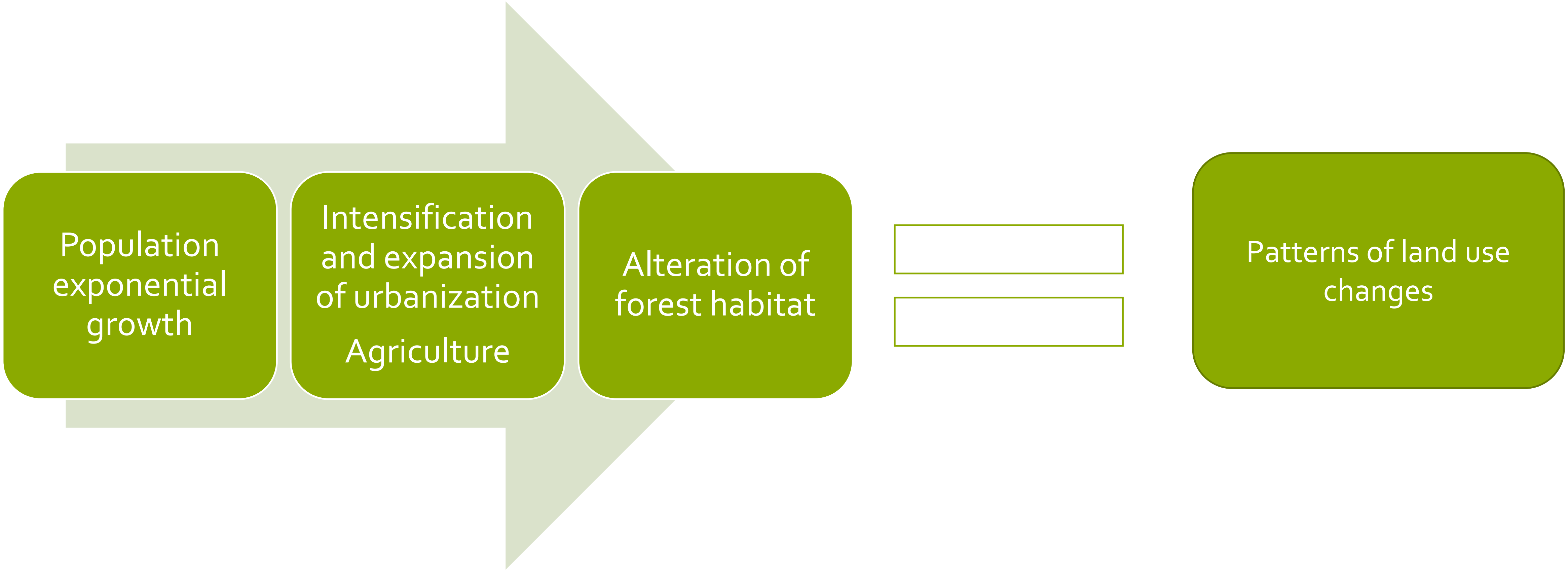


Patterns of infectious diseases

Environmental changes can impact directly and indirectly by:

1. Increasing exposure to infectious agents
2. Expanding vector's habitat

Ecology of Infectious Diseases



Ecology of Infectious Diseases

Patterns of land use changes

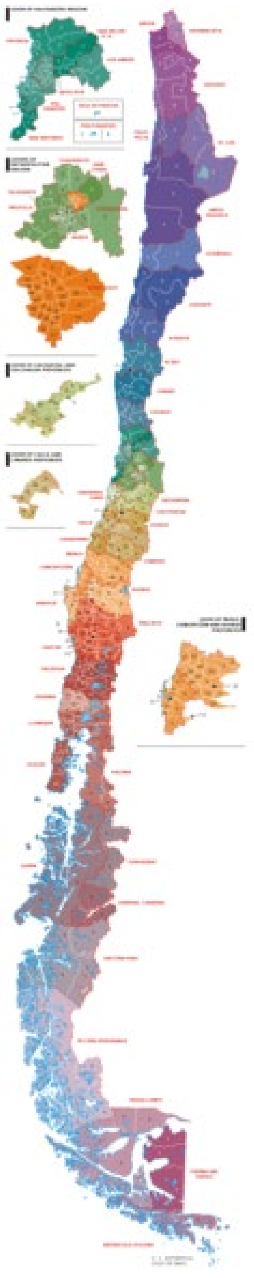
Vector changes and reservoirs' domestication

