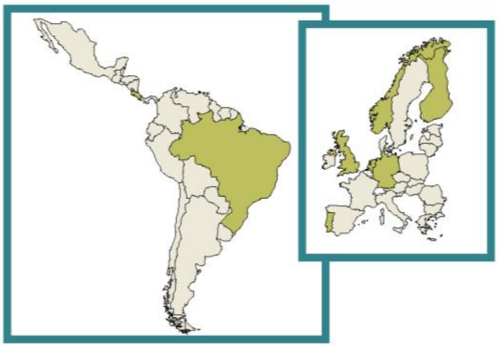


REPORT

Issue No. xx

POLICYMIX - Assessing the role of economic instruments in policy mixes for biodiversity conservation and ecosystem services provision

Costa Rica: National level assessment of the role of economic instruments in the conservation policymix

Adriana Chacón-Cascante, Muhammad Ibrahim, Zayra Ramos, Fabrice De Clerk, Rafael Vignola and Juan Robalino

policymix.nina.no

POLICYMIX Report series brings work in progress to publication. Report results are also summarized in Technical and Policy Briefs. Reports and Briefs are also available online: http://policymix.nina.no

About POLICYMIX. POLICYMIX focuses on the role of economic instruments for biodiversity conservation and ecosystem services provided by forest ecosystems. POLICYMIX evaluates the cost-effectiveness and benefits of a range of economic versus regulatory instruments in a variety of European and Latin American case studies.

Title of project: Assessing the role of economic instruments in policy mixes for biodiversity conservation and ecosystem services provision

Instrument: FP7-ENV-2009-1: Collaborative project. Small or medium-scale focused research project

Grant Agreement number: 244065

Start date of project: April 1st 2010 Duration: 48 months

Project funded by the European Commission within the Seventh Framework Programme (2007-2013)

NINA

SYKE

Finnish Environment Institute

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

CENSE center for environmental and sustainability research

CATIE Solutions for environment and development Soluciones para el ambiente y desarrollo

REDES

FundAg

iied International Institute for Environment and Development

IVM Institute for Environmental Studies

Costa Rica: National level assessment of the role of economic instruments in the conservation policymix

Adriana Chacón-Cascante

Muhammad Ibrahim

Zayra Ramos

Fabrice De Clerk

Rafael Vignola

Juan Robalino

Chacón-Cascante, A., Ibrahim, M., Ramos, Z., De Clerk, F., Vignola, R. and Robalino, J. [2012]. "Costa Rica: National level assessment of the role of economic instruments in the conservation policymix."

PUBLICATION LAUNCH DATE
April, 2012

ISBN: [xx] POLICYMIX, digital document (pdf)
ISBN: [xx] Other institution
ISBN: [xx] Other institution

AVAILABILITY
Open

EDITORS:
NA

QUALITY CONTROLLED BY
David Barton

CLIENT(S)
NA

CLIENTS' CONTACT PERSON(S)
NA

FRONT-COVER PHOTOS
José Mario Cárdenas

KEY WORDS
Costa Rican payment for environmental services program, conservation areas, certification, forest law, biodiversity status

CONTACT DETAILS
Adriana Chacón-Cascante
GAMMA Program, CATIE
Headquarters, CATIE 7170
Cartago, Turrialba 30501, Costa Rica
Email: achacon@catie.ac.cr

Abstract

POLICYMIX aims to contribute to achieving the EUs goals of reversing trends in biodiversity loss beyond 2010 through the use of cost-effective and incentive-compatible economic instruments. POLICYMIX focuses on the role of economic instruments in a mix of operational conservation policy instruments. The project includes seven case studies from six countries: Norway, Germany, Portugal, Finland, Brazil (Mato Grosso and Mata Atlantica) and Costa Rica.

The present report discusses Costa Rican biodiversity goals and the main policies historically implemented to reach conservation objectives. The study first discusses national current biodiversity status and challenges; then an assessment of the existing economic instruments is presented to later analyze their roles in the policy mix for forest biodiversity conservation and ecosystem service provision. Instruments considered in the analysis are the national payment for ecosystem services program, protected areas, certification and law-enforced measures.

Index

Summary and conclusions

POLICYMIX aims to contribute to achieving the EUs goals of reversing trends in biodiversity loss beyond 2010 through the use of cost-effective and incentive-compatible economic instruments. POLICYMIX focuses on the role of economic instruments in a mix of operational conservation policy instruments.

Figure 1

In the recent past Costa Rica presented one of the highest tropical deforestation rates in response to policies that incentivized agricultural colonization. However, over the last two decades there has been a significant increase in the area of forest resources and percentage of tree cover, process that has been associated to conservation policies, especially related to law and market-based mechanisms.

Deforestation rates in Costa Rica have been reversed to the point that forest cover is now argued to have reached 50%. Multiple factors contribute to Costa Rica's conservation focus, including a generally environmental conscious public, and progressive environmental laws both mandating forest protection and conservation, as well as recognizing the conservation efforts of individual landowners through nationalized Payments for Ecosystem Services program lead by FINAFIFO.

PolicyMix aims to understand how the interaction between national, regional and local incentives promotes the conservation of forest biodiversity. The Costa Rican case study will focus its attention on the national payments for ecosystem services (PES) program but will also incorporate into the analysis the national protected areas system and Forest Law (which prohibits land use changes) as they are the strongest instruments aiming at protecting biodiversity nationwide. In addition, forest certification is to be analyzed as representative of existing private initiatives aimed at forest conservation and because of its prospective impacts on forest biodiversity. An analysis on REDD + as a potential instrument is also included in light of its imminent adoption as part of Costa Rica's national environmental policy.

In addition to the policy analysis, nation's biodiversity status and conservation gaps were discussed. From this analysis it was concluded that (i) Costa Rica has a biodiversity conservation strategy, outline in the GRUAS II report that identifies priority conservation areas; (ii) there is a recognized and accepted lack of information regarding threatened and endangered species; and, (iii) phytogeography regions provide a reasonable surrogate for conservation gaps.

The historical context of conservation policies in Costa Rica highlights the fact that until the 90's national deforestation rates were extremely high, up to the point that forests cover was reduced to 26% in mid 80's. Many policy attempts were made to reduce this tendency but it was not until 1996 that a new forest law was enacted prohibiting land use changes and launching a payment for environmental services program. Deforestation rates were reduced and forest cover was recovered to, a claimed, more than 50%.

Four main instruments were selected to make an assessment analysis: the PES program, protected areas, certification and direct regulations. For each instrument, a separate analysis of its effectiveness, efficiency and social impacts is performed when possible, all based on existent literature. It was made evident that the PES program is the policy that more attention of researchers has called as it has being widely analyzed. However, there are still study gaps to be filled, especially centered on the program's effectiveness in protecting biodiversity and ensuring ES provision; in this respect most analysis focus on avoided deforestation as a surrogate for environmental protection achievement.

Analysis of instrument interaction makes evident that Costa Rica's biodiversity conservations and ecosystem services (ES) provision instruments interact in many ways. Some of these interactions are regarded as complementary while other are self-defeating. In general, direct regulation (law) interacts with all other instruments. Usually this interaction is counterproductive as it decreases potential effectiveness of the alternative instruments. Examples of this situation are given by the prohibitions of private land in national parks to receive PES and of indigenous communities to extract rents from forest products. The first reduces the effectiveness of the PES in high value conservation lands while the other creates a perverse incentive against sustainable forest management in indigenous reserves. Certification and PES can be viewed as complementary instruments as they can enhance the other's outcome. The same can be said for the interaction between certification and direct regulations. Certification can be viewed as a way of producers to comply with environmental law and at the same time receive an economic incentive in the form of price premiums. Unfortunately in the case of Costa Rica, this interaction is probably inexistent as there is no domestic market for certified timber products.

Text box – key national level policy messages

1 Introduction

In the recent past Costa Rica presented one of the highest tropical deforestation rates in response to policies than incentivized agricultural colonization. However, over the last two decades there has been a significant increase in the area of forest resources and percentage of tree cover, process that has been associated to conservation policies, especially related to law and market-based mechanisms.

Forestry incentives in Costa Rica began in the late 70´s with tax credits aimed at offsetting costs involved in establishing and managing forest plantations. From remarkably favorable credit conditions, to trade tax vouchers, Costa Rica used subsidies to promote growth of the forestry sector, but subsidies were removed because of international pressures (Daniels et al., 2010). A forest law enacted in 1996 introduced a permit system to restrict timber extraction and forest-cover change on private land, and a program of Payments for Environmental Services (PES). The PES program was authorized as the fourth national forestry law in 1996 which recognizes four environmental services provided by forest ecosystems: biodiversity, watershed function, scenic beauty and greenhouse gas mitigation through carbon storage and sequestration.

Deforestation rates in Costa Rica have been reversed to the point that forest cover is now argued to have reached 50%. Some suggest that this will be the national plateau and that conservation of additional forests will be difficult. Multiple factors contribute to Costa Rica’s conservation focus, including a generally environmental conscious public, and progressive environmental laws both mandating forest protection and conservation, as well as recognizing the conservation efforts of individual landowners through nationalized Payments for Ecosystem Services program lead by FINAFIFO.

PolicyMix aims to understand how the interaction between national, regional and local incentives promotes the conservation of forest biodiversity. The Costa Rican case study will focus its attention on the national payments for ecosystem services (PES) program but will also incorporate into the analysis the national protected areas system and Forest Law (which prohibits land use changes) as they are the strongest instruments aiming at protecting biodiversity nationwide. In addition, forest certification and protected areas are to be analyzed; the former as representative of existing private initiatives aimed at forest conservation and because of its prospective impacts on forest biodiversity. An analysis on REDD + as a potential instrument is also included in light of its imminent adoption as part of Costa Rica’s national environmental policy.

Costa Rica has also invested in a national level evaluation of priority conservation areas which highlights conservation gaps by phyto-geographic region. The PolicyMix Costa Rica team will evaluate the effectiveness of Costa Rica’s PES program in reaching conservation targets as outlined by Gruas II, but will consider the additional contribution of the PES program to other national goals including national commitments to the Convention on Biological Diversity, and the Millennium Development Goals.

The study effectiveness study will be complemented with legitimacy analysis. By legitimacy we understand the procedures by which decisions are made including representation, distribution of power, accountability and transparency and based on procedural and distributive justice. Legitimacy will ensure three main outcomes: (i) effectiveness - capacity to deliver reduced biodiversity and raise funds and good governance structure fits the type of good or service involved, and the capacity to ensure additionality and permanence avoiding leakage. (ii) efficiency - ability to deliver cost-effective results- involves the cost of action –avoiding biodiversity loss-and the transaction costs related to the chosen governance structure; and, (iii) equity: distributional effects of the chosen system- issues concerning income, linking rights aspects. Despite the overwhelming role of the Costa Rican PES in biodiversity conservation and economic development, the legitimacy of government involvement is questioned.

The central question of Costa Rica's case study analysis is verifying and describing how ecosystem service based conservation incentives, particularly through the nationalized PES program, contributes to conservation goals (effectiveness) in an efficient way ensuring equitable participation. The team will pay particular attention to the scale interactions between nationally set goals, and local priorities. Second, the team will explore whether financial conservation incentives do, or should simultaneously target social goals such as poverty eradication.

1.1 Research questions and objectives

The objective of this report is to highlight the Costa Rica's established conservation goals, and to describe its nationalized PES program as the primary financial incentive for achieving these goals. We highlight both the contributions of the FONAFIFO program in reaching these goals, as well as identify key research gaps that should be addressed in the PolicyMix Project.

Specific research questions highlighted by the Hojancha research team aim to understand the impact of this national conservation incentive, on simultaneously reaching local ecosystem service based goals, and national targets outlined below. These questions include:

1. How have conservation strategies affected LUCC, and how has LUCC affected the provision of ES?
2. Where are areas of conflict and synergy between bio-physical and perceived ES provisions?
3. How can we spatially optimize conservation and socio-economic benefits on the landscape?

1.2 Methods and clarifications

To answer the research questions this report centers in describing current status of the PES and at lesser level, other instruments and policies enforced to protect biodiversity, meaning: forest certification, protected areas and forest law.

This report focus on tools related to conservation of biodiversity and sustainable use of ecosystem services in forests and agro-forest systems that are enforced in the Hohancha region. However, since most policies analyzed are enforced nationally and there is not specific evidence of performance for the instruments at the local level, this investigation is a coarse grain national case study. In light to the POLICYMIX analysis framework the report will also address some key policies and instruments in other sectors that interact with forest ecosystem services and biodiversity conservation.

The next two chapters investigate the mentioned existing policies as well as REDD+ as a proposed instrument for biodiversity conservation and ecosystem services management. All of them are to be assessed based on four criteria following the PolicyMix framework: (i) conservation effectiveness (WP3); (ii) cost-effectiveness and benefits (WP4); (iii) distributive impacts and legitimacy (WP5); (iv) institutional options and constraints (WP6).

1.3 Case study comparisons - instrument, methodology and ecosystem services clusters

Table 1 shows the instruments being analyzed in the present study and how it compares with other national case studies.

1.4 Outline of report

The report is organized in several sections trying to go from the general aspects of biodiversity conservation and ecosystem services (ES) provision in Costa Rica, some historical context related to the development of environmental policies, a national-level analysis of existent policy instruments and the way they interact. Finally, general features of the fine grain case study are provided.

Table 1. Comparison between national Case Studies

Case clusters			Costa Rica	Mato Grosso	São Paulo	Port-ugal	Fin-land	Ger many	Nor-way
Instrument		**Specification**							
	REDD+	international/national	C	P	P				
	EFT	national/state		C&P	C	C&P		P	P
	Certification	national/state	C	C			C		C
	Offsets/TDR/HB	National/state		C	C				
	PES	national / state agri-env.	C	C&P	C&P	C	C	C	P
		project /local		C	C				
	Protected areas	national	C						
	Command and control	national	C						
		C=current, P=proposed or potential. Table includes only economic instruments addressed in 2 or more case studies							
Methodologies		*Only methodologies addressed in 2 or more cases studies*							
WP3	**GIS mapping**								
		Composite B&ES indices		?		?		?	X
		Biodiversity & habitat quality	X	X	X	X	X	X	X
		Pollination&pest control	X	X	X				
		Carbon & timber	X	X	X	X	X	X	X
		Run-off &infiltration&erosion	X		X	X		X	
		Non-timber forest products	X	X					
		Recreation	X					X	X
		? = subject to findings of the coarse grain analysis							

	Landowner & forest user surveys								
WP4 & WP5		Value transfer - available datasets		?					X
		Choice experiment - contract design				X		X	
		Opportunity costs	X	X	X	X	X	X	X
		Transaction costs	X	X	?	?	X	X	X
		Social impact & legitimacy				X	X		X
		? = subject to findings of the coarse grain analysis							
WP6	**Existing instrument evolution, path dependency**		X	?	?	X	?	?	X
	Proposed instrument architecture		X	X	X	X	X	X	X
WP3-WP4..WP9	**BACI:Before-after-control-impact evaluation**		PES	EFT		?	PES		
WP3-WP6..WP9	**Scenario evaluation, incl. GIS mapping**			EFT				EFT	
WP3-WP6..WP9	**MCA: Multi-criteria analysis**								
		MacBeth , other MCA software	?		X		?		?
		Marxan - spatial site selection	X			?	?		X

2 Identifying biodiversity status, challenges and context

2.1 Biodiversity status

2.1.1. Why protect biodiversity in Costa Rica?

Costa Rica is embedded in the Mesoamerican biodiversity hotspot, which is particularly recognized for its high diversity of endemic species, and for the role that the region plays as corridor between the North and South American sub-continents (SINAC-MINAE 2007). It is part of the Mesoamerican Biological Corridor, a regional conservation strategy that comprises the seven Central American countries and the south part of Mexico. Costa Rica has adopted the strategy and consolidated through the establishment of the National Program of Biological Corridors, which comprises 37 biological corridors spread all over the country (Fig. 2) (SINAC, 2009b).

With only 51,100 km^2 of territory, Costa Rica is considered one of the most biodiversity rich countries per unit area (SINAC 2009). It contains an estimated 500,000 species, that represent s 5% of the global terrestrial biodiversity (http://www.inbio.ac.cr/es/biod/ContextoNal.html), distributed between 53 vegetation macrotypes, according to Gomez and Herrera (1986) classification (SINAC-MINAE, 2007). The country contains the highest diversity of known species of flora and vertebrates in the Central American region (INBio, 2006), and shares around the 80% of its biological richness with the other Central American countries (SINAC, 2009a).

Costa Rica is a signatory to the Convention on Biological Diversity, and thus agreed with the conventions goals of reducing the rate of biodiversity loss by 2010; a goal which globally has been missed. The main strategy used for achieving this goal was the adoption of a work plan on protected areas. One of the commitments of signatories to the convention was to have by 2006 a completed analysis of conservation gaps at the national and regional level based on protecting representatives units of national biodiversity. In order to reach this goal, Costa Rica underwent two national analyses known as GRUAS I and GRUAS II. The last one provides the most complete analysis until now for the country and it constitutes the base for setting national conservation goals (SINAC, 2009).

In a nutshell, Costa Rica's conservation goals are to maintain a representative sample of the totality of the country's biodiversity through the declaration of protected areas, through private conservation efforts, or through nationally relevant production systems that are compatible with biodiversity conservation. Gruas II is a tool that hopes to bridge the gap between the national conservation and development goals of the country.

