Collaborative Project

Role **O**f **B**iodiversity **I**n climate change mitigatio**N**

ROBIN

D.3.1.4: Identifying options for integrating biodiversity conservation and climate change mitigation: A multi-scale perspective

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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1. Executive Summary

The objective of ROBIN Work Package 3.1 (Stakeholder-driven scenarios and options for biodiversity based climate change mitigation) has been to identify options for the integration of biodiversity and ecosystems in climate change mitigation through participatory scenario development and optimal land use appraisal.

This deliverable, (D3.1.4) is the last deliverable in a series of deliverables that have responded to these broad objectives of the WP. Specifically, this deliverable presents a multi-scale approach to said objectives of the WP by presenting: 1) the participatory development of policy options selected by stakeholders in participatory stakeholder workshops, 2) a bio-economic modelling approach assessing potential policy options for forest conservation and climate change mitigation in agro-ecosystems at the provincial level, and 3) an analysis of drivers of deforestation at the national scale in Latin America and the Caribbean. Using this multi-scalar approach this document will develop a suite of options that could be developed and used by decision makers to integrate biodiversity and ecosystems in climate change mitigation.

The local scale work developed and presented offers potential local-scale policy options selected through a participatory approach. The options selected from this local-scale analysis have been selected from Fuzzy Cognitive Mapping (FCM), analysis using Analytic Network Process (ANP) and stakeholder based voting and prioritisation of options. The use of these participatory (FCM, ANP and voting), and multi-criteria tools (ANP and voting) have allowed for the selection of entirely stakeholder selected and prioritised options for integrating biodiversity and ecosystems in climate change mitigation. This work completes the series of stakeholder workshops developed as part of ROBIN in Ascensión de Guarayos (Bolivia) and Flona Tapajós (Brazil), and builds upon the work developed in the first two rounds of workshops. These previous workshops analysed the present and future states of the environment and socio-economic development through participatory scenarios and Fuzzy Cognitive Mapping (D3.1.3; Varela-Ortega et al., 2014a). In the third round of workshops, societal and policy-relevant options were selected from work developed and demonstrated in FCMs constructed by stakeholders in the 2nd workshop and analysed using ANP. Further, options were also selected during the workshop by stakeholders in the 3rd workshop who selected, characterised and prioritised these options through voting based on their potential for integrating biodiversity into plans for mitigating climate change.

The provincial scale analysis designed in WP 3.1 was formulated using data collected from an extensive period of field-work in Bolivia funded by UPM[1]. As part of this field work 31 semi-structured, informal, one-one interviews were performed with farmers, agricultural experts and

[1] Biodiversidad y bienestar humano ante el cambio global en áreas tropicales protegidas de América Latina. Project No.: AL13-PID-18. UPM Grants for activities with Latin American countries. Universidad Politécnica de Madrid, International Relations Office.

technicians in two of the three municipalities of the Province of Guarayos. The interviews covered over 3% of the agricultural area of the province, which contains protected forest areas of high ecological value, threatened by agricultural expansion and logging. From this field-work and the data collected, representative farm types were identified through cluster analysis (subsistence to large scale commercial farms). These farms types were specified using a multi-period optimisation bio-economic model, permitting the simulation of various policy measures. Four policy measures (economic incentives, disincentives and enabling measures) were analysed to identify their efficacy for conserving ecosystems within the agro-forestry systems of the Province of Guarayos. A similar field-work has been performed in Brazil, funded also by UPM[2]. Over 70 interviews performed with farmers, agricultural experts and technicians across three municipalities of the State of Pará. A similar analysis is currently being developed using the data gathered from these interviews, and a similar model and policy measures will be applied.

Completing the multi-scalar approach, this deliverable identifies the socio-economic, institutional, bio-physical and technical factors that determine deforestation at the national scale across Latin America and the Caribbean, contributing to the characterisation of different deforestation patterns across the region. To achieve this, statistical analysis and econometric modelling were performed using a database developed for 27 Latin American and Caribbean countries, which contained over 70 variables (biophysical, socio-economic, agricultural, technological and governance) for the years 2000, 2005 and 2010. The first phase of the analysis incorporated a characterisation of countries considering land uses, forest cover, deforestation rates, socio-economic and institutional context, physical and geographical features and technological, with countries clustered according to key deforestation related endogenous variables. A second phase of the analysis included a selection of key potential explanatory variables using Principal Component Analysis (PCA) followed by the estimation of a short panel two-stage regression model for deforestation at the country level.

This deliverable is divided into four parts and presented with a section dedicated to each scale, along with a final section dedicated to the summary of the findings and development of conclusions. **Section One** builds on the previous WP 3.1 deliverable "Methods and Results from the Second Round of Stakeholder Meetings" (D3.1.3; Varela-Ortega et al., 2014a). Examples of the FCMs developed in the 1st workshops in previous workshops of both Ascensión de Guarayos and Flona Tapajós were analysed to further understand the dynamics and structure of these FCMs using network analysis. Using the information collected and the FCMs from the 2nd round of stakeholder workshops, a set of policy options were selected for both Bolivia and Brazil. These options were selected using the positive future scenario Fuzzy Cognitive Maps developed in Ascension de Guarayos ('good life') and Flona Tapajós ('desired'). Using these FCMs, potential options were selected in relation to a number of the drivers (identified by stakeholders) of the systems within the FCM. These options and the FCMs (good life and desired) were translated

[2] Biodiversidad y cambio climático en la Amazonía: perspectivas socio-económicas y ambientales. Project No.: AL14-PID-12. UPM Grants for activities with Latin American countries. Universidad Politécnica de Madrid, International Relations Office.

into networks that could be interpreted by the software (Super Decisions) used so that options for integrating biodiversity for climate change mitigation could be prioritised using the Analytic Network Process (ANP) (Saaty, 1999, 2001). **Section Two** highlights the bio-economic model developed from provincial field-work performed in the department of Santa Cruz, Bolivia. The model was designed to improve the understanding of agro-forestry production systems in the Province of Guarayos and to simulate the impacts of the implementation of various potential policy options for ecosystem conservation. A similar model is currently in development based upon field-work performed in the state of Pará, Brazil. However, this model is still under construction and therefore results have yet to be finalised. **Section Three** focuses on the development of a statistical analysis and econometric modelling to characterise deforestation patterns and to identify explicatory variables of deforestation across Latin America and the Caribbean at a national scale. **Section Four** provides a summary of the analyses performed and provides conclusions to the multi-scale approach developed within this document.

In detail, Section one introduces the mathematical network analysis of the present FCMs developed in the 1st stakeholder workshops in both Ascensión de Guarayos and Flona Tapajós. This analysis confirmed a number of observations; that the central factors described by stakeholders during the workshop (deforestation in both cases) were found to be one of, if not the most influential and important factor within each network. Further, the analysis also identified that the drivers of the systems, as identified by stakeholders, are somewhat divergent from those factors identified by the analysis. This analysis and the treatment of FCMs as complex systems contributes to a more robust calibration process, supports systematic analysis of the maps and permits further analysis of the dynamics of the systems within the FCM (Varela et al., 2015a).

Further, section one concludes the series of participatory workshops developed in Ascensión de Guarayos (Bolivia) and Flona Tapajós (Brazil), with the final workshop giving further voice to stakeholders by allowing them develop a series of policy options. In both workshops, a distinct group of stakeholders were invited compared to the previous two, with considerably more policy makers participating in Santa Cruz de la Sierra (Bolivia) and Belém (Brazil). Options were selected directly from the FCMs of the future (positive scenarios), and were prioritised using Analytic Network Process. Further options were selected independently by stakeholders during the 3rd workshop. Both sets of options were characterised and voted for by stakeholders to identify which options they believed would aid in the provision of biodiversity conservation and mitigation against climate change in the region.

Stakeholders in Bolivia prioritised the following three options; technical training, programmes to assist subsistence farmers and improving the implementation of land use and building up a database as being the most important. These three factors were characterised by stakeholders to have high social acceptance, but with moderate-very high costs of implementation, but all were considered to be compatible with present legislation. Whereas in Brazil: governmental coordination, investment in health and education and programmes to aid integration of agricultural and forestry activities were voted as being the most important. These options were

found in general to have considerably high social acceptance, with high levels of associated implementation costs and widespread compatibility with present legislation.

The results suggest that those policy options selected would receive widespread social acceptance, but would not be without costs both economically and legislatively. Further, the outcomes of these workshops, and the entire series of workshops developed in both countries highlights not only the strength of the methodologies applied, but also the relationships developed between ROBIN institutions and local stakeholders.

The bio-economic model (section two) developed based upon data collected from field-work performed in the Province of Guarayos (Bolivia) develops an improved understanding of an agro-forestry system in the Amazonian lowlands of Bolivia, whilst simulating the potential effects of policy options on ecosystem conservation and economic income.

The development of the model and simulation of the individual impacts of policy options on conservation and income highlighted a number of conclusions. Firstly, whilst considering environmental protection and the trade-offs with socio-economic development, the socio-economic optimal solution for the individual may not be the societal optimal. Further, the outcomes of the modelling suggest that the application of policy measures can be duplicitous depending upon the farm type and should be context and site specific. On one farm a policy could be largely beneficial, whereas the same measure, in the same region, could result in a distinct outcome on another; therefore consideration of this should be made before enforcement. To conserve forests in regions where deforestation has not already been banned, will require high compensation costs and in turn large public expenditure. The development of economic, agricultural and nature conservancy policies will need to be integrated and coordinated in the future to find synergies and develop a balance of actions for the future (Esteve et al., 2015).

The national scale analysis (section three) developed a statistical analysis and econometric modelling to characterise deforestation patterns and to identify explicatory variables of deforestation across Latin America and the Caribbean at a national scale. The analysis firstly demonstrated that countries could be grouped together using two endogenous and independent variables, forest cover and deforestation rate. The analysis identified five clear clusters in which the 27 countries could be positioned, depending upon their forest cover and rate of deforestation. The econometric analysis highlighted that the following explicatory variables (total population growth, male and female mortality rates, a corruption metric and an instrumented forest cover variable (arable land area metrics, permanent crop area metrics, rural population growth, rule of law) could explain a considerable level of the variance (68.2%) in deforestation across Latin America and the Caribbean between 2000 and 2010 (Varela-Ortega et al., 2015b).

The national scale analysis demonstrates that patterns and drivers of deforestation are subtly different across countries, therefore policies developed for conservation or climate change mitigation should consider these localised differences. It also highlights that governance,

economic and social factors are determinants of these national differences. Using this analysis, policy development consideration should not only address the immediate threats of deforestation, but should address the diffuse threats and focus upon the development of social and institutional mechanisms to support development and conservation.

From this multi-scale analysis a number of patterns have emerged that appear to repeat themselves. It appears imperative that for effective conservation of ecosystems that there is the provision of cross-ministry and local-national scale governmental coordination. This provision appears fundamental, not only to direct coordinated and coherent policies, but also to initiate the integration of environmental, agricultural and development policies.

Conservation policies should not only consider immediate threats, but also the diffuse ones too. The perceived benefits of technical capacity building and investments in health and education have been demonstrated at the local-scale. However, it seems perfectly justifiable to say that over a longer period the benefits of such policies would benefit regions and countries as a whole, both socio-economically and environmentally. This would therefore, support the idea that the most effective policies can improve well-being at a local-scale.

Finally, this analysis has demonstrated that one-size fits all policy options are very unlikely to be successful. Policies should be tailored specifically for each farm, province and region, rather than one policy per country. It has been repeatedly shown throughout this document and its predecessors the heterogeneous patterns of change that affect each local, province and country. To achieve such complex, tailored and site specific policy development will require considerable governmental consideration and may be highly dependent upon improved multi-scale governmental coordination and policy integration.

D.3.1.4: Identifying options for integrating biodiversity conservation and climate change mitigation: A multi-scale perspective

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2. Introduction

2.1 Objectives

The objective of this deliverable is to identify policy options for ecosystem conservation and climate change mitigation. These socially acceptable and applicable policy options will be identified based upon a multi-scale approach including local, provincial and national level.

This multi-scalar approach will address the whole system approach developed as part of ROBIN, whilst allowing for cross-scale socio-economic/ ecological interactions at multiple scales to be considered and will ultimately contribute to the delivery of the goal of WP 3.1 of ROBIN which is to provide "Stakeholder-driven scenarios and options for biodiversity based climate change mitigation".

2.2 Background

Work package 3 of ROBIN aims to identify options for integrating biodiversity and ecosystems and mitigating climate change through participatory scenarios. The work package has developed the participatory process based upon on strong stakeholder involvement and a series of workshops. Previous deliverables (D3.1.2; Varela-Ortega et al., 2013) provided a review of the methodology used in the development of stakeholder-driven scenarios for ROBIN. Further, it offered an in depth analysis of participatory scenario development, and identified a methodology suitable for ROBIN.

D3.1.3 (Varela-Ortega et al., 2014a) built upon the knowledge gained from D3.1.2 and developed and applied the method chosen for the participatory process: Fuzzy Cognitive Mapping (FCM). Fuzzy Cognitive Maps (FCMs) are a form of cognitive map or "mind map" useful for showing causal relationships between variable concepts (like social instability, rather than society), together with the strength of interaction between these variables. Fuzzy Cognitive Maps force the participants of the process to be explicit in their description of the system. With FCMs the purpose is to achieve a better understanding of the stakeholders' perception of both the present system and the system state in various future scenarios.

D3.1.3 outlined the results from the first two rounds of stakeholder workshops and offered an in-depth analysis of the findings from the workshops. It also delivered comparative analysis of the results for the FCMs developed for the current, as well as the future scenario FCMs. The participatory process developed as part of work package 3 consisted of a series of stakeholder workshops performed in the case study sites of ROBIN. The series of workshops was assisted by an initial training session performed in Madrid in 2013 (Varela-Ortega et al., 2013). The first round of workshops served to identify and characterise the current state of the environment, land use changes, biodiversity, societal and human well being and the main factors determining these system, whilst developing FCMs in each of the three case studies of ROBIN: Ascensión de

Gaurayos (Bolivia), Flona Tapajós (Brazi) and Chamela-Cuitzmala (Mexico). The second round focussed upon the development of future scenarios at these sites and the development of FCMs using IPCC based scenarios. Both D3.1.2 and D3.1.3 have provided a basis for the development and implementation of the work herein described in D3.1.4. As agreed amongst ROBIN partners, the third and final round of stakeholder meetings was performed in Santa Cruz de la Sierra (the case of Guarayos, Bolivia) and Belém (the case of Flona Tapajós, Brazil) for selecting policy options.

Table 1. Outline of the series of stakeholder workshops performed in the three case study sites of ROBIN

	Ascención de Guarayos (Bolivia)				**Flona Tapajós (Brazil)**			**Chamela-Cuitzmala (Mexico)**		
	PWS[3]	1st SHW	2nd SHW	3rd SHW	1st SHW	2nd SHW	3rd SHW	PWS	1st SHW	2nd SHW
Date	23rd January 2013	30th January 2013	18th June 2014	1st July 2015	27th November 2013	28th November 2013	3rd August 2015	a) 26th January 2013 b) 28th January 2013	8th March 2013	22nd/ 23rd November 2014
Venue	Ascensión de Guarayos	Ascensión de Guarayos	Ascensión de Guarayos	Santa Cruz	Santarém	Santarém	Belem	a) Hotel Villa Purificación, Jalisco b) Research Station Chamela, Jalisco	Villa Purificación	-
No of Participants	26	30	27	29	23	26	39	a) 52 b) 38	28	42
Format	1 day workshop 3 groups	1 day workshop 2 groups	1 day workshop	1 day workshop 2 groups	1 day workshop 2 groups	1 day workshop 1 group	1 day workshop 2 groups	a) 1 day workshop, 2 groups b) 1 day workshop 4 groups	1 day workshop 2 groups	1 day workshop
Methodology	Focus Group	Brainstorming Card Technique FCMs	Brainstorming Card Technique FCMs	ANP Characterisation Voting	Brainstorming Card Technique FCMs	Brainstorming Card Technique FCMs	ANP Characterisation Voting	a) Focus group b) Focus group	Brainstorming Card Technique FCMs	Brainstorming Card Technique FCMs
Main Results	Mapping of current natural resources	Identification of factors that have influenced the natural environment as it is today	Scenario development (positive and negative) of the future state of the natural environment and land use in Guarayos in 2050	Selection of options for integrating biodiversity and climate mitigation	Identification of factors influencing the current state of Amazonia	Scenario development of positive future state of the Amazon in 2050.	Selection of options for integrating biodiversity and climate mitigation	a) Identification of land use changes b) Identification governmental policies related to BD and CC	Identification of factors that have influenced the present state of land use and of the environment during the past 50 years.	Scenario development of the desired and undesired future.

[3] Preparatory Workshop

A brief overview of the case studies of Bolivia and Brazil are herein provided, however a more in-depth overview can be found in D3.1.2 (Varela-Ortega et al., 2013). A concise review of the results from the previous workshops held in each site is also provided. Further information of the workshops can be found in D3.1.3 (Varela-Ortega et al., 2014a) and in the D3.1.3 addenda for the case of Mexico (Gerritsen et al., 2015). A timeline of the workshops in each of the ROBIN case studies has been provided in Table 1.

2.2.1 Bolivia

Ascención de Guarayos is the provincial capital of the Province of Guarayos, located in the eastern Amazonian lowlands of Bolivia in the Department of Santa Cruz (Figure 1). It covers an area of over 766,700ha, with more than 25000 inhabitants. The region is extremely rich in biodiversity, with extensive areas of protected forests (Reserva de Vida Silvestre Rio Blanco y Rio Negro) within transitional humid forests (Amazonia to Chiquitano dry forest).

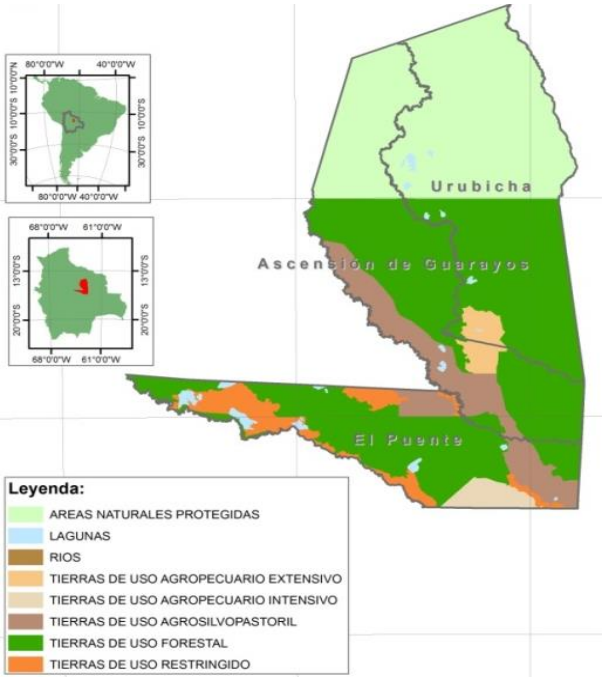


Figure 1. Ascension de Guarayos case study location.

The main production and economic activities are agriculture, livestock rearing, timber trade and small-scale manufacturing industries associated with oil palm and handicrafts also present. Due to the extractive nature of these activities, the region has an extremely high annual deforestation rate (2-6%), with rapid land use changes due to expansion of commercial agriculture (soy, rice and maize) coupled with land tenure insecurity, a lack of governance and high levels of poverty.

Table 1 offers a brief overview of the series of workshops that have taken place in Bolivia as part of WP3.1 of ROBIN. A clear succession can be seen from the preparatory workshops, to the identification of factors that were effecting the natural environment in the first workshop in 2013, to the development of positive and negative scenarios of the future state of the environment in Guarayos by 2050 in the 2nd workshop in 2014 and finally the selection, characterisation and prioritisation of policy options in the 3rd and final workshop in 2015.

2.2.2 Brazil

The National Forest of Tapajós, in the State of Pará, was established in 1974 and covers 530,622ha (Figure 2). Tapajós is populated by 16 different communities, with the main productive activity in the region being agriculture. The inhabitants of the area are classified as being low-income, with education levels being especially low. The main socio-ecological challenges in the region are the intensive use of land, agricultural expansion and increased land occupations.

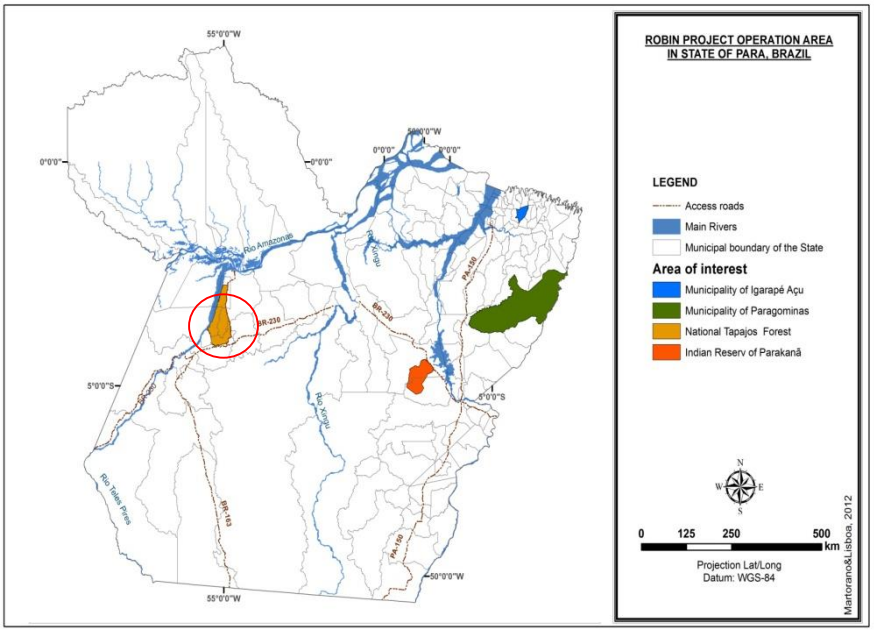


Figure 2. Flona Tapajós case study coverage and location.

The above factors have resulted in a high rate of deforestation, soil degradation, biodiversity loss and increased levels of poverty in the local communities. No preparatory meetings were performed in Brazil before the workshops.

Table 1 offers a similar overview of workshops performed in Flona Tapajós, the first workshop (November, 2013) identified factors that were effecting the current state of the Amazon, the 2nd workshop (November, 2013) developed positive and negative scenarios of the future state of

the Amazon by 2050, and finally the 3rd workshop (August, 2015) selected, characterised and prioritised policy options.

2.2.3 Overview of Results from Previous Workshops

The outcomes of the first two rounds of workshops, in particular the second round, have served to aid in the development of the work herein described and analysed. The results from the 'future' round of workshops have been used here to develop a series of policy and societal options for integrating biodiversity into climate change mitigation. The 2nd round of workshops developed scenarios of the future of the local area in Bolivia, Brazil and Mexico.

In Bolivia, these two models represented two diametric scenarios, one representing a positive future 'good life', and the second a negative future 'bad life'. The two FCMs developed from these scenarios demonstrated the factors, processes and actors that would be in place in such future scenarios. In the good life scenario, sustainable use of forests and sustainable agriculture were considered the centralised ideals with the map, with various: policy, economic, social and environmental processes assisting in achieving these ideals. Conversely, in the bad life scenario biodiversity loss and poverty become the centralised processes; the driving processes behind this negative future are largely social, political and economic.

In Brazil, only the positive future ('desirable') FCM scenario was fully developed, which highlighted the factors, processes and actors involved in such future. This desirable scenario, resulted in a FCM where development policies have been integrated, and income, quality of life and the human development index (HDI) have all been improved. The processes behind such integration and improvements are both social and political.

In Mexico, two models were developed 'desired' and 'undesired', two FCMs were developed from these scenarios. Further information about the 2nd stakeholder workshop held in Mexico can be found in the addenda to ROBIN Deliverable D3.1.3 (Gerritsen et al., 2015).

A brief comparison of the three future positive models highlights the importance of social and political processes in developing and driving change towards such a future. In particular, the importance of social environmental awareness, and institutional and political coordination were addressed within the workshops as drivers of change. Further, a more in depth analysis of these future models (Bolivia and Brazil), as well as those developed for the present can be found in the D3.1.3 (Varela-Ortega, et al., 2014a).

2.3 Contents

This document has been developed to cover, analyse and integrate the multi-scale approach adopted in WP3.1. It highlights the results from the 3rd and final stakeholder workshops held in Bolivia and Brazil, prioritising policy options selected by stakeholders for biodiversity integration in climate change mitigation policy. At the provincial scale, it delivers the results of the bio-economic model developed to simulate the potential impacts of policy options on ecosystem conservation. At the national scale it characterises and develops deforestation patterns and also highlights explanatory factors driving deforestation across Latin America and the Caribbean.

Finally, this document will offer a series of conclusions, potential policy options (developed for Bolivia and Brazil) and key messages for policy makers.

3. Multi-Scale perspective for identifying options for biodiversity and climate change mitigation

The multi-scale analysis described within this document and fundamental to WP 3.1 as a whole allows for a richer understanding of the problems identified and addressed with ROBIN. This document considers the issues of identifying and selection potential policy options for the integration of biodiversity into climate change mitigation strategies from multiple perspectives. As demonstrated by Figure 3, the identification of options has been developed at three levels, local, provincial and national, with the aims of each being subtly different but supporting the whole system approach developed within ROBIN. This multi-scale approach allows for addressing how human outcomes can affect behaviour through the development of Fuzzy Cognitive Maps and Analytic Network Process simulations, the bio-economic modelling at the provincial level and with the econometric modelling at the national level demonstrating the impacts of socio-economic human variables at each scale.

From this understanding of the impacts of socio-economic and human variables, policy options can be considered not solely from a top-down, one-size fits all national perspective, but also considered from a bottom-up, highly tailored local viewpoint. This approach further removes the possibility of considering results in isolation, but depends upon cross-scale socio-economic and ecological interactions which are relevant up and down the scales and are not mutually exclusive but may be interdependent.

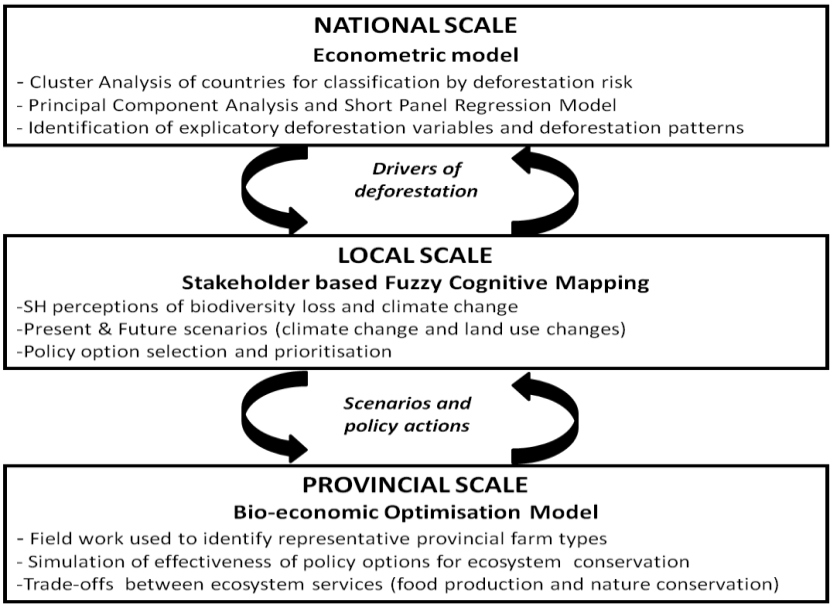


Figure 3. Schematic representation of the multi-scale approach developed and applied in this document for option selection for integration of biodiversity for climate change mitigation.

At the local level, stakeholders in Ascensión de Guarayos (Bolivia) and Flona Tapajós (Brazil) have been invited to attend workshops with the aim of selecting and prioritising locally specific policy

options. The selection of such options followed the development of present and future scenarios of the local using Fuzzy Cognitive Mapping, improving the understanding of the present and future socio-economic and environmental problems in the area. The use of these scenarios (IPCC-ROBIN) adapted to stakeholder visions has addressed the identification of how changes in climate mitigation capacity can benefit society as considered by whole system approach of ROBIN. The selection of policy options at this local scale reinforces the participatory approach inherent to this WP and ROBIN in general, whilst supporting a bottom-up approach to policy selection.

To address the need for the identification of provincial scale options, a regional bio-economic optimisation model was employed to simulate the effectiveness of various potential options for ecosystem conservation in agro-forestry systems. This analysis can be used to answer the question of what are the trade-offs in these systems in terms of ecosystem services and disservices. This provincial scale analysis, in concert with the local scale analysis developed and applied, can contribute to the understanding of the national scale analysis and demonstrates that interactions are present up and down the scales of this analysis.

The national scale analysis considers via the development of econometric modelling the patterns and drivers of land use changes across Latin America and the Caribbean. The insights developed from this analysis can help to identify whether any higher scale, top-down policies could be applied sensitively to groupings of countries without unintentional outcomes. The development of deforestation risk categories, based upon explicatory variables of deforestation can be used for the grouping of countries and the development of country specific policies that can cater for multiple countries.

Finally, the implementation of this multi-scale approach will help to improve the understanding and support the systemic approach implemented by ROBIN in identifying how changes in policies and management options can affect climate change and land use changes in terms of directing the relevance of policy designed based upon the results.

4. Local Scale Analysis

4.1 Mathematical Analysis of Fuzzy Cognitive Maps using complex network concepts

Over the last year, UPM has been working with researchers from the Department of Mathematics within the university to further analyse the functioning of the participatory FCMs developed in Bolivia and Brazil from previous ROBIN stakeholder workshops. This work has been presented at an International Conference (see Varela-Ortega et al., 2015a) at the General Assembly 2015 of the European Geosciences Union, Vienna (Austria)) and is in process of being published.

In short, it demonstrates that FCMs which represent social-ecological systems (networks) can be interpreted as complex system structures or complex networks. Therefore, the application of complex network concepts for the analysis of FCMs can improve the understanding of the structure, coherence and dynamics of the social-ecological systems illustrated as FCMs. The analysis has been conducted using as examples two FCMs developed in the first round of stakeholder workshops held in both Ascensión de Guarayos (Bolivia) and Flona Tapajós (Brazil) (Varela-Ortega et al., 2014a). In total, six network measures were identified to analyse the two FCMs selected:

Centrality
This group of 3 parameters can be used to determine the importance of influence of a node within the context of the complex network as a whole.

- *Pagerank*
  The pagerank of a node represents its importance within a network, or how influential a node is to the network as a whole based upon its centrality. Those nodes with higher values for this parameter are considered nodes to be the most important/ influential within the network.

$$PR(u) = \sum_{v \epsilon B_u} \frac{PR(v)}{L(v)} \quad (1)$$

  The PageRank value for a node u is dependent on the PageRank values for each node v contained in the set B_u (the set containing all nodes linking to node u), divided by the number $L(v)$ of links from page v.

- *Betweeness*
  This is a measure of the influence of any particular node within the network, it quantifies the number of times a node acts as an intermediary along the shortest path between any two nodes. It was initially introduced to quantify the control that an individual can achieve on the communication between other humans within a social network.

- *Closeness*
  This parameter measures how close any particular node is from the rest of the nodes within the network. It represents how long it will take a node to spread information to all other nodes. In connected networks, a natural distance between all pairs of nodes can be defined, which is given by the length of the shortest path connecting each pair of nodes. Therefore, the closeness of a node is defined as the inverse of the sum of its distances to all other nodes. The more centralised a node is relative to the network the lower its total distance is to all other nodes.

Clustering

The clustering of a network measures the number of closed triangles within the network. Local clustering measures the degree to which the neighbours of a node are also linked. Thus for a node of degree k_i the local clustering can be expressed as:

$$C_i = \frac{2L_i}{k_i(k_i - 1)} \quad (2)$$

Where L_i represents the number of links among the neighbours of i. C_i= 0 suggests that none of the neighbouring nodes of i link to each other, while C_i= 1 suggests that the neighbours of i form a complete graph- they all link to each other.

In-degree and Out-Degree

This represents the cumulative strengths of connections that respectively enter and exit any given node (factor within the map) within the network. This is weighted by the number of connections of the node.

Using these parameters a profile of the network represented within the map can begin to be established. These 6 parameters were applied to both of the maps representing the presenting situation in Bolivia and Brazil (Varela-Ortega et al., 2014).

4.1.1 Complex Network Examples: Bolivia and Brazil

Bolivia

From Figure 4 and Annex 9.1.1.1 a number of key points can be made in consideration of the Bolivian FCM analysed as a complex network.

Pagerank
The most important factor was identified as the loss of biodiversity, followed by deforestation/ clearing. That deforestation is one of the most important nodes (factors) is perhaps little surprising considering that it was identified as the central factor of the map (Varela-Ortega et al., 2014). The pageranks can be seen in Figure 4, demonstrating their relative scales (blue circles) for each node within the network. The importance of loss of biodiversity and deforestation are clearly evident. The arrows represent the relationships between nodes, with the colour of the arrows representing their relative strength. The bluer the arrow the more negative the relationship, with the redder the arrow representing a more positive relationship.

Betweeness
The results highlight a slightly distinct grouping of factors (nodes) with poverty, illegal logging and loss of subsistence agriculture found to be the three most highly measured nodes. This demonstrates the importance of this small, connected cluster of nodes in influencing the network.

Closeness
This analysis found deforestation, agricultural expansion and grazing expansion to be the most centralised of the nodes. The identification of deforestation as having the highest measure of closeness is perhaps of little surprise considering that it has the second highest pagerank.

Clustering
The clustering analysis suggests that the most clustered nodes within the network were land encroachment, loss of biodiversity, fires and grazing expansion.

In-degree
The in-degree analysis (the cumulative strength of relationships entering a node) demonstrated that contamination, agricultural expansion, loss of biodiversity and deforestation received the greatest cumulative incoming relationships. This would suggest that contamination within the system is caused by a multitude of different factors.

Out-degree
Four nodes were identified as the most important driving nodes of the network; deforestation, agricultural expansion, grazing expansion and application of the INRA law. This analysis demonstrates that the impacts of deforestation on the system are considerable and widespread.

The network analysis has identified a number of points, the centrality and importance of deforestation to this network, with it repeatedly mentioned in each of the analysed metrics. These results support the identification of this factor as the central factor to the system by stakeholders. However, this analysis has not only supported the previous analyses, but also offers a new insight into fuzzy cognitive maps and potential new methods of analysing the systems which they represent.