More interaction between humans and pathogens

Chilean context

- Chile extends from the Tropic of Capricorn to the peri-Antarctic waters south of Cape Horn, and from the Cordillera de los Andes to the Pacific Ocean
- Four geographical zones can be differentiated:

1. Cordillera de los Andes
2. Intermediate depression
3. Cordillera de la Costa
4. Costal plain



Chilean context

- 20% of national land being protected
- National PA system established in 1984
- There are 36 National Parks, 49 National Reserves and 15 Natural Monuments
- 84% of protected land located on most southern regions: Aysén and Magallanes

Data

- Database on Mandatory Notification of Diseases (1999-2014), Ministry of Health, Chile
- Observations at the municipality level based on annual diagnosed cases of Echinococcosis, Trichinosis, Typhoid and Parathyroid Fever, Carbuncle, Syphilis, Hepatitis B and Rubella
- Protected area at the municipality level
- Covariates on population, road density, distance to regional capital, municipality land area, temperature, precipitation, altitude and slope

Baseline on diagnosed disease cases

- No data before 1999 -> no control on diseases base line
- It was empirically tested that the independent variables used in the model help to determine the baseline
- To test this hypothesis, a propensity score matching between post-1999 protected and non-protected municipalities was implemented
- Mean comparison between matched municipalities

Table 1. Mean comparison test between matched non protected municipalities and municipalities protected after 1999

	Mean 1	Mean 2	Difference
(Para) Typhoid Fever	5.200	3.444	1.756
Echinoccocosis	1.200	1.889	-0.689
Trichinellosis	0.000	0.000	0.000
Anthrax	0.000	0.000	0.000
Syphilis	8.200	13.667	-5.467
Hepatitis B	0.800	1.111	-0.311
Rubella	7.000	5.444	1.556

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

Table 2: Descriptive Statistics

	Mean Value Unprotected Municipalities	Mean Value Protected Municipalities	Diff Mean Value	Norm diff[a]	t statistic
(Para) Typhoid Fever	1.255	0.952	0.103	0.106	2.822
Echinoccocosis	0.649	1.250	-0.240	-0.215	-9.978
Trichinellosis	0.111	0.102	0.010	0.032	0.131
Anthrax	0.009	0.011	-0.015	-0.140	-0.624
Syphilis	9.646	8.466	0.049	0.017	1.130
Hepatitis B	1.523	1.085	0.081	0.078	2.222
Rubella	1.646	0.788	0.084	0.095	2.497
Population	48061.470	34823.180	0.203	0.001	5.766
Roads density (km/km^2)	0.766	0.366	0.878	1.453	26.348
Distance to regional capital (km)	61.122	100.393	-0.645	-0.064	-21.639
Slope (°)	7.657	12.125	-0.801	-0.230	-28.859
Altitude (masl)	617.527	897.616	-0.345	-0.012	-12.869
Average temperature in July (°C)	6.484	4.778	0.531	0.243	19.061
Average temperature in January (°C)	16.274	13.631	0.782	0.212	26.106
Rainfall (ml)	874.754	1170.980	-0.447	-0.013	-15.202

N protected municipalities (treated) = 1600; N unprotected municipalities (control) = 3820

[a]Normalized difference $= \frac{\bar{X}_T - \bar{X}_C}{\sqrt{\frac{S_T^2 + S_C^2}{2}}}$, where T= protected and C= unprotected

