

The Katoomba group
**CONFERENCIA INTERNACIONAL SOBRE
PAGAMENTO POR SERVICIOS AMBIENTALES**

Fundacao Getulio Vargas
Sao Paulo, Brasil
Outubro 2006

**The macrometrics of environmental services
payment in Costa Rica**

A FUNDECOR study commissioned by FONAFIFO
(Consultants: Franz Tattenbach, German Obando and Johnny Rodriguez)

Franz Tattenbach
Executive Director FUNDECOR
Costa Rica

WHAT IS FUNDECOR?

A private, non-for-profit NGO that believes conservation and development complement each other and should coexist in harmony.

Created by the Costa Rican Government under the auspices of U.S. AID to "promote the conservation and sustainable use of the natural resources of the Central Volcanic Mountain Range using market mechanisms, scientific knowledge and cutting edge technology to improve Costa Rica's conservation public policy."

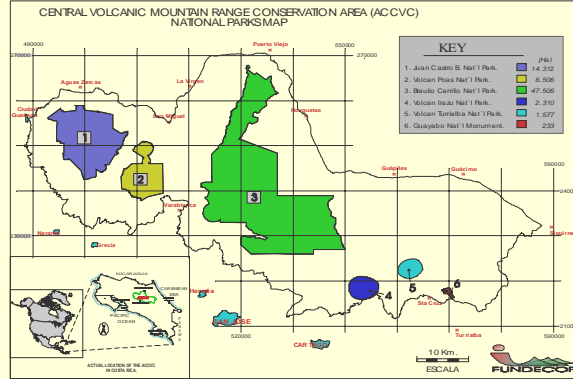
WHERE IS THE CVR (ACCVC in Spanish)?



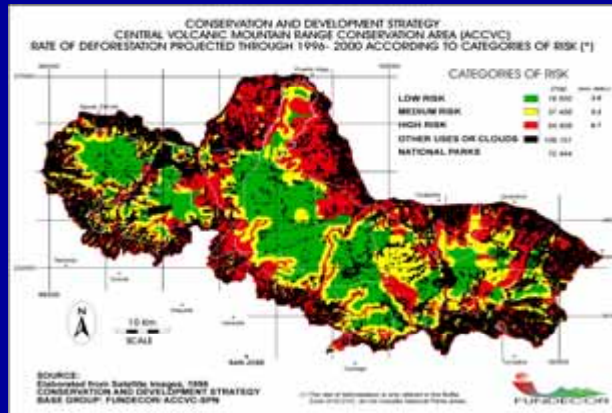
WE STARTED WITH A DIAGNOSTIC: OUR AREA WAS FACING ONE OF WORLD HIGHEST DEFORESTATION RATES



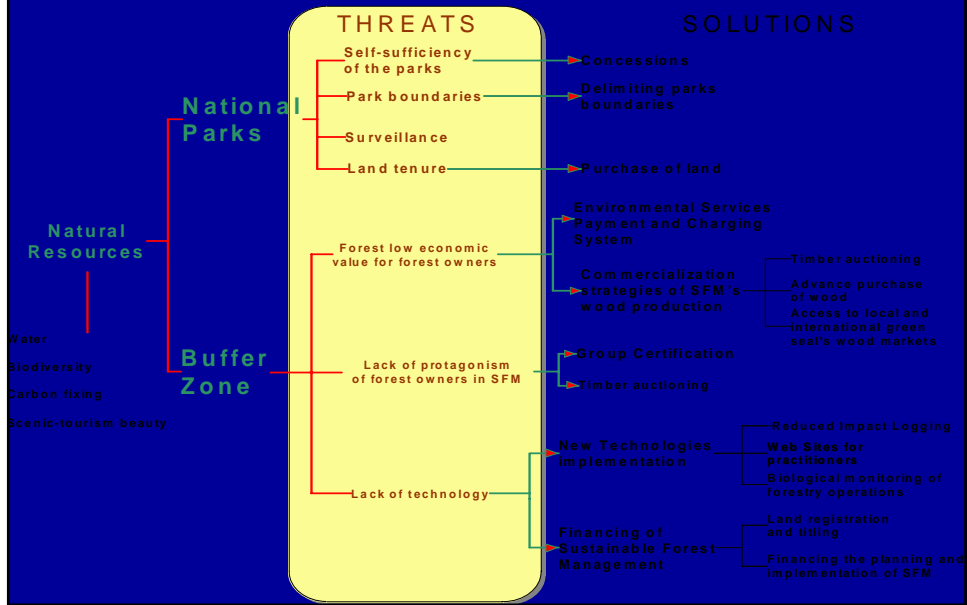
NATL. PARKS & BIOLOGICAL RESERVES WERE PART OF THE ANSWER



BUT PARKS' BUFFER ZONES WERE ECO-IMPORTANT, POPULATED AND DEFORESTING FAST!



AN INTEGRATED RESPONSE TO PUBLIC LANDS AND PRIVATE LANDS ISSUES WAS THE ANSWER

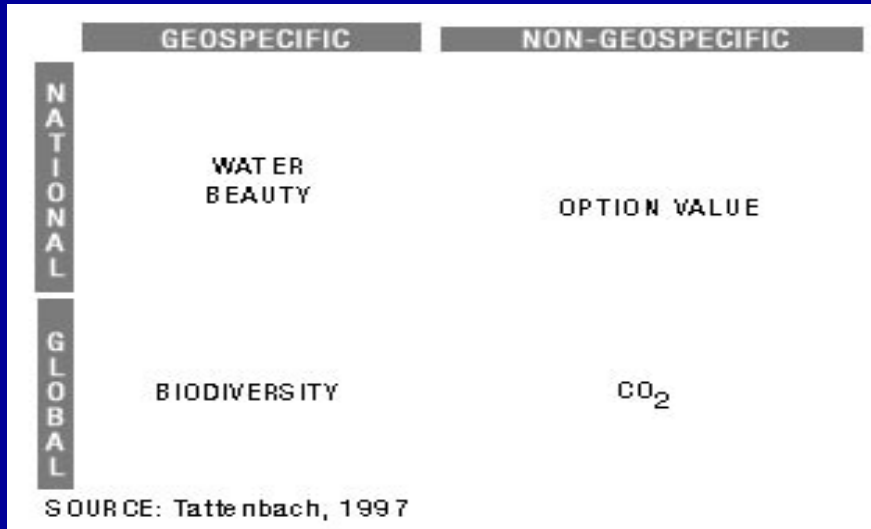


If conserving forest is a good bussiness for the world, it should also be so for countries & people who care for them!

