

Measuring the Effects of Natural Resource Conservation Policies on Household Welfare

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Outline

- ◆ Food Security Research Project
- ◆ Tourism in Zambia
- ◆ Game Management Areas
- ◆ Data and Methods
- ◆ Results



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Food Security

- ◆ Food Security Research Project (FSRP)
- ◆ Objective: *to integrate research into policy dialogue and program design to promote sustainable agricultural growth as a means to cut hunger and poverty*
- ◆ Research theme: food security and natural resource management interactions

Tourism in Zambia

- ◆ Natural resource-based
- ◆ International tourist arrivals
 - 2004: 515,000
 - 9.7% avg annual growth (1990-2004)
- ◆ Tourism receipts (US\$)
 - 2004: \$161 million
 - 9.8% avg annual growth (1990-2004)
 - 12.7% of exports
- ◆ One of three priority sectors in national development plan
- ◆ Research: impact of policies on rural development



Zambia

- Landlocked country in southern Africa
- Tropical climate
- Flat plateau (1000-1500 m)
- Nine provinces



Zambia (continued)

- ◆ Population: 11.5 million
- ◆ Rural population: 65%
- ◆ GDP per capita: \$1,273
- ◆ Living below \$1 per day: 64%
- ◆ Living below \$2 per day: 87%
- ◆ Malnourished population: 46%



- ◆ Life expectancy at birth: 41.2 yrs (178/179)
- ◆ People without improved water: 42% (106/123)
- ◆ Illiteracy rate: 32% (93/127)
- ◆ Human development index: 0.43 (165/177)

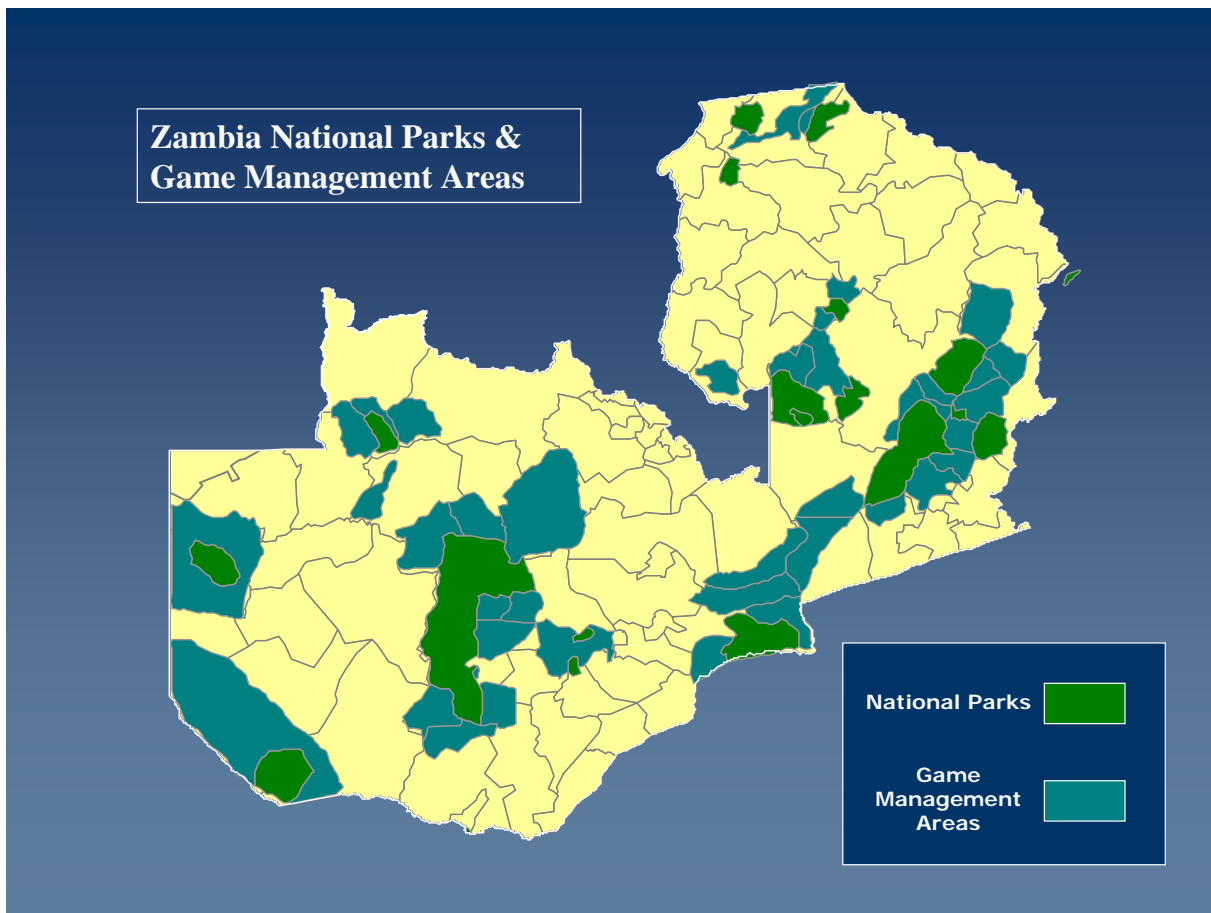
Community-Based Natural Resource Management