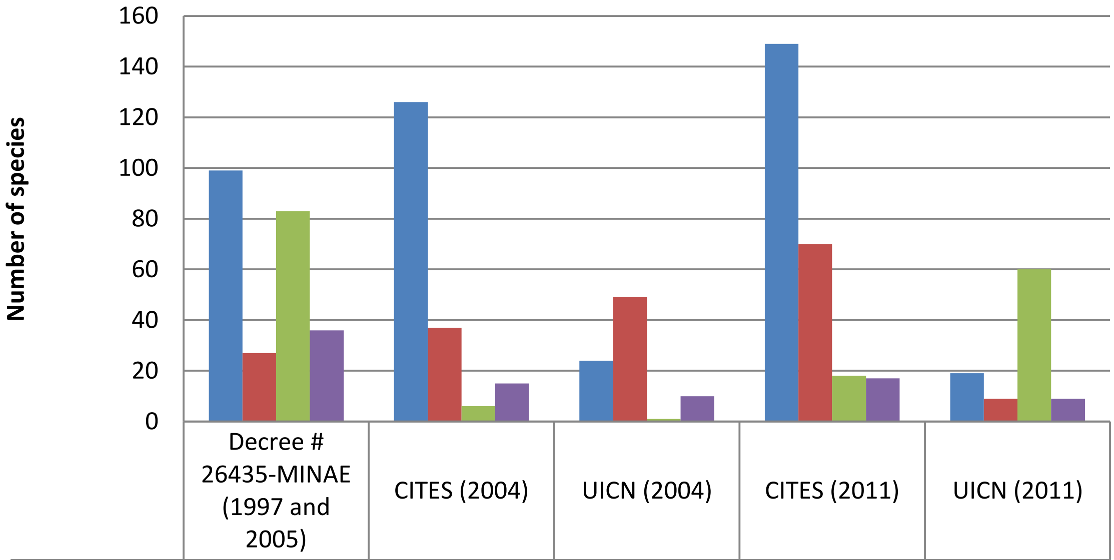
2.1.2. Trends in threatened species

Several lists of threatened species exist for Costa Rica, though hard scientific data regarding the distribution and conservation status of these species is generally lacking. This is evident from the different lists identifying endangered species, many of which use different sources of information, and for that reason they not necessarily agree (Figure 1 and Table 2). This disagreement is more than matter of agreement on what qualifies as threatened, but distinct species are found listed by the three list. The most important are the CITES appendices and UICN red list. Also, MINAET emits a decree, as official instrument, where the threatened species are listed. The last decree (No. 26435-MINAE) was published in 1997, and has not been updated, although it was incorporated in 2005 into the new regulation to Wildlife Law, but with minimum changes.

Currently, 283 animal and 758 plant species found in Costa Rica are found in CITES appendices I, II and III. An additional 30 are being reviewed (http://www.unep-wcmc-apps.org/isdb/CITES/Taxonomy/, consulted on March 16, 2012). The IUCN red lists 175 threatened animal and 116 plant species (IUCN 2011). For amphibians, a taxonomic group of significant concern, 60 species are listed as threatened, 23 species are critically endangered, 23 species as endangered and 14 species as vulnerable (IUCN, 2011).

INBio (2006) mentions that according to the decree No. 26435- MINAE, 46% of Costa Rica's amphibian populations are endangered and 1.12% face severe extinction risk; 12% of reptile's are endangered, and 3.5% face severe extinction risk. 10 % of birds and 6% of mammals populations with 9.6% are endangered; and 6% and 5.5% face severe extinction risk respectively. As in other lists, amphibians remain is the most threatened group, though there is no clear understanding of the cause of their decline. Studies by University of Costa Rica biologists Gerardo Chavez and Federico Bolaños in 1990 (INBio, 2006), revealed that the populations of 23 amphibian species have declined and 11 species out of these 23 are potentially extinct and have not been observed in the wild (INBio, 2006). IUCN red list (2011) reports 39 species of endemic amphibians, of which 23 species are threatened. Despite Costa Rica's prominence as a nature loving country, few exhaustive studies have been conducted to determine the conservation status of the country's biodiversity. This may be unrealistic considering the high degree of species richness in Costa Rica (compared to temperate regions), and low priority of these surveys compared to other national needs.

Figure 1. Number of species included in each list for four groups of vertebrates



	Decree # 26435-MINAE (1997 and 2005)	CITES (2004)	UICN (2004)	CITES (2011)	UICN (2011)
Birds	99	126	24	149	19
Mammals	27	37	49	70	9
Amphibiams	83	6	1	18	60
Reptiles	36	15	10	17	9

Source: INBIo, 2006; IUCN 2011; http://www.unep-wcmc-apps.org/isdb/CITES/Taxonomy/, consulted on March 16, 2012.

Table 2. Current number of animal and plant species included in CITES appendices and UICN red list

LIST		**CATEGORIES**		
CITES*	Appendix I	Appendix II	Appendix III	**TOTAL**
Animals	25	253	5	**283**
Plants	4	750	4	**758**
IUCN**	CR	EN	VU	**TOTAL**
Animals	31	51	93	**175**
Plants	4	33	79	**116**

*Appendix I: species threatened with extinction, and their trade is usually prohibited. Appendix II: species that may become threatened with extinction and their trade need to be **strictly** regulated. Appendix III: **species that are protected in at least one country that has asked other CITES parties for help in controlling trade**.

**CR: Critically endangered, considered to be facing an extremely high risk of extinction in the wild. EN: endangered, considered to be facing a very high risk of extinction in the wild. VU: vulnerable, considered to be facing a high risk of extinction in the wild (2001 IUCN Red List Categories and Criteria version 3.1).

2.1.4 GRUAS II Phytogeographic Units as coarse-grain surrogates of biodiversity status[1]

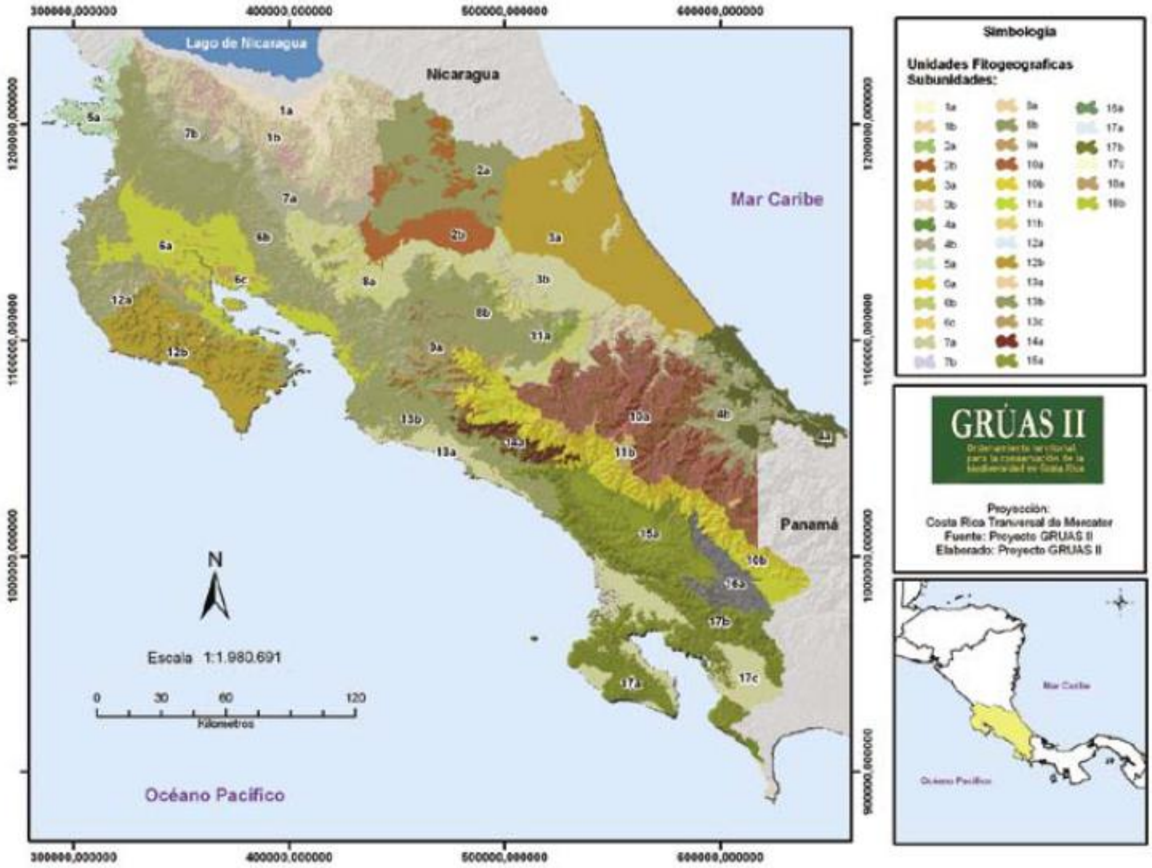
In 1995-96, the country underwent the first conservation gap analysis known as GRUAS I. The main objective was to secure the conservation of at least 90% of the national biodiversity (Garcia, 1996), using as indicator the vegetation macrotypes of Gomez and Herrera (1986 in INBio 2006). From GRUAS I, a conservation strategy was developed. After 10 years of this proposal, the country was able to implement 12% of the total area proposed for conservation by increasing the extension of existing PAs, and 11% of the land needed to maintain the connectivity between PAs by the implementation of private conservation initiatives. This was largely seen as failing to meet established conservation goals due to lack of resources, staff and communication.

In 2007, GRUAS II was published. An important step in conservation planning is identifying which parcels of land should be prioritized in order to meet conservation goals. In order to do this, Gruas II used site selection software MARXAN to identify priority sites based on 6 factors: 1) fragments must be > 1000 ha in size, 2) presence of species of particular conservation concern, 3) presence of endemic species, 4) land use capacity (either VI or VII), 5) aquatic recharge areas or 6) presence of freshwater ecosystems previously identified and having high ecological integrity (see Table 3).

As coarse grain underlying ecological units, GRUAS II used “Phytogeographic Units” (PGU) in the analysis of conservation gaps for terrestrial systems (Figure 2map of PGU). The definitions of the PGU were done by overlapping the classification of vegetation macrotypes (used in GRUAS I) and the floristic regions (Gomez and Herrera, 1986 in INBio 2006, and Hammel et al. 2003, respectively). In total, 31 phytogeographic units or florisitic provinces were identified and mapped with different abundances in their distribution from 11a with the smallest area represented and 10a with the largest. For example, for the Hojancha site, the Laderas and low lying zones of the Nicoya Penninsula is one of the floristic provinces rarest with a very small geographic extent. The same is true with the Paramos of the Central Volcanic Range which includes the Turrialba and Irazu Volcanos (the rarest of all actually). An important point of reference regarding the use of Phytogeographic Units. When GRUAS was initiated, the idea was to identify and use the distribution of critically endangered species to identify conservation gaps. Researchers quickly realized however that they did not have sufficient information to use this criteria, and settled on phytogeographic zones as surrogates for conservation gaps. This is similar to FONAFIFO’s use of forest cover as a measure of success – though the phytogeographic units are more detailed, and provide a clearer indication of existing gaps.

[1] This section is from SINAC-MINAET, 2007a, much of the text included is a direct translation

Figure 2. Map of Phytogeografic Units used by GRUAS II in the national conservation gap analysis



Source: SINAC-MINAE, 2007.

In addition to the vegetation mapping, GRUAS II considered species of conservation concern by identifying species that were listed as globally threatened in the IUCN Red List, endemic species, and those listed by the Alliance for Zero Extinction. This list included 68 species of birds, mammals, amphibians and reptiles. For plants, they used a list generated by Estrada et al. (2005) which included 40 species of conservation concern. This produced a list of 108 species whose potential distribution was mapped.

When considering the ecological integrity and viability of ecological populations, the report utilized criteria defined by Groves et al. (2003). These include the size of the protected area, the condition of the area which included measures of structural complexity, intactness, and reproductive success amongst others; finally, it includes the landscape context that considers how surrounding land uses affect ecological dynamics and disturbances as well as connectivity.

Table 3. Priority Setting

An important step in conservation planning is identifying which parcels of land should be prioritized in order to meet conservation goals. In order to do this, Gruas II used site selection software MARXAN to identify priority sites based on 6 factors: 1) fragments must be > 1000 ha in size, 2)

presence of species of particular conservation concern, 3) presence of endemic species, 4) land use capacity (either VI or VII), 5) aquatic recharge areas or 6) presence of freshwater ecosystems previously identified and having high ecological integrity.

For fragment size, patches that were >1000 ha received a value of 3, between 500-999 ha, a value of 2, and patches <500 ha, a value of 1. The scoring was quite different for species of conservation concern with very heavy weighting in this category. Areas that are listed in the Alliance for Zero Extinction received a value of 1000 (see table below, 5 are listed for Costa Rica), endemic species with a limited distribution a value of 100, areas containing endemics with a broad distribution a value of 10, and areas with species at risk of extinction, a score of 1. For the third category, patches were given a score of 1 or zero with the respective presence or absence of endemic plant species.

Costa Rica has classified its territory into land use suitability classes, which identify the agricultural capacity (or lack thereof) of each class. These range from class I which is the least restrictive in terms of agricultural productivity, to class VIII, which is the most restrictive, essentially prohibiting land use. Fragments that are under the class VII and class VIII were given a score of 1, whereas all other suitability classes were given a score of 0.

The fifth value used to determine the importance value of fragments is tied to aquatic recharge areas. From this point of view we see the Gruas II authors recognize the importance that some areas play in terms of providing essential ecosystem services, both the humans as well as to wildlife. The authors recognize that scientific evidence backing the selection of these areas is generally lacking, but that they were able to make a broad scale categorization based on data published in the Costa Rican Technical Institute's Digital Atlas of the country. Areas that are identified as being important for recharge are given a value of 1 and areas that are not, are given a value of 0.

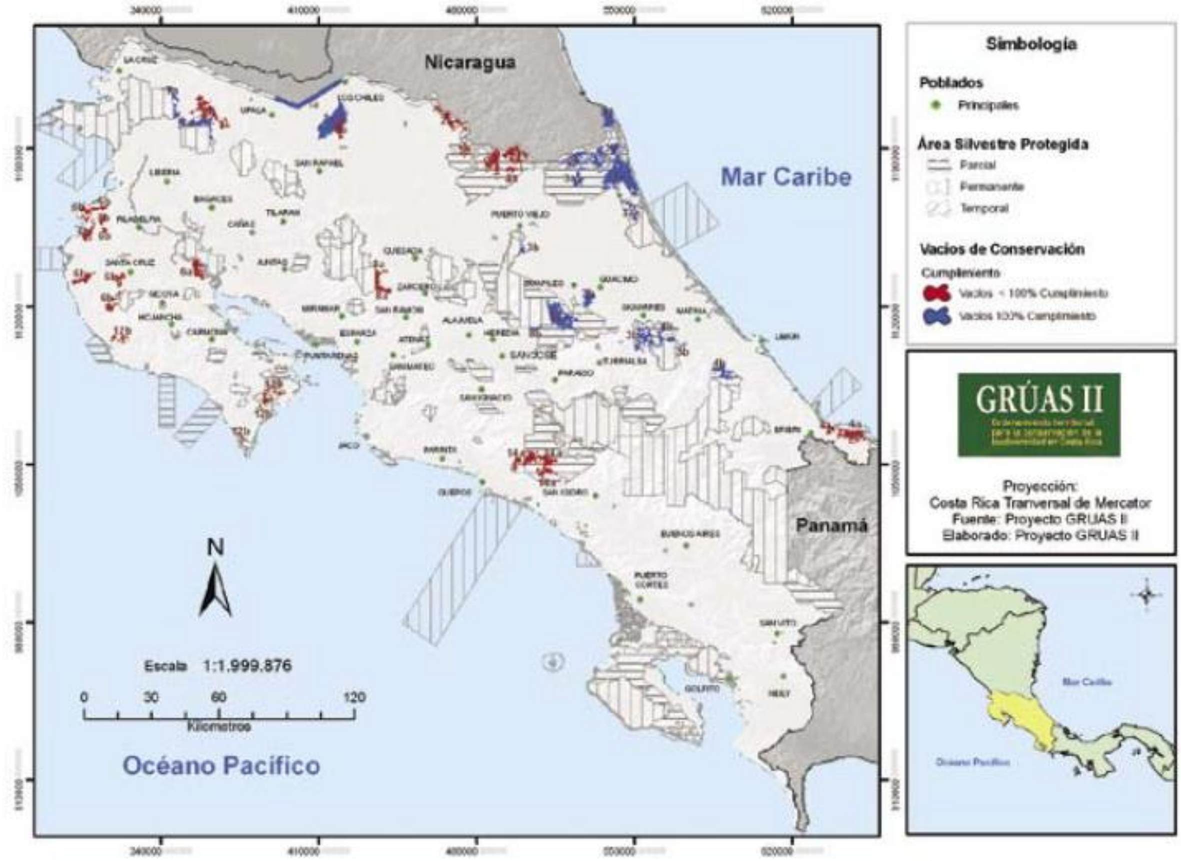
The sixth criteria used to assign importance values were related to the prior identification of important freshwater systems. Fragments that overlapped with these freshwater systems were given a value of 1, and those without overlap, a 0.

Based on this rapid review of criteria, we quickly see that significant weighting is given to the five areas that were identified as critical by the Alliance for Zero Extinction.

What gaps exist?

Considering the existing gaps, we find that some of the phytogeographic regions meet their conservation goal and are currently safeguarded by permanent protected areas (Figure 3). Others rely on the contribution of partial protection; none of the provinces reaches its conservation goal with the temporary protected areas. The total area need to reach all conservation goals is 283,322 ha. Costa Rica currently has a total of 1,529,945 ha or 30% of the national territory under some form of protection. If these new areas are added, it would represent 35% of the total national territory.