Disease outcome variables

Echinococcosis

Trichinosis

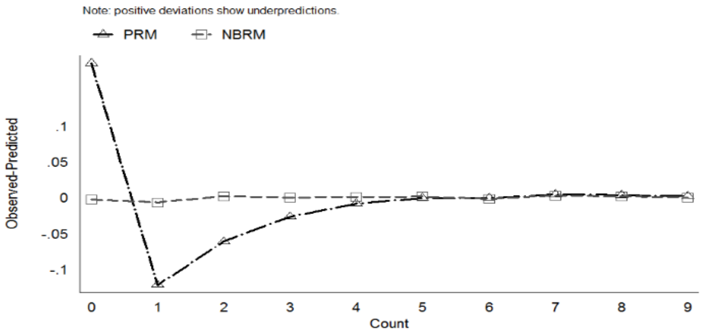
Carbuncle

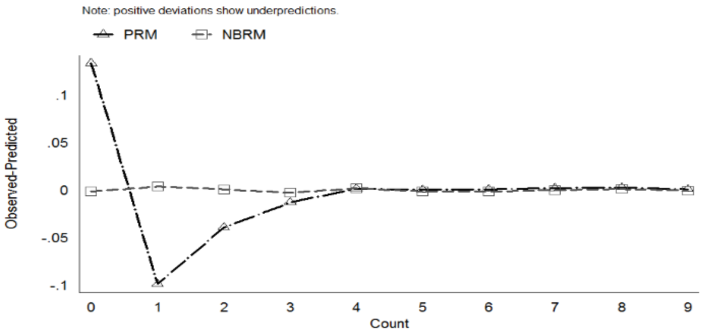
Typhoid and Parathyroid Fever

Statistical methods

- Count data model: Poisson and negative binomial regression
- Random effects model
- Estimation of marginal effects
- Inclusion of placebo diseases: Syphilis, Hepatitis B and Rubeola

