# Ecosystems for sale

## Land prices and payments for ecosystem services in Costa Rica

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In Costa Rica, policymakers know in their hearts that the time of 'cheap' conservation of biologically important land is gone. Conservation policy has often been a 'shot in the dark' when it comes to acknowledging the opportunity costs of forest conservation. In theory, knowledge of opportunity costs could help authorities calibrate payments for ecosystem services so that they provide a cost-effective incentive by compensating for opportunity costs.

Although different models exist to estimate opportunity costs, they tend to have limited applicability to real-time policy making. We propose using market prices for land as an initial proxy indicator for opportunity cost. Land prices are easy to understand, and in a well-functioning market should roughly represent the net present value of the benefits derived from the land over time. We show that the competitiveness of conservation policies will in future depend on a policy mix of PES acting in concert with national forest policy and local land-use regulations. However, to be effective, PES will need to complement strengthened municipal-level land-use zoning regulations, both in rural and peri-urban areas.

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# Technical glossary

| | |
|---|---|
| Base year analysis (BYA) | BYA is a mathematical formula used to analyse economic trends in relation to a specific base year, thus eliminating the effects of inflation. It is often used for expressing gross domestic product (GDP) and by eliminating inflation results in a more accurate measure of economic growth that takes into account changes in price level. In our analysis, we use the Costa Rica consumer price index, estimated by the Central Bank. The formula used is: $\text{Value}_{(\text{Base year})} = \text{Value}_{(\text{Chosen year})} \times \text{Price index}_{(\text{Base year})} / \text{Price index}_{(\text{Chosen year})}$. |
| Bid-rent approach | This is a hedonic economic model used to understand the peri-urban land market problem in terms of competition between urban (residential) and agricultural uses. 'Land' is treated as a consumption good, where natural amenities and location are key components affecting consumer utility (see Randal and Castle, 1985). |
| Biological corridor | Biological corridors are the designation for a continuous geographic extent of habitat linking ecosystems, either spatially or functionally; such a link restores or conserves the connection between habitats that are fragmented by natural causes or human development (Boyle, 2013). |
| Hedonic price method (HPM) | The HPM is a valuation technique used to estimate environmental amenities (e.g. existence of forest, nice view, or pollution) and affects the market value of a property. It is commonly applied to changes in housing prices that reflect local environmental attributes. |
| Hicksian utility model | This is an economic model to analyse demand, in terms of the demand of a consumer over a bundle of goods (i.e. in our paper a bundle that includes land and environmental amenities) that minimises their expenditure (i.e. available income) while delivering a fixed level of utility. |
| Indigenous area | Legally created in Costa Rica in 1977, indigenous areas are politically natural reserves administered exclusively by associations of indigenous groups. There are a total of 24 indigenous territories in Costa Rica belonging to eight major ethnic groups. |
| Legal entities (*sociedades anónimas*) | Some PES contracts are signed with legal entities (*personas jurídicas*) established through a registration process, with legal rights and liabilities that are distinct from their employees and/or shareholders. Many of these are *sociedades anónimas* – which directly translated means 'anonymous societies' – designating a type of corporation in countries that mostly employ civil law. It is roughly equivalent to a public limited company in common law jurisdiction and is different from partnerships and private limited companies. |
| Life zones | The Holdridge life zones system is a global bioclimatic scheme for the classification of land areas. It provides an objective mapping criterion based on the interactions of precipitation, potential evapotranspiration ratio, and bio-temperature. |
| Opportunity costs | In economics, the opportunity cost is the value of the best viable alternative that must be forgone in order to pursue a certain action. These costs are very time and location bound. For example, the opportunity cost of conserving forest for a particular farmer can be measured in terms of what he would have received for agriculture or residential development, if he is legally allowed to change the existing land use. |
| Ordinary Least Squares (OLS) | Statistical method for estimating unknown parameters in a linear regression model. |
| Outliers | Statistical observations that are distant from the majority of other observations. |
| Payments for environmental services (PES) | PES are an economic instrument used to transfer rewards or payments (cash or in-kind) as a recognition of the environmental benefits provided by healthy ecosystems. In Costa Rica, private forest owners can receive annual payments for carbon sequestration, protection of biodiversity and water sources, and landscape beauty. |

| | |
|---|---|
| Protected areas | In Costa Rica, these correspond to areas of biological importance that have been legally created to protect areas of biological and cultural importance. They can include national parks, wildlife refuges, and wetlands. |
| Small and medium enterprises (SMEs) | SMEs are companies whose personnel numbers fall below certain limits. In Costa Rica, they account for 95 per cent of the formally registered business sector (Leiva Bonilla, 2013), |
| Social development index (SDI) | Indicator for relative wealth (in terms of health, participation, economics, and education) used by Costa Rican government institutions to establish priority for social policy and budget allocation (MIDEPLAN, 2007), and used by the PES programme since 2004. Its estimation, however, is not linked to land ownership, which is a basic requirement to participate in PES and, as a starter, puts most landowners in a different socio-economic category that makes them relatively better off than those without land. Previous research has highlighted that because the PES programme is aimed at landowners with valid titles, uncontested possession, and no cadastral inconsistencies, participants are relatively better off than non-participants even if they have land (for example Ortiz *et al.*, 2003; Miranda *et al.*, 2003; Zbinden and Lee, 2005). |
| von Thünen's location theory | This economic model links the value of land beyond productivity alone to where it is located in relation to distance to markets. His approach is key to the development of further models that deal with the non-linearity of land values. |


'*Se Vende*' – ocean-view property in Osa Peninsula. Ownership patterns have changed strikingly in this area, where traditional farm and forest land are now sold primarily to tourism-oriented markets and international investors able to pay the prices. Photo credit: David N. Barton

# Summary

Forest cover in Costa Rica has changed dramatically in the past 50 years, responding to policies and market signals. Yet conservation policy is rarely designed to take explicit account of factors affecting people's preferences, making policy outcomes a 'shot in the dark'. In this article we concentrate on opportunity costs of conservation in relation to payments for ecosystem services (PES). Given the changing patterns and increasing pressure on land in Costa Rica, we argue that only by understanding the processes behind land speculation will conservation policies stand a reasonable chance to adapt and succeed in the long term.

Opportunity costs of conservation, however, are difficult to measure. In practice, conservation planners resort to poorly designed proxies to guide conservation policies. Payments for conservation in the PES programme uses a national-level figure originally based on rental values for pasture which, barring partial adjustments for inflation, has changed little since 1997. But the context in which the PES programme now operates has changed, and it is important to understand local conditions when designing targeting measures and/or potential differentiated payments. We propose to use market land values as an indicator for opportunity costs, following the economic theory that in a well-functioning market, land values will represent the present value of future net benefits from the property. For this reason, we base our analysis on the information provided by the Ministry of Finance, through the *zonas homogéneas* study on land values and property characteristics conducted between 2008 and 2010. The national-level database provides over 32,000 geo-referenced observations, allowing us to account for other factors that help explain variability in values. We test land values against priority criteria established by the PES Programme, and propose to incorporate this variable in the analysis of social impacts of the programme.

Our analysis shows that traditional surrogates for land planning, like land-use capacity (LUC) and social development index (SDI) are weakly correlated with land prices, questioning their reliability as a basis for conservation policy. We provide hard evidence on what many policymakers know in their hearts: the time of 'cheap' conservation of biologically important land is gone and opportunity costs are now very high. There is no general 'rule-of-thumb' regarding land prices: rural land prices vary dramatically across the country, driven by urbanisation and fragmentation of properties to capitalise on market prices. The highest land prices (and indeed, to conservation, opportunity costs) are on the fringes of cities – those areas particularly important for watershed protection and near the coasts – are being driven upwards by the tourism industry. As expected, the lowest land prices are in those areas where change in land use has the heaviest restrictions, such as protected areas and on forested land covered by a ban on land-use change.

The purchasing power of PES has been falling since the inception of PES, while land prices have simultaneously been rising. Our study rejects the hypothesis that the payments of the current PES programme would be competitive without the simultaneous ban on land-use change imposed by the 1997 Forest Law on forest land. However, this blanket regulation is hard to enforce and has social impacts that are difficult to disentangle from PES.

The competitiveness of conservation policies will in future depend on a policy mix of PES acting in concert with national forest policy and local land-use regulation. PES will need to act as a targeted complement of strengthened municipal level land-use zoning regulations, both in rural and peri-urban areas.

# Introduction

# 1

In a budget-tight environment, managers of the payments for ecosystem services programme in Costa Rica and other countries are continuously called to provide measures of value for money and often evidence of social benefits (Porras *et al.,* 2013). In order to measure the cost effectiveness of spatial targeting of conservation, indicators for environmental costs and outcomes are required. Limited as it is, until now the main indicator used for environmental effectiveness has been forest cover, sometimes combined with spatial indicators like landscape connectivity or fragmentation of forests (Mitchard *et al.*, 2012; Schelhas and Sánchez-Azofeifa, 2006). Indicators for costs have been mostly case study-related or limited to specific single regions (Arriagada *et al.,* 2010; Daniels *et al.,* 2010; Barton *et al.,* 2009). Because of the difficulty of deriving broadly applicable measures at the national level, indicators for opportunity costs[1] for PES participants and non-participants have been mostly ignored.

In our study, we argue that the market price for land is a suitable proxy for these opportunity costs. We also argue that it can be used as a first step indicator to personal wealth: an indicator which, so far, has been missing when it comes to understanding the distribution of benefits among landowners receiving PES.

## 1.1 The problem setting: opportunity costs and conservation

Environmental programmes like Costa Rica's PES are often designed with a weak understanding of causal relationships, benefits, and costs, which limit how effectively they can be evaluated (Ferraro, 2009). Understanding individual costs and benefits are the basic building blocks of landowners' motivations underlying decisions on land use, which are important for designing performance-based instruments (like PES) that compensate landholders for the costs they incur in their conservation efforts, while aligning the private and public benefits from conservation (Jack *et al.*, 2008). They are also important for understanding priority-setting at landscape level, and designing incentives and policy mixes that are more likely to induce a behavioural change in landowners.

A key concept for programme management is 'cost-effectiveness', or the 'unit' cost of producing a well-defined objective. Measures of this are affected by how environmental effectiveness is defined (i.e. hectares of forest protected, forest gain, forest loss, and net deforestation) but also by what costs (transaction, administrative, and opportunity) are included as part of the calculation (Rusch, 2013; Brouwer *et al.*, 2013).

Opportunity costs are considered the largest costs affecting the decision to engage in conservation, e.g. reducing emissions from deforestation and forest degradation (REDD+). They are important to understand drivers of deforestation, and who bears the highest costs across different social groups. There are several methodologies for assessing opportunity costs based on land-use capacity indicators used in many site priority-setting models which nevertheless do not capture access and market effects on land value (Barton, 2013; see also discussion in chapter 5). There are at least four approaches for estimating opportunity costs in conservation:

- Auctions are probably the best way to elicit the farmer's own opportunity costs. Used during the design phase of a PES programme, procurement auctions can be used to reliably estimate a supply curve of ecosystem services obtained per dollar spent (Jack *et al.*, 2008).
- Willingness to accept compensation studies stated as preferences in a contingent valuation or choice-experiment survey, using hypothetical conservation scenarios (Brouwer *et al.,* 2013).
- Land-use capacity, which combines maps of land-use capacity with agricultural prices regularly updated by the Ministry of Agriculture (MAG) (Barton *et al.*, 2013).
- Land-use values. In a well-functioning land market, the sale price of a piece of land will roughly represent the discounted flow of net revenue to commercial activities that the parcel would be expected to generate in the future (the net present value). More generally, the sale price should reflect both the monetary and non-monetary net benefits as perceived by the owner, considering any perceived restrictions on land use. The difference between unrestricted land price and the price under conservation restrictions is equal to the expected discounted opportunity cost of the land-use restrictions.

Typically, opportunity costs are estimated using cost-flow or bio-economic models that rely on observable plot or farm characteristics to generate cost estimates at farm level. But these methods tend to be time consuming and difficult to replicate at larger scales necessary for national policy making. On the other hand, easier-to-find, larger-scale indicators such as biological land-use capacity become rougher in their estimations. Opportunity costs are elusive and are time and space bound – varying with farm units, the seasons

[1] Opportunity costs represent the income or benefits foregone by a landowner when choosing to participate in the PES programme, such as the revenue from growing crops. It is the difference in income between the most profitable land use (before PES) and forest conservation.

and landowners' perceptions of restrictions on land use. Calculations are often data consuming, throwing policy planners off balance when faced with the need to move from theory to practice, especially for the design of national-level policies in developing countries. For these reasons, the use of opportunity costs of conservation for conservation targeting remains largely unknown to policy planners.

## 1.2 Objective of this study

We centre our analysis in Costa Rica, where the payments for ecosystem services programme has been effective since 1997. This programme rewards forest owners for land-based activities that are expected to result in better provision of ecosystem services (increase carbon sequestration and landscape beauty, and protect biodiversity and water sources). Payments levels depend on the land-based activity promoted (i.e. variations of strict protection, reforestation, agroforestry, and forest management), but these payments do not change across the country and fail to reflect heterogeneity of participants' characteristics (e.g. in terms of different costs of participation).[2] In this study, we investigate how differences in land prices can be used as an aggregate indicator of the opportunity costs of conservation at the national level and how they relate to the existing criteria to prioritise PES contract allocation.

The main objective of our study is to understand how land prices relate to variables currently used or proposed to allocate priority for PES contracts. In particular, we want to explore the relationship between land prices and two key priority criteria:

- Land-use capacity (LUC), which is used as a basis for setting spatial priorities for land use and opportunity costs.
- Social development index (SDI), which is used as a social indicator to allocate PES contracts in areas with higher vulnerability and as a way to measure the social impact of the programme.

[2] See Porras *et al.* (2013) for an up-to-date analysis of the PES programme.

# Context and methodology

In this section we present a brief discussion of the evolution of land prices in Costa Rica; a description of the payments for ecosystem services programme; a description of the methods used to investigate the linkages between land prices and the PES programme; and the data available for our research. Specific details of some of the methodologies (e.g., the hedonic model) are given in each respective section.

# 2

## 2.1 Trends review: evolution of land prices

We focus exclusively on properties located in rural areas, in zones defined as agricultural, ranching, or forestry. This means we exclude areas designated as commercial or residential. We also exclude properties located within the maritime zone (200 metres from high-tide mark); these are properties mostly used for tourism and the prices are significantly higher, depending on their location.

Conversion and conservation of forests has been a direct result of historical land speculation in Costa Rica. During the 1950s, the Costa Rican government pushed a policy of land colonisation beyond the Central Valley, with a combination of soft credit and land titling where ranching was sufficient to guarantee possession.

The aggressive colonisation process saw small farmers often staying at the fringes of economic policies, indigenous people displaced by non-indigenous farmers,[3] with large landowners (both national and foreign) moving in to occupy as much territory as they could claim. Ranching was a suitable vehicle to secure land while waiting for land prices to rise and at the same time obtaining some (often minimal) returns (Roebeling *et al.*, 2010). This conversion trend was mostly reversed during the elimination of subsidies and collapse of the beef markets during the 1980s. Since this period of ‘free land’, a series of laws (Rojas-Valverde, 2011) affecting land ownership in rural and more urban areas has affected land prices.

To our knowledge, this is the first study to evaluate whether the land-use change ban for forest land has affected land prices.

Although there are no reliable historical data on land prices, some isolated studies have been made (see for example Roebeling *et al.* (2010) in the Atlantic). Real land prices appear to vary considerably over time, with no visually evident general trend, but there are roughly four main periods that have affected them (see Table 1).

Current land prices[4] are expected to be broadly consistent with von Thünen’s location theory and Ricardian land-use capacity (Randall and Castle, 1985). Higher prices are found near the centre of the country (reflecting a high demand for urban and high-value agriculture export products); along the Pacific coast for tourist resorts; or in rural areas on land with higher productivity (due to features such as slope, soil depth, soil type, and drainage). Tourism is a major player in

Table 1. Main periods affecting land prices

| PERIOD | DESCRIPTION |
|---|---|
| Mid 1970s | Land prices increase linked to the creation of national parks and stricter control of deforestation. |
| Mid to end of 1980s | Land prices increase following the passing of the FODEA Law, which cancelled debts and provided better financing especially for ranchers. Roads improved, with the construction of the highway connecting San José to the Atlantic Zone harbour. |
| Early 2000s | Land prices increase following massive tourism expansion in the 1990s, when ecotourism gave an added value to forests (Watson, pers. comm), and a larger inflow of foreign purchases of land for recreation and conservation, either as private land and/or private reserves (González-Pérez, pers. comm). |
| Mid 2000s | Land prices decreased following the crash of international markets and a slump from which real estate in Costa Rica has not fully recovered. Nevertheless, prices remain relatively high in coastal areas linked to tourism and this is reflected in the values reported during the study on Zonas Homogéneas (see footnote 5) in 2008–9. |

Source: Authors’ own

[3] In Costa Rica, non-indigenous peoples are those of European or African descent.
[4] We gathered approximately 200 observations from advertised property sales in rural areas, collected between October 2012 and December 2013 from advertisements in newspapers, the Internet, and directly from real-estate agents. We used this data to validate the prices obtained from the ZH study.

land markets. Looking at land prices from 200 real-estate advertisements for rural properties between 2012 and 2013, we found that nearly all listings are aimed at the tourist, residential or recreational markets. Larger properties located near cities and town centres are often advertised 'for development', indicating the potential for subdividing and re-selling as smaller plots. Highly touristic areas (near Osa for example) offer special 'gated communities' deals for foreign investors. Plots along the coast can fetch the highest prices: land is sold as 'lots' of less than one hectare starting at US$150,000. Ocean-front properties can sell at more than US$700/m$^2$ in Jaco, Puntarenas.