- ◆ Natural resource management historically “top-down”
- ◆ CBNRM – complement to wildlife management programs since 1980s
 - Importance of engaging local communities
- 1. Natural resource conservation
 - Wildlife, habitat
- 2. Rural development
 - Empowerment, decision-making opportunities
 - Livelihoods, household income

Game Management Areas

- ◆ Buffer zone around national parks
- ◆ Licensed safari and subsistence hunting are controlled by permit
- ◆ Protected Area system covers about 30% of Zambia
 - 19 national parks
 - 35 game management areas (GMAs)





Game Management Areas (continued)

- ◆ Zambia Wildlife Authority (ZAWA)
- ◆ Shares hunting license revenues and wildlife management responsibilities with communities
 - Community Resource Boards (CRBs)
- ◆ Dual objectives of wildlife conservation and rural development
 - Employment of village scouts
 - Development projects

Impact of Game Management Areas

- ◆ Benefits
 - Rural employment
 - Revenue sharing
 - Meat distributed after hunting
 - Development projects
- ◆ Crop damage
- ◆ Opportunity cost of alternative land uses



Three Research Questions

1. What is the effect of GMAs on household income?
2. What are the *sources* of income that generate the GMA effect?
3. What are the effects of GMAs on crop losses from wildlife damage?



Data

- ◆ Stratified two-stage cluster sampling
- ◆ 139 statistical enumeration areas (SEAs) adjacent to four national park systems
- ◆ Rural household survey
- ◆ 2,800 households selected
 - About half GMA and non-GMA (control)
 - Only about 32 non-response (1.1%)
- ◆ Measure the impact of wildlife conservation on household income

Descriptive Statistics

	Full Sample	GMA	Non-GMA	
Number of sample households	2,717	1,574	1,143	
Total household income (Kw)	4,235,762	3,591,253	5,123,301	*
Household size	5.28	5.08	5.57	***
Age of household head (in years)	42.46	41.00	44.48	***
Sex of household head (=1 if male)	0.74	0.73	0.76	**
Maximum education (in years)	6.78	6.42	7.27	***
Number of children (< 15 years)	2.55	2.46	2.67	***
Number of female adults	1.10	1.08	1.12	
Number of male adults	1.03	1.00	1.07	**
Distance to nearest main road (km)	5.09	6.08	3.80	***
Cropped area (hectares)	0.92	0.93	0.92	

Significance based on t-test of unequal variance:
 * 10% significance ** 5% significance *** 1% significance

Descriptive Statistics: *(continued)*

	Full Sample	GMA	Non-GMA	
Value of consumer assets (Kw)	401,588	285,362	561,641	**
Value of productive assets (Kw)	618,036	256,729	1,115,584	***
Population density (per sq km)	35.20	41.41	26.97	***
Infrastructure	3.62	3.64	3.59	
Tourist lodge in SEA (=1)	0.07	0.10	0.02	***
GMA-1 classification (=1 if primary)	0.17	0.30	n.a.	
GMA-2 classification (=1 if secondary or specialized)	0.20	0.35	n.a.	