Results


Note: positive deviations show underpredictions.
PRM
NBRM
Observed-Predicted
.1
.05
0
-.05
-.1
0 1 2 3 4 5 6 7 8 9
Count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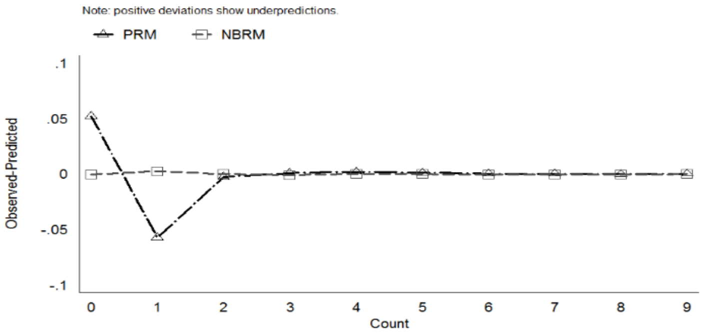
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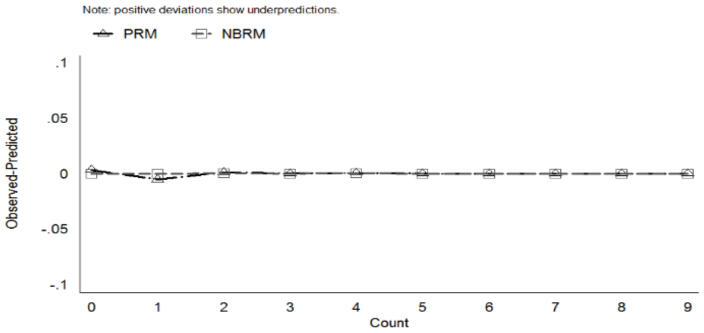
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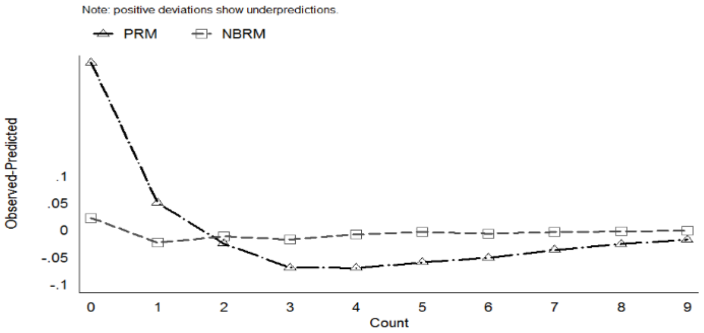
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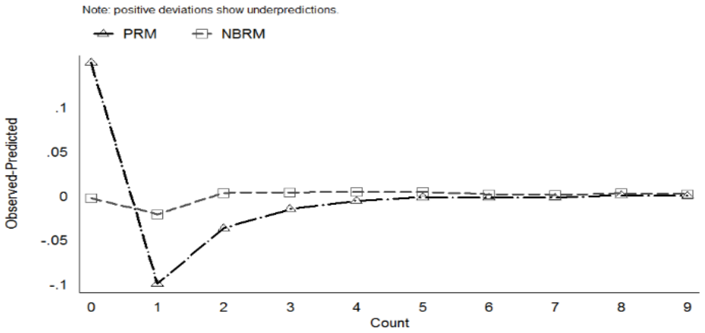
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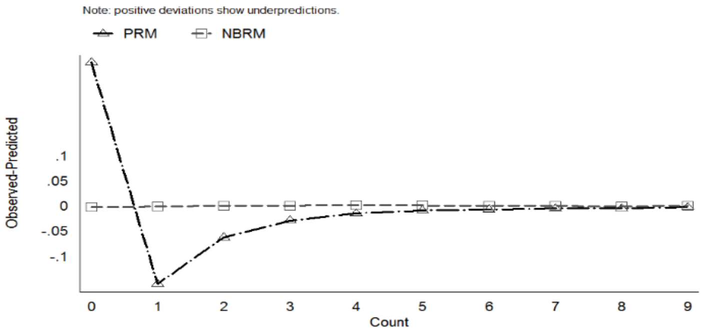
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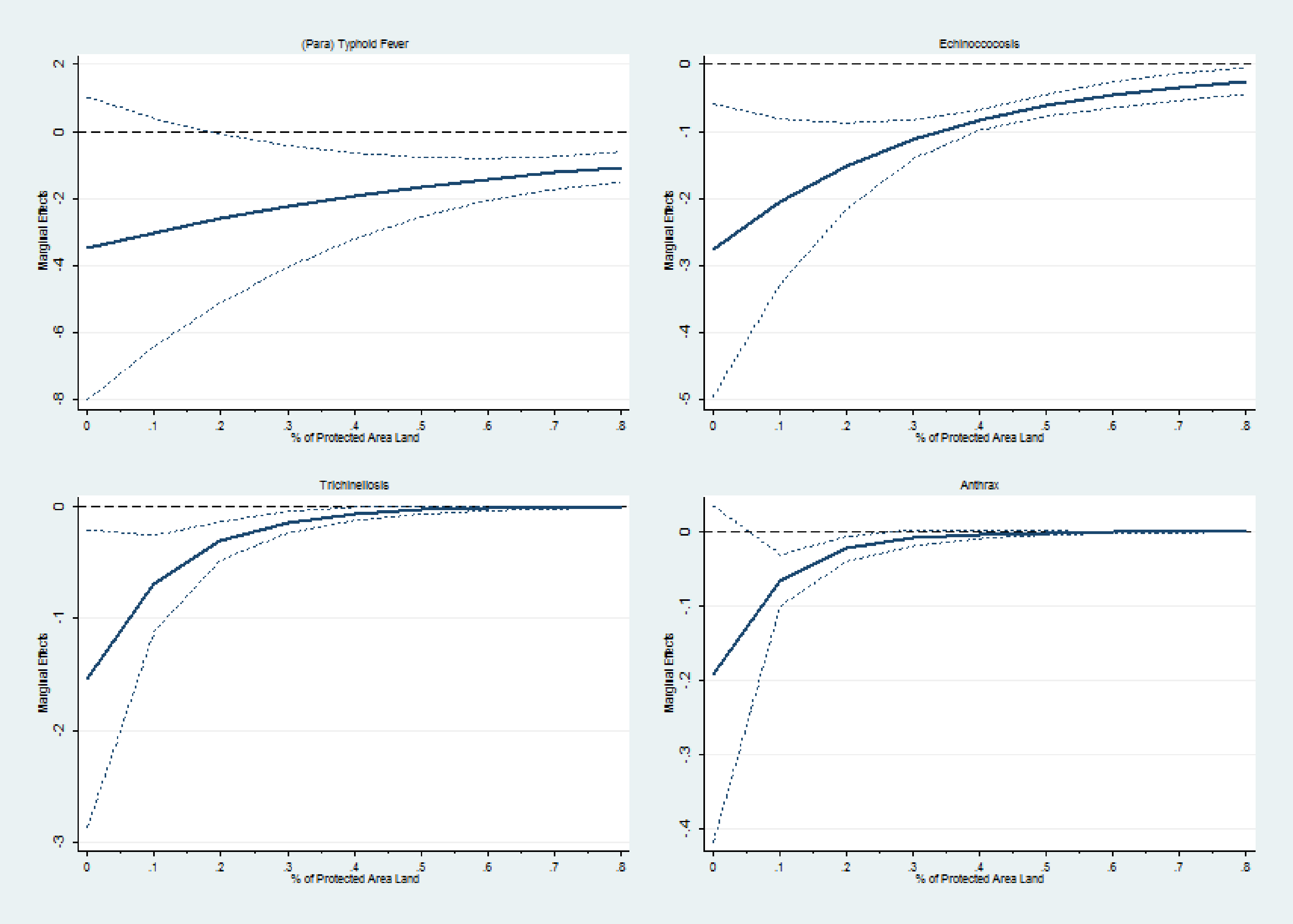
0
-.05
-.1
0 1 2 3 4 5 6 7 8 9
Count