Figure 3. Vegetation occurrences in fragments >1000 ha needed to reach the conservation objective proposed for each floristic province

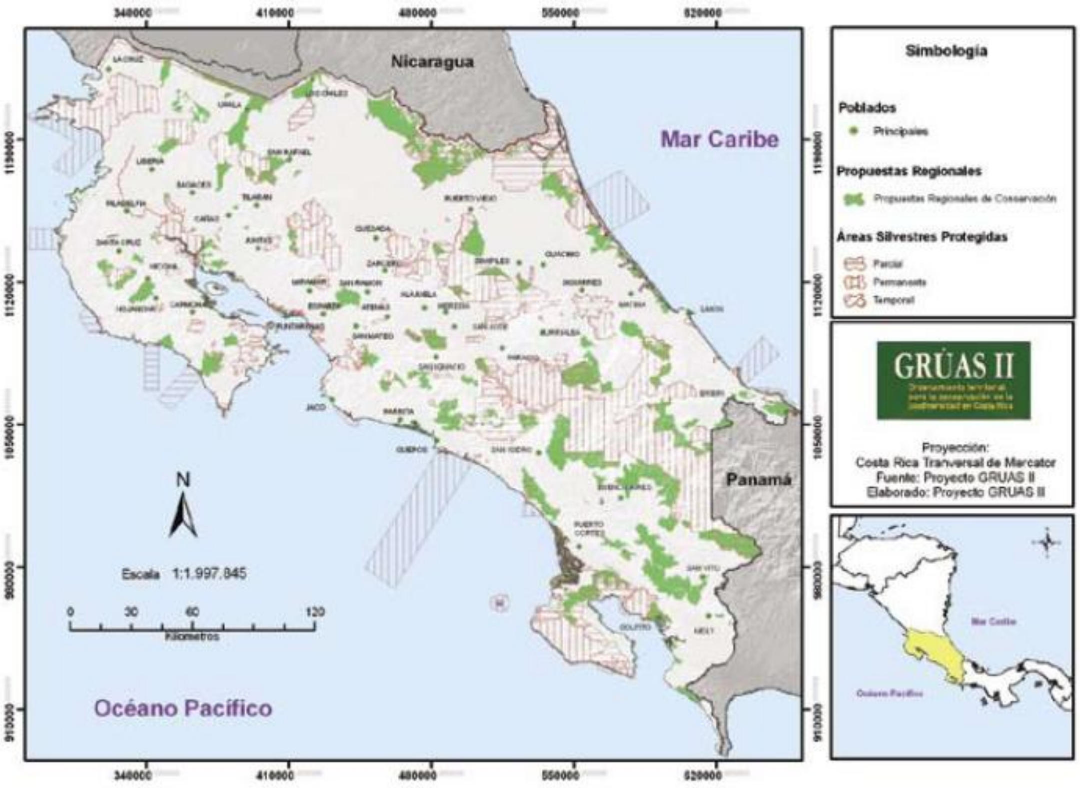


Source: SINAC 2007.

In addition to the GIS analysis of fragments within critical floristic provinces, the authors of GRUAS II conducted extensive consultations (through workshops in 2006) with regional leaders in order to identify areas of conservation conserve at the regional level (Figure 4). This step was essential for multiple reasons, including that it provided a space for local stakeholders and civil servants to provide their input. The total area identified by local stakeholders requiring protection totaled 711,000 ha, three times the areas covered by the national level analyses. It is important to note that the regional process for identifying these priority areas was significantly different than the national methodology outlined in Gruas II, but included the conservation of important areas for the provision of ecosystem services (mostly hydrological), wetlands, recreational areas, and biological corridors rather than the mostly ecological criteria used in Gruas II.

These regional conservation targets were overlain with national targets to evaluate the degree of coincidence. Note that the national level analysis is conducted based on Costa Rica's system of Conservation Areas.

Figure 4. Regional conservation proposals identified through workshops with regional stakeholder in 2006



2.2 Biodiversity policy goals, targets and key issues

Conservation Areas in Costa Rica

Gruas II conducts a national level analysis of conservation gaps, but also breaks down these gaps by Conservation Areas. SINAC is a decentralized and participatory federal institution that is responsible for the management of forests, wildlife, and protected forest areas of the Ministry of Environment and Energy (MINAE) with the aim of developing policies, planning action, and executing interventions aimed at achieving sustainability in the management of Costa Rica's natural resources (SINAC webpage – Costa Ricas 1998 Biodiversity Law).

SINAC is comprised of 11 subsystems called Conservation Areas, and a central office. A Conservation Area is an administrative territory where both private and Federal agencies collaboratively seek and implement strategies for the sustainable use and conservation of natural resources. SINAC uses an integrated conservation strategy that offers the development of a responsible public management that include the state, civil society, private business, and individuals interested and committed to the development of a healthy and ecologically balanced environment.

GRUAS II presents a clear strategy and path towards ensuring the protection of a significant portion of Costa Rica's biodiversity. However there is poor articulation between the objectives set by GRUAS II and the policy objectives set by FONAFIFO's PES program. GRUAS II clearly identified critical regions that should be targeted for PES funds in order to ensure 10% protection of each of Costa Rica's Phytogeographic regions, however FONAFIFO site selection is conducted largely independently of these goals. First because the request for funding comes from the farmer, rather than targeting payments in priority areas, pays for forests that are already protected, or pays for reforestation which for the most part has been exhibited in the form of plantations rather than native forests. The conservation value of these plantations for species of conservation concern is virtually non-existant. The short duration of FONAFIFO contracts, 5 years, puts in question the "protection in perpetuity" goals of most conservationists. Finally, as some authors have pointed, the total extension of forests covered by the PES schemes fails in comparison to the additional land needing protection.

2.3 Data gaps in evaluating instruments' effectiveness

As discussed above, it is critical to better understand conservation gaps at the species level. However, it is recognized that a better understanding at this level in a species-rich country as Costa Rica would require a significant investment that would face strong competition compared to other national priorities. The use of phytogeographic provinces provides a logical and ecologically sound alternative in face of the resource constraint. Evidence of the effectiveness of financial instruments in reaching these conservation goals are best evidenced by evaluating the contribution of financial instruments to conservation priorities as defined by the GRUAS II report. Excluding payments for the establishment of plantations would increase the evaluation of the instruments effectiveness if biodiversity conservation is the primary goal of interest. Additional measures should include the contagion of the additional areas, either to each other, or to other protected areas with greater value given to instruments that contribute to the priorities identified in Table 3.

The gap in understanding which species are threatened in Costa Rica is fully recognized, and it is generally agreed that this gap will be difficult if not impossible to rectify. The phytogeographic zones identified provide a realistic surrogate for these conservation goals. In addition, the conservation goals outlined by GRUAS II have been properly vetted and approved by the major conservation groups working in the country. As such, the effectiveness of conservation instruments from a purely biological point of view can be compared to the conservation priorities identified by GRUAS II. The biggest gap then becomes not the lack of biological data but a possibly disjunction between the objectives established by FONAFIFO and those identified by Gruas II. Questions remain as to whether a program with multiple goals (increasing forest cover on private lands, poverty alleviation, hydrological services, scenic value, and carbon sequestration in addition to biodiversity conservation) can effectively meet these goals.

2.1 Historical policy context

In the recent past Costa Rica had one of the highest tropical deforestation rates, but over the last two decades, there has been a significant increase in the area of forest resources and percentage of tree cover. This has been associated to conservation policies (regulatory and market based mechanism) and efforts to recover and conserve biodiversity in the country. Table 4 summarizes the historical context of key economic and social factors affecting forest cover, policies and outcomes related to biodiversity in a time sequence. Deforestation rate averaged in the vicinity of 3.7% from early 1970s until early 1990s before dropping to less than 1.5% at the end of the twentieth century (Sanchez-Azofeifa et al. 2001). The rate of deforestation began to increase in the 1930s with the influx of landless peasants, the introduction of land colonization policies and settlements that encouraged land clearing, agricultural subsidies, and the expansion of the road network (Hall 1984;

Watson et al. 1998). However, it was not until with the increasing demand and exportation of beef (referred to as the Hamburger connection) in the 1950s that deforestation rates radically escalated (Kaimowitz, 1996; Watson et al., 1998) and this was further facilitated by Government subsidies that were provided with the support of the World Bank and the United States AID (Kaimowitz, 1996; Quesada and Stoner, 2004). However, international beef prices decreased between 1975 and 1977, rose for a few years, and then started falling again after, and this resulted in structural reforms of the agricultural economy.

In view of the considerable loss of forest cover and biodiversity and the negative impacts on ecosystems services and livelihoods of people, Costa Rica created a regulatory and institutional framework for forest conservation, recovery and management through a series of policy and legal changes and establishment of institutional frameworks over four decades. In 1969, the first Forest Law in the country regulated forest use on public land and established a national parks system and private reserves which today represents about 25% of the national territory (Sanchez-Azofeifa et al., 2003). An environmental department was created and it subsidies for reforestation and forest management on private land were implemented. In 1990s, the National System of Conservation Areas (SINAC) was created to decentralize forest management and conservation.

Evolution of forestry incentives in Costa Rica began in the late 70´s with tax credits aimed at offsetting costs involved in establishing and managing forest plantations (figure 1). From remarkably favorable credit conditions, to trade tax vouchers, Costa Rica used subsidies to promote growth of the forestry sector but they were later removed die to international pressures (Daniels et al., 2010). A forest law enacted in 1996 introduced a permit system to restrict timber extraction and forest-cover change on private land, and a program of Payments for Environmental Services (PES), which led to the creation of the National Forestry Financing Fund (FONAFIFO) to administer the PES program. PES was authorized as the fourth national forestry law in 1996; four environmental services provided by forest ecosystems were recognized: biodiversity, watershed function, scenic beauty and greenhouse gas mitigation through carbon storage and sequestration.

With an interest to achieve sustainability for water resources, in 1996 the President passed a decree (32868) referred to as the Cannon del Agua- which requires all users of water to pay an ecological tax, 50% of the funds are to be invested in watershed protection, maintenance and ecosystem recovery in both private and public areas (i.e. protected areas). Funds destined to protected areas are managed by FONAFIFO to finance the PESprogram in private areas at the watershed where the ecosystem service is generated. Currently Costa Rica is in the process of negotiations of REDD+ mechanism which is envisaged to enhance the PES program to reach its objectives for biodiversity conservation.

Additionally, in the process of implementation of environmental policies, Costa Rica transitioned from a primarily agricultural economy to a service based one as evident in 1994 when the tourism industry surpassed all other economic sectors in earning foreign currency. For example in 2011 the number of tourist reached 2,192 million and generated approximately $1.985,4 million.

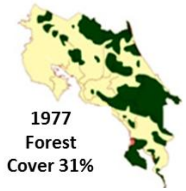
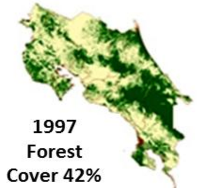
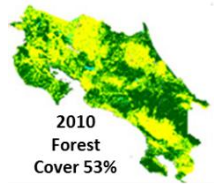
The Ministry of Agriculture and the private sector (Corforga, Dos Pinos) has implemented polices and incentive mechanisms for sustainable intensification of cattle ranching in recent years, and the real estate development and urbanization are now the key drivers of land use change in some parts of Costa Rica (Daniels 2010). These factors, together with recent expansion of pineapple production and to some extent African palm because of good market prices, is related to increased opportunity cost and competition for PES program

Threats to increasing forest cover. International beef prices have been increasing over the past years and the Costa Rican Chamber of Cattle farmers has prioritized the reactivation and modernization of the cattle industry in Costa Rica. During the last 3 years the international beef price averaged $2.8, value similar to 1970 prices. The Guanacaste ranchers have been leading a national reactivation of the program-pressure on scarce resources. In addition to these changes to the cattle industry, a second pathway of forest-cover change could be through tourism infrastructure and real estate development. According to Cordero and Paus 2008, by 2006 foreign investment in Costa Rica amounted to US$1,410 milliones, almost 3.5 times

A third pathway of land –use change that threatens Guanacaste’s secondary forests in the near future is the expansion of agribusiness and the introduction of new crops that are adapted to hilly terrain and dry conditions (Hecht and Saatchi, 2007). For example, Ricinus Comunis (Castorbean) and Jatropha Curcas (Physic Nut) are two biofuel crops adapted to hilly conditions in Guanacaste. There are two plans to expand irrigation schemes in the lowlands of Guanacaste (MIDEPLAN 2008) that could also further encourage the expansion of large scale agribusiness.

Table 4. Summary historical context of key economic and social factors affecting forest cover, policies and outcomes related to biodiversity in a time sequence

	1950s	1970s	1980s	1990s	2000s	2010+
Social and Macro-economic context	Colonization of public lands	Large scale expansion of cattle ranching due to relatively high prices for beef	Structural adjustments	Rapid growth in population	Halt in agricultural expansion	Demographic shift population: rural to urban
	Agricultural expansion to rural areas (Coffee, cattle ranching, banana)	Economic crisis	Population increase	Free market system	Intensification of agriculture-	Land ownership changes: private to companies
		Central America war	Industrial expansion	Tourism	Conservation of watersheds in urban areas	Increase opportunity cost of land
		Import substitution	Slump of beef prices??	International movements- Kyoto, biodiversity convention	International recognition of CR (Noble Peace prize)	Expansion of commercial crops for exports: Pineapple
					International pressure: Climate change, MEA, TEEB	Global Financial crisis
Policy instruments	Land titling	Land titling and settlements, creation of national park, income tax credit	Expansion of national parks and protected areas, soft credits, forest payment certificate (CAF, CAFA-advanced)	Regulations: Environmental law-96, biodiversity law-98, Forest payment certificate for management (CPB), Payment for environmental services	Water cannon	Biodiversity Thrust fund REDD+
	Soft Credits and subsidies for agriculture	Credit and subsidies for agriculture, sales tax exemption for reforestation	Income tax deductions for reforestation	Creation of environmental institutions: INBIO, SINAC, Fonafifo		
	First protected area	US- bilateral collaboration funding	CAF (86); CAFA (88)			
			Elimination of subsidies for reforestation			

	1950s	1970s	1980s	1990s	2000s	2010+
			Debt for nature swaps (end of 80s)			
Outcomes	Rapid deforestation	Rapid deforestation,	Conversion of primary forest for plantation	Decrease in deforestation rate	Lowest deforestation rates, > forest cover	➢ Forest cover
		Increase social capital	National parks	Private reserves	Increase secondary forest	
		In rural areas	Conservation units		➢ Silvopastoral system	
Maps- land cover						

2.2 Choosing instruments for analysis

As mentioned before, the Costa Rican case study will focus its attention on the national payments for ecosystem services (PES) program, its protected areas system and on Forest Law, which prohibits land use changes. The selection of these instruments responds to the recognition that they are the strongest policies aiming at protecting biodiversity nationwide. In addition, forest certification is to be analyzed as representative of existing private initiatives aimed at forest conservation and because of its prospective impacts on forest biodiversity. An analysis on REDD + as a potential instrument is also included in light of its imminent adoption as part of Costa Rica's national environmental policy.

One of the main advantages of PES as an instrument for biodiversity conservation is its capacity of reducing the trade-offs between conservation efforts and social welfare (Pfaff et al.,2008) and as such, it is one of the most preferred biodiversity conservation policy in the country. In addition, Costa Rica´s PES is one of the most advanced projects of its kind in the developing world (Pagiola, 2002 in Pfaff et al., 2008). Between 1997 and 2008, 8500 families had participated in the program reaching more than 700 thousand hectares, most of them under forest protection. This represents over $200 million injected to rural areas. As of 2011, there were a total 373.075 ha under contract[2]; of this around 70% were under the forest protection modality which pays landowners for maintaining their forest unaltered.

Globally, establishment of protected areas has been the most popular strategy to ensure conservation. Costa Rica is well known for its efforts in creating protected areas under different management categories. Currently, about 27% of total area in Costa Rica is under some kind of protection (national parks, wilderness life national refugees, biological reserves, forestry reserves, protected zones, wetlands, national monuments and natural absolute reserves). About half of this area corresponds to National Parks (a total 28 national parks) which is one of the most restrictive protection categories.

Although Costa Rica lacks a national system of forest certification, this instrument is an important tool for biodiversity conservation as it represents efforts made by the private sector. As of the beginning of 2011, there were almost 53.000ha certified by the Forest Stewardship Council (FSC). During the last 10 years, this number increased by 8,5% which indicates a steady, although somehow low, growth of the instrument's importance in Costa Rican forest conservation initiatives.

The Reduced Emissions for Deforestation and Forest Degradation initiative is adopted in this analysis as it constitutes one the most important enterprises adopted worldwide related to forest management and conservation. Forest degradation and deforestation are regarded as the second most important driver of global warming as they are responsible for about 20% total greenhouse effect gases.

Participation of Costa Rica into the REDD+ initiative is highly viable in light of the country's early attempts to reduce deforestation. Examples of these early efforts are its PES program, its protected area system, laws prohibiting land use changes, incentivizing reforestation and promoting carbon markets. In addition, the country has been selected to participate of the Forest Carbon Partnership

[2] It is important to mention that since its establishment, the program has been unpredictable in terms of land cover and number of contracts. Therefore, both numbers has widely varied along the years.

Facility (FCPF). This is a World Bank initiative to provide countries with financial and technical support to develop capacities to actively participate in a future REDD+ program.

3 Role of existing economic instruments

This section presents an overview of the current Costa Rican PES program and of other instruments that impact provision of ecosystem services and biodiversity conservation. Other policies analyzed include certification, protected areas, direct regulations (command and control) and sectorial regulations interacting with these instruments.

When possible, an assessment of social and economic impacts, effectiveness and efficiency of the different instruments is made based on existent evidence. A general conclusion for most instruments, especially in the cases of PES and protected areas, is that they might have important social impacts although they had not been originally conceived as social-oriented policies. Certification, although important, is not a generalized tool used in the country, especially because it is totally oriented towards international markets rather than for domestic purposes.

3.1 Payment for environmental services

The Costa Rican Payment for Environmental Services program was launched in 1997. It was one of the first national programs adopted in the developing world. The program pays farmers for the provision of 4 key ecosystem services: carbon sequestration, hydrological services, scenic value and biodiversity conservation.

The underlining hypothesis of PES schemes emphasizes its potential for efficiency gains by internalizing externalities to the decisions of ES producers. In general, the governance and implementation of the National PES scheme has been dominated by strictly forest related actors with little space for innovation and expansion to other land use based sectors such as agriculture and livestock. It is only recently and with a strong collaboration between CATIE and the Ministry of Agriculture that silvopastoral systems have been included.

The Costa Rican PES program is voluntary, individual farmers or cooperatives can apply to have parcels of forest on their land subject to payments; or can receive payments for reforestation and agroforestry systems. An underlying assumption of the program is that forests, regardless of their type, structure, composition or position in the landscape provide the four services mentioned.

The immediate antecedent of the program is the national Forest Law 7575 (1996) in which land use changes were declared illegal if performed without proper permits. In this sense the program not only recognized the need to compensate forest owners for the environmental services provisioned by their lands, but it was also a way to make the land-use-change prohibition more acceptable.

The first years of the program are the base of what the program currently is. Is has gone through a series of changes such as the institution in charge of its administration, criteria to select beneficiaries and the opening of additional regional offices in an effort to reduce transaction costs.

Initially and until 2002, the National Conservation Area System (SINAC) was in charge of administering the program while National Forestry Financing Fund (FONAFIFO) worked as the program´s financing fund. In 2002 FONAFIFO was made the sole administrator of the program (beneficiary selection, document revision and contract formalization, definition of priority areas and payment conditions), so SINAC could focus on conservation efforts. It was considered that FONAFIFO had gained enough experience during the five-year period the program has be enforced to be able expand and enhance service to landowners.