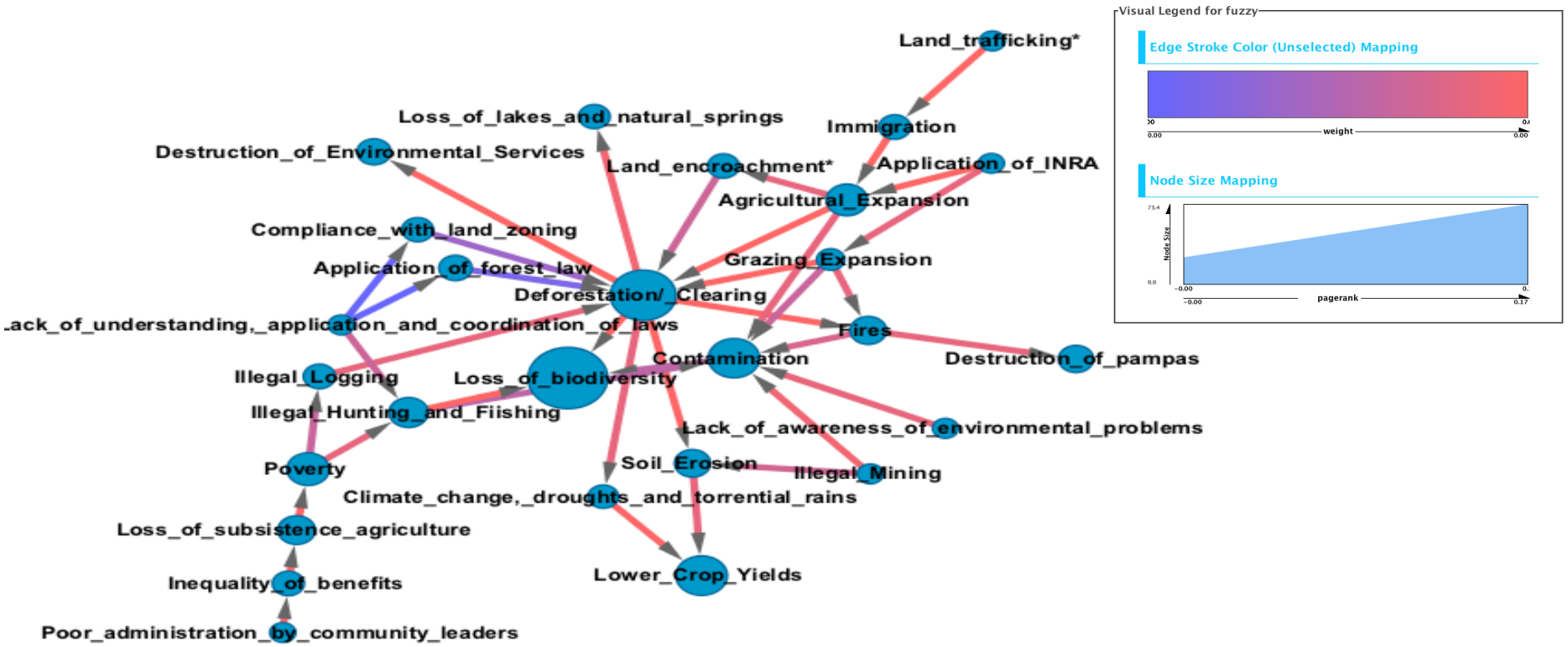


Figure 4. Network analysis of the present Fuzzy Cognitive Map developed in the 1st Stakeholder Workshop in Bolivia

Brazil

From Figure 5 and the table in Annex 9.1.1.2 a number of key points can be made in consideration of the Brazilian FCM analysed as a complex network.

Pagerank

The pagerank results for the Brazil FCM present similar results to that of Bolivia, with deforestation, loss of environmental services and loss of biodiversity considered the most important nodes of the network (factors in the map). These results are clearly evident in both Table 9.1.1.2 (Annexes) and Figure 5, which clearly show the scale of the importance of these three factors with respect to others. This result supports the definition of deforestation as the central factor to the FCM (Varela-Ortega et al., 2014a).

Betweeness

Deforestation, population purchasing power and infrastructure projects are the nodes (factors) that act as the greatest intermediaries in the pathways between other nodes. This suggests that these three factors are important in terms of the dynamics within the system, as they are repeatedly involved in a number of relationship pathways.

Closeness

A lack of efficiency in policies for subsistence farming, lack of environmental awareness and lack of governmental coordination were found to be the most centralised of the nodes. Initially this may be somewhat surprising, until consideration is made of the network (FCM) itself and the acknowledgement that these three factors are drivers of the FCM as identified by stakeholders. Therefore as drivers, with multiple outward relationships they have considerable influence upon the network as a whole, and therefore become centralised within it.

Clustering

The most clustered nodes within the network demonstrated by the FCM of the present were climate change and increase in Amazon population.

In-degree

The factors which received the greatest cumulative incoming relationships were loss of environmental services, loss of biodiversity and infrastructure projects.

Out-degree

The following nodes were found to be the most important within the network: deforestation, environmental monitoring and agricultural expansion. This analysis demonstrates, like that of Bolivia, that the impacts of deforestation on the system as a whole are considerable and widespread, far more important than agricultural expansion. Interestingly, the second most important node environmental monitoring, was to be found negative suggesting it has a dampening effect upon those factors which it is linked with. For example, environmental monitoring reduces deforestation, illegal logging and forest fires. This suggests that this node is a beneficial factor within the system, aiding in reducing the negative aspects of the system. The results of this parameter are fairly distinct compared to the factors

identified as drivers of the system in the FCM, this discrepancy maybe due the definition of drivers within the maps, which are factors which only have outgoing relationships.

To conclude, the results of this analysis demonstrate considerable correlation between both the Bolivian and Brazilian networks. Deforestation is repeatedly identified as a fundamental factor within the networks having some of the highest measures of pagerank, betweeness and out-degree.

Conclusion

The implementation of this novel analysis of the FCMs for both Bolivia and Brazil has provided, as originally aimed, a new perspective of the networks demonstrated within the maps. The analysis has not only reinforced previous understanding of the maps and the fundamental importance of deforestation in both maps, but also offered new insights. These include the clear suggestion that factors other than those identified as drivers in the FCM maps, may in fact be 'driving' the systems, as suggested by the out-degree metric. This analysis has offered a tantalising glimpse into the sheer complexity of the stakeholder developed systems and encourages further use of this analysis in the future. Interpreting FCMs as complex systems and using this complex network analysis can contribute to; a more robust calibration process in the future and it can support a more systematic analysis of the map. Finally, analysing FCMs with complex network concepts can be used in the future for policy development by identifying key elements and processes upon which policy makers and institutions can act.

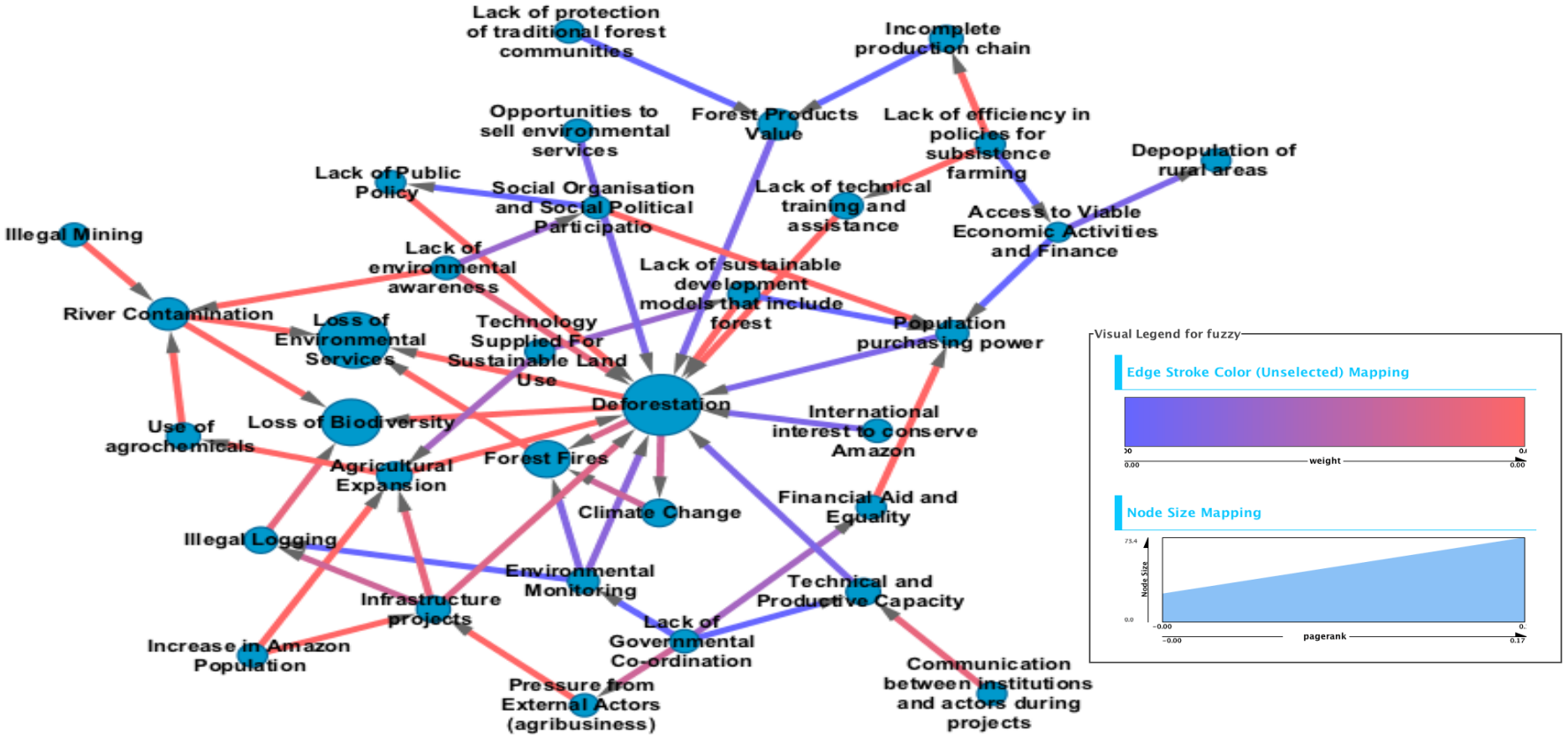


Figure 5. Network analysis of the present Fuzzy Cognitive Map developed in the 1st Stakeholder Workshop in Brazil.

4.2 Objectives and description of the 3rd Stakeholder Workshops

The objectives of the third, and final round of local scale stakeholder workshops was to continue the participatory and stakeholder based approach fundamental to WP3, whilst selecting stakeholder identified, characterised and prioritised policy options for integrating biodiversity to mitigate climate change. The selection of these options was developed through an extensive participatory and analytical process, which included at various stages stakeholder involvement and validation. In both workshops, a distinct group of stakeholders were invited compared to the previous two, with considerably more policy makers participating in Santa Cruz de la Sierra (Bolivia) and Belem (Brazil).

4.3 Methodology applied in the 3rd Stakeholder Workshops

The methodology applied for the selection of these options was three-fold: **firstly** the Analytic Network Process (ANP) (Saaty, 1999, 2001) was applied to prioritise options selected from the stakeholder developed Fuzzy Cognitive Maps from the second round of stakeholder workshops, which developed FCMs based upon future scenarios, both positive and negative (Varela-Ortega et al., 2014a). Options in this analysis were selected in response to drivers within the positive future FCMs, referred to as the good-life in Bolivia and the desired in Brazil. These selected options were then prioritised using the ANP. **Secondly,** further options were selected and characterised by stakeholders from a third round of workshops in both Bolivia and Brazil. **Thirdly**, options were prioritised through a series of stakeholder based voting.

4.3.1 Prioritisation of options: Implementing Analytic Network Process (ANP) based on FCMs

The ANP offers a multi-criteria tool for deriving relative priorities from individual (or group) judgements that can assist in decision making processes. The ANP builds upon the Analytical Hierarchical Process (AHP) (Saaty, 1977), offering a framework for considering real world issues, without assuming elemental independence within a network. It differs from AHP, in that it can consider interactions between elements as a network, rather than just hierarchically. The ANP has been applied in a multitude of situations and for a variety of applications including; forest management (Wolfslehner & Vacik, 2011; Ghajar & Najafi, 2012) and environmental management (Grošelj & Stirn, 2015).

The consideration of elemental dependence makes ANP an ideal tool for the analysis developed for the 3rd SHW. The ANP also requires quantification of elemental interactions, which considering the relationships (and their weights) formulated in FCMs, makes ANP analysis suited for application to FCMs. ANP also requires the development, or definition of factors that are to be analysed and in turn prioritised. The development of these factors is fundamental to the ANP, as they are compared with respect to their impact upon the network and the network's impact

upon them, prioritising their respective importance to the network. These factors or 'Alternatives' can be elements already present within the network, or they can be added. This development of alternatives further demonstrates the suitability of the ANP for the local analysis, as these alternatives can be policy options for biodiversity conservation and climate change mitigation, derived from the positive future scenario maps. The ANP was therefore selected for option selection and prioritisation from networks developed in the future Fuzzy Cognitive Maps (Varela-Ortega et al., 2014a).

In selecting the options (alternatives) to be applied to the FCMs, a number of potential means of selection were considered. However, from the maps it was quite clear that if some factors were addressed, it would improve the system greatly. Therefore, it was decided that factors which stakeholders had identified as drivers in the maps, could be addressed with potential options to reinforce their impacts. Therefore, options were selected based upon their applicability to drivers within the map. As such, within the positive future scenario FCMs of Bolivia and Brazil, options which addressed drivers were added to the maps (Figures 7 and 15) and relationships were developed uniquely between these options and the respective driver they were designed to address.

Following the selection of options, quantification of their respective influence on or importance to the network was modelled, to prioritise their respective importance. To model this, and as a fundamental part of the ANP, an extensive series of pairwise comparisons (similar to AHP) was performed between elements (factors) within the network (map), with respect to a third control element. These comparisons were made only for those elements demonstrated to be related, in using a FCM, translation of relationships between factors in the map are applied to elements within the derived network. Further, and as part of the ANP, all elements should be related to the alternatives (options) to prioritise them.

The pairwise comparisons quantify the relative influence of a control element, with respect to two compared elements, or the influence of the two elements with respect to the control. As suggested there are two comparisons that can be made 1) to identify which of the two elements is most greatly affected by the control and 2) which of the two elements most greatly affects the control element. To simplify, consider the following two examples, "With respect to element 3, which of element 1 and 2 are most greatly affected by it?" Or, "With respect to element 3, which of elements 1 and 2 most greatly affect it?" This duplicity highlights one of the strengths of the ANP, in that it permits multi-directional relationship analysis. In both cases, a user has to manually quantify the relative scale of impact of the elements with respect to the control.

This process of quantification can be difficult, and requires considerable user input based upon expert judgement or previous knowledge. In applying the ANP to the FCMs, pair-wise comparisons can be made based upon the relationships and weights of relationships as developed by stakeholders within the FCM. Importantly, consideration can also be made of both the direct and indirect relationships demonstrated in the FCMs, inclusion of these indirect relationships is important to demonstrate the potentially important, yet dispersed impact of not only the options, but also other elements within a network.

To quantify the relationships and perform the pairwise comparisons, the 'relationship pathways' evident in the FCMs were used. Figure 6 shows an example of such a pathway, as well as highlighting how these pairwise comparisons can be made. Figure 6 shows that the influence of element 3 on element 1 is 0.80, whereas on element 2, it passes through two other elements, therefore we quantify the relationship as 0.32 (calculated from (0.9*0.7)*0.5).

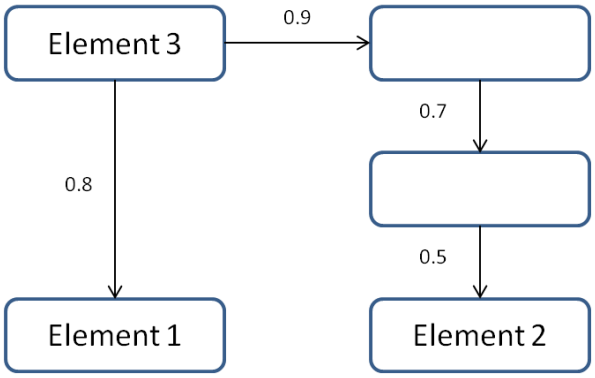


Figure 6. A stylised example of relationships taken from a FCM, and highlighting how pairwise comparisons can be made from such relationships.

To then quantify the impact of element 3 on elements 1 and 2, the relationships are normalised resulting in the normalised comparative affect of element 3 on 1 being 0.72 and on 2 being 0.28, which is used in the pairwise comparison. This is repeated for all the relationships within the FCM, and based upon these; the ANP calculates and derives the relative priorities of the options with respect to the network. To facilitate the ANP and the speed of the analysis, the ANP based program Super Decisions (Super Decisions, 2013) was used in the analysis process.

4.3.2 Stakeholder Option Selection and Characterisation

Stakeholders were also invited to select their own options, beyond those selected from the good-life and desired future scenarios. In the 3rd stakeholder workshops for Ascensión de Guarayos (Bolivia) and Flona Tapajós (Brazil) stakeholders were asked to select options which they felt would integrate biodiversity in climate change mitigation and improve the future situation in the region.

Following the option selection processes, stakeholders were invited to characterise each of the options, both those developed from the FCMs and those developed by themselves during the workshop. As part of this characterisation process stakeholders were asked to characterise the options based upon the following 7 criteria;

1. Who will benefit from its implementation?
2. Which groups should be responsible for its implementation?
3. When should it be implemented?
4. What level of financial resources does it require?
5. Is it compatible with present laws, policies and programmes?
6. Does it require technical assistance?
7. What level of social acceptance would it have?

As part of this process, stakeholders were asked to complete a form where (Bolivia: Annex 9.1.2.2 and Brazil: Annex 9.1.3.2) they responded to each of these 7 questions for each option that they were assigned. Following this a discussion period was provided to allow stakeholders to characterise each option as a group, with all participants invited to talk and share their opinions.

4.3.3 Option Voting and Prioritisation for biodiversity conservation

Following characterisation, stakeholders were then invited to vote on which of the options they felt would best respond to the following criteria;

1. Socio-economically (which option delivers the most social and/ or economic benefits?)
2. Environmentally (which option has the most positive impact environmentally?)
3. Ease of implementation (which option is easiest to apply in terms of cost, application with other laws, necessity for technology and social acceptance?)

As part of this process stakeholders in both workshops were presented with a table in (Annex 9.1.2.3 in Bolivia and the table in Annex 9.1.3.3) which to vote. In the voting, stakeholders were given the option to vote three times within each criterion; with stakeholders voting on the option which they felt most appropriately fulfilled each criteria on a scale of a 3 (high importance), a 2 (moderate importance) for the next option and a 1 (less importance) for the final option. Therefore, each stakeholder had to vote 9 times (3 times in each criterion) but could not give all their votes to the same option within the same criteria. Further, and unbeknown to the stakeholders, stakeholders were identified using different coloured stickers (based upon their group: technician, local community group, scientist or politician) allowing for differential group analysis to be made of the voting. The total votes were tallied and priorities were developed from these tallies.

4.4 3rd Bolivian Stakeholder Workshop

4.4.1 Objectives of the Workshop

The objectives of this workshop were for participants to select, characterise and prioritise their own policy options, which they considered would integrate biodiversity in climate change mitigation and would result in the future envisaged in the 'good life' FCM.

The workshop was held on the 1st of July 2015, in Santa Cruz, Bolivia and was attended by 33 stakeholders from a range of different interest groups including policy makers, academic researchers, local indigenous communities, farmers and foresters. The interest groups represented a variety of institutes including; The Forest and Land Administration (ABT) Gabriel René Moreno Autonomous University, Noel Kempff Mercado Natural History Museum, Food

and Agricultural Organisation (FAO), Local Government (Guarayos Mayoral Office) and indigenous groups (TCO).

As part of the workshop participating stakeholders were briefly introduced to the ROBIN project, along with some of the general results derived from the project relating to climate variation and land use change. Further, attendees were given a re-cap of the previous two workshops' results, as well as the other work being developed in WP3.1 (presented within this deliverable).

4.4.2 Application of ANP to FCMs and deriving Policy Options

The policy options selected and as previously mentioned were formulated in response to a number of the drivers found within the 'good life' future FCM (Varela-Ortega et al., 2014a). Deriving the options directly from the FCM and the stakeholder discussions that went into the development of the FCM, continued the participatory nature of the analysis and ensured that the options were entirely stakeholder derived, using the opinions and visions expressed within the map. In total, 6 options were selected and applied to the 'good-life' map (Figure 7), and incorporated in the ANP. These options include:

1. **Compliance with Laws to Control Production Activities:** This was selected in response to the desire for a control in commercial agricultural expansion, illegal mining and controlled hunting and fishing.

2. **Facilitation of Access to Credit:** This was selected to improve family benefits and income, with the knock of positive effect of reducing poverty.

3. **Institutional and Policy Coordination:** This option was selected to address the desire for adequate institutional coordination and the resultant positive effects this would have upon the system.

4. **Programmes to Assist Subsistence Farmers:** This option was selected from the desire to protect subsistence farming and the positive effects of reducing poverty, whilst improving sustainable agriculture.

5. **Reforestation Programmes:** This option was selected to encourage forest plantations, and encourage the knock on beneficial effects relating to the sustainable use of forests.

6. **Technical Training:** This option was selected to address the necessity for technical capacity and the wide-scale positive effects that this would have.

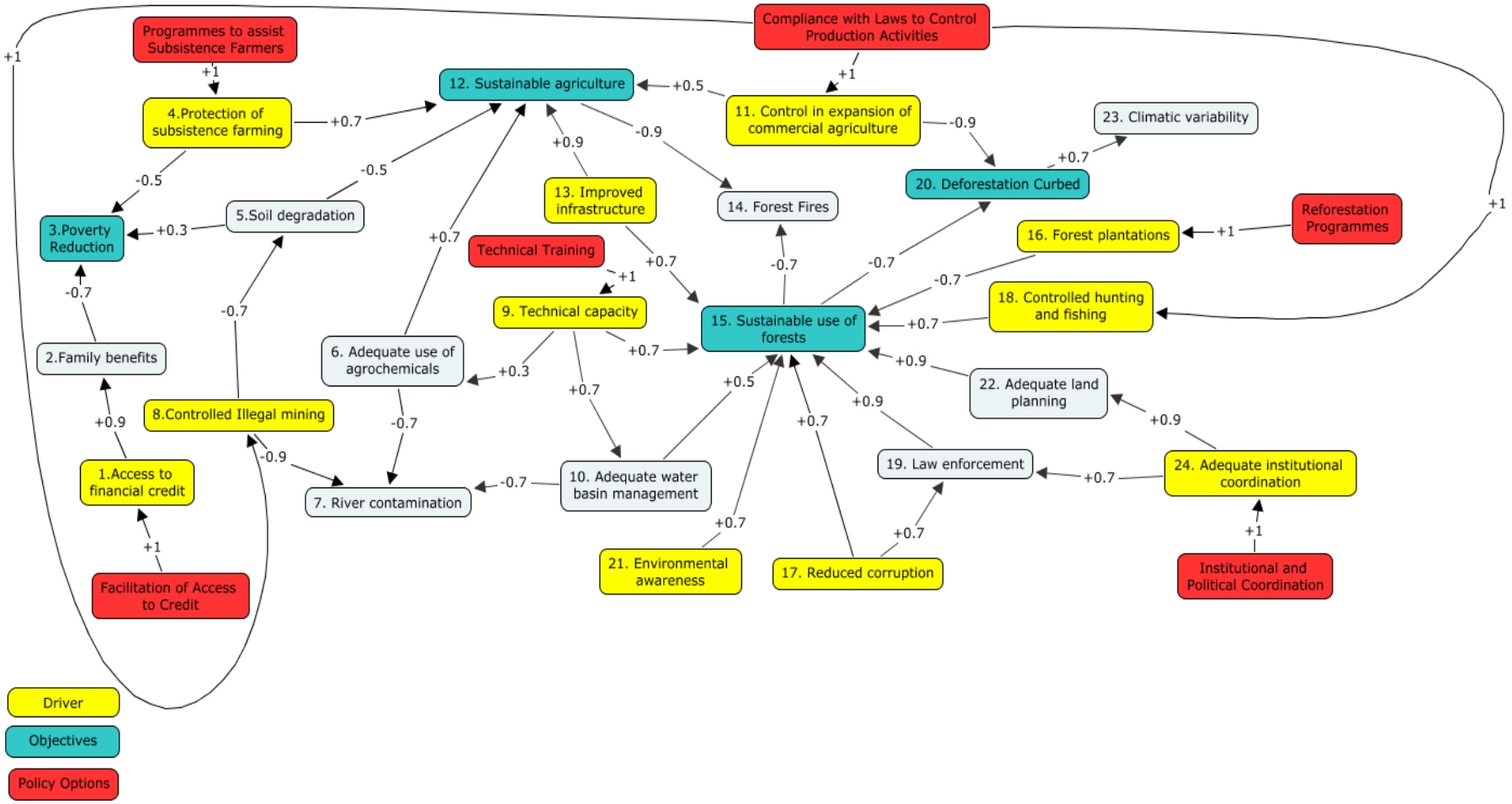


Figure 7. Fuzzy Cognitive Map of the 'good life' scenario in Ascensión de Guarayos, with the policy options and objectives of the ANP highlighted.

Following the integration of these 6 options to the FCM, and the translation of this map to a network (Figure 8) incorporated into Super-Decisions, the pairwise comparisons between all the related factors were calculated and the ANP formulated the relative importance of the 6 options, with respect to the network (Figure 9).

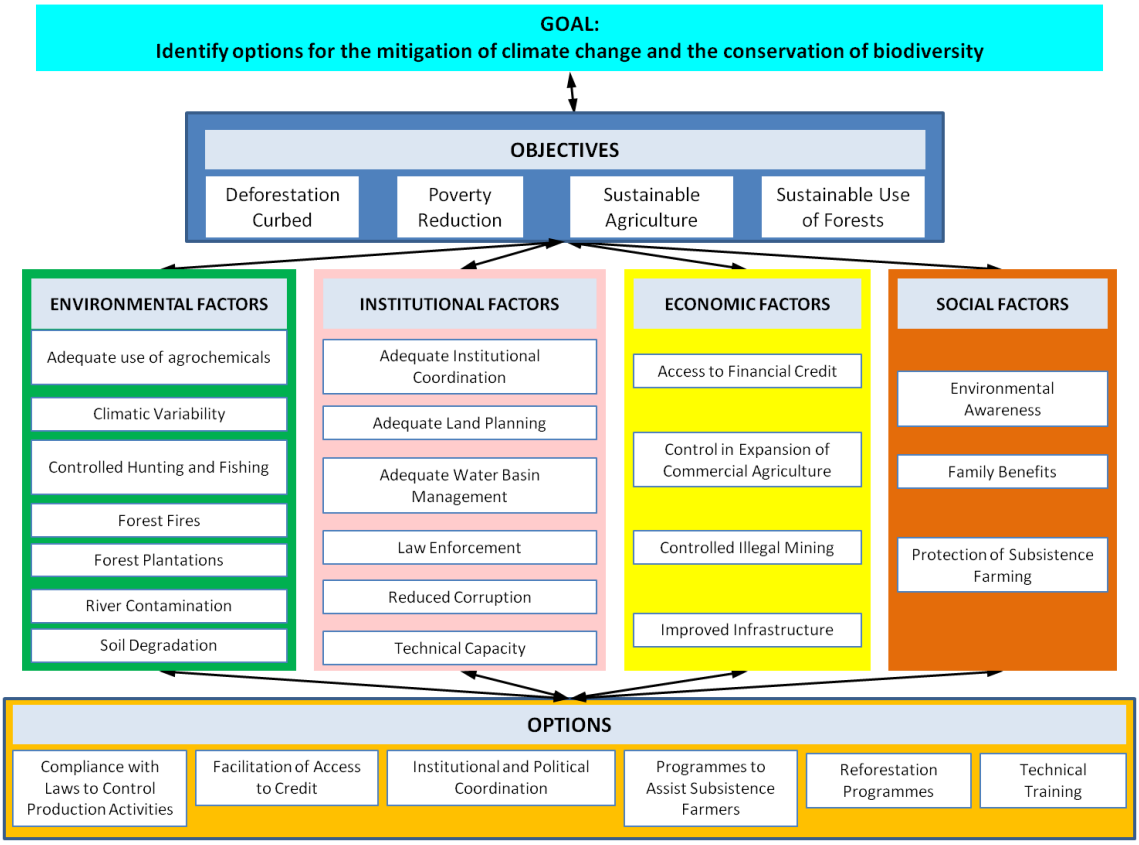


Figure 8. The FCM from Figure 8 translated into a schematic network that can be used in the Analytic Network Process, using Super-Decisions.

The ANP prioritised: 1) Compliance with Laws to Control Production Activities, 2) Technical Training and 3) Institutional and Political Coordination (Figure 9). These results demonstrate that, purely from perspective of the network described in the FCM that, greater compliance with laws designed to control production activities would be the most effective in bringing about this 'good-life' future.

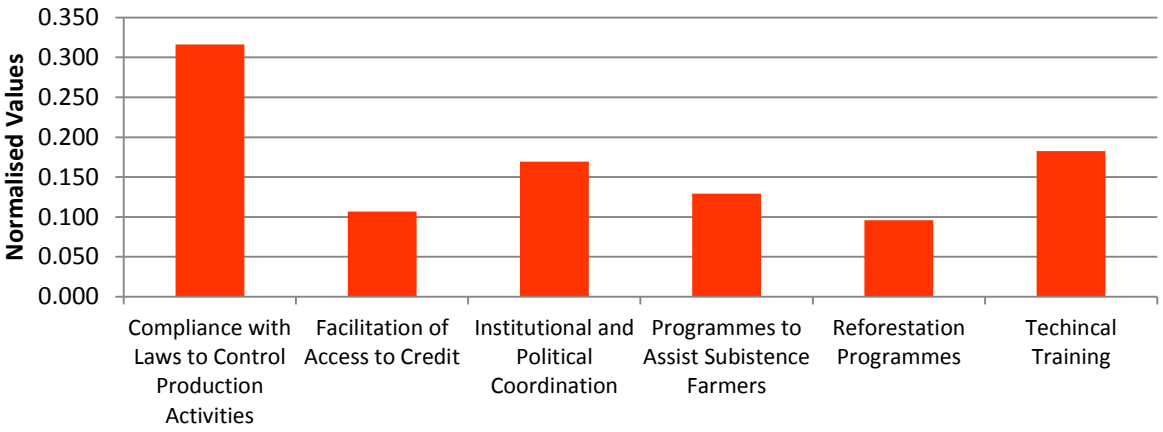


Figure 9. Relative importance of the proposed options with respect to the 'good life' scenario.

4.4.3 Participatory selection, characterisation and voting of policy options

4.4.3.1 Option Selection

Following the introduction of the previous maps developed for the region, participants were introduced to the ANP process, and the process for prioritisation of options for the maintenance of biodiversity and mitigating climate change in the region. As part of this section, stakeholders were introduced to the options selected from the future 'good life' FCM (developed previously) and the prioritisation of the options using ANP. Stakeholders were shown that these options were selected directly from the FCM. Therefore, they were considered validated by stakeholders due to their direct development from stakeholder opinion and perceptions. However, stakeholders were still introduced to the options and appeared to widely agree with the options selected. Following extensive discussions, stakeholders selected 6 novel policy options including:

1. Improving the implementation of land use and building up a database
2. Monitoring program to determine the potential value of natural resources
3. Enhancing the focus of green municipalities
4. Definition of property rights to avoid land trafficking
5. Support for the organisational structure of the Guarayos
6. Diversity in income to reduce poverty

Along with the 6 options selected from the future 'good life' FCM (developed in the 2nd SHW):

1. Compliance with Laws to Control Production Activities
2. Facilitation of Access to Credit
3. Institutional and Political Coordination
4. Programmes to Assist Subsistence Farmers
5. Reforestation Programmes
6. Technical Training

4.4.3.2 Characterisation of Options

Following the discussion and selection of these 6 policy options, the stakeholders were split into two groups, and were invited to characterise the options selected directly from the FCM and those which they had selected themselves earlier.

The full characterisation of the 12 options is available in Tables 2 and 3, during the process of characterisation there was considerable debate and discussion concerning each characteristic. In particular, participants discussed in both groups concerning the economics of these potential policy options, in terms of how finances could be most efficiently sourced and directed.

From the characterisation, a number of patterns can be discerned; firstly it is clear that participants believed that all options could become operational within 4 years and that the majority should be implemented immediately. Secondly, all of the options characterised were considered wholly compatible with present Bolivian legislation, which would suggest a relative ease of development and implementation. Thirdly, the majority of these options were considered to have a high level of social acceptance, with only two of the twelve characterised as being moderately acceptable from a social perspective. This point is particularly interesting, considering that these 12 highly diverse options, characterised by a diverse group of stakeholders are largely considered to be socially acceptable. This would suggest that there is quite a considerable public desire for social, political and economic changes in the future.

However, consideration must be made of one of the most telling characteristics, from a policy maker's perspective, the cost of the implementation. Of the 12 options, 8 were considered to require high or very high financial support for their implementation, with a further 3 considered to have moderate costs and only one (Definition of Property Rights to Avoid Land Trafficking) to have low. This would clearly be considered by a policy maker in their decision making process in order to implement such options. However, due to the considered high level of social acceptance, this may outweigh the short-term and long-term costs of such development and implementation.

Those groups considered important for the implementation of these options appear to be generally similar, with governmental bodies, civil society groups, private institutions and research institutions mentioned. For the majority of the options, local scale government bodies are repeatedly identified as vital, which would suggest the perceived importance of their participation in such option development and implementation.

Briefly comparing the characterisation of the options developed from the good life future FCM, and those developed within the workshop, there appears to be very little, if any, discernible differences in terms of their characterisation.

Table 2. Characterisation of the options developed by Group 1 during the 3rd Bolivian stakeholder workshop.