TYPES OF PRODUCTS AND SERVICES	BENEFICIARY		
	WORLD	COUNTRY	OWNER
WOOD			✓
WATER		✓	
SCENIC BEAUTY		✓	
BIODIVERSITY	✓		
CO ₂	✓		

Source: Tattenbach, Franz, Practical Examples of Activities Implemented Jointly in Costa Rica, (1997) in J. Hacker & A. Pelchen, Goals and Economic Instruments for the Achievement of Global Warming Mitigation in Europe (Lüwer Academic Publishers, 1999).

THE PRIVATE & PUBLIC LOGIC HAS TO BE RECOGNIZE
TO CREATE AN ENVIRONMENTAL SERVICES MARKET

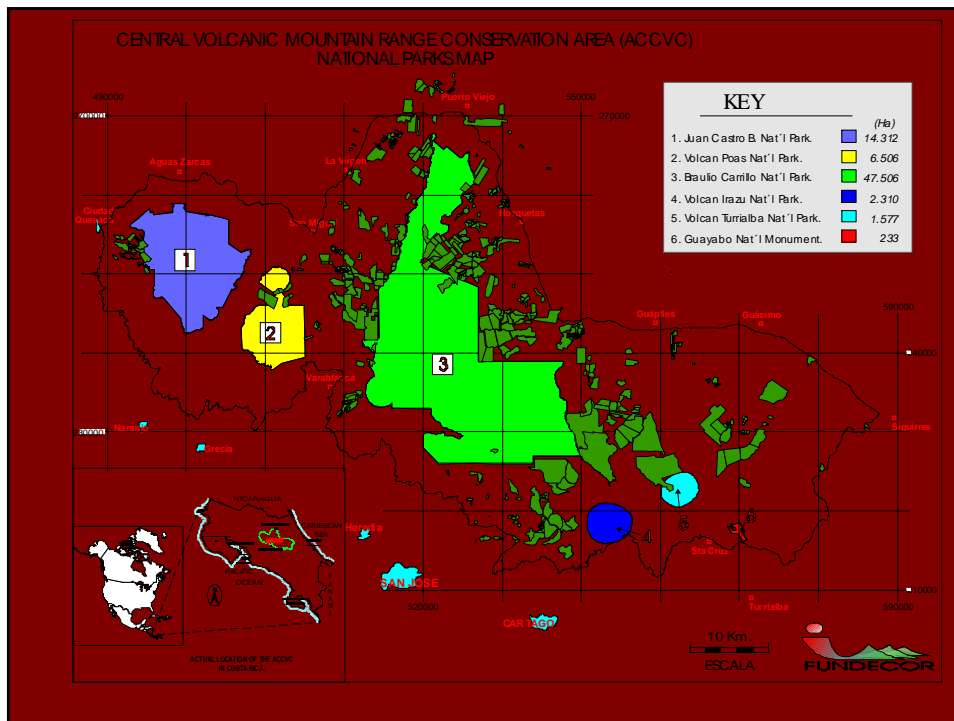
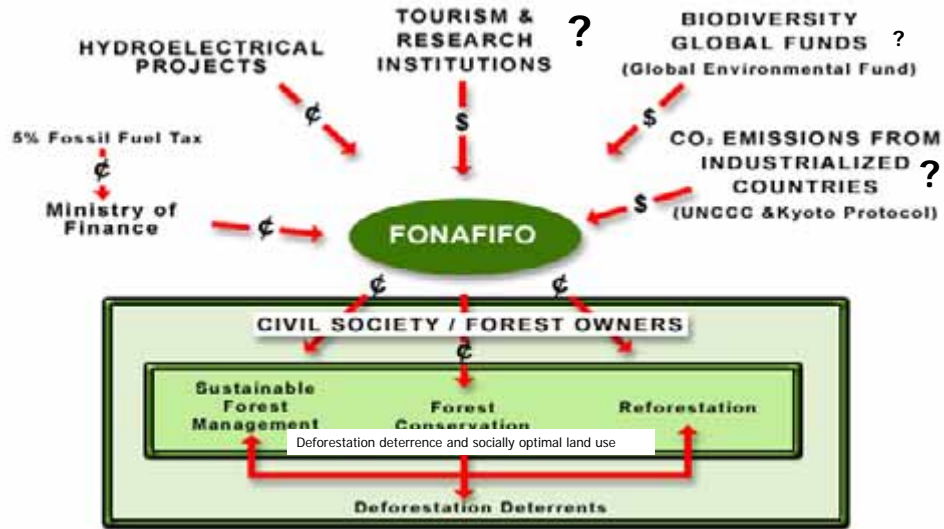


President Clinton in CVR's Braulio Carrillo National Park



A MARKET OF ENVIRONMENTAL SERVICES EMERGES

PUBLIC WATER UTILITIES
BEVERAGE & BREWERIES CO.



EMERGING ESP MARKET IN FUNDECOR's CVR AREA



A DEFINITION OF FOREST ENVIRONMENTAL SERVICES

An environmental benefit (or cost) produced by the existence (or disappearance) of forest not captured by owner, but by others

The public and private logic of Costa Rica's environmental service payment program

If we allow for the following terminology:

P payment for environmental services,

C private opportunity cost (land rent of alternative uses) and

V total value of environmental services

we can define ESP feasibility range with the following 3 equations

$$P \geq C \quad \text{Private Logic} \quad (1)$$

$$V \geq P \quad \text{Public Logic} \quad (2)$$

$$V \geq P \geq C \quad \text{ESP feasibility range} \quad (3)$$

The public and private logic of Costa Rica's environmental service payment program

The total value of environmental services (V) can be disaggregated into values captured globally (V_g) and values captured by country (V_c). However, from a country's perspective, the global values are equal to the economic compensation (G) obtained for them.

$$V = V_g + V_c \quad \text{disaggregated total value} \quad (4)$$

$$V_g = G \quad \text{global values captured by country} \quad (5)$$

$$P \leq V_c + G \quad \text{country logic} \quad (6)$$

The public and private logic of Costa Rica's environmental service payment program