Significance based on t-test of unequal variance:
* 10% significance ** 5% significance *** 1% significance

Methods

Two stages of analysis

1. Ordinary least squares regression
 - Determinants of household income
2. Double-hurdle models (Cragg)
 - Probability and value of wage earnings
 - Probability and value of self employment
 - Probability and value of crop losses

Model 1: GMA Impact on Income

- ◆ Welfare measured as total household income
- ◆ OLS regression

$$\ln Y_i = \alpha + \beta X_i + \gamma G + \varepsilon_i$$

- ◆ Y_i = total income for household i
- ◆ X_i = vector of household and community characteristics (education, size of household, assets, infrastructure)
- ◆ $G = 1$ if household lives in a GMA

Model 1: OLS Regression

Impact on Household Income

Variable	Coeff (std error)	Sig.
Intercept	13.101 (0.12)	***
Age of household head (in years)	- 0.003 (0.00)	*
Sex of household head (=1 if male)	0.069 (0.06)	
Maximum education (in years)	0.043 (0.01)	***
Number of children (< 15 years)	0.019 (0.01)	
Number of female adults (15-60 years)	0.113 (0.03)	***
Number of male adults (15-60 years)	0.070 (0.03)	**
Distance to nearest main road (km)	- 0.005 (0.00)	***
Cropped area (hectares)	0.039 (0.02)	*
Log of consumer assets (Kw)	0.020 (0.00)	***
Log of productive assets (Kw)	0.010 (0.00)	***
Population density (per sq km)	0.001 (0.00)	***
Infrastructure	0.032 (0.01)	***
Tourist lodge in SEA (=1)	0.186 (0.10)	*
GMA-1 classification (=1 if prime GMA)	0.170 (0.08)	**
GMA-2 classification (=1 if secondary or specialized GMA)	0.022 (0.07)	

R-squared: 0.213 * 10% significance ** 5% significance *** 1% significance

Distribution of GMA Effect

- ◆ Stratified households by asset quintiles to investigate how GMA effect is distributed

Consumption assets	GMA-1	GMA-2
Lower 2 quintiles	0.033	-0.059
Lower 3 quintiles	0.031	0.040
Upper 2 quintiles	0.046**	-0.008

- ◆ Poorest 40% (and 60%) of the population are not significantly affected by GMAs
- ◆ Wealthiest 40% of the population are significantly and positively affected by GMAs
 - Income gains from living in a GMA are likely to be captured by non-poor segments of the population (better access to financial, human capital)

Impact on Household Income (continued)

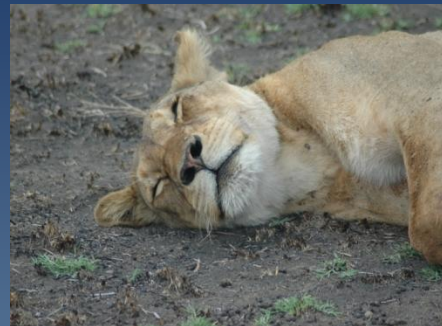
- ◆ Households in prime GMAs have 17% higher income than households in other rural areas, controlling for other factors
 - The presence of a tourist lodge in the SEA contributes another 18% of household income
- ◆ Gains from living in a prime GMA accrue to wealthiest 40% of the population

Model 2: Sources of Income

- ◆ What are the *sources* of income that generate the GMA effect?
- ◆ Zeros, OLS bias (corner solution)
- ◆ Double-hurdle regression to estimate
 1. the probability of earning income from wage employment
 2. the determinants of wage income
- ◆ Same approach for self-employment income (Cragg, 1971; Burke, 2009)

Cragg Double-Hurdle Model

- ◆ Impact of GMAs on probability and value of wage income
- ◆ Two-stage model
 1. $P(W_i=1|X_i) = \gamma X_i + \mu_i$
 2. $\ln Y_i = \alpha + \beta X_i + \varepsilon_i$
 - W = reported income from wage employment
 - X_i = vector of household and community characteristics
 - Y_i = value of wage earnings