Options	Who will benefit from its implementation?	Who should be responsible for its implementation?	When should it be implemented ?	What level of financial resources does it require?	Is it compatible with present laws, policies and programmes?	Does it require technical assistance?	What level of social acceptance would it have?
Compliance with Laws to Control Production Activities	Indigenous people, rural communities (campesinos), farmers, cattle ranchers, (small and medium) and stakeholders from the forestry sector.	ABT (Land and Forest Authority), INRA (National Institute for Agrarian Reform), COPNAG (Centre for Native Guarayo Villages), Municipal and departmental governments, federation of rural workers	Short term, urgent! 1 year (planning period) and medium term (2 to 4 years for implementation)	Very High (Urgent need to secure funding for implementation)	Yes	Institutional support for municipalities, which would be the stakeholder in charge of the implementation. Advising and capacity building continues.	High
Facilitation of Access to Credit	Local communities, farmers and forestry sector	Finance entities, the government, cooperatives, international assistance	Based on medium-term potential (2-4 years old)	Moderate/ High	Yes	Property rights, planning to identify benefits. Strengthening organizational and administrative (accounting). Legal advice.	Moderate
Programs to Assist Subsistence farmers	Subsistence farmers and cooperatives	Municipalities (local development program), EMAPA (Business for Assisting Food Production), INIAF (National Institute for Agricultural and Forestry Innovation), CIAT (International Centre for Tropical Agriculture)	Immediately	Moderate/ High	Yes	Capacity building, technological transfers, participatory investigations, diversity in production	Very High

Options	Who will benefit from its implementation?	Who should be responsible for its implementation?	When should it be implemented ?	What level of financial resources does it require?	Is it compatible with present laws, policies and programmes?	Does it require technical assistance?	What level of social acceptance would it have?
Improving the implementation of land use and building up a database	Society in general	Municipalities, departmental government, ABT (Land and Forest Authority), INRA (National Institute for Agrarian Reform), local communities, peasant farmer organisations	Immediately	Very High	Yes	Improve legislation, Update biophysical and socioeconomic information, diffusion of information, democratisation of knowledge	High
Enhancing the focus of green municipalities	The municipality in general	All municipal stakeholder groups (municipal authorities, mayor, municipal council)	Immediately	Very High	Yes	Incorporate the municipal charter. Workshop for participation. Training. Specific regulations. Upgrade municipal development plan.	Very High
Support for the organisational structure of the Guarayos.	Community and regional organizations, CEMIG (Indigenous Guarayo Women's Group), COPNAG (Centre for Native Guarayo Villages)	National, department and municipal governments, technical institutions (NGOs), AFIN(Association of Indigenous Forestry Organisations)	Immediately	High	Yes	Organisational development, capacity building, management of finances and administration. Multi-disciplinary and inter-institutional team strengthening	Very High

Table 3. Characterisation of the options developed by Group 2 during the 3rd Bolivian stakeholder workshop

Options	Who will benefit from its implementation?	Who should be responsible for its implementation?	When should it be implemented ?	What level of financial resources does it require?	Is it compatible with present laws, policies and programmes?	Does it require technical assistance?	What level of social acceptance would it have?
Technical Training	Small and medium producers. Large scale producers (with intensification of land use).	Municipality, COPNAG(Centre for Native Guarayo Villages), CIAT (International centre for tropical agriculture), FCA (Faculty for Agricultural Sciences) (INIAF(National Institute for Agricultural and Forestry Innovation), FEDTCG (Federation for Countryside Workers of Guarayos)	Immediately	High	Yes	New technologies (cusi: native palm whose oil is prized for cosmetics, biodiesel), Integrated production systems, democratisation of knowledge, processing factories	High
Institutional and Political Coordination	Municipality, national and departmental governments	Mayor, municipal council, state government, social organisations	Immediately	Moderate	Yes	Training capacity building of knowledge (laws, management institutes)	High
Reforestation Programmes	Ministry of the Environment, Municipality (UDP: Productive development unit), Farmers	INIAF, ABT (Land and Forest Authority), UAGRM (Gabriel René Moreno Autonomous University), APMT (Mother Earth Authority), FONABOSQUE (National Fund for Forestry Development)	Immediately	High	Yes	Zoning (topoclimatic , species). Silvicultural treatments, planting and nursery management .	Very High
Monitoring program to	Municipality, Farmers, TCO (Communal Lands)	Municipality, government, CIAT (International centre	Medium term	High	Yes	Availability and organisation of information(systems/	

Options	Who will benefit from its implementation?	Who should be responsible for its implementation?	When should it be implemented ?	What level of financial resources does it require?	Is it compatible with present laws, policies and programmes?	Does it require technical assistance?	What level of social acceptance would it have?
determine the potential value of natural resources		for tropical agriculture), UAGRM (Gabriel René Moreno Autonomous University), ABT (Land and Forestry Authority), APMT (Mother Earth Authority)				databases), capacity building of human resources	Moderate
Definition of property rights to avoid land trafficking	TCO (Communal Lands), rural peoples and intercultural communities (new colonists from highlands)	Municipality, Public Ministry, MDRyT (Ministry of Rural and Land Development), INRA (National Institute for Agrarian Reform)	Immediately	Low	Yes	Environmental and socio-cultural capacity building	Very High
Diversity in incomes to reduce poverty	Small and medium farmers	Municipal and state governments, CIAT (International centre for tropical agriculture), MDRyt (Ministry of Rural and Land Development), INIAF (Institute of Agricultural and Forest Innovation), Government seed company,	Immediately	High	Yes	New technology, capacity building of human resources. Diversified productive systems. Cost-benefit análisis. Integrated management (soil and wáter)	High

4.4.3.3 Voting of Options and Development of Prioritisation

Following this group characterisation work, the two groups were brought back together, where the characterisation processes could be presented to the other group. To conclude the workshop each participant was invited to vote on the options, which they felt would be best socio-economically, environmentally and for ease of application.

Figures 10- 14 demonstrate the results of the voting performed during the workshop, they represent the proportional total of votes given to each option, using the sum of the three criteria. From the workshop total (Figure 14) the result of the voting offers one clearly preferred and two further preferential options:

1. Technical Training
2. Programmes to Assist Subsistence Farmers
3. Improving the implementation of land use and building up a database

The results of the voting have been broken down into the four different represented stakeholder groups (Figures 10-13) and a workshop total (Figures 14). Reviewing these figures, a number of general patterns can be noted; **firstly** that technical training was unanimously voted as the most important option. **Secondly,** that the votes given by scientists and local community members follow similar patterns. **Thirdly,** that votes given by the politicians deviate from the pattern of the other three groups, with almost half of the options not receiving votes.

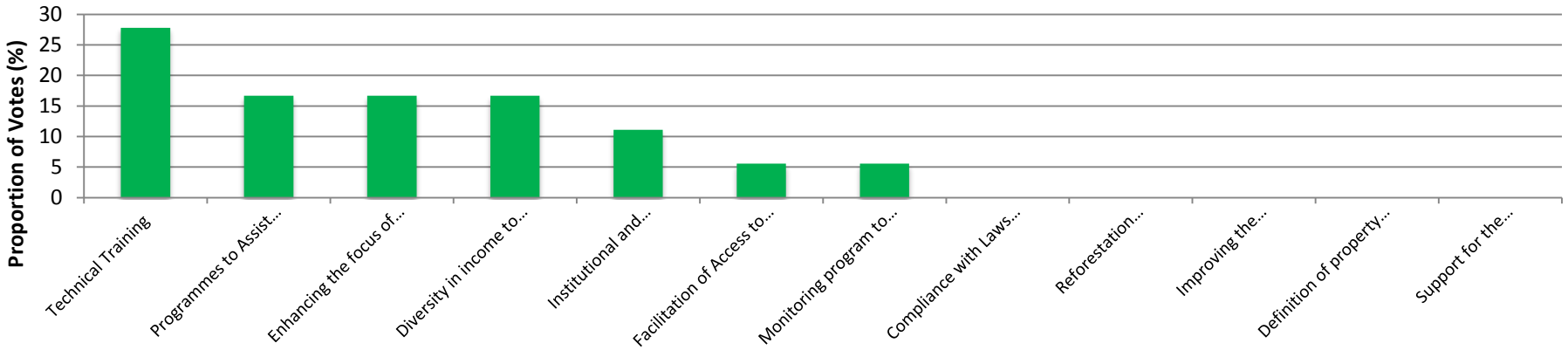


Figure 10. Results developed from the votes given by politicians during final workshop in Bolivia. Bars represent the proportional value of votes given to each of the twelve options.

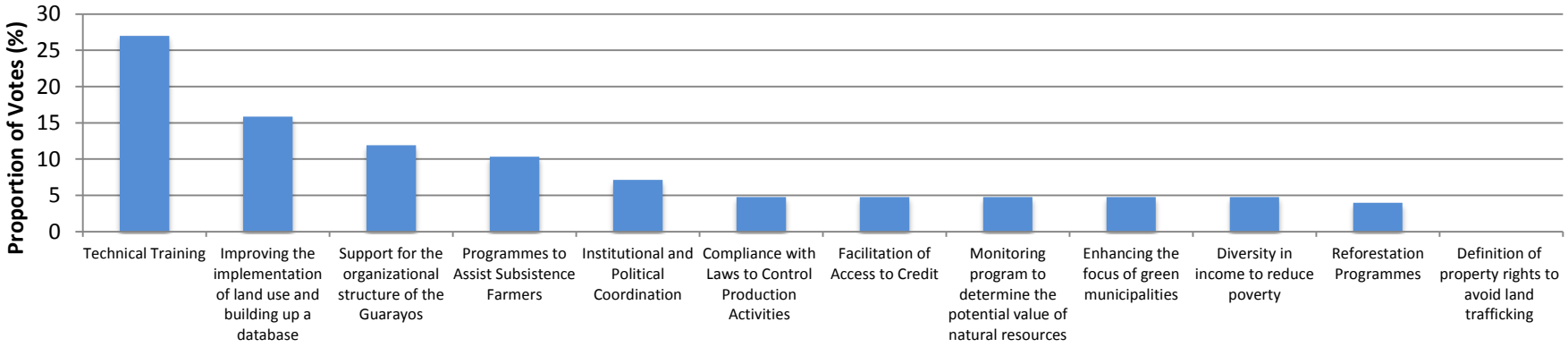


Figure 11. Results developed from the votes given by scientists during final workshop in Bolivia. Bars represent the proportional value of votes given to each of the twelve options.

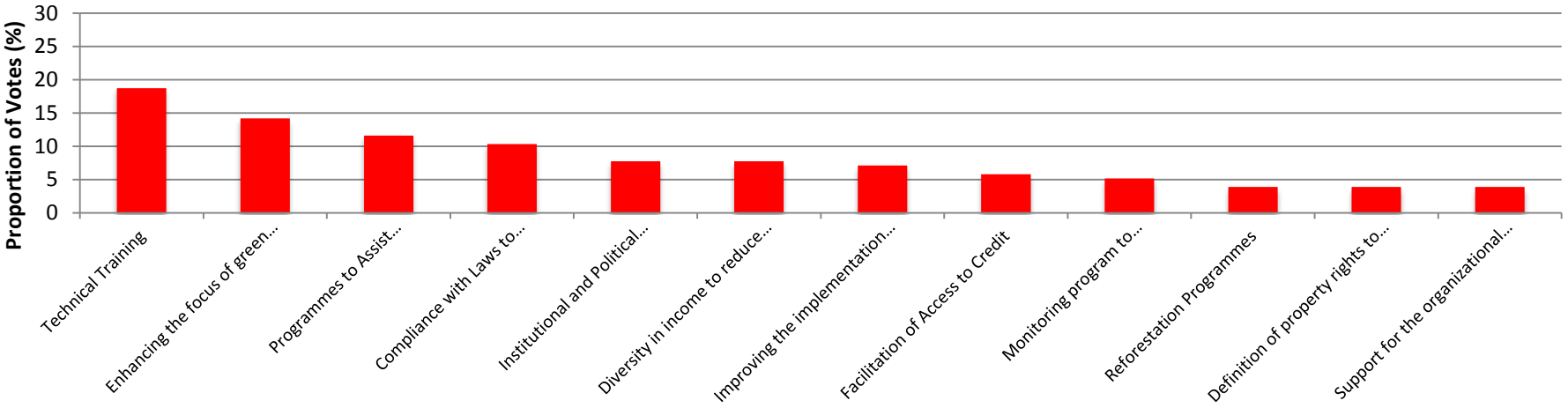


Figure 12. Results developed from votes given by technicians during final workshop in Bolivia. Bars show the proportional value of votes given to each of the twelve options.

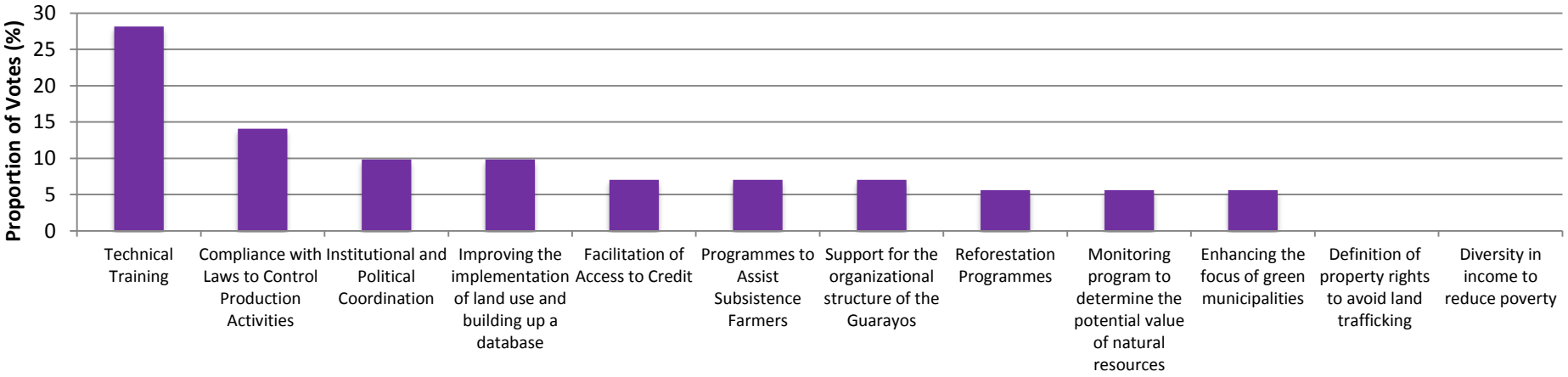


Figure 13. Results developed from the votes given by local community members during final workshop in Bolivia. Bars represent the proportional value of votes given to each of the twelve options.

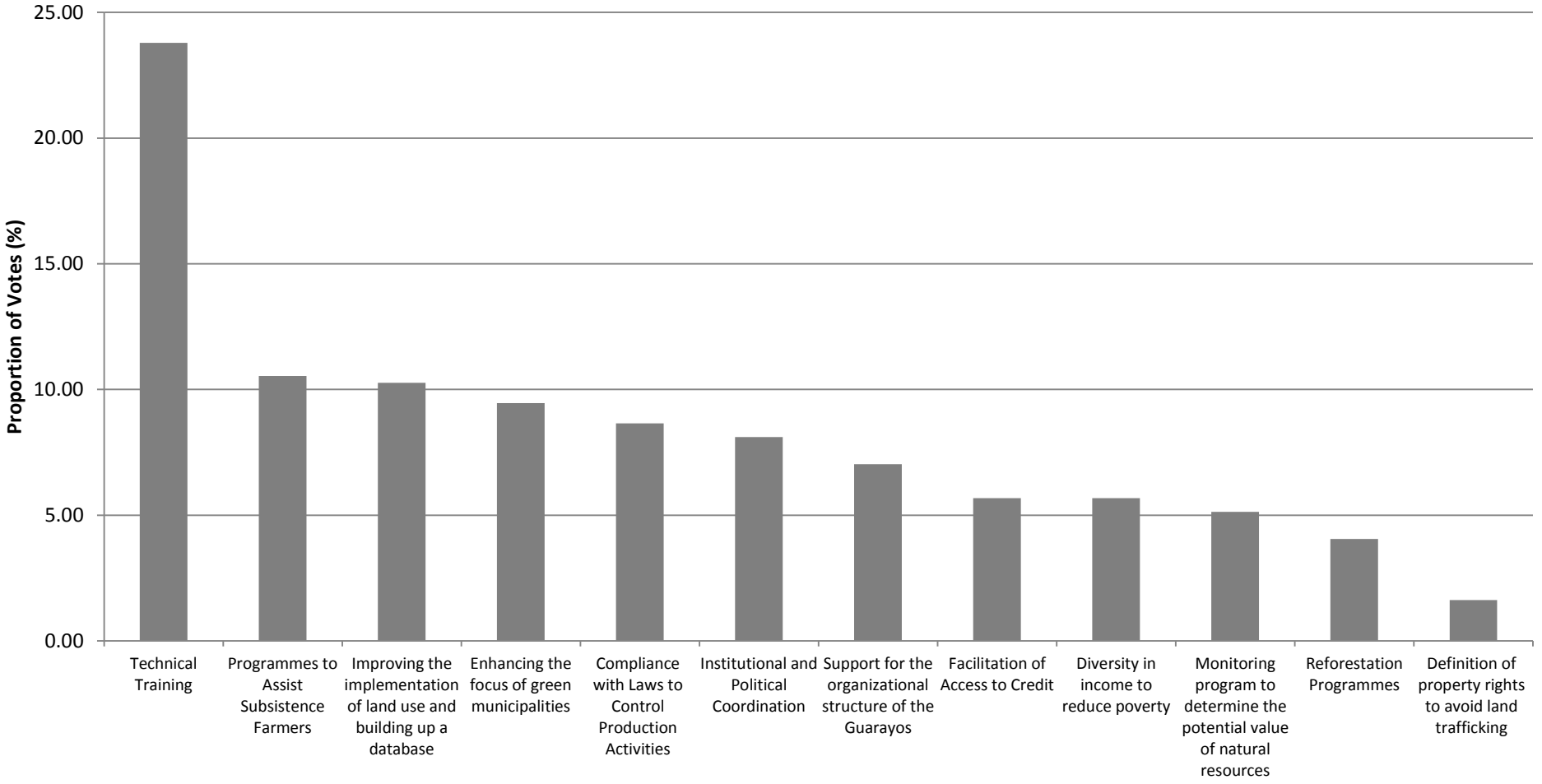


Figure 14. Results developed from the votes given by all workshop participants during final workshop in Bolivia. Bars represent the proportional value of votes given to each of the twelve options and represent the sum outcome of the workshop.

From Table 4, and continuing the three previous points, there appears to be a cluster of 3/4 options, which were considered to be the most viable by participants. The most preferred option (Technical Training) is obvious, however beyond this there are the following three which are repeatedly ranked by the different groups within the top three:

- Programmes to assist subsistence farmers
- Improving the implementation of land use and building up a database
- Enhancing the focus of green municipalities

These factors focus upon the necessity for improvements in technical capacity and training, as per the most favoured option. Further, the inclusion of 'Programmes to Assist Subsistence Farmers' demonstrates the consideration by politicians and technicians alike of the fundamental importance of socially directed options. It is curious however, that this option was not considered to be one of the three most important options by the local community members, they considered that policy based options would result in the desired outcome, with their election of 'Compliance with Laws to Control Production Activities' and 'Improving the implementation of land use and building up a database'. Overall, the outcomes of the voting from the workshop in general result in a diverse group of options that are directed at multiple sectors; technological, social and legislative (Technical Training, Programmes to Assist Subsistence Farmers and Improved Application of Land Management).

Table 4. Results of the voting session from the final workshop in Bolivia. The top three options voted for by the four stakeholder groups and the stakeholder total are shown.

	Stakeholder Group				Workshop
Rank	**Politician**	**Scientist**	**Technician**	**Local Community**	**Workshop Total**
1	Technical Training	Technical Training	Technical Training	Technical Training	Technical Training
2	Programmes to Assist Subsistence Farmers Enhancing the Focus of Green Municipalities Diversity in income to reduce poverty	Improving the implementation of land use and building up a database	Enhancing the focus of green municipalities	Compliance with Laws to Control Production Activities	Programmes to Assist Subsistence Farmers
3		Support for the Organisational Structure of the Guarayos	Programmes to Assist Subsistence Farmers	Improving the implementation of land use and building up a database	Improving the implementation of land use and building up a database

That Technical Training was selected as the most important, is perhaps unsurprising as the provision of technical training was developed from the results from 'good-life' FCM (Figure 7) and supported by the discussions from the workshop that considered the present situation (Varela-Ortega et al., 2014a). The outcomes of this voting confirms a number of factors, firstly, that despite the individuals being largely distinct from one workshop to another, the interpretation of the situation within the region is largely the same. Secondly, that the finding of the 'Technical Training' option being unanimously voted as the most important begs the question (and offers a good means of further investigation), as to what this technical training would entail and what technical abilities are missing. From the characterisation of the options (Tables 2 and 3) there are repeated mentions of the necessity for capacity development of various sorts, highlighting that it is not necessarily a lack of capacity in one field of expertise or sector but many, requiring considerable training.

Further considering the characterisation, it can be noted that the implementation of Technical Training would achieve extremely high levels of social acceptance. Further solidifying its importance, stakeholders consider that it should be implemented immediately demonstrating the perceived necessity of it not only for the future but for the present and importantly, it is very compatible with the present legislative landscape of Bolivia. However, and demonstrating the scale of difficulty associated with the implementation of such an option, it would require high levels of financial investment, most likely over an extensive period. Therefore, despite its potentially huge social acceptance, it could run into considerable opposition.

Finally, it is interesting to note the difference in results from Figure 9, showing the results gained from the ANP process, with those of the voting process (Figure 14). The most important option derived from the ANP was the Compliance with Laws to Control Production Activities, whereas this factor was voted the fifth most important option by stakeholders. It is curious that this option should be considered so relatively unimportant by participants when voting, whilst using stakeholder interpretations from the FCM, results in it being number one.

4.5 3rd Brazilian Stakeholder Workshop

4.5.1 Objectives of Workshop

The objectives of this workshop were two-fold; firstly it was used as means for validating the maps developed previously for the present and the desired future FCMs (Varela-Ortega et al., 2014a). Secondly, participants were offered the opportunity to discuss, select, characterise and prioritise their own policy options, which they considered would support biodiversity integration to climate change mitigation and would result in the future envisaged in the 'desired' FCM.

The workshop was held on the 3rd of August 2015, in Belem, Brazil and was attended by 39 stakeholders from over 20 different interest groups including; policymakers, educational and research institutions, representatives from local community groups, local NGOs, as well as rural businesses. The interest groups represented a variety of institutes including amongst others; The Nature Conservancy (TNC), Agricultural Protection Agency of Para (ADEPARA), The Maguary Community, The Institute of Social Ecology, The Institute for Environmental Protection of the Amazon (IPAAM), Santarem's Municipal Environmental Department (SEMMA), The Ministry of Agriculture, Livestock and Supply (MAPA), and Luiz de Queiroz College of Agriculture (ESALQ-USP).

As part of the workshop participating stakeholders were allowed to introduce themselves, and the institutions they represent. Following this, attendees were briefly introduced to the ROBIN project, where the importance of the Amazon from a global perspective was demonstrated in the context of climate change and biodiversity conservation. A further presentation addressed the findings and work of ROBIN, highlighting the multi-scalar nature of the work (local-national) and the methodologies applied for the development of this work. As part of this presentation, the attendees were introduced to the local perceptions of land use change and socio-economic development in the local area, as captured within the Fuzzy Cognitive Maps developed in the first and second stakeholder workshops (Varela-Ortega et al., 2014a).

Continuing the interactive and stakeholder orientated basis of Work Package 3.1, stakeholders were invited to validate the maps previously developed, and offering their opinion on whether they believed they fully represented the present and potential future situation in the region.

4.5.2 Validation of Present and Future FCMs

Participants were presented with the maps developed in the 1st and 2nd workshop in Brazil (Varela-Ortega, et al., 2014a) and were given 30 minutes to review the maps. Following this, participants were invited to give their opinions and whether they believed that they reflected both the present state of the region, but also the situation desired in the future scenario.

Present

From the introduction of the maps a lively debate ensued where a number of participants were particularly animated about the contents of the present map. Although participants widely considered that it reflected the reality of the present situation in the region, there were a number of comments and suggestions for improvements.

Firstly, that illegal hunting was not included within the map. Participants mentioned that as it is so widely practiced in protected areas by inhabitants, it should be reflected in the map due to its importance for biodiversity loss. Further, a number of participants mentioned that it should include forest degradation, as it was considered to be as problematic in the region as deforestation. This point was supported by the suggestion that as international projects such as REDD+ have incorporated the concept of degradation within their development. This point was reiterated with the fact that there is wide-scale legalised deforestation, which has been permitted by the government. Finally, a lack of consideration of infrastructure was also considered an important omission of the map, as it is causing considerable deforestation due to soy production expansion and hydroelectric dams within the region. Coupled to this, the expansion of urban areas into protected areas was also mentioned as a potential addition.

Future 'Desired' Scenario

Considering the map developed for the 'desired' future scenario, there was also widespread agreement that this map reflected what stakeholders wanted to see in such a future. However, a number of suggestions were made that could have been incorporated within the map. One point suggested was that there should have been a factor that considered environmental services and natural capital, and beyond this that economic valuations of protected areas should be formulated. A further suggestion was that there should be some inclusion of oversight of practices and environmental policing to protect these services and the natural capital that they encapsulate. Finally, consideration should have been made for the quality and maintenance of water within the region, which arguably could be encompassed within the environmental services factor.

Overall, stakeholders stated openly that they felt both maps accurately reflected the present situation and the desired future. Despite the suggestion of the previously mentioned factors there appeared to be unanimous approval of the maps.

4.5.3 Application of ANP to FCMs and deriving Policy Options

Prior to this workshop, and as previously mentioned a process of policy option selection was formulated, and prioritisation was made using the ANP. The policy options selected were formulated in response to a number of the drivers found within the 'desired' future FCM (Varela-Ortega et al., 2014a). Deriving the options directly from the FCM and the stakeholder discussions that went into the development of the FCM, continued the SH based analysis and ensured that

the options were entirely SH based, using the opinions and visions expressed within the map. In total, 6 options were selected and applied to the 'desired' map (Figure 15), and incorporated in the ANP. These options include:

1. **Development of Technical Capacity.** This option was developed to address the necessity for technical assistance in the desired scenario FCM and its positive knock-on effects in the local communities.

2. **Governmental Coordination.** This was formulated with goal of improving the articulation of and between governmental bodies.

3. **Investment in Health and Education.** This option was formulated to encourage increased expenditures in health and education and the positive effects that these would have upon both the political and development sectors**.**

4. **Programmes to Aid Integration of Agricultural and Forestry Activities.** This option was designed in order to respond to the necessity for management programmes and strategies for sustainable development.

5. **Programmes to Develop Environmental Awareness.** This option follows the investment option, with similar aims of improving social standing and understanding of the environment and to capitalise on the beneficial impacts of such improved conscientiousness would have.

6. **Support for Social Participation in Policy Development.** Like option 3 and 5, this is directed and social mobility and participation in the actions that affect them.

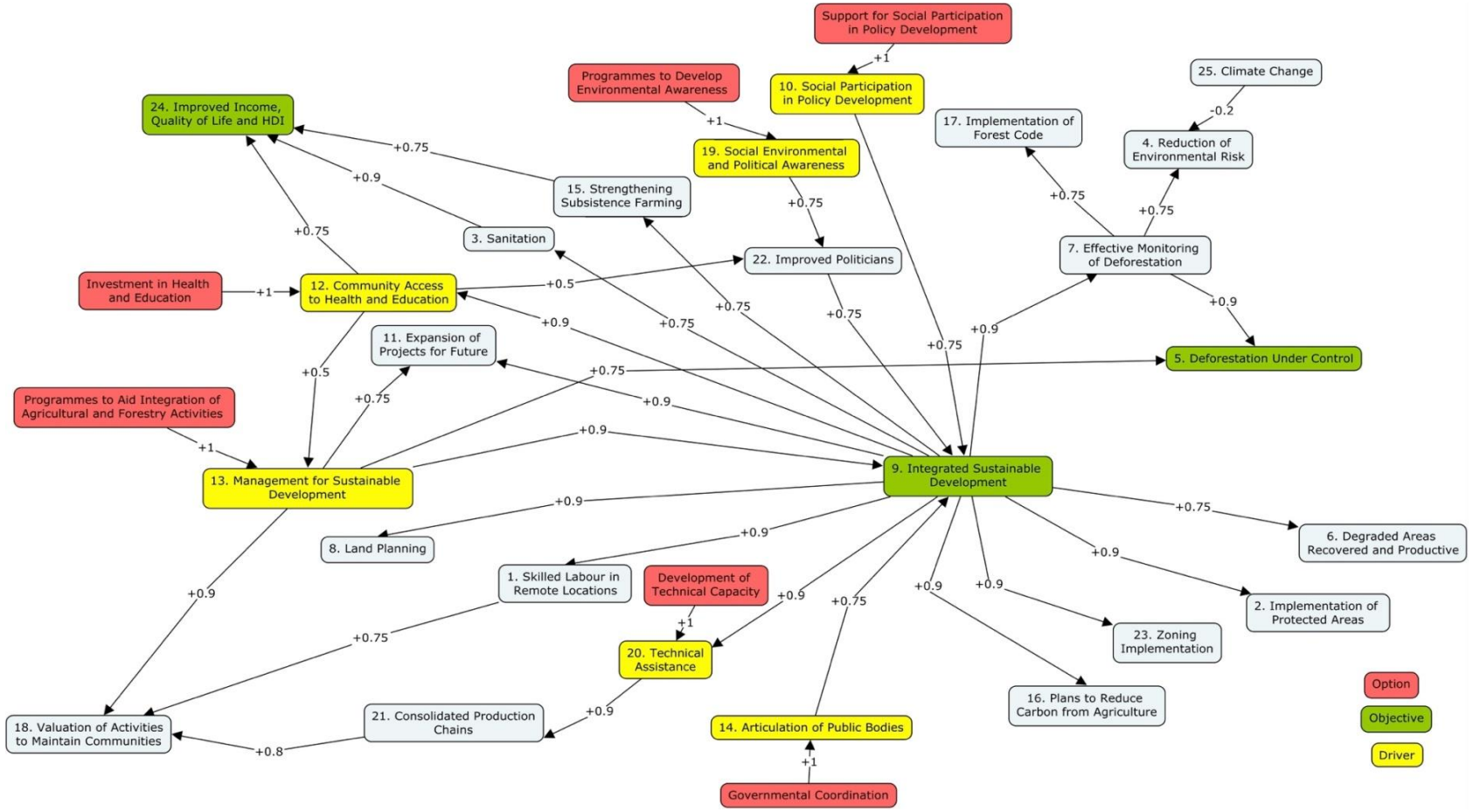


Figure 15. Fuzzy Cognitive Map of the 'desired' scenario in Flona Tapajos, with the policy options and objectives of the ANP highlighted.

Following the application of these 6 options to the FCM, and the translation of this map to a network (Figure 16) incorporated into Super-Decisions, ANP was used to prioritise the 6 options with respect to the network as a whole.

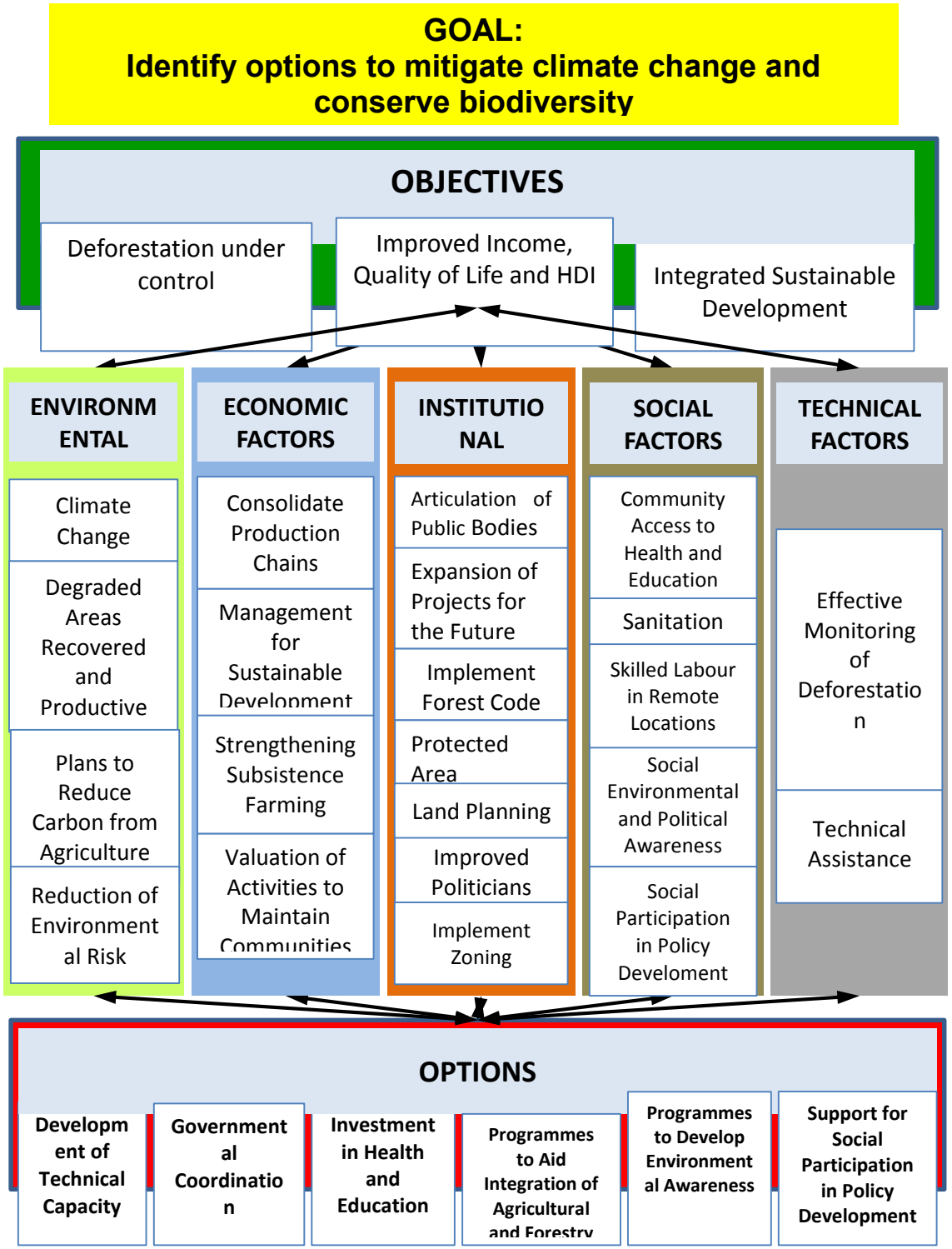


Figure 16. The FCM from Figure 16 translated into a schematic network that can be used in the Analytic Network Process and performed using Super-Decisions.