It is difficult to obtain historical data on land prices to analyse trends. Most values reported at the Land Registry were purposely kept low because of tax evasion, until the recent real-estate valuation analysis for revamping the tax system conducted between 2008 and 2009 by the Ministry of Finance to reassess taxes – referred here as the *zonas homogéneas*[5] (ZH) study (see Appendix 1).

## 2.2 Economic instrument context: PES and land ownership

The premise of the PES programme in Costa Rica is anchored in private land ownership. The programme legally[6] assigns the property rights to ecosystems services provided by forests to their owners (e.g. carbon sequestration or protection of water quality). Through this, it allows them to receive payments for the provision of these services (either by the government or through potentially private deals). While the benefits from better habitats accrue to society in general, it is only those with land that can receive payments for ecosystem services.

Geographic location of this land is also crucial to access the programme. While participation is open to all types of forest anywhere in the country, oversubscription has led programme managers to try different methods to prioritise contract allocation (see Porras *et al.* 2013 for a description of the main methods used since 1997). Currently, this priority is given based on several characteristics: biophysical components – where land-use capacity is used as an indicator for the preferred land use and identification of critical areas – and components aimed at fulfilling social objectives.

The system is based on points: properties with forest located in any part of the country receive an initial allocation of 55 points. Extra points are given to forests located in:

- indigenous areas (+30 points);
- conservation gaps (+30 points);
- areas protecting water resources (+25 points);
- biological corridors (+25 points); and/or
- wildlife protected areas – including non-expropriated properties located there (+20 points).

Additionally, properties can receive 'social boost' points: properties located in areas with a low social development index score (+10 points); properties of less than 50 hectares (+25 points); and a boost for continuity (+10 points if the property has a contract expiring that year).

## 2.3 Methodological context

Based on data from the *zonas homogéneas* study (see below) we tested for correlations between variables used for PES political setting (e.g. indigenous areas, property size, biological corridors, and social development index) and land values. We performed a hedonic regression (Lausted Veie and Panduro, 2013) at the national level to understand how variables relate to each other (see Section 3).

In our analysis, we evaluate whether land values can be used to calibrate the land-use capacity indicators for opportunity costs. In the long term, it is unlikely that the richness of information obtained through the land-prices survey will be repeated often. At the moment, the land-prices data provides an opportunity to calibrate existing, cost-effective ways (like land-use capacity) to gauge opportunity costs of conservation policies. For this, we performed a valuation or cross-check of opportunity costs calculated using LUC, to see how well they were correlated in space. We used the Osa Peninsula and Nicoya Peninsula as specific case studies, as we have in-depth information on these locations from previous projects (PESILA-REDD and Policymix).

Except in specific cases, the wealth of PES participants was roughly measured in terms of the social development index. Much has been discussed of the limitations of the SDI as a proxy for land-related wealth (see Porras *et al*., 2013) and we expected that by using land values we could obtain better results. This is due to the fact that the relationship between wealth/ land ownership is more theoretically consistent and it provides better spatial resolution than the district-level SDI. For this, we performed a pairwise correlation

[5] *Zonas homogéneas* or homogenous zones are standardised sub-units at national level that share common characteristics, for example type and quality of services and proximity to markets that affect the value of land. These homogenous units are now used by the Ministry of Finance to estimate the property tax paid by the property owner.
[6] Law 7575, approved in 1996.

analysis of SDI, land prices, and prices of properties participating in the PES programme.

### 2.3.1 Data sources

For our analysis, we used three main sources of data:

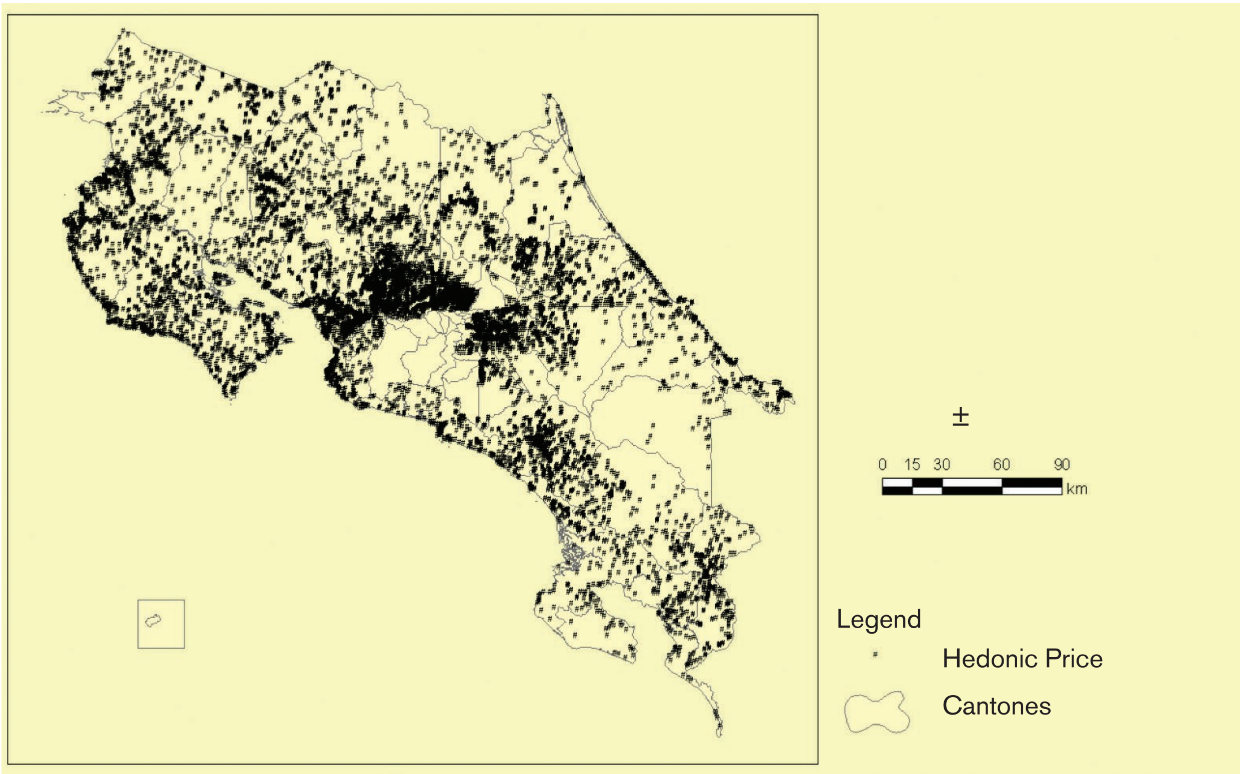
- **ZH database**: geo-referenced property data, using information collected by the *zonas homogéneas* (ZH) study (Empresa Roche Consulting Group LTD, 2008). This study was commissioned by the Ministry of Finance to update land prices across the country in order to revamp land taxes, and was carried out between 2008 and 2009. Using personal interviews, the study collected detailed information on key variables including: land prices; approximate area (but without access to cadastral maps); type of available services; regularity of plot; main economic activity; and land-use capacity. Reliability varies for the observations, but overall it is the best available information on land prices with national coverage to date. Land speculation has been high in Costa Rica, but tends to concentrate around urban and peri-urban areas and beach-front properties where the tourism boom is more evident. We have excluded properties reporting very high prices in relation to other prices in the area. Although we concentrated on rural areas, our final viable dataset consists of 32,208 observations located in urban and rural areas all over the country (see Figure 1).
- Using the geo-referenced **Costa Rica Atlas** (ITCR (2008) we link the ZH study to other geographic variables, for example distance to San José, main cities, local schools, sawmills, roads (types), protected areas, biological corridors, volcanoes, beaches, hospitals, banks, and hotels, etc.
- **PES database**: information on PES contracts, including number of hectares, money allocated, type of participant and property sizes was provided by the PES programme managers (FONAFIFO, 2012) for the 1998–2012 period. The final viable dataset has 14,702 observations.

### 2.3.2 Linking the data sources

Unfortunately, at this stage we did not have comparable geo-referenced information for the PES dataset, which has limited our analysis. For example, we were not able to directly overlap the three databases and link the PES properties to the nearest land prices available in the area, or to other variables that are likely to affect local opportunity costs.

To link the information from both datasets we used the following adjustments:

Figure 1 Distribution of observations on land values from ZH study




Note: observations from several *cantones* in San José are missing. Most of them are from urban areas so we do not expect the results to change significantly. Source: prepared by Diego Tobar from CATIE using data from the ZH study (Empresa Roche Consulting Group Ltd, 2008).

1. In the ZH database, we used a dummy variable at district level, indicating whether there are any PES contracts within 1km of the property. This variable provided an indicator for the presence of the programme in the area.
2. From the ZH database we obtained average district prices for rural properties, which we then transferred to the PES database. Two further adjustments were made to this value before we plugged it into the PES database:
   - **Adjustment by property size** (see Box 1): as discussed in section 3.2, we found that land prices vary significantly by size and, by using the rough district average, can result in over-estimation. As a result we adjusted the average district level by individual property sizes.
   - **Real prices**: we needed to adjust for time because the ZH study only provided information collected in one period (2008–2009), but the PES contracts database contains data from 1998 to 2012. To adjust for this, we conducted a base-year analysis, using the Costa Rica CPI consumer price index,[7] estimated by the Central Bank (see Appendix 2). This provided time-series values at 2008 prices.

## BOX 1. ADJUSTING AVERAGE DISTRICT LAND PRICES BY PROPERTY SIZE

< 2 hectares = average *1.5

2 to < 10 hectares = average

10 to < 50 hectares = average *0.2

> 100 hectares = average *0.1

[7] The consumer price index (CPI) measures changes in prices of all goods and services consumed by the population of a country. It is constructed with the prices of a sample of representative items (e.g. food, transportation, education, or clothing) by recording prices monthly.

# The economic model

This section is divided in two parts. A theoretical section discusses the economic foundations of land as a productive asset and a consumption good, leading to the presentation of a hedonic price method (HPM) as a statistical form to explore the relationship variables and how they affect land values as an indicator for opportunity costs. The results section shows first the general trends and baseline relations, and the results of the model applied to rural properties in Costa Rica.

3

# 3.1 Theoretical framework

## 3.1.1 Land as production asset and consumption good

'Land', both as production input and consumption good, is a central concept for engineers, politicians, and social scientists (Randall and Castle, 1985). Early classical and neoclassical economists treated land as a basic part of the aggregate production function, either on its own (classical) or as a component of capital where land productivity responds directly to investments. Later on, location theory, led by von Thünen, urban economics, and environmental economics, went further, and incorporated land as a consumption good, directly influencing consumers' preferences.

Economic theories help us to understand people's decisions, and can help planners design policies that reflect these preferences. In a basic asset model, land is treated as a marketable asset valued as a factor for producing a stream of goods (e.g. agricultural commodities). In this model, the price of land at an initial time (t=0) would represent the anticipated stream of rents accruing at all subsequent times (Osano *et al*., 2011). Given an unchanging set of expectations, the price of the asset at any time fully reflects the discounted value of future production. Von Thünen's early work on location theory looks not so much at land quality (as per Ricardian theory), but to where land is located in terms of costs in relation to a 'centre', for example a city, in order to predict rents. Through this, we see emerging patterns of land use and where prices decrease (not necessarily in a linear way) as we move away from this centre.

Recent approaches treat land in a more holistic way, involving law, sociology, and political science, and as a basic unit to provide environmental amenities. The bid-rent approach (see technical glossary), for example, deals with the urban land market problem, and competition for land between urban and agricultural uses at the edge of a city. Here, land is treated as a consumption good, where consumer utility is positively related to the amount of land (e.g. residential space) occupied in relation to the amount of amenities at a given location, a quantity of composite good consumed and other costs (like commuting). Using a Hicksian utility model shows that for a consumer to be in equilibrium, the marginal value of each amenity must be equal to the increment to land cost. Hedonic price theory is used to assess the impacts of on-site, neighbourhood and regional amenities in land prices.

Understanding land as a productive asset makes it easier to understand land as a wealth-holding asset, and relatively easy to convert to a financial asset where property rights are clear. As such it is both a financial and real asset, which can be used as a form of security for loans and potential capital gains. Equity and wealth through real estate is also important to soften exposure to macroeconomic policy via employment, wages, and prices. Returns above or below the norm are expected from time to time, for example in response to market shocks and windfalls. How much a landowner can capitalise on these gains will depend on institutional factors, for example rigidities in financial institutions, farm commodities, tenure issues, or land-use regulations. Location theory suggests that land will be assigned to the use that returns the greatest rent.

Understanding land-market theory has direct implications for land-use planning and regulation, and the protection of wildlife areas. The non-exclusiveness and non-rivalry characteristics of some ecosystem services that result in market failures suggest the intervention of governments to control or manage land, for example through zoning. As restrictions on travel costs decrease and demand for wildland amenities increase, land markets will be less sensitive to distance and biological productivity and more to the quality of non-consumptive amenities (e.g. nice coastal views). Hedonic models are used then to estimate benefits of environmental improvements in terms of land prices. This helps to predict the impact on rents from land values as a response to government policies – and potentially design user charges in proportion to these gains or value-capture policies to tax capital gains to finance a particular project.

## 3.1.2 Definition of the analytical model

The hedonic price model (HPM) suggests that prices of complex goods like the real-estate market embed information on the implicit prices of the components of the good. For example, a house overlooking a natural forest may be more expensive than a similar house with a less interesting view. Other factors such as the size, age, and shape of the house and its economic distance to services, amenities (the forest), and workplaces will also affect the final market price of the real-estate property.

The hedonic pricing method typically uses multiple regressions on groups of characteristics, where the dependent variable is the property price:

US$/$m^2$ = f (plot characteristics; access to public services; geographical characteristics; environmental policy variables; location)

Table 2 presents the list of the main variables we used in our analysis, the indicators, and expected direction of the effect on land prices.

