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Estimating the Sustainability of Managed Natural Forests in Costa Rica—A Hybrid Delphi & Choice Experiment Approach

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Abstract: Management of natural forests in Costa Rica allows timber extraction in so far as it is guaranteed that the logging activities comply with diverse Sustainability Principles, Criteria and Indicators (PCIs). These are hierarchical and complex systems used, ex-ante in the formulation and approval of the Management Plan but have not been used for ex-post evaluation of managed forests. Development of sustainability evaluation systems that include few criteria is highly recommended. In that sense, the choice experiments contribute to simplification of the initial system of decision making, complementing a complex system of PCIs that permits detailed analysis of the management units. In this study, a choice experiment was included in a Delphi application and 5 key variables were identified to evaluate the sustainability of managed natural forests. These variables are, in order of importance—technical, legal and administrative conditions; external financing conditions; production performance; costs of preparing the Management Plan; and payment mechanisms for environmental services. The definition of these variables confirms not only that the technical, legal and administrative conditions are critical for sustainability but also that they could reflect the type of governance involved in sustainability forest management.

Keywords: expert; stakeholder; stated preferences; survey; tropical humid forest

1. Introduction

International forest policy makers in most countries recognize the importance of sustainable forest management (SFM) [1], that is, a management system that pursues a balance between social and economic development and the ecological values associated to the forests, for present and future generations [2]. As References [3,4] point out, SFM was initially interpreted as the sustainability of forest logging, where forest logging is improved in order to ensure the equilibrium of production between cycles. Although the ecosystem aspects are most relevant for attaining sustainability, the social and economic dimensions have gained importance in the last few years. Thus, the relevance of property rights, organization and participation, knowledge about the institutions that rule SFM, and ecosystem services, has increased [5,6], so that SFM has turned into the dominant paradigm [7].

Forest certification schemes constitute one way to demonstrate the performance of SFM. They are standardized evaluation processes that include product labelling, ensuring that the products come from properly and sustainably managed forests. Another way to demonstrate sustainability is the compulsory adoption of Sustainability Principles, Criteria and Indicators (PCIs) [8]. The PCIs usually describe desired ends for SFM, without necessarily addressing potential means to achieve those

ends [9]. These sets of reference indicators are no different from structured lists that can be utilized in different contexts and conditions [10]. PCIs on SFM have been developed by many countries and regions [11–13]. PCIs are the structure that Costa Rica and other countries in all regions around the world have used in the formulation phase of management plans (MP) [14].

Since the 90s, Costa Rica's Government has recognized the importance of sustainable development. The first version of the National Forest Development Plan (PNDF, for its acronym in Spanish), at the start of the millennium, indicated that Costa Rica had the potential to manage 160,000 ha of forests that were in the hands of private owners [15]. However, this plan did not include any specific policy regarding promotion or attention of SFM, apart from what was established in the Forest Law. During the period 2001–2010, SFM in the whole country accounted for 3% of the harvested volume and in 2010, it achieved only 1.7% of the total harvest [16]. Clearly, although the 2001–2010 PNDF's aim was that 25% of the timber for the local market would come from SFM [17], that target was not achieved. In order to correct this deficiency, SFM is explicitly addressed in the 2011–2020 PNDF as a policy [18]. During this period and since 2009, a system of payments for environmental services (PES), specifically for SFM, has been in effect and the PCIs' regulations have changed. Under this scheme, SFM contribution increased from 1.7% at the end of 2010 to 5.1% in 2016 [19], though still a small contribution in terms of area relative to the potential indicated by Reference [20].

At present, SFM in Costa Rica legally require that any logging activities within forest must adhere to strict PCIs clearly defined in the MP. In Costa Rica, PCIs are complemented by a code of good practices that determine the technical regulation of SFM as a productive activity. Moreover, a manual of procedures is available to ensure the legal sustainability of FM, which defines the field of action of the State Forestry Administration [21]. Under this system, complex technical and legal conditions are imposed in Costa Rica that discourage SFM development by forest owners [22].