Cragg: Impact on Wage Earnings

	Probit		CAPE		UAPE	
Age of household head	-0.000		-0.017		-0.009	
Sex of household head	0.023	**	-3.109	*	0.234	
Maximum education (years)	0.015	***	0.166		0.331	***
Number of children	-0.001		-0.300		-0.043	
Number of female adults	0.000		0.162		0.175	
Number of male adults	0.001		2.452	**	0.259	*
Cropped area (hectares)	-0.005		-0.085		-0.101	
Log of consumer assets	0.002	***	0.021		0.037	***
Log of productive assets	-0.001	***	-0.002		0.035	***
Distance to nearest main road (km)	-0.001	**	-0.016		-0.018	
Population density	0.003	***	0.000		0.004	***
Infrastructure	0.003	*	-0.203		0.038	
Tourist lodge in SEA (=1)	0.066	***	0.703		1.031	***
Prime GMA (=1)	0.078	***	-0.088		1.160	***
Secondary GMA (=1)	0.074	***	1.025		1.245	***

Log-likelihood: -527.9 * 10% significance ** 5% significance *** 1% significance

Impact on Wage Earnings

- ◆ Households in prime GMAs are 7.8% more likely to be employed
 - Households in secondary or specialized GMAs are 7.4% more likely to report wage income
 - Households in communities where there is a tourist lodge are 6.6% more likely
- ◆ Households in prime GMAs can be expected to earn 116% more on average from wage employment

Impact on Self-Employment

- ◆ Households in prime GMAs are 6.9% more likely to report income from self employment
 - Effect is less than for wage income
 - Household size (number of children and adults) and infrastructure also contribute to self-employment income



Losses from Crop Damage

- ◆ Impact of GMA and household characteristics on crop damage
- ◆ Two-stage model
 1. $P(CD_i=1|X_i) = \gamma X_i + \mu_i$
 2. $\ln Y_i = \alpha + \beta X_i + \varepsilon_i$
 - CD = crop damage variable
 - X_i = vector of household and community characteristics (education, size of household, assets, infrastructure)
 - Y_i = value of crop losses



Variable Means – Crop Damage

	Full Sample	GMA	Non-GMA	
Number of sample households	2,717	1,574	1,143	
% of households that reported crop damage	13.6	16.5	9.6	***
Value of crop damage (Kw)	28,423	30,079	26,140	
Age of household head (in years)	42.46	41.00	44.48	***
Sex of household head (=1 if male)	0.74	0.73	0.76	**
Distance to nearest main road (km)	5.09	6.08	3.80	***
Cropped area (hectares)	0.92	0.93	0.92	
Population density (sq km)	35.20	41.41	26.97	***
Number of scouts	1.00	1.56	0.24	**

Cragg: Impact on Crop Damage

	Probit		CAPE		UAPE	
Age of household head	-0.000		0.002		-0.001	
Sex of household head	-0.006		0.032		-0.046	
Household size (#)	-0.006	**	-0.003		-0.076	**
Distance to nearest road (km)	0.001	**	-0.002		0.009	*
Cropped area (hectares)	0.010	**	-0.051	*	0.077	
Consumption assets (Kw)	-0.000		-0.000		-0.005	
Production durable assets (Kw)	-0.001	*	-0.002		-0.010	**
Population density	-0.000		-0.000		-0.000	
Infrastructure	-0.001		-0.002		-0.013	
Number of scouts (#)	0.004		0.006		0.053	*
Value of harvest	0.006	***	0.024	***	0.102	***
Prime GMA (=1)	0.161	***	0.010		1.486	***
Secondary GMA (=1)	0.122	***	0.022		1.238	***

Log-likelihood: -1513.7 * 10% significance ** 5% significance *** 1% significance

Crop Damage: *(continued)*

- ◆ GMA households more likely to have crop damage
- ◆ Distance to main road - positively associated with crop damage
- ◆ Prime GMAs - positively associated with crop damage
 - Lesser extent with secondary and specialized GMAs



Conclusions

- ◆ How do tourism and wildlife conservation affect household income?
 - Tourist lodges and prime GMAs are positively associated with household income, wage employment
 - Gains accrue primarily to non-poor households
- ◆ How do GMAs affect household welfare in terms of crop damage?
 - Prime GMAs are positively associated with both probability and value of crop damage losses
 - Broader role for village scouts to curb crop damage
 - Mechanism for compensating farmers for losses?

For More Information...

- ◆ Food Security Research Project – Zambia
- ◆ <http://www.aec.msu.edu/fs2/zambia>
- ◆ Natural Resource Management, Pro-Poor Tourism, Food Security and Rural Development: Resource Materials
- ◆ <http://www.aec.msu.edu/fs2/zambia/resources/index.htm>

Thank You!