Table 2. Variables expected to influence land prices, and expected direction of impact

| MAIN CHARACTERISTIC | INDICATORS | EXPECTED EFFECTS ON LAND VALUES |
|---|---|---|
| Structural characteristics of the plot | Area | (–) Larger properties will have lower price per $m^2$. |
| | Frontage | Uncertain. One the one hand, larger frontages command better values, but frontages are also linked to plot size so we expect a possible negative here. |
| | Slope | (–) |
| | Regularity | (+) |
| Access to public services in neighbourhood, reflecting quality of surroundings | Types of service (continuous variable 1–16, 16 is best); | (+) The more public services available, the higher the land price. |
| | Water source available in the property (1–5, 1 is best); type of road adjacent to the property (1 is best) | (–) The better the quality of the water source in the property (closer to 1), the better the price. Same applies to type of road adjacent to the property. |
| | Distance to nearest bank, hospital and high school; distance to nearest main city; distance to secondary and main roads | (+) We expect a positive correlation between US$$m^2$ and services within the neighbourhood of the property. We will test for levels of correlation among these variables to avoid collinearity. |
| | Social development index (1–100, 100 is best) | (+) SDI reflects local services. |
| Geographic characteristics | Province | Dichotomous variables; we expect diversity within provinces, but in general expect land prices to be higher in more metropolitan or touristic places. |
| | Rainfall | Uncertain. |
| | Elevation | (+) But not necessarily linear. |
| | Property located within 10km of Pacific beach | (+) These are highly touristic areas, even when excluding the land directly within the maritime zone. |
| Economic variables (tourism treated separately) | Main economic use in property | Dichotomous variable reported by the ZH enumerators, denoting agriculture (yes/no), forestry (yes/no), and cattle (yes/no). |
| | Distance to nearest sawmill | Uncertain. Probably negative. |
| | Land-use capacity (LUC) (1–8, 1 is best) | (–) The closer to 1, the more activities are possible. Land prices are expected to go down as LUC score increases. |

| | | |
|---|---|---|
| Environmental variables that can be seen/affect the plot (includes information from land-cover maps 2008) | Property on indigenous land (yes/no), biological corridor (yes/no), or protected area (yes/no) | (–) We expect that the legal restrictions that apply in these areas will reduce land prices. 'Protected areas' refers to land-use capacity (LUC) category rather than a legally created park. See Table 8 for a description of LUC. |
| | Distance to protected area (and location within) | Uncertain, but likely negative. Most protected areas are in remoter parts of the country, with lower land prices. Positive effect in some places if it is linked to potential ecotourism activities. |
| | PES: property located within 1km of forest receiving PES | (–) Most PES is linked to forest conservation, usually in areas with lower opportunity costs. A positive sign might also indicate that PES within 1km contributes to increasing the price of the property w.r.t other forested areas not receiving PES. |
| | Distance to areas with high risk of flooding | (+) The further the distance from risk of flooding, the better prices land can fetch. Potentially correlated with elevation. |
| | Land cover 2008 | Uncertain. |
| Tourism-related characteristics | Distance to nearest (registered) hotel, distance to beach; distance to volcanoes | (–) Negative but non-linear. The shorter the distance to tourism facilities, the higher the price expected for land. |
| | Distance to San José City; distance to main international airport | (–) Negative. Better-connected properties will fetch better prices. |

Source: authors' own data

Table 3. Average prices rural and urban, US$/m²

| | OBSERVATIONS | MEAN | STD. ERR. | [95% CONF. INTERVAL] | |
|---|---|---|---|---|---|
| Rural | 10,583 | 7.54 | 0.11 | 7.33 | 7.75 |
| Urban | 21,659 | 75.05 | 0.76 | 73.56 | 76.54 |
| Total | 32,208 | 52.9 | 0.54 | 51.87 | 54.00 |

Source: ZH study (Empresa Roche Consulting Group Ltd, 2008)

# 3.1 Results

## 3.2.1 Baseline prices: general trends and partial correlations

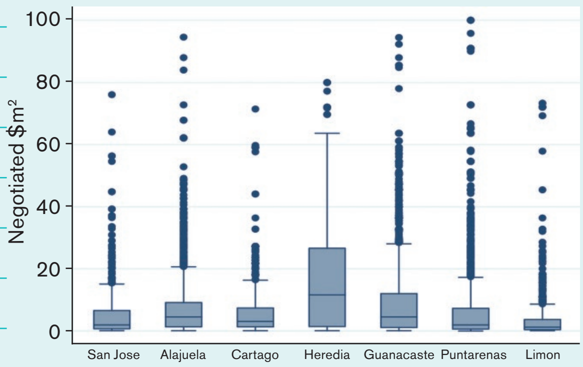
Using the ZH dataset, we obtained a complete set of 32,208 observations of land prices in rural (10,583) and urban (21,659) areas (see Table 3). At the national level, the average price of land is US$53/m².

Initial analysis showed a significant difference in prices in rural (US$7.54) and urban (US$75.05) areas. For the purpose of our analysis in the subsequent sections we have focused on rural prices; although it is important to keep in mind how proximity to urban areas and increasing urbanisation in the country blur the rural–urban divide and create a wider de-facto peri-urban fringe.

Table 4. Rural land prices (US$/m²) by province

| | US$/m² | STANDARD ERROR | N |
|---|---|---|---|
| San José | 5.1 | 0.27 | 811 |
| Alajuela | 7.3 | 0.18 | 2,646 |
| Cartago | 5.9 | 0.26 | 963 |
| Heredia | 16.2 | 0.60 | 775 |
| Guanacaste | 9.3 | 0.27 | 2,179 |
| Puntarenas | 6.4 | 0.25 | 2,165 |
| Limon | 3.8 | 0.25 | 1,044 |
| Total | **7.5** | **0.1** | **1,0583** |

DISPERSION PLOT

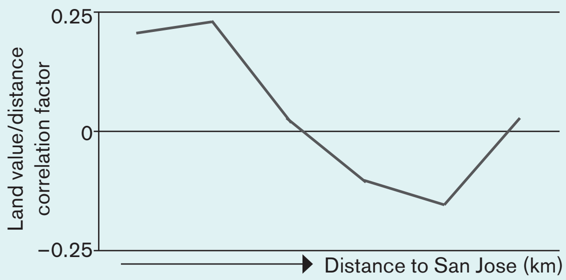



Source: ZH database (Empresa Roche Consulting Group Ltd, 2008)

Table 5. Correlation analysis for land prices and distances to San José City

| DISTANCE TO SJ | CORRELATION FACTOR |
|---|---|
| 10km or less | 0.2071 |
| 10–20km | 0.2289 |
| 20–50km | 0.0241 |
| 50–100km | –0.1071 |
| 100–150km | –0.1535 |

CORRELATION GRAPH LAND VALUES AND DISTANCE TO SJ




Source: ZH database (Empresa Roche Consulting Group Ltd, 2008)

## Location

Prices vary considerably at the province levels, especially for some provinces. The highest average rural prices are found in the province of Heredia (which also presents greater dispersion) and the lowest in the province of Limon in the Caribbean. Values in Guanacaste are the second highest, followed by Alajuela (see Table 4).

Land prices are non-linearly correlated with geographic characteristics. Prices are strongly affected if the property is in Heredia (positive correlation) and within 10km of a beach along the Pacific coast. At the same time, they also decrease for properties further away from the metropolitan area, measured in relation to San José City, but increase again nearer to the coast (especially the Pacific).

This non-linearity is illustrated strongly in Table 5 and its corresponding figure. The prices of properties have a positive and strong correlation for properties within 10km or even less than 20km from San José City. These are areas near the airport, with strong residential potential. The strength of the correlation decreases sharply after 20km and the relationship becomes negative after about 50km. However, after approximately 150km prices increase again – as properties are located nearer coastal areas. The same type of relationship, but inverse, is observed when distances are taken in relation to proximity to beach.

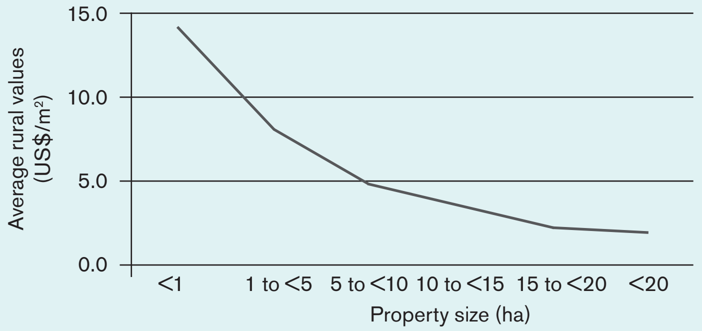
## Structural characteristics of the plot

Land value per square metre is negatively correlated to **property size**: smaller properties tend to have higher value per square metre (see Table 6). The partial

Table 6. Land prices (US$/m²) and property size

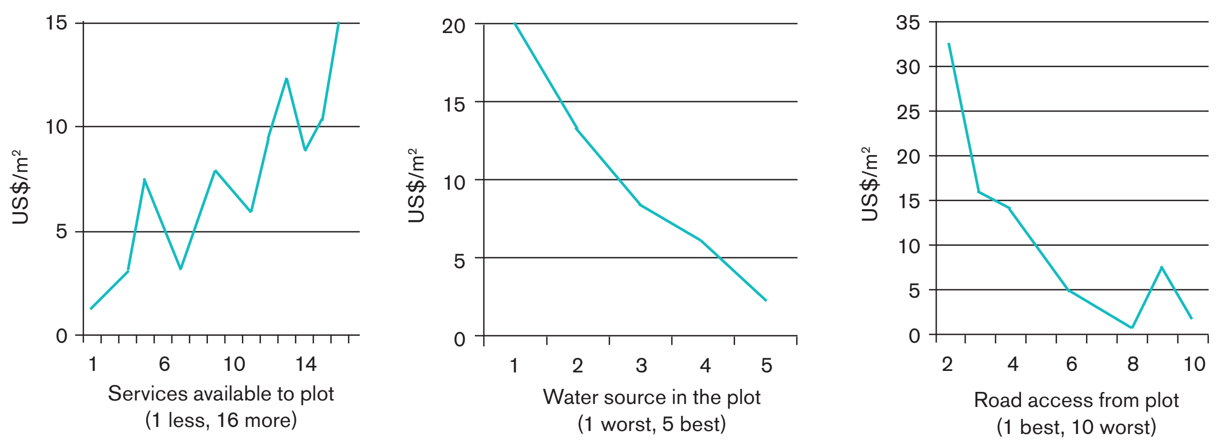
| | RURAL | URBAN |
|---|---|---|
| < 1 | 14.1 | 75.0 |
| 1 to <5 | 8.2 | 86.0 |
| 5 to <10 | 4.9 | 57.3 |
| 10 to <15 | 3.5 | 87.7 |
| 15 to <20 | 2.2 | 83.6 |
| > 20 | 1.9 | 11.6 |
| Total | **7.5** | **75.0** |

GRAPHIC DEPICTION RURAL VALUES




Source: ZH database (Empresa Roche Consulting Group Ltd, 2008). We use this relationship to base our price adjustment presented in Box 1 in the methodological section.

Figure 2. Land prices and public services




correlation factor between land value and property size in rural areas is negative and statistically significant (−0.0357). These peri-urban areas, classified as rural, are under heavy pressure from land conversion policies, which is reflected in their prices.

This is a big concern for property fragmentation, with larger properties being converted and sold as smaller units to maximise market prices. We observed exceptions in San José and Guanacaste, where property prices are positively correlated with size, although the coefficient is small (0.0417 and 0.0068, respectively). Properties with larger frontages can command a higher price, especially close to urban areas. However, the size of frontage is also linked to property size. Larger properties are likely to have larger front, and as we described above, property size is negatively correlated with price. The resulting correlation in our dataset for property front is negative (−0.168).

Regularity of the plot shows a very low correlation with prices, as well as with nearly all other variables. Slope is negatively (and strongly) correlated with price, showing that flatter properties fetch better prices.

## Access to public services

Land prices are negatively correlated (−0.2620) to type of water source (1 describes best access – e.g. from a tap, 5 is worse – e.g. from rainwater). The same relation applies to road access (−0.3787), which describes type of road immediately leading to the front of the property (1 is best). Public services available presents a positive relationship (0.3926), showing the more available the services, the higher the price of the property. Land prices decrease with distance to banks (−0.299), to hotels (−0.345), and to hospitals (−0.1407). All correlation factors are statistically significant (see Figure 2).

The social development index (SDI) is positively correlated with land values (0.3960) and is statistically significant. SDI is strongly correlated with distance to services: SDI decreases as the distance to services increases. Caution is required here to read this variable, as it is at district level, rather than plot level. All distance variables are negatively correlated: price decreases the further away from these services the property is.

## Regulations based on environmental characteristics

Land-use restrictions imposed on properties for being inside an indigenous area (see also Section 4.1 for further discussion), a biological corridor, or within a protected area can potentially reduce land prices if there is pressure for conversion to e.g. agricultural use (see Table 7). Indigenous areas are linked to higher slopes, lower level of services and SDI, higher rainfall, and higher distances to services. Property prices increase the further away from a protected area or an area at risk of flooding. The rank ordering of average property prices is consistent with what would be expected in relation to the relative restrictions on land use and property transactions in each of these management categories. The sale of property is legally restricted in indigenous areas. Land-use change regulations are likely to be more enforced in protected areas (multiple-use reserves, not including national parks), while biological corridors have no official protected-area status. A latent variable determining land-use regulation is forest cover, which may also explain the differences in land-use values in Table 7.

There is a strong negative correlation between property prices and the existence of PES contracts within 1km of the property (–0.2174): this is in line with the hypothesis that PES is often located in areas with lower opportunity costs and therefore lower market values. The probability of PES contracts within 1km of the property is negatively correlated with SDI (the richer the district, the less likely there is to be PES), and positively correlated with rainfall.

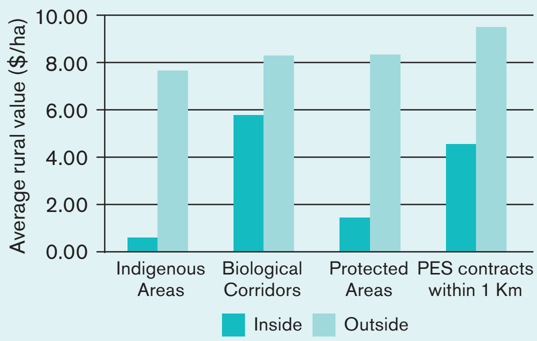
Land values appear to increase for properties located further away from protected areas (0.088) and from areas prone to flooding (0.205), but they decrease if the properties are located away from volcanoes[8] (–0.058), from the beach (–0,0621), or from hotels (–0.35) which is an indicator of tourism opportunities.

## Land values and land-use capacity as surrogates for land planning

Land-use capacity (LUC) has been used as a surrogate basis for computing opportunity costs when it comes to land planning. LUC maps are based on slope, soil characteristics, life zones, risk of flooding, dry periods, fog, and wind influences. LUC categories range from 1 to 8 (see Table 8), and are linked to the viability of the land for economic activities (lower categories allow for more economic activities). Conversion of forests to other uses is more expected in areas where conditions are more favourable to agriculture (e.g. lower slopes, better soils). A ninth category indicates areas that should ideally be kept as protected areas, or under legal restrictions to prevent deforestation (shown in

Table 7. Average land price by key land-use regulation factors

| | INSIDE | OUTSIDE | FIGURE |
|---|---|---|---|
| Indigenous areas | 0.59 | 7.63 | |
| Biological corridors | 5.76 | 8.30 | |
| Protected areas | 1.41 | 8.32 | |
| PES contracts within 1km | 4.5 | 9.5 | |



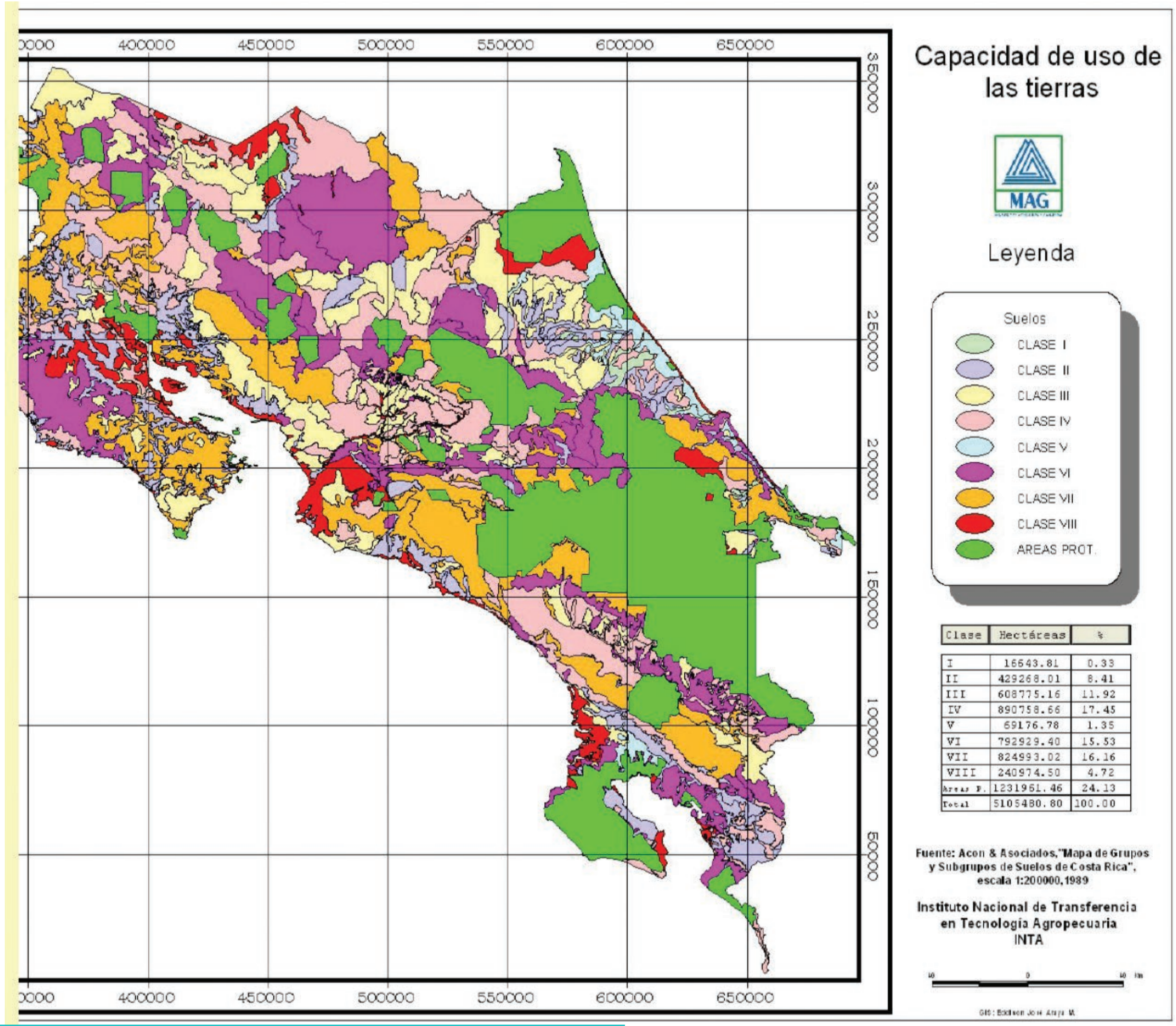

Source: ZH Database (Empresa Roche Consulting Group Ltd, 2008)

[8] A probable reason for this is that most volcanoes in Costa Rica are associated with richer soils and climate, making the areas better suited for agriculture, tourism and/or residential opportunities.

bright green in Figure 3). These categories are used as a basis for land regulation and assess critical areas where existing land use substantially varies with the land-use capacity (i.e. *sobre uso* or overuse). Studies have shown that LUC is a useful indicator for relative productivity, and by holding other relevant factors constant, less productive plots are more likely to be selected for protection (see for example Andam, 2008).