This hierarchical system leads to the formulation of the MP, which is evaluated for approval. However, the evaluation of the MP—after its execution—is not usually performed. This is due to high control and follow-up costs, because the activities developed are usually registered in written documents rather than in integrated digital systems. Sustainability evaluation is, thus, arduous and costly, with expenses even surpassing the benefits of the system. Consequently, the development of evaluation systems contributing to an easier decision-making process by using few criteria is recommended. In this regard, discrete choice experiments (DCE) can help simplify the initial decision-making system, without having to abandon the complex PCI system that allows a thorough analysis of the managed forest units. DCEs are widely used to perform assessments of multidimensional programs, such as forest management (FM) [23].

A DCE allows estimation of use and non-use values, the latter being intangible values whose purpose is to bequest present assets to future generations or exclusively for conservation purposes [24]. Sustainability could be considered as one of those intangibles. Although sustainability is discussed worldwide [25] it can only be measured approximately. In this sense, a DCE could contribute to the analysis of the sustainability of FM units based on a limited set of criteria—assumed to be fundamental for most people—without entering into highly complex aspects that would require systems of abundant—and likely expensive to collect—evidence. Similarly, the results of a DCE could provide information to forest planners for their decision processes and policy design [26,27].

Contributions from DCEs are abundant in varied applications worldwide, although in Costa Rica these tools have not been used much nor are they well known. Some exceptions are preference studies for the development of ecotourism [28], transport [29], organic products [30], environmental management [31], renewable energy and recreational tourism projects [24] and conservation of protected areas [32] among others.

In this article we propose that the sustainability of FM—beyond the specific technical fundamentals and the complexity of quantifying it by means of hierarchical complex systems such as the PCIs—is perceived differently by forest experts, based on a set of limited variables. Thus, quantifying these variables in terms of social preferences would allow obtaining a synthetized indicator of sustainability of the FM.

2. Materials and Methods

2.1. Study Area

The study area is located in the North Zone of Costa Rica (Figure 1), where the greatest number of natural forest MPs were executed. The statistics of the country for the last 5 years indicate that 97.5% of the total authorized logging was performed in this region of 892,400 ha, of which 175,468 ha (19.7%) consisted of private forest. Of this private forest, 5445 ha had been subjected to FM through MP during the period 2012–2018. The FM represented 3.1% of the forest area in the northern zone.

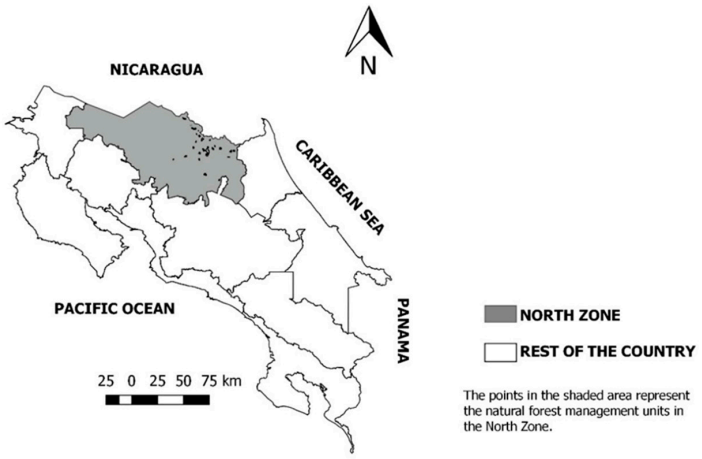

Figure 1. Location of the North Zone of Costa Rica corresponding to the study site.

2.2. The Sample

This study was based on the stated preferences of a panel of forestry experts that included two private forest owners, eight state officials that authorize and supervise the MPs, three forestry experts that had participated in the design of the PCIs used in the planning of the management activities in the last 20 years, ten private forest engineers in charge of planning and executing the SFM, two supervisors of the professionals at national level and five academic experts in SFM. The experts participated in two survey rounds, following an iterative consultation process based on the Delphi method [33–35]. The panel of experts was composed of 30 people in the first round, of which seven (one forestry expert, two state officials, one private owner and three forest engineers) abandoned the panel in the second round of consultations. The results from the first round of experts were presented in the second round in what is known as 'controlled feedback' in the Delphi application. Throughout the surveys, the identity of the participants was kept anonymous. Figure 2 shows the sampling process that was performed in this study.