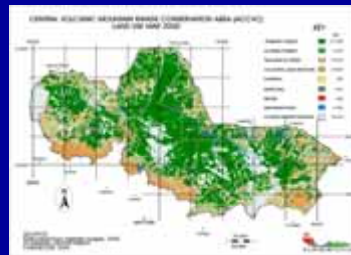
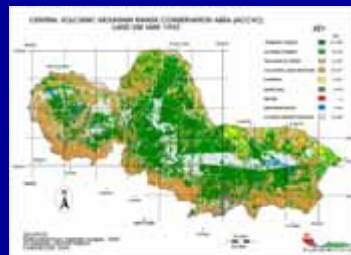
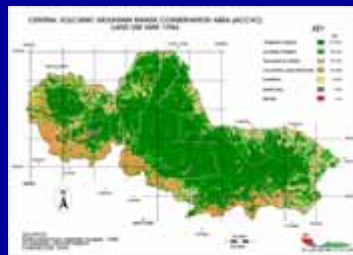
Country values can be disaggregated into nation wide values (V_n) and values that are geo-specific, and captured at the site, or regional level (V_r). From a ESP perspective, payment in region r (P_r) should not exceed nation wide values plus revealed values (willingness to pay) at site r (R) plus revealed global values (G)

$$V_c = V_n + V_r \quad \text{disaggregated country values} \quad (7)$$

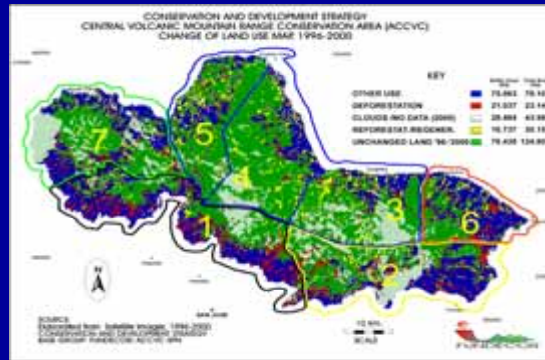
$$V_r = R \quad \text{Geo-specific values reveled} \quad (8)$$

$$P_r = V_n + R + G \quad \text{ESP program logic} \quad (9)$$

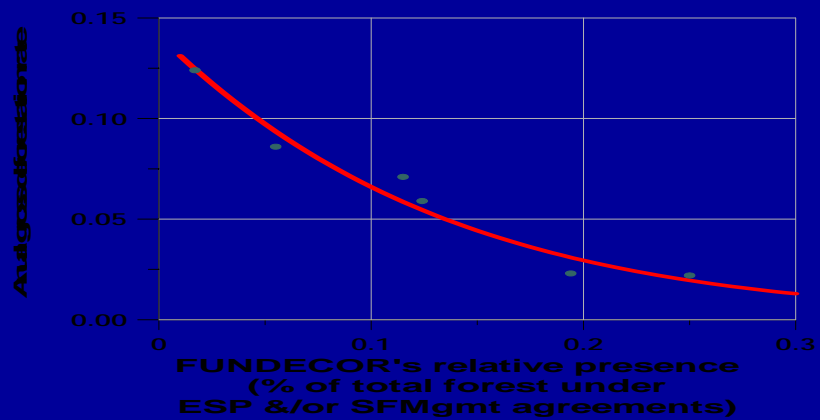
REDUCED DEFORESTATION IS OUR BOTTOM LINE



WE USE SATELITE IMAGES TO MEASURE RESULTS



AND STATISTICS TO KNOW IF WE CAUSE THEM



$$\ln\left(\frac{d_r^{t_0}}{1-d_r^{t_0}}\right) = a + bP_r$$

$$a = -1.80591; b = -8.44113$$

$$R^2 = 0.94 / t_a = -11.402 / t_b = -7.906$$

MODELO ECONOMETRICO

Deforestación: función de las ganancias por deforestar

Ganancias: función del valor del uso alternativo y el PSA

$$D_r = f(G_r) \quad (1)$$

$$d_r = f(g_r) \quad (2)$$

$$0 \leq d_r \leq 1$$

$$d_r = \frac{1}{1 + e^{-f(g_r)}} \quad (3)$$

$$g_r = (r_r^a - r_r^{spsa})(1 - P_r) + (r_r^a - r_r^{cpsa})P_r \quad (4)$$

$$g_r = r_r^a - kP_r \quad (5) \quad r_r^{cpsa} = k \quad r_r^{spsa} = 0 \quad r_r^a = \varphi C_r$$

$$g_r = \varphi C_r - kP_r \quad (6)$$

MODELO ECONOMETRICO

Deforestación como función lineal del valor alternativo de la tierra y la presencia media de PSA (“cross sectional data”)

$$f(g_r) = a + b(\varphi C_r - kP_r) \quad (7)$$

$$d_r = a + \alpha C_r - \beta P_r \quad (8) \quad \alpha = b\varphi \quad \beta = bk \quad \frac{\beta}{\alpha} k = \varphi$$

$$d_r = \frac{1}{1 + e^{-(a + \alpha C_r - \beta P_r)}} \quad (9)$$

$$\ln \left[\frac{d_r}{1 - d_r} \right] = a + \alpha C_r + \beta P_r + e_r \quad (10)$$

MODELO ECONOMETRICO

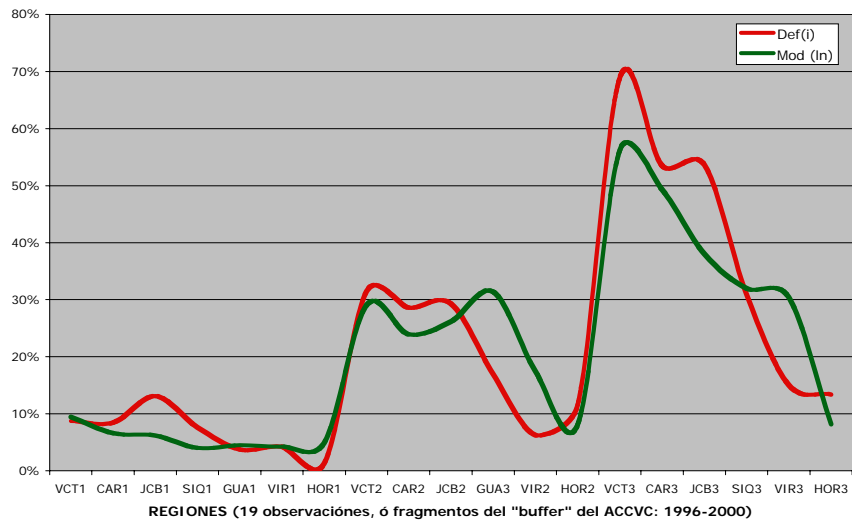
El modelo explica un 83% de la deforestación observada. El valor alterno y la presencia de PSA tiene la influencia esperada y ambos resultaron significativos a más del 98%