Because LUC is linked to economic alternatives, we expected land prices to significantly drop for higher LUC categories (e.g. as the land-use capacity declines). Using the information from the ZH database, we confirmed this relation: land values and land-use capacity are statistically (and significantly) correlated and land prices – reflecting opportunity costs – decrease as the quality of the plot decreases. Higher slopes, more fragile soils and higher precipitation[9] reduce development potential. However, the coefficients are small, indicating that other factors affect land values. One reason behind this can be traced directly to the way LUC is calculated, and the opportunity cost it reveals is mostly linked to agriculture, ranching, and forestry activities while, as we discussed in previous sections, pressure for land conversion in Costa Rica increasingly comes from urbanisation and/or tourism and this is not captured in the usual calculations of LUC. As we have also discussed in other sections of this study, conservation policies are not only affected by biophysical characteristics. In order to maximise policy uptake, conservation planners must take into account pressure from other sectors beyond agriculture. Section 5 presents a more detailed discussion of opportunity costs combining LUC at the local level.

Figure 3. Land-use capacity map




Source: Diego Tobar, CATIE.

[9] The average precipitation in the sample is just over 2900mm/year, with a minimum of 1400mm/year and a maximum of 7500mm/year.

Table 8. Land-use categories and average land values

| LUC | US$/m² RURAL AREAS | DESCRIPTION |
|---|---|---|
| I | N/A | Agricultural production – annual crops. |
| II | 8.3 | Suitable for agricultural production requiring special land- and crop-management practices such as water conservation, fertilisation, irrigation etc. |
| III | 7.6 | Suitable for agricultural production requiring special land- and crop-management practices such as water conservation, fertilisation, irrigation etc. |
| IV | 10.6 | Moderately suitable for agricultural production; permanent or semi-permanent crops such as fruit trees, sugar cane, coffee, ornamental plants etc. |
| V | 4.2 | Strong limitations for agriculture; forestry or pastureland. |
| VI | 5.0 | Strong limitations for agricultural production; land is only suitable for forest plantations or natural forest management. |
| VII | 7.0 | Strong limitations for agricultural production; land is only suitable for forest plantations or natural forest management. |
| VIII | 8.1 | Land is suitable only for watershed protection and forest management. |
| IX[10] | 1.6 | Protected areas (areas that ideally should be under legal protection). |
| Total n=10549 | **7.5** | **Correlation factor: −0.1367** |

Source: Land-use categories as described by Law N° 23214-MAG-MIRENEM (13/04/1994)..

### 3.2.3 Results from the hedonic pricing model

The first model, presented in Table 9, summarises the results when looking only at observations in rural areas. We have 10,549 valid observations from the seven provinces.

Overall, the model partially helps explain the variability of land prices across the rural landscape. We find that plot characteristics, namely type of water source available (from a tap = 1, rainwater = 5) and type of road access (1 = best) are negatively linked to land prices, and are some of the most important variables explaining price differences. Land prices decrease when the reported use is agriculture or forestry – but this result should be treated carefully as most of the values in the survey correspond to surveyors' observations at the point of entry and not necessarily with the real land use of the plot. The readings of the surveys, for example, do not refer to residential or tourism uses in rural areas (only agriculture, forestry, or ranching were used). These 'use dummies' have probably more significance in urban properties, where direct observation of use is easier to make.

Distances to services are negatively correlated with land prices: the farther away the property is from hotels, hospitals, and schools the lower the land prices. This is reflected in the positive and statistically significant link to SDI: the higher the social development index, the higher the land prices. Prices are lower inside biological corridors and designated protected areas supporting earlier partial correlation analysis. Land prices decrease the further away the property is from the beach, or from an airport. They increase for properties further away from volcanoes, which tend to be more inaccessible and many are active. Land prices are negatively linked

[10] Protected areas are a separate category with no LUC information computed. Protected areas can have LUC in classes I–VIII based on biophysical characteristics, but this is not mapped for political reasons. The ZH survey, however, includes 820 observations of land prices in these areas, with an average price of US$1.6/m². In the regression model in the following section, we use a variable 'inside protected areas'. This variable refers to actual protected areas, and not the LUC category.

Table 9. Ordinary least squares (OLS) regression using only observations in rural areas

| VALUE–FINAL | ESTIMATED COEFFICIENT | STD. ERR. | T | BETA | NOTES ON LAND PRICES |
|---|---|---|---|---|---|
| **Characteristics of the plot** | | | | | |
| Size (in hectares) | 0.0003 | 0.0002 | 1.09 | 0.0089 | Land prices decrease as water sources and type of access decline – which have some of the strongest weight in explaining land price variability. They decrease if the main use is declared as agriculture or forestry (which correlate with LUC). The effect of property size and frontage of the property are very small. |
| Frontage (in metres) | −0.0020 | 0.0003 | −7.11 | −0.0611 | |
| Water availability | −1.8160 | 0.1158 | −15.69 | −0.1393 | |
| Type of access | −1.7052 | 0.0692 | −24.64 | −0.2278 | |
| Main use: agriculture | −2.1822 | 0.2924 | −7.46 | −0.0823 | |
| Main use: forestry | −0.0422 | 0.3741 | −0.11 | −0.0012 | |
| **Characteristics of the area and access to services** | | | | | |
| Social development index | 0.1237 | 0.0108 | 11.42 | 0.1395 | Land prices are positively linked to higher SDI, and negatively linked to distance to basic services like hotels, hospitals, and schools. Distance to banks seems to be positively linked to land prices, which is unexpected. |
| Distance to bank (km) | 0.0897 | 0.0192 | 4.67 | 0.0535 | |
| Distance to hotel (km) | −0.2570 | 0.0170 | −15.11 | −0.1539 | |
| Distance to hospital (km) | −0.0169 | 0.0084 | −2.01 | −0.0211 | |
| Distance to school (km) | −0.1208 | 0.0286 | −4.23 | −0.0412 | |
| **Environmental characteristics** | | | | | |
| Rainfall (mm) | −0.0007 | 0.0001 | −5.73 | −0.0632 | Looking at the beta coefficients, we see a very small negative impact on land prices in areas with high rainfall and high altitude. |
| Altitude (masl) | −0.0001 | 0.0002 | −0.46 | −0.0061 | |
| **Regulations linked to environmental characteristics** | | | | | |
| Inside indigenous area (dummy) | 3.8777 | 0.8425 | 4.6 | 0.0384 | Unexpected effect suggests that land prices are higher inside indigenous areas (which partial correlation analysis showed to be negative). Prices are lower inside biological corridors and designated protected areas. The impact of LUC is uncertain, as all dummies are positive but with a small beta coefficient. |
| Inside biological corridor (dummy) | −1.3442 | 0.2057 | −6.54 | −0.0550 | |
| Inside designated protected area (dummy) | −0.9216 | 0.3642 | −2.53 | −0.0261 | |
| Land-use capacity IV | 1.4131 | 0.2465 | 5.73 | 0.0562 | |
| Land-use capacity V | 2.4306 | 0.9417 | 2.58 | 0.0214 | |
| Land-use capacity VI | 0.7326 | 0.3026 | 2.42 | 0.0230 | |
| Land-use capacity VII | 1.2434 | 0.3227 | 3.85 | 0.0363 | |
| Land-use capacity VIII | 3.0349 | 0.4053 | 7.49 | 0.0649 | |
| Land-use capacity IX | 2.6933 | 0.4704 | 5.73 | 0.0646 | |

| | | | | | |
|---|---|---|---|---|---|
| **Recreation opportunities linked to landscape** | | | | | |
| Distance to beach (km) | −0.0098 | 0.0062 | −1.57 | −0.0207 | Land prices decrease the further away the property is from the beach, or from an airport. They increase for properties further away from volcanoes, which tend to be more inaccessible and many are active. Land prices are negatively linked to the existence of PES contracts, which can also be interpreted as presence of forest in the area. |
| Distance to SJ (km) | 0.0035 | 0.0039 | 0.91 | 0.0180 | |
| Distance to airport (km) | −0.0587 | 0.0045 | −13 | −0.2461 | |
| Distance to volcano (km) | 0.1299 | 0.0093 | 13.9 | 0.1811 | |
| PES contract for conservation within 1km (proxy for forest) | −2.0104 | 0.1934 | −10.4 | −0.0879 | |
| **Location (province)** | | | | | |
| Alajuela | 1.8479 | 0.4360 | 4.24 | 0.0717 | All dummy variables for province are statistically significant. The largest effect on price (beta coefficients) are from Puntarenas, Heredia and Limon (Guanacaste prices are significantly higher but we purposely left out properties directly on the beach front). |
| Cartago | 1.3938 | 0.5136 | 2.71 | 0.0359 | |
| Heredia | 8.3146 | 0.5387 | 15.43 | 0.1937 | |
| Guanacaste | 2.8358 | 0.5995 | 4.73 | 0.1027 | |
| Puntarenas | 5.8110 | 0.4398 | 13.21 | 0.2093 | |
| Limon | 4.7010 | 0.4987 | 9.43 | 0.1257 | |
| Constant | 21.6402 | 1.0757 | 20.12 | | |

| SOURCE | SS | DF | MS | NUMBER OF OBS | 10549 |
|---|---|---|---|---|---|
| Model | 488345.263 | 33 | 14798.34 | F(33, 10515) | 187.89 |
| Residual | 828188.197 | 10515 | 78.76 | Prob > F | 0.000 |
| Total | 1316533.46 | 10548 | 124.8 | R-squared | 0.3709 |
| | | | | Adj R-squared | 0.369 |
| | | | | Root MSE | 8.8748 |

to the existence of PES contracts, which can also be interpreted as the presence of forest in the area. The largest impacts on price (beta coefficients) are from the provinces of Puntarenas and Heredia. Land prices in the Guanacaste province can be significantly higher but we purposely left out properties with direct access to the beach front, ensuring outliers corresponding to tourist developments are excluded.

The coefficient 'inside protected areas' can tell us something about opportunity costs. The regression suggests that properties are US$0.92/m$^2$ (US$9200/ha) cheaper inside protected areas than outside – all things being equal. Using a discount rate of 6 per cent and a time horizon of 10 years, it is possible to amortise the amount to an annual opportunity cost of US$1250/year (or US$583/year over a 50-year time horizon).

More analysis needs to be taken in relation to the PES variable, as it provides circumstantial evidence of the opportunity cost of the Forest Law. If it is a proxy for 'forest', our results suggest that the opportunity cost of forest land is US$2/m$^2$. But the interpretation is much more difficult than that. If true, it suggests that the marginal effect of 'forest' versus 'non-forest' is larger than the marginal effect of 'inside protected area'. This provides the basis for a hypothesis for further testing, i.e. that the ban on forest land-use change has a larger marginal effect on opportunity costs than protected areas. Further autocorrelation analysis is needed to separate effects and understand the relative magnitudes for the coefficients.

At the aggregate level, property size seems to have a positive impact on land prices: higher prices for larger properties, which contradicts earlier partial correlation analysis. We found a similar unexpected relation suggesting that land prices are higher inside indigenous areas (which partial correlation analysis showed to be negative).

Table 10 presents the results from using all observations at national level, including urban and rural properties. The interactions between variables are more complicated, and the 'use' component of land shows different impacts to the 'location' component of land. Overall, location variables show the strongest impact on land prices.

Table 10. OLS results from all observations (rural and urban)

| VALUE_FINAL | COEF. | STD. ERR. | T | BETA | NOTES |
|---|---|---|---|---|---|
| Characteristics of the plot | | | | | |
| Located in urban area (dummy) | 60.26498 | 3.404621 | 17.7 | 0.290163 | The two most important variables explaining land prices are: whether the property is located in urban (positive) or rural (negative) areas, and the quality of access directly to the property (worse access equals lower prices). Land value is negatively linked to property size but positively linked to frontage of the property. It increases if the reported use is agriculture but decreases if it is forestry. The water variable does not have much meaning here as all urban properties have tap water. |
| Size (in hectares) | −0.00108 | 0.002163 | −0.5 | −0.00247 | |
| Front (in metres) | 0.013117 | 0.00254 | 5.16 | 0.028618 | |
| Water availability | 10.09567 | 0.996519 | 10.13 | 0.128234 | |
| Type of access | −19.0973 | 0.40762 | −46.85 | −0.27827 | |
| Main use: agriculture | 3.035316 | 2.602928 | 1.17 | 0.013519 | |
| Main use: forestry | −1.51578 | 3.385791 | −0.45 | −0.00295 | |
| Characteristics of the area and access to services | | | | | |
| Social development index | 0.770802 | 0.058557 | 13.16 | 0.100988 | Land prices positively linked to higher social development index, and negatively to distance to services like banks, hotels, schools and hospitals. All coefficients are statistically significant. |
| Distance to bank (km) | −0.38982 | 0.109569 | −3.56 | −0.02499 | |
| Distance to hotel (km) | −1.13485 | 0.094677 | −11.99 | −0.07496 | |
| Distance to hospital (km) | −0.10154 | 0.045748 | −2.22 | −0.0148 | |
| Distance to school (km) | −1.2323 | 0.165156 | −7.46 | −0.0465 | |
| Environmental characteristics | | | | | |
| Rainfall (mm) | −0.00681 | 0.000725 | −9.4 | −0.06744 | Land prices negatively linked to higher precipitation and higher altitudes. |
| Altitude (masl) | −0.01149 | 0.001455 | −7.9 | −0.068 | |
| Regulations linked to environmental characteristics | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Inside indigenous area (dummy) | 13.9635 | 5.51935 | 2.53 | 0.013013 | Incorporating urban sites in the analysis suggests that – unlike earlier partial correlations – prices are higher inside indigenous areas and protected areas. This result is unexpected. All coefficients for land-use capacity from categories 4 to 9 are positive. This suggests that the model is very sensitive and will benefit from further testing with the variables. |
| Inside biological corridor (dummy) | −2.84601 | 1.178289 | −2.42 | −0.0128 | |
| Inside designated protected area (dummy) | 12.94212 | 2.595046 | 4.99 | 0.030642 | |
| Land-use capacity IV | 9.014765 | 1.283019 | 7.03 | 0.043327 | |
| Land-use capacity V | 24.51247 | 6.01829 | 4.07 | 0.020336 | |
| Land-use capacity VI | 11.64818 | 1.638128 | 7.11 | 0.041484 | |
| Land-use capacity VII | 3.027989 | 1.91859 | 1.58 | 0.008714 | |
| Land-use capacity VIII | 5.928723 | 2.461463 | 2.41 | 0.012313 | |
| Land-use capacity IX | 29.32384 | 2.812482 | 10.43 | 0.064527 | |
| **Recreation opportunities linked to landscape** | | | | | |
| Distance to beach (km) | 0.17787 | 0.034553 | 5.15 | 0.041724 | Introducing urban properties reduces the effect that rural variables may have on price. For example, distance to the beach now presents a positive sign (was negative for rural properties only), but other distance variables are negative, like distance to the capital (San José) and airports. Proximity to PES contracts (as proxy of forest) remains negative and statistically significant. |
| Distance to SJ (km) | −0.00577 | 0.023037 | −0.25 | −0.00344 | |
| Distance to airport (km) | −0.30795 | 0.025748 | −11.96 | −0.14416 | |
| Distance to volcano (km) | 0.996553 | 0.052279 | 19.06 | 0.151032 | |
| PES contract for conservation within 1km (proxy for forest) | −10.9757 | 1.107167 | −9.91 | −0.05186 | |
| **Location (province)** | | | | | |
| Alajuela | −14.6378 | 2.107797 | −6.94 | −0.06538 | Using data from urban and rural areas introduces more variability at province level than only rural. Results show that prices increase if the property is located in Heredia and Puntarenas and decrease otherwise. |
| Cartago | −8.48301 | 2.496253 | −3.4 | −0.02744 | |
| Heredia | 3.847544 | 2.432433 | 1.58 | 0.011832 | |
| Guanacaste | −11.1435 | 3.42247 | −3.26 | −0.04281 | |
| Puntarenas | 14.41692 | 2.327564 | 6.19 | 0.056956 | |
| Limon | −9.14854 | 2.669391 | −3.43 | −0.02759 | |
| Constant | 78.97558 | 6.706598 | 11.78 | . | |

| SOURCE | SS | DF | MS | NUMBER OF OBS | 32208 |
|---|---|---|---|---|---|
| Model | 85836733 | 33 | 2601113 | F( 33, 32174) | 380.1 |
| Residual | 2.2E+08 | 32174 | 6843.154 | Prob > F | 0 |
| Total | 3.06E+08 | 32207 | 9501.3 | R-squared | 0.2805 |
| | | | | Adj R-squared | 0.2798 |
| | | | | Root MSE | 82.723 |

# Land prices and PES priority criteria

In this section, we will examine how differences in land prices – as indicators of opportunity costs – are correlated with these variables. A high correlation between the conservation targeting criteria and land values would indicate that the potential for cost-effective targeting of PES is limited. A low correlation indicates that priority areas could be obtained at a low opportunity cost.