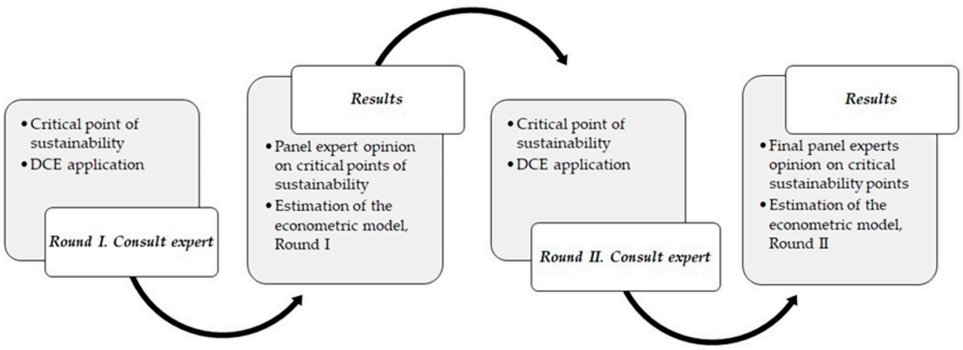

Figure 2. Sampling process following the Delphi method applied in this study.

2.3. Discrete Choice Experiments

Selection and definition of the critical points to be evaluated were key issues in the design of a DCE. In this regard, Reference [23] indicates that while the survey respondents may consider different types of critical points, it is important for the DCE to capture those that are common for the majority, so as to avoid considerations about omitted critical points. Previous exploration is suggested and advice from experts and focal groups facilitates the definition of the critical points and their respective levels.

A two-round iterative survey was applied to determine the elements that the experts considered as critical points for sustainability of management unit (MU). Different dimensions of SFM were contemplated and a list of possible elements was made. Each element corresponds to the attributes of productivity, stability, adaptability, equity and self-management, following the MESMIS framework (Sustainability evaluation of complex socio-environmental systems) [36]. In the first round each expert was asked whether they considered those elements as critical points and whether new elements needed to be added (Table 1).

A DCE was designed in this first round using five elements identified in the literature as relevant for the study of SFM. The choice cards presented to the experts were the result of a pivoting design based on a D-efficiency criterion using the Ngene software 1.1. [37]. Figure 3 shows an example of the cards used in the first round experiment.

Critical point	*Management Unit A*	*Management Unit B*	*Management Unit C*	*Management Unit D*
Production performance	Low	Normal	Normal	Low
Cost of obtaining and executing a management plan	High	Normal	Normal	High
Payment for environmental services	Absent	Present	Absent	Present
Need for external financing to carry out the management	High	Normal	High	Normal
Member of organized groups of producers	No	No	Yes	Yes
RANKING:	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4

Figure 3. Example of one of the choice cards used in round I of the Delphi method. Each expert selected the order for the management units (MUs) A to D, where 1 represents the most sustainable MU and 4 the least sustainable.

Following the results from the first round, the critical points to be included in the DCE of the second round were finally determined, as well as the levels for each one of them (Table 1). Unlike the experiment of the first round, the critical points were selected based on the opinions of the panel of experts, which largely coincided with the literature review realized for the first round. The differences consisted of the critical point 'legal and administrative technical conditions for management', which was not included in the first round and the critical point 'member of organized groups of producers', which was discarded in the choice experiment of the second round. Similarly, expert consultations allowed to establish the levels of the critical points differently from the first round, some of them being quantitatively defined. Thus, in the second round a new experiment was proposed, following the same experimental design procedure (pivoting and D-efficient) and question format (ranking 1 to 4) of the first round. Figure 4 shows an example of one of the cards used in the second round.

Table 1. Critical points and levels used for the choice experiment in the first and second round.