Negative Binomial Random Effects Regression

	(Para) Typhoid Fever	Echinoccocosis	Trichinellosis	Anthrax	Syphilis	Hepatitis B	Rubella
Protected areas (% of total area)	-1.482*	-3.018***	-8.109***	-10.746**	-0.590	-0.501	-0.574
	(0.886)	(0.979)	(1.919)	(4.227)	(0.623)	(0.998)	(1.116)
Population	0.000***	0.000***	0.000***	0.000	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Roads density (km/km^2)	0.126	-0.941***	0.722**	-3.584***	0.800***	0.588***	0.883***
	(0.144)	(0.209)	(0.319)	(1.036)	(0.104)	(0.160)	(0.183)
Distance to regional capital (km)	-0.001	0.004**	-0.003	-0.003	-0.001	-0.001	-0.005***
	(0.001)	(0.002)	(0.003)	(0.005)	(0.001)	(0.001)	(0.002)
Slope (°)	0.010	0.009	0.002	-0.041	0.010	0.002	0.040***
	(0.011)	(0.017)	(0.032)	(0.041)	(0.008)	(0.013)	(0.013)
Average altitude (m.a.s.l.)	-0.000*	-0.001***	-0.001**	-0.000	-0.000	-0.000***	0.000
	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Average temperature in July (°C)	-0.016	-0.203***	-0.078	-0.811***	0.018	0.052*	0.082***
	(0.028)	(0.039)	(0.073)	(0.142)	(0.020)	(0.030)	(0.031)
Average temperature in January (°C)	0.005	0.041	-0.004	0.594***	-0.059**	-0.146***	0.006
	(0.031)	(0.043)	(0.068)	(0.135)	(0.023)	(0.036)	(0.039)
Rainfall (ml)	-0.000	0.000	0.001***	0.001*	0.000	-0.001***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
[a]0 to 20 years of protection	-0.246	0.119	0.905**	-0.986	-0.280**	-0.280	0.310
	(0.185)	(0.254)	(0.355)	(1.079)	(0.123)	(0.196)	(0.230)
[a]20 to 40 years of protection	0.114	-0.259	0.273	-0.429	-0.341**	-0.397*	-0.584**
	(0.197)	(0.243)	(0.591)	(0.831)	(0.136)	(0.221)	(0.255)
[a]40 to 60 years of protection	-0.222	-0.023	0.826	-0.919	-0.144	-0.333	-0.133
	(0.233)	(0.285)	(0.512)	(0.846)	(0.164)	(0.286)	(0.291)
[a]More than 60 years of protection	0.094	0.565**	1.565***	0.759	0.005	0.071	0.478*
	(0.186)	(0.227)	(0.294)	(0.554)	(0.136)	(0.238)	(0.256)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.307	1.698**	-3.673***	-6.855***	0.963**	1.235*	-1.390*
	(0.595)	(0.851)	(1.315)	(2.126)	(0.480)	(0.745)	(0.798)
N	5,340	5,340	5,340	5,340	5,340	5,340	5,340
bic	11,286	10,136	2,474	627	23,228	9,654	6,216

Results: marginal effects



Conclusions

- Human health is feasibly between the most underappreciated ecosystem services and the particular relationship between health and ecosystem change has not been well documented
- Additionally, the lack of evidence about economic contributions of ecosystem services to people contributes to the perception that conservation initiatives, like PAs, only constrain social benefits of economic extractive activities, thus involving only costs to local population
- By analyzing a rich dataset comprising human health outcomes and biophysical, land-use, demographic and socioeconomic factors, we find that PAs decrease the incidence of the diseases outcome and has no impact on negative controls
- Health dividends decrease with higher levels of protection

Gracias