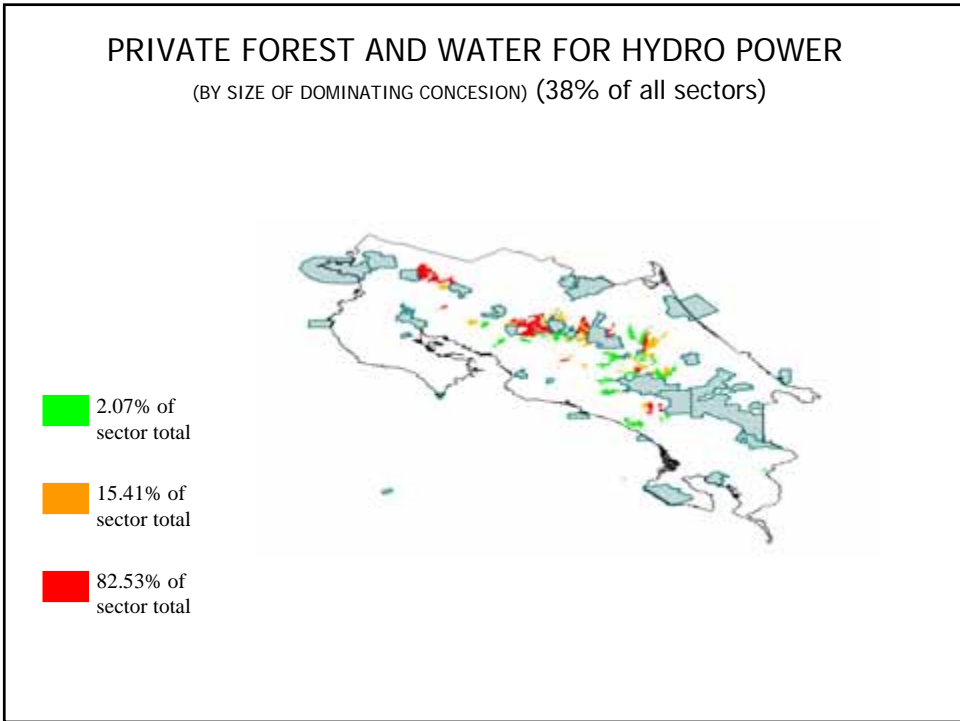
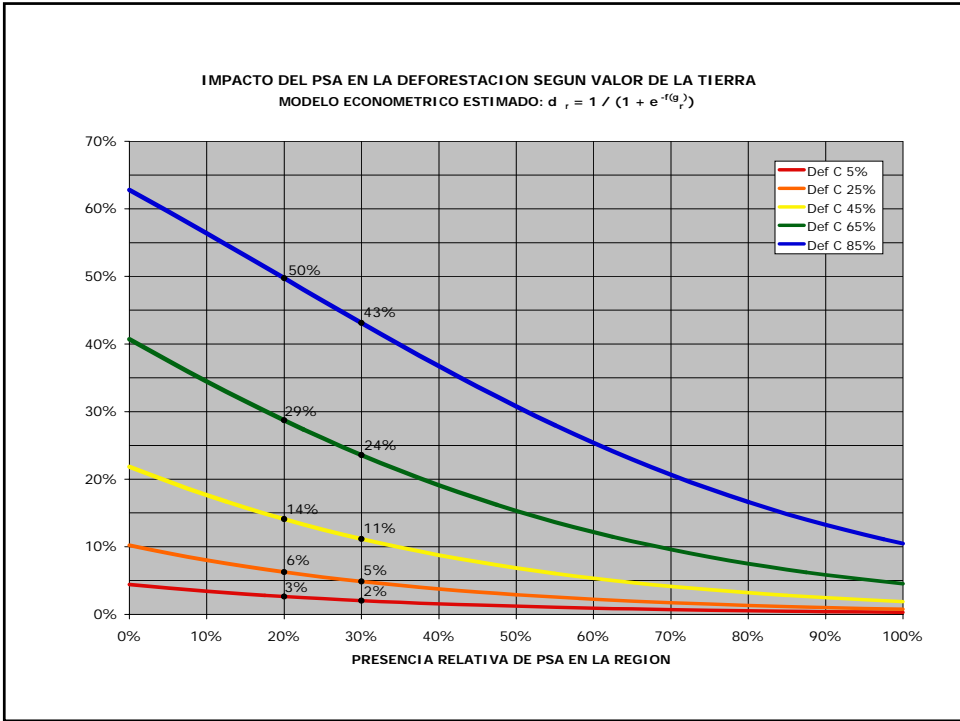
$$d_r = 0.6542 C_r - 0.5762 P_r \quad (10) \quad t_{\alpha,\beta} > 2.76, n = 19$$

$$d_r = \frac{1}{1 + e^{-(3.23 + 4.52C_r - 2.81P_r)}} \quad (11) \quad R^2 = 0.83$$

DEFORESTACION OBSERVADA VS DEFORESTACION ESTIMADA

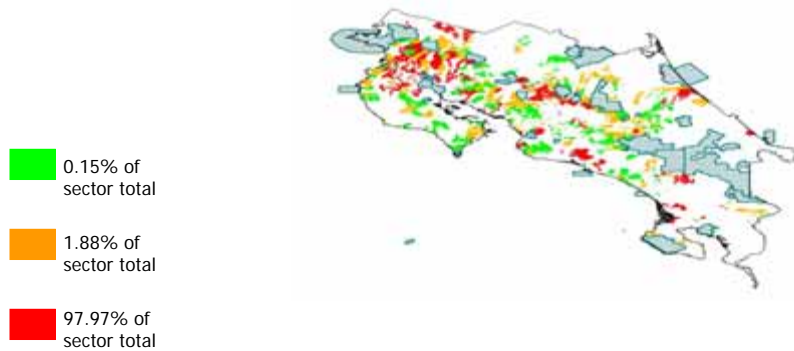
D = 0.65C - 0.58P (parámetros de c y p significativos al 98%) D = 1/1+e^(3.2 - 4.5C + 2.8P) R² = 83%





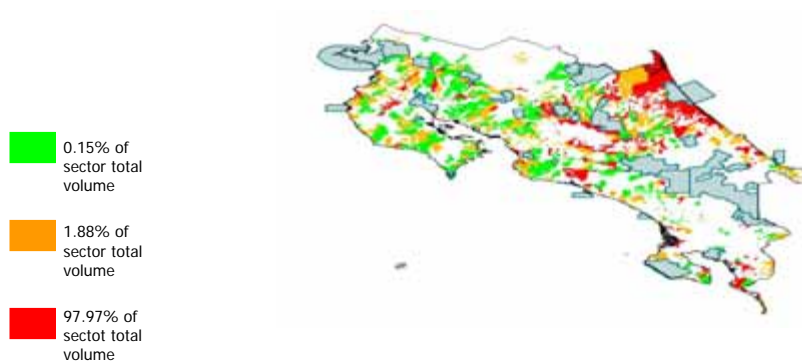
PRIVATE FOREST AND WATER FOR IRRIGATION

(BY SIZE OF DOMINATING CONCESSION) (12% of all sectors)