Critical Points	Level (I round)	Level (II round)
Production performance: a Minimum Reference Value (MRV) of basal area is used in managed forests, depending on the site.	• Low • Normal	• 10% higher than MRV • Equal to MRV • 10% less than MRV
Cost of obtaining and executing a management plan: costs incurred by the owner to generate the Forest Management Plan and the costs of execution at the time of timber extraction	• Normal • High	• 10% higher than the average • Equal to the average • 10% less than the average
External financing: the owner needs to seek external financing in order to assume the production and execution of the Forest Management Plan.	• Normal • High	• Yes • No
Payment for environmental services (PES): it refers to the real options that exist in the country to receive PES once the forest has been harvested. The options correspond to: PES for forests that besides protection activities also offer hydric resources; PES for forests that offer protection; PES for managed forests and lastly, forests that do not receive PES.	• Absent • Present	• 74 $/ha/year • 60 $/ha/year • 46 $/ha/year • 0 $/ha/year
Technical, legal and administrative conditions for the management plan: it refers to the formalities or procedures related to the permit granting and the supervision exercised by the State when activities are authorized through a forest management plan	Not included in the experimental design	• **Inflexible:** the State is perceived to apply management procedures and norms without considering the differences among the forests subjected to management. • **Variable:** procedure results vary depending on the State official or the office that deals with the process. • **Stable:** ideal conditions, the user perceives no influence from the official, nor from the office in charge. The process of approval and issuing of the timber transportation control form abides by the rules but shows flexibility regarding the particularities of the forest.
Membership of groups of organized producers: it refers to producers being members of cooperatives, agricultural centres, non-governmental organizations and producer associations, among others, which may provide the producer with technical and legal services.	• Yes • No	Not included in the experimental design

Critical Point	Management Unit A	Management Unit B	Management Unit C	Management Unit D
Cost of obtaining and executing the management plan (with respect to the average)	↘ -10%	= 0%	↗ +10%	= 0%
Production performance (with respect to the average)	↘ -20%	↘ -10%	↘ -10%	= 0%
Need for external financing to realize the management plan	Yes	Yes	No	No
Technical, legal and administrative constraints	Stable	Variable	Inflexible	Variable
Payment for environmental service (for 5 years)	60 $/ha/year	46 $/ha/year	74 $/ha/year	0 $/ha/year
RANKING:	**1 2 3 4**	**1 2 3 4**	**1 2 3 4**	**1 2 3 4**

Figure 4. Example of one of the choice cards used in round II of the Delphi method. Each expert selected the order for the MUs A to D, where 1 represents the most sustainable MU and 4 the least sustainable.

2.4. Model and Data Analysis

Two Contingent Ranking (CR) experiments were presented to a representative sample of forestry experts (landowners, technicians, government employees, etc.). The CR experiments were included in a two-round Delphi analysis dealing with the SFM in Costa Rica. For both CR, each respondent was faced with 12 choice cards, each one containing four MU described by a set of five attributes or critical points (Table 1). In each choice set, the experts ranked the MUs from 1 (the most sustainable) to 4 (the less sustainable). Experts ($i = 1, \ldots, I$) are supposed to be rational and maximising their utility when choosing from a set of alternatives ($j = 1, \ldots, J$) in each choice set (C). For each alternative j of the choice set, the expert indirect utility function (U_{ij}) depends on: *i*) a deterministic element (V_{ij}) and *ii*) a stochastic component (ε_{ij}), which cannot be observed by the researcher.

$$U_{ij} = V_{ij} + \varepsilon_{ij}, \tag{1}$$

In terms of probabilistic inference, the choice probability is:

$$P(U_{ik} > U_{ij}) = P\left[\left(V_{ik} - V_{ij}\right) > \left(\varepsilon_{ij} - \varepsilon_{ik}\right)\right] k \neq j,\ k, j \in C, \tag{2}$$

This study departs from the econometric model developed by Reference [38] to analyse the information obtained from a contingent ranking. Only the best ranks were used for the analysis as suggested by References [39–42], among others. Therefore, random parameter logit models (RPL) provide a compliant way to analyse the discrete choice data and to deal with unobserved preference heterogeneity [43]. The random parameter specification supposes that individual preference values β vary in the population with density $f(\beta|\Omega)$, where Ω denotes the parameters of density. Therefore, the probability of expert i's observed best rankings $[y_1, y_2, \ldots, y_T]$ is calculated by solving equation 3 using 1000 iterations and Halton sequences in simulations [43,44].