The ANP prioritised (Figure 17) that based upon the information given by stakeholders from the FCM the following prioritisation of options: 1)Investment in Health and Education, 2)Programmes to Aid Integration of Agricultural and Forestry Activities and 3)Support for Social Participation in Policy Development. These results demonstrate that from the desired future map that greater investments in health and education would result in improved biodiversity integration the resultant situation demonstrated in the 'desired' FCM. The relative importance and prioritisation of the 6 options can be seen in Figure 17.

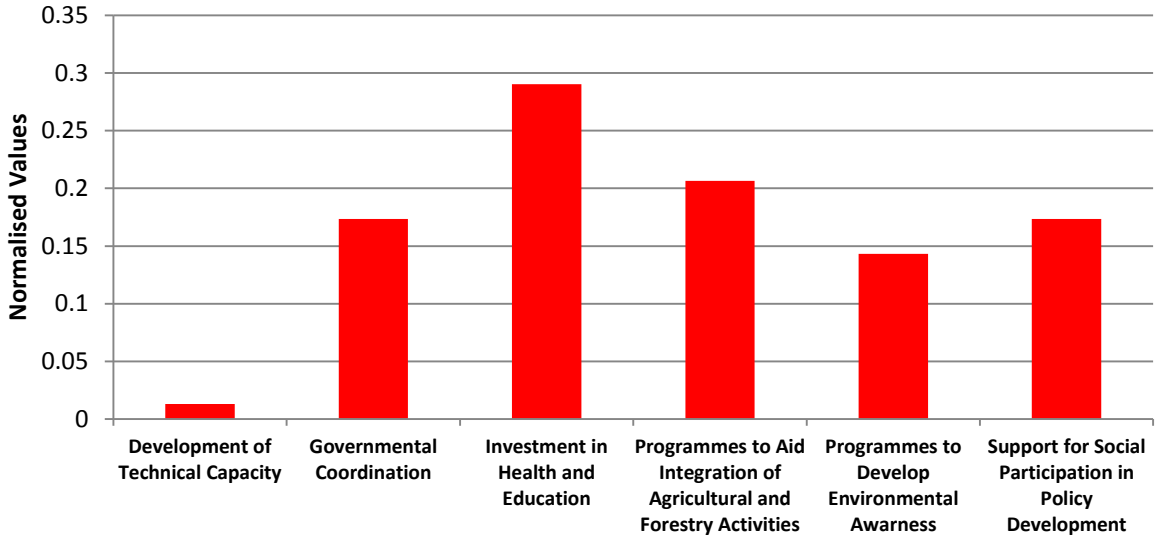


Figure 17. Relative importance of the proposed options with respect to the 'desired' scenario.

4.5.4 Participatory selection, characterisation and voting of policy options

Following the introduction to and validation of the previous results developed for the region, participants were introduced to the ANP process, and the process for prioritisation of options for the maintenance of biodiversity and mitigating climate change in the region. As part of this section, stakeholders were presented with the options selected for the future 'desired' FCM (developed previously) and the prioritisation of the options using ANP.

4.5.4.1 Option Selection

Stakeholders were offered the opportunity to select as a group a number of their own options. These options were developed based upon the proviso that they would help in the conservation of local biodiversity, mitigate climate change and improve the local socio-economic situation. Following extensive discussions, stakeholders selected the following 6 novel policy options:

1. Programmes for Forest Restoration
2. Economic Valuation of Protected Areas

3. Programmes for Payments of Ecosystem Services
4. Strengthening of Forest Monitoring and Inspections
5. Implementation of Land Planning and Zoning
6. Monitoring of Water Quality and other Ecosystem Services

Along with the 6 options selected from the future 'desired' FCM (developed in the 2nd SHW):

1. Development of Technical Capacity
2. Governmental Coordination
3. Investment in Health and Education
4. Programmes to Aid Integration of Agricultural and Forestry Activities
5. Programmes to Develop Environmental Awareness
6. Support for Social Participation in Policy Development

4.5.4.2 Characterisation of Options

Following the discussion and selection of these 6 policy options, the stakeholders were split into two groups, and were invited to characterise the options selected by UPM for the desired future FCM, and the new options they had participated in selecting. These two groups were given three of the new options, along with three of the options developed by UPM from the future FCM to characterise. The two groups were split heterogeneously, with a variety of stakeholder groups represented in each, the first containing 13 participants and the second 22.

The characterisation of the 12 options is available in Tables 5 and 6, during the process there was ample debate and discussion concerning each characteristic. In particular, concerning the economics of these potential policy options, in terms of how finances could be most efficiently sourced and directed.

From Tables 5 and 6 a number of patterns are easily noted; firstly that stakeholders believe that the 12 defined options should be implemented immediately, or at the latest within 5 years. Secondly, that the majority of these options are highly or at least partially compatible with current legislation, therefore their implementation wouldn't require extensive re-writing of legislation to improve compatibility. Thirdly, and perhaps most interestingly the options characterised were widely considered to be socially acceptable, with only specific interest groups highlighted as not being so accepting. This point is particularly telling, in such a diverse group of stakeholders that they came to the conclusion that of these 12 options, 8 would have either have high or very high social acceptance, 3 would be moderately acceptable and only 1 (Implementation of Land Planning and Zoning) would have low social acceptability, due to conflicts of interest is encouraging.

However, consideration must be made of one of the most telling characteristics, the cost of the implementation. Of the 12 options, 9 were considered to require high or very high financial support, with the other 3 considered to have moderate associated costs. This may be a decisive

factor in the decision making process for potential implementation of such an option. However, due to the considerably high level of social acceptance, this may outweigh the potential costs of option development and implementation.

Those groups who considered important for the implementation of these options appear to be largely similar, with governmental bodies, civil society groups and private institutions considered. Interestingly, for each option, there is a considerable diversity in the specific group or institute necessary for implementation. This may suggest the recognition of the importance of multi-scale and multi-sector coordination and communication for these options to be successful.

Briefly comparing the options selected from the desired future FCM, and those selected within the workshop, there appears to be very little, if any, discernible differences in terms of their characterisation. It could be suggested that some of those selected from the FCM may have slightly lower social acceptance, but this appears to be limited and their acceptance doesn't differ drastically. Whilst considering their cost of implementation, groups required for implementation and period in which they should be implemented, there is considerable similarity. That there are minimal differences may be expected, mainly due to the fact that those options selected from the FCM, are concrete ideas developed from the opinions and interpretations of the situation in the region developed by a similarly diverse group of stakeholders previously.

Table 5. Characterisation of the options developed by Group 1 during the 3rd Brazilian stakeholder workshop.

Options	Who will benefit from its implementation?	Who should be responsible for its implementation?	When should it be implemented?	What level of financial resources does it require?	Is it compatible with present laws, policies and programmes?	Does it require technical assistance?	What level of social acceptance would it have?
Development of Technical Capacity	Producers, Public and Private Technicians from Technical Assistance and Rural Extension (ATER), Technical and graduation educational institutions.	Technical Assistance and Rural Extension Enterprise of Pará (EMATER); Brazilian Enterprise for Research and Agropastoralism (EMBRAPA); Federal Institutions; NGO's	Immediately	High	Yes	New technologies; Adapted technologies; Traditional knowledge reused	Moderate
Governmental Coordination	Society in General	Public administration, organised civil society	Immediately	Medium	No	Application of available knowledge; Less political influence	Very High
Investment in Health and Education	Society in General	Public administration and private sector	Immediately	Very High	Yes	New technologies; Available knowledge application; Reuse of traditional knowledge; Training of staff	Very High
Programmes for Forest Restoration	Environmental bodies; Producers with environmental liabilities; Government and other countries	Environmental bodies; Private initiative; Organised civil society	The following year	Very High	Yes	Application of available knowledge.	High (society in general) Low (rural sector)

Economic Valuation of Protected Areas	Government, society, international community	Government and international community; society in general	Immediately	High	Yes	International support; research bodies; Technical knowledge; Consistent methodologies.	High/ Moderate
Programmes for Payments of Ecosystem Services	Farmers, traditional communities and environmental bodies.	Government; Civil society organizations (stock exchange); Private initiative	The following year	Very High	Yes	International support; research groups; new technologies; Training in existing and in new methodologies when necessary	Very High (in Amazonia) Low (for those Who pay)

Table 6. Characterisation of the options developed by Group 2 during the 3rd Brazilian stakeholder workshop

Options	Who will benefit from its implementation?	Who should be responsible for its implementation?	When should it be implemented?	What level of financial resources does it require?	Is it compatible with present laws, policies and programmes?	Does it require technical assistance?	What level of social acceptance would it have?
Strengthening of Forest Monitoring and Inspections	Society, traditional groups, managers, timber speculators.	Government, research bodies, environmental police, communities, NGOs	Immediately	Very High	Yes	Monitoring and applications for community based monitoring	High
Implementation of Land Planning and Zoning	National Institute of Citizenship and Agrarian Reform (INCRA) / Institute of Lands of Pará (ITERPA); Municipal Secretariat of the Environment (SEMMA) / Counties; Heritage Service Union (SPU); National Indian Foundation (FUNAI); Landowners; "Grileiros"[4]; Traditional and rural settlement's Marketers.	National Institute of Citizenship and Agrarian Reform (INCRA) / Institute of Lands of Pará (ITERPA); Heritage Service Union (SPU); Ministry of Agrarian Development (MDA); Pará State Public Ministry (MPPA)/ Federal Public Ministry (MPF)	Immediately	High	Yes/ Partially	Georeferencing of property; Qualified staff; Methodological standardisation, land titulation and legalisation	Low (due to conflicts of interest)
	National Water Agency (ANA)/ Municipal Secretariat	National Water Agency (ANA)/ Municipal Secretariat of the		High	Partially	Qualified staff; Creation of technical	Very High

[4] "Grileiro" is a person who illegally appropriates land and presents fake title deed.

Options	Who will benefit from its implementation?	Who should be responsible for its implementation?	When should it be implemented ?	What level of financial resources does it require?	Is it compatible with present laws, policies and programmes?	Does it require technical assistance?	What level of social acceptance would it have?
Monitoring of Water Quality and other Ecosystem Services	of the Environment (SEMMA)/Counties; Ministry of the Environment (MMA)/ Ministry of Mines and Energy (MME); Society; Fishermen; Geological Service of Brazil (CPRM) - Mineral Resources	Environment (SEMMA)/Counties; Geological Service of Brazil (CPRM); Hydrelectrics.	The next 5 years			committees; Creation and improvement of laboratories (NET)	
Programmes to Aid Integration of Agricultural and Forestry Activities	Farmers; Brazilian Forest Service (SFB)/ State Institute of Forests (IEF); Technical Assistance and Rural Extension Enterprise of Pará (EMATER); Brazilian Enterprise for Research and Agropastoralism (EMBRAPA); Executive Committee of Cocoa Farming Plan (CEPLAC); Chico Mendes Institute for Biodiversity Conservation (ICMBio); National Institute of Citizenship and	Brazilian Enterprise for Research and Agropastoralism (EMBRAPA)/ Ministry of Agriculture, Livestock and Supply (MAPA); Technical Assistance and Rural Extension Enterprise of Pará (EMATER); Ministry of the Environment (MMA)/ Ministry of Agrarian Development (MDA); National Agency for Technical Assistance and Agrarian Reform (ANATER); Ministry of Social Development and the Fight against Hunger (MDS);	Immediately	Very High	Yes	Staff qualifications; ATER / Technical, Social and Environmental Assistance Program to Agrarian Reform (ATES); Seed banks and nurseries; zoning; appropriate technologies	Moderate

Options	Who will benefit from its implementation?	Who should be responsible for its implementation?	When should it be implemented ?	What level of financial resources does it require?	Is it compatible with present laws, policies and programmes?	Does it require technical assistance?	What level of social acceptance would it have?
	Agrarian Reform (INCRA); NGO's; Traditional Communities	Cooperatives/Associations; Corporate Sustainability Index (ISE) an Research					
Programmes to Develop Environmental Awareness	Chico Mendes Institute for Biodiversity Conservation (ICMBio); Communities. Educational and Research Institutions; Ministry of Education (MEC)/ State Department of Education (SEE)/ City Department of Education (SME); Society in general	Chico Mendes Institute for Biodiversity Conservation (ICMBio); Ministry of the Environment (MMA)/Ministry of Education (MEC)/ State Department of Education (SEE)/ City Department of Education (SME); NGO's; Educational and Research Facilities	Immediately	High/ Medium	Yes	Suitable language (adaptation); Access to Information and Communication Technology (ICT); Appropriate media; Qualified staff.	High
Support for Social Participation in Policy Development	Local communities, society in general	Organized Civil Society; Pará State Public Ministry (MPPA)/ Federal Public Ministry (MPF); Syndicates	Immediately	Medium	Partially	Multidisciplinary technical teams; Community empowerment; community empowerment	Moderate

4.5.4.3 Voting of Options and Development of Prioritisation

Following this group characterisation work, the two groups were brought back together, where the two characterisation processes of the options could be presented to the other group.

To conclude the workshop and to bring an end to the work developed by the stakeholders, each participant was invited to vote on the options, which they felt would be best socio-economically, environmentally and for ease of application. The stickers they were given were colour coded, based upon their stakeholder group; politician, technician, scientist or local community group member.

Figures 18-22 demonstrate the results of the voting, they represent the proportional total of votes gained by each option, based upon the sum of the three criteria. These results are broken down into the four different represented stakeholder groups (Figures 18-21) and a workshop total (Figure 22). Reviewing these figures, a number of general patterns can be noted; **firstly** that the voting given by the politicians, scientists and technician resulted in a similar pattern of preferred options, with governmental coordination identified as the most preferred option. **Secondly** that the pattern of voting across these three groups is largely homogenous, with the options given largely the same proportion of votes with some minor deviations, as can be noted in Table 7. **Thirdly** that votes given by the local community groups members deviate considerably from that of the other three groups with investment in health and education voted as being the most desirable option of the twelve available. The votes given to this option were proportionally higher than for any other option in any other stakeholder group, achieving over 30% of all votes given. **Fourthly** that from the results of the voting (Figure 22) there are three clear preferred options:

1. Governmental Coordination
2. Investment in Health and Education
3. Programmes to Aid Integration of Agricultural and Forestry Activities

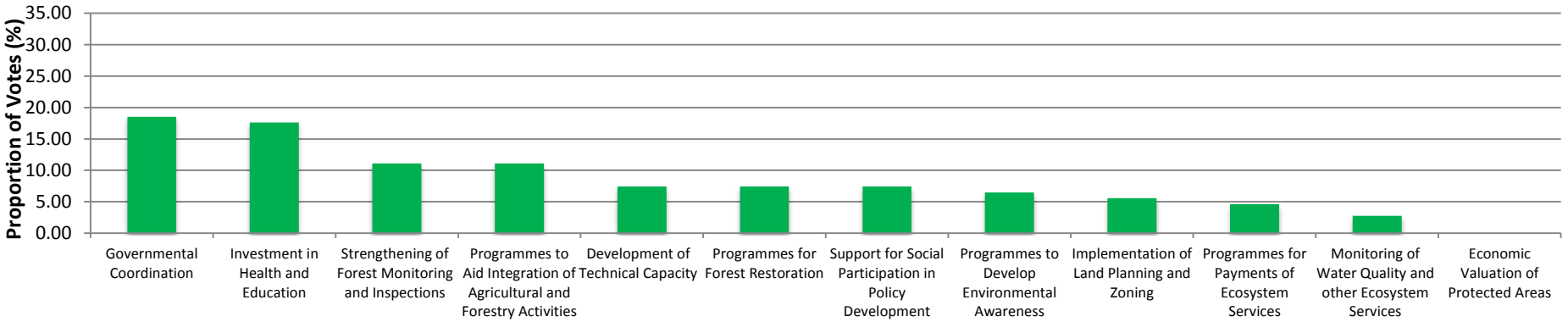


Figure 18. Results developed from the votes given by politicians during final workshop in Brazil. Bars represent the proportional value of votes given to each of the twelve options.

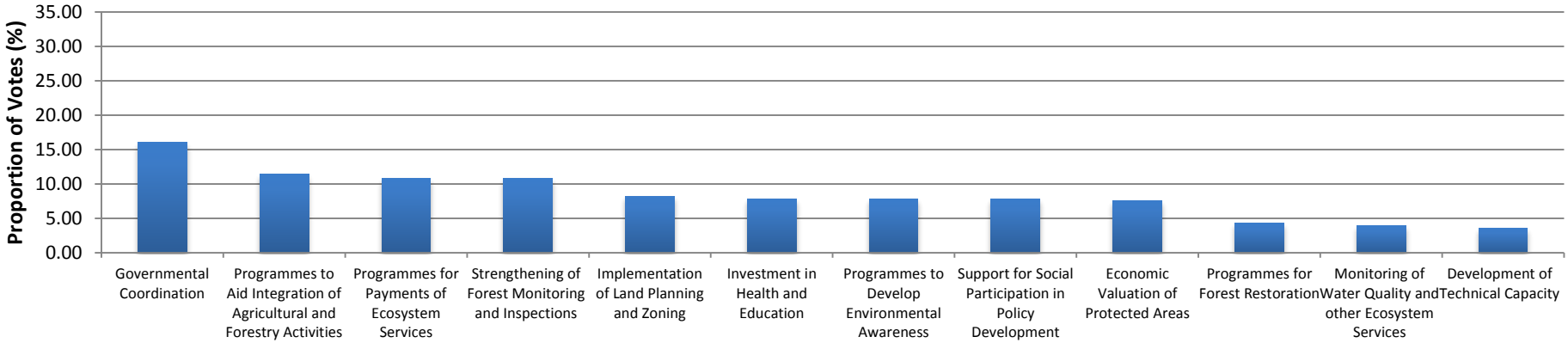


Figure 19. Results developed from the votes given by scientists during final workshop in Brazil. Bars represent the proportional value of votes given to each of the twelve options.

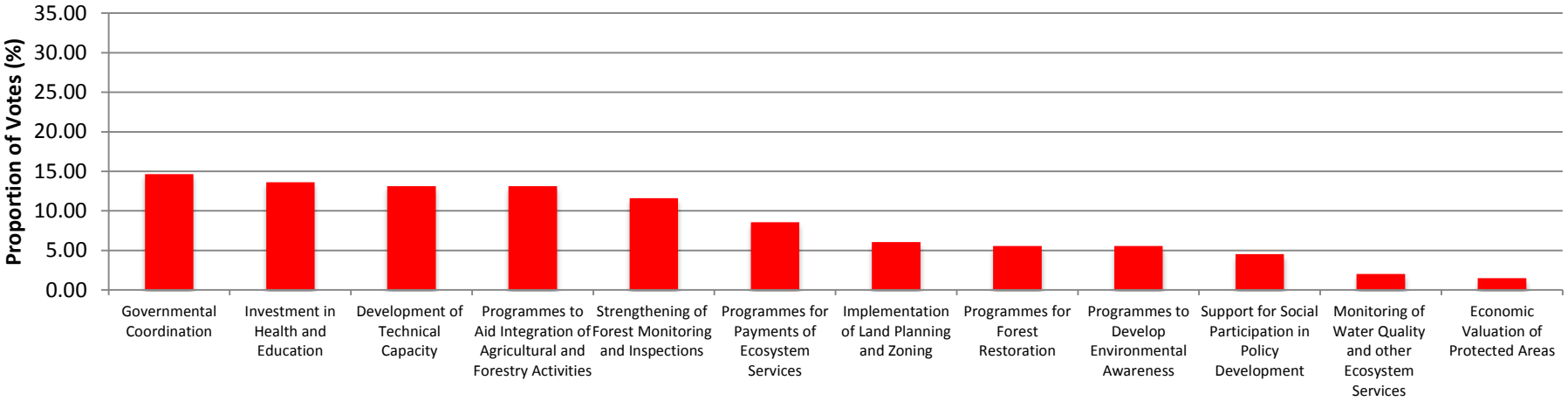


Figure 20. Results developed from the votes given by technicians during final workshop in Brazil. Bars represent the proportional value of votes given to each of the twelve options.

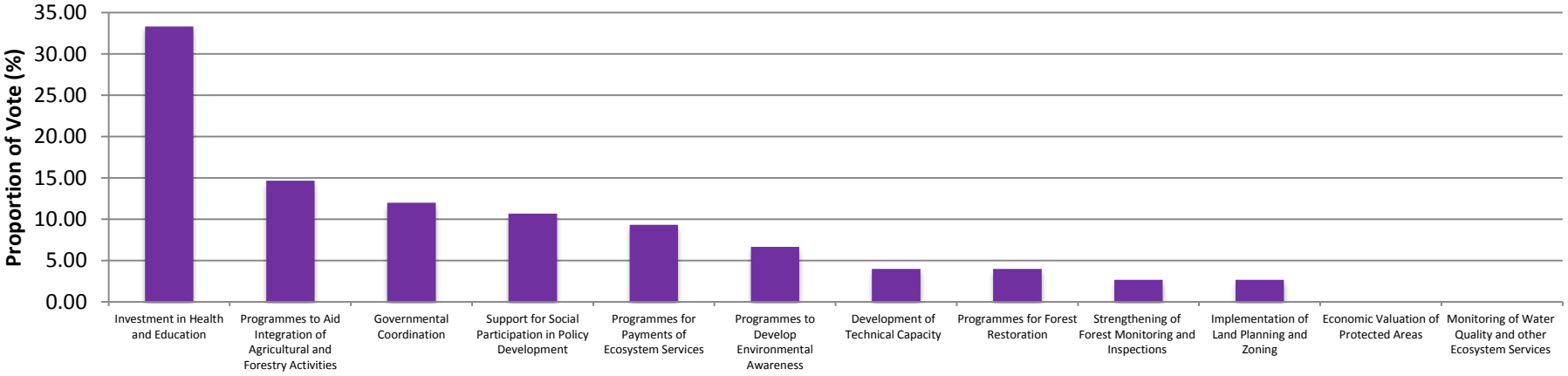


Figure 21. Results developed from the votes given by local community members during final workshop in Brazil. Bars represent the proportional value of votes given to each of the twelve options.

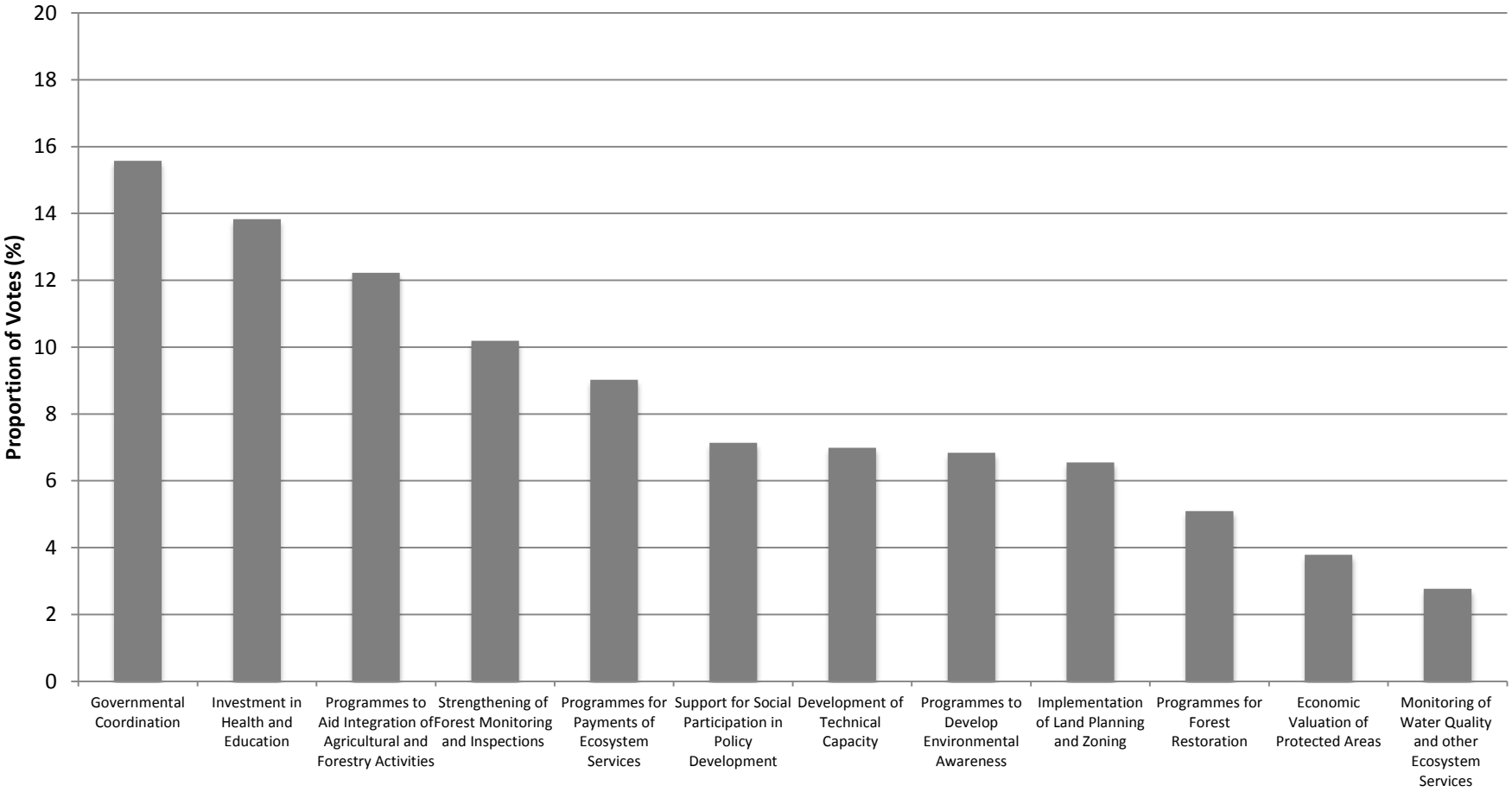


Figure 22. Results developed from the votes given by all workshop participants during final workshop in Brazil. Bars represent the proportional value of votes given to each of the twelve options and represent the sum outcome of the workshop.

From Table 7, and continuing the four points previously identified a clear pattern of highly prioritised options can be seen across the stakeholder groups and the workshop result. The same options were repeatedly identified by stakeholders, and are those ranked as the top three in the workshop total. Further options such as Strengthening of Forest Monitoring and Inspections, Programmes for Payments of Ecosystem Services and Support for Social Participation in Policy Development were also identified within some of the stakeholder groups.

The votes given by the Local Community stakeholders are particularly interesting, from their perspective investment in health and education would be the most suitable option, considerably different from the other groups that considered governmental coordination. The rationale behind such an outcome may be entirely dependent upon the contact that each of these groups has to the present situation of the region and in considering the future. Those stakeholders from the local community groups may be individuals who are witness to the slow changes occurring in the region, therefore the identification of education and improvements in health are vital for improving the future, this may be supported by the result that this factor was ranked number two by technicians, who may have greater exposure to the local reality.

Table 7. Results of the voting session from the final workshop in Brazil. The top three options voted for by the four stakeholder groups and the stakeholder total are shown.

	Stakeholder Group				Workshop
Rank	**Politician**	**Scientist**	**Technician**	**Local Community**	**Workshop Total**
1	Governmental Coordination	Governmental Coordination	Governmental Coordination	Investment in Health and Education	Governmental Coordination
2	Investment in Health and Education	Programmes to Aid Integration of Agricultural and Forestry Activities	Investment in Health and Education	Programmes to Aid Integration of Agricultural and Forestry Activities	Investment in Health and Education
3	Strengthening of Forest Monitoring and Inspections Programmes to Aid Integration of Agricultural and Forestry Activities	Strengthening of Forest Monitoring and Inspections Programmes for Payments of Ecosystem Services	Programmes to Aid Integration of Agricultural and Forestry Activities	Support for Social Participation in Policy Development	Programmes to Aid Integration of Agricultural and Forestry Activities

Further, it was repeatedly mentioned in the workshop of the present situation (Varela-Ortega et al., 2014a) the importance of a lack governmental coordination, it was so important that it was considered a driver in the Fuzzy Cognitive Map developed for the present. For the desired future

scenario FCM, the importance of integration of development policies was also highlighted as fundamental to achieve the desired future that it was placed as a central factor (Varela-Ortega et al., 2014a). Therefore, it is perhaps of little surprise that an option that aims to improve governmental coordination and all its benefits would be voted as the most desirable option for achieving the goal to conserve biodiversity and mitigate climate change.

Briefly considering the information given in the characterisation process (Tables 5 and 6), it would appear that the implementation of this option would receive extremely high levels of social acceptance, and would importantly require not considerable levels of financial investment. However, and demonstrating the scale of difficulty associated with the implementation of such a factor, it was characterised to be incompatible with present laws. Therefore, despite its potentially huge social acceptance, it could run into considerable issues concerning vested interests and current legislation and programmes.

4.6 Comparative Analysis of option prioritisation for biodiversity conservation: based upon ANP and Voting Results

The following section develops upon the findings from the two case study sites where options were selected and prioritised from the future scenario FCMs, as well by participants from the stakeholder workshops. This section formulates a comparative analysis between the two case study sites, to identify whether there are similarities in the options selected and prioritised and to identify whether there are any patterns that may help in direct international policy development.

Table 8. Top 3 options derived from the ANP from the positive future scenario FCM and those voted for by stakeholders in the 3rd stakeholder workshop.

	Bolivia		**Brazil**	
Rank	**ANP**	**SH Voting**	**ANP**	**SH Voting**
1	Compliance with Laws to Control Production Activities	Technical Training	Investment in Health and Education	Governmental Coordination
2	Technical Training	Programmes to Assist Subsistence Farmers	Programmes to Aid Integration of Agricultural and Forestry Activities	Investment in Health and Education
3	Institutional and Political Coordination	Improving the implementation of land use and building up a database	Support for Social Participation in Policy Development	Programmes to Aid Integration of Agricultural and Forestry Activities

Using the Bolivian case study to start, there appears to be one option that represents a vital ingredient missing from the ability of Ascensión de Guarayos to develop into the province demonstrated in the 'good life' scenario (Varela-Ortega et al., 2014)- technical capacity. That the

option for technical training is the only option of the 6 highlighted in Table 8 to be considered in the top 3 most viable options by both the ANP and form stakeholder voting is telling. It demonstrates a number of things, firstly that two different groups of stakeholders (2nd SHW and 3rd SHW) identified this factor as being fundamental to the future of the region.

Technical training was prioritised the number two option from the ANP and number one from the stakeholder voting, suggesting that there is a considerable shortfall in technical capacity in the province and most likely in the entire region. This lack of technical capacity is repeatedly identified in the characterisation of the options, suggesting there is a considerable lack of technical training across multiple sectors. Further, using the map of the 'good life' scenario, it can be further assumed that technical training and capacity refers also to improving the management of natural resources. This would suggest that this lack of technical training is currently inhibiting the development of the region along the pathway that would be required for the future demonstrated in the scenario. This lack of capacity for such management could also result in the negation in importance of the number one option from the ANP analysis 'Compliance with Laws to Control Production Activities' with proper management, training and ability for enforcement the provision of technical training could result in the control of such activities including; agricultural expansion, illegal fishing and hunting, and illegal mining. This development elevates the importance of technical training even further and using this conclusion would suggest that development of technical capacity in the area, through the provision of technical training, would provide extreme benefits to the region environmentally.

Consideration of this option from the characterisation process provides more information, technical training was considered to have high social acceptance and is very compatible with present legislation. However, it was noted by participants that the development and implementation of this option would require considerable financial resources, which may inhibit its development. Notwithstanding, this may be the ideal political option for the many levels of government in Bolivia to make a considerable investments in their country and the citizens of it. It is clear from the results of this workshop that stakeholders from a variety of backgrounds feel that this would be the best means of developing a future demonstrated in the good life scenario. Further, it could also be a means for directing funding from non-governmental sources into the country, to aid in the protection and management of Bolivian natural resources through long-term, nationwide training schemes.

Interestingly in Brazil, technical capacity was found to be the least important option from the ANP and was voted the 7th most important by participants of the workshop. In Brazil, a country that has seen considerable economic and social investments over recent decades, with extensive investment in a number of institutes like EMBRAPA and OBT, amongst a host of others, it is perhaps of little surprise that this option isn't considered fundamental to movement towards a future demonstrated in the desired future map.
However, it must be noted that this option did receive a number of votes, but it is perhaps not considered inseparable from future development. In Brazil, there is a similar pattern of one or two options considered vital, the first being investments in health and education and the second being governmental coordination. The results from the ANP developed for Brazil, place investment in

health and education as the most important option, with stakeholders voting it as the second (Table 8). It could be suggested that from both these sources of information (the FCM of the future and the voting) that participants in both workshops consider and recognise the importance of social investments for the long-term benefit of the region. From considering the map of the future investments in health and education would have wide scale impacts, resulting in improved incomes, improve the standard of politicians and result in the development of sustainable management schemes. This option therefore, is clearly perceived to have considerable beneficial effects not only in the short-term, but perhaps more importantly for the long-term too. This may be somewhat similar to Bolivian case, where the provision of technical training (which could be considered education) is considered vital, whereas in Brazil it is the general term of the investment in education. It is clear that in both countries there is a conscious recognition of the importance of education and that at some level it is presently lacking in the current situation. To return to the Brazilian case, investments in health and education were considered to have very high social acceptance, would be compatible with current legislation and would benefit society in general. However, and similar to Bolivia, this favoured option would require considerable financial resources for its implementation, but perhaps the benefits of this option in both the short and long-term would outweigh its perceived costs.

Further consideration must also be made of the Governmental Coordination option which was voted the most important option during the 3rd workshop, but wasn't prioritised highly by the ANP. This factor was repeatedly mentioned during the workshop dedicated to the present situation in the region (Varela-Ortega, et al., 2014a) and the lack of governmental coordination was considered a driver of the present situation. Therefore it is perhaps of little surprise that this option would be considered fundamental to the development of a future that conserves biodiversity and attempts to mitigate climate change. This option was considered to have very high social acceptance, would benefit all society, would require relatively little financial resources, but would be incompatible with present legislation. This continues the theme that has developed in this analysis; all the chosen options have one considerable negative, be that cost or compatibility with present legislation.