The 2002 decree, and its transferring of the program administration to FONAFIFO, cleared the way to important changes in the program. For example payments for forest management were eliminated and in 2003 a new category for agroforestry was created; in 2004 an additional category of natural regeneration was also created. In addition, 7 new regional offices were opened nationwide in an effort to reduce application transaction costs (Robalino et al., 2011). In 2005, payment amounts for all modalities were increased and set to dollar units to protect beneficiaries from inflation.

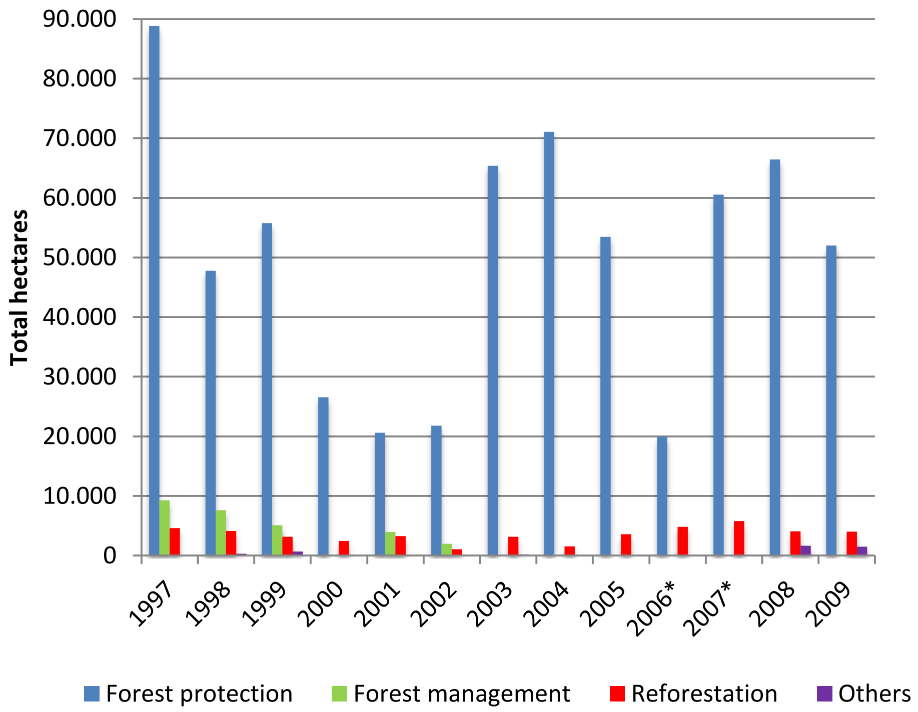
At the beginning of the program, prioritization principles were ambiguous as each local office defined its own criteria based in their conservation goals. After some experience was gained over time, criteria became clearer and simpler. In 2003 five principles were defined to classify priority areas: (i) areas inside biological corridors; (ii) projects with expired contract from previous years; (iii) private areas inside protected areas; (iv) forest areas that function as watershed protection; and, (v) within the previous criteria, priority is given to those districts with Social Development Index below 40 (Robalino et al., 2011).

The Program is government funded but resources come from different sources: public funds in the national budget, timber and fuel taxes, donations, credits from international organisms, private funds and FONAFIFO own generated funds. In addition, in 2001 the Environmental Credit Certificate was created as a financial instrument that allows FONAFIFO to receive funds from companies interested in paying forest owners for their conservation efforts.

As mentioned before, since its creation, the program has paid several modalities of forest conservation and management such as forest protection, reforestation, forest management, natural regeneration, establishment of plantations (no longer exists), agroforestry systems, protection within protected wild areas, water resource protection, protection of conservation gaps and pasture land regeneration. Forest protection has been the modality with the highest share since the program's launching, followed by reforestation and forest management3 (Figure 5).

[3] Payments for forest management have been suspended several times (2000, 2003, 2004, 2005, 2008 and 2009) on the grounds of its questionable viability (Louman et al. 2005).

Figure 5. Costa Rica: total hectares under different payment modalities (1997-2009)*



*Reforestation includes data on natural regeneration.

Source: Elaborated from FONAFIFO (2011a) and La Gaceta (2010).

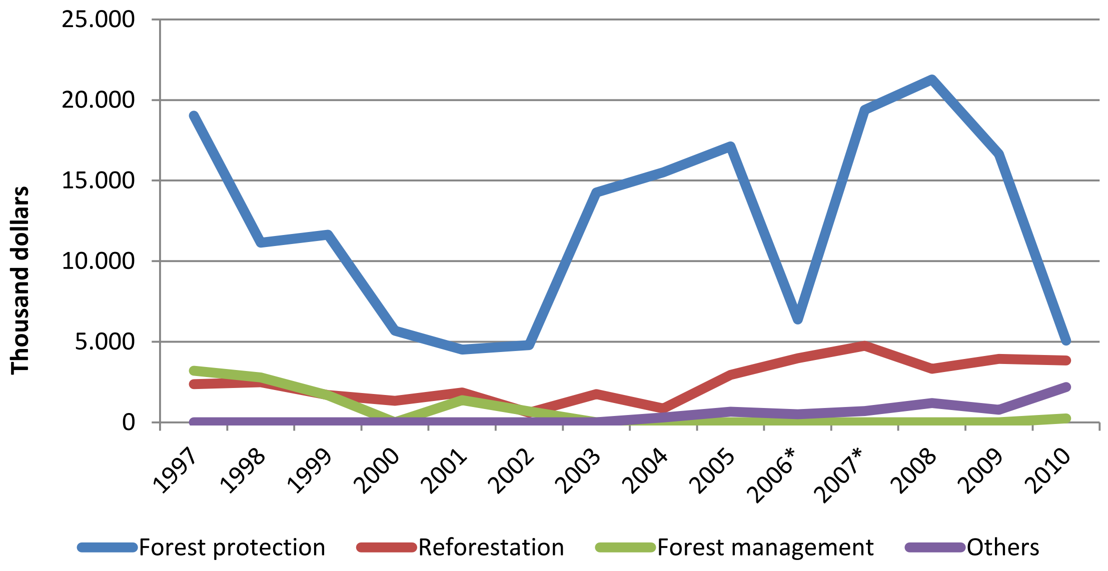
Payments are made during the contract life spam, which is usually five years. For most modalities, but reforestation and agroforestry systems, annual payments equivalent to 20% of the total amount are made during the five-year contract. In the case of reforestation, payments are distributed as follows: 50% in year 1, 20% and 15% in years 2 and 3 respectively; 10% in year 4 and the final 5% in year 5. Contract lifespan for agroforestry systems is three years and compensation is heavily skewed toward the first year when a 65% is awarded, followed by a 20% in year 2 and a final payment correspondent to 15% at the end of the contract (FONAFIFO 2011).

As mentioned before, amounts awarded have varied for all modalities along time. Most payments have increased and are being set in dollars (rather than Costa Rica's national currency - colones) to protect beneficiaries from inflation and ensure more total value along the contract period. Payments for forest protection for example, went from \$214 ha^{-1} in 1997 to \$320 ha^{-1} in 2010. In the case of reforestation, compensation per hectare raised from \$514 at the beginning of the program to \$989 in 2010. Payments under the agroforestry modalities are made on the basis of trees rather than per area; unit compensation started at \$0,73 in 2004 but were raised later to its current level of \$1,30. Amounts granted for forest management is the only one that has gone down with respect to its initial level (recall that this modality has been suspended several times); it started around \$340 ha^{-1} but was lowered to \$250 ha^{-1} after its reintroduction in 2010.

The difference in payments is a partial effort to reflect differences in opportunity costs. For example, payments for protection in areas of high hydrological importance are \$400 ha^{-1} as they are subject to high urbanization pressures and the higher payment tries to compensate for this situation.

Regarding total amounts awarded since the beginning of the program to each payment modality, forest protection is the variety with the highest share, followed by reforestation. It is worth mentioning though that since 2007 the difference between both modalities has shrink to the point that by 2010, total amount distributed to reforestation was only 25% lower than to forest protection, compared to an average difference of almost 80% between 1997 and 2005 (Figure 6).

Figure 6. Costa Rica: distribution of total payments under different modalities 1997 – 2010 (thousands of real 2011 dollars)



Source: Elaborated from FONAFIFO (2011) and La Gaceta (2010)

As of 2010, there are 5.762 valid contracts covering around 373.075 hectares and 2.698.164 trees from agroforestry systems. It is worth mentioning that demand for PES has more than exceeded available funds since the beginning of the program. Only a fourth of all applications have historically been awarded payments (Rojas y Aylward, 2003). From 2003 to 2010, only 35% of applications for forest protection and reforestation have been awarded, while the numbers regeneration and agroforestry are 27% and 51% respectively (FONAFIFO 2011)

3.1.1 Cost efficiency

Cost efficiency of PES programs in general depend on a wide variety of variables affecting both opportunity costs and transaction costs. In the case of the opportunity costs of forest protection, it can be defined as the net yearly income or the net present value forgone due to avoided land use changes.

In practice, opportunity costs are highly dependent on space, time and alternative land uses. They are also affected by methodological, legal, economic, geographical and physical factors such as the ones depicted in Table 5 (Grieg-Gran et ál., 2006; Olsen and Bishop 2009).

Table 5. Determinant factors of PES' opportunity costs

Legal, economic, social, geographical and physical factors	Methodological factors
Regulations affecting resource usage	Treatment of exploitation costs and logging
Prices of alternative products	Type of land/forest considered
Physical and economic viability of alternative activities	Way alternatives are modeled
Climate and soil characteristics affecting agricultural productivity	Method used to estimate carbon density per unit.
Operating scale	
Inputs, technology and management capacity	
Distance to markets and transport infrastructure	

Besides the many factors affecting opportunity costs, one of their most important determinants is alternative land uses. The relationship is positive and as such, the highest opportunity cost values are to be found near regions with high value activities. In the case of Costa Rica, opportunity costs are higher in areas close to high urban and industrial growth and in regions where forest and alternative economic activities are profitable (i.e. pineapple).

It has been argued that the opportunity cost of Costa Rican forest is zero since forest land cannot be legally converted to other uses. However, there are doubts regarding the governmental ability to fully enforce the law, resting value to the argument. In addition, legislation is meant for forest lands which imply that the opportunity costs of other land uses eligible for PES participation are higher than zero.

As a result, measuring cost effectiveness of the Costa Rican PES program is still relevant. To our knowledge, such analyses are rare. There is however a specific study that directly analyzed the cost effectiveness of the program's first 8 years (Arriagada et al., 2010). Results indicate that the cost of each additional hectare of forest (induced by the PES program) varies between $255 and $382 (without considering administrative costs). At the time of the study, landowners were receiving payments of approximately $43/ha, implying that the program was not covering opportunity costs. It is possible though that the cost effectiveness of the program have improved as it has matured, especially considering that since 2002, the first-come first served policy has been replaced by a more targeting oriented policy to assign payments.

Effectiveness of the program has also being analyzed in the light of other conservation mechanisms such as protected areas. For example, the project Ecomercados concluded that the PES program is more cost effective per unit of conservation than a protected area, although the area safeguarded might be smaller than in protected areas (World Bank, 2000). Ferraro and Simpson (2002) and Ferraro and Kiss (2002) support this idea by concluding that direct payments are far more efficient than other common investments that induce ecosystem protection as a byproduct.

Besides these results, there are critics regarding the effectiveness of the Costa Rican program on the grounds of targeting. Although having a voluntary program might enable fulfilling few policy objectives and help on its cost effectiveness, the voluntary dimension might also direct payments to areas with low opportunity cost (Sierra and Russman, 2006). The problem strives in that those areas might not coincide with the conservation needs of areas with high opportunity costs (Pagiola et al., 2004) which might keep been deforested.

In line with the believe that the cost effectiveness of the program would improve if selection criteria were based on deforestation risk, Robalino et al. (2011) concluded that the most effective regional offices are those located in areas with high deforestation rates. This result is supported by Barton et al. (2009) who state that selection criteria in the period 2002-2003 were twice more cost effective than the ones applied between 1999 and 2001. Results of Wünscher et al. (2008) also support this thesis by showing that using selection criteria would increase cost efficiency (effectiveness per unit spend) as payments adjust to heterogeneous transaction, opportunity costs and to direct costs.

3.1.2 Environmental effectiveness

There is a the lack of solid scientific studies analyzing the impact of the PES program on provision of environmental services per se, which heavily limits a proper analysis of its effectiveness. Most studies on services provided by the program have focused on forest cover as a surrogate for all four ecosystem services and biodiversity conservation. Besides, explicit and site specific indicators of ecosystem services have not been integrated into the set up.

Overall effectiveness of the program has been widely discussed, but based on forest cover and participation in the program. However, studies differ in terms of used methodologies and period analyzed which difficult finding a consensus regarding the program's effectiveness along its life spam.

When focused on protection, many studies agree on the limited impact of the program in avoiding deforestation, especially during its first years. For example, Pfaff et al. (2008) concluded that forest protection contracts from 1997 to 1999 reduced deforestation in just 0,08%; findings from Sánchez-Azofeifa et al. (2007) are even less optimistic as the authors argue that contracts from 1997 to 2000 did not reduce total deforestation[4].

Recent studies have reached more optimistic conclusions, although results indicate that the program has been more effective in promoting reforestation than in avoiding deforestation. For example Arriagada et al. (2010), who analyzed the effectiveness of the program in Sarapiquí for the period 1997-1998, found no effect of the program on deforestation but positive and significant impact in forest total cover. Sierra y Russman (2006) analyzed the impact of the program in the Osa Peninsula

[4] This reduced effectiveness in terms of avoided deforestation is sometimes related to the law prohibiting forest land use changes.

and concluded that it accelerated abandoning of agricultural lands, which were left for natural regeneration. However, the authors also concluded that forest cover was the same in plots receiving and not receiving PES. In line with these findings, Daniels (2010) states that the program might be an efficient instrument in preventing deforestation rather than in recuperating lost forest.

In a lesser degree the effectiveness of the PES program has been analyzed based on other modalities besides forest protection. For example, Yale-Paredes (2005-2006) evaluated the impact of the program in its plantation modality comparing plots under PES with exploitations with only voluntary certification, voluntary certification and PES and with no payments. The authors did not find any significant difference in the environmental performance (hydrological erosion control and compliance with activities during processing) of plots with payments and those with not payments or certification.

A limitation of most studies is their local character, they are based on specific regions which make it difficult to draw conclusions regarding the effectiveness of the program at the national level. Besides this limitation, by comparing similar studies (in terms of their methodology) it can be inferred that the degree of effectiveness of the program is region dependent. This is supported by a recent evaluation of Robalino et al. (2011) who found that deforestation between 2000 and 2005 was reduced between 0 and in 1% depending on the region analyzed.

Table 6 presents a summary of results obtained in different evaluations of the program. It shows the factors that affect the probability of participating in the program as well as its effectiveness.

Table 6. Factors affecting likelihood of participation in Costa Rica's PES and effectiveness of the program

	Factores que afectan probabilidad de participación en PES					Factores que afectan efectividad de PSA		
	a nivel de tracto censal	a nivel de finca				vs. no-PSA sobre cubertura de bosque a nivel de finca		
Covariables	Arriagada 2008	Robalino et al. 2011	Zbinden and Lee 2005	Morse et al. 2011	Sills et al. 2008	Sierra y Russmann 2006	Sanchez-Azofeifa et al. 2007	Arriagada et al. 2010
Ubicación								
Distancia a San Jose		-						
Distancia a pueblos	-	+					+ / 0	
Distancia a caminos nacionales		+						
Distancia a caminos locales		+						
Distancia a aserraderos		+						
Distancia al Atlántico		-						
Distancia al Pacífico		+						
Distancia a oficina forestal								+
Distancia a puerto	-							
Características naturales de zona								
Precipitación / Precipitación2		+						
Pendiente alto	+	-	+		+		+	+
Elevación		+						
Densidad población	-							
Características socio-económicos de zona								
Prioridad Proyecto Ecomercados	+							
Area en ASP no eligible para PSA	-							
Porcentaje hogares inmigrantes	+							
Porcentaje hogares que usan leña	+							
Porcentaje con empleo fuera de finca	-							

	Factores que afectan probabilidad de participación en PES					Factores que afectan efectividad de PSA		
	a nivel de tracto censal	a nivel de finca				vs. no-PSA sobre cubertura de bosque a nivel de finca		
Covariables	Arriagada 2008	Robalino et al. 2011	Zbinden and Lee 2005	Morse et al. 2011	Sills et al. 2008	Sierra y Russmann 2006	Sanchez-Azofeifa et al. 2007	Arriagada et al. 2010
Características de la finca								
Area de finca			+					+
Propiedad tiene título			+					
Asentamiento de IDA	+							
Tasa deforestación previa a PSA							-	
Cubertura forestal inicial		+			+			+
Capacidad de uso del suelo alto	-							
Costos de cambio de uso						+		
Costos de transporte						+		
Degradacion de suelo			+					
Características del finquero								
Endeudamiento			+					
Edad del dueño								
Años de educación			+					
Residente en parcela desde 1996					-			
Ingreso fuera de la finca			+					
Ingreso de la agricultura				-				
Mano de obra del hogar			-					
Participación previa en programa forestal					+			
Del valle central					+			
Participación en extención previa a PSA			+					

Source: Porras et al., 2012.

It is of common agreement that targeting or identifying priority areas for payments would increase the effectiveness of the program. Interestingly, how this targeting should be conducted depends on the focus people consider the program should have; e.g. some argue the poverty hotspots should be targeted (social scientists), others argue that ecological modeling should be used to identify where services are either needed (missing) or currently provided, and yet another group focus on questions of additionality (arguing that forests in per urban areas, on the agricultural frontier, or along roadsides should be targeted) at the expense of more extensive, but more isolated and therefore less threatened forests.

The debate on how best target the program's beneficiaries is evident in the literature. For example, Robalino et al. (2008) and Sierra y Russman (2006) favor targeting based on individual beneficiaries. Other recommendations include focusing on lands located close to existing forests and higher incidence of natural disasters (Ortiz et al., 2003); on abandoned agricultural lands and marginal vulnerable areas (Miranda et al., 2003 and Sierra and Russman, 2006); and more recently on land connectivity (Daniels et al., 2010). Others suggest that the program could be more effective in maintaining natural forests and increasing forest cover in biological corridors if focused on landowners with low forest dependency (Morse et al., 2009).