$$P_i[y_1, y_2, \ldots, y_n] = \int \ldots \int \prod_{t=1}^{T} \left[\frac{e^{\alpha_j + S_{ij}\beta_i}}{\sum_{k=1}^{J} e^{\alpha_k + S_{ik}\beta_i}} \right] f(\beta|\Omega) d\beta, \tag{3}$$

3. Results

3.1. Attitude towards Critical Elements

The first round determined which elements in a MU represented the critical points for the unit's sustainability, that is, those elements that influenced the probability of the unit of being classified as sustainable. Initially the expert evaluated the critical isolated elements qualitatively, then in the DCE, these same elements were evaluated jointly so that trade-offs among them occurred.

After asking the experts about each element in the first round, we confirmed that a high percentage agreed on certain critical points as being critical for sustainability more than in others (Table 2). For example, legal and administrative inflexibility accounted for 90% of the responses, variation in the procedures between offices, 53.3% of the responses and the technical, legal and administrative variations, 70% of the responses. As this result (technical, legal and administrative conditions) was from the first round (and not from the literature review), it was not included in the first round DCE but the strength of the opinions of the expert panel led us to include this critical point in the second round DCE. Also critical for sustainability is high dependence on financing, related to high indebtedness of producers (73.30% of the responses). Both, the high cost of management tasks (63% of the responses) and the low production performance (53.30% of the responses), were also included as critical by the experts. Neither migration of nearby populations to other parts of the country, nor deterioration of communal organization were considered as critical elements at all. These results were used as elements to be considered in the definition of the points to be evaluated in the second round of the DCE.

Deforestation, which is related to the loss of the value of the land covered with forests (73.3%), was considered a critical point in 80% of the opinions. But this element was not used in the second round as critical point, because the change of land use in Costa Rica is prohibited by law, in addition, the mere fact that deforestation was identified caused the entire MU to be catalogued as unsustainable. Finally, the loss of land value of the forests was considered a critical point for sustainability and along with deforestation, it was discarded in the choice exercise of the second round.

Table 2. Expert panel opinion on critical points of sustainability.

Attribute	Critical Point	Considered as A Risk (%)	
		I Round	II Round
Productivity	High cost of forest management work	63.30	*87.00*
	Low production performance	53.30	78.30
	Low product quality	36.70	56.50
	Absence of payments for environmental services (PES)	13.30	13.00
Stability	Deforestation (change in land use)	80.00	95.70
	Technical, legal and administrative variations	70.00	87.00
	Product price instability	26.70	73.90
	Soil and water pollution	20.00	65.20
	Soil loss or degradation	13.30	52.20
	Pesticide damage	10.00	17.40
Adaptability	Technical, legal and/or administrative inflexibility	90.00	95.70
	High dependence on external financing	40.00	65.20
	High cost of supplies	16.70	30.40
Equity	Loss of forested land value	73.30	95.70
	Variations in the procedures between State offices	53.30	65.20
	Social differences in the community	26.70	17.40
	Population migration	0.00	0.00
Management	High indebtedness of producers (dependence on financing)	73.30	69.60
	Lack of organization among producers	43.30	52.20
	Deterioration of the communal organization	0.00	0.00

Contrastingly, it is remarkable that few experts considered the absence of PES as a critical element for sustainability (13.3% of the qualitative responses). However, this attribute was used again in the second round because the results of the first round DCE showed that this attribute was statistically significant at 99%, (Table 3). Lastly, none of the experts considered necessary to add critical points to the list chosen in first round DCE.

The DCE second round confirmed that deterioration of community organization and migration of populations close to the forests in other parts of the country were not considered critical points for sustainability (Table 2). The mentioned critical point was included in the first DCE but because of this result, it was removed in the DCE second round. Another relevant result of the DCE second round was that the critical points of sustainability were confirmed, with the advantage that each critical point increased the overall number of opinions. In conclusion, we can affirm that the panel of experts reached consensus about the critical points.