4.7 Conclusions

It appears clear that two or three options fully developed, considered, planned and implemented could have hugely beneficial impacts on the regions of implementation over the long-term. Therefore the following options could be recommended for Bolivia and Brazil:

- Bolivia: The provision of technical training to develop technical capacity.

- Brazil: Governmental coordination

In terms of the application of the ANP to the selection and prioritisation of options from the FCMs the implementation of these two methodological approaches develops mutual benefits. The use of FCMs helps in the structuring of a problem, whilst the combined use of ANP supports a quantified

decision process, including the development of decision preferences and the ability for their evaluation (Wolfslehner et al., 2011). This analysis has highlighted the utility of combining these two methodologies to develop a number of potential policy options that have been developed based upon a problem structured through FCM and prioritised using ANP.

4.8 Stakeholders' Evaluation of the 'Option' Workshops

Similarly to the workshops relating to the present and future, a questionnaire accompanied the option workshops to get a better understanding of the perceptions of the participants relating to the workshops in general. In particular, stakeholders were asked to comment on the utility of the workshop, and methodology applied for choosing and developing the options. The following is a brief overview of the opinions offered by the stakeholders when responding to this questionnaire. Please note that the findings below and the percentages shown represent the responses of those stakeholders that responded to each question, rather than a percentage of all stakeholders. Figure 23 represents the responses to a 'mood-o-meter' performed at the end of the workshop.

Figure 23. Stakeholder perceptions on the utility of the workshops.

In both Bolivia and Brazil, the workshops received high approval levels (Figure 23), with over 95% of participants in Brazil stating they felt that the workshop had been useful. In Bolivia, 100% of participants agreed that the workshop had been useful.

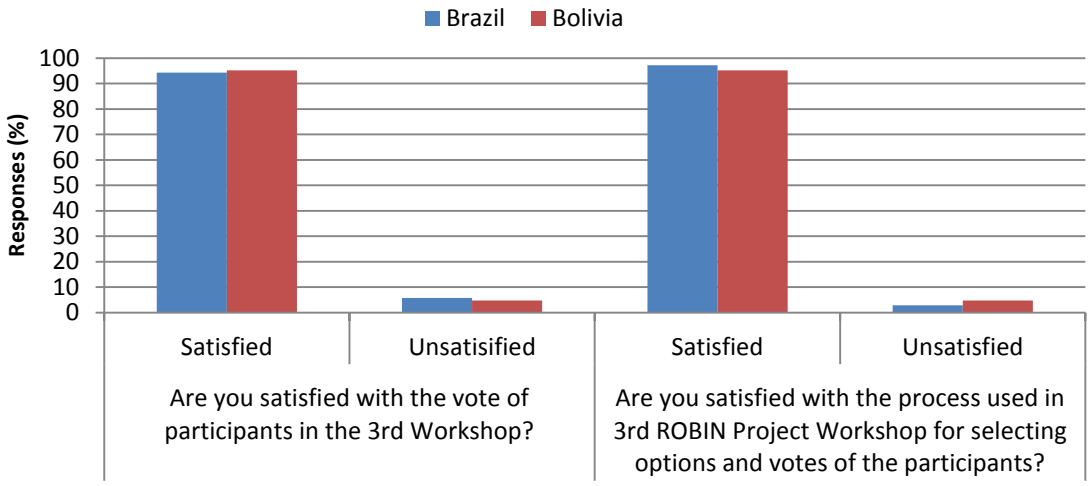


Figure 24. Stakeholder's responses to questions relating to the voting and the choice of options within the workshop.

In terms of the voting and the choice of options within the workshop (Figure 24), stakeholders in both Bolivia and Brazil stated that they were entirely satisfied with results of the voting for the options, receiving over 90% approval in both Bolivia and Brazil. Further, when asked whether they were satisfied with the process used in the 3rd workshop for selecting options participants in both workshops stated that, similarly to the results derived from the voting that they were highly satisfied with the process implemented. Once again in both Bolivia and Brazil over 90% of participants stated their satisfaction.

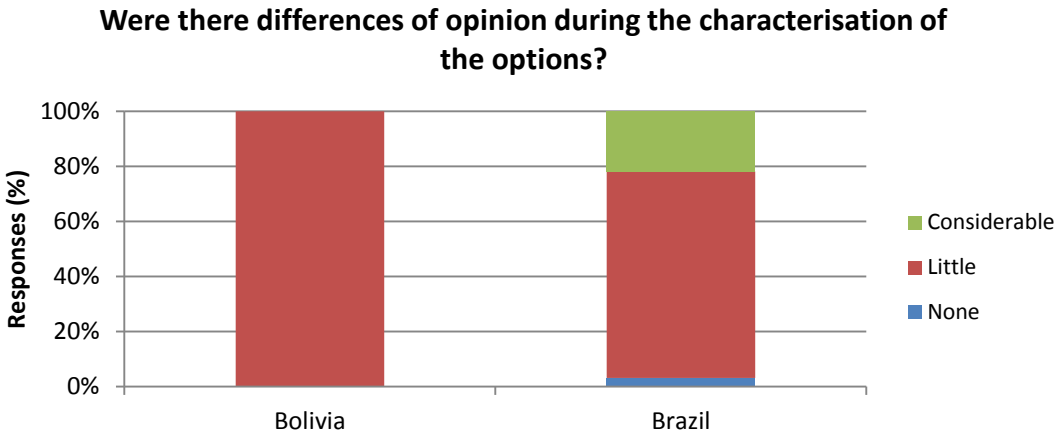


Figure 25. Stakeholder responses to the scale in which opinions differed during the characterisation process.

In Brazil, over 70% of respondents stated that there were little differences of opinion during the characterisation of the options and in Bolivia 100% of respondents stated that there was little difference (Figure 25). That there were relatively minor differences in opinion during the characterisation would suggest the relative strength of the options in terms of their definition and their aims.

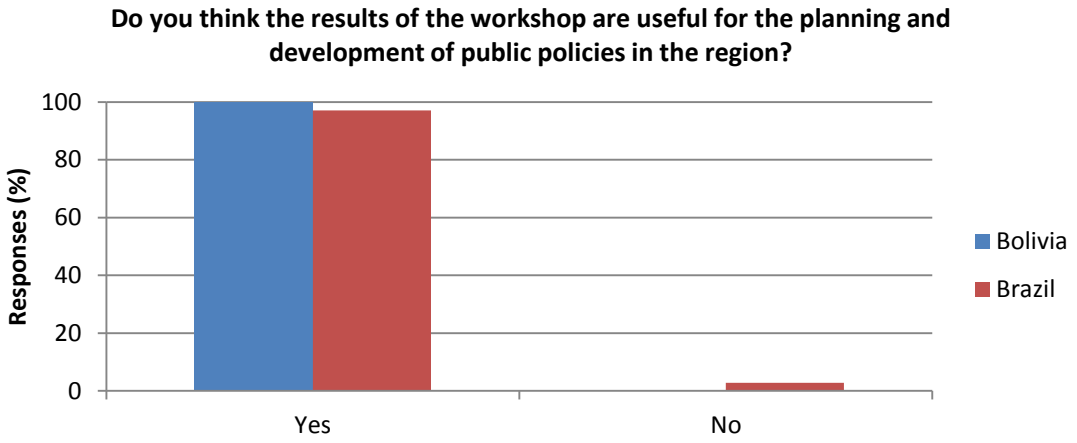


Figure 26. Stakeholders' responses to the utility the workshop for planning and development policies formulation.

The value of these workshops can clearly be seen in Figure 26, which clearly demonstrates the perceived utility of the results of the workshop for the planning and the development of public policies in the region. In Brazil, over 90% of participants in the workshop believe this to be true, and in Bolivia 100%.

Figure 27 offers an insight into the perceptions of the stakeholders present at the workshops. Only 45% of stakeholders in Bolivia and over 70% in Brazil agreed that other participants in the workshops were able to fully express their opinions, with the others stating that they partially agreed with this statement, which is similar to the outcomes of the results from the second workshop (Varela-Ortega et al., 2014a). However, when asked whether they believed that their own opinions and ideas were taken into account, over 50% responded that they agreed in Bolivia and more than 80% in Brazil.

Similar to the results from previous workshops, over 80% of stakeholders completely agreed that the workshop in Bolivia met their expectations, with fewer than 80% in Brazil agreeing entirely. This clearly highlights the success of the methodology for option selection and prioritisation, the meeting in general and of those implementing and directing the meeting. This point is clearly supported by the view that over 90% of Bolivian and over 80% of Brazilian respondents believed that the meeting had improved their understanding of the situation. The work developed during the workshop was also considered fairly applicable to the work of the participants, with 100% in both countries stating that it could be applied in some form.

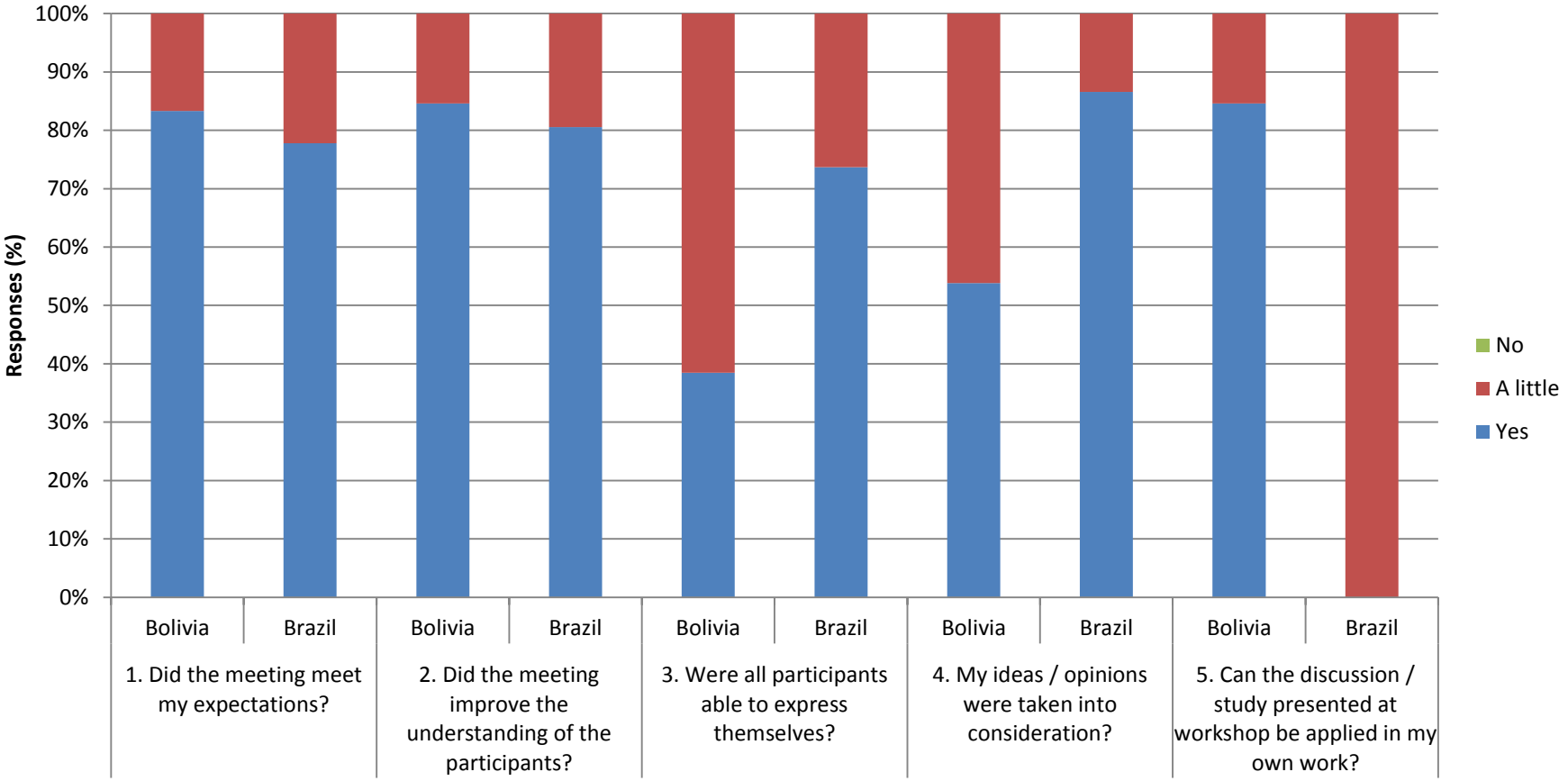


Figure 27. Stakeholders' perceptions of the option development workshops.

In conclusion, the workshops were generally well received by the stakeholders and that in both Bolivia and Brazil they were widely regarded as being useful. It is clear that workshops provided a solid platform for participants to select, characterise and vote for options for biodiversity integration to climate change mitigation.

Encouragingly there were extremely positive appraisals of the utility of the methodology and the options selected for development and planning of future public policies. Coupled with this interpretation of the utility of the selected policy options is the clear demonstration that the work developed within these third, and final workshop could be integrated within the work of the stakeholders present. Further, it also appears clear that these workshops have aided in furthering the understanding of the situation in both countries, and encouraging a debate and knowledge development for the future.

5. Provincial Level Analysis

Historically, Latin American land use changes, including deforestation, were attributable to small-scale localised subsistence farming (Hosonuma et al., 2012). Over recent decades, local and national markets have globalised, developed and diversified to respond to resource demands in ever expanding markets. This has resulted in considerable alterations to the dynamics and agents of change, with the drivers of land use change and deforestation becoming medium-large commercial farms (Müller et al., 2012; Verburg et al., 2014). The secondary effects of such expansion in agricultural area, usually within forested areas can be directly linked to considerable negative outcomes upon ecosystem services, biodiversity losses, reduction in carbon sinks and in turn climatic changes (Malhi et al., 2008; Davidson et al., 2012).

To respond to these increasingly rapid changes and negative externalities, a breadth of strategies, such as command-and-control and incentives have been developed and applied in regions of considerable change across the world. The fundamental aim of these strategies is to preserve and restore tropical forests. Unfortunately, the associated costs of such strategies and programmes are generally considerable, not only for their implementation but also in their enforcement (Martín-Ortega et al., 2013; Börner et al., 2014).

5.1 Objectives and description of provincial scale analysis

The objective of this provincial scale analysis, in concert with the lower 'local' analysis, and the higher 'national' analysis, aims to analyse the effectiveness of different policy measures (including economic incentives and disincentives) at encouraging ecosystem conservation at the farm level in tropical agro-forest systems. This work has been presented at the International Congress of Ecosystem Services Partnership 2014 in San Jose (Costa Rica) (Varela-Ortega et al., 2014b) and the 11th International Conference of the European Society for Ecological Economics (ESEE) 2015 in Leeds (UK) (Esteve et al., 2015), and both are in process of being published.

5.2 Methodology: Bio-economic Modelling

To assess the effectiveness of these policy measures a bio-economic model was developed for the Province of Guarayos (in the department of Santa Cruz, Bolivia) and is in the process of being developed for the municipalities surrounding the Flona Tapajós (Belterra, Ruropolic and Placas in the state of Pará, Brazil). This modelling is based upon data collected from extensive field work carried out in the Province of Guarayos (Bolivia) and across the municipalities surrounding the Flona Tapajós (Brazil). These field works were funded by UPM (project AL13-PID-18 in Bolivia and project AL14-PID-12 in Brazil)[5].

[5] Biodiversidad y bienestar humano ante el cambio global en áreas tropicales protegidas de América Latina. Project No.: AL13-PID-18. UPM Grants for activities with Latin American countries. Universidad Politécnica de Madrid, International Relations Office.

As part of these periods of fieldwork, farmers as well as provincial experts were approached to perform one-one, semi-structured interviews; examples of the interviews can be found in Annexes 9.2.1 (Bolivia) and 9.2.2 (Brazil). Farmers were asked an array of questions, allowing for the development of extensive databases populated with data relating to agricultural metrics, including but not limited to; crop yields, prices, fertiliser and pesticides use, transport costs, marketing channels, agricultural and land management practices and labour use. Further, farmers were also questioned about their ability to access credit, their perceptions of certain farming risks, as well as socio-economic questions relating to their household, including family members and education level. Where data was missing or not available from the interviews, supplementary reviews of relevant literature as well as reviews of national and provincial statistics were performed. The data collected during these fieldworks were used to characterise the agricultural and forestry sectors and to define farms and farming type.

The information collected during the field-work formed the foundation of the bio-economic models, which was designed for Bolivia and is being designed for Brazil to simulate the efficacy of conservation measures and policies. The use of bio-economic models has been previously applied to agriculturally driven deforestation processes (Walker, 2003; Börner et al., 2007).

5.3 Bolivia

5.3.1 Fieldwork and Identification of Farm Typologies

The fieldwork was coordinated and performed by members of the Universidad Politécnica de Madrid (UPM) and Instituto Boliviano de Investigación Forestal (IBIF) during a two week period in November 2013 (see footnote 5). In total, 34 interviews were performed with both farmers (31) and experts (3) in the Province of Guarayos, which forms part of the eastern Department of Santa Cruz. These interviews were conducted in two of the three municipalities within the province; Ascención de Guarayos, El Puente, no interviews were performed in the third municipality of Guarayos (Urubichá). The total coverage of the interviews, including forest area was 4509has, which represents just over 0.2% of the provincial surface area. However, considering just the agricultural area coverage of the interviews (2082has), the fieldwork coverage equates to 3.41% of the agricultural area in the province. Interviews were performed randomly with a range of farmers, who were found to be practicing distinct scales of farming from subsistence-large scale, with cultivated areas ranging from less than 1ha, to more than 500ha.

The information collected from the fieldwork and enriched from a review of the literature and national statistics was processed, and farms were grouped together using cluster analysis (Figure

Biodiversidad y cambio climático en la Amazonía: perspectivas socio-económicas y ambientales. Project No.: AL14-PID-12. UPM Grants for activities with Latin American countries. Universidad Politécnica de Madrid, International Relations Office.

28) based upon their inherent characteristics into three representative farm types (very small subsistence, small commercial and medium/ large commercial) (Table 9).

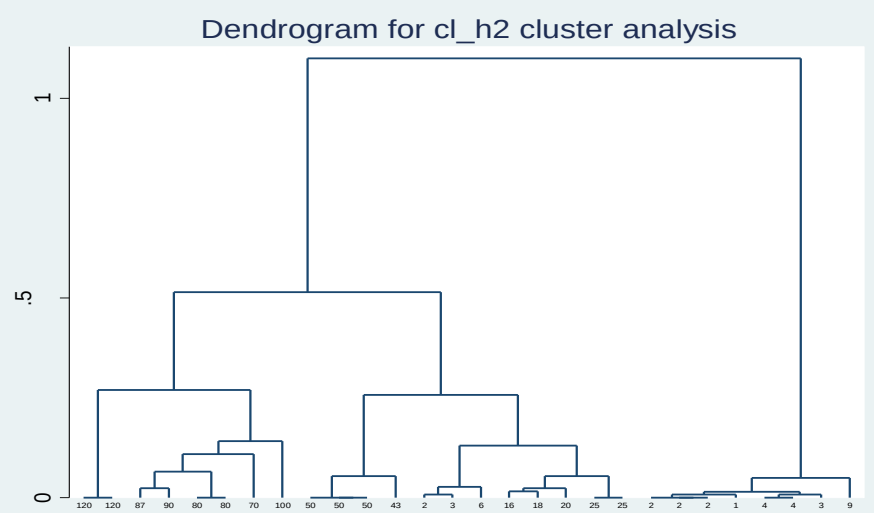


Figure 28. The cluster analysis performed on the farms from the field work in the Province of Guarayos.

Table 9.Clusters of farm types developed from the fieldwork performed in the Province of Guarayos. Farms clustered based upon inherent characteristics.

Farm Type	Total Size (ha)	Cropped Area (ha)	Forest Area (ha)	Access to Credit (%)	Cropping Pattern	
					Winter	Summer
Very Small Subsistence	50	3.5	46.5	0	Cassava, bean, banana	Cassava, rice, plantain, maize
Small Commercial	50	20	30	33	50% bean, 50% sorghum	50% maize, 50% rice
Medium/ Large Commercial	200	70	130	60	42% rice, 14% sorghum, 29% soy	57% soy, 43% rice

5.3.2 The Bio-economic Model

The farm types of Table 9 were subsequently specified using a multi-period bio-economic optimization model that permits simulation of different policy measures. The model is specified by the equations explained below.

The objective function (1) shows the maximisation of the discounted value of farmer's expected annual utility over a period of 15 years (t), calculated as the expected annual gross margin, Z,

minus utility losses driven by the risk inherent to crop production, with a discount rate i. The risk component is defined by a risk aversion coefficient ϕ, which is used as calibration parameter, and the standard deviation of farm's gross margin σ(Z).

$$Max \sum_{t} \frac{(Z_t - \varphi \cdot \sigma(Z_t)}{(1+i)^t} \quad (1)$$

Equation 2 shows farm gross margin estimation (Zt), where: gmc,r : gross margin per crop (c) and technique (r) including revenues, input costs and transport; Xc,r,t : Production area per crop and technique and per year; fco: family labour opportunity cost; flabp,t: Family labour use per period of the year (p) and year; hlw: hired labour wage (€/h); hlabp,t: hired labour per period and year; Clt: Forest area cleared per year; ClCost: cost of clearing per hectare; CREDt: money borrowed per year; k: interest rate of loans.

$$Z_t = \sum_c \sum_r gm_{c,r} \cdot X_{c,r,t} - fco \cdot \sum_p flab_{p,t} - hlw \cdot \sum_p hlab_{p,t} - Cl_t \cdot ClCost - CRED_t \cdot k \quad (2)$$

The maximisation of farmers' utility is subjected to different constraints, including those concerning available land (3), maximum allowed forest clearance (if any) (4), greenhouse gas emissions (5), labour (6 and 7) and financial resources (8) limitations:

$$\sum_{c,r} X_{c,r,t} \leq surf_{t-1} + Cl_t \quad (3)$$

$$Cl_t \leq Cl\_Max \quad (4)$$

$$\sum_{c,r,p} (GHG_{c,r,p} \cdot X_{c,r,p,t}) + Cl_t \cdot GHGcl \leq (\sum_{c,r,p} X_{c,r,p,t} + Cl_t) \cdot QGHG \quad (5)$$

$$\sum_{c,r} labreq_{c,r,p} \cdot X_{c,r,t} \leq flab_{p,t} + hlab_{p,t} \quad (6)$$

$$flab_{p,t} \leq flab\_av_p \quad (7)$$

$$TCost_t \leq Cash_{t-1} + CRED_t \quad (8)$$

Where surft-1 is the farm size area in the previous year; Cl_Max: maximum allowed forest clearance; where GHG c,r,p represents the emissions values for each crop based upon modelling performed using the Cool Farm Tool, GHGcl are the emissions from clearing of forest, QGHG is the maximum allowable emissions of greenhouse gasses, labreqc,r,p is the labour requirements per crop and technique and per period (p) (summer or winter); flab_avp is the maximum family labour available per period; TCostt: Total production costs including cost of inputs, labour ,

machinery and clearance and interests pais for loans; Casht-1 : available cash obtained in the year t-1 (revenues reinvested in the farm).

The impacts of four policy measures developed to assess their efficacy for ecosystem conservation and socio-economic development were simulated. These measures included; a tax on carbon emissions, a quota for carbon emissions, a prime for forest conservation and a prime for reforestation. The target and type of measure for each of these measures can be found in Table 10. The measures were developed to reduce the negative externalities (CO_2 emissions) of agro-forestry landscapes, whilst increasing the services gained from them (Börner et al., 2007; Börner et al., 2014).

Table 10. Simulated policy measures developed for the provincial-scale bio-economic modelling. The associated target of each measure is also included.

Measure	Type of measure	Target
Quota for carbon emission (5tn CO_2/ha)	Command-and-control	To lessen negative externalities from agriculture and deforestation. Reducing carbon emissions from crop production and forest clearing
Tax on carbon emission (30$/tn CO_2 equivalent)	Economic disincentive	To lessen negative externalities from agriculture and deforestation. Reducing carbon emissions from crop production and forest clearing
Prime for forest conservation (950$/ha of primary forest)	Economic incentive	To enhance forest-based ecosystem services. Keeping land in primary forest when it could be converted to agriculture
Prime for reforestation (1175$/ha of secondary forest) & Deforestation ban	Command-and-control & Economic incentive	To enhance forest-based ecosystem services. Keeping land in primary forest and converting agriculture land in secondary forest

The values applied for these different measures were developed based upon considering tax implementation in other countries, and testing levels of primes until land use changes began to be seen.

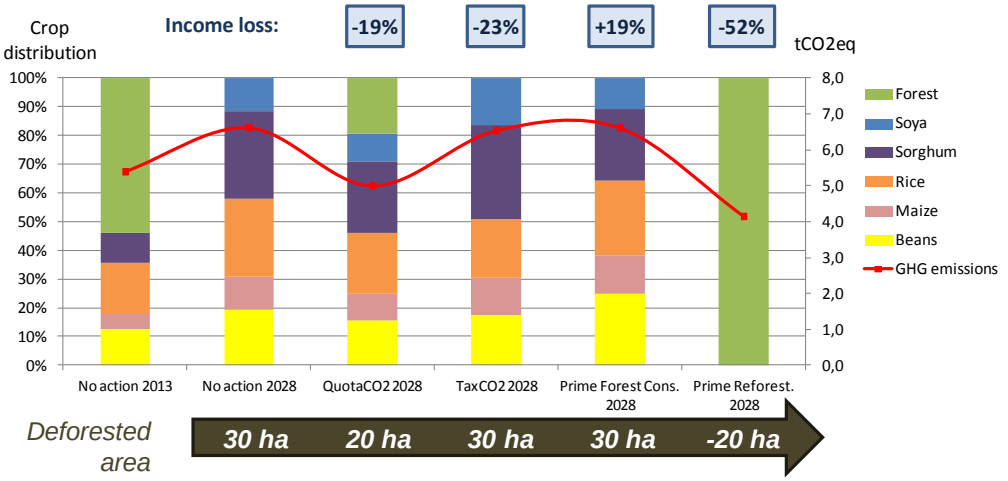
To identify the effects of these policies, analysis will be made of their impacts upon food production, crop diversity, farm income and CO_2 emissions.

5.3.3 Results

The following results are examples of the modelled impacts of the aforementioned measures on two of the three representative farm types; small commercial (50ha) and medium/large commercial (200ha). Figures 29 and 30 have been designed to compare the impacts of these measures upon farm income, crop distribution, CO_2 emissions and forest cover in these two representative farms. Further, the figures offer a comparison of the current situation in each

farm type as of 2013, where no measures have been enforced, a no action (business-as-usual) scenario for 2028, and the results of the four measures. Figure 29 demonstrates the results of the modelling upon the small farm example, and Figure 30 for the large representative farm.

Figure 29. The outcomes of the conservation measures applied to the bio-economic model for a



representative small commercial farm (50ha) in the province of Guarayos, Bolivia.

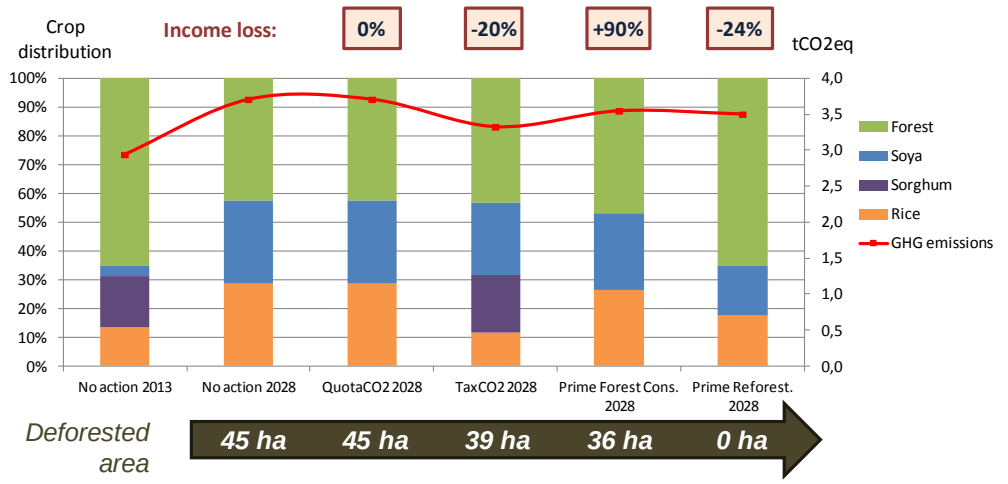


Figure 30. The outcomes of the conservation measures applied to the bio-economic model for a representative medium/large commercial farm (200ha) in the province of Guarayos, Bolivia.

Firstly, it is evident from a brief glance at Figures 29 and 30, as well a Table 11, that the impacts of the policy measures are distinct in the two representative farms.

Table 11. Impacts of measures on three of the four metrics analysed in the model. Blue arrows represent increase or decrease of values for small farms in comparison to the 2028 no action model, dashes signify no change. Red arrows and dashes represent the large farm.

	CO2 Quota	CO2 Tax	Premium for Forest Conservation	Premium for Reforestation
Forest Area (ha)	↑ —	— ↑	— ↑	↑ ↑
Emissions (CO2eq)	↓ —	— ↓	— ↓	↓ ↓
Income Change (%)	↓ —	↓ ↓	↑ ↑	↓ ↓

No Action

Despite these differences, one similarity is that if both farm types were to continue on a business-as-usual (no action) trajectory, both farms would continue to deforest by 2028. In the case of a small farm, without the implementation of conservation measures, the bio-economic model predicts that a further 30ha would be deforested, resulting in a totally deforested parcel of land by 2028. In the large farm, a further 45ha would be deforested by 2028, resulting in just 40% forest cover compared with over 60% in 2013. This would suggest that present conservation, which largely consider protected public forests, will not counter future deforestation occurring on private lands, and therefore such strategies should be redressed.

The contributory factors to such land use change, are clearly visible from the results from Figures 29 and 30). In the small farm (Figure 29), under the no action trajectory, we see a proportional increase in the four crops (sorghum, maize, beans and rice) initially cultivated in 2013, at the expense of forest. Further, there is development of soy cultivation by 2028, where no such production existed in the initial 'No action 2013' model. The impacts of soybean production are acutely obvious from Figure 30, where such production covers a few percent of the farm area in 2013, by the 2028 it expands to just below 30%. This expansion comes at the expense of sorghum production, and forests. This soybean production contributes to the expansion of the agricultural frontier, with a reduction of over 20% of forest cover in the farm as a whole.

This expansion of the agricultural frontier due to soybean production, may be particularly obvious in large farms, where they have greater access to credit (Table 10 information about farms), however such frontier expansion is also important in the small farms. Business-as-usual models causing further deforestation is supported by the literature (Soares- Filho et al., 2006), as well in ROBIN (van Eupen et al., 2014). The trajectory of deforestation in D2.2.1 of ROBIN (van Eupen et al., 2014) suggests that by 2050, under the business-as-usual scenario (SSP5S) there

would be a 3.6% increase in annual crops, and a 13% reduction in forest area in Bolivia, in respect to a 2005 baseline.

Quota for carbon emission

The impacts of this measure differ greatly between the two representative farm types, with considerable effects in the small farm, and limited changes in the large farm. In terms of forest conservation, this measure is successful, with it resulting in 20% forest cover, compared with 0% in the B-A-U example. This forest conservation is the result of reduced sorghum and rice production, with soy still cultivated. The quota has also caused a considerable reduction in emissions, but at considerable financial cost, with a 19% reduction of income. On the large farm example, the measure has no effect upon forest area, emissions, crop cultivation or income.

Tax on carbon emission

Like the quota, the tax on carbon emissions has distinct impacts upon the two farm types. On the small farm, this measure results in no conservation of forests, an almost identical pattern of crop cultivation, similar emissions and farm income reduction of 23%. On the large farm, the tax results in 6 ha more of forest, small reductions in emissions, but at the cost of 20% of farm income. Further, this tax encourages the movement from only cultivating two crops (soya and rice), to the introduction of sorghum, largely at the expense of rice production.

Prime for forest conservation

The provision of a prime for forest conservation, results in zero forest conservation in the small farm, identical emissions and almost identical patterns of cultivation compared with the B-A-U baseline. However, it does result in a considerable benefit of income, with a 19% increase. On the large farm, the results are slightly different; emissions reduce slightly, forest area increases by 9ha and the farm income increases by 90%.

Prime for forest reforestation

This measure results in the most dramatic effects for forest conservation in both the small and large farm. In the small farm, the implementation of such a measure would result in the entire farm being reforested, resulting in considerable reductions in emissions, but at the cost of a reduction of farm income of 52%. On the large farm, the payment for reforestation would result in a net increase of forest cover of 45ha at equal expense to rice and soy cultivation. However, this results in a reduction of 24% of farm income and only limited reductions in emissions.

5.3.4 Conclusions and Policy Considerations

When consideration is made of conservation and in particular conservation of environmental services, serious thought should be paid to fact that the socio-economic optimal solution for any individual may be entirely distinct to that of the optimal for society. To address such a disparity policies are required but as the results of this model have shown, they should be context and site specific. The results have demonstrated the potentially duplicitous nature of potential policy measures, and how they can have conflicting impacts on farms.

On one farm a measure could be largely beneficial, whereas the same measure, in the same region could result in distinct outcomes on another, therefore consideration of this should be made before enforcing any measure. As demonstrated in the model taxes on CO2 emissions can contribute in reducing deforestation in certain medium-large farms, but would produce detrimental economic impacts on small farms. Quotas for CO2 emissions would however be more effective for reducing deforestation in smaller farms, with less forest area. This supports the findings of Godar et al. (2014) that conservation policies should be specifically tailored considering the context and farm type.

This model has clearly shown that conserving forests will require high compensation costs (especially in large commercial farms). To successfully protect private forests, economic incentives will be necessary, at considerable public cost. The results herein described support those of Müller et al. (2013), in that the implementation of economic incentives (payments for ecosystem services) for forest conservation would be fundamental to counteract the considerable cost (foregone profit) of reducing deforestation in what are profitable agricultural areas. However, these considerable public costs may hinder the development and long-term implementation of such incentive programmes. Further, financial policies that may not be directly related to ecosystem conservation, for example widespread access to credit to farmers may be determinant. If all farms were able to access credit, intensive cultivation would likely increase, accelerating deforestation rates considerably. In reality though, many farmers don't have access to such credit, which has the knock on effect of being beneficial for the environment but hugely detrimental to the individual income.