4

Some of the variables are used not only for priority criteria but also to analyse the programme's social impacts, for example how many contracts or payments are allocated to indigenous groups or to farmers located in areas with a low social development index score or, more recently, to relatively smaller-scale farmers. In some specific projects like Ecomarkets,[11] special attention has been given to female-headed households.[12] In this section, we explore how land values interact with each of these indicators, concentrating on four main indicators: **indigenous areas, biological corridors, protected areas, and property size** to take into account fixed costs of participation, and the **social development index** for allocating social priority.

## 4.1 In properties of less than 50 hectares

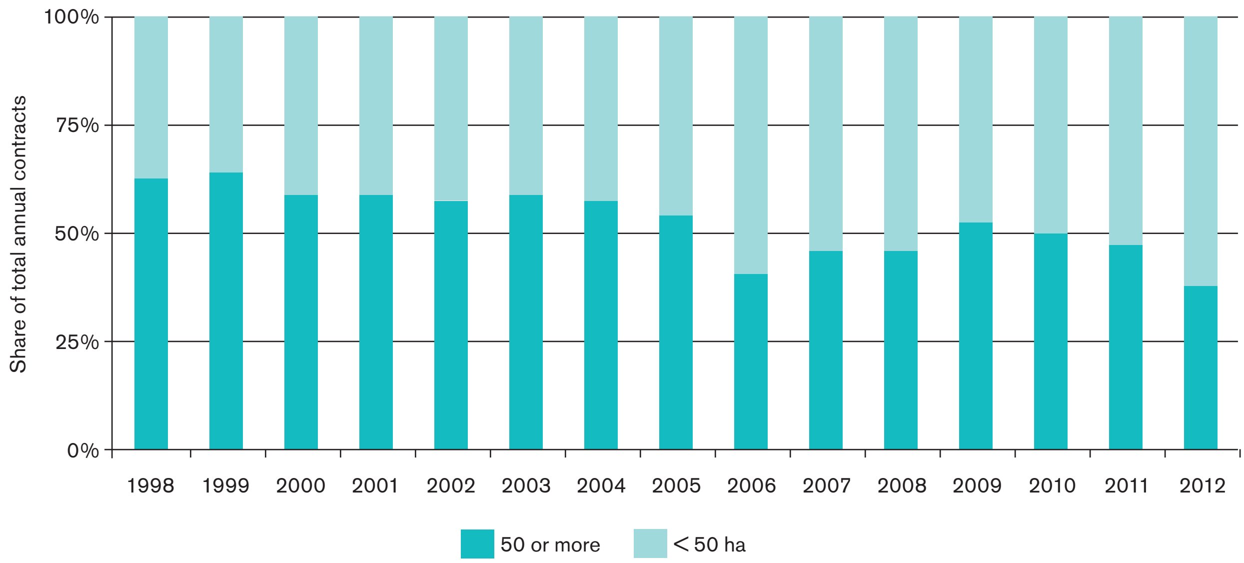
Applications for payments from properties of less than 50 hectares receive 25 additional points. The reasons for using this indicator include:

- Law 7575 requires FONAFIFO to promote participation of 'small and medium producers'. While other indicators may be more appropriate, e.g. income for individuals or registration as a small and medium enterprise (SME), property size is the easiest indicator to use for this.
- Fixed transaction costs for applying for and participating in PES fall harder on smaller properties. The use of the priority criteria is expected to boost their participation in the programme.
- On the social impact of the programme: it is expected that owners of smaller properties are less wealthy than larger landowners. Property of less than 50ha is used as a rough indicator for the relative vulnerability of smaller-scale participants.

Participation of owners with properties of 50 hectares or less in the PES has risen from 272 contracts in 1998 (out of 732, equivalent to 37 per cent) to 764 contracts in 2012 (out of 1226, or 62 per cent). Figure 4 shows that participation of this group has not been under-represented in the overall statistics throughout time, and since 2006 they represent over 50 per cent of annual contract allocation.

Using information from the ZH database, we can estimate the average land values by property size, and how this is in turn linked to the 50-hectare threshold currently used by FONAFIFO to allocate contract priority.[13]

Figure 4. Participation of properties of <50 hectares in PES contracts (1998–2012)

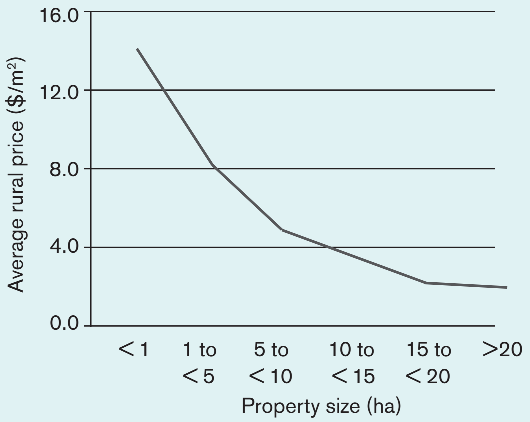



Note: presented as a percentage of annual contracts. Data does not include contracts with indigenous associations or group contracts.
Source: PES database, FONAFIFO (2012).

[11] The World Bank's Ecomarkets Project for Costa Rica aims to increase forest conservation by supporting the development of markets and private sector providers for environmental services supplied by privately owned forests including protection of biological diversity, greenhouse gas mitigation, and provision of hydrological services. See: www.worldbank.org/projects/P052009/ecomarkets-project?lang=en
[12] Unfortunately, there is no information in the ZH study on personal characteristics of property owners, and as such no indicators can be derived in terms of gender.
[13] Information on the size of properties included in the ZH survey can be imprecise at times, especially for larger properties when the property owner was not directly interviewed and property size was estimated by the surveyors.

Table 11. Average land values by property size in rural areas, at national level (US$/m²)

| SIZE IN HECTARES | RURAL | URBAN | GRAPHIC RELATION RURAL PRICES (US$/m²) |
|---|---|---|---|
| < 1 | 14.1 | 75.00 | |
| 1 to <5 | 8.2 | 85.97 | |
| 5 to <10 | 4.9 | 57.30 | |
| 10 to <15 | 3.5 | 87.71 | |
| 15 to <20 | 2.2 | 83.56 | |
| > 20 | 1.9 | 11.60 | |
| Total | **7.5** | **75.05** | |
| Correlation factor | –0.0357<br>(n= 10549, sig. level 0.0002) | –0.0224<br>(n= 21659, sig. level 0.0010) | |




Note. Properties over 20 hectares do not show much difference in average prices. Source: ZH database (Empresa Roche Consulting Group Ltd, 2008).

As expected, land prices and property size are negatively correlated both in rural and urban areas (Table 11). Looking at all the data, the correlation factors are small but statistically significant. The decline in price is more evident when making sub-groups of property size, with smaller properties consistently showing higher prices than larger ones.

Road access and fragmentation of property are linked (Table 12). Although a large majority of observations are for properties of less than 50 hectares we can still observe some price differences. Large properties with poor road access directly to the property have the lowest average land price (US$0.96/m²). Having better road access to these large properties could increase their value by up to nearly US$4.5/m².

Conversely, smaller properties (less than 50 hectares) with good road access have higher average values (US$15/m²), and poor road access significantly reduces their price. The network of roads in Costa Rica is getting increasingly better, opening up easier access to many areas previously considered remote and where conservation of forests faced less competition for conversion.

Although prices are affected by other variables, there is no mistaking the pressure that larger properties face to subdivide and change use from agriculture/ranching to residential, especially if they are located in or near urban areas. Conservation planners face a growing problem, as larger blocks of farmland get subdivided, land prices increase and with it the opportunity cost of conservation. This will have increasing implications for conservation purposes, where protection of larger blocks is needed to ensure landscape connectivity.

It is very difficult for PES planners to assess relative vulnerability based only on property size, as land prices vary widely throughout the country. Table 13 provides some examples of average property values (US$/ha) in rural areas in several districts where the PES operates.

Properties around the metropolitan area, key for protecting watershed services delivered to more than half of the country's population, fetch an average of over US$70k/ha. A 50-hectare property in Santo Domingo in Heredia is valued at approximately US$3.5 million. The district of La Fortuna in Alajuela, where PES contracts protect over 1300 hectares of forests, has average land prices of over US$120,000 per hectare. A 50-hectare property in this district can cost nearly US$2 million. The same 50-hectare property in La Suiza, Cartago is roughly priced at US$250,000; US$1.7 million in Naranjito, Puntarenas; approximately US$125,000 in Upala, Guanacaste; and just over US$70,000 in La Virgen de Sarapiquí in Heredia. A 50-hectare property in Guaycara in Golfito is valued at approximately US$15–20,000; while a property of 50 hectares in Samara in Guanacaste, fronting the sea and with a relative short distance to the international airport, could fetch US$5 million.

Table 12. Land price differences by size and road access

| DESCRIPTION | GOOD ACCESS | POOR ACCESS | TOTAL |
|---|---|---|---|
| More than 50 hectares | 4.44 (n=637) | 0.96 (n=109) | 1.47 |
| 50 or less | 14.92 (n=7263) | 5.59 (n=2540) | 8.00 |
| Average | **14.49** (n=7900) | **5.21** (n=2649) | **7.54** |

Note: 'Good' road access refers to categories 1 to 4, as defined by the ZH study. 'Poor' road access refers to categories 5 and over.

Even aiming to prioritise smaller properties might not be enough if geographic differences are not taken into account. A 10-hectare property in La Fortuna, Alajuela, valued at approximate US$1.4 million, is equivalent in price to a property of well over 300 hectares in Upala, Guanacaste.

Rapid urbanisation pushes up land prices and results in fragmentation of the landscape, with serious consequences for conservation managers. Photo credit: D.N. Barton.

The information from the ZH study shows that property size alone is not enough to understand relative wealth or vulnerability. Table 13 presents just a sample of how combining land values with property size can provide a more informed understanding of the relative wealth of participants, and that not all landowners with 50 hectares can be considered 'vulnerable' and in need of priority criteria when accessing the PES programme.

The previous analysis suggests that in rural areas, the 50ha threshold for prioritising PES is giving additional priority to properties with higher land prices. If the intention of this criterion is to prioritise 'small and medium producers' as stated by the Forest Law 7575, for poverty alleviation reasons the criterion is likely having an unintended opposite effect. Furthermore, rising land prices by property size suggest that – for a fixed PES payment level – the likelihood of attracting applicants is more likely to fall to smaller-sized properties. This is perhaps one contributing factor to the falling trend in these applicants since 2009 (when this criterion was introduced). If properties are being subdivided for residential/tourism purposes, the <50ha threshold has a further unintended effect of targeting non-producers (contrary to the Forest Law's aims).

The analysis hints that the social benefits of helping properties of less than 50 hectares are dubious, especially considering that participation of this group already accounts for nearly half of annual contracts. Rather than only looking at property size, efforts should be more targeted.

Table 13. Example of prices per hectare at district level

| DISTRICT | < 1 ha | 1 to <5 ha | 5 to < 10 ha | > 20 ha | DISTRICT AVERAGE | 50 HECTARES PROPERTY VALUE |
|---|---|---|---|---|---|---|
| Santo Domingo, Heredia | – | 92,625 | 86,400 | 68,200 | 70,700 | 3,410,000 |
| Fortuna, Alajuela | 112,255 | 131,614 | 133,980 | 39,700 | 121,287 | 1,985,000 |
| Naranjito, Puntarenas | 271,193 | 327,608 | 957,300 | 34,600 | 21,633 | 1,730,000 |
| Sierpe, Puntarenas | 10,940 | 31,437 | 19,289 | 11,900 | 48,079 | 595,000 |
| Rivas, PZ San José | 76,400 | 18,732 | 4880 | 8433 | 210,057 | 421,650 |
| La Suiza, Cartago | 47,300 | 23,439 | 1767 | 4867 | 18,408 | 243,350 |
| Hojancha, Guanacaste | 140,925 | 21,210 | 13,857 | 3425 | 30,432 | 171,250 |
| Upala, Alajuela | 81,020 | 68,655 | 6240 | 2500 | 34,377 | 125,000 |
| La Virgen de Sarapiquí, Heredia | 75,886 | 43,941 | 13,392 | 1414 | 19,172 | 70,700 |

Note: These values represent minimum levels, with outliers taken out to avoid overvaluation. Source: ZH database (Empresa Roche Consulting Group Ltd, 2008).

## 4.2 In indigenous areas

By law, land classified as an indigenous area cannot be bought or sold in markets and changes in forest cover are legally forbidden.

However, there are significant inconsistencies between the law and common practice and although illegal, there are private properties which are under some pressure to change land use within and around these reservations. By overlapping information from the ZH study with GIS coordinates, we found 268 observations located in indigenous territories (see Table 7). These properties show (statistically) significantly lower values, with an average of US\$0.6/m$^2$ (N=131) in rural areas and US\$8.3 (N=137) in urban areas, significantly lower than averages for rural (US\$7.6/m$^2$) and urban properties (US\$75.5/m$^2$) in the rest of the country.

The allocation of contracts (mostly for protection) in indigenous lands has increased significantly since the beginning of the PES programme, from 3 per cent in 1998 to 27 per cent in 2012 (see Figure 5). Aside from the important social benefits that these cash injections have in the local communities, it makes economic sense to invest in protection in areas with lower opportunity costs, as demonstrated by the lower land values. At the same time, from an efficiency perspective, this suggests potential gains from lowering payments and eliminating the upper limit for contracts (at 1000 hectares at the moment).

Other considerations of course may apply. There is a debate as to whether protection in these areas counts as **additional**, given the very low level of risk of deforestation. Also, although perhaps valid from a cost-minimisation point of view, the political cost of reducing the payment level in indigenous areas may be too high to be a route taken by programme managers.

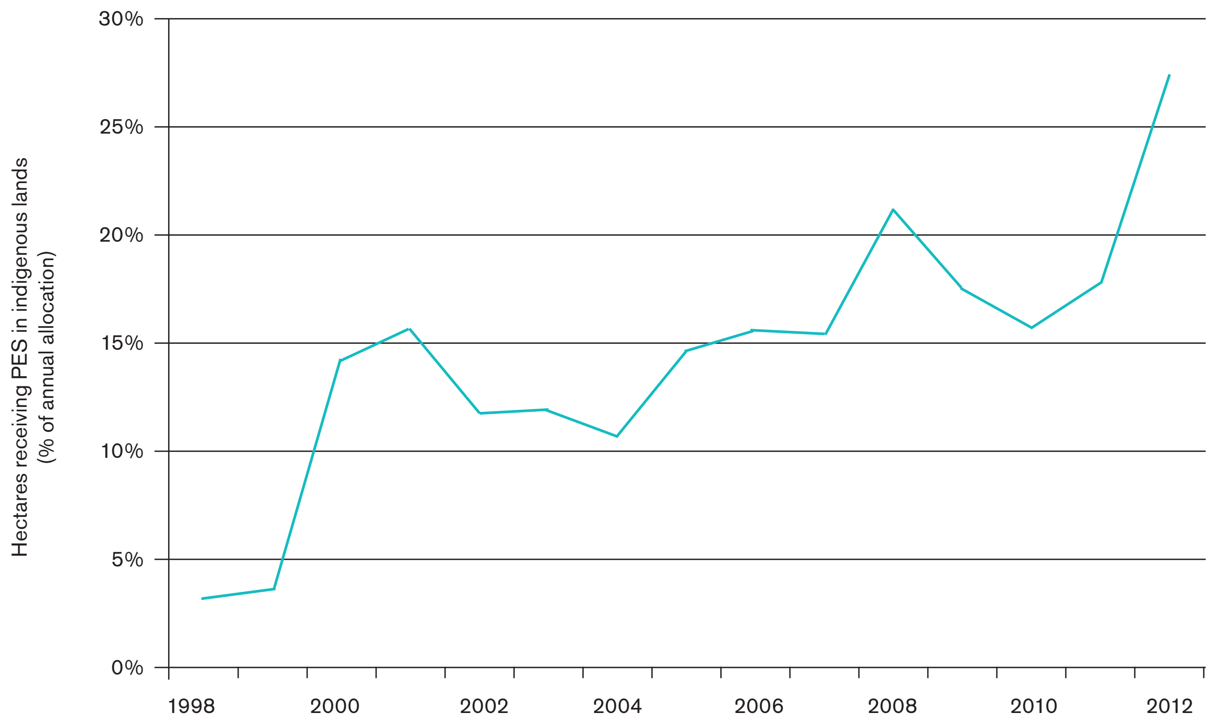
Again, it is important to be cautious with land values provided by the ZH study, as legally there are no land markets for properties in these areas. But in general, the data shows that PES in indigenous areas consistently has some of the lowest opportunity costs for the PES programme and provides an important contribution to local economies. Indigenous areas are also located in areas with the lowest social development index scores in the country.