3.2. Tendency of Each Attribute

The results of the RPL model obtained from first round indicated that all the critical points were significant at 99%, except for the membership in organized groups (Table 3). The pseudo R^2 was 0.5724, that is, model fitting was above the minimum ranges commonly accepted in the literature [45,46]. Similarly, the significance of the random parameters, under the assumption of normality, showed that there was heterogeneity among the experts. Thus, despite the fact that the panel included individuals with different interests and perceptions, a relative convergence was achieved on most sustainability critical points.

The critical points identified by the RPL model in round 1 included production performance as the most relevant, followed not too close by the cost of obtaining and executing the MP. Then, with similar levels, we identify the need for external financing to carry out management activities, followed by the presence of PES. These results indicated that the higher the production performance, the higher the probability of the MU of being classified as sustainable. If the cost of obtaining and executing a MP was on average, the probability of the unit to be considered sustainable increased, compared to a situation with high cost. The PES also increased the probability of a MU being classified as sustainable. Finally, the presence of external financing for the management increased the probability of sustainability.

Table 3. Results from the estimation of the Random Parameters Logit Model, for the most critical risk elements for sustainability of a managed forest unit in the North Zone of Costa Rica–Round I.

	Coefficient	**Standard Error**	**Standard. Deviation of Random Parameters**	**Standard Error**
Production performance	4.01514 ***	0.56021	1.68547 ***	0.49002
Cost of obtaining and executing a management plan	2.42229 ***	0.35348	0.91413 ***	0.29769
Payment for environmental services (PES)	1.99616 ***	0.32459	1.01636 ***	0.37212
External financing	2.22839 ***	0.32961	0.89840 ***	0.32767
Membership of organized groups	0.31797	0.24526	0.66256 **	0.32702
Log likelihood function	−213.39756			
Restricted log likelihood	−499.06597			
McFadden Pseudo R-squared	0.5724061			
AIC	446.8			
AIC/N	1.241			
Number of individuals	30			

***, ** Significance at 1% and 5% levels respectively.

The critical point 'membership in organized groups' was eliminated in the second round because it was not statistically significant in the RPL model obtained in the first round (Table 4). However, the technical, legal and administrative conditions were included in the second round because this

critical point included *a priori* relevant elements determined by the expert´s panel. In this case, we presented the results of the RPL model, codifying the qualitative critical points as effect codes and avoiding null values for the reference levels. The pseudo R^2 obtained a value of 0.3454, again above the minimum threshold recommended.

Table 4. Results of the estimation of the Random Parameters Logit model, for the most critical risk elements for the sustainability of a managed forest unit in the North Zone of Costa Rica—Round II.

	Coefficient	Standard Error	Standard. Deviation of Random Parameters	Standard Error
Production performance	0.15057 ***	0.02571	0.08662 ***	0.02311
Cost of obtaining and executing a management plan	−0.05040 ***	0.01574	0.05288 ***	0.01639
Payment for environmental services (PES)	0.02646 ***	0.00706	0.02284 ***	0.00633
External financing Yes #	−0.68269 ***	0.23089	0.26462 *	0.14836
External financing No ##	0.34135 ***	0.11545		
Technical, legal and administrative conditions for the management plan inflexible #	−1.04173 ***	0.36166	0.49103 **	0.20222
Technical, legal and administrative conditions for the management plan stable #	0.13248	0.28697	0.08671	0.44536
Technical, legal and administrative conditions for the management plan variable ##	0.30308	0.19826		
Log likelihood function	−250.4757			
Restricted log likelihood	−382.6172			
McFadden Pseudo R-squared	0.3457			
AIC	525.0			
AIC/N	1.902			
Number of individuals	23			

***, **, * Significance at 1%, 5% and 10% levels respectively, # Adjusted coefficients for effect codes, ## Estimated coefficients for the reference levels (effects coding).

