Recreational Value of Two Peri-urban forests in Mexico City

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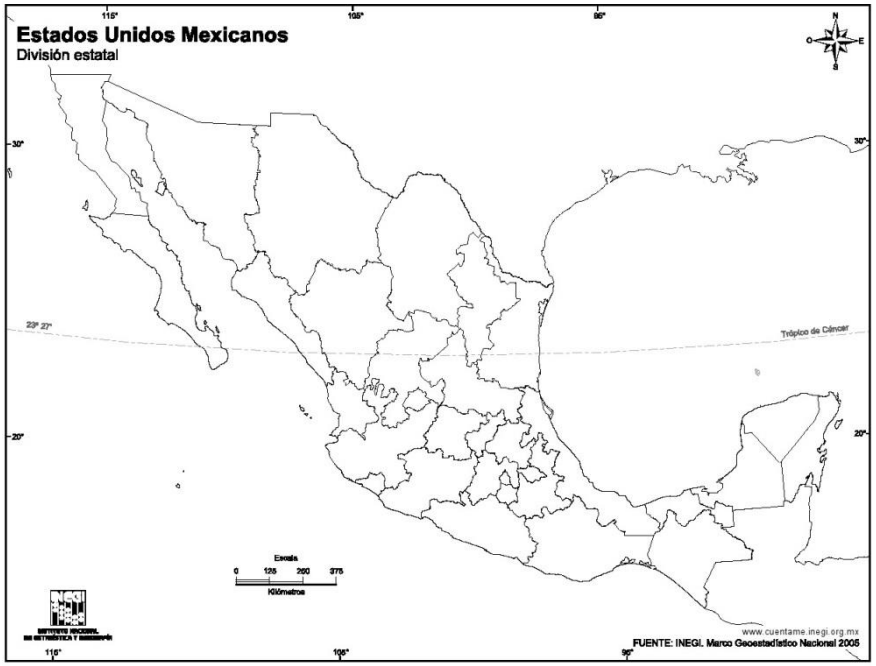
Motivation

- Peri-urban forests provide valuable ecosystemic services, but they are under great land development pressure in middle-income countries
- They provide unique recreational services, associated to quality of life, but they are often overlooked relative to other services

Contribution

- Method: estimates take into account the visitors heterogeneity, using Latent Class Count Models.
- Application to middle-income country
- The estimates provide inputs for Payment for Environmental Services design

Location


Estados Unidos Mexicanos
División estatal
Trópico de Cáncer
Escala
0 125 250 375
Kilómetros
www.cuentame.inegi.org.mx
FUENTE: INEGI. Marco Geoestadístico Nacional 2005