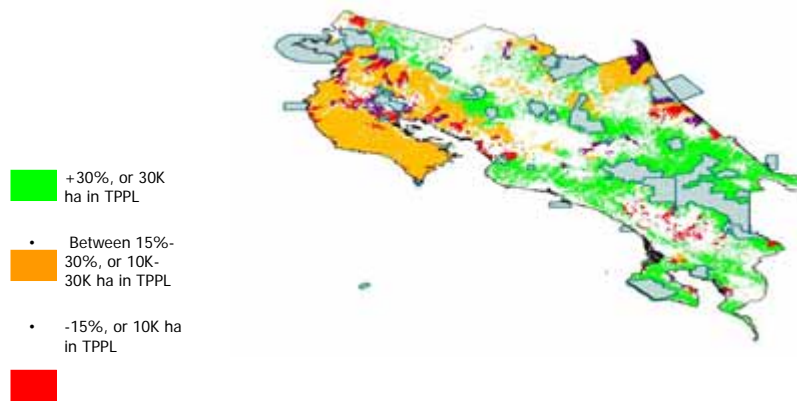


PRIVATE FOREST AND WATER FOR HUMAN USE

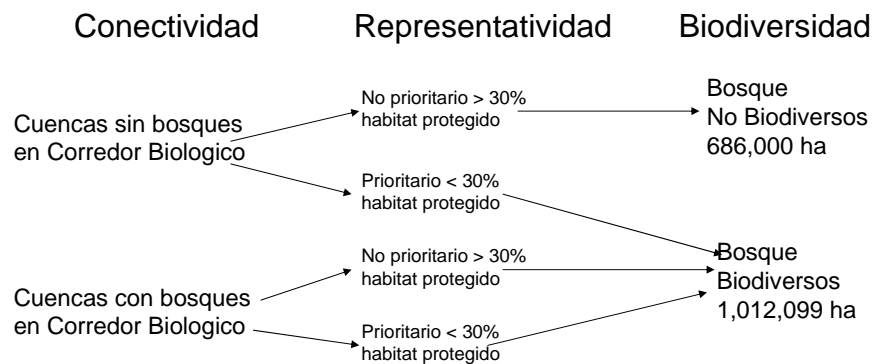
(BY SIZE OF DOMINATING CONCESSION) (0.8% of all sectors)



PRIVATE FOREST AND HABITAT PRESENCE IN TOTALLY PROTECTED PUBLIC LANDS (TPPL)



Metafragmentos Biodiversidad



Metafragmentos Calida de agua

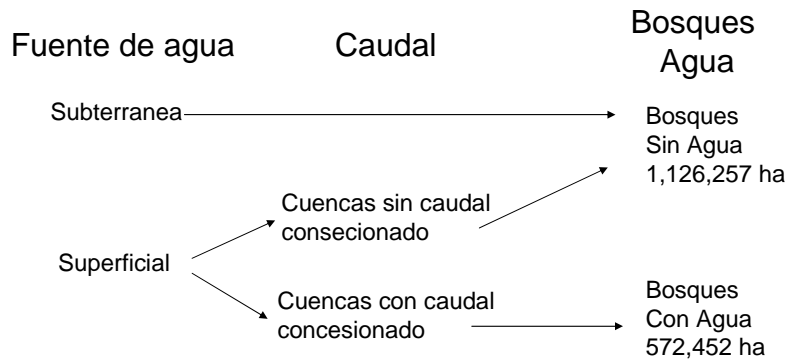


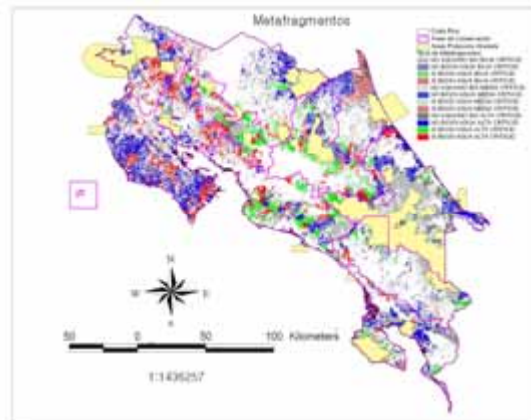
Table 6: Clasificación del bosque fuera de áreas de protección absoluta según servicio ambiental Agua y Biodiversidad.

Biodiversidad	Agua superficial		Total
	Sin caudal hidráulico ni para otros usos	Con caudal hidráulico y para otros usos	
Bosques fuera de corredores biológicos mejor representados en el sistema nacional de áreas protegidas	487,281 ^a	199,329 ^b	686,609
Bosques dentro de corredores biológicos mediana o pobremente representados en el sistema	638,976 ^c	373,123 ^d	1,012,099
Total	1,126,257	572,452	1,698,709

Tabla 7: Distribución del bosque fuera áreas de protección absoluta en 1999 según sus valores públicos y privados

Valor público: SA	Valor privado de la tierra, o grado de amenaza de deforestación			
	Bajo	Medio	Alto	TOTAL
Solo Carbono	159,510	127,909	199,862	487,281
Solo Biodiversidad	43,490	129,631	465,855	638,976
Solo Agua	12,188	32,393	154,748	199,329
Agua y Biodiversidad	56,402	55,652	261,070	373,123
TOTAL	271,590	345,584	1,081,535	1,698,709

Metafragmentos



Cuadro No. 7: Servicios Ambientales por tipo de bosque (uni

Tipo de bosque y servicio ambiental	Valor privado, o amenaza de deforestación		
	Bajo	Medio	Alto
<u>Bosques "solo carbono"</u>			
Carbono (TMC/ha)	100	100	100
<u>Bosques de "Biodiversidad"</u>			
Carbono (TMC/ha)	100	100	100
Biodiver. (ha)	1	1	1
<u>Bosques de "agua"</u>			
Carbono (TMC/ha)	100	100	100
Agua sup. no hidro (m3/a)	55	814	889
Agua sup. hidro (m3/a)	34,963	36,661	23,366
<u>Bosques de "agua y biod."</u>			
Carbono (TMC/ha)	100	100	100
Biodiver. (ha)	1	1	1
Agua sup. no hidro (m3/a)	151	948	3,324
Agua sup. hidro (m3/a)	1,236	11,513	20,028