Similar arguments regarding lack of insufficient targeting, both of beneficiated lands and services are used to discuss the effectiveness of the program in water and biodiversity protection. It has been mentioned for example that since 2005 only 35% of PES lands were located within a watershed with downstream beneficiaries and only between 30% y 65% of PES parcels were key in protecting biodiversity (Blackman y Woodward, 2009).

Observed effectiveness of the program is also linked to the size of the payments. Since the amounts awarded do not cover the opportunity costs of alternative practices that are privately profitable and generate negative externalities, the program is not succeeding in incentivizing only socially desirable practices (Engel et al., 2008; Pattanayak et. al., 2010).

Others assert that due to the law enforced prohibition to cut forest, the PES program cannot have an impact on deforestation reduction (Sánchez-Azofeifa et al., 2007; Pfaff et al., 2008). However the program might have helped to make the prohibition more socially acceptable. Under this hypothesis, additionality of the program is put in doubt.

3.1.3 New approaches and finachial mechanisms

To overcome the limitations that are reducing both the effectiveness and efficiency of the Costa Rican PES program, a new approach to distribute payments based on bids is proposed. This mechanism would at least overcome problems related to flat-payments and the resultant inexistent differentiation between land quality, biodiversity and ecosystem services delivered.

With the proposed auction system, land owners are invited to submit bids (their required payment or compensation to enter into PES contract) for delivery of types of conservation activities the conservation agency (FONAFIFO) has specified. Rewards are based on specific activities for example change of land uses or land management practices.

It is expected that auctions would increase effectiveness and efficiency of the program as it increases the probability of achieving additionality compared to the current fixed payment scheme (Ferraro

2008). That is because paying low cost landowners less through an auction frees up resources to pay high cost -land owners who are much more likely to provide a much lower ecosystem services in the absence of a PES contract. Auctions may also be more targeted to take account of the heterogeneity of ecosystem services over the landscape, not just variations in opportunity cost. In the case of effectiveness, auctions may reduce cost for reaching environmental objective substantially compared to fixed price PES arrangements (Ferraro 2008; Rolfe and Windle 2008; Windle and Rolfe 2008).

3.1.4 Social and Economic Impacts

Although the primary objective of PES programs is to improve provision of environmental services, most government-financed programs (as the Costa Rican) have a social connotation (Wunder et al., 2008). In the case of Costa Rica, it has been argued that its PES program has a strong bias toward equity, since payments are made on the basis of a flat rate per hectare and are independent of land characteristics or provisioning costs (Pascual et al., 2010).

However this hypothesis might be wrong. Historical data shows that participation in the PES program is higher among owners of relatively large plots, higher education level, better access to information, higher debt capacity and that live outside their farms (Zbinden y Lee, 2005). Participation in the program has also being linked to lobbying from landowner or non-governmental institutions (Miranda et al. 2003 y Barton et al. 2003), which might imply that socio-economic benefits of the program are not uniformly distributed.

Specific studies have concluded that the program has had a modest impact on employment, infrastructure and micro enterprises through reforestation projects (Miranda et al., 2003, Tacconi et al., 2010) and on macroeconomic variables (Ross et al., 2007). It is argued on the other hand that there is still much analysis pending regarding direct impacts on family budget and small enterprises, and indirect impacts on tourism and quality of life of beneficiaries of improved ecosystem services (Ross et al., 2007).

Other social benefits are put into doubt. For example, the impact on helping landowners to legalize their ownership status has been limited as most applicants already have property titles when applying (Porras, 2010). There is also the issue of sustainability of the benefits in the long run, especially when payments do not cause permanent changes in the way people produce unless compensation is continuous (Pagiola et al*.,* 2007).

Intangible benefits such as perception of the program, improved relationships within the community and justice perception have not been widely analyzed although different studies indicate that such benefits are key for program participation even when opportunity costs as not fully covered (Blackman and Woodward 2010) as has been the case in Costa Rica.

In light of the low correspondence between FONAFIFO's multiple goals (increasing forest cover on private lands, poverty alleviation, and the four ES recognized) and those identified by Gruas II, it is evident that there is a need of analyzing the effectiveness of the program based on ecological terms. This would imply expanding the analysis to include indexes of biodiversity and ecosystem service provision.

3.2 National parks and protected areas

Since the decade of 1940 Costa Rica started protecting biodiversity as result of the national concern about the accelerated loss of forest cover and environmental degradation that the country was undergoing. Along with this process, Costa Rica began the development of a legal and institutional framework, in continuing evolution, that today supports the conservation of Costa Rica's rich biodiversity (Table 7).

Currently, Costa Rica is divided into 11 Conservation Areas; all together comprise the National System of Conservation Areas (SINAC, for its Spanish name). SINAC, as part of the MINAET, is the national entity in charge of the administrative management of the wildlife protected areas (http://www.sinac.go.cr/quienesomos.php).

Table 7. Some icon events for the conservation of biodiversity in Costa Rica

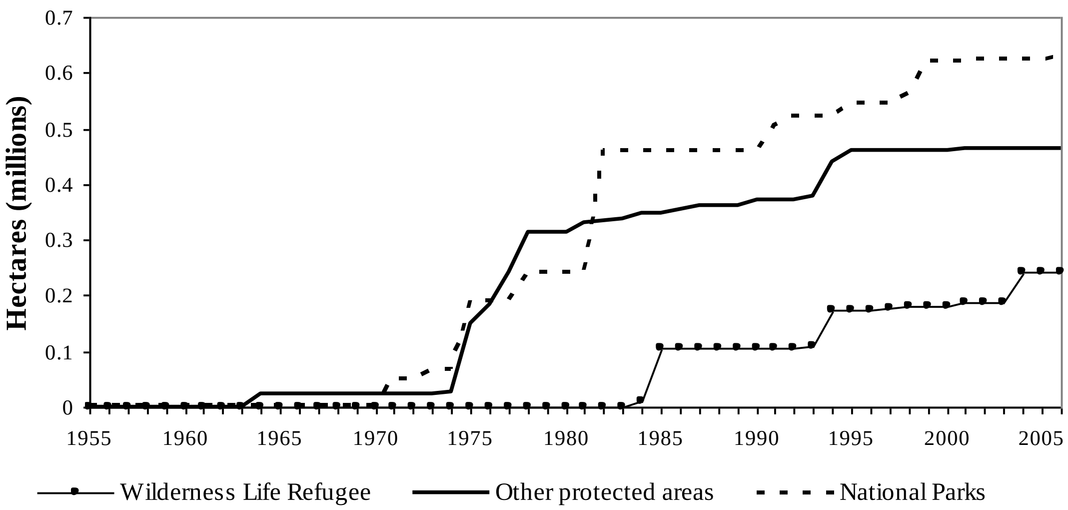
Year	Event
1945	A forest area ("Robledales") along the Inter-American highway, south of Cartago city, was declared as protected by the Law No. 197.
1955	Organic Law of the Costa Rican Institute of Tourism No. 1917 came into force, in which was declared that a circumference of 2 km around all the volcanic craters would be managed by the Costa Rican Institute of Tourism as National Parks. Turrialba and Irazu National Parks were created.
1963	Cabo Blanco Absolute Natural Reserve was created, becoming the first wildlife protected area created in the country.
1969	Forest Law No. 4465 came into force. This Law stipulated the creation of PAs (Protecting Zones, Forest Reserves, National Parks and Biological Reserves) in order to conserve the forest resources.
1977	National Park Service was created under the Law No. 6084, having as function to develop and manage the National Parks in order to protect the natural patrimony of the country.
1986	The Ministry of Natural Resources, Energy and Mines (MIRENEM) was created.
1990	Forest Law No. 7174 substituted the Law No. 4465, and the definitions of PAs categories evolved.
1992	Law of Wildlife Conservation No. 7317 came into force, and defined the creation of wildlife refuges.
1995	Environmental Organic Law No.7554 came into force, which stipulated that MIRENEM became MINAE (Ministry of Environment and Energy). This Law, in general terms, defined the PAs objectives and introduced the "Natural Monument" protected area category.
1996	Current Forest Law No.7575 came into force. This Law prohibits the conversion of forests to other land cover/uses types, and introduced the concept of "Natural Patrimony of the

	State" (Patrimonio Natural del Estado).
1998	Biodiversity Law No. 7788 came into force, in which the SINAC is consolidated.

Source: translated and adapted from http://www.sinac.go.cr/historia.php; INBio, 2006.

The first set of national parks was established in 1955, but most of them were created in the 1970s; only three have been set up since year 2000 (Figure 7). La Amistad is the largest National Park with almost 200,000 ha and Las Baulas the smallest with 110 ha.

Figure 7. Costa Rica: creation of protected areas: hectares by year



Another important category within the protected areas classification for Costa Rica is the Wilderness Life National Refugee which corresponds to the category IV in the IUCN known as Habitat/Species Management Area. This is a less strict category of conservation designated to protect and investigate the flora and fauna, especially when they are in extinction threat. In Costa Rica, there are three different types of wilderness life national refuges according to the property rights: private, public and mixed owned refuges. In the private owned refuges, human settlements are allowed inside the area, but species extraction is prohibited[5]. There are 71 wilderness life national refuges covering a 4.63% of national area (SINAC, 2007). Most of them are private or mixed owned refuges and have been created in the last 25 years, which demonstrates that there is a trend in the country to include private efforts into the protected areas conservation policies. Other protected areas categories are biological reserves, forestry reserves, protected zones, wetlands, national monuments and natural absolute reserves.

Currently, Costa Rica has 169 Wildlife Protected Areas managed by SINAC, from which 148 protect continental landscapes and 21 protect coastal-marine areas (SINAC, 2009). The national system of protected areas covers 26.2% of the continental territory and the 0.9% of the marine area belonging to the country (Table 8) (SINAC, 2009; SINAC-MINAE, 2007). The protected areas in conjunction with the private reserves protect nearly 30% of the country (SINAC-MINAE, 2007).

[5] Species extraction is also forbidden in public and mixed protected areas.

Table 8. Protected Areas by Category of Management, 2009

Number of Protected Areas	Category of management	Continental Area under protection (Ha)	Percentage (%) of continental national territory (51,000 km^2)	Coastal-marine area under protection (Ha)	Percentage (%) of coastal-marine national territory (30,308 km^2)	Porcentage (%) of exclusive economic oceanic zone (568,054 km^2)*	Total area under protection (Ha)
28	National Park	629,219	12.33	475,620	15.69	0.82	1,104,839
8	Biological Reserve	21,633	0.42	5,207	0.17	0.01	26,840
31	Protecting Zones	157,905	3.09	0	0	0	157,905
9	Forest Reserve	216,378	4.24	0	0	0	216,378
75	Wildlife National Refuge	238,307	4.67	38,436	1.27	0.07	276,743
13	Wetlands	68,542	1.34	5	0	0	68,547
5	Other categories	8,888	0.17	1,612	0.05	0	10,500
169	**TOTAL**	**1,340,872**	**26.26**	**520,880**	**17.18**	**0.9**	**1,861,752**

Source: translated and adapted from*: SINAC-MINAET 2009, and GRUAS II*

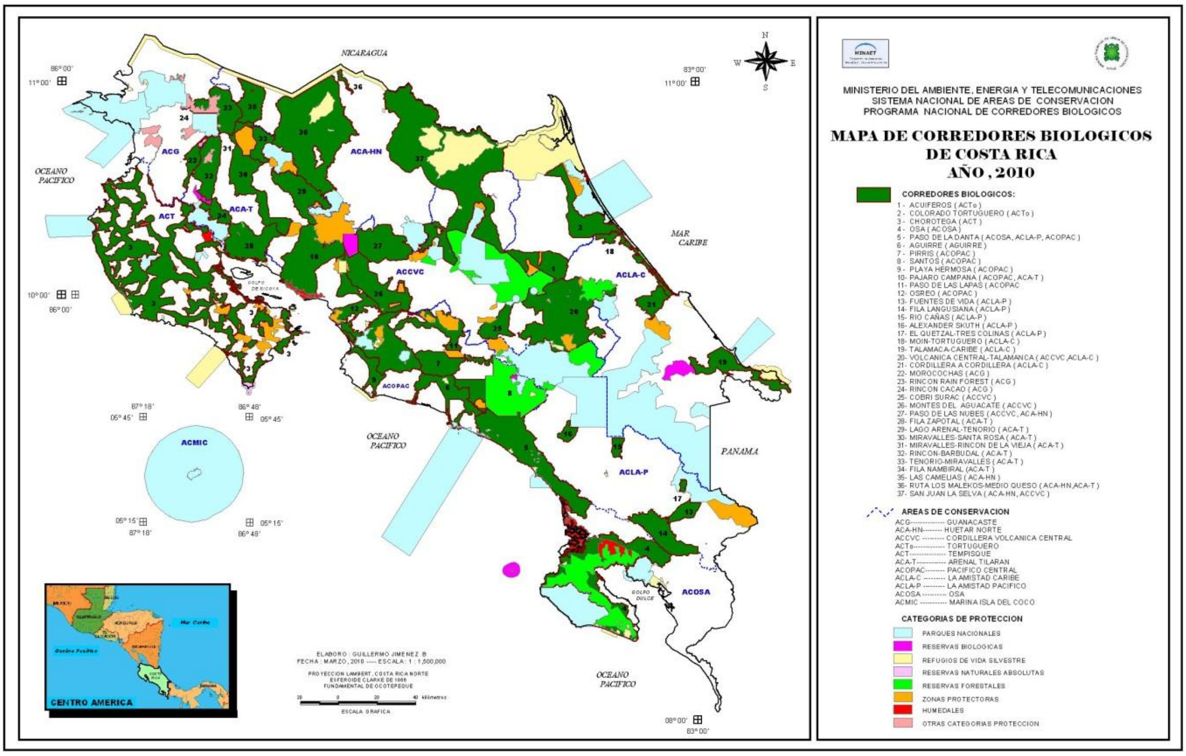
*GRUAS II reported as marine area under some PA categories the total of 5208.80 km^2 (SINAC-MINAE 2008).

How are areas protected in Costa Rica, and what is the extent or proportion of the nation under different forms of protection? The Gruas II authors identify 12 conservation categories in Costa Rica. These can be classified as areas under strict protection (14%), areas were limited resource extraction is permitted, or areas that are partially protected (10%) and areas that are temporarily protected (6%) including private reserves (1%) and farms receiving PES payments (5%). The total land area under one or more of these conservation regimes totals 30% (though note that recent reports have stated that Costa Rica currently enjoys greater than 50% forest cover).

As part of the consolidation of conservation efforts, Costa Rica adopted as national conservation strategy the establishment of biological corridors; a commitment to continue the Mesoamerican Biological Corridor initiative, that represents two decades of regional efforts.

In 2006, the National Program of Biological Corridors (NPBC) is legally constituted by the executive decree. No. 33106-MINAE. The NPBC operates under the SINAC framework and has as central objective to promote the sustainable management and conservation of Costa Rica's rich biodiversity on lands out of protected areas. In other words, biological corridors are established on private lands and their success depends on social concerted efforts (SINAC, 2009b). The 37 biological corridors that exist today cover 34% of the national territory, approximately 1,753,822 ha (Figure 8). Considering the total conservation gap reported by GRUAS II (283.322 ha), 21.5% of these areas are located within biological corridors (61,000 ha) (SINAC, 2009b).

Figure 8. Current Biological Corridors initiative in Costa Rica, protected areas and their distribution on the 11 conservation areas



Source: http://www.sinac.go.cr/corredoresbiologicos/home.html

3.2.1 Environmental impacts

Although Costa Rica has been successful in creating a conservation network of protected areas- it has been questioned whether it is functioning effectively as a network for structural and functional conservation of biodiversity.

Measuring the effectiveness of protected areas has methodological restrictions as the effective rates of avoided deforestation and biodiversity protection cannot be directly measured. That is, it is not possible to observe the real values these variables would have taken in the absence of protected areas. To overcome this pitfall, some analyses have applied novel techniques that allow comparing surrogates for environmental impacts (deforestation for example) between protected areas and comparable counterfactuals. It is important to highlight the fact that “naïve” techniques -not based on similar counterfactuals- overestimate the impact of protected areas.

Andams et al. (2008) for example, measured the impacts of the Costa Rican protected areas system on deforestation between 1960 and 1997. They found that this instrument was successful in reducing deforestation in approximately 10%. However, other authors have concluded that the benefits of protected areas, particularly in terms of avoided deforestation, are conditional on park's location such as closeness to cities and national roads and on land characteristics, specifically slope. It has been found for example that avoided deforestation is higher in parks close to cities and national roads and on land with lower slopes (Pfaff et al., 2009), probably as the opportunity cost of conservation tend to increase with those features.

Another challenge made to the effectiveness of protected areas relates to the land types they are protecting. Analysis of Sanchez-Azofeifa et al. (2003) indicate that number-level-1 conservation areas currently exists for moist forest lower-mountain and wet forest mountain life zones although they account for most fertile soils in the country.

A limiting factor of the effectiveness of protected areas is that spillovers from protected to unprotected areas are almost insignificant, that is, protected areas do not reduce deforestation in circumvent areas (Andams et al., 2008). Moreover, results indicate that as distance increases from national parks and biological reserves, total deforestation and deforestation rates also increase (Sanchez-Azofeifa et al. 2003).

Three main trends are observed when deforestation rates are compared across periods. The first evidence is observed for the Guanacaste, Tenorio Volcano and Carara 10-km buffers where high deforestation rates during the first two periods were followed by sharp reduction during the period 1976-1997. Sanchez Azofeifa et al. (2003) found increased deforestation rates during the last 10 years, specifically the buffer zones around Tortuguero, Braulio Carillo and Manuel Antonio national parks. Results show that areas surrounding Level 1[6] conservation areas are highly fragmented, i.e. Braulio Carrillo and Cahuita, which may be due to agricultural intensification with banana and pineapple.

The need for better targeting in the location of protected areas is brought into discussion as a way to improve effectiveness. Pfaff et al., (2009) for instance advocate for governments to target areas close to cities and national roads (in light of their research findings) for the establishment of protected areas. In general it could be argued that protected areas should be located close to regions where the opportunity cost of conservation is high.