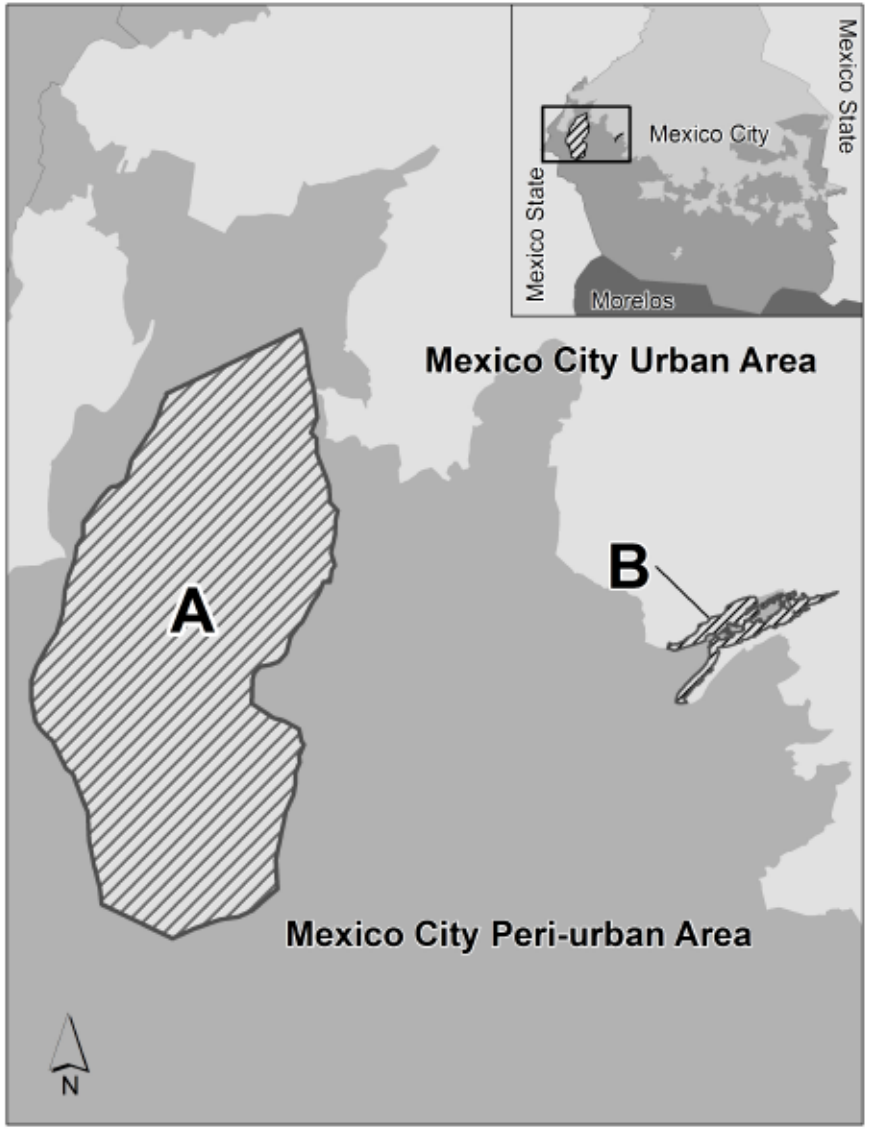

Mexico State
Mexico City
Mexico State
Morelos
Mexico City Urban Area
A
B
Mexico City Peri-urban Area
N

Table 1: Descriptive statistics of variables included in empirical specifications, Desierto de los Leones Natural Park (n=336)

	Mean	Std Dev	Min	Max
Trips in 2003	8.12	20.10	1.00	200.00
Individual Round Travel Cost[a]	38.35	47.59	1.43	298.57
Travel Cost to closest substitute[a,b]	65.75	75.18	1.50	350.36
Biker[c]	0.18	0.39	0.00	1.00
Accompanied by kids[c]	0.63	0.48	0.00	1.00
Gender[c]	0.36	0.48	0.00	1.00
Age in years	36.67	10.66	17.50	55.00
Monthly income[d]	11.71	9.73	0.15	33.00
Education in years	13.68	4.42	0.00	20.00

[a] Mexican pesos (MP); [b] 6 possible substitutes: Aragon, Chapultepec, Tlalpan, Cerro de la Estrella, Ajusco, and Tepeyac [c] 1 if the characteristic is observed (1 if female); [d] thousands of MP.

Table 2: Descriptive statistics of variables included in empirical specifications, Dinamos Natural Park (n=168)

	Mean	Std Dev	Min	Max
Trips in 2003	41.03	59.82	1.00	215.00
Individual Round Travel Cost[a]	40.43	50.03	0.85	276.36
Travel Cost to closest substitute[a,b]	58.75	65.18	0.10	305.36
Runner[c]	0.10	0.30	0.00	1.00
Accompanied by kids[c]	0.30	0.46	0.00	1.00
Gender[c]	0.50	0.50	0.00	1.00
Age in years	36.85	12.12	15.00	67.00
Monthly income[d]	5.99	5.45	1.20	32.50
Education in years	11.48	3.99	3.00	19.00

[a] Mexican pesos (MP); [b] 6 possible substitutes: Aragon, Chapultepec, Tlalpan, Cerro de la Estrella, Ajusco, and Tepeyac [c] 1 if the characteristic is observed (1 if female); [d] thousands of MP.

Table 3: On-site negative binomial specifications. Desierto de los Leones Natural Park (n=336). Dependent variable: trips in 2003.