BOSQUE 1999 Y 2005 SEGUN ESENAIO DE PSA (ha)						
	LINEA BASE		2005 CON PSA:			
	1999	2005 s/psa	n&d 99-05	99-05, igual p	n 99, d 99	n 99-05, d 99
	159.510	153.949	155.830	157.098	155.220	155.978
	43.490	41.395	42.553	42.380	42.190	42.626
	12.188	11.550	11.893	11.837	11.698	11.784
	56.402	55.232	56.045	56.168	55.808	56.254
	127.909	104.081	106.868	110.362	105.879	106.993
b' =	129.631	111.053	117.386	116.443	115.155	117.487
	32.393	27.192	29.151	28.639	28.197	28.777
	55.652	45.698	50.732	48.358	47.346	48.316
	199.862	116.059	133.608	131.224	126.952	133.889
	465.855	238.847	280.395	275.599	262.620	277.689
	154.748	82.241	94.099	94.358	88.716	92.820
	261.070	127.427	144.191	148.150	142.222	151.645

**SERVICIOS AMBIENTALES ASOCIADOS A DIFERENTES
“VECTORES” DE BOSQUE SEGUN ESENAIO DE
PSA de CONSERVACION DE BOSQUES (unidades absolutas)**

	1999	2005 s/psa	n&d 99-05	99-05, igual p	n 99, d 99	n 99-05, d 99
	169.870.886	111.472.328	122.265.090	122.060.752	118.208.249	122.405.853
Ub' =	1.012.099	619.651	691.302	687.098	665.421	694.016
	1.093.648.339	571.093.756	643.867.429	654.603.681	628.516.370	664.936.955
	11.168.689.277	6.468.875.372	7.224.467.934	7.261.895.073	6.978.265.430	7.298.810.295
	Max ideal	n&d 99-05	n 99-05, igual p	n 99, d 99	n 99-05, d 99	Efecto-EcoMerc
Carbon	58.398.559	10.792.762	10.588.424	6.735.921	10.933.525	(140.763)
Biodiversity	392.449	71.652	67.447	45.771	74.366	(2.714)
Agua human.	522.554.583	72.773.673	83.509.924	57.422.614	93.843.199	(21.069.526)
Agua hidroel.	4.699.813.905	755.592.563	793.019.701	509.390.059	829.934.923	(74.342.360)

**PRODUCCION DE SERVICIOS AMBIENTALES: 1999-2005
PSA de CONSERVACION DE BOSQUES (en unidades absolutas)**

Cuadro No. 8: PRODUCCION DE SERVICIOS AMBIENTALES DEL PROGRAMA DE PSA DE 1999 A 2005

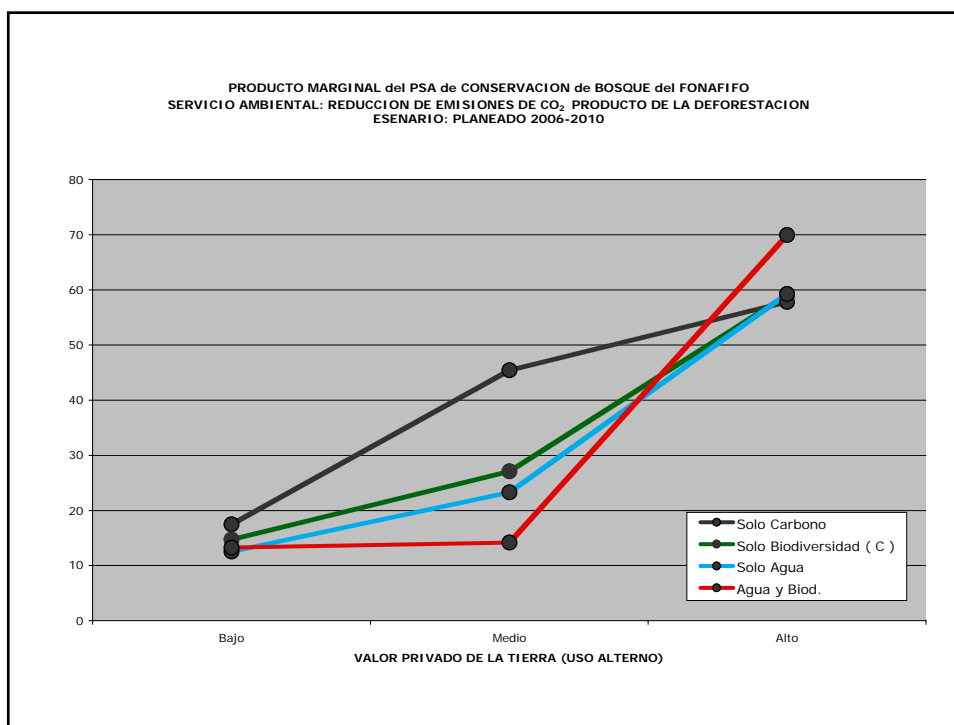
	En bosque-99 (max servicio)	En bosque-05 sin PSA (min servicio)	En bosque-05 con PSA 99-05 (servicio proyect)	Producción de Serv. Ambiental Prog. PSA-99-05
Servicio Ambiental:				
Carbono (tm)	169.870.886	111.472.328	122.265.090	10.792.762
Biodiversidad (ha)	1.012.099	619.651	691.302	71.652
Agua uso humano (m3/año)	1.093.648.339	571.093.756	643.867.429	72.773.673
Agua para hidroeléctricas (m3/año)	11.168.689.277	6.468.875.372	7.224.467.934	755.592.563