In consideration of these conclusions a suite of policy instruments should be made available and applied sensitively. This suite of policies which include economic, agricultural and conservancy policies will need to be integrated and coordinated, with appropriate synergies developed and actions balanced.

5.4 Brazil

5.4.1 Fieldwork and Identification of Farm Typologies

The fieldwork was coordinated by UPM and jointly performed with EMBRAPA between October 2014 and Abril 2015 (see footnote 5). In total, over 70 interviews were performed within three

municipalities within the state of Pará (Belterra, Placas and Ruropolis). The fieldwork was performed during four phases:

- Phase 1(8th October 2014): interviews performed with 13 farmers from the municipality of Belterra.
- Phase 2 (11th October 2014): interviews performed with 5 farmers in the municipality of Belterra.
- Phase 3 (7th November 2014): interviews performed with 7 farmers in the municipality of Belterra.
- Phase 4 (27th March- 2nd April 2015): interviews performed with 46 farmers in the municipalities of Belterra, Placas and Ruropolis.

The geographic distribution of these interviews can be seen in Figure 31, the representative coverage of interviews within each municipality surrounding the Flona Tapajós has also been highlighted.

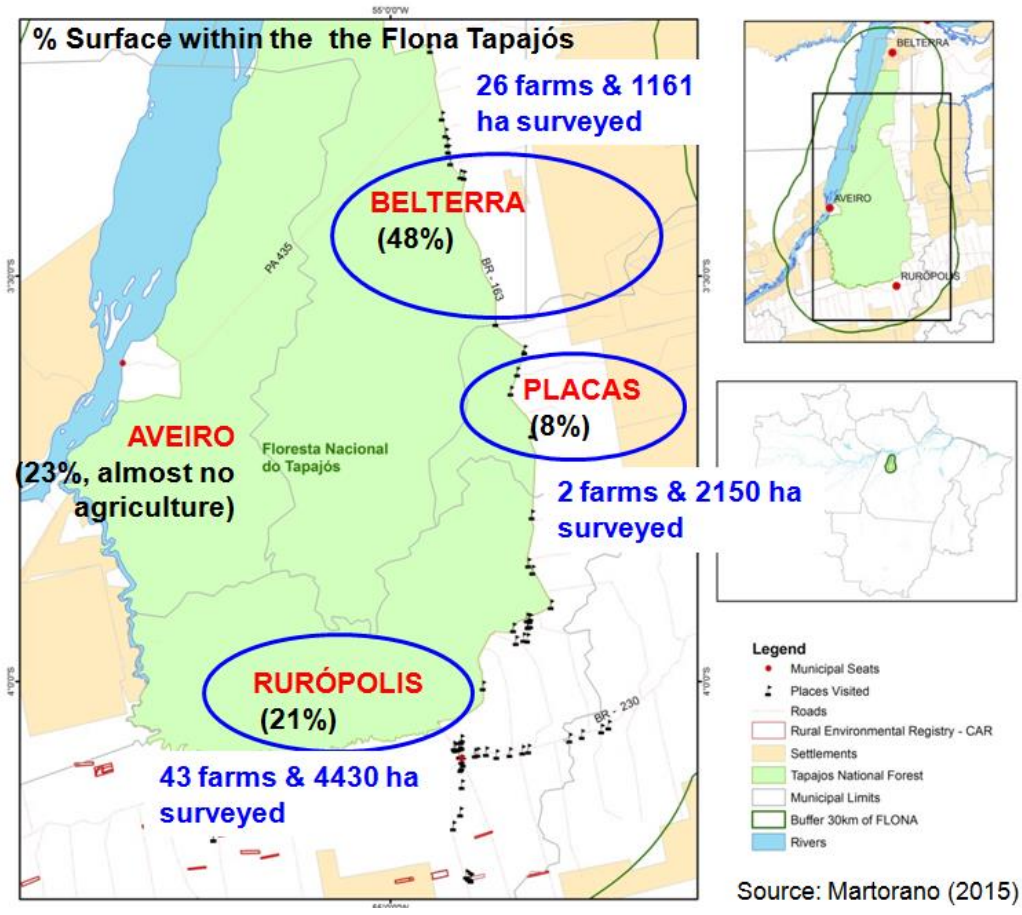


Figure 31. Distribution of interviews performed as part of the field-work in Brazil**.** The number of interviews performed in each municipality and total area covered in each municipality highlighted. Source Martorano (2015), see Annex 9.2.3.

The information collected from the fieldwork and enriched from a review of national statistics was processed, and allowed for selection of farm typologies for each of the three municipalities (Table 12)

Table 12. Farm typologies from the field-work in the municipalities surrounding the Flona Tapajós.

Farm Type	**Belterra**	**Rurópolis**	**Placas**
Very Small (Subsistence 0-10ha)	1.5ha of cropped area (manioc, maize), 8.5ha forest 30% of the farms		
Small (10-100ha)		10ha of cropped area (manioc, vegetables), 15 pastures (no livestock), 25ha forest 30% of the farms	
Medium (100-300ha)	25ha of cropped area (manioc, banana), 25ha pastures and small livestock, 50ha forest 30% of the farms	25ha cropped area (cacao, rice), 25ha pastures and livestock, 50ha forest 70% of the farms	30ha cropped area (fruit trees, black pepper, cacao), 20ha pastures and 50ha forest 100% of the farms
Large (300-2000ha)	300 ha of cropped area (soybean, maize), 300 ha forest 40% of the farms		

From the preliminary analysis of the fieldwork the following key findings have been made:

- Subsistence farms are located along the Tapajós riverbank. They have the largest (>80%) forest area and all logging is legal.
- Small-medium farms of 100ha (50% cropped area + pastures, 50% forests) are predominant due to colonies established in the 70s. Most valued farms are those located along the main road (BR 163) Santarém-Cuiabá
- Trend to single crop cultivation (soybean) in large farms of more than 300ha. Expansion of soy is taking place on abandoned pastures and not on newly deforested areas
- Farmers have access to social programs, but most do not have property rights and therefore, cannot benefit from credit lines

5.4.2 The Bio-economic Model

The next step of this work is to develop and implement a bio-economic model for Brazil, similar to Bolivia and simulate the impacts of a number of potential policy options. This model is in the process of being developed, following a similar structure to that of the model of Bolivia.

6. National Level Analysis

Climate change is a major threat to human and natural systems, with its insidious impacts to ecosystem functionality and services widely noted (IPCC, 2014). Tropical deforestation is increasingly recognised for the importance it plays in not only driving climatic changes, but also for potentially mitigating it. An estimated 11-17% of global greenhouse gas emissions originate directly from deforestation, forest degradation or other land use changes, largely occurring in tropical or sub-tropical regions (Baccini et al., 2012 and Harris et al., 2012). This deforestation not only contributes to emissions through the break-down of organic material, but it also reduces the capacity of forests as terrestrial carbon sinks and has dramatic effects upon biodiversity (Peres et al., 2010 and Pereira et al., 2012). Forest conversation and management offers a strategy for climate change mitigation, with Smith et al. (2014) highlighting the potentially vital role that reduced deforestation could have in avoided emissions, estimated to be around 1.4PgC yr-1 (Houghton et al., 2012).

Latin American and Caribbean forests have been subject to extensive deforestation; between 1990 and 2010 Ecuador saw a 28% reduction in forest, Paraguay 16% and Brazil 10% (FAO, 2010). The direct causes behind such extensive land use changes, in particular deforestation, can be attributed to conversions due to agricultural expansion, infrastructure development and timber extraction (Geist and Lambin, 2002). The drivers behind these relatively local-scale causes are more extensive in terms of both their sources and the scale of their effects. The underlying drivers of deforestation can be largely categorised into economic, governance and policy, social and biophysical factors. However, as no two countries are the same it is vital to identify the drivers of change in each country, as well as to consider whether patterns of deforestation can be identified across countries. This understanding and contextualisation of deforestation may be vital for the development of tailored, applicable and relevant national policies to mitigate climate change, conserve biodiversity and to protect ecosystem services.

6.1 Objectives and description of national scale analysis

To respond to these issues, the objective of this higher scale analysis is twofold; firstly, to identify explicatory variables which determine deforestation across Latin America and the Caribbean and secondly to describe the patterns of deforestation that these variables contribute to developing in the region. This work has been at the 11th International Conference of the European Society for Ecological Economics (ESEE) 2015 in Leeds (UK) presented (see Varela-Ortega et al., 2015b) and is in process of being published.

6.2 Methodology: cluster analysis and econometric models

To address this objective, statistical analysis as well econometric modelling were implemented based upon a database that incorporated multi-disciplinary factors that could potentially be descriptive as causes of deforestation in Latin America and the Caribbean. The construction of the database was directed by an extensive review of the contemporary literature on deforestation causes and drivers within Latin America and the Caribbean. This review covered over 80 peer-reviewed articles, which identified factors in over 15 Latin American and Caribbean countries at various scales, from local-continental. Based upon this review, the database was populated with data for over 70 factors in 27 Latin American and Caribbean countries. Factors included within the database were sourced from an extensive group of fields including social, economic, geographic, environmental, infrastructural, forestry, governance and agriculture. Further, data covering forest protection programmes, including REDD were included when available. Data was collected for the years 2000, 2005 and 2010, as these years coincided with the most recent FAO Forest Resource Assessments (FRA) reports. Data included within the database was sourced from a variety of open access databanks including FAOStat, WorldBank, UNDP and REDD/+.

The first phase of this analysis developed a descriptive process where countries were collectively characterised based upon an extensive selection of factors including; geographic features, land use, governance metrics, economic metrics, social and technological development. Using this descriptive analysis, countries were subjected to systematic cluster analysis, where countries were clustered with others characterised with similar attributes. This clustering was developed based upon endogenous variables identified to be important for deforestation (annual deforestation rate and national forest cover area) formulated the basis of this characterisation. National deforestation rates were formulated upon interpolation between two time steps (2000-2005 and 2005-2010).

The second phase of the analysis identified potential explanatory variables for deforestation using Principal Component Analysis (PCA). The central function of PCA is to reduce the number of dimensions within a data set, whilst retaining the greatest amount of variability explained by the data using orthogonal transformation (Pearson, 1901 & Hotelling, 1933). The PCA was performed using a correlation matrix with the rate of annual deforestation for the two time periods used as the dependent variable. The PCA was performed using the previously described database containing over 70 potentially explicatory variables of deforestation.

Following the PCA, a stepwise regression analysis of those variables identified by PCA permitted for selection of potentially explanatory variables for the model. These variables were subjected to a short panel two-stage regression model using data from the years 2005 and 2010. The endogenous variable ‘average annual deforestation’ was calculated from the periods 2000-2005 and 2005-2010 as previously mentioned.

6.3 Results of the Cluster Analysis and Econometric Modelling

6.3.1 Cluster Analysis

Initial analysis of forest cover and deforestation in the two time periods (2000-2005 and 2005-2010) across the 27 countries analysed demonstrated that these two variables were exclusively independent of each other, as evident from Figure 32. The analysis shows that deforestation rate and forest cover are independent factors, therefore highlighting their suitability as endogenous variables for the cluster analysis. Despite deforestation being the subject of analysis, forest cover was also used to categorise countries.

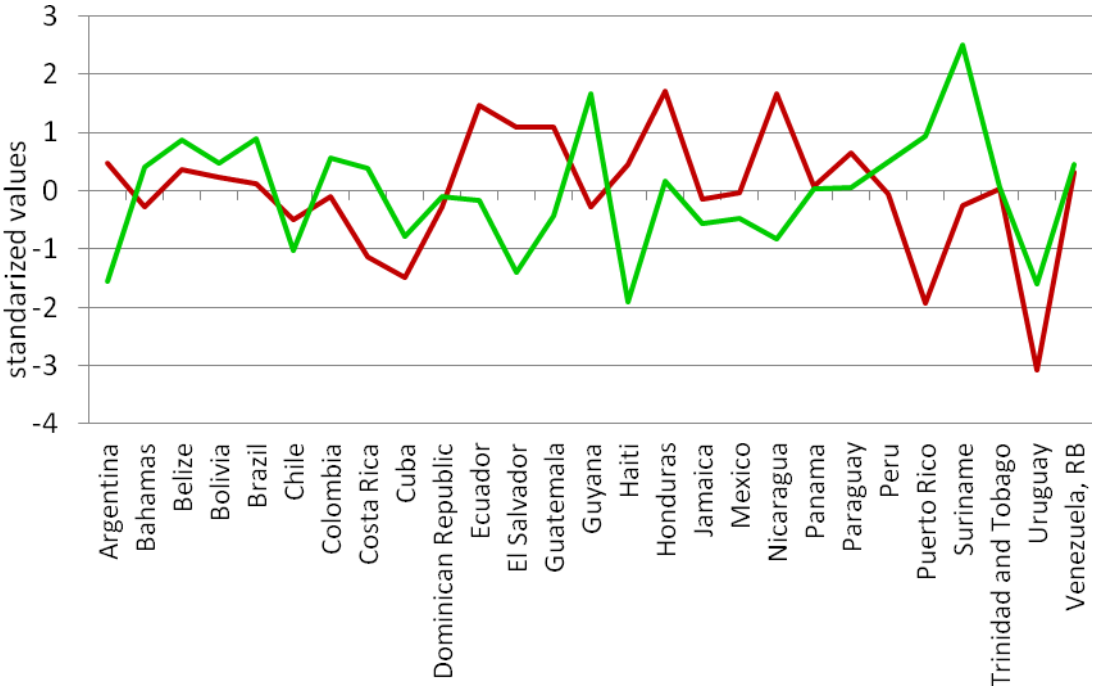


Figure 32. Deforestation and forest cover standardised values in the year 2010 across 27 Latin American and Caribbean countries. Red line represents the annual deforestation rate in 2010 (2005-2010) and the green line the forest cover area in 2010, both are standardised values.

From the cluster analysis, using both annual deforestation rate (standardised) and forest area (%) five distinct country clusters were identified and established; Extreme Risk, High Risk, Moderate Risk, Low Risk and Very Low Risk (Figure 33 and Table 13).

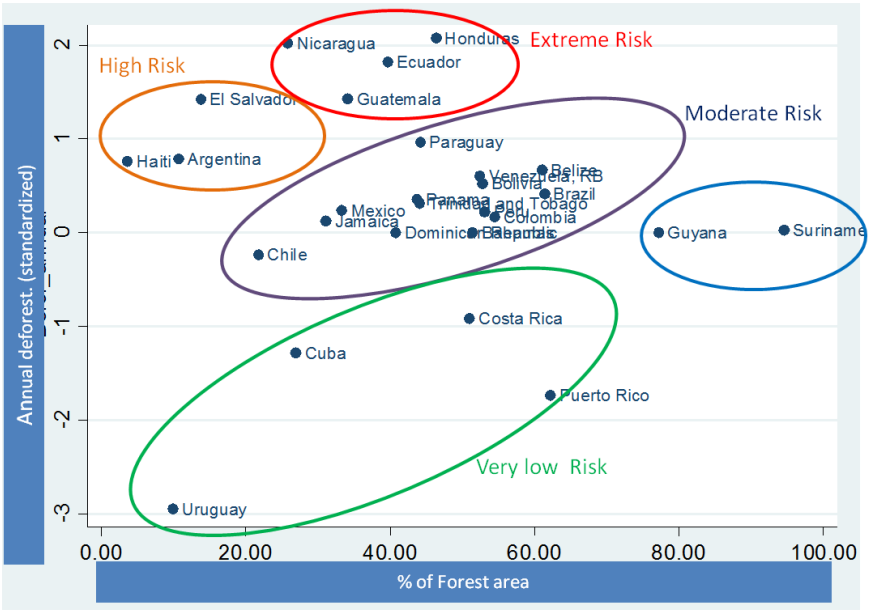


Figure 33. Country clusters developed from cluster analysis using standardised deforestation rate and forest cover.

Countries located within the extreme risk and high risk clusters are those that were considered to represent the greatest likelihood of deforestation, with low-medium levels of forest cover and high deforestation rates. Countries considered to be subject to moderate risk, were those with medium levels of forest cover, but with low-medium rates of deforestation. Low risk countries were those with extensive forest cover and very low (if any) deforestation, whilst those counties in the very low risk category had low forest cover, but were found to be reforesting (negative deforestation).

Table 13. The results of the cluster analysis, with each of the 27 countries analysed placed within their respective cluster. Clusters were developed based upon characterisation and grouping based upon such characterisation.

Cluster	Countries
Extreme Risk	Ecuador, Guatemala, Honduras, Nicaragua
High Risk	Argentina, El Salvador, Haiti
Moderate Risk	Bahamas, Belize, Bolivia, Brazil, Chile, Colombia, Dominican Republic, Jamaica, Mexico, Panama, Paraguay, Trinidad and Tobago, Venezuela
Low Risk	Guyana, Suriname
Very Low Risk	Cuba, Costa Rica, Puerto Rico, Uruguay

6.3.2 PCA and Panel Regression Model

The PCA highlighted agricultural and cattle ranching expansion, and certain factors associated with economic development, policy elements, social welfare as well as demographics. These factors were found to be highly relevant for determining deforestation.

The econometric model developed for deforestation in Latin America and the Caribbean (Equation 2) is, as previously mentioned a two stage regression model. The first stage of this model being to estimate the instrumented variable of forest cover ($\widetilde{\text{Forest}}\text{C}_{c,t}$), using the following six variables as instrumental variables; *arable land (percentage of land area and agricultural area), permanent crop land (percentage of land area and agricultural area), rule of law and rural population*, which were found to be significant determinants of forest cover.

$$\widetilde{ForestC}_{c,t} = \alpha + \beta_1 \cdot ArabLandPL_{c,t} + \beta_2 \cdot PermCrops_{c,t} + \beta_3 \cdot PopRurGr_{c,t} + \beta_4 \cdot RuleLaw_{c,t} + \beta_5 \cdot ArabLandPA_{c,t} + \beta_6 \cdot PermCropsPC_{c,t} + \varepsilon_{c,t} \quad (1)$$

Where: $\widetilde{ForestC}_{c,t}$ *is the instrumented estimation of forest cover in country c for year t; ArabLandPLc,t is the area covered by Arable Land as a percentage of land area in country c and year t, PermCropsc,t is the area covered by permanent crops as a percentage of land area in country c and year t, PopRurGrc,t is rural population growth as a percentage in country c and year t, RuleLaw is the level of the rule of law in country c and time t, ArableLandPA is the area covered by arable land as a percentage of agricultural area in country c and time t and PermCropPCc,t is the area covered by permanent crops as a percentage of total agricultural area in country c and time t.*

The use of forest cover as an instrumented variable permits the consideration within the analysis of a larger set of explanatory variables without reducing the model's degrees of freedom. In the second stage of the model (equation 2), the instrumented forest cover, population growth, mortality rate, and control of corruption are used as explanatory variables of deforestation. The results from the model estimation (Table 14) demonstrate that the exogenous variables in the model are highly significant, explaining 68% of variability within the average annual deforestation rate of those countries analysed.

$$Defor_{c,t} = \alpha + \beta_1 \cdot \widetilde{ForestC}_{c,t} + \beta_2 \cdot PopGr_{c,t} + \beta_3 \cdot MortMl_{c,t} + \beta_4 \cdot MortFm_{c,t} + \cdot ContrCorr_{c,t} + \varepsilon_{c,t} \quad (2)$$

Where: Deforc,t is the average annual deforestation rate of country c for year t; $\widetilde{ForestC}_{c,t}$ *is an instrumented variable of forest cover per country and year; PopGrc,t is the population growth rate per country and year, MortMlc,t and MortFmc,t are male and female mortality rate per country and year, and ContrCorrupc,t is a governance indicator for the control of corruption per country and year.*

Table 14. Results of the econometric model estimation.

Defor	Coef.	Robust std. error
$\widetilde{ForestC}$	-0.0048**	0.0025
PopGr	0.6549***	0.0932
MortMl	0.0116***	0.0025
MortFm	-0.0125***	0.0029
ContrCorrup	-0.6622***	0.1290
Constant	-1.2735***	0.3598

*Significance level: ***99%, **95%*

From Table 13 it is evident that the four non instrumented explanatory variables are significant at the 99% level, whilst the instrumented forest cover is significant at the 95% level. From these results further information can be identified, countries with greater forest cover have less deforestation, countries with higher population growth have greater deforestation, countries with more male mortality have greater deforestation, whereas with more female mortality have less deforestation, whilst countries with greater controls of corruption have less deforestation.

It is particularly interesting that the mortality metrics were identified as being so fundamentally important for explaining deforestation. These two metrics cover the probability of an individual dying between the ages of 15 and 60, which is the probability of 15 year old dying before reaching 60, if subject to current age- specific mortality rates between those ages (World Bank). If one considers these metrics, it is quite evident that these probabilities are dependent upon a wealth of other metrics such a political stability, social development, and economic factors amongst a host of others. Therefore, it can be assumed that a person in a politically stable country with a developed social welfare system is likely to have considerably lower probability of dying during these ages. Thus the use of these metrics could be considered as a proxy for development within the countries. However, it is curious that an increased mortality rate for each sex results in diametric results, male mortality results in increased deforestation, whereas female the contrary.

This work has been somewhat hampered by the relatively low data availability, which hindered the development of a long panel data model, which would have been able to consider the patterns of deforestation temporally. However, and in spite of this limitation, the model's goodness of fit, measured by the adjusted R2 (68.2) is high, describing of 68% of the variation in deforestation across Latin America and the Caribbean.

6.3.3 Country characterisation

Following the development of this step-wise regression model, consideration was made of the explanatory variables against the 5 clusters previously developed to formally develop the characterisation of the countries. Considering the characteristics of each country, clear patterns being to emerge, where those countries with the highest risk of deforestation ('High Risk' and 'Extreme Risk'- Table 13) are also those with the lowest levels of control of corruption, which supports previous research (Smith et al., 2003). Further, it is within these more corrupt, 'high risk' countries that we see mortality rates (both male and female) above average, and forest cover below average for all countries analysed. These results also suggest that such high and extreme risk countries may also have considerable social issues, as well as governance failures. The mortality metrics are defined as being the likelihood of death between the ages of 15-60, so such countries with higher mortality may have less ability to invest in healthcare, social welfare or social stability. Therefore, if such were true, one may assume that the protection of ecosystems and in particular forests may be particularly low on the list of policy concerns.

This analysis have supported the idea that patterns and drivers of deforestation may be subtly different across countries, and therefore policies that are developed to address deforestation must be contextually sensitive to consider such differences. It further not only highlights the immediate, direct and visible threats to forests from agricultural expansion, but also the somewhat unobservable underlying factors such as governance and the impacts of corruption. Any policy developed for forestry protection should address not only the immediate threats but also underlying ones. Developing institutional and social mechanisms that foster sustainable development, must also implement institutional safe-guards that redress the impacts of governance failures.

6.4 Conclusions

To briefly conclude this national-scale analysis, a number of points are worth repeating. **Firstly**, that before policies designed for biodiversity conservation and/or climate change mitigation are considered and drafted an in-depth consideration of drivers and causes of deforestation and land use change should be developed. The results of this analysis have demonstrated that there are considerable differences in these factors across countries and negate the possibility for one-size fits all policy development. **Secondly**, that governance, economic and social factors are fundamental to these differences. **Thirdly**, that future policies and international initiative such as REDD/+/++ should not only consider the immediate threats to deforestation, such as agricultural activity, but should pay further attention to the diffuse threats and focus upon the development of social and institutional mechanisms that will support development and in turn conservation.

7. Summary and Conclusions

This deliverable has presented a multi-scale approach responding the goal of Work Package 3 with the results of the third and final round of local stakeholder workshops of the ROBIN case studies in Guarayos (Bolivia) and Flona Tapajós (Brazil), the development and implementation of a bio-economic model in the Province of Guarayos and the national level econometric analysis of deforestation across Latin America and the Caribbean.

The third round of workshops for the cases of Guarayos (Bolivia) and Flona Tapajós (Brazil) were designed to allow for participatory selection of policy options for biodiversity conservation and climate change mitigation in both locales. In both case studies, stakeholders selected a variety of potential options from various sectors including: technological, social, economic and environmental potential options. Stakeholders were then invited to characterise each of the options to define, who would be responsible for their implementation, the level of public support, the compatibility with current legislation, the cost of implementation amongst other characteristics to offer a more in-depth understanding of the options. The workshops were completed with a series of voting to prioritise potential implementation.

Two clear options were selected as preferred by stakeholders, technical training in Bolivia and governmental coordination in Brazil. In Bolivia, the provision of technical training to develop technical capacity was prioritised as the most important option. The implementation of this option, according to the stakeholders, would have high levels of social acceptance, would be very compatible with present legislation. However, it was noted by participants that the development and implementation of such training would require considerable financial resources. In Brazil, governmental coordination was prioritised as the most important option for implementation. This coordination would receive extremely high social acceptance, would benefit society in general, should be implemented immediately and would require very little financial resources. However, and dissimilar to the prioritised option in Bolivia, this coordination would come up against considerable legislative problems as it is not currently considered compatible with present legislation. The analysis of the participatory process after the stakeholder workshops permitted for the evaluation of stakeholders' opinions on the development of the workshops, the options selected and the results. A majority of participants considered that the workshops were useful for them. Further, consideration must be made of the differences between the results of the ANP prioritisation and that of the stakeholder voting. Such comparisons show that there is rarely one clear option that stands out amongst various stakeholders to resolve all problems, but that a combination of policies would be required to resolve local issues and result in integration of biodiversity into climate change mitigation.

The multi-scale analysis developed within this document continued with a provincial analysis, to improve the understanding of an agro-forestry production system in Bolivia. The analysis developed a bio-economic model constructed using data collected from a period of fieldwork in the Province of Guarayos. The model explored the efficacy of a number of potential policy

measures that could be applied in the region to encourage ecosystem conservation on different farm types.

The model demonstrated the potential duplicitous outcomes of policies, which can potentially result in conflicting impacts on different farm types. On one farm a policy measure could be largely beneficial, whereas the same measure, in the same region could result in distinct outcomes on another, therefore consideration of this should be made before enforcing specific policy measure. Further, the model clearly demonstrated the large compensation costs required for conserving forests, which demonstrates the necessity of economic incentives, but at considerable public cost. The model has shown two clear conclusions: 1) a suite of policy instruments should be made available and applied sensitively to conserve ecosystems. 2) economic, agricultural and conservation policies need to be integrated and coordinated, with appropriate synergies developed and actions balanced.

Finally at the national level this analysis described patterns of deforestation across Latin American and the Caribbean, whilst identifying explicatory variables for determining deforestation across the continent. This analysis was formulated using a multi-step methodology; firstly based upon statistical analysis, cluster analysis and using econometric modelling.

From this analysis a number of patterns of deforestation were identified, with clear groupings of countries that fall within these distinct patterns made. Interestingly, neighbouring countries were often found to be in different groups, demonstrating the complexity of land use changes across the continent. There was also clear identification of drivers (including governance, economic and social factors) of deforestation across the continent and that these drivers also differ between countries, therefore demonstrating the necessity for in-depth consideration and analysis of national drivers and causes of deforestation before policies are drafted. Developing institutional and social mechanisms that foster sustainable development, must also implement institutional safe-guards that redress the impacts of governance failures. Finally, future policies and international initiative should not only consider the immediate causes of land use changes, such as agricultural activity, but should consider the diffuse threats and focus upon the development of social and institutional mechanisms that will support social development and in turn conservation.

From this multi-scale analysis a number of patterns and points have emerged that appear to repeat themselves. It appears imperative that for effective conservation of ecosystems that there is the provision of cross-ministry and local-national scale government coordination. This provision appears fundamental, not only to direct coordination and coherent policies, but also to integrate multi- sector policies such as environmental, agricultural and development.. The formation of such governmental coordination would be widely supported by the general public.

Conservation policies should not only consider the immediate threats, but also the diffuse ones too. The benefits of technical capacity building and investments in health and education have been demonstrated at the local-scale. However, it seems perfectly justifiable to say that over a

longer period the benefits of such policies aimed at these two factors would benefit countries and entire regions as a whole, both socio-economically and environmentally. This would therefore, support the idea that the most effective policies can improve well-being at a local-scale.

Finally, this analysis has demonstrated that one-size fits all policy options are very unlikely to be successful. Policies should be tailored specifically for each farm, province and region, rather than one policy per country. It has been repeatedly shown throughout this document and its predecessors the heterogeneous patterns of change that affect each local, province and country. To achieve such complex, tailored and site specific policy development will require considerable governmental consideration and may be highly dependent upon improved multi-scale governmental coordination and policy integration from multiple ministries.

8. References

Baccini, A., Goetz, S.J., Walker, W.S., Laporte, N.T., Sun, M., Sulla-Menashe, D., Hackler, J., Beck, P.S.A., Dubayah, R., Friedl, M.A., Samanta, S. and Houghton, R.A., (2012). Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. Nature Climate Change.2:182-185. DOI:10.1038/nclimate1354

Börner, J., Mendoza, A., Vosti, S.A. (2007) Ecosystem services, agriculture, and rural poverty in the Eastern Brazilian Amazon: Interrelationships and policy prescriptions. Ecological Economics 64: 3 5 6 – 3 7 3, doi:10.1016/j.ecolecon.2007.03.001

Börner, J., Wunder, S., Wertz-Kanounnikoff, S., Hyman, G., Nascimento, N. (2014) Forest law enforcement in the Brazilian Amazon: Costs and income effects. Global Environmental Change, doi:10.1016/j.gloenvcha.2014.04.021

Davidson, E.A., de Araújo, A.C., Artaxo, P., Balch, J.K., Brown, I.F., Bustamante, M.M.C., Coe, M.T., de Fries, R.S., Keller, M., Longo, M., Munger, J.W., Schroeder, W., Soares-Filho, B.S., Souza Jr, C.M., Wofsy, S.C. (2012) The Amazon basin in transition. Nature 481(7381):321–328.

Esteve, P., Blanco-Gutiérrez, I., Varela-Ortega, C. and Toledo, M. (2015). Balancing agricultural development and forest conservation in Amazonia: Can ecosystem degradation be reversed? Paper presented at The 11th International Conference of the European Society for Ecological Economics (ESEE), 30th June- 3rd July 2015. Leeds, UK.

Geist, H. J. & Lambin, E. R. 2002. Proximate Causes and Underlying Driving Forces of Tropical Deforestation. BioScience, 52:143- 150.

Gerritsen, P., Lazos, E., Balvanera, P., Díaz, J., Alvarez-Grzybowska, N., Solís-Carpio, J., Varela-Ortega, C., Blanco, I., Manners, R. and Esteve, P. (2015). Addenda to D.3.1.3 'Methods and Results from the first and second round of local stakeholder meetings' Case Study of Chamela-Cuitzmala, Mexico. Deliverable D3.1.3. ROBIN project. European Commission.

Ghajar, I. And Najafi, A. (2012). Evaluation of harvesting methods for Sustainable Forest Management (SFM) using the Analytical Network Process (ANP). Forest Policy and Economics. 21:81- 91. DOI: 10.1016/j.forpol.2012.01.003

Godar, J., Gardner, T.A., Tizado, E.J., Pacheco, P. (2014) Actor-specific contributions to the deforestation slowdown in the Brazilian Amazon. Proceedings of the National Academy of Sciences of the United States of America 111(43):15591–15596, doi:10.1073/pnas.1322825111

Grošelj, P. and Stirn, L. Z. (2015). The environmental management problem of Pohorje, Slovenia: A new group approach within ANP – SWOT framework. Journal of Environmental Management. 161:106- 112. DOI: 10.1016/j.jenvman.2015.06.038.

Harris, N.L., Brown, S., Hagen, S.C., Saatchi, S.S., Petrova, S., Salas, W., Hansen, M.C., Potapov, P.V. and Lotsch, A. (2012). Baseline Map of Carbon Emissions from Deforestation in Tropical Regions. Science. 336(6088): 1573-1576. DOI: 10.1126/science.1217962

Houghton, R.A., (2012). Carbon emissions and the drivers of deforestation and forest degradation in the tropics. Current Opinion in Environmental Sustainability. 4:597- 603. DOI: 10.1016/j.cosust.2012.06.006

Hosonuma, N., Herold, M., de Sy, V., de Fries, R.S., Brockhaus, M., Verchot, L.,Angelsen, A., Romijn, E. (2012) An assessment of deforestation and forest degradation drivers in developing countries. Environmental Research Letters 7(4): 4009, doi:10.1088/1748 9326/7/4/044009.

Hotelling, H. (1933). Analysis of a complex of statistical variables into principal components. Journal of. Educational Psychology. 24, 417–441, 498–520.

Martín-Ortega, J., Ojea, E., Roux, C. (2013). Payments for Water Ecosystem Services in Latin America: A literature review and conceptual model. Ecosystem Services 6: 122-132, doi:10.1016/j.ecoser.2013.09.008

Malhi, Y., Roberts, J.T., Betts, R.A., Killeen, T.J., Li, W., Nobre, C.A. (2008) Climate change, deforestation, and the fate of the Amazon. Science 319(5860):169–172.

Martorano, L., Correa, S., de Souza, H.H., Nascimento, N. and Sotta, E. (2015). Technical Report WP3.1. ROBIN Project, European Commission.

Müller, R., Müller, D., Schierhorn, F., Gerold, G. and Pacheco, P. (2012). Proximate causes of deforestation in the Bolivian lowlands: an analysis of spatial dynamics. Regional Environmental Change., 12:445- 459. DOI:10.1007/s10113-011-0259-0

Müller, R., Pistorius, T., Rohde, S., Gerold, G., Pacheco, P. (2013) Policy options to reduce deforestation based on a systematic analysis of drivers and agents in lowland Bolivia. Land Use Policy, 30, 895– 907

Pearson, K. (1901). On lines and planes of closest fit to systems of points in space. Philosophical Magazine. (6), 2, 559–572.

Pereira, H. M., Navarro, L. M. and Santos-Martins, I. (2012). Global Biodiversity Change: The Bad, the Good, and the Unknown. Annual Review of Environment and Resources, 37:25- 50.

Peres, C. A., Gardner, T. A., Barlow, J., Zuanon, J., Michalski, F., Lees, A. C., Vieira, I. C. G., Moreira, F. M. S. and Feeley, K. J. (2010). Biodiversity conservation in human-modified Amazonian forest landscapes. Biological Conservation, 143:2314- 2327.

Saaty, T.L., (1977). A scaling method for priorities in hierarchical structures. J. Math. Psychol. 15, 234–281.