	I		II		III		IV		V	
constant	-11.40	***	-2.62	***	-2.86	***	-2.96	***	-3.30	***
	(0.76)		(0.76)		(0.80)		(0.81)		(0.89)	
cost[a,b]	0.01		-0.02		-0.03		-0.01		-0.03	
	(0.01)		(0.03)		(0.03)		(0.02)		(0.03)	
substitute[a,b]	0.03		0.05		0.05		0.04		0.05	
	(0.08)		(0.06)		(0.06)		(0.05)		(0.05)	
biker			4.66	***	4.59	***	4.71	***	4.60	***
			(0.22)		(0.25)		(0.19)		(0.25)	
cost*biker			0.03		0.03				0.03	
			(0.04)		(0.04)				(0.04)	
kids					-0.05		-0.04		-0.02	
					(0.20)		(0.20)		(0.20)	
gender					0.07		0.08		0.10	
					(0.19)		(0.19)		(0.19)	
age[a]					0.07		0.07		0.09	
					(0.08)		(0.08)		(0.08)	
income[c]					0.01		0.01		0.00	
					(0.01)		(0.01)		(0.01)	
education									0.03	
									(0.02)	
α[d]	604251	***	3.61		3.28		3.38		3.26	
LL[e]	-1017.76		-485.43		-484.02		-484.31		-483.18	
-2ln(Lr/Lu)	0.86		1065.51		1068.33		1067.75		1070.01	

Standard errors in parentheses. * p-value<0.10; ** p-value<0.05;
*** p-value<0.01. [a] Scaled by 10. [b] One-tail test. [c] Scaled by 1000.
[d] Overdispersion parameter. [e] Loglikelihood.

Table 4: On-site negative binomial specifications. Dinamos Natural Park (n=168). Dependent variable: trips in 2006.

	I		II		III		IV		V	
constant	-7.88	***	-7.41	***	-5.19	***	-5.68	***	-3.94	**
	(0.38)		(0.31)		(1.55)		(1.28)		(1.87)	
cost[a,b]	-0.21	***	-0.23	***	-0.21	***	-0.19	***	-0.20	***
	(0.02)		(0.02)		(0.02)		(0.02)		(0.02)	
substitute[a,b]	0.13		0.12		0.12		0.11		0.11	
	(0.09)		(0.08)		(0.08)		(0.08)		(0.08)	
runner			0.79	***	0.92	***	1.18	***	0.90	***
			(0.29)		(0.30)		(0.27)		(0.30)	
cost*runner			0.09	**	0.08	*			0.07	
			(0.05)		(0.05)				(0.05)	
kids					-0.56	***	-0.55	***	-0.51	***
					(0.19)		(0.19)		(0.20)	
gender					0.69	***	0.68	***	0.70	***
					(0.17)		(0.17)		(0.17)	
age[a]					-0.08		-0.08		-0.08	
					(0.07)		(0.07)		(0.07)	
income[c]					-0.05	***	-0.05	***	-0.04	***
					(0.02)		(0.01)		(0.02)	
education									-0.04	*
									(0.02)	
α[d]	163057	***	91310	***	12005		19496		4910	
LL[e]	-730.34		-717.52		-700.89		-702.45		-699.23	
-2ln(Lr/Lu)	181.42		181.42		181.42		181.42		181.42	

Standard errors in parentheses. * p-value<0.10; ** p-value<0.05; *** p-value<0.01. [a] Scaled by 10. [b] One-tail test. [c] Scaled by 1000. [d] Overdispersion parameter. [e] Loglikelihood.

Table 6: Two-classes on-site specification. Class 1 described by a negative binomial. Class 2 described by a Poisson. Desierto de los Leones Natural Park (n=336). Dependent variable: trips in 2003.[a]

	Mean[b]	Class 1		Mean[b]	Class 2	
constant		-2.10	***		-3.79	***
		(0.46)			(0.45)	
cost[c,d]	38.35	-0.04	**	38.43	-0.09	***
	(47.94)	(0.02)		(44.04)	(0.02)	
substitute [c,d]	66.78	0.03		65.15	0.01	
	(76.10)	(0.02)		(73.21)	(0.01)	
biker	0.14	4.89	***	0.69	5.15	***
	(0.35)	(0.20)		(0.47)	(0.37)	
gender	0.36	-0.77	***	0.35	3.15	***
	(0.48)	(0.20)		(0.49)	(0.34)	
age[c]	36.51	0.06		38.65	0.37	***
	(10.67)	(0.08)		(10.52)	(0.07)	
income[e]	11.40	0.01		15.38	0.02	***
	(9.37)	(0.01)		(12.93)	(0.01)	
trips	7.47			15.88		
	(20.05)			(19.44)		
α_c[f]		1.10	**		NA	
LL[g]		-366.54			-67.85	
π_c[h]		0.82			0.18	
Members[i]		310			26	

Standard errors in parentheses. * p-value<0.10; ** p-value<0.05; *** p-value<0.01. [a] Specification controls for *kids*. [b] Average value including only the members of the class. Standard deviation in parentheses. [c] Scaled by 10. [d] One-tail test. [e] Scaled by 1000. [f] Overdispersion parameter for each class. [g] Loglikelihood. [h] Subpopulation proportions. [i] Individuals assigned to class they most probably belong to, according to $\pi_{c,i}$ (see section 2).