According to the obtained results in the RPL model of the second round, the selected critical points significantly influence the decision about the sustainability of a MU. It was observed that the higher the cost of obtaining and executing the MP, the lower the probability of the MU of being considered sustainable. Meanwhile, the greater the production performance, the greater the probability of qualifying the MU as sustainable. The coefficient relative to the need of external financing showed that when there was a need for financing, not only it was the MU less likely to be considered sustainable but it was one of the most relevant critical points. Moreover, when external financing was not required, the coefficient obtained was in the expected direction, that is, when the MU does not need external financing, the sustainability of the MU is higher. Similarly, if the MU had benefits deriving from PES, the likelihood of being sustainable increased. Lastly, the experiment suggested three levels of technical, legal and administrative conditions for the management—inflexible, variable and stable conditions. The model results showed a significant level for the condition 'inflexible'. According to the sign and the magnitude of the coefficient, an MU that faced inflexible conditions in regard to the technical legal and administrative process was less likely to be

4. Discussion

As mentioned by Reference [25], the SFM is about "many issues for many people" but production of goods and services for present and future generations is a common topic. They also mention that the promise of sustainability lies in two premises—first, self-renovation potential of the ecosystems, which is summarized in adaptability and resilience; and second, that economic activities and social perception are options that can be modified to guarantee the long term productivity and health of the ecosystem.

This article presents a two-round DCE framed within a Delphi analysis. To our best knowledge, there are no similar studies in the literature related to the management of renewable natural resources.

The comparative advantage of realizing two rounds is that it allowed validating the use of 4 of the 5 attributes originally selected based on the SFM literature review and added one more, the technical, legal and administrative conditions. This critical point was highly recommended by the panel of experts and it resulted in the critical point that most contributed to the assessment of the sustainability of the MU. When the technical, legal and administrative conditions are inflexible, classifying a MU as sustainable becomes difficult. This result is not a novelty but it constitutes a new empirical evidence, since for sustainability to be achieved, there must be an equilibrium between the pillars that support it (social, economic and ecosystem aspects), while enabling, instead of threatening, socioeconomic conditions around the SFM. On this topic, Reference [47] found in an analysis of cases that the existing over-regulation around the SFM in Costa Rica negatively affects its profitability. Among the aspects regarding over-regulation, Reference [47] include logging intensity, minimum time of the cutting cycles, definition of zones of protection and banning of highly valued commercial forest species. All these regulations are still present in the new PCI's scheme approved in 2008. However, the regulation persist as barriers to SFM of natural forests, according to Reference [21]. Regarding this same topic, Reference [21] found no consensus among the officials of the State Forestry Administration relative to the legal, technical and administrative regulations. For this reason, private forestry professionals and property owners have to rely on the officials' interpretation and application at their discretion.

Over-regulation also negatively affects production performance, since part of the elements that are inflexible in the procedures are indirectly related to production performance. That is why in large single MU or more productive MUs for reasons of location and environmental conditions, the overall effect is higher production performance. In an over-regulated scenario, this condition places the forest in comparative advantage, over those with average sizes around 50 ha. Among the effects on production performance is that some officials add banned species, at their discretion [21]. According to Reference [47], in more productive lands the effect on profitability is up to 40% higher than in less productive lands. This reduced productivity is linked to an increase in the slopes of the land, where SFM is feasible but more expensive.

The need for external financing is confirmed as a critical point of sustainability, for, when it is needed, the likelihood of the MU of not being sustainable is among the highest compared to the rest of critical points proposed. This is because financing entails additional payment deadlines and interest rates that exacerbate the costs impacts. When the production performance is restricted by some variable, the foreseeable immediate income must be high in order to compensate the financial costs. As Reference [21] mentions, under SFM the owners generally do not have access to financing sources to develop and execute the MP, either because of lack of information or real impossibility (not qualifying for financing). The commonest consequence is that the producer sells the standing timber, with no additional value to the legal cutting permit. Under this scheme, it is obvious that the profit margins are greatly reduced compared to selling logwood at the farmyards or sawmills. According to Reference [19], timber prices can be incremented from 50% to 92% if the timber is sold as logs at the industry yards, although that implies additional costs.