## 4.3 Within biological corridors and protected areas

Key in the determination of priority criteria is whether or not properties are located in areas categorised as biological corridors or protected areas. Each of these categories receives 25 additional points.

Table 14 shows average land prices inside and outside protected areas[14] and biological corridors obtained from

Figure 5. Share of hectares receiving PES in indigenous lands, by year (1998–2012)




Source: FONAFIFO database (1998–2012)

the ZH database. Overall, prices inside these areas are smaller than outside, indicating lower opportunity costs for conservation. The price is considerably lower for properties inside protected areas, which are highly likely to face legal obstacles to land-use changes or attempts to sell. Of these properties, only those that are inside legally created protected areas that have not been expropriated by the government will receive the priority points.

Prices remain lower inside biological corridors and protected areas independently of property size with respect to properties outside. At the same time, the sample shows that rural properties inside these areas are consistently larger than those located outside: 99 hectares for properties inside protected areas, and 40 for properties inside biological corridors.

Using information from PES contracts between 1998 and 2012,[15] we found that the district average price of properties located inside biological corridors receiving PES is approximately US$1.2 million.[16] Average values are linked to the size of the properties, as we discussed in the previous section. Smaller properties (less than 2 hectares: US$365,000; 2–10 hectares: US$557,000) present the highest average values but their participation is minimal (just over 5 per cent of total contracts). Approximately 34 per cent of properties are between 10 and 50 hectares (with an average value of approximately just over one million US dollars). And 35 per cent of contracts within biological corridors have been allocated to properties over 100 hectares, where the average value of the property is about US1.7 million (see Figure 6). These prices are indicative, but highlight a) the magnitude of the value of properties receiving priority to participate in the PES programme, and b) more importantly, the opportunity cost of conservation of forests on private lands for the highly important habitats represented in biological corridors.

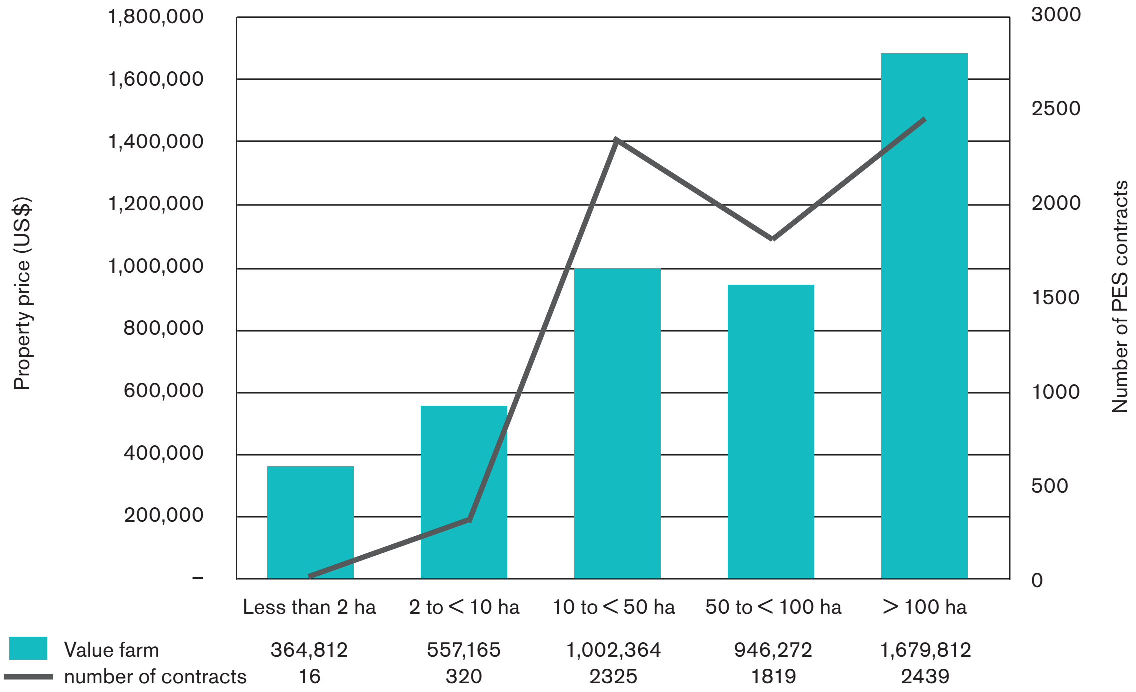
[14] The variable 'inside protected areas' is used from the Costa Rica Atlas, and refers to an officially designated protected area, rather than the land-use category.
[15] And adjusting district prices following the methodology presented in Section 2.3.
[16] This excludes indigenous and global contracts for which there is no information on individual properties.

Table 14. Average prices of land in rural properties inside biological corridors and protected areas

| | PROTECTED AREAS | | BIOLOGICAL CORRIDOR | |
|---|---|---|---|---|
| | OUTSIDE | INSIDE | OUTSIDE | INSIDE |
| Average property size (ha) | 15.77 | 99.55 | 18.92 | 40.03 |
| Average US$/m2 by property size (ha) | | | | |
| < 1 | 14.18 | 8.50 | 14.50 | 12.49 |
| 1 to < 5 | 8.67 | 2.28 | 8.99 | 6.43 |
| 5 to < 10 | 5.66 | 1.12 | 5.47 | 3.69 |
| 10 to <15 | 4.11 | 0.73 | 4.09 | 2.46 |
| 15 to < 20 | 2.90 | 0.55 | 2.17 | 2.36 |
| > 20 | 2.49 | 0.39 | 1.97 | 1.88 |
| **Total** | **8.32** | **1.41** | **8.30** | **5.76** |

Source: ZH database (Empresa Roche Consulting Group Ltd, 2008)

Figure 6. District average farm value of properties that participate in PES inside biological corridors




Source: Prepared using data on contracts from FONAFIFO (1998–2012) and average district values from the ZH study. Does not include indigenous associations or group contracts.

## 4.4 In districts with low social development index scores

Properties located in districts with low social development index (SDI) scores receive an additional 10 points for priority criteria. With a maximum value of 100, the cut-off point for the PES programme is 40. For the 1998–2012 period this roughly accounts for 27 per cent of the districts participating in the PES programme, and 37 per cent of all contracts allocated.

SDI<40 has been used since 2005 as a way to target the social objectives of the programme and report on the impacts on more vulnerable landowners. In Porras *et al.* (2013) we argued that because it is a general indicator, the main beneficiaries of this priority are large landowners located in districts with a low SDI score. In this report, we explore this relation further by analysing the relationship between SDI and wealth, using land values.

Using data from the ZH database for all rural properties at country level we find a positive, and statistically significant, relation between SDI and land prices (Table 15). We expect this relationship to hold: areas with better access to services will fetch better prices in the market. This is in turn reflected in the average prices reported in the ZH database, which are considerably lower (US$2.72) in districts with a low SDI score as opposed to those with higher SDI score (US$8.92). This means that, although incomplete, the SDI partially reflects relative wealth at district level.

Using the information from the ZH database we can analyse the relationships shown by properties participating in the PES programme. During 1998–2012 the average size of farms participating was relatively larger in districts with low a SDI (120 hectares) than in those with a higher SDI (101 hectares). The average value of farms was relatively large: US$618,000 for properties in areas with a low SDI and significantly larger for those located in districts with a higher SDI (US$1.2 million) (see Table 16).

Table 15. Correlation factors between land values and SDI

| | SDI<40 | SDI>40 | ALL |
|---|---|---|---|
| Pairwise correlation factor | 0.3736 | 0.4023 | 0.396 |
| Average land value (US$/m$^2$) | 2.72 | 8.92 | 7.54 |
| Sample (ZH database) | 2340 | 8209 | 10549 |

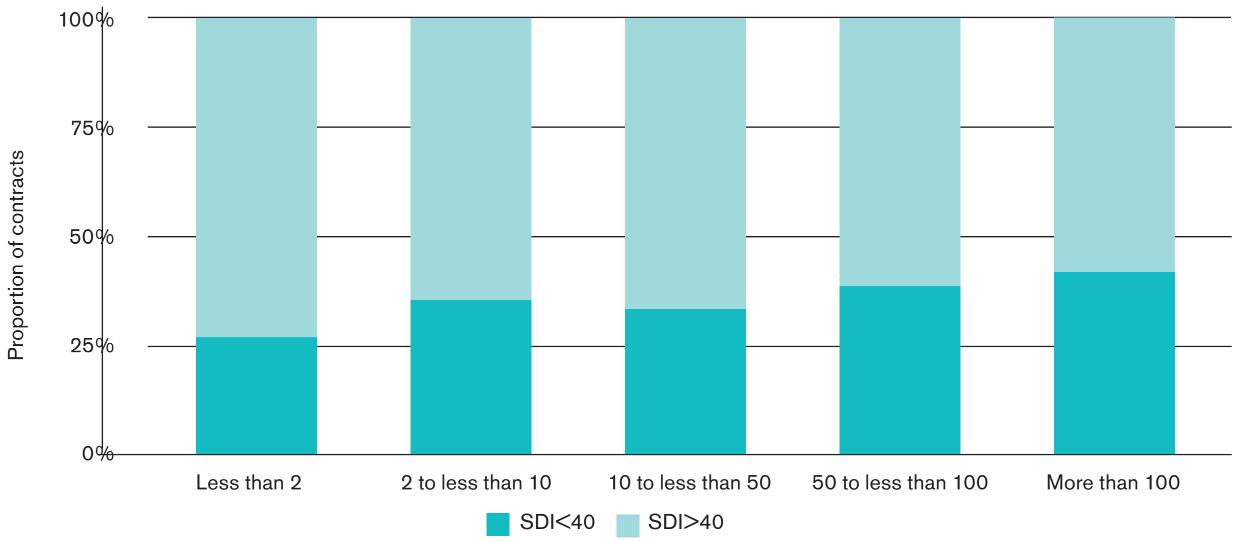
From the ZH database (Empresa Roche Consulting Group Ltd, 2008).

Table 16. Land prices and properties in relation to PES and SDI

| PROPERTY SIZE (HA) | SDI<40 | | SDI>40 | | TOTAL |
|---|---|---|---|---|---|
| | PROPERTY PRICE | PROPORTION OF CONTRACTS | PROPERTY PRICE | PROPORTION OF CONTRACTS | |
| > 2 | 50,886 | 2.8% | 146,482 | 4% | 119,651 |
| 2 to > 10 | 190,593 | 12.2% | 417,945 | 13% | 335,943 |
| 10 to > 50 | 559,205 | 28.8% | 1,025,228 | 34% | 868,087 |
| 50 to > 100 | 595,753 | 22.6% | 1,011,215 | 21% | 848,439 |
| > 100 | 888,641 | 33.6% | 2,107,507 | 28% | 1,598,113 |
| Total (average property size) | **618,731** (120 ha) | **n=5361** | **1,208,276** (101 ha) | **n=8969** | **987,721** |

Note: Information on property sizes from the PES database 1998–2012. Excludes contracts with indigenous associations and group contracts.

Figure 7. Allocation of PES contracts by SDI division




Source: From PES database (FONAFIFO, 2012).

The majority of contracts in very small properties (less than 10 hectares) are located in districts with a higher SDI. In districts with an SDI of less than 40 – a key target population in terms of social impact – over one-third of the contracts are for properties with over 100 hectares, with an average value of almost US$890,000. These values are indicative, and probably underestimate the real property values, but they show that a significant proportion of those accessing social priority would not qualify necessarily as 'vulnerable'.

It is extremely difficult to assess the social impact of the PES programme using rough indicators at district level. As the previous analysis shows, even if an SDI of less than 40 reflects relatively lower land values (and lower stock of wealth), the priority is mostly captured by relatively larger and wealthier landowners (64 per cent of whom are legal entities (see technical glossary), and as such it is nearly impossible to read the real social impact of the programme. While the SDI is a targeting criterion which uses low-cost information, targeting using per hectare property prices – as reflected by ZH mapping – would be a cost-effective way of better targeting more vulnerable households.

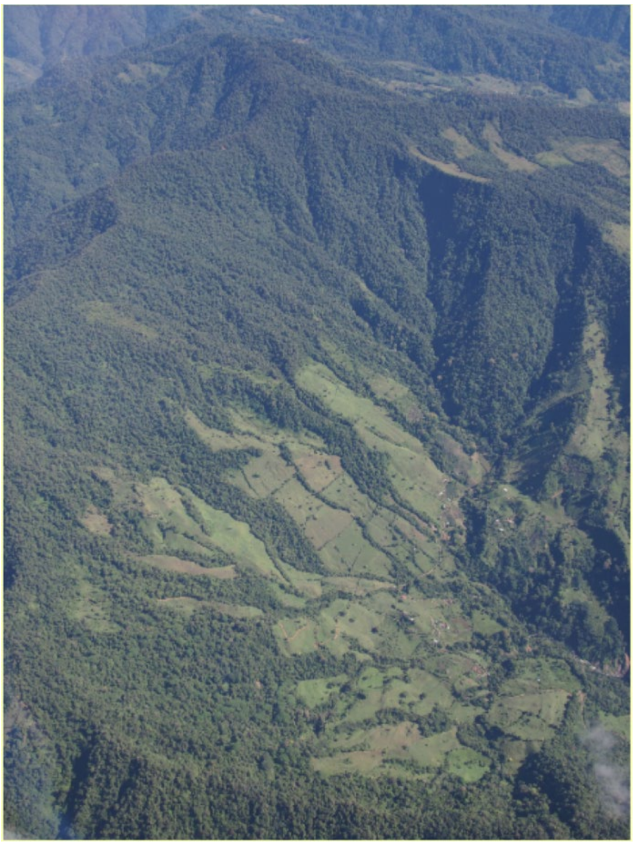
## 4.5 Summary of relations

Overall, we found that land in indigenous reservations represents the lowest market value, partly because there are few economic activities but mostly because of legal restrictions over land tenure. At US$0.6/m$^2$ land prices here are significantly lower than the average national rural average (US$7.6/m$^2$). These areas are important for the PES programme, because they cover significantly large forested areas in the country. By law, land is not available on the open market, but existing values can indicate pressure to illegally invade.

Values are significantly lower inside biological corridors and protected areas, with the lowest value inside the latter (reflecting stricter legal restrictions on changing use). Properties inside these sites are consistently larger than outside (especially for protected areas).

Additional priority is given to farms of 50 hectares or less, regardless of where they are in the country. The objective of this is twofold: to help smaller properties that struggle with the fixed costs of participation, and to comply with the requirement to promote participation of 'small and medium producers'. Our results show that, on average, land values are highest for smaller properties, especially if they are located nearer urban areas or near the coast. These higher prices for smaller properties are driving a fragmentation process in the country, with landowners subdividing larger properties into smaller units which are easier to sell and at better prices. This presents greater challenges for conservation that requires continuous large areas. Defragmentation of property and higher land values near urban and peri-urban areas has significant consequences in ecosystems that provide watershed services to cities.

The higher prices attached to smaller properties highlights another difficulty for the programme: giving priority to properties of less than 50 hectares anywhere in the country to promote participation of smallholders is too wide an indicator to help measure vulnerability, and within this group there will be many landowners wealthy enough not to require any priority in the application process. For example, the average value of a 50-hectare farm in Upala is reported at roughly US$125,000, while



Forest 'frontier' is 'high' and 'far' near Cerro de la Muerte.
Photo credit: D.N. Barton.

a similar sized farm in La Fortuna, Alajuela can fetch nearly US$2 million. This of course is a rough measure of wealth: the owner of the farm in Upala can be a multinational and the property in La Fortuna can belong to a family. But at least land prices can provide a better indicator of wealth based on land.