Table 7: Three-classes on-site specification. Classes 1 an 2 described by a negative binomial. Class 3 described by a Poisson. Dinamos Natural Park (n=168). Dependent variable: trips in 2006.

	Mean[a]	Class 1		Mean[a]	Class 2		Mean[a]	Class 3	
constant		5.34	***		4.15	***		1.05	**
		(0.27)			(0.43)			(0.41)	
cost[b,c]	34.99	-0.16	***	36.61	-0.46	***	51.70	0.05	
	(60.48)	(0.02)		(41.15)	(0.05)		(56.91)	(0.02)	
substitute[b,c]	55.45	0.12		57.68	0.06		48.04	0.01	
	(63.48)	(0.10)		(65.15)	(0.02)		(80.91)	(0.02)	
runner	0.22	0.43	**	0.07	1.69	***	0.09	1.44	***
	(0.42)	(0.18)		(0.25)	(0.37)		(0.28)	(0.28)	
kids	0.44	-1.73	***	0.27	-0.03		0.28	-0.85	***
	(0.50)	(0.19)		(0.44)	(0.23)		(0.46)	(0.22)	
gender	0.50	-0.00		0.46	0.62	***	0.59	1.07	***
	(0.51)	(0.15)		(0.50)	(0.21)		(0.50)	(0.23)	
age[b]	36.41	-0.16	***	38.31	-0.02		34.30	-0.65	***
	(12.30)	(0.06)		(12.01)	(0.08)		(12.02)	(0.11)	
income[d]	6.06	0.02		5.36	-0.33	***	7.13	0.13	***
	(4.49)	(0.02)		(5.17)	(0.04)		(6.42)	(0.01)	
trips	84.19			44.12			4.96		
	(67.65)			(61.10)			(8.37)		
α_c[e]		0.20	***		1.19	**		NA	
LL[f]		-173.86			-268.60			-74.94	
π_c[g]		0.23			0.48			0.29	
Members[h]		32			90			46	

Standard errors in parentheses. * p-value<0.10; ** p-value<0.05; *** p-value<0.01. [a] Average value including only the members of the class. Standard deviation in parentheses. [b] Scaled by 10. [c] One-tail test. [d] Scaled by 1000. [e] Overdispersion parameter for each class. [f] Loglikelihood. [g] Subpopulation proportions. [h] Individuals assigned to class they most probably belong to, according to $\pi_{c,i}$ (see section 2).

Table 8: Comparison of Consumer surplus per trip (dollars[a])

	Model			
	Negative binomial	Latent Class[b]		
		Class 1	Class 2	Average[c]
Desierto	NA	33.3	11.8	29.5
	NA	(11.5-144.2)	(7.8-19.5)	(11.2-120.6)
Dinamos	5.3[d]	6.3	2.2	2.5
	(4.4-6.8)	(5.1-8.2)	(1.8-2.8)	(2.1-3.0)

Bootstrapped 95% confidence interval in parenthese (1000 replications).
[a] Exchange rate: 10 mexican pesos/dollar. [b] Estimates for class 3 in Dinamos are not reported because cost parameter is not different from zero (one-tail test). [c] Weighted sum of consumer surplus across classes. Weights are the subpopulation proportions. [d] Based on specification (IV) in table 4.

Policy implications

- The value for recreation justifies federal spending in effective conservation programs.
- Since 2004, the federal government implemented a Payment for Ecosystemic Services (PES) program, paying 30 USD per hectare at the time of the study.
- A single trip by one person to Desierto de Los Leones justifies the federal payment for one hectare, and only on the basis of the service of recreation.
- If the PES is effective, there are basis to expand the program to other areas.
- If the policy goal is to internalize the positive externality: entry-fees, voluntary PES