SFM costs are confirmed as a critical point of sustainability, with significant negative values both in the first and in the second round of the DCE. In Costa Rica, costs refer to three fundamental aspects—(1) preparing the permit, (2) formalizing the permit that includes preparing the application of environmental viability and (3) timber extraction [47]. However, there are other costs related to surveillance, boundary maintenance, administration that are assumed by the owner and not accounted as part of the SFM. The most significant and fundamental cost is permit formalization (i.e., cost of procedures and waiting time), reaching up to 65% of the total costs. Permit preparation follows with 27.3% [47]. Thus, any variation in the costs negatively affects the sustainability since, as mentioned, most of the forest owners in Costa Rica sell the standing timber, mainly because they do not have access to favourable financing programs to carry out the SFM of a private natural forest.

The PES results obtained are noteworthy because private owners who carry out SFM in Costa Rica can have access to PES for (1) protection of hydric resources for human consumption; (2) protection of

biodiversity; or (3) only because they have a MU. However, there are owners who do not register for PES either because they do not want to or because the forests are not within the priority areas that benefit from PES. The PES amounts are different, the highest being payed to owners who register their farms for protection of hydric resources for human consumption. As expected, whoever enters this scheme will do so under the expectation of additional benefits including the likelihood that the MU will be classified as sustainable under a PES scheme. It is also true that if the property is not within a priority area, the owner will have to acquiesce to a management PES or will simply have no access to the PES program, which results in reduced probability of achieving sustainability. As Reference [20] mentioned in 2002, PES to forest management was eliminated as a response to pressure exerted by the environmental groups who were opposed to SFM and who were not even willing to recognize the environmental services provided by managed forests. Also, Reference [48] confirms that only people or companies with greater economic power can absorb the expenses of the SFM since the activity is not profitable without the management PES. This same finding was supported by Reference [47] and later confirmed by Reference [21], despite the fact that the management PES was restored in 2009. The amount of the PES benefit currently given in Costa Rica is not as high as the transaction costs involved, which can bear negative consequences for sustainability. However, As Reference [49] indicates, should there be no payment for environmental services, the costs of providing these services would be fully assumed by the owner. If PES is payed, at least society perceives that the services received are compensated in some way, even if the amount payed to the owners is only a small portion of the total benefits they are really providing through forest management [49].

5. Conclusions

The use of DCE as a valuation tool for non-market goods is once more confirmed as a valuable information source. Using few attributes, assessments can be performed to predict the complexity around sustainability, in this case, of MU under a SFM system. The weight given by the experts to each critical point in the first and second rounds and the results of the coefficients showed the same tendency, that is, the magnitude of the weighting of the expert panel was confirmed by the modelling results.

The experts' perception with respect to the common variables that define the sustainability of a managed forest relates to elements simple to determine. Four of these aspects were restated as significant in the two rounds of application of the DCE—the need for external financing, production performance, costs of preparation of the MP and of the work of execution and availability of PES. These four variables correspond to the social, economic and ecosystem dimensions that traditionally have been the basis for the definition of SFM. The fifth variable that the experts recognize as relevant refers to the technical, legal and administrative conditions. This is a significant variable in the DCE and it was identified as the most relevant with regard to inflexible conditions. In addition, this variable corresponds to the institutional dimension, which as a component of the social dimension, gains relevance from the point of view of governance relative to the decision making concerning the use of forests in private lands.

The results of this study also indirectly confirm the results of other studies about SFM, which conclude that certain technical, legal and administrative conditions influence profitability, becoming barriers to SFM. This study shows how those conditions, identified as barriers in other investigations, can become one of the main reasons for classifying managed forests as unsustainable.

The perception of sustainability and the variables that could define it should be analysed by decision makers and those responsible for governance, since it is clear that the heaviest weight for forest management to be considered sustainable must not be put on ecosystem aspects solely. Now, more than ever, those who depend on forest management as a means to subsist should also regard it as a source of well-being, in coherence with the environmental, social and economic relevance of these ecosystems.

In the near future, it is important to address in depth the subjacent causes of non-access to the PES by private forest owners, as well as the amount of the granted payments. It is also important to deepen what requirements are fundamental to enrol more private owners of MU, which would contribute in part to improve the profitability of the SFM.

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