A similar problem arises when giving priority to properties located in areas with a low social development index (SDI<40): although the average land value in those areas is lower than for the rest of the country, properties receiving PES in these areas are considerably larger (an average of 120 hectares), with over one-third of properties receiving social priority valued at an average value of nearly US$890,000 and largely owned by legal anonymous entities (64 per cent).

The previous analysis puts hard numbers on some serious issues affecting the economic viability of the PES programme. Opportunity costs of conservation – measured by market land values – are very high. The real value of the payment for protection and reforestation contracts has fallen by roughly half since the beginning of the programme (Porras *et al.,* 2013). The continuous threat of fragmenting property near growing urban and tourism development areas is pushing this price up. Traditional land planning indicators like LUC that do not take into account access costs, urbanisation, and/or tourism are failing to reflect the real opportunity costs. At the moment the PES programme remains attractive as an option for private conservation (proof of this is the continuous over-demand for contracts) because legal restrictions to convert forests drive opportunity costs down. In terms of social impact the challenge to deliver is even more difficult. Although easy to use, rough-and-ready indicators like SDI or property size are not necessarily best placed to convey a realistic idea of the social impact of the PES. This only highlights what any programme manager already knows: the challenge to deliver social benefits for a nationally managed programme is huge and there are no win-win solutions.

# Land prices and opportunity costs correlation in Nicoya and Osa

# 5

At the regional level we also carried out a comparative analysis of ZH land values with forestry and agricultural returns in the Osa and Nicoya Peninsulas (see Figure 8) based on agricultural and forestry price statistics, production costs, and expert evaluation of productivity. The objective of this analysis was to test, at the local level, **if land prices correlated with our measures of opportunity costs**.

Correlation factors (Table 17) show that land value is not significantly correlated (at p=10 per cent) with our measures of opportunity costs of forest conservation in either Nicoya or Osa Peninsula. Our measures of opportunity costs require further investigation – assuming that clear-cut forest ('cc' in Appendix 3) is the foregone opportunity, opportunity costs are increasing with higher land-use capacity (LUC) because remaining forests are on low LUC land. If sustainable forestry ('sust') is assumed to be the foregone opportunity, opportunity costs are lower for lower land-use capacity because net returns to sustainable forestry are lower on low LUC land than to agriculture on higher LUC land. There are large regional differences in the correlations between opportunity costs and LUC between Nicoya and Osa.

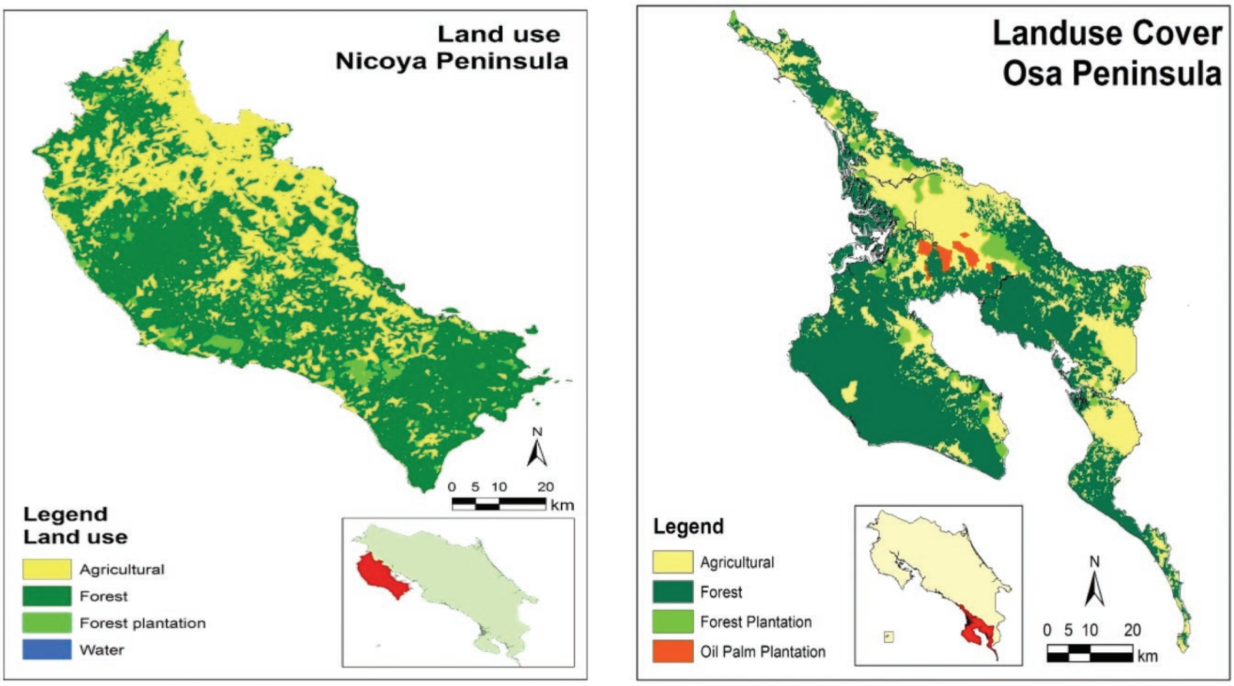
A caveat to the above is that our opportunity-cost measures look at all land, both agricultural and forested. We also looked at the correlation between land value and our opportunity-cost measures only on forested land (see Appendix 3). In Nicoya, there is a strong correlation between opportunity cost and the LUC for forest land, while this is weaker for Osa. In Nicoya, forest regeneration covers a wider range of LUC areas, while in Osa forest cover is mainly in low LUC areas.

In Table 17 we conduct a simple linear regression of forest presence, property characteristics, and types of regulation as explanatory variables for per hectare land value. As stated previously, opportunity cost is not significantly correlated with land value.

Opportunity cost is calculated based on information about land-use capacity and forest cover so Table 17 includes an alternative model with these two explanatory variables. The 'forest' dummy variable indicates whether the geo-coordinates given in the ZH survey for the property has forest cover. This is not significant, but as it does not measure percentage of forest cover on the property or neighbouring properties this is not surprising. Land-use capacity is significant at 10 per cent in the Nicoya Peninsula, but the result is the opposite of what is expected if logging and agriculture are assumed to be the best alternative land uses to conservation.

Contrary to national level averages presented in Table 14, properties inside protected areas have higher prices in the Osa and Nicoya peninsulas. The effect is greater in Nicoya than Osa. In the Osa Peninsula, property values are significantly lower within biological corridors. In the Osa Peninsula, the biological corridor overlaps with a forest reserve with additional land-use restrictions as well as significant land-tenure problems. Indigenous

Figure 8. Land-use cover in Nicoya and Osa Peninsulas




Source: Authors' own, prepared by CATIE.

Table 17. A simple OLS regression of per hectare land value in Osa and Nicoya Peninsulas

| VARIABLES | MODEL OSA | MODEL OSA 2 | MODEL NICOYA | MODEL NICOYA 2 |
|---|---|---|---|---|
| Forest (dummy) | 121.4 | | 275.5 | |
| | *(161.2)* | | *(360.1)* | |
| Land-use capacity(categorical) | 38.03 | | 150.0* | |
| | (33.83) | | (81.82) | |
| Opportunity cost (clear cut) | | 0.0465 | | 0.0856 |
| | | *(0.0553)* | | *(0.165)* |
| Indigenous reserve (dummy) | 85.28 | 163.1 | –1,016* | –910.5 |
| | *(137.8)* | *(110.0)* | *(582.7)* | *(557.5)* |
| Biological corridor (dummy) | –301.0*** | –307.2*** | –510.1 | –454.6 |
| | *(82.44)* | *(85.75)* | *(327.9)* | *(316.1)* |
| Protected area (dummy) | 327.9* | 376.7** | 629.1** | 734.9*** |
| | *(182.2)* | *(177.9)* | *(250.9)* | *(232.9)* |
| Water source (categorical) | –238.7*** | –244.6*** | –475.2*** | –477.4*** |
| | *(25.24)* | *(26.88)* | *(49.41)* | *(49.17)* |
| Access (categorical) | –186.3*** | –185.6*** | –1,271*** | –1,241*** |
| | *(49.09)* | *(47.86)* | *(348.9)* | *(348.5)* |
| Services (categorical) | 22.18 | 16.95 | –20.47 | –40.26 |
| | *(14.15)* | *(12.40)* | *(46.87)* | *(43.75)* |
| Constant | 1,633*** | 1,826*** | 8,863*** | 9,561*** |
| | *(433.8)* | *(415.4)* | *(2,520)* | *(2,503)* |
| Observations | 887 | 887 | 3,951 | 3,951 |
| R-squared | 0.092 | 0.090 | 0.024 | 0.023 |

Notes: OLS: Ordinary Least Squares Regression. Robust standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$

reserves are very small in both peninsulas and their effect is either not significant or weakly negative in the Nicoya Peninsula.

Regarding property characteristics, the number of services available on the property is not significant for land value in either region. As expected, lacking access to improved water sources negatively affects land value at a similar level of magnitude in both peninsulas. Finally, access is a determinant of land value by two orders of magnitude more in Osa Peninsula than in Nicoya Peninsula.

Based on Table 17 and the simple correlations analysis presented in Appendix 3, we conclude that land price does not represent the biological productivity of land in the Osa and Nicoya peninsulas. Local road access and travel costs are not incorporated in our opportunity-cost measures, but seem to be a good proxy of opportunity costs in the Osa Peninsula, while they are much less so in Nicoya.

Based on our knowledge of the two peninsulas, neither agriculture nor forestry are perceived as alternatives to conservation in these areas. There is no reason we should expect property prices to vary with biological productivity (a Ricardian perspective), while we still see evidence that they do from an access point of view (a von Thünen perspective). However, road access seems only to be a good proxy in an area that still has remains of a forest frontier (Osa). As concluded elsewhere in the report, it is difficult to find physical proxies of opportunity costs that are generally valid for the whole country.

Based on personal observation, property prices in the Nicoya and Osa peninsulas are not an accurate proxy for the opportunity costs of forest conservation, because there is no legal land-use alternative to current forest cover. While this is not perfectly enforced, land-cover change in the two peninsulas has been dispersed and found in small areas during the last ten years (Global Forest Watch, 2014). Peninsulas are near the sea, and land prices are more a reflection of demand for residential and tourism infrastructure development. Residential and infrastructure development is an exception to the Forest Law ban on land-use change and is granted by concession – which highlights the dangers for forest conversion.

In the two peninsulas, land prices seem more valid as social targeting criteria, than as an indicator of opportunity cost or risk of forest conversion. For conservation-land purchase, it is of course still a good proxy for conservation cost.

In general, explanatory power of the OLS regression is poor. Improvements in the model would better account for spatial autocorrelation. A more accurate description of forest cover on and around the property would be necessary to value forest cover as an amenity characteristic.

# Discussion

6

Smaller properties face the largest opportunity costs, because of the risk of fragmentation and conversion to urban uses. There is no doubt that the market value of these properties is high. Land is a valuable asset and even more so in Costa Rica at the moment, making conservation more costly and the requirement for a social impact more difficult to establish: who are these vulnerable landowners that require priority?

We focus our discussion around three points: land prices as proxies for opportunity costs of conservation; land prices and property values as the basis for differentiated payments; and land prices and property values as criteria for social priority and impact of the PES programme.

***Land prices as indicators for opportunity costs***
We argue that, at the moment, differences in land prices are a useful and low-cost indicator of opportunity costs of forest conservation for some kinds of properties. Land values rise for smaller properties in rural areas because land use shifts from productive activities (provisioning) to residential or tourism (cultural) services. Forest conservation is often compatible with low-density residential and tourism development. In these cases, land prices are not indicative of opportunity costs. In fact, forest conservation often represents an amenity – an opportunity benefit – to these land uses. Hedonic pricing studies therefore need to control for land use and tourism/recreation need to be better incorporated as explanatory variables. Outside urban areas and the coastal-maritime zone we do not have data to distinguish land uses for residential and tourism purposes, but 'services available, water source, and road access' together constitute a good proxy.

The existing information provided by the Ministry of Finance has the highest resolution, is geo-referenced, and available to all local municipalities. Our study demonstrates how land prices vary widely across the country, reflecting local development opportunities but also the direct link to urbanisation processes and tourism infrastructure, all of which affects the viability of conservation programmes like PES.

We find that opportunity costs are high, perhaps higher than initially thought. Incentives for conservation, like PES, can only be effective if they are backed by regulation like the prohibition to deforest. Although this is challenged by some as redundant (a reward for doing what landowners are supposed to do) we argue that – in face of rising land prices – regulation is the main reason PES contracts remain an attractive option for landowners with few agricultural and no forest-use alternatives. Fragmentation of properties to capitalise on higher values for smaller properties will have direct impacts on the management of the programme, especially in terms of transaction costs. For residential and tourism land uses, PES is an attractive source of additional financing (given that high land prices do not reflect the opportunity costs of conservation, especially in touristic areas, as shown by the analysis in Section 5).

Land regulations forbidding changes in forest cover and illegal hunting exist, but they are poorly enforced. Photo credit: D.N.Barton.

## 6.1 Land prices as a basis for differentiated payments

Until 2009, the PES programme in Costa Rica used a flat-level payment for all participants under the same category of land use (e.g. conservation). The flat-rate system was considered transparent and easy to explain and manage. But it was also criticised on the grounds of efficiency, because it did not take into account local nuances (like characteristics of the farm and the owner) that affect their desire to participate and different opportunity costs and benefits – which are partially reflected by variability of land prices.

Following this argument, one could argue that ZH 'land-price maps' could be used to target PES or for eligibility criteria. Payments would be lower where land prices – as a proxy for opportunity costs – are lower, for example in remote areas where there is less risk of change, and for forests under stricter regulation that forbids land-use change. This would potentially liberate resources to pay higher levels of payments where forests are more at risk, or where the programme wants to support rehabilitation of degraded ecosystems.

Our analyses linking land prices with opportunity costs at the local level are less conclusive than that. We found that relative land prices provide an indication of the slope of the **forest conservation supply curve** for properties whose best alternative is a productive land use – rather than conservation for tourism or recreation where the existence of forest represents a benefit rather than an economic 'cost'.

However, ZH land-use values do not necessarily reflect the absolute value of PES as an incentive to protect forests. In economist parlance, the intercept of the conservation supply curve is specific to each land user's perception of land-use opportunities and for that reason very context-specific. This type of information would only be obtained either by in-depth analysis of opportunity costs at the national level, or designing an auction-based approach that would reveal the individual's opportunity cost of taking part in the PES programme.

Our analysis provides some information to push forward the debate on differentiated payments for the PES programme. More research would be needed, however, to fully understand the depth of opportunity costs as a basis for differentiated payments.

## 6.2 Land values as indicators of wealth

While PES is primarily an economic instrument to promote environmental outcomes, there are at least four reasons why the PES programme needs to consider its social angle. Firstly, it relies heavily on government funds and needs to demonstrate that it promotes social welfare and opportunities of small and medium producers. Secondly, every year programme managers need to present their case to legislators to ensure that the committed annual budget is honoured, and the programme is constantly presented as an instrument for rural development. Thirdly, the PES programme claims to provide important co-benefits, of which social benefits are important. Last but not least, its reputation is important: despite positive impacts on protecting forests, the programme would face fierce critique nationally and internationally if it mostly favours the wealthy.

Section 4.2 has shown how the programme has been successfully allocating increasing funds to indigenous areas, bringing in important benefits to local economies. For other privately held lands, the programme uses two main indicators to gauge vulnerability, allocating priority, and measuring its social footprint: properties of less than 50 hectares, or in areas with a low social development index score (discussed in detail in sections 4.1 and 4.4).

Our analysis shows that in rural areas, the 50 hectares threshold for prioritising PES is giving additional priority to properties with higher land prices. If the intention of this criterion is to prioritise 'small and medium producers' as stated by the Forest Law 7575, for poverty alleviation reasons the criterion is likely having an unintended opposite effect. Furthermore, rising land prices by property size suggest that – for a fixed PES payment level – the likelihood of attracting applicants would fall with smaller property sizes. This is perhaps one contributing factor to the falling trend in these applicants since 2009 (when this criterion was introduced). If properties are being subdivided for residential or tourism purposes, the <50ha threshold has a further unintended effect of targeting non-producers (contrary to the Forest Law's aims).

We also argue that using the SDI as an indicator for relative vulnerability in the PES is good, but not sufficient. The average property size participating in the programme has been relatively large: 120 hectares in areas with low SDI and over a third of properties receiving social priority are valued at nearly US$890,000 – 64 per cent of them belonging to legal entities. Owners of these properties can hardly be considered poor or vulnerable, even if they are located in districts with a low social development index score. Our analysis indicates that, with the exception of indigenous groups (which already receive priority in contract allocation) the benefits from the 10 extra points in applications with low SDI are captured first by relatively better-off landowners, rather than by those who really need it.