3.2.2 Socioeconomic impacts

Conservation policies are relevant not only for pursuing environmental objectives but also because they have socioeconomic implications. For instance, tourism and ecotourism specifically related to protected areas play a central role within the tourism industry. For the last five years, visitation in protected areas in Costa Rica exceeded 1 million visits per year, generating revenues for entrance fees that exceeded 5 million dollars in year 2005 and employing directly around 500 people (SINAC 2007).

Previous empirical studies in Costa Rica have quantified how much national parks contribute to socioeconomic development at three different levels: local, regional and national. Fürst et al. (2004) conducted a cluster analysis in Chirripó, Poás Volcano, and Cahuita national parks, and Naranjo

[6] Level-1 denotes areas under protection such as national parks and biological reserves where no land cover change is allowed.

(2007) applied a similar methodology in Braulio Carrillo National Park. Fürst et al. found that the main impacts at local level are the income generation in the tourism activities, the benefits caused by the watershed protection, the increase in the land price, and the appearance of new activities related to tourism such as guides, handcrafts and local products sales. At the regional level, the positive impacts also are related to the tourism activities and watershed protection as well as the taxes revenues for the local government. Finally, at a national level, the main impacts are related to profits by the entrance fee, which are reinvested in the national conservation system. Other similar study cases are being currently conducted by CINPE at National University of Costa Rica (UNA).

Three recent studies estimated the effect of national parks on welfare, controlling for other factors that can be correlated with the outcomes, thus finding appropriate comparing groups that serve as baseline. Andam et al. (2010) found that protected areas have alleviated poverty in year 2000. They do not only show that protected areas reduce poverty but also prove that poverty alleviation from protected areas is higher in areas with higher baseline poverty levels and in strict protected areas (IUCN classes I and II). Also, Robalino and Villalobos (2009) found that people living close to national parks entrances receive higher wages than comparable individual living far away from parks or far from park entrances. Villalobos (2009) found similar results for employment opportunities, i.e., parks reduce the probability of being unemployed for workers living close to parks, especially when located close to the park' entrance.

3.3 Certification schemes

Voluntary forest certification is a process in which a forest or forest plantation owner voluntarily requests an independent certification entity to inspect and verify that her estate complies with clearly defined environmental and social criteria and standards. The verification process may also include the audit of products from the storage points to sale points and concludes with the issuance of a certification seal awarded by the independent third party (WWF 2010 a, b; Viana et al.1996).

The overall objective of certification is to improve forests and forest plantations management to provide producers that operate with higher environmental standards, means to differentiate their products in the market. This differentiation enables consumers to recognize products coming from high conservation value forests and that generated greater amount of social and environmental benefits compared with their uncertified counterparts (Gullison, 2003; WWF, 2010a).

The first forest management unit certified in Costa Rica was awarded in 1992 (Louman et al. 2005). In 1994, in the framework of the commitments undertaken by the country at the Earth Summit in Rio, it began a national process to develop standards of sustainable forest management, mainly promoted by private enterprise. In this context is that forest certification started drawing more attention (Méndez et al., 2004).

This process created the need to create a national system of forest certification. As part of the forestry law, the State Forestry Administration (Administración Forestal del Estado, AFE) was assigned the task of granting licenses to certifying companies and regulating and monitoring the certification process (Méndez et al., 2004). Likewise, the National Commission of Forest Certification (Comisión Nacional de Certificación Forestal -CNCF) was created.

In 1998, the CNCF published a decree containing the principles, criteria and national indicators to promote national forest management. Although the Forest Stewardship Council (FSC) was asked to recognize this process, its approval was not granted in part due to governmental participation in the process. As a result and up until now, interested parties must follow an independent certification process in order to obtain seals endorsed by the FSC, that is, without any governmental participation (Méndez et al*.* 2004).

Forest and forest plantation certification in Costa Rica may be either individual or group. In the first, a single state is granted the seal if it complies with FSC criteria. In the second case, an umbrella scheme was developed in which FUNDECOR asks a certifying institution to review its procedures to follow up individual operations of its members. This structure grants small owners an opportunity to participate in a certifying process that would not have otherwise but at the same time, implies a big responsibility to the organization as a serious fault from any given farm would imply losing the seal for the entire group.

As of February 2011, there were 52934 ha certified by FSC and 14 different seals including forest management and custody chains (FSC, 2011). In 2001 there were 44839 ha certified (Stoian y Carreras 2001), which implies a total growth of 8095 ha, 8.5%, in 10 years. In 2004, 32% of the existing 131913 ha of forest plantations were certified, percentage higher than any other country worldwide (Méndez et al. 2004).

In Costa Rica, FUNDECOR y and the Centro Cantonal de Hojancha (Hojancha's Cantonal Center - CACH) are two of the main organizations that facilitate the umbrella certification scheme. In the specific case of Hojancha, any producer affiliated to CACH is entitled to certificate her exploitation.

From the demand side perspective, there is no national market for certified wood; the objective of the certification process is oriented toward the international markets and to comply with international requirements. The exception is given FUNDECRO and Portico, the former works directly with small and medium producers who sell its product to Portico and receive prices up to 50% higher than local prices (Méndez *et al.* 2004).

3.3.1 Effectiveness, cost efficiency and social impacts

It is been claimed that certified forest firms acquire a culture of social and environmental responsibility than their non-certified counterfactuals lack (Méndez et al. 2004). In this sense, one would expect certification processes to have a positive impact; however, we did not find any study assessing those impacts for the case of Costa Rica.

Some general studies have challenged the economic benefits certification provides to producers, particularly to small entrepreneurs (Stoian y Carrera 2001). Others claim that certification, due to its relatively high associated costs, are too restrictive to small and low-income communities (Scherr et al*.* 2003), which not only reduces the effectiveness of the mechanism but also functions as an entrance market restriction able to create oligopolistic power for big companies.

Certification costs are usually high and directly correlated to the area to be certified. Furthermore, costs per ha are inversely proportional to the size of the exploitation. They have been estimated to ascend to \$1 ha^{-1} in the case of collective processes and between \$1.5 y \$2 ha^{-1} for individual certifications.

3.4 Direct regulations

Costa Rica is known for its wide regulations related to biodiversity management. This legal framework contains about 24 rules, laws and decrees in reference to the subject. Only in 1994 there was a 44% increase in the issuance of regulations, coinciding with the inclusion in national development policy sustainable, which promoted the conservation approach. In addition, international conventions and treaties have had an effect on the country's legal system, since the ratification of the Convention on Biological Diversity and the one on Climate Change the protection of 30 wilderness areas were added to the then existing 100 protected areas (INBIO, CR).

With regard to the conservation of biodiversity, the law establishes objectives, the application scenario, principles, and ownership for biodiversity. Due to the complexity of biodiversity issues many rules have been put in place. These cover a diverse range of economic, cultural, scientific-technical and general cross-scale management issues (INBIO, CR). To date in Costa Rica there are a total of 165 protected areas belonging to different protection categories of whom 44% are in private hands, and many of which have no sufficient resources for their sustainable management (CR GEO).

Campos (2005) indicates the existence of 45 laws that regulate some aspect of land use that is relevant for biodiversity conservation such as urban development, infrastructure, water, sanitation and health, natural resources, municipalities, takings and easements, watershed management, among others. In 1998, the Government enacted the Law of Conservation and Land Use Management, which is an extensive regulation of over 170 articles, and is currently the legal basis for the protection of biodiversity.

3.5 Sector instruments potentially affecting conservation

Several instruments have been designed and implemented by different sectors with the common aim to conserve ecosystem services in Costa Rica although with different emphasis on type of ecosystem services and intended beneficiaries. Moreover the designed or implemented instruments have a different focus also in respect to the scale of targeted demand and supply of ES.

For example, at international level Costa Rica, as many other Central American Countries, have established agreements to support the growth of its trading sectors through the bilateral Free Trade Agreements with European Union and the US. The negotiation of both agreements included some consideration of the potential impacts of its activities on ecosystem services although many oppositions from civil society, environmental NGOs, and political parties raised in respect to the opening to international markets of key natural resources that might affect conservation and access to water and biodiversity Indeed, although there has been debate on these issues during the FTA negotiations, little enforcement of instruments is ensured to guarantee the appropriate measures to minimize impacts on ecosystem goods and services (Merino del Rio, 2003).

At a more local level, since the start of the Municipal Regime with the 1949 Constitution, Municipalities have had an intended role to protect local interests and with the following Laws (4574-1970 and 7794-1998) have acquired a role in the planning of their territories. Since 1998 Law more than 120 Municipal Land Planning Laws have been discussed at the Legislative level and recent data show that Municipal Environmental Planning Committees represent an interesting space for involvement and participation of citizens on the planning related to environmental issues (Rojas, 2008). Municipalities are provided with the power to establish instruments (e.g. the mandated constitution of Municipal Environmental Committees) to promote the conservation of different ES. Moreover, they participate in the SINAC Regional Conservation Councils with an active role in ensuring that local initiatives are framed in respect of regionally relevant ecosystem processes.

Several legislative instruments have been approved to reinforce local administration of Natural Resources such as the 7554-1995 Law that established the Regional Environmental Councils which were endowed with resources by the 7575-1996 FONAFIFO Law which established the National Payment for Ecosystem Services scheme. The creation of the Local Councils for Biological Corridors (Executive Decree 33106- MINAET, 2006) adds an additional space for participation of civil society in biodiversity conservation although a recent assessment suggests that where water-related problems are a critical issue for those participating in these platforms they perform higher stability and activity over time (Canet, Pers. Comm.).

We could also include among the non-National instruments user-defined ES conservation schemes (Engel et al., 2008) which are adopted especially in relation to water resources where a specific user is interested in the appropriate provision of an ES that is a key input into its production function such as CNFL, Platanar, Heredia ESPH, La Costenia, Azucarera El Viejo, Florida Ice & Farm, Exporparc and Hydroelectric Aguas Zarca all related to water issues and Desarrollo Hoteleros Guanacaste to tourism (Pagiola, 2008).

At the National level, the environmentally-adjusted water tax (*Canon de Agua*) is a cross-sectoral instrument intended to internalize the costs of using water resources and provide rules for its redistribution to ES conservation initiatives to conserve water quality and biodiversity. More specifically, it taxes sectors where domestic, industry, agriculture and livestock, and hydropower users are benefitting from National water resources. The redistribution of the financial resources rules that the tax component proceeding from the use of the resource will be assigned to strengthen the Water Department of the Ministry of Environment (MINAET) while the portion related to the provision of hydrologic ecosystem services is provided to the National System for Protected Areas (SINAC). This instrument provides consideration for those enterprises that are already internalizing the environmental cost of the water they use by discounting these resources they pay to FONAFIFO or other ES managing organization from their correspondent water tax (Ponce, 2006).

A more sectorial approach to the analysis of National ES conservation instruments in Costa Rica includes agricultural and forestry sectors given their strong influence on conservation of ecosystem services.

For the agricultural sector, the National Plan (SEPSA in Spanish), has included policies to address conservation efforts including provision for the adoption by sector activities of adequate ecosystem management, land use planning and sustainable agriculture practices. Since the National PES scheme has traditionally financed only forest type of activities, the agricultural sector has been excluded by the opportunities to promote ES conservation. In this respect, a recent environmental and social validation workshop on the National proposal for REDD+ regime, representatives of associations of small agriculturalists have highlighted the need to include their conservation efforts into the scheme. The recent Organic Agriculture Law contemplates financial resources for the Ministry of Agriculture to establish a mechanism to provide economic incentives (direct transfer or indirect through tax and banking preferential services) to organic farmers for the provision of ES related to Greenhouse Gas Emissions, water quality and biodiversity (8591-2007 Law).

3.6 Interactions in the existing policymix

Table 9 presents a summary of the assessment of the various instruments previously analyzed regarding their effectiveness, cost efficiency, social impacts, and political viability.

Table 9. One way functional role analysis of the analyzed instruments

Policy	Effectiveness	Efficiency	Socio economic effects	Political viability
Costa Rican PES	Low-moderate	Moderate-high	Low	High
Protected areas	Moderate-high	Moderate-high	Low-moderate	Moderate
Certification	Moderate	Low	Low	Low
Direct regulations	Moderate-high	Moderate-high	Low	Low-moderate
Sector instruments	Low	-	-	Depends on the instrument

As discussed broadly, effectiveness of most instruments, particularly PES and protected areas, has been compromised by weak targeting. Nonetheless, the lowest effectiveness is observed in certification schemes, sector instruments and at a lesser degree on the PES program. In the case of certification, low effectiveness is explained by the fact that forest plantations are not intended, nor fit, for biodiversity protection. Sector instruments on the other hand are not directly developed with ecosystem services provision in mind, so their impact on biodiversity is limited and almost coincidental. Finally, the PES program has had a small, although significant, impact on avoided deforestation due to limited targeting, especially at the beginning of the program.

Cost-efficiency of certification schemes is considered low because of the high transaction costs implicit in the certification process. Since sector instruments are not developed with environmental goals in mind, its efficiency is not analyzed in this context. Meanwhile, cost-efficiency levels are considered moderate to high in the cases of the PES program, protected areas and direct regulations. In the first two cases, this indicator could be improved via targeting. In addition, cost efficiency of PES can be enhanced by decreasing transaction costs and by making payment levels proportional to opportunity costs. Porras et al. (2012) for example indicate four possible scenarios of alternative combinations of land profitability (opportunity costs) and regulation in determining achievable efficiency (and effectiveness) levels of the Costa Rican PES (Table 10).

Table 10. PES cost efficiency levels as determined by alternative combinations of land profitability (opportunity costs) and land use regulation

Profitability		Land use regulation: Yes	Land use regulation: NO
	High	Secure regulation PES no needed for deforestation protection	(For example pineapple in agriculture lands) PSA does not compete.
	Low	Lower payments can keep forests	PES enhances financial viability. For regeneration purposes, higher payments are needed.

Source: Porras et al., 2012.

The hardest challenges are represented by highly profitable areas. In one hand, when land use regulations are enforced PES is not needed for forest protection. Although payments can be considered as compensation to land owners for conserving forests and as such politically desirable, eliminating payments in these areas would increase efficiency of the program. On the other hand, if land use regulation is no enforced, payments are incapable of making forest conservation financially attractive in comparison to alternative land uses (pineapple and urbanization for example).

In lands of low profitability PES can potentially be effective. However, payment adjustments are recommended depending on whether land use regulations are being enforced. In the presence of regulations, lower payments levels can be enough to protect forests, which would increase the cost efficiency of the instrument. On the contrary, in the absence of land use regulations, PES enhances financial viability of forest but higher payments are needed for regeneration purposes to secure the continuity of these areas under current land use.

Regarding the socio economic impacts, several analysis conclude that most instruments have a relatively limited effect. The only exception is protected areas, for which some studies have found moderate impacts in terms of salaries and poverty alleviation. It must be kept in mind that none of the analyzed instruments have been developed with an explicit social orientation, although poverty reduction is one of the several goals they must serve.

Finally, political viability highly varies within the instrument in question. The most popular instrument is the PES program, which demand has exceeded fund availability almost since the program's launching. Protected areas are also viable with the limitation that land expropriation for establishment of new national parks is costly and is usually subject of popular rejection. Political viability of certification is regarded as low due to the country's failed attempts in trying to implement a national certification program. It is also considered that additional regulations are not highly viable from a political perspective as they can be considered excessive by the public in light of the many existing laws.

It can be concluded from this analysis that there is potential for complementarities between instruments. For example, moderate and highly viable political instruments with relatively low effectiveness can be combined with instruments with lower viability but high potential in terms of effectiveness and efficiency. Under this scenario one could argue that PES and certification can work together as payments received by farmers could finance the costs associated to the certifying process. The complementarity of both instruments can be further enhanced (effectiveness and cost-efficiency) by targeting payments in hot spots areas of biodiversity conservation or deforestation.

In this line of thinking, the complementarity between PES and certification was analyzed by Yale and Paredes (2005). They evaluated the impact of both instruments on environmental performance of commercial plantations. The authors analyzed plots without PES or certification; plots with only certification; plots with only PES; and, plots receiving both incentives. The best performance (protection and control of hydrological erosion, compliance of activities during the exploitation process) was observed in plantations with only certification and on those with both certification and PES.

Table 11 presents a two way analysis of possible instruments interactions. Probably, all instruments have related in one way or the other, but there is not data available to analyze some of those interactions. Direct regulation has been enforced with all other instruments as Forest Law is mandatory nationwide. Although there are not explicit analysis of the effectiveness of the forest law and the PES program working together, one would expect that the effectiveness and cost-efficiency of the later has being challenged by the former as both policies are meant to target the same problem (deforestation). Since forest law is mandatory, and assuming that enforcement is achieved, it can be easily concluded that direct regulation is limiting potential effectiveness of the PES.

Table 11. Two way analysis of instruments interaction

Policy instruments	Costa Rican PES	Protected areas	Certification	Direct regulation
Costa Rican PES		+/-	+	-
Protected areas			+	-
Certification				+
Direct regulations				

As the table shows, interaction between direct regulation, protected areas and PES has been regarded as contradictory, reducing the effectiveness of the PES program; and thus, the interaction is considered negative. Two main examples are given illustrate this phenomenon. The first is related to indigenous territories and law prohibition to extract rents from forest products and the second to the impossibility of private land located within national parks boundaries to apply to PES. The other relates to the impossibility of private land located within national parks boundaries to apply to PES.

In the first case, indigenous people are limited by law to benefit from forest services only within the reserve boundaries. This prohibition disables them to commercialize timber products, punting them in disadvantage with respect to other sectors of the society that can apply for sustainable forest management permits and projects. In fact, this prohibition has had socio-economic negative impacts on indigenous communities as sustainable forest management projects are no longer attractive.

In the second case, forest law requires possession of land title to apply to the program; however, most landowners within national parks do not have legal rights of their lands as they are being disputed with the state (Navarro, 2010). This reduces the effectiveness of the protected areas in safeguarding biodiversity as private landowners are not eligible for PES. At the same time, additionality of the PES is compromised in areas with high conservation value such as protected areas.

The interaction between protected areas and PES has not yet being analyzed. However, based on separate analysis of the impact of both instruments some conclusions can be drawn. For example, studies conclude that protected areas are more effective when established on land with high opportunity costs (e.g. close to cities and national roads and with lower slopes) while effectiveness of PES is low in such areas (payments cannot compete with high opportunity cost activities). This opens the door to complementarities as potential areas can be targeted according to their cost opportunity.