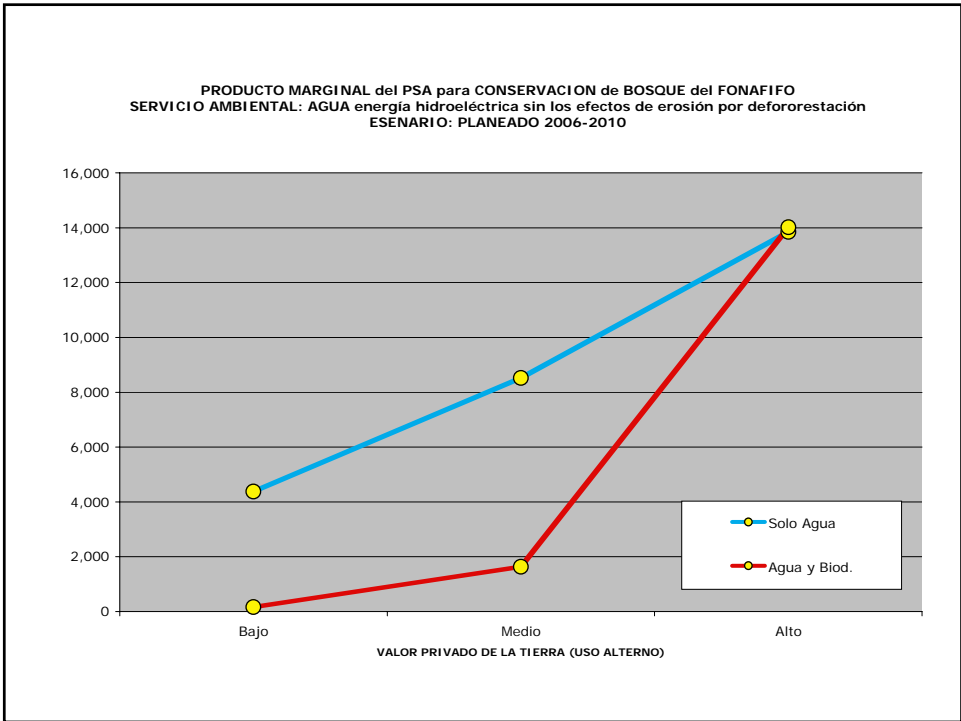
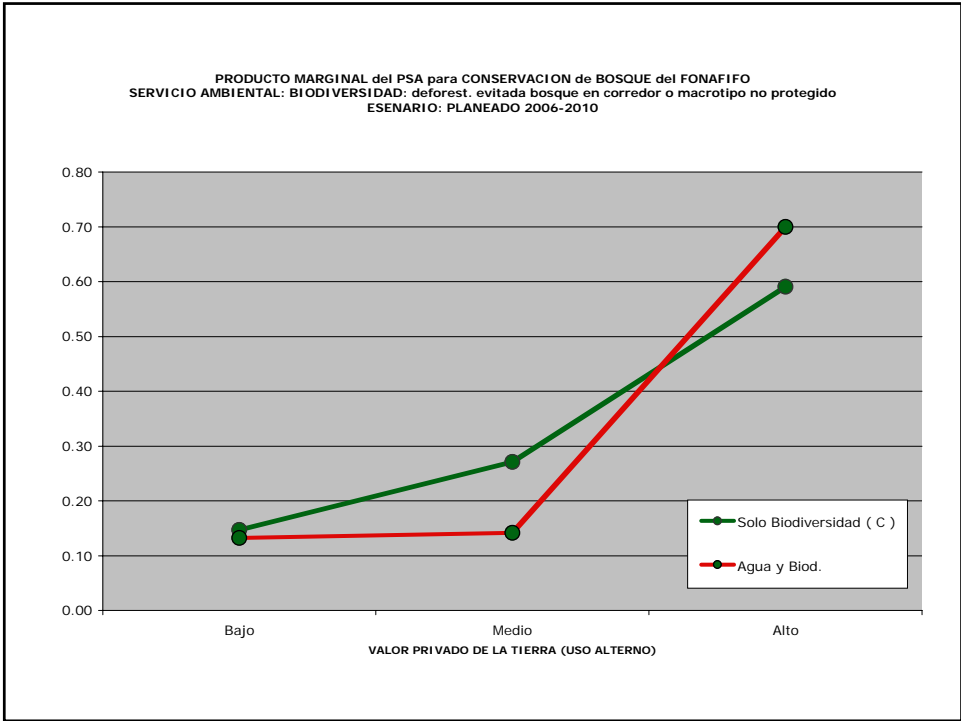
PRODUCCION DE SERVICIOS AMBIENTALES: 1999-2005
PSA de CONSERVACION DE BOSQUES (% del máximo ideal)

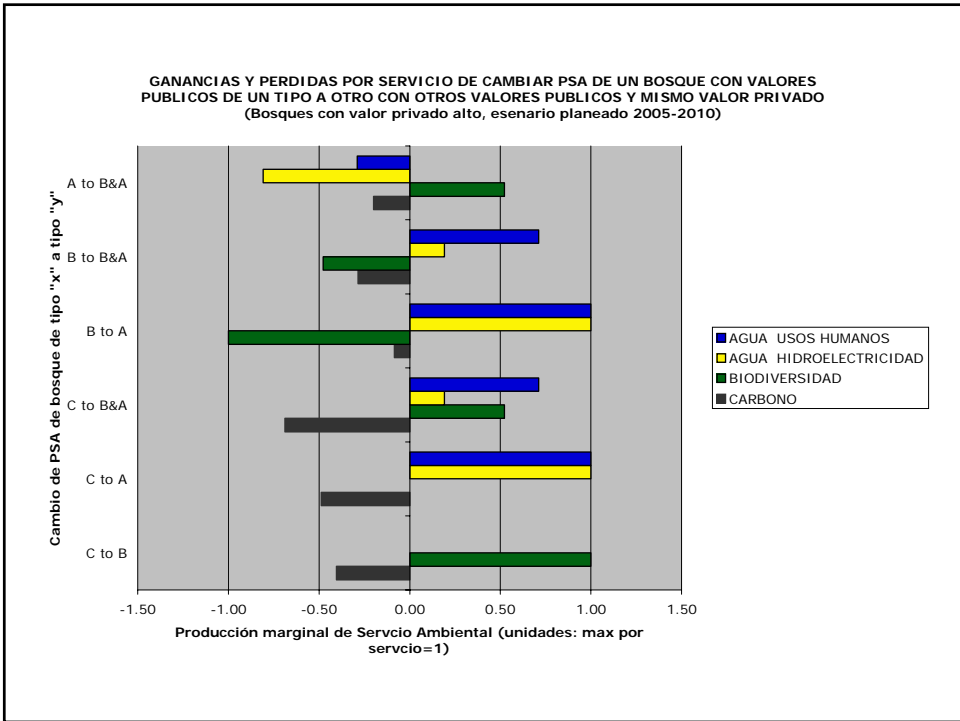
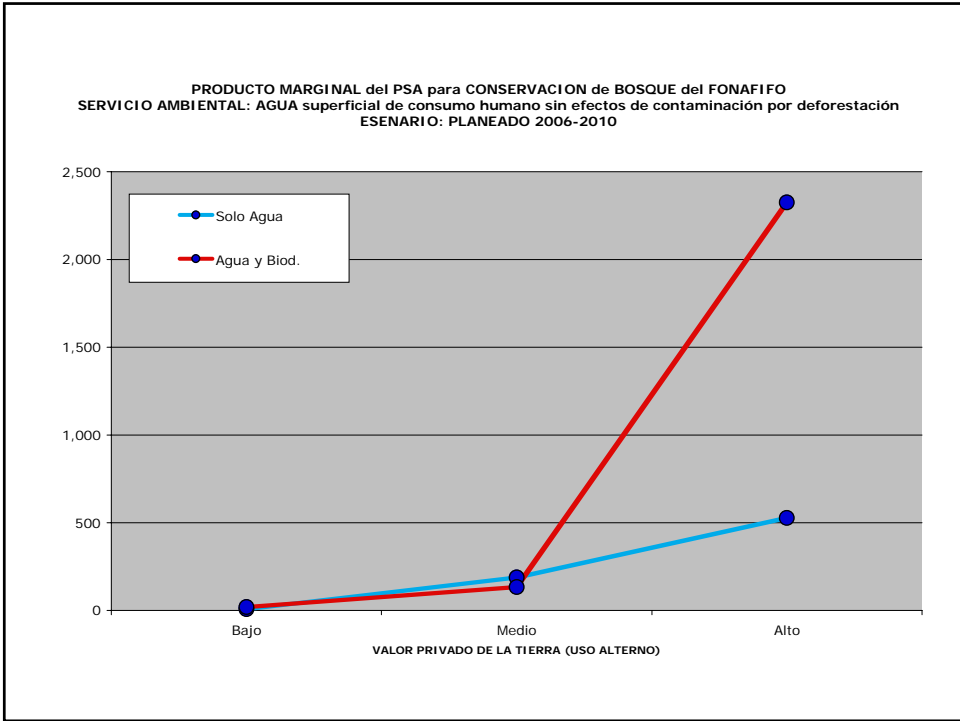
	PRODUCCION	LINEA BASE	EFFECTO NETO	EFFECTO ECOMARKETS POR F.	
	SA: PSA99-05	FONAFIFO 99	ECOMARKETS	AUM DE NIVEL	CAMBIO ASIG
Carbon	18,5%	11,5%	6,9%	7,2%	-0,2%
Biodiversity	10,3%	11,7%	6,6%	7,3%	-0,7%
Agua human.	13,9%	11,0%	2,9%	7,0%	-4,0%
Agua hidruel.	16,1%	10,8%	5,2%	6,8%	-1,6%
Promedio	16,7%	11,3%	5,4%	7,1%	-1,6%