Saaty, T.L., (1999). Fundamentals of the Analytic Network Process. International Symposium on the Analytic Hierarchy Process. Kobe, Japan. 12-14 August 1999. Available online: http://lab2.ioz.pwr.wroc.pl/download/AnpSaaty.pdfhttp://lab2.ioz.pwr.wroc.pl/download/AnpSaaty.pdf

Saaty, T.L., (2001). Decision Making with Dependence and Feedback: The Analytic Network Process. RWS Publishers, Pittsburgh.

Smith, J., Obidzinski, K., Subarudi, Suramenggala, I. (2003). Illegal logging, collusive corruption and fragmented governments in Kalimantan, Indonesia. International Forestry Review, 5(3): 293-302.

Smith, P., Bustamante, M.,Ahammad, H., Clark, H., Dong, H., Elsiddig, E.A., Haberl, H., Harper, R., House, J., Jafari, M., Masera, O., Mbow, C., Ravindranath, N.H., Rice, C.W., Abad, C.R., Romanovskaya, A., Sperling, F. and Tubiello, F. (2014). Agriculture, Forestry and Other Land Use (AFOLU). In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Soares-Filho, B.S., Nepstad, D.C., Curran, L.M., Cerqueira, G.C., Garcia, R.A., Ramos, C.A., Voll, E., McDonald, A., Lefebvre, P., Schlesinger, P. (2006) Modelling conservation in the Amazon basin. Nature 440(7083):520-523, doi:10.1038/nature04389

Super Decisions. (2013).Version 2.2.6 developed by Creative Decisions Foundation, Pittsburgh, USA. Available at: www.superdecisions.com

Van Eupen, M., Cormont, A., Kok, K., Simoes, M., Pereira, S., Kolb, M., and Ferraz, R. (2014). Modelling Land Use Change in Latin America. Deliverable D2.2.1. ROBIN project, European Commission.

Varela-Ortega, C., Kok, K., Blanco, I., Helfgott, A., Toledo, M., Clavijo, F., Lazos, E., Gerritsen, P., Martorano, L., Simoes, M., Ferreira, S., Juárez, E. (2013). A handbook to the participatory process in ROBIN: Development of methods for local stakeholder meetings. Deliverable D3.1.2, ROBIN project. European Commission.

Varela-Ortega, C., Blanco, I., Manners, R., Esteve, P., Kok, K., Toledo, M., Martorano, L., Simoes, M., Diniz, F., Lazos, E. and Gerritsen, P. (2014a). Methods and Results from the first and second round of local stakeholder meetings. Deliverable D3.1.3. ROBIN project. European Commission.

Varela-Ortega, C., Esteve, P., Blanco, I**.,** Toledo, M. (2014b). Analysing trade-offs between food production and ecosystem services in tropical forests of lowland Bolivia. Paper presented at the International Congress of Ecosystem Services Partnership 2014, 8-12 September 2014. San José, Costa Rica.

Varela-Ortega, C., Tarquis A.M., Blanco-Gutiérrez, I., Esteve, P., Toledo, M., Martorano, L. (2015a). Interpreting participatory Fuzzy Cognitive Maps as complex networks in the social-ecological systems of the Amazonian forests. Paper presented at the General Assembly 2015 of the European Geosciences Union (EGU), 12-17 April 2015. Vienna, Austria.

Varela-Ortega, C., Esteve, P., Manners, R., Blanco-Gutiérrez, I. and Barrios, L. (2015b). Analysis of current patterns of deforestation in Latin America and the Caribbean. Paper presented at The 11th International Conference of the European Society for Ecological Economics (ESEE), 30th June- 3rd July 2015. Leeds, UK.

Verburg, R., Filho, S.R., Lindoso, D., Debortoli, N., Litre, G. and Bursztyn, M. (2014). The impact of commodity prices and conservation policy scenarios on deforestation and agricultural land use in a frontier area within the Amazon. Land Use Policy. 37:14- 26. DOI:10.016/j.landusepol.2012.10.003

Walker, R. (2003) Mapping Process to Pattern in the Landscape Change of the Amazonian Frontier. Annals of the Association of American Geographers, 93(2), 376–398.

Wolfslehner, B. And Vacik, H. (2011). Mapping indicator models: From intuitive problem structuring to quantified decision-making in sustainable forest management. Ecological Indicators. 11:274- 283. DOI:10.1016/j.ecolind.2010.05.004

WorldBank. *Mortality rate.* Available: http://data.worldbank.org/indicator/SP.DYN.AMRT.MA. Last accessed 14 Apr 2015.

9. Annexes

This section presents additional materials from the work carried out and developed within this document.

9.1 Supplementary materials of the local scale analysis

9.1.1 Results of the complex network analysis carried out for interpreting FCMs

9.1.1.1 *Analysis of the FCM of the present: case study of Guarayos (Bolivia)*

FCM Factor	Pagerank	Betweenness	Closeness	Clustering	In_degree	Out_degree
Agricultural Expansion	0.045	0.035	0.222	0.100	1.800	1.750
Application of forest law	0.022	0.015	0.175	0.000	-0.900	-0.500
Application of INRA	0.014	0.000	0.203	0.000	0.000	1.400
Climate change/ droughts and torrential rains	0.025	0.023	0.038	0.000	0.500	0.800
Compliance with land zoning	0.020	0.000	0.175	0.000	-0.700	-0.200
Contamination	0.066	0.020	0.038	0.095	2.250	0.100
Deforestation/Clearing	0.123	0.160	0.260	0.030	1.700	4.700
Destruction of Environmental Services	0.035	0.000	0.000	0.000	0.900	0.000
Destruction of pampas	0.035	0.000	0.000	0.000	0.500	0.000
Fires	0.040	0.032	0.087	0.333	1.400	0.850
Grazing Expansion	0.018	0.015	0.214	0.333	0.500	1.600
Illegal Hunting and Fishing	0.041	0.012	0.077	0.167	0.750	0.850
Illegal Logging	0.026	0.049	0.175	0.000	0.200	0.500
Illegal Mining	0.014	0.000	0.103	0.000	0.000	0.900
Immigration	0.026	0.018	0.168	0.000	0.900	0.900
Inequality of benefits	0.026	0.022	0.130	0.000	0.900	0.900
Lack of awareness of environmental problems	0.014	0.000	0.051	0.000	0.000	0.500
Lack of understanding/application and coordination of laws	0.014	0.000	0.203	0.000	0.000	-1.350
Land encroachment*	0.025	0.018	0.175	1.000	0.500	0.250
Land trafficking*	0.014	0.000	0.141	0.000	0.000	0.900
Loss of biodiversity	0.127	0.000	0.000	0.333	1.750	0.000
Loss of lakes and natural springs	0.028	0.000	0.000	0.000	0.600	0.000
Loss of subsistence agriculture	0.037	0.040	0.148	0.000	0.900	0.900

FCM Factor	Pagerank	Betweenness	Closeness	Clustering	In_degree	Out_degree
Lower Crop Yields	0.071	0.000	0.000	0.000	1.300	0.000
Poor administration by community leaders	0.014	0.000	0.119	0.000	0.000	0.900
Poverty	0.047	0.055	0.179	0.000	0.900	0.700
Soil Erosion	0.039	0.002	0.038	0.000	1.200	0.500

9.1.1.2 *Analysis of the FCM of the present: case study of Flona Tapajós (Brazil)*

FCM Factor	Pagerank	Betweeness	Closeness	Clustering	In Degree	Out Degree
Access to Viable Economic Activities and Finance	-0.004	0.007	0.096	0.000	-0.900	-1.250
Agricultural Expansion	0.029	0.010	0.128	0.200	1.125	1.575
Climate Change	0.029	0.000	0.042	1.000	0.250	0.250
Communication between institutions and actors during projects	0.011	0.000	0.075	0.000	0.000	0.500
Deforestation	0.170	0.084	0.125	0.042	1.250	2.125
Depopulation of rural areas	0.010	0.000	0.000	0.000	-0.500	0.000
Environmental Monitoring	0.017	0.006	0.125	0.167	-0.825	-1.725
Financial Aid and Equality	0.012	0.001	0.075	0.000	-0.125	0.750
Forest Fires	0.068	0.003	0.031	0.500	0.175	0.750
Forest Products Value	0.042	0.010	0.087	0.000	-1.500	-0.500
Illegal Logging	0.024	0.005	0.031	0.000	-0.650	0.500
Illegal Mining	0.011	0.000	0.056	0.000	0.000	0.750
Incomplete production chain	0.023	0.001	0.075	0.000	0.750	-0.750
Increase in Amazon Population	0.011	0.000	0.136	1.000	0.000	1.500
Infrastructure projects	0.024	0.018	0.158	0.200	1.650	1.150
International interest to conserve Amazon	0.011	0.000	0.087	0.000	0.000	-0.500
Lack of efficiency in policies for subsistence farming	0.011	0.000	0.164	0.000	0.000	0.600
Lack of environmental awareness	0.011	0.000	0.169	0.000	0.000	1.000
Lack of Governmental Co-ordination	0.011	0.000	0.201	0.000	0.000	-1.450
Lack of protection of traditional forest communities	0.011	0.000	0.075	0.000	0.000	-0.750
Lack of Public Policy	0.011	0.010	0.087	0.000	-0.750	0.900
Lack of sustainable development models that include forest	0.018	0.006	0.113	0.333	-0.250	0.000
Lack of technical training and assistance	0.023	0.000	0.087	0.000	0.750	0.750

FCM Factor	Pagerank	Betweeness	Closeness	Clustering	In Degree	Out Degree
Loss of Biodiversity	0.109	0.000	0.000	0.000	2.000	0.000
Loss of Environmental Services	0.149	0.000	0.000	0.333	2.250	0.000
Opportunities to sell environmental services	0.011	0.000	0.087	0.000	0.000	-0.500
Population purchasing power	0.020	0.025	0.087	0.100	0.000	-0.500
Pressure from External Actors (agribusiness)	0.009	0.004	0.120	0.000	0.250	0.900
River Contamination	0.049	0.004	0.063	0.000	2.250	1.500
Social Organisation and Social Political Participation	0.009	0.007	0.096	0.000	-0.250	0.000
Technical and Productive Capacity	0.026	0.005	0.087	0.000	-0.250	-0.500
Technology Supplied For Sustainable Land Use	0.011	0.000	0.136	0.000	0.000	-0.375
Use of agrochemicals	0.023	0.006	0.056	0.000	0.750	0.750

9.1.2 Complementary materials from the 3rd SHW in Santa Cruz de la Sierra (Bolivia)

9.1.2.1 *Agenda of the Workshop*

PROGRAMA DEL 3º TALLER DE ROBIN EN BOLIVIA
Hotel Cortez, Santa Cruz de la Sierra, Bolivia
1 de julio de 2015

8:00-9:00	Bienvenida e inscripción de los participantes
9:00-9:30	Presentación del equipo IBIF y del proyecto ROBIN (Nataly Ascarrunz-IBIF y Consuelo Varela-Ortega-UPM) Explicación del Programa (Marisol Toledo)
9:30-9:45	Presentación de los participantes
9:45-11:00	Avances del proyecto ROBIN: • La importancia del bosque del húmedo de la Amazonía para el clima local y global (Lucieta Martorano-EMBRAPA) • Deforestación e Integridad Ecosistémica en la Amazonía (Margareth Simoes-EMBRAPA) • 3er taller participativo: Bolivia (Marisol Toledo-IBIF) • Búsqueda de soluciones compatibilizando el desarrollo humano y la conservación de la biodiversidad (Irene Blanco-UPM)
10:30-11:00	*Refrigerio*
11:30:12:00	Análisis y priorización de opciones para preservar la biodiversidad y los bosques en base a los resultados de talleres anteriores (Consuelo Varela-Ortega-UPM)
12:00-13:30	Selección y caracterización de opciones adicionales para preservar la biodiversidad y los bosques Selección de opciones adicionales en plenaria (Nataly Ascarrunz-IBIF y Consuelo Varela-Ortega-UPM) Trabajo en grupos: Caracterización de las opciones (quién, cómo, cuándo, barreras)
13:30-14:30	*Almuerzo*
14:30-16:00	Presentación y debate de las opciones caracterizadas en el trabajo en grupos plenaria (Nataly Ascarrunz-IBIF y Consuelo Varela-Ortega-UPM) Votación de las opciones plenaria (Nataly Ascarrunz-IBIF y Consuelo Varela-Ortega-UPM)
16:00-16:30	Clausura de la reunión y entrega de certificados plenaria (Nataly Ascarrunz-IBIF)
16:30-17:00	*Refrigerio*

9.1.2.2 *Options Characterisation Template*

Caracterización de opciones para preservar la biodiversidad y los bosques

Opciones	**A quién va dirigido** (quién será el principal afectado/ beneficiado)	**Actores responsables de su aplicación** (instituciones públicas, universidades, ONG, cooperación, otras)	**Cuándo debería aplicarse** (inmediatamente, el próximo año, en los próximos 5 años)	**Necesidad de recursos financieros** (muy alto, alto, medio, bajo)	**Compatibilidad con los programas, políticas y leyes actuales** (sí o no)	**Necesidad de apoyo técnico** (nuevas tecnologías, rescate de conocimientos tradicionales)	**Grado de aceptación social** (muy alto, alto, medio, bajo)
1.							
2.							
3.							
4.							
5.							
6							

9.1.2.3 *Option Voting Template*

Votación de opciones para preservar la biodiversidad y los bosques

Opciones	**Criterio Socio-económico** ¿Cuál de las opciones aporta más beneficios sociales y/o económicos?	**Criterio ambiental** ¿Qué medida tiene un impacto más positivo en el medio ambiente?	**Facilidad de Aplicación** ¿Qué medida es más fácil de aplicar? - Menos costosa - Más fácil de aplicar con las leyes y políticas actuales - Necesita menos tecnologías o conocimientos previos - Más aceptada socialmente	**PUNTUACIÓN TOTAL**	**PRIORIDAD** (Puesto en el ranking)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					

9.1.2.4 *Pictures of the Workshop*

Stakeholder introductions

Discussing the results from the ANP

Characterisation of the potential options

Voting for options

Participants of the workshop in Santa Cruz, Bolivia

9.1.3 Complementary materials from the 3rd SHW in Belém (Brazil)

9.1.3.1 *Agenda of the Workshop*

Apresentação de resultados de percepções, elaboração de mapas cognitivos e cenários na Amazônia: Flona Tapajós e seu entorno

Embrapa
Amazônia Oriental

Programação | 3.agosto.2015

8h	Credenciamento dos participantes e entrega de material
8h30-8h45	Abertura do III Workshop com stakeholders. Adriano Venturieri, chefe-geral da Embrapa Amazônia Oriental
8h45-9h	Breve apresentação de cada participante indicando nome, área de atuação e instituição.
9h-9h15	Importância da Amazônia no efeito escala do Sistema Climático e da biodiversidade na mitigação de mudanças climáticas . Lucieta G. Martorano, líder do Projeto Robin no Brasil, pesquisadora da Embrapa Amazônia Oriental
9h15-9h30	Integridade do Ecossistema na Amazônia Brasileira. Margareth Simões, pesquisadora da Embrapa Solos
9h30-9h45	Resultados obtidos no I e II Workshops no âmbito do projeto ROBIN: mapas cognitivos e cenários - Consuelo Varela-Ortega e Irene Blanco,Universidade Politécnica de Madrid -UPM
9h45-10h15	Validações e discussões dos resultados Irene Blanco, Universidade Politécnica de Madrid – UPM em conjunto com o moderador Fábio Homero Diniz , Embrapa Gado de Leite.
10h15-10h30	Apresentação de pôsteres: resultados obtidos no âmbito do Projeto ROBIN na Amazônia
10h30-10h45	Coffee break
10h45-11h15	Análise e priorização de opções para a manutenção da biodiversidade e das florestas obtidas a partir dos mapas cognitivos gerados nos Workshops I e II em Santarém, Pará. Consuelo Varela-Ortega, Universidade Politécnica de Madrid –UPM e Fábio Homero Diniz , Embrapa Gado de Leite
11h15-13h15	Seleção e caracterização de opções adicionais para a manutenção da biodiversidade na Amazônia: - Seleção de opções adicionais na sessão plenária. Moderador Fábio Homero Diniz , Embrapa Gado de Leite e equipe de apoio. - Formação dos grupos de trabalho com os Stakeholders e montagem das tabelas para a caracterização das opções
13h15-14h15	Almoço no Espaço Memória, pavilhão da chefia geral na Embrapa Amazônia Oriental
14h15-15h15	Discussão e apresentação das tabelas de opções pelos grupos .
15h15-16h15	Votação sobre as opções em plenária
16h15-16h30	Coffee break
16h30-17h	Encerramento

Projeto Parceiros

9.1.3.2 *Option Characterisation Template*

III WORKSHOP Projeto ROBIN: PLANO DE TRABALHO - W.P. 3.1:
Apresentação de resultados de percepções, mapas cognitivos e cenários na Amazônia: FLONA Tapajós e seu entorno.
Belém, 03 de agosto de 2015.

Caracterização de alternativas para preservar a biodiversidade e a floresta

Opções	**Quem serão os interessados ?** (Quem será o principal afetado/beneficiado)	**Atores responsáveis por sua aplicação** (Instituições públicas, universidades, ONG, cooperativas, extencionistas e outras)	**Quando deveria ser aplicado ?** (Imediatamente, no próximo ano, nos próximos anos)	**Necessidade de recursos financeiros** (Muito alta, alta, média, baixa)	**Compatibilidade entre os programas, políticas e leis atuais** (Sim e Não)	**Necessidade de apoio técnico** (Novas tecnologias, resgate de conhecimentos tradicionais)	**Grau de aceitação social** (Muito alto, alto, médio, baixo)
1.							

2.							
3.							
4.							
5.							
6							

9.1.3.3 *Option Voting Template*

III WORKSHOP Projeto ROBIN: PLANO DE TRABALHO - W.P. 3.1:
Apresentação de resultados de percepções, mapas cognitivos e cenários na Amazônia: FLONA Tapajós e seu entorno.
Belém, 03 de agosto de 2015.

Votação de alternativas para preservar a biodiversidade e a floresta

Opções	**Critério sócio econômico** Qual das opções traz mais benefícios sócio-econômicos?	**Critério ambiental** Que medida tem impacto mais positivo no meio ambiente?	**Facilidade de aplicação** Que medida é mais fácil de aplicar? - Menos custo - Mais fácil de aplicar de acordo com as leis e política atuais - Necessita de menos tecnologia e conhecimento prévio - É mais aceita socialmente	**PONTUAÇÃO TOTAL**	**PRIORIDADE** (Ranking)
1.					

2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					

9.1.3.4 *Pictures of the Workshop*

Stakeholder introductions

Discussing factors of change in the area

Characterisation of the potential options

Voting for options

Plenary session of the workshop in Belem, Brazil

9.1.3.5 *Report of the Workshop*

III COGNITIVE PERCEPTION WORKSHOP "THE BIODIVERSITY ROLE IN CLIMATE CHANGE MITIGATION"

Members of ROBIN Project

Lucieta Guerreiro Martorano
Embrapa Eastern Amazon

Consuelo Varela Ortega
Polytechnic University of Madrid (UPM)

Irene Blanco
Polytechnic University of Madrid (UPM)

Eleneide Doff Sotta
Embrapa Macapá

Belém, August, 2015

Introduction

The Embrapa Eastern Amazon on August 3rd, 2015 organized the III Cognitive Perception Workshop, together with the Polytechnic University of Madrid, under the ROBIN "Role Of Biodiversity In climate change mitigation", in the city of Belém. The Project is funded by the European Community and counts with the participation of 12 countries, including researchers from South America, Meso America and Europe. In Brazil, Embrapa represents the national team in the evaluation of indicators that points to the maintenance and loss of biodiversity in the Brazilian Amazon, as well as the case study conducted in the Tapajós National Forest.

This meeting has ensured compliance with Action Plan targets 3.1 (WP 3.1), where the results were presented in the 1st and 2nd Perception Workshop, in which cognitive maps and scenarios in the Amazon - Flona Tapajós and its surroundings were developed. The event happened in the city of Belém, at Embrapa Eastern Amazon's Research Pavilion and had the participation of representatives of governmental and nongovernmental organizations working in the Amazon.

In the III Workshop, two researchers from the Polytechnic University of Madrid together with the coordination of Embrapa Eastern Amazon actively participated in the organization of that meeting. The event had the participation of more than 20 educational, research and extension institutions as well as local traditional communities representatives from Flona Tapajós, rural entrepreneurs in the Northeast Pará grain's pole, representatives of environmental organizations in the Amazon and NGOs. A member of the Austrian team was also present, participating as an international observer, appointed by ROBIN coordination.

The dynamics adopted in the work plan were essential to stimulate the sharing of scientific technical knowledge, local and field experiences, facilitating the evaluation of cognitive maps built in the two previous workshops and the rethinking of new options to **preserve and conserve biodiversity and Amazon rainforest.** After intensive discussion between the teams divided into two working groups, there was the selection of 12 options leading up to the vote on the basis of socioeconomic, environmental and easiness of application criteria, which were scored and categorized into levels of priority.

1. Activities Program

1.1 In The Morning

In a brief opening ceremony, the Communication Center Coordinator (Kurumoto) gave an overview about the project and welcomed the participants. The general director of Embrapa Eastern Amazon (Adriano Venturieri) gave a warm welcome to all guests and spoke about the importance of the project to Amazon. Stressed that the work will help them better understand the importance of the region under its current conditions and climate change scenarios. He also congratulated the organizing committee for their commitment and leadership for organizing the event in Belém. He thanked the participation of those present and gave a special thanks to the visiting researchers and Santarém Municipal Secretary for the Environment (Podalyro Neto). Mr. Venturieri emphasized the importance of disseminating the results of the ROBIN to support public policies in the Amazon.

There was a moment when every participant presented him/herself, telling their names and the institutions they were representing at the event.

Following the event, the speaker asked researcher Lucieta to do the opening speech. To support the participants' understanding of the ROBIN project approach, the speaker talked about the need that the scientific community has to point out indicators showing the extent of the Amazon in scale effect of the climate system, where the region's biodiversity is critical in the mitigation of climate changes. She commented about authors who point out that species diversity increases towards the tropics (Primack; RODRIGUES, 2001), showing that the closer the equator, the smaller the variations in climatic conditions (Figure 1) and that is how there is greater biodiversity in equatorial regions.

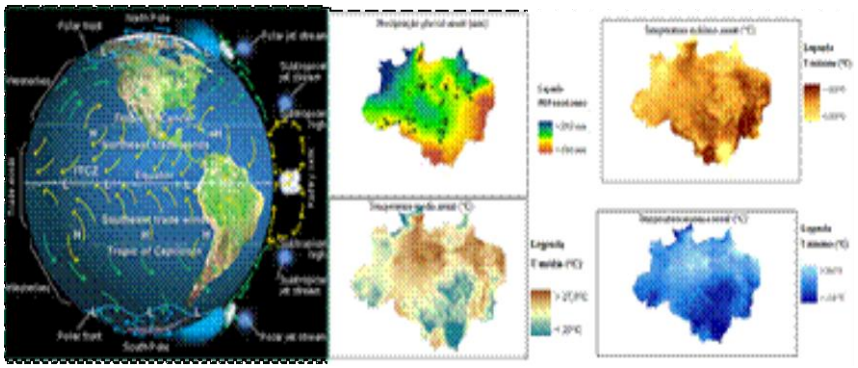


Figure 1. Evidence of weather patterns in the Amazon

The speaker (Figure 2) addressed issues such as:

Figure 2. Opening speech of the III Workshop

- A timeline indicating that the changes in the integration process of the Amazon have been linked to developmental policies and territory demarcation with incentives to fill the demographic gap in military period was presented.
- International pressure with regard to deforestation and the burning in the forest areas prompted the Brazilian government in 2009 to take a more conservationist stance. The commitments made at COP15 triggered several new actions, including the "zero deforestation" commitment to reduce the emissions of greenhouse gases, mainly encouraging an economy with bases in the ABC Program (Low Carbon Agriculture Program) in the municipalities. She also commented about Paragominas green municipality stamp received by the adoption of sustainable practices.

- Maps for easy visualization of the dynamic of space-time forces, such as: deforestation, based on the data from PRODES (INPE): Effective dynamics of cattle from 1974 to 2011, based on data from the IBGE were shown. She has also shown maps indicating hotspots and population density.
- She commented that about 60% of Amazon is under legally protected area, and that Flona Tapajós, the most studied conservation area, was chosen to carry out the case study on a local scale. The research over 40 years of forest inventory from Embrapa subsidizes the studies of ROBIN project. The speaker commented on some important results of the ROBIN project as two master's thesis and one doctoral thesis completed, as well as a few graduation monographs and some papers presented at scientific meetings.

Afterwards Professor Consuelo Varela-Ortega lectured on **"Seeking solutions conciliating human development and biodiversity conservation"** addressing the deforestation causes through perceptions about current and future conditions. The results were presented in meetings in Mexico and Bolivia (Figure 3).

Figure 3. Speaker teacher of Polytechnic University of Madrid, Spain

The professor explained that she was presenting a summary of all the work done throughout the duration of the ROBIN project. She said that the study was conducted in three scales: the first at the national level covering 27 countries in Latin America and the Caribbean, using econometric techniques and sought to answer on the relationship between the rate of deforestation and forest cover. It was presented a slide in which was possible to observe the map (Figure 4) with the different levels

of deforestation risk in Latin and Central America (Extreme Risk, High, Moderate, Low and Very Low). It was warned to the importance of identifying the causes and factors that promote deforestation in the region, for example at the national level focus on Brazil's Amazon.

Figure 4. Deforestation risk levels in Latin and Central America

About the local cognitive perception studies done during in the I and II Workshop in Santarem, it was shown that there is a lot of relationship between the variables, factors and the national and local indicators. The results of cognitive maps, were able to identify the main driving forces threating the integrity of Flona Tapajós and its surroundings, as well as the important elements and their relationships.

After the coffee break, Consuelo talked about the analytical process networks (ANP), which is a tool to support decision making in the desirable future scenario for the Amazon in 2050. Goals and objectives and their use were presented. Considerations about the political differences between Brazil and Bolivia were also raised. Each member was asked to have a close look in cognitive maps obtained in Santarem, showing that the results of perceptions of the two groups were evaluated together and combined to make get to the present time (Figure 5).

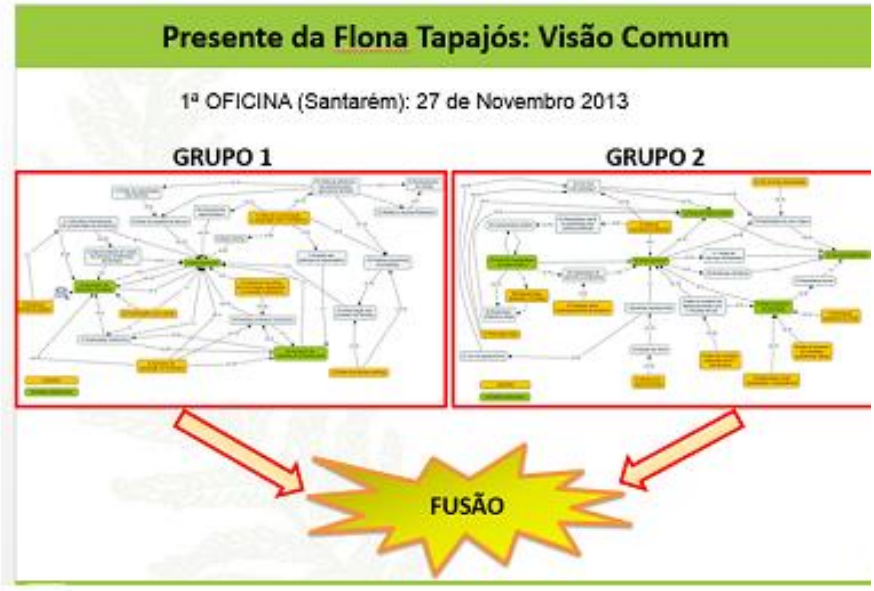


Figure 5. Cognitive maps of Group 1 and 2 obtained in Santarém in the I Workshop.

During the debate options for proposals were launched for the future of Amazon in 2050 scenario (Figure 6):

Figure 6. Discussion on future options for the Amazon in 2050

The indications of the participants in the workshops were:

- Support for social participation in the development of new public policies;
- Improve the efficiency of governance;
- Technical capacity improvement.
- Investment in health and education;
- Programs to improve environmental awareness;

- Programs to promote the integration of agricultural activities.

Subsequently, a poster section presented the works under ROBIN project (Figure 7).

Figure 7. Papers presented as posters that are inserted under the ROBIN project.

1.2 In the Afternoon

After the lunch, the participants were divided into two groups of discussion about the characterization of options on preserving biodiversity and forest. Group 1, had 13 members and had as mediators a researcher from Embrapa Amapá (Eleneide Sotta) and Professor Consuelo, from the Polytechnic University of Madrid, Spain (Figure 8).

Figure 8. Discussion of options for preserving biodiversity and forest. (a) Group 1 participants and moderators Eleneide Sotta (left) and Consuelo Varela (right).

Group 1 showed the following options:

- Technical capacity improvement;
- Governance efficiency improvement;
- Investment in health and education;
- Forest restoration programs;
- Economic valuation of protected areas;

- Payment for environmental services.

Other options questioned by the group were:

- Forest restoration programs: participants argued a lot about what would be the interest and needs of financial resources.
- Economic valuation of protected areas: In this topic participants argued a lot about what would be the economic valuation and how would that be for sustainable use areas and areas of integral protection.

Group 2 contained 22 members (Figure 9) and featured the moderators Fabio Diniz (Embrapa Dairy Cattle) and Lucieta Martorano (Embrapa Eastern Amazon) and the support of Professor Irene Blanco (Polytechnic University of Madrid).

Group 2 presented the following options:

- Strengthen forest monitoring capacity;
- Implementation of land and land use planning;
- Monitoring of water quality and other environmental services;
- Programs to foster the integrity of agricultural and forestry activities;
- Programs to improve environmental awareness;
- Support for social participation in the development of public policies.

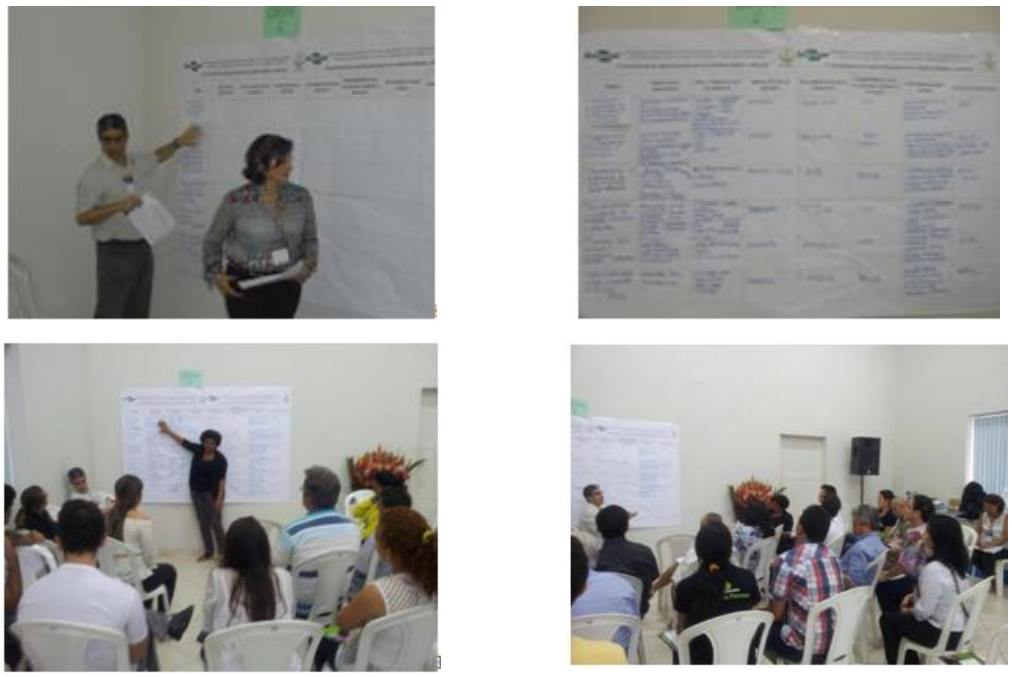


Figure 9. Characterisation of options by Group 2.

After the presentation of the results and discussion between the groups, It was conducted a voting section where each participant individually chose the three most important options out of the 12 ones. Each event participant was entitled to vote hierarchically on three options according to how important he considered, which were: 3 (high importance); 2 (average importance) and 1 (minor importance).

The most voted options chosen by the degree of importance on the order of 1st; 2nd and 3rd were respectively (Figure 10):

- Governance efficiency improvement;
- Investment in health and education;
- Programs to promote the integrity of agricultural and forestry activities.

Figure 10. Result of the vote of the options for forest conservation and biodiversity.

2. III Workshop's Closing Time

The event's organization committee thanked the participants for the excellent workday and team integration (Figure 11).

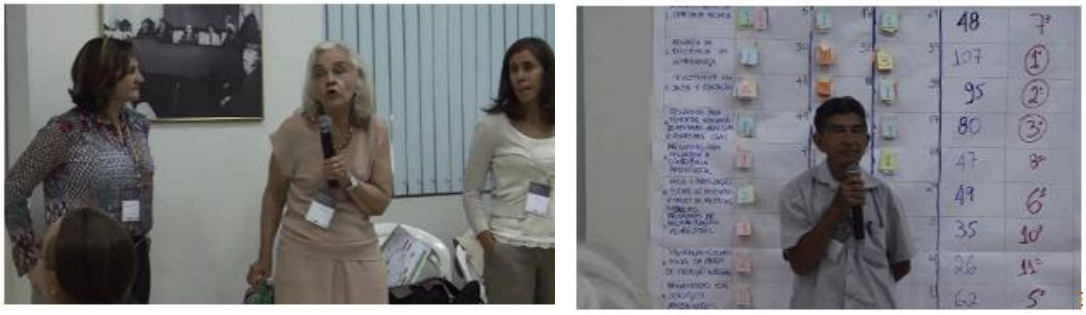


Figure 11. The team of organizers of the III Workshop thanked the present and some participants made their statement about the success of the event.

3. Moment of Accouting Data

After the event, the team continued working to see the results of all voting section and to put the list of options in digital media, the result of discussions between the two groups options (Figure 12)

Figure 12. Organising team doing the accounting records and the results of votes

Records of members in relaxation times of the group at the end of the event with the reward of accomplishment (Figure 13).