There is also evident interaction between certification and the PES program. The particularity of this interaction relies on the many similarities shown by both instruments (the two of them are voluntary and market based) but also on their complementarity. Table 12 presents a comparison of the Costa Rican forest certification mechanism and PES program based on general principles, characteristics of funding and payments source and nature. The differences in both instruments support their complementarity, as discussed earlier. For example, while certification does not guarantee the producer any given level of payment (it depends on market dynamics) introducing a risk factor, enrolling in the PES program does ensure the producer receiving a certain flat payment during the contract's life spam. Combining both mechanisms would reduce at some level the income risk producers face if only certification schemes are adopted. Another complementarity is related to social outcomes. Eco-labeling incorporates social principles that guarantee minimum working conditions in forest plantations. This feature might be used by policy makers to enhance social outcomes of biodiversity conservation efforts.

Table 12. Principles and source of finding of Costa Rican Certification and PES mechanisms

	Certification	**PES**
Principles	ES provision depends on forest management and label principles	ES provision depends on land use or in the particular case of Costa Rica, on the PES
Source of funding	Final international consumer through timber chain actors	Governmental, international credits, donations, FONAFIFO's own generated.
	Depends on consumer´s willingness to pay for higher prices	Independent of consumer's willingness to pay as it is not a consumer funded program

Nature of funding	Price premium of certified products	Variable
Payments	Determined at the market level Based on the purchase of certified timber products Based on units sold Differential payments according to product's quality, market demand, etc. Payments fluctuations, no guarantee of a given price as it depends on markets dynamics	Not endogenously determine78d Contract based Based on land area (ha) Flat payment for each modality Payment level guaranteed during the contract life spam.
Characteristics and limits	Payments not associated to specific ES Payments (price premium) might include social factors besides biodiversity conservation and ES provision Depends on international markets dynamics	Payments associated to a bundle of ES Payments do not include social aspects but the program has a socio-economic connotation Requires the institutional development of new markets for ES

Source: updated from Le Coq et al., 2012.

4 Roles of proposed and potential new economic instruments: the case of REDD+

If managed properly, the REDD+ mechanism has the potential of delivering significant benefits to biodiversity conservation because forest harbor much of the terrestrial and freshwater biota, and are threatened by ongoing forest clearance and degradation. However, some authors have raised concerns of possible negative outcomes of REDD+ mechanism on biodiversity and ecosystem services if safeguards are not observed and integrated in the design and implementation of REDD+ (Gardner xxxxx). For this reason it is important for the countries to adopt the Cancun agreement (Apendix 1 decision 1/CP 16). REDD+ activities should be consistent with the objective of the environmental integrity and take into account the multiple functions of forests and other ecosystems and further that actions are consistent with the conservation of natural forest and biological diversity- ensuring that (REDD+ activities) are not used for the conversion of natural forests but are instead used to incentivize protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits.

A key step in the initial planning and design of national REDD+ programs is to set criteria for selecting priority ecological regions of investments in emission and reductions through forest conservation and management, and determine the type of REDD+ activities to be implemented.

At the moment Costa Rica is in the process of negotiations with REDD+ mechanism and has set key goals for reducing deforestation (

Table 13) considering the priorities of GRUAS II and other co-benefits to be achieved with the implementation of the REDD+ mechanism. The criteria used for selecting areas were based on the risk for deforestation and degradation and other co-benefits. The specific actions outlined to avoid deforestation and degradation are:

1) Integration of carbon capture in national parks and biological reserves in the REDD+ strategy;

2) Maintain the coverage of the payment for environmental services program (PES);

3) Increase the coverage of PES program;

4) Promote sustainable production and use of timber in natural forest (primary and secondary) and reforestation using recognized certification schemes for sustainable forest management and production;

5) Coordinate and support the Cadaster and Regularization initiative on areas under special regimes, including indigenous communities;

6) Strengthen SINAC to control illegal forest harvesting or and or logging and forest fires;

7) Strengthen the management audit action of CIAgro;

8) Generate fresh, predictable and long run funds to finance the national REDD+ strategy.

There has been a lot of concerns as to how equity and legitimacy are addressed within the REDD+ planning and implementation. In Costa Rica a large percentage of the area is within private indigenous reserves, and the indigenous groups participated in the consultation and design of REDD+ and there is a formal agreement between these groups and FONAFIFO with respect to their participation.

As mentioned above, REDD+ activities will include avoided deforestation and degradation and one of the challenges will be to develop a MRV-monitoring, reporting and verification system which provides data to evaluate changes in forest cover, type and level of degradation and restoration and emission factors which estimate likely changes in carbon stocks and emissions resulting from activities planned in the REDD+ scheme. Currently, PES program is using tree cover as a proxy to monitor impact of PES but it will be required a more robust MRV system for reporting within the REDD+ scheme. One of the joint goals of the Pesalia-Policymix project is to develop a monitoring and evaluation system using GIS tools which is linked to the Cadaster, and has indicators of forest degradation and biodiversity.

Table 13. Costa Rica's goal for deforestation reduction

Option	Tenure regime	Option to reduce emission	PES area (ha)	CO_2 tons
A	Private and indigenous reserves	Additional PES area for avoided deforestation old forest.	107,600	4,793,000
B	Private forests	For avoided deforestation medium regeneration	19,191	833,503
C	Private forests	Additional PES area for carbon sequestration under early regeneration	123,120	6,517,412
D	Private forests	Additional PES area for carbon sequestration under new plantation establishment	72,132	7,623,406
E	Indigenous reserves	Additional PES area for carbon sequestration under early regeneration	18,742	1,147,726
F	Do not apply	Carbon sequestration in wood products by increasing wood usage	-	10,000,000
	Total		340,784	30,9151,45

Environmental concerns surrounding REDD+ can be broadly divided into three, overlapping categories: ensuring that no further harm is done to natural forest, maintaining the long term ecological integrity of forests and capitalizing on opportunities to secure net –positive impacts for biodiversity (CBD 2010). The first set of concerns relates primarily to the risk of conservation of natural forest, the displacement (leakage) of deforestation and forest degradation activities to areas of lower carbon but high biodiversity value /including non-forest ecosystems such as savannahs, and the potential for afforestation of non-forest land, , all as direct and indirect result of REDD+ activities. The second set of concern is focused on ensuring the permanence of forest carbon stocks and emphasizes the importance of considering the functional significance of biodiversity (Diaz et al. al 2009) and lessons from landscape ecology and the ecosystem approach (Gardner et al., 2009) as enabling conditions for maintaining ecological resilience in human-modified forest ecosystems. The third type of concern relates to the risk of failing to exploit significant economies of scale and deliver additional benefits for biodiversity if REDD+ activities are not designed strategically, and with the conservation of forest conservation and biodiversity targets and incentives outside the strict remit of the UNFCC negotiations /miles and kapos 2008).

As a key step in the initial planning and design of national REDD+ programs is to decide upon the priority regions for investments in emission reductions through forest conservation and management, and the type of REDD+ activities that should be implemented. MRV- monitoring reporting and verification- will require data to verify data: activity data to describe changes in forest cover, type and level of degradation and restoration and emission factors ‘which estimate likely changes in carbon stocks and emissions resulting from these activities.

5 Interactions of economic instruments and the policymix

5.1 Synthesis

Costa Rica’s many biodiversity conservations and ES provision instruments interact in many ways. Some of these interactions are regarded as complementary while other are self-defeating. In general, direct regulation (law) interacts with all other instruments.

Usually this interaction is counterproductive as it decreases potential effectiveness of the instruments. Examples of this situation are given by the prohibitions of private land in national parks to receive PES and of indigenous communities to extract rents from forest products. The first reduces the effectiveness of the PES in high value conservation lands while the other creates a perverse incentive against sustainable forest management in indigenous reserves.
Certification and PES can be viewed as complementary instruments as they can enhance the other’s outcome. The same can be said for the interaction between certification and direct regulations. Certification can be viewed as a way of producers to comply with environmental law and at the same time receive an economic incentive in the form of price premiums. Unfortunately in the case of Costa Rica, this interaction is probably inexistent as there is no domestic market for certified timber products.

5.2 Further research questions regarding functional role analysis for local fine grain analysis

From the functional role analysis of the main instruments affecting biodiversity conservation and ecosystem service provision in Costa Rica, it has been made evident the asymmetry in the degree that each policy has been studied. The PES program is the instrument that by far has been more deeply analyzed. Yet, there are still some missing aspects to be analyzed, particularly in terms of the interaction of the program with other instruments and the impact of that interaction on the effectiveness, efficiency, social outcome and legitimacy of the instrument.

Analysis of these aspects will enable answering the following questions:

1. How have conservation strategies affected LUCC, and how has LUCC affected the provision of ES?
2. Where are areas of conflict and synergy between bio-physical and perceived ES provisions?
3. How can we spatially optimize conservation and socio-economic benefits on the landscape?

6 Impact evaluation (Step 3a)

This section explain in a general manner the methodologies and data gaps existing to analyze the effectiveness, efficiency, social impacts and legitimacy and institutional constraints of the Costa Rican PES program in light of the Policymix framework.

6.1 Conservation effectiveness

The Costa Rican case study will mainly focus on the effectiveness analysis of the PES program. This goal will be accomplished by analyzing the impact of the program on several biodiversity indicators.

This analysis will be based quasi-experimental methods where a counterfactual to PES plots is to be created. This counterfactual mimics what would have been happened with PES plots in absence of the program in terms of the impact indexes of interest. For the purpose of the project, indicators are to be centered on indexes of ecosystem service provision (erosion control, adaptive capacity to climate change and pollination) and ecological integrity.

The greatest limitation in terms of data availability is the availability of proper surrogates for biodiversity conservation and ES provision. This weakness will be addressed by directly collecting biodiversity data in situ in Hojancha. Also, aerial orthophotos from the Cadastre program are to be used to approximate forest cover and quality. Data sets gathered from existent analysis (particularly in Central Volcanic Cordillera) are to be used as well in order to generate a more complete database.

6.2 Cost-effectiveness and benefits (WP4)

Cost effectiveness analysis will be partially based on results from conservation effectiveness and paired with a detailed study of transaction and opportunity costs. When possible, results of the cost-effectiveness estimation are to be compared to existent literature on the cost-effectiveness of other instruments to draw conclusions on the relative efficiency of the PES program in regards to alternative policies.

6.3 Distributive impacts and legitimacy (WP5)

This analysis of legitimacy and social impacts will consists on an ex-post study of the social outcomes of the PES program aiming at answering the following questions:

1. Does the current design of the PES program meet procedural justice?
2. What have been the main socio-economic impacts of the program?
3. What factors have played a role in the definition of those impacts?
4. How the legitimacy of the program has affected its effectiveness?

This analysis will be mainly made based on secondary data sources as well as on primary data collected in field experiments aiming at responding the other impact questions included in the study.

7 Scenario analysis (Step 3b)

(Zayra Ramos-Bendaña, Oscar Abelleira, Mo Essen, Sara Galbraith, and Héctor Tavárez-Vargas , Fabrice DeClerck)

The fine grain case study is being developed in Hojancha area, which includes the counties of Hojancha, Nicoya and Nandayure in the Nicoya Peninsula of Costa Rica. This region is comprised of seasonally dry tropical forest, a global threatened ecosystem. This study area was chosen because of its unique history of development, deforestation, disturbance, and reforestation.

The core for the scenario analysis will be the PolicyMix/IGERT research on socio-ecological resilience in changing landscapes. This research will be developed by an interdisciplinary team of five PhD Students. Four of the students are part of the CATIE/University of Idaho Joint Doctoral Program (JDP) funding by the US National Science Foundation's Integrated Graduate Education Research Traineeship (NSF-IGERT) on "Socio-ecological resilience in changing landscapes". The fifth, Zayra Ramos-Bendaña, is a JDP CATIE/UI student funded by PolicyMix. Also, another JDP CATIE/UI student, Natalia Estrada-Carmona, who is doing research in the region, will contribute to the analysis.

The interdisciplinary research is spatially explicit and aims to answer the following question: ***Using historical and contemporary perspectives, how can we better understand socio-ecological resilience to maximize synergies and reduce tradeoffs between environmental and socio-economic goals in Hojancha region?*** This will require the combination of two major components: 1) a historical case study of response to disturbance using a resilience framework; and 2) the identification of synergies and tradeoffs between socio-economic and ecological benefits under alternate land use and cover changes scenarios in this region. Three types of ecosystem services have been selected: hydrological services, pollination services, and functional connectivity for wild biodiversity. A fourth ecosystem service, control of soil erosion, will be incorporated with Estrada-Carmona research. Also, three Costa Rican conservation strategies have been selected as the main ones for the policyscape: Protected Areas, the Chorotega Biological Corridor, and the nationalized Payment for Ecosystem Services (PES) program (FONAFIFO). The PES program aims to complement and enhance the conservation objectives of the first two strategies.

The team is composed of biophysical scientist and social scientists to ensure that key social and ecological components for the analysis are included. Each PhD Student will work on disciplinary questions that contribute to the larger interdisciplinary study that services as PolicyMix's fine grained study (see table

Table 14).

Table 14. IGERT student's research fields in the framework of Costa Rica's fine grain study

Student	Field	Research (current title)	Potential Contribution
Sara Galbraith	Entomology	Pollination services in a changing landscape: Understanding the distribution of native bees among land uses in Hojancha, Costa Rica	WP-3
Oscar Abelleira	Ecohydrology/ Forest Ecology	Water use of reforestation with tree plantations in the seasonally dry tropics: implications for droughts	WP-3
Hector Tavarez-Vargas	Economics	Ecosystem Services and Social Welfare: An Economic Approach	WP-4
Mo Essen	Social Sciences	Geographies of adaptive capacity to climate change and the significance of Payments for Environmental Services	WP-5
Zayra Ramos-Bendaña	Landscape Ecology/ Forest Ecology	Beyond forest cover: Incorporating spatial indicators of ecological integrity in landscape conservation planning	WP-3/WP-6
Natalia Estrada-Carmona	Landscape Ecology	Modeling the contribution of different land cover types to control of soil erosion	WP-3

Since the PhD studies will be finalized post PolicyMix project, the scenario analysis will be priority in order to fulfill the project objectives. This analysis will be completed using existing information and some preliminary data from the PhD research.

Scenario modeling using Marxan with zones

Costa Rica has reported conservation gains by reporting gain in forest cover through time (e.g. 53% in the 2010 Forest Cover Map of FONAFIFO), and by monitoring increases in the area under formal protection (e.g. percentage of land under protected areas, biological corridors, and payment for ecosystem services). However, forest cover by itself does not provide meaningful social and ecological information for decision-makers. Better information for targeting conservation incentives at the landscape scale, such as PES, is needed in addition to ecological meaningful information regarding the contribution of different land cover types to conservation objectives and the provision of ecosystem services. In addition, information is needed about spatial tradeoffs and synergies between conservation and production, since contribution to poverty reduction is also a key objective for PES program in Costa Rica. In this sense, livelihood improvement could be measure as result of either or both: (1) access to PES, and (2) ecosystem services received, for example: access to clean water, pollinators, and control of soil erosion.

The scenario analysis will be developed using 'Marxan with zones' software. Marxan is a decision support tool that provides land use zoning options in geographical regions for biodiversity conservation (Watts et al. 2009). In addition, the MARXAN modeling environment is very plastic and allows for the inclusion of different data types into the analysis, such as ecological (e.g. species distribution, habitat quality, ecosystem services maps), sociological (e.g. demographic data, land tenure, community capitals), and economic (e.g. opportunity cost).

MARXAN with zones allows any parcel of land or sea be allocated to a specific zone. Each zone has the option of having its own management/conservation actions, objectives and constraints, and therefore with the flexibility of defining its own contribution to the overall landscape conservation goals. The objective of the tool is to minimize the total cost of implementing the zoning plan while achieving a variety of conservation and land-use objectives (Watts et al. 2009). This agrees with the idea that alternative land uses make different contributions to the conservation of biodiversity, the provision of ecosystem services and socio-economic development. For example, native forest and forest plantations will have different ecological contributions to biodiversity conservation, but will also contribute differently to community livelihoods.

The case study will focus on scenario analysis with Marxan for targeting PES with the objective of jointly achieving social and conservation goals. Marxan will allow us to consider the contribution of alternate land use scenarios on the provision of ecosystem services. One scenario could be focusing on local conservation targets, and the second on national conservation targets. The comparison of these two scenarios would permit to identify whether exist or not synergies between the different types of objectives.

We are also incorporating the concept of 'rural hotspot' introduced by Harvey et al. (2008) in the scenario analysis with Marxan. Rural hotspots are defined as places where the conservation of biodiversity and rural livelihoods can be achieved jointly. The rural hotspot concept considers those areas where traditional smallholder livelihoods are most vulnerable and where agro-ecological systems and knowledge are being rapidly lost. These diverse, traditional, smallholder agro-ecosystems are critical for conserving biodiversity in agricultural landscapes since they often provide, for instance, tree cover, follow vegetation, habitat diversity and forest connectivity - elements most likely to be lost with agro-industrial intensification (Harvey et al. 2008). We adopt the idea of Garcia et al. (2010) that the application of the concept will face complex realities and in order to succeed it is needed to place the aspirations of the farmers at the center of the approach. Chazdon et al. (2009) emphasize that successful conservation strategies require an understanding of the constraints and drivers behind local stakeholders' management decisions.

In order to spatially defined and identify the rural hotspots, the rural livelihoods framework will be used, which is based in measuring five community capitals: social, financial, human, natural, and physical (Table 15). In addition, information of the opportunity cost that landowners need to face when taking decisions of land use changes will be incorporated in the scenario analysis.

The key ecological information will be the ecosystem services maps: hydrological services, control of soil erosion, pollination services, and functional connectivity for wild biodiversity. Also, different land cover types will be mapped with high resolution remote sensed images that will be the base for modeling the ecosystem services and the Marxan analysis. One of the objectives of the land cover mapping is to identify different forest structural types, for example different native forest successional stages (early, intermediate, and late) and forest plantations in order to account for their differences in contributing to the provision of the selected ecosystem services.