BOSQUE 2005 y 2010 SEGUN ESENAARIO DE PSA (ha)								
LINEA BASE		2010 CON PSA:						
2005 (Mproy.)	2010 alpsa	ACTUAL	Presencia =	MaxPareto P=	capa.bfndb=	cpre,cagua.bfund	MaxPareto pto n	MaxPareto Pdf
155 830	150 397	153 233	156 476	150 397	152 968	153 233	150 397	150 397
42 553	40 503	42 184	42 413	40 503	42 161	42 306	40 503	40 503
11 093	11 271	11 866	11 806	11 271	11 679	11 926	11 271	11 271
56 045	54 882	56 944	56 715	54 882	56 942	56 045	54 882	56 114
106 868	86 960	91 300	97 679	89 534	90 679	91 300	90 346	96 099
117 306	100 562	109 995	110 447	100 562	109 865	110 688	100 562	106 201
29 151	24 471	27 642	27 118	24 471	27 718	27 971	26 526	27 218
50 732	41 658	50 024	46 609	41 658	50 075	50 544	42 063	43 690
133 508	77 527	104 120	99 627	109 736	101 743	104 120	112 795	106 957
380 395	143 761	210 783	193 084	227 986	209 774	216 175	236 270	229 700
94 099	50 009	69 741	66 336	77 754	70 425	72 420	77 178	76 364
144 191	70 379	90 208	96 114	117 611	96 249	97 922	119 690	111 230
1 222 651	862 390	1 017 040	1 004 444	1 046 366	1 018 676	1 034 649	1 062 482	1 056 943
Def bruta anual	6,1%	3,4%	3,6%	2,9%	3,3%	3,1%	2,6%	2,7%

PRODUCCION:	IDEAL	ACTUAL	Presencia =	MaxPareto P=	,agua,humid=	,agua,humidab	MaxPareto pto n	MaxPareto Pdif	MaxPar Pdif elas=Op
Carbon	37.027.098	16.465.981	15.206.396	19.398.583	16.629.603	18.226.883	21.010.207	20.366.349	19.316.452
Biodiversity	239.557	107.393	93.636	131.458	111.320	121.954	142.226	136.892	131.479
Agua human.	297.160.781	94.155.607	107.209.782	181.661.238	111.627.633	122.956.189	190.113.783	163.750.674	161.298.792
Agua hidroel.	2.807.765.314	1.092.886.640	1.072.640.083	1.594.269.266	1.213.615.305	1.330.249.942	1.702.415.892	1.561.897.499	1.532.839.720







PRODUCCION de SERVICIOS AMBIENTALES de 1999 a 2005 (como % del ideal)				
	Quinquenio 2005-2010			
	1999-2005	DIST Y NIV. 05	PLAN s/efecto dis	PLANEADO
CARBON (def. evita	18%	44%	45%	49%
BIODIVERSIDAD	18%	45%	46%	51%
AGUA U. HUM.	14%	32%	38%	41%
AGUA ELECT.	16%	39%	43%	47%
PROMEDIO	17%	40%	43%	47%

PRODUCCION DE SERVICIOS AMBIENTALES ACTUAL Y PLANEADO				
SERVICIO AMBIENTAL	N & D ACTUAL		N & D PLANEADO (ca	
	como % ideal	como % max	como % ideal	como % ma
CARBON (def. evitada)	44%	78%	49%	87%
BIODIVERSIDAD	45%	76%	51%	86%
AGUA U. HUM.	32%	50%	41%	65%
AGUA ELECT.	39%	64%	47%	78%
PROMEDIO	40%	67%	47%	79%

CONCLUSIONES

El PSA reduce deforestación

La producción de servicios ambientales del PSA se puede medir

El PSA actual contribuye significativamente al bien público

El PSA tiene “adicionalidad”

El comercio contribuyó significativamente a la producción de SA

El producto del PSA va en aumento por más recursos y re-distribución

El PSA planeado (incluyendo cañón de agua y biofund) parece eficiente

La necesidad de precios diferenciados aún no es evidente

Subastas del PSA basadas en “matching funds,” puede aumentar recursos y lograr reasignación con relación de precios para trade-offs entre servicios globales, nacionales y locales (similar y complementario al cañón de agua y al biofund?)