Our argument is that, despite its limitations, per hectare land prices[17] are a better indicator for and provide a better measure of the relative wealth of participants in the PES programme. Despite its limitations (static nature; that it reflects stocks and not income, and does not show other forms of capital) land price is the best existing indicator at the national level that does not require additional surveys to assess. Our analysis shows that when used individually, neither SDI nor a focus on properties of less than 50 hectares is truly targeting small and medium producers as specified by the Forest Law.

[17] As explained before, we acknowledge several limitations in the analysis when looking at land value as indicator of wealth. For example: a) the existing data does not provide information of participants' off-farm income; b) we assume that investments in the farm are reflected in the average prices collected during the ZH study; and c) we do not have information on multiple properties for the same owner.

# Conclusions and recommendations

# 7

Because it is difficult to estimate, conservation planners resort to poorly designed proxies to guide conservation policies. Spatial targeting is necessary to target the cost-effectiveness of the PES programme (see discussion in Porras *et al*., 2013). Programme managers have made important advances in relation to environmental indicators, but are still missing a reliable, relatively easy-to-obtain, national-level indicator for the opportunity costs of conservation. In this paper, we proposed using land prices as a surrogate for opportunity costs for the purpose of PES eligibility and spatial targeting. We assessed its viability against traditional indicators, like land-use capacity (LUC) and the social development index (for social targeting).

We found that traditional indicators fail to incorporate market values that are more likely to affect personal decisions regarding land use. One reason behind this can be traced directly to the way LUC is calculated, and the opportunity cost it reveals is mostly linked to agriculture, ranching, and forestry activities, but fails to capture the impact that urbanisation and the tourism industry are having on opportunity costs. Conservation planners face a growing problem. As larger blocks of farmland are subdivided, land prices increase and so too does the opportunity cost of conservation. This will have increasing implications for conservation purposes, where protection of larger blocks is needed to ensure landscape connectivity. Relatively cheaper land for conservation is heavily regulated, as it is located in indigenous areas or properties with a land-use category equivalent to a protected area (e.g. very fragile areas, high slopes).

The economic and social trade-offs are stark: larger properties have the cheapest land value per unit (e.g. US$/m$^2$), but not only are they disappearing through the fragmentation process but this factor raises questions over the social angle of the PES programme. In terms of social targeting, we find that 'rough and ready' indicators like the social development index or even property size are giving indiscriminate priority to both those who really need it – and also those who plainly do not.

From our analysis, we propose three options for the PES programme:

- **Option 1**: Combine both indicators to provide priority. For example, extra points (+15) given to applications of small properties (<50 ha) located in areas of low social development index.
- **Option 2**: Use property prices as an indicator of wealth. Working directly with the Ministry of Finance to access to the *zonas homogéneas* database and maps, each individual application can be ranked according to the ZH value. PES programme managers (MINAE/FONAFIFO) will determine a threshold for the value of properties labelled as 'social interest'.[17] The resolution provided at the *zona homogénea* would be sufficient to provide a relatively accurate estimate of the relative wealth of PES applicants (given the limitations highlighted above). This information is easily available, and because it is used to estimate land taxes, we would expect the Ministry of Finance to update their estimates periodically to reflect longer-term trends in property prices (and potential real-estate bubbles).
- **Option 3**: Forget using rough indicators for priority, like SDI or property size, and instead agree at national level what is the social interest group in the PES programme (given that indigenous groups already receive a different priority) and offer social priority only to this group. After nearly 20 years of experience, the country should be able to define which landowners truly require support, and deal with them directly.

The results of our study should be analysed carefully given the potential limitations of the data. One of the limitations from this work arises from the static nature of the land-prices information. The richness of the information generated by the ZH study is not likely to be repeated often, therefore limiting the potential for understanding opportunity costs through time at the national level. A well-designed tender or auction approach will bypass this problem, and our study can offer a unique platform to compare and double-check values obtained through tenders and the opportunity costs captured by land prices at the national level, as well as the potential distribution of outcomes across different groups given the heterogeneity of farms and landowners.

We do not have information on the characteristics of any building within the property. This and other omitted variables are reflected in the size of the error term of the regression. We have eliminated properties with values above US$100/m$^2$, which probably are highly linked to extra investments in property (hotels, swimming pools, etc.). Importantly, when looking at land prices as an estimate for wealth, we have not accounted for other factors typically related to wealth, e.g. farm and non-farm income, education of landowner, or other types of capital (investments on and off the farm, other

[17] This would have to be a subjective decision supported by evidence.

properties, etc.), which can only be elucidated via personal surveys. However, these limitations are already present in the way the PES programme operates and within these limitations our study introduces a relatively more accurate approach to understanding land-based wealth.

The final message of our analysis is simple. In exploring the linkages between land prices and opportunity costs of conservation, we found hard evidence on what policy makers know in their hearts: the time of 'cheap' conservation of biologically important land is gone. The competitiveness of conservation policies will in future depend on a policy mix of PES acting in concert with national forest policy and local land-use regulations, where PES as an instrument will need to act as a targeted complement of strengthened municipal-level land-use zoning regulations, both in rural and peri-urban areas.

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# Appendices

## Appendix 1. Description of the zonas homogéneas study

This information was collected by the consulting firm Roche Consulting Group Ltd, commissioned by the Ministry of Finance and the Inter-American Development Bank. The random study of nearly 50,000 observations of land values and characteristics of each property across the country was carried out between 2008 and 2009.

FORMULARIO F155a is the form used by field enumerators to collect information. This included:

**Location:** province, district, zone, etc.

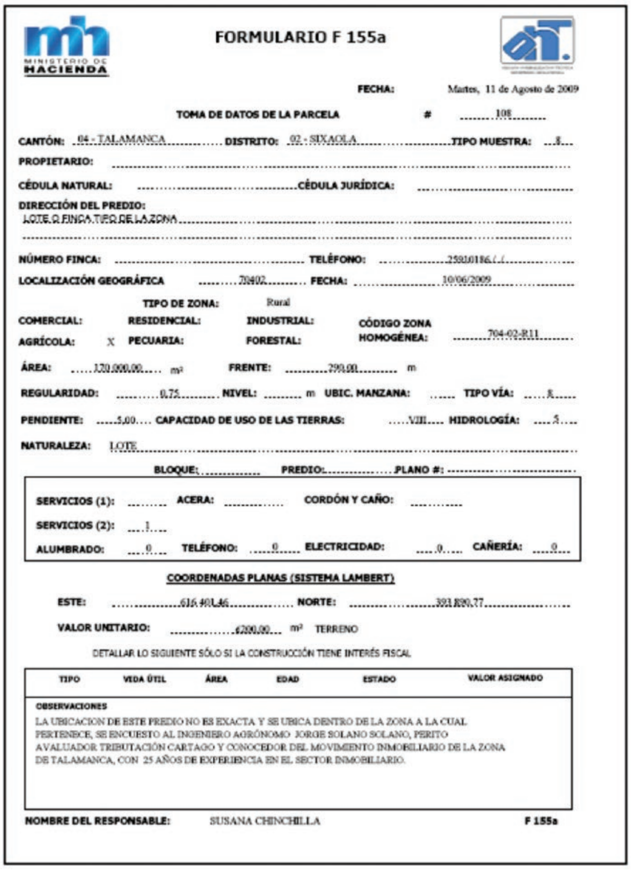
**Identification:** identity number, telephone, etc.

**Type of use:** rural/urban, commercial, residential, industrial, cattle, forestry – roughly indicating the main economic activity in the area. The accuracy of this variable is not very high, as it is based on partial observations from the surveyors.

**Plot variables:** area: total area (m), front: length of property fronting a public road (m), regularity: shape of the plot, measured as between 0 to 1 (the more regular the plot e.g. closer to a rectangular or square shape, the closer to 1 the value). Slope: average slope measured at point of entry:100% corresponds to a 45° angle. Type of access: continuous variable 1–11 for type of road, with 1 indicating the better ones (better materials, width, upkeep, etc.) and 10 and 11 indicating access only by boat or train. Type of public services: continuous variable 1–16 (16 is better) indicating existence of public services (drainage, electricity, telephone, public lights, etc,). Water: main water source available in the property, scale is 1–5: 1 is best (one or more water sources including one tap/ with drainage), 5 is rain-fed dependent water source.

**Land-use capacity:** variable indicating the potential land use in terms of economic activities, following the criteria established by the Tropical Science Center, Costa Rica in 1995. Lower levels are apt for almost any land-use activity (better soils, drainage, flat or little slope, etc.); higher levels indicate more restricted potential because of very steep slopes or poor soils, etc.

**Land prices:** land prices were obtained after a negotiation process, which was adjusted by value of properties nearby and also expert criteria. Researchers from Roche Consulting Group Ltd approached property owners as potential buyers, and negotiated initial prices as if to finalise an actual purchase. Landowners were not aware that the information was to be used for tax purposes, so there was no risk of artificially lowering values for tax evasion. Land values reported were later compared in 2012 by IIED to newspapers and estate agents to assess whether prices were still valid.



MINISTERIO DE HACIENDA

FORMULARIO F 155a

FECHA: Martes, 11 de Agosto de 2009

TOMA DE DATOS DE LA PARCELA # 108

CANTÓN: 04 - TALAMANCA DISTRITO: 02 - SIXAOLA TIPO MUESTRA: 8

PROPIETARIO:

CÉDULA NATURAL: CÉDULA JURÍDICA:

DIRECCIÓN DEL PREDIO:
LOTE O FINCA TIPO DE LA ZONA

NÚMERO FINCA: TELÉFONO: 25910186

LOCALIZACIÓN GEOGRÁFICA 70402 FECHA: 10/06/2009

TIPO DE ZONA: Rural

COMERCIAL: RESIDENCIAL: INDUSTRIAL: CÓDIGO ZONA HOMOGÉNEA: 704-02-R11

AGRÍCOLA: X PECUARIA: FORESTAL:

ÁREA: 120.000,00 m² FRENTE: 290,00 m

REGULARIDAD: 0,75 NIVEL: m UBIC. MANZANA: TIPO VÍA: 8

PENDIENTE: 5,00 CAPACIDAD DE USO DE LAS TIERRAS: VIII HIDROLOGÍA: 5

NATURALEZA: LOTE

BLOQUE: PREDIO: PLANO #:

SERVICIOS (1): ACERA: CORDÓN Y CAÑO:

SERVICIOS (2): 1

ALUMBRADO: 0 TELÉFONO: 0 ELECTRICIDAD: 0 CAÑERÍA: 0

COORDENADAS PLANAS (SISTEMA LAMBERT)

ESTE: 616.401,46 NORTE: 393.890,77

VALOR UNITARIO: 6200,00 m² TERRENO

DETALLAR LO SIGUIENTE SÓLO SI LA CONSTRUCCIÓN TIENE INTERÉS FISCAL

| TIPO | VIDA ÚTIL | ÁREA | EDAD | ESTADO | VALOR ASIGNADO |
|---|---|---|---|---|---|

OBSERVACIONES
LA UBICACION DE ESTE PREDIO NO ES EXACTA Y SE UBICA DENTRO DE LA ZONA A LA CUAL PERTENECE, SE ENCUESTO AL INGENIERO AGRÓNOMO JORGE SOLANO SOLANO, PERITO AVALUADOR TRIBUTACIÓN CARTAGO Y CONOCEDOR DEL MOVIMIENTO INMOBILIARIO DE LA ZONA DE TALAMANCA, CON 25 AÑOS DE EXPERIENCIA EN EL SECTOR INMOBILIARIO.

NOMBRE DEL RESPONSABLE: SUSANA CHINCHILLA F 155a

# Appendix 2. Adjusting temporal values using exchange rates

One problem of the ZH database is the static nature of the values collected. While it provides a very clear picture of prices across the country in 2008, it is limited when working with the PES 1998–2012 database. One way around this is by using a base year analysis (BYA). BYA is often used for expressing gross domestic product (GDP), and by eliminating inflation results in a more accurate measure of economic growth that takes into account changes in price level.

Calculation is done by:

$$\text{Value}_{(\text{base year})} = \text{Value}_{(\text{chosen year})} \times \text{Price index}_{(\text{base year})} / \text{Price index}_{(\text{chosen year})}$$

Or equally:

$$\text{Value}_{(\text{chosen year})} = \text{Value}_{(\text{base year})} \times \text{Price index}_{(\text{chosen year})} / \text{Price index}_{(\text{base year})}$$

In our analysis, we used an average annual exchange rate (provided by the Central Bank) as an indicator for price index. The ZH study provides values for the base year 2008. For example, if the estimated value in 2008 is US\$0.5/m$^2$, the equivalent value in 1998 would be 0.5x256.9/522.4; or US\$0.25/m$^2$. This means that in 1998 the equivalent value of land in that property was US\$0.25/m$^2$. We plug these values into the PES database to estimate approximate value of properties participating in the programme.

| YEAR | COSTA RICA CPI (WORLD BANK) | COSTA RICA CPI (WORLD BANK) (2008=100)* | ADJUSTMENT FACTOR |
|---|---|---|---|
| 1997 | 43.0 | 232.37 | 3.21 |
| 1998 | 48 | 256.94 | 2.88 |
| 1999 | 53 | 285.43 | 2.60 |
| 2000 | 59 | 307.90 | 2.34 |
| 2001 | 65 | 328.57 | 2.12 |
| 2002 | 71 | 359.47 | 1.94 |
| 2003 | 78 | 398.20 | 1.77 |
| 2004 | 88 | 437.19 | 1.57 |
| 2005 | 100 | 476.88 | 1.38 |
| 2006 | 111 | 510.03 | 1.24 |
| 2007 | 122 | 514.44 | 1.13 |
| 2008 | 138 | 522.41 | 1.00 |
| 2009 | 149 | 568.45 | 0.93 |
| 2010 | 158 | 520.53 | 0.87 |
| 2011 | 165 | 500.30 | 0.84 |
| 2012 | 171.52 | 497.41 | 0.80 |
| 2013 | 177.7 | 493.97 | 0.78 |

# Appendix 3. Opportunity cost regression results

## Nicoya

```
             | oppcos~c oppcos~t value_ha luc
-------------+-----------------------------------
 oppcost_cc  | 1.0000
oppcost_sust | −0.6172* 1.0000
   value_ha  |            1.0000
        luc  | 0.1051* −0.7294*   1.0000
```

## Nicoya, only property with forest

```
             | oppcos~c oppcos~t value_ha luc
-------------+-----------------------------------
 oppcost_cc  | 1.0000
oppcost_sust | 0.9901* 1.0000
   value_ha  |            1.0000
        luc  | −0.9851* −0.9771*   1.0000
```

## Osa

```
             | oppcos~c oppcos~t value_ha luc
-------------+-----------------------------------
 oppcost_cc  | 1.0000
oppcost_sust |    1.0000
   value_ha  |            1.0000
        luc  | 0.2668* −0.3677*   1.0000
```

## Osa, only property with forest

```
             | oppcos~c oppcos~t value_ha luc
-------------+-----------------------------------
 oppcost_cc  | 1.0000
oppcost_sust | 0.9105* 1.0000
   value_ha  |            1.0000
        luc  | −0.5192* −0.3980*   1.0000
```

# Abbreviations and Acronyms

| | |
|---|---|
| CATIE | *Centro Agronómico Tropical de Investigación y Enseñanza* (Tropical Agricultural Research and Higher Education Centre) |
| CPI | Consumer price index |
| FODEA Law | *Ley de Fomento a la Producción Agropecuaria* (Law to Promote Agricultural Production) |
| FONAFIFO | *Fondo Nacional de Financiamiento Forestal* (National Forestry Financing Fund, Costa Rica) |
| HPM | Hedonic price method |
| IIED | International Institute for Environment and Development |
| LUC | Land-use capacity |
| NINA | Norwegian Institute for Nature Research |
| PES | Payments for ecosystem services |
| PESILA | Payments for Ecosystem Services in Latin America |
| REDD+ | Reducing emissions from deforestation and forest degradation |
| SDI | Social development index |
| SME | Small and medium enterprise |
| ZH | *Zonas homogéneas* (homogenous zones) |

In Costa Rica, policymakers know in their hearts that the time of 'cheap' conservation of biologically important land is gone. Conservation policy has often been a 'shot in the dark' when it comes to acknowledging the opportunity costs of forest conservation. In theory, knowledge of opportunity costs could help authorities calibrate payments for ecosystem services so that they provide a cost-effective incentive by compensating for opportunity costs.

Although different models exist to estimate opportunity costs, they tend to have limited applicability to real-time policy making. We propose using market prices for land as an initial proxy indicator for opportunity cost. Land prices are easy to understand, and in a well-functioning market should roughly represent the net present value of the benefits derived from the land over time. We show that the competitiveness of conservation policies will in future depend on a policy mix of PES acting in concert with national forest policy and local land-use regulations. However, to be effective, PES will need to complement strengthened municipal-level land-use zoning regulations, both in rural and peri-urban areas.



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