Table 15. Community capitals framework

Capital	Description
Human	The skills, health and education of individuals that contribute to the productivity of labour and capacity to manage land.
Social	Reciprocal claims on other by virtue of social relationships, the close social bonds that facilitate cooperative action and the social bridging, and linking via which ideas and resources are scare.
Natural	The productivity of land, and actions to sustain productivity, as well as the water and biological resources from which rural livelihoods are derived.
Physical	Capital items produced by economic activity from other types of capital that can include infrastructure, equipment and improvements in genetic resources (crops, livestock)
Financial	The level, variability and diversity of income sources, and access to other financial resources (credit and savings) that together contribute to wealth.

Some of the steps that the Hojancha case study will follow are:

(1) Historical case study of response to disturbance using a resilience framework through a review of the literature and existing databases (2012-2013).
(2) Land covers mapping (2012-2013).
(3) Field work: the five PhD researches (2012-2013 preliminary data for PolicyMix project, 2014-2015 post PolicyMix work).
(4) Ecosystem services modeling: based on the preliminary field data from the PhD studies and literature review (2012-2013).
(5) Marxan with zones: based on spatial explicit information from the previous four steps, we will model alternative scenarios for targeting conservation incentives. The scenario analysis will be performed twice, the first during the PolicyMix project (2012-2013), and the second in a Post PolicyMix period, when all the PhD field works are completed (2014-2015).

Notice, that scenario analysis with Marxan is a participative process that implies different moments of consultation to key stakeholders in order to achieve satisfactory and meaningful results. Part of the interdisciplinary research and disciplinary studies includes interviews and workshops with stakeholders for gathering information and feedbacks.

8 Conclusions and recommendations

This document presented an analysis of existent biodiversity conservation gaps and a national assessment of the effectiveness, efficiency and social impacts of several instruments in Costa Rica. The analysed policies were the payment for environmental services program, forest certification, mandatory regulations and REDD+ as a proposed instrument (not currently adopted).

In addition, interaction analyses of the instruments were performed. It was concluded from this exercise that although there are complementarities between the different instruments, they also relate in a counterproductive manner limiting their potential effectiveness and decreasing their cost efficiency.

Finally, a general description of methods and data gaps of the fine grain study is provided. Details of the future analysis are to be defined, leaving therefore some pending questions to be answered.

9 References

Andam, K.S; Ferraro, P.J; Pfaff, A.; Pfaff, A., Sanchez-Azofeifa, J.A. and Robalino, J. 2008. "Measuring the effectiveness of protected area networks in reducing deforestation. PNAS 105 (42): 16089-16094.

Andam, K.S; Ferraro, P.J; Sims, K.R.E; Holland, M and Healy, A. 2010. Protected Areas Reduce Poverty in Costa Rica and Thailand. PNAS Forthcoming.

Arriagada, R. A., P. Ferraro, E. Sills, S. Pattanayak, and S. Cordero. 2010. Do payments for environmental services reduce deforestation? A farm level evaluation from Costa Rica.

Barton, D., D. P. Faith, G. Rusch, M. Acevedo, and M. Castro. 2009. Environmental service payments: Evaluating biodiversity conservation trade-offs and cost-efficiency in the Osa Conservation Area, Costa Rica. Journal of Environmental Management **90**:901-911.

Blackman, A. and R. Woodward (2009). User Financing in a National Payments for Environmental Services Program. Working paper, Resources for the Future. RFF DP 09-04-REV.

Chazdon, R. L., C. A. Harvey, O. Komar, D. M. Griffith, B. G. Ferguson, and M. Mart. 2009. Beyond Reserves : A Research Agenda for Conserving Biodiversity in Human-modified Tropical Landscapes. Biotropica 41:142-153.

Daniels, A., K. Bagstad, V. Esposito, A. Moulaert, and C. M. Rodríguez. 2010. Understanding the impacts of Costa Rica's PES: Are we asking the right questions? Ecological Economics **69**:2116-2126.

Ellis, F. 2000. The Determinants of Rural Livelihood Diversification in Developing Countries. Journal of Agricultural Economics 51:289-302.

Engel, S., Pagiola, S. and Woodward R. (2008). "Designing payments for environmental services in theory and practice: An overview of the issues." Ecological Economics 65: 663:674.

Estrada A. Rodríguez A. y Sánchez J. 2005. Evaluación y Categorización del Estado de Plantas en Costa Rica. INBio, Museo Nacional de Costa Rica.

Ferraro, P. J. and D. R. Simpson. 2002. The cost-effectiveness of conservation payments. Land Economics 78:339-353.

Ferraro, P. J. and Kiss, A. 2002. Science's Compass. Vol 298. www.sciencemag.org.

Ferraro, P. J. and Simposn, D. 2002. "The Cost-Effectiveness of Conservation Payments." Land Economics.

FONAFIFO (Fondo Nacional de Financiamiento Forestal). 2011. FONAFIFO (en línea). Consultado el 1 de febrero del 2011. Disponible en: http://www.fonafifo.go.cr

Forest Stewardship Council. (2011). Operaciones forestales pequeñas, de baja intensidad y comunitarias. estudios de caso. Cooperativa productora de muebles en Honduras available at http://www.fsc.org/fileadmin/webdata/public/document_center/publications/Case_Studies/Spanish_-_Case_Studie-_Honduras.pdf

Fürst, E., Moreno, M.L., García, D., and Zamora, E. 2004. Desarrollo y conservación en interacción: ¿cómo y en cuánto se benefician la economía y la comunidad de las áreas silvestres protegidas en Costa Rica. Informe final del proyecto interinstitucional INBio-CINPE.

García, R. 1996. Propuesta Técnica de Ordenamiento Territorial con Fines de Conservación de Biodiversidad en Costa Rica: Proyectos GRUAS. San José, Costa Rica: Ministerio de Ambiente y Energía Sistema Nacional de Áreas de Conservación. 114 pp.

Gómez L.D. and Herrera, W. 1986. Vegetación de Costa Rica. En: Gómez L.D. 1986. Vegetación y clima de Costa Rica. Volumen 1. San José, Costa Rica. (Available on-line: Clave para macrotipos de vegetacion de costa rica, http://www.inbio.ac.cr/es/biod/minae/Estudio_Pais/estudio/macrotipos.html

Groves, C. 2003. Drafting a conservation blueprint: a practitioners guide to planning for biodiversity. Contri- butors, Michael W.Beck, Jonathan V.Higgins, Earl C. Saxon. The Nature Conservancy, Island Press, Washington, DC. 455 pp.

Gullison, R.E. 2003. Does forest certification conserve biodiversity? FFI, Oryx, 37(2), 153–165. http://www.yale.edu/forestcertification/pdfs/03_oryx_certification.pdf [accesado el 26 de Noviembre del 2010].

Hammel, B.E, Grayum M.H, Herrera C, y Zamora N. 2003. Manual de Plantas de Costa Rica. Missouri Botanical Garden Press.

Harvey, C. A, O. Komar, R. Chazdon, B. G. Ferguson, B. Finegan, D. M. Griffith, M. Martínez-Ramos, H. Morales, R. Nigh, L. Soto-Pinto, M. Van Breugel, and M. Wishnie. 2008. Integrating agricultural landscapes with biodiversity conservation in the Mesoamerican hotspot. Conservation Biology 22:8-15.

INBio. 2006. Consultoría: "Evaluación de la situación actual de la biodiversidad y la sostenibilidad / representatividad ecológica del Sistema de Áreas Silvestres Protegidas". Informe Final. Instituto Nacional de Biodiversidad, Costa Rica. 146 p.

IUCN. 1994. Guidelines for Protected Areas Management Categories. IUCN, Cambridge, UK and Gland, Switzerland. 261pp.

IUCN 2011. The IUCN Red List of Threatened Species. Version 2011.2. http://www.iucnredlist.org>. Downloaded on 16 November 2012.

La Gaceta. 2010. Decreto No 35762-MINAET. 8p.

Le Coq, J.F., Soto, G., Gonzáles Hermández, C. 2012. "PES and Eco-Label: A comparative Analysis of Their Limits and Opportunities to Foster Environmental Services Provision." Chapter 11 in in Ecossytem Services from Agriculture and Agroforesty: Measurement and Payment. Ed. Rapide, B., De Clerk F., Le Coq, J.F. and Beer, J. Earthscan Ltd. London, UK.

Louman, L; Garay, M; Yalle, S; Campos,J.J; Locatelli, B; Villalobos, R; López, G; Carrera, F. 2005. Efectos del pago por servicios ambientales y la certificación forestal en el desempeño ambiental y económico de manejo de bosques naturales en Costa Rica. CATIE, Turrialba. 40p.

Méndez, J; González, P; Solano, G; de Camino, R. 2004. La certificación Forstal en Lationamérica. Estudio de Caso Costa Rica Revista Forestal Centroamericana no. 34: 6-11.

Merino del Río, 2003. Available at http://www.cipamericas.org/archives/1022, accessed on 4th of April 2012.

Miranda, M., I. Porras, and M. L. Moreno. 2003. The social impacts of payments for environmental services in Costa Rica. A quantitative field survey and analysis of the Virilla watershed. . International Institute for Environment and Development (IIED), .

Morse, W. C., J. L. Schedlbauer, S. E. Sesnie, B. Finegan, C. A. Harvey, S. J. Hollenhorst, K. L. Kavanagh, D. Stoian, and J. D. Wulfhorst. 2009. Consequences of environmental service payments for forest retention and recruitment in a Costa Rican biological corridor. Ecology and Society 14:23[online].

Naranjo, M.A. 2007. The contribution of protected nature areas towards socio-economic development in Costa Rica: a cluster analysis of Braulio Carrillo National Park. Thesis Mag. Sc. Wageningen University.

Navarro, G. 2010. "The Evolution of Costa Rica's carbon rights." REDD net. Available at http://redd-net.org/files/Costa%20Rica.pdf

Ortiz, E., L. F. Sage, and C. Borge. 2003. Impacto del Programa de Pago por Servicios Ambientales en Costa Rica como medio de reducción de la pobreza en los medios rurales. RUTA, San José.

Pfaff, A., Robalino, J. and Sanchez-Azofeifa. 2008. "Payments for Environmental Services: Empirical Analysis for Costa Rica." Terry Sanford Institute of Public Policy. Working Papers Series SAN08-05.

Pfaff, A. Robalino, J., Sanchez-Azofeifa, G.A., Andam K.S. and Ferraro, P. (2009). "Park Location Affects Forest Protection: Land Characteristics Cause Differences in Park Impacts across Costa Rica." The B.E. Journal of Economic Analysis & Policy. 9 (2) (Contributions), Article 5.

Pagiola, S. 2008. Payments for environmental services in Costa Rica. Ecological Economics 65 (4):712-724.

Pagiola, S., P. Agostini, J. Gobbi, C. De Haan, M. Ibrahim, E. Murgueitio, E. Ramírez, M. Rosales, and J. P. Ruiz. 2004. Paying for biodiversity conservation services in agricultural landscapes. The World Bank, Washington DC.

Pagiola, S. Ramírez, E., Gobbi, J., de Haan, C., Ibrahim, M., Murgueitio, E., Ruíz, J.P. 2007. "Paying for the environmental services of silvopastoral practices in Nicaragua." Ecological Economics. 64: 374-385.

Pascual, U; Muradian, R; Rodríguez, L; Duraiappah, A. 2010. "Exploring the links between equity and efficiency in payments for environmental services: A conceptual approach." Ecological Economics 69: 1237-1244.

Pattanayak, S. K., Wunder, S. and Ferraro, P. 2010. "Show Me the Money: Do Payments Supply Environmental Services in Developing Countries?" Review of Environmental Economics and Policy: 1-21.

Porras, I. 2010. Fair and green? The social impacts of payments for environmental services in Costa Rica. International Institute for Environment and Development, London, UK

Porras, I., Miranda, M., Barton, D.N., Chacón, A. 2012. DE RIO A RIO+: Lecciones de 20 años de experiencia en servicios ambientales en Costa Rica. International Institute for Environment and Development. Londres.

Raghuramulu, R. Nasi, and P. Vaast. 2010. Biodiversity conservation in agricultural landscapes: challenges and opportunities of coffee agroforests in the Western Ghats, India. Conservation Biology 24:479-88.

Robalino, J; Pfaff; Sánchez-Azofeifa, A; Alpízar, F; León, C; Rodríguez, M. 2008. Deforestation Impacts of Environmental Services. Costa Rica's PESprogram 2000-2005. Discussion Paper Series EfD DP 08-24, Environmental for Development. Resources for the furture: 19p.

Robalino, J. and Villalobos.L., 2009. Conservation Polices and Labor Markets: Unraveling the Effects of National Parks on Local Wages in Costa Rica. Forthcoming.

Robalino, J., Pfaff, A. and Villalobos, L. 2011. "Assessing the Impact of Institutional Design of Payments for Environmental Services: The Costa Rican Experience." Chapter 14 in Ecossytem Services from Agriculture and Agroforesty: Measurement and Payment. Ed. Rapide, B., De Clerk F., Le Coq, J.F. and Beer, J. Earthscan Ltd. London, UK.

Rojas, M; Aylward, B. 2003. "What are we learning from experiences with markets for environmental services in Costa Rica? A review and critique of the literature." Markets for Environmental Services Series, No 2, International Institute for Environment and Development, London.

Rojas, R. O. 2008. Evolución del régimen Municipal en Costa Rica (1999-2006). Informe Estado de la Nación, San José, Costa Rica.

Ross, M., B. Depro, and S. K. Pattanayak. 2007. Chapter 11. Assessing the Economy-Wide Effects of the PESProgram.in G. Platais and S. Pagiola, editors. Ecomarkets: Costa Rica's Experience with Payments for Environmental Services.

Sánchez-Azofeifa, A., A. Pfaff, J. Robalino, and J. Boomhower. 2007. Costa Rica's Payment for Environmental Services Program: intention, implementation, and impact. Conservation Biology **21**:1165-1173.

Scherr, J; White, A; Kaimowitz, D. 2003. A New Agenda for Forest Conservation and Poverty Reduction: Making Markets Work for Low Income Producers. Forest Trends

Sierra, R. and E. Russman. 2006. On the efficiency of environmental service payments: A forest conservation assessment in the Osa Peninsula, Costa Rica. Ecological Economics **59**:131-141.

Sistema Nacional de Áreas de Conservación (SINAC) del Ministerio de Ambiente y Energía (MINAE). 2006. El Sistema de Áreas Silvestres Protegidas de Costa Rica: Informe Nacional. II Congreso Mesoamericano de Áreas Protegidas. Panamá, 24-28 de abril de 2006. 96 p.

Sistema Nacional de Áreas de Conservación (SINAC) del Ministerio de Ambiente y Energía (MINAE). 2007. Áreas silvestres protegidas de Costa Rica: Informe nacional para presentar al II congreso latinoamericano de parques nacionales y otras áreas protegidas Bariloche, Argentina.

Sistema Nacional de Áreas de Conservación (SINAC) del Ministerio de Ambiente y Energía (MINAE). 2007. GRUAS II: Propuesta de Ordenamiento Territorial para la conservación de la biodiversidad de Costa Rica. Volumen 1: Análisis de Vacíos en la Representatividad e Integridad de la Biodiversidad Terrestre. San José, Costa Rica. 100 pp.

Sistema Nacional de Áreas de Conservación (SINAC) del Ministerio de Ambiente, Energía y Telecomunicaciones (MINAET). 2008. GRUAS II: Propuesta de Ordenamiento Territorial para la conservación de la biodiversidad de Costa Rica. Volumen 3: Análisis de Vacíos en la Representatividad e Integridad de la biodiversidad marina y costera. San José, Costa Rica. 60 pp.

Sistema Nacional de Áreas de Conservación SINAC. 2009a. IV Informe de País al Convenio sobre la Diversidad Biológica. GEF-PNUD, San José, Costa Rica. Mimeografiado. 216 p

Sistema Nacional de Áreas de Conservación SINAC. 2009b. Plan Estratégico del Programa Nacional de Corredores Biológicos de Costa Rica para el quinquenio 2009-2014. San José, C.R. 40p.

Stoian, D; Carreras, F. 2001. La certificación forestal en la encrucijada: entre la panacea y un callejón sin salida. CATIE, Turrialba. 6p.

Tacconi, L., S. Mahanty, and H. Suich. 2010. Payments for environmental services, forest conservation and climate change. Edward Elgar.

Viana, V., Ermin, J., Donovan, R. Z., Elliot, C., Gholz, H. 1996. "Certification of Forest Products, Issues and Perspectives." Island Press, Washington D.C.

IUCN 2011. The IUCN Red List of Threatened Species. Version 2011.2. Availabe at http://www.iucnredlist.org>. Downloaded on 16 November 2012.

Villalobos, Laura. 2009. National Parks' effects on local communities' wages and employment in Costa Rica. Thesis Mag. Sc. CATIE, Turrialba, Costa Rica.

Watts, M. E., I. R. Ball, R. S. Stewart, C. J. Klein, K. Wilson, C. Steinback, R. Lourival, L. Kircher, and H. P. Possingham. 2009. Marxan with Zones: Software for optimal conservation based land- and sea-use zoning. Environmental Modelling & Software 24:1513-1521.

World Bank. 2000. Ecomarkets Project: Project Appraisal Document. World Bank, Washington D.C.

World Wildlife Fund (WWF) (2010a) Global Forest and Trade http://gftn.panda.org/practical_info/basics/sound_forest/certification/forest_certification/ [accessed el 26 de Noviembre del 2010]

World Wildlife Fund (WWF) (2010b) http://wwf.panda.org/what_we_do/footprint/forestry/certification/ [accessed el 26 de Noviembre del 2010]

Wünscher, T., S. Engel, and S. Wunder. 2008. Spatial targeting of payments for environmental services: A tool for boosting conservation benefits. Ecological Economics **65**:822-833.

Wunder, S., Engel, S. and Pagiola, S. 2008. “Taking Stock: A comparative analysis of Payments for Environmental Services Programs in Developed and Developing Countries.” Ecological Economics 65:834-852.

Yale-Paredes, S; Campos, J; Louman, B. 2005-2006. La certificación forestal y el pago por servicios ambientales como mecanismos de promoción del manejo sostenible de bosques naturales en Costa Rica. Recursos Naturales y Ambiente. No. 46-47.

Zbinden, S. and D. Lee. 2005. Paying for Environmental Services: An Analysis of Participation in Costa Rica’s PESProgram. World Development **33**:17.

policymix.nina.no