Figure 13. Team at the end of the event

4. Participating Institutions

- Agência de Defesa Agropecuária do Pará – ADEPARA
- Comunidade Maguary
- Cooperativa Mista da Flona do Tapajós – COOMFLONA
- Empresa de Assistência Técnica e Extensão Rural do Estado do Pará – EMATER/ Regional Santarém/ Belterra
- Empresa Brasileira de Pesquisa Agropecuária – Embrapa
- Escola Superior de Agricultura "Luiz de Queiroz" – ESALQ – USP
- Faculdades Integradas do Tapajós – FIT
- Universidade Luterana do Brasil – ULBRA
- Grupo Arboris – Manejo Florestal
- Instituto Chico Mendes de Conservação da Biodiversidade – ICMBIO
- Instituto Nacional de Pesquisas Espaciais – INPE
- Institute of Social Ecology
- Instituo de Proteção Ambiental do Amazonas – IPAAM
- Ministério da Agricultura, Pecuária e Abastecimento – MAPA
- Museu Paraense Emílio Goeldi – MPEG
- Secretaria Municipal de Meio Ambiente de Santarém – SEMMA
- The Nature Conservancy – TNC

- Universidade Federal do Oeste do Pará – UFOPA
- Universidade do Estado do Pará – UEPA
- Instituto de Desenvolvimento Florestal do Estado do Pará - Ideflor

5. Support Material to Participants of the Workshop

Participants were provided with a folder with the brochure containing the schedule of the III Workshop, an identification badge as well as the discussions aid material (cognitive maps of the present and future and an options table). The certificate was handed over to the final event to each participant (Figure 14).

Figure 14. Material distributed to the participants of the III ROBIN Project's Cognitive Perception Workshop (a) brochure with the event schedule; (b) participant identification badge; (c) certificate of participation.

In Figure 15, we see the moment of accreditation of participants of the event and the opportunity and dissemination of products made by artisans of the Maguari Community, in Flona Tapajós.

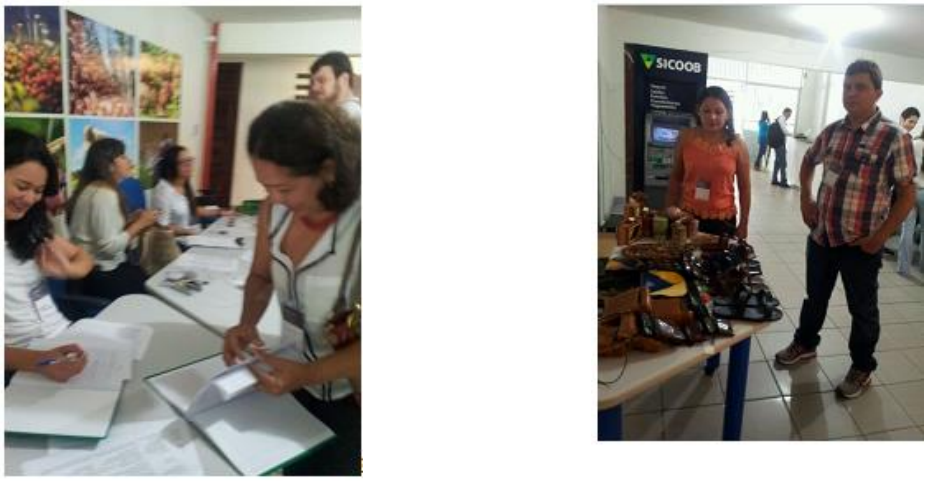


Figure 15. Registration and disclosure of the work of artisans in the Community of Maguari, in Flona Tapajós

6. Results of the Event Evaluation by All Participants

The Commission handed to all participants at the end of the III Workshop questionnaires containing a total of 11 questions.

We observe in Figure 16 that 85% of event participants considered the event relevant and that its results reflect the reality of the Amazon and Flona Tapajos and its surroundings. It was also observed that in Figure 17 which institutions and segments of society participated in the event, in which 31% were representatives from the Federal Government and 22% were representatives from Research and Educational Institutions, both representing the biggest parcel of the participants.

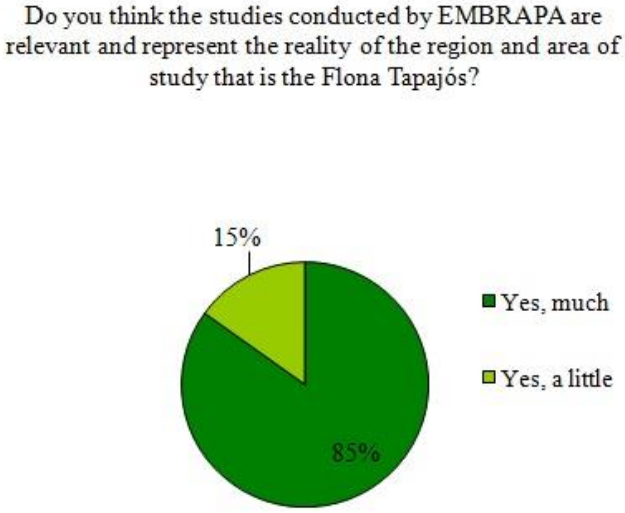


Figure 16. Result of questions contained in the questionnaires relating to ROBIN Project.

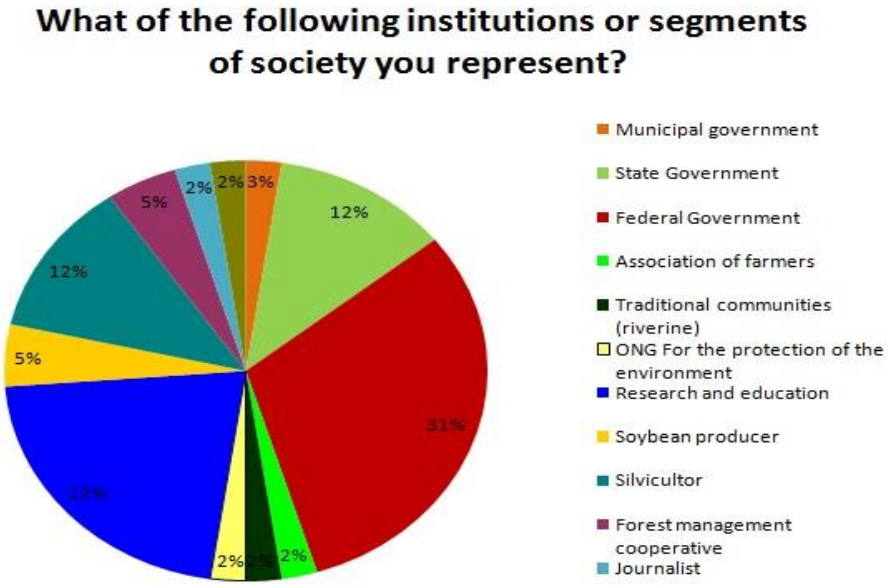


Figure 17. Institution or segments of society participants.

From all participant, 26 were satisfied with the results of cognitive maps, and 24 agreed with the scenarios for Amazon in 2050 (Figure 18).

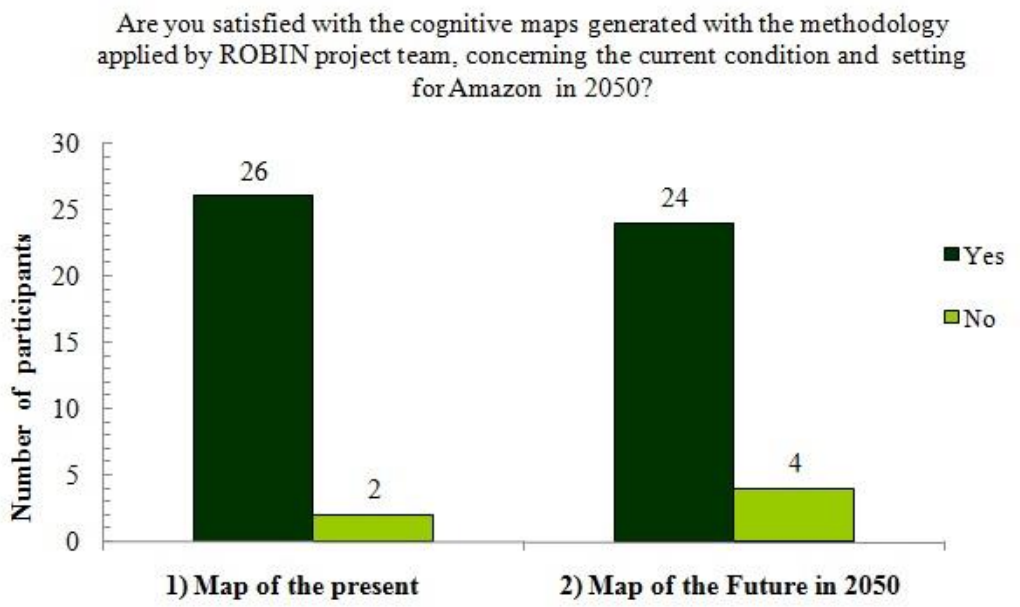


Figure 18. Cognitive maps reflect the present conditions and point evidence on Amazon scenario in 2050.

The degree of satisfaction (Humômetro) was evaluated and from 40 participants 39 replied that they were satisfied, only 1 marked as unsatisfied (Figure 19).

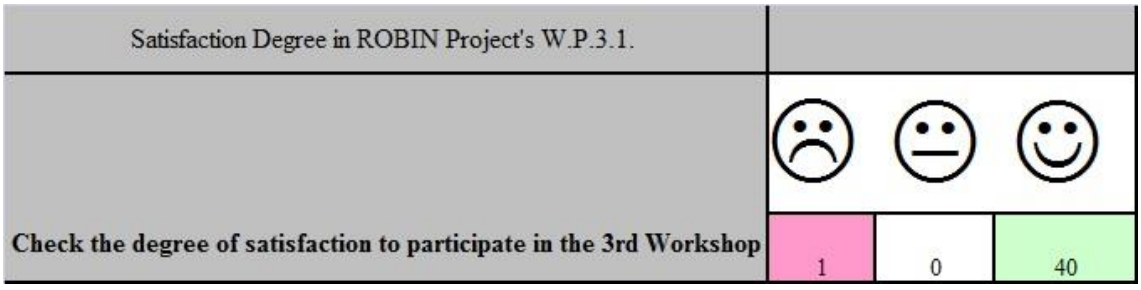


Figure 19. Evaluation result on the mood of the participants at the end of the event.

The result of the question if each participant was pleased with the vote of the options (Figure 20), shows that 94% of participants were satisfied, namely the 35 who answered this question, only 2 subjects (6%) did not agree with the result of the satisfaction of participants of the III ROBIN Workshop as the options to ensure the maintenance of biodiversity in the Amazon.

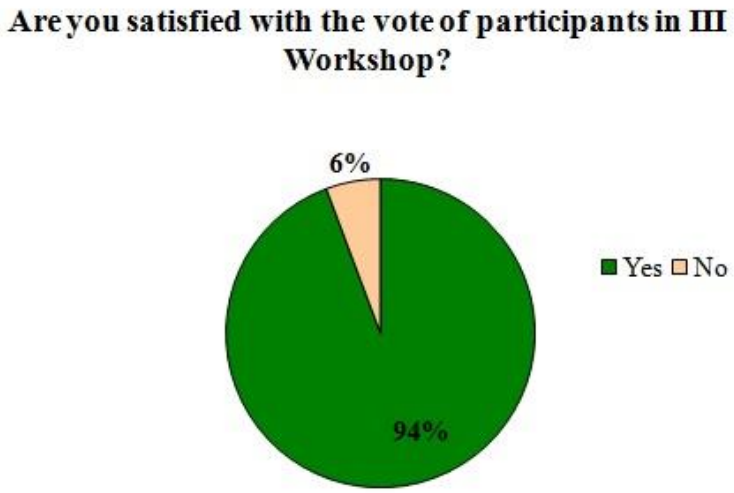


Figure 20. Satisfaction of participants of the Workshop about voting options for the Amazon.

When asked about the degree of satisfaction with the process used at the meeting for selecting options and votes of the participants, 97% of people were satisfied with the methodology adopted at the meeting, and 3% said they were not satisfied (Figure 21).

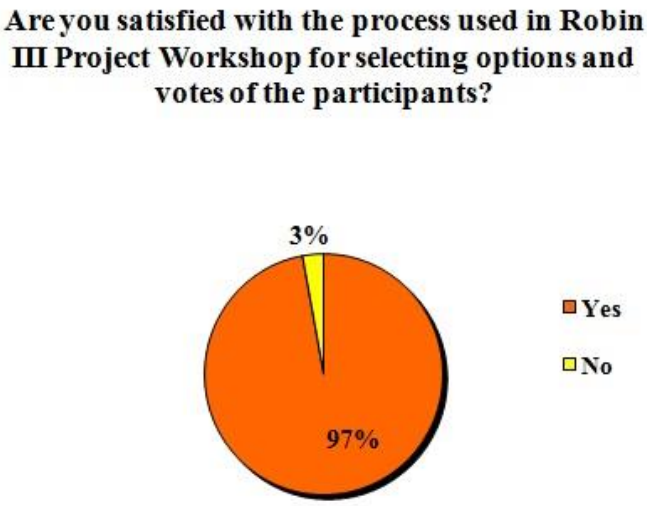


Figure 21. Satisfaction of event participants about the process used in ROBIN III Workshop for selecting options and votes of the participants.

The evaluation if the meeting had met the expectations of participants, 78% answered "a lot", that is, the III Workshop ROBIN project reached the goal proposed in the perception of 28 participants. On the other hand, 8 participants, representing 22% of our sample unit answered that the event met some expectations (Figure 22), possibly because they did not participate in other workshops and the time may not have been enough to understand the methodological approach used in WP 3.1. Also, considering that 80% of the participants were attending for the first time (Figure 23).

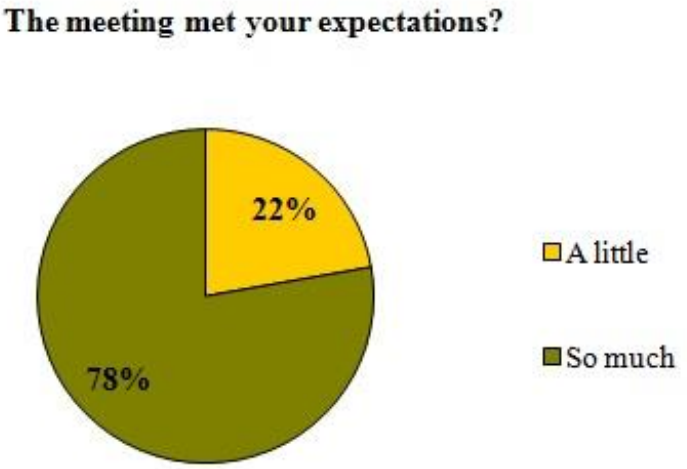


Figure 22. Attendance percentage of participants' expectations regarding the III Workshop ROBIN

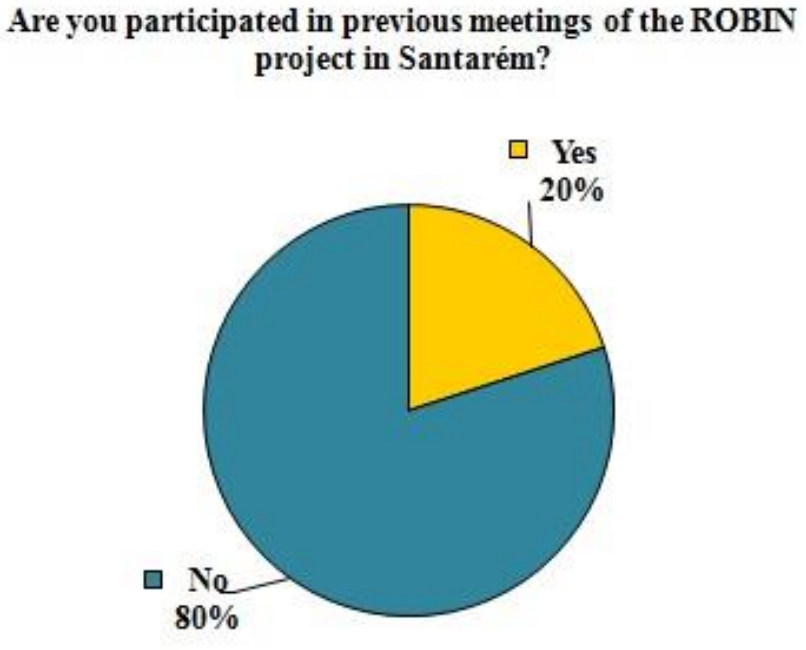


Figure 23. Percentage answering the expectations of the participants to participate in the III WP Workshop 3.1.

7. Technical Considerations

Among the comments that were recorded in the questionnaires collected at the end of the event are:

- ICMBio representative expressed interest in receiving the publications arising from the analysis of perceptions held by ROBIN Project and congratulated all the organising team of the event;
- Some participants stressed the importance of the methodology applied by ROBIN WP Project 3.1 and the possibility of applying it for their research activities in their institutions;
- Other participants positively assessed the issue addressed in the workshop, as well as its applications suggested in other studies to ensure sustainable development in the Amazon in the medium and long term.
- It is worth noting that the event obtained full success, exceeding expectatives of the attending stakeholders.

8. Acknowledgements

The III Workshop Organizing Committee records their thanks to the Head of Embrapa Eastern Amazon for welcoming the participants of the event, to the unit's researchers who participated and collaborates in technical discussions, to the speaker Winicuis Kuromoto and Sheila Melo for their support during the event. Also records their thanks to the Communication Center of Embrapa Eastern Amazon, especially Sabrina Gaspar for the creation of the art of marketing materials (brochure and badge) and Ana Laura Lima for their support in the promotion of the Workshop. The event reached its planned target through the active participation of representatives from more than twenty institutions that were present, collaborating in discussions of the results of cognitive maps, selection of new options in the two working groups and general vote of the participants in the selection of 12 options. We could not fail to register our thanks to moderator Fabio Diniz that was kindly provided by Embrapa Dairy Cattle (Juiz de Fora) to strengthen the ROBIN project team, supporting the

enforcement activities of the evaluation methodology of the stakeholders' perceptions. Also, it is worth noting our thanks to the four observers for their attention, commitment and their records of all the participatory process throughout the event. We express our thanks to the students who presented their work as a poster touring the participants through the results obtained under the Project, as well as for our fellow interns from Agrometeorology Laboratory who performed their activities in accreditation, delivery microphones to participants during the technical discussions and any support during lunch and group work. To the driver of the minibus from Embrapa for his collaboration in the hotel's shuttle to Embrapa and vice versa. To the great support from Embrapa's employee Sandoval in the preparation of the flower arrangements in the auditorium, support the committee throughout the process of organization and completion of activities in the Space Memory of Embrapa Eastern Amazon. Finally, our special thanks to the Arboris Group for sharing of the expenses of the event, offering the participants a coffee break in the morning and in the afternoon.

9.2 Supplementary materials of the provincial scale analysis

9.2.1 Example of field work interview, Bolivia

ENCUESTA A LOS AGRICULTORES

Nombre:
Localización de la propiedad:
Edad: Educación: Nº miembros de la familia: Nivel de ingresos:
Antigüedad en la tierra: Infraestructuras, saneamiento y carreteras:

1. ¿Cuál es la superficie de su propiedad/tierra? ¿Qué tipos de propiedades/tierras son las más frecuentes? (en cuanto a tipo de agricultor, por tamaño y cultivo)

2. ¿Usted tiene la tierra en propiedad o en alquiler? ¿A cuánto está la venta (secano y regadío) en Bs/ha? ¿A cuánto está el alquiler en la zona (secano y regadío) en Bs/Ha?

3. Cultivos, ingresos y costes:

	Cultivo	Superficie (ha)	Fecha de siembra y de cosecha (mes)	Rendimiento (kg/ha)	Precio (Bs/kg)	Semilla (Bs/ha)	Fertilizante (Bs/ha)	Fitosanit. (Bs/ha)	Maquinaria (Bs/ha)	Mano de obra (horas/ha)
1										
2										
3										
4										
5										
6										

4. ¿Qué rotaciones realiza usted entre los cultivos? Especificar cultivos y fechas. ¿Tiene segundas cosechas? ¿Cultivos asociados (agroforestal)?

5. ¿Cultiva más unos cultivos en un tipo de suelo que en otro distinguiendo entre bueno y malo? ¿Cuánto pueden variar los rendimientos de tener un suelo bueno a un suelo malo?

6. Cultivos permanentes: costo para producción y año en que entra en producción.

7. ¿Qué hace con sus productos? ¿Cuánto destina para consumo en su hogar? ¿Cuándo y dónde vende sus productos? ¿Cooperativas?

8. ¿Tiene usted algún mecanismo para protegerse del riesgo de la cosecha? ¿Cuánto paga por ello?

9. **Financiación:**

a. **A corto plazo** (dentro de una misma campaña): financiación de las semillas, fertilizantes…, etc. Es decir, todo lo que se utilice en la misma campaña. ¿Quién financia esto? ¿Las casas de fertilizantes, semillas…, o piden un crédito bancario? Especificar condiciones.

b. **A largo plazo:** Inversiones en la agricultura, adquisición de maquinaria, etc. ¿Quién financia esto? ¿Se pide un crédito? Especificar condiciones.

10. **Mano de Obra:**

a. Mano de obra familiar. ¿Qué labores hace: gestión, laboreo, supervisión, etc.? ¿Cuántas horas trabaja usted al día (especificar cada campaña)? ¿Y el resto de sus familiares?

b. ¿Se utiliza mano de obra contratada fija o/y eventual? ¿Cuántas **horas** trabajan respectivamente al día, en qué periodo del año trabaja más? ¿Para qué funciones y/o cultivos la contrata? ¿Cuánto cuesta **(Bs/h)** la mano de obra contratada fija? ¿Y la eventual?

OTRAS PREGUNTAS

11. ¿Cómo decide qué cultivar cada año (tradición, incentivos, precios…)?

12. ¿Se plantea introducir nuevos cultivos o variedades? ¿Tiene acceso a información y apoyo para innovar?

13. ¿Realiza usted actividades de ganadería o forestales? ¿Tiene usted alguna otra fuente de ingresos distinta de las actividades mencionadas?

14. ¿Participa usted en alguna iniciativa de manejo sostenible de tierras?

15. ¿Se beneficia usted de alguna ayuda del gobierno (nacional, regional…)? ¿Qué leyes afectan más a su actividad?

16. ¿Qué daños en las cosechas son más frecuentes (heladas, plagas…)? ¿Hay problemas de robo de productos?

9.2.2 Example of field work interview, Brazil

QUESTIONÁRIO PARA OS AGRICULTORES

Nome:

Localização da exploração:

Dados pessoais:

- Idade e sexo:
- Escolaridade:
- Tempo de trabalho na agricultura:
- A residência é no local onde desenvolve atividades como agricultor?:
- Tem outra fonte de renda além da atividade na agricultura?:

- Que tipos de fazendas são mais comuns? (Em termos de tipo de agricultor, tamanho, culturas).

- Qual é a área da sua exploração:

Destino do uso da terra	Hectares
1. Produção agrícola	
2. Pastos	
3. Florestal	
4. Outros	

- Você possui propriedade (titulo) da terra? E alugada? ou usa em parceria? Ou já mora nessa propriedade hà muitos anos? Quanto custa sua propriedade (real por hectare). Há diferentes valores para as propriedades, conforme o solo e o local? Quanto custa o aluguel de um hectare?

- Nos últimos 14 anos você considera que a sua propriedade aumentou o valor de mercado? Quanto?

- Quem trabalha na sua propriedade? Que trabalhos fazem, gestão, mobilização, supervisão etc? Quantas horas você trabalha por dia no período mais chuvoso e no menos chuvoso.Trabalham outros membros da família? Dedicam quanto tempo nesse trabalho? Vocês trabalham em mutirão? Quantos são realizados ao ano?

- Mão de obra contratada:

Tipo	Nº pessoas	Meses/ano Horas/día	Para que funções e/o cultivo?
- Fixa			
- Eventual			

Quanto custa R$/h a mão de obra contratada fixa? E a eventual?

- Como comercializa seus produtos? Através de intermediários ou diretamente a consumidores e indústrias?

- **Financiamento:**

  - **A curto prazo** (até um ano): o financiamento para sementes, fertilizantes, entre outros... Isto é, tudo o que é usado na mesma campanha. Quem financia isso? As casas de fertilizantes, sementes ou pede um empréstimo bancário? Especificar condições.
    PRONAF (Você já utilizou ou utiliza esse apoio financeiro?

  - **A longo prazo**: Os investimentos em exploração, compra de máquinas, etc. Quem financia isso? Solicita crédito? Especificar condições.

- Você participa de qualquer iniciativa de conservação ou manejo florestal sustentável?

PRODUÇAO AGRÍCOLA

Tipo de cultura	Superfície (ha)	Data de plantio e colheita (mês)	Irrigação? (se é assim a técnica)

- Qual o tipo de solo explorado? Cultiva mais de uma cultura em um tipo de solo? Como classificaria o solo explorado: bom, mal ou regular.

- Em sua propriedade você identifica algum processo de erosão do solo, ou seja, aquelas aberturas no solo.

- Como você classifica a sua terra, como bem produtiva, media produção ou alta produção. Qual fator garante que você esta correto na classificação ?

- As culturas permanentes: custo de colocação no mercado e ano em que entra em produção.

- Que rotação você realiza entre as culturas? Especifique culturas e datas. Você tem segundas culturas? Consorciação de culturas?

- Onde você comercializa os seus produtos? Cooperativas? Quando você vende seus produtos?

- Você já garantiu a produção ou colheita? Quanto isso custa?

Dados das culturas

Cultura	Rendimento (Kg/ha)	Preço (R$/Kg)	Subsídios (R$/ha)	Água (R$/ha)	Sementes (R$/ha)	Fertilizantes (R$/ha)	Fitossanitários (R$/ha)	Máquinas (R$/ha)	Mão de obra (R$/ha)	Necessidades de mão de obra (horas/ha)

- Quais os maquinàrios utilizados? (tratores, reboque, caminhao, arados, outros…)? Você è o proprietário? Se nao, como você consegue esses maquinários?

PRODUÇAO PECUÁRIA:

ADEPARÁ

TIPO DE ANIMAL	NÚMERO (2014)	NÚMERO (2013)	NATALIDADE (2013)	MORTALIDADE (2013)	COMPRA E PROCEDENCIA DA COMPRA (2013)	VENDA E DESTINO DA LA VENDA (2013)

Dados da pecuária

ANIMAL	KG/ANIMAL	PREÇO (R$/KG)	SUBSÍDIOS DO GOVERNO (R$/ANIMAL)	RENDA PELA VENDA DO ANIMAL (R$/ANIMAL)	CUSTOS COM ALIMENTAÇAO DO ANIMAL: (R$/ANIMAL)	CUSTOS DA MAO DE OBRA (R$/HORA)	NECESIDADE DE MAO DE OBRA (HORAS/ANIMAL)	OUTROS CUSTOS (R$/ANIMAL)

PRODUÇAO FORESTAL/MADEIREIRA:

TIPO DE ÁRVORES	HECTARES	NUMERO DE ARVORES POR HECTARE	TEMPO PARA O CORTE DA ÁRVORE (ANOS)	SUPERFICIE CORTADA (2013)

- Quais os serviços proporcionados pela floresta? Qual a finalidade de usos da madeira? Casa? Barco? Serviços recreativos? Turismo? Outros?

- Quais outros bens da floresta que são comercializados? Resinas, sementes, frutos, outros?

- Rotatividade do corte das árvores:

Dados de produtos da floresta

PRODUTO	VOLUME DE MADERA (M3/HA)	PREÇO (R$/$M^3$ DE MADERA)	SUBSÍDIOS DO GOVERNO (R$/ÁRBOL/HA)	RENDA COM A VENDA (R$/HA)	CUSTOS PLANTAÇAO (R$/HA)	CUSTOS: CORTE (R$/HA)	CUSTO DE MAO DE OBRA (R$/HORA)	NECESIDADES DE MAO DE OBRA (HORAS/HA/EMPREITADA)	OUTROS CUSTOS (R$/HA)

9.2.3 Technical report of the Brazilian field work

TECHNICAL REPORT W.P. 3.1

This work has been funded by the Universidad Politécnica de Madrid: Biodiversidad y cambio climático en la Amazonia: perspectivas socio-económicas y ambientales. Project No.: AL14-PID-12. UPM Grants for activities with Latin American countries. Universidad Politécnica de Madrid, International Relations Office

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2015

Amazon, Brazil

SOCIOECONOMIC AND TECHNICAL DATA COLLECTION: Field work

(Rurópolis e Belterra 27/03 to 02/04/2015)

1. Introduction

The ROBIN Project (*Role Of Biodiversity In climate change mitigatioN*), funded by the European Community (FP7-ENV-2011), aims to assess the role of biodiversity in climate change mitigation. The knowledge of "everyday life" can be described through analysis of perceptions that reflect conditions of time, place or situations experienced.

This report presents data, information and photographic records obtained during the field trip held from 03/27/2015 until 02/04/2015 to obtain socio-economic information of the productive sector (agriculture, forestry, fishing and others), as well as technical data about agricultural developments and logging based on forest management plan.

To make this field trip the leadership of ROBIN Project/BR had the collaboration of INPA, which provided an Agronomist Engineer to give a support in the field activities. In addition, during the field activities the Agronomist Sergio Correa had an active participation. During the meeting, on November 2013 and October 2014, there was a commitment of a Emater's extension agent to collaborate with ROBIN team in the survey.

The information in this fieldwork will support analyses obtained during the workshops of perceptions that generated the Fuzzy cognitive maps that will consolidate the results of the scenarios in accordance with public policies under ROBIN project. Comments on the way to the properties, conversations with experts and representatives of institutions (EMATER, CPLAC, residents and representatives of producers and farmers associations).

The survey was done as if it was a conversation with the producers in order to let them comfortable so that the questions were transformed into a conversation where each producer was led to share their field experiences and tacit knowledge of their production systems. The visited producers do not usually have a book of notes. During this visit was then explained the importance of keeping notes so that this information could be used to improve the scientific collaborations, such as finding opportunities for new varieties, consumer markets, management system, adding value for organic products, among others. They all agreed to adopt the new practice of keeping daily notes.

2. Crops Specifications

In Flona Tapajós there are 23 communities living at Tapajos riverbank. In the surroundings of Flona exits 07 horticulturists. The main extracted non-logging products are: brazilnut, tonka bean, forest essences (andiroba, copaiba), latex. And the main industrial products and fruit produced are: banana, cocoa, cupuassu, assaí, soursop and hog plum in Rurópolis/Placas; and watermelon and black pepper in Belterra.

Exports: The main markets for the production of the municipalities surrounding the Flona Tapajós are the cities of Manaus and Macapa, little is traded in Belém, the capital of Pará.

➢ All logging is legal and performed with Forest Management Plan. CONFLONA has the authorisation to manage the area of Flona Tapajós.

a) There are two types of logging, characterised as:

- CONFLONA - Wood in logs

Rurópolis - Small sawmills (by law all that wood must come from forest

Producers in "cassava flour chain": There are around 2,000 (two thousand) farmers working directly in the cassava flour production chain in Belterra, around 4,000 hectares of cultivated area are concentrated in the city.

The most important production systems were identified:

Rurópolis: Dairy and beef cattle; fruit growing in AFS, Cacao and Banana

Belterra: Grains (Soy and Corn), beef cattle and small livestock (free-range chicken), cassava and black pepper.

Production systems prevalent in Rurópolis are small and medium farmers. In Belterra, agricultural production is concentrated in large producers in the chain of grain, medium producers in beef cattle and small producers (family farmers, cassava, pepper, fruit growing in AFS and small animals with free-range chickens).

In the field trip was made a selection of producers able to provide an overview of the productive sector in the region. Contacts were established with:

- Representative of the Union of grain producers, representatives of rural workers, employer association of Santarém (SIRSAN), Cooperative - COPETRA, farmers associations.

- Institutions: EMATER and CEPLAC, which are the main institutions with offices in Rurópolis.

Conversations were held with experts (Talk Wheel at EMATER and CEPLAC)

1. During the conversation, we wondered which actors would be more related to deforestation?

- In Belterra there is no logging operation, only in CONFLONA
- In Rurópilis there may be illegal wood removal that is not inspected by IBAMA. However, it is believed that the wood processed in small sawmills is all from forest management.

2. What are the types of most relevant production systems and their main features?

- Grains (soybeans and corn) in acreage extension and cassava in number of producers to Belterra
- Dairy and beef cattle to 75% of producers
- Cocoa/Banana in AFS for 20%
- Cassava and beans (soya and corn) 5%

3. What are the most relevant public policies in agriculture, forestry, forest protection, among others? How are they being applied? Are there problems for its implementation and enforcement?

- Rural Environmental Registry - CAR is the most important public policy applied as it affects marketing and access to credit;
- PRONAF - National Program for Strengthening Family Agriculture. With a maximum ceiling of R$ 150,000.00 in the food Program.

Concerns regarding the main lines of credit were also addressed, such as:

Examples of sources of funding: PRONAF Women; PRONAF young; PRONAF microcredit; PRONAF costing; PRONAF agribusiness; PRONAF investment; PRONAF forest (see Table 1, 2, 3, 4,5,6 8, 9 and 10). Is worth mentioning that small farmers have access to social programs, such as: "Bolsa

familia" for families with children at school age, "Seguro defeso" for fishermen during the time of fish reproduction and "Bolsa verde" for most people who live in National Forests (the residents of the Tapajós Flona receive R$ 400.00 quarterly).

PAA (FAP) - Food Acquisition Program – the government purchases the production from the farmers and gives it to care institutions, neighborhoods, nursing homes, prisons, etc.

PINAE (NPSM) - National Program of School Meals - the government purchases from farmers and provides the food for school meals, which at least 30% must come from family farms.

PRONAF beneficiary: explore land parcels provided owner, leaseholder, tenant or partner not exceeding four fiscal modules. PRONAF Credit purpose:

Group A - Investment + Costing; Costing limited to 35% of the budget.
Group B - Investment (can also be used for agricultural costs).

-GROUP A / C - Costing.

- FAMILY PRODUCERS - Investment plus Costs - (Group AF) or "V"

Note: The credits are available individually or collectively

Collective - When formalized with producer groups for collective purposes. Also are PRONAF beneficiaries according to the income and characterisation of labour used:

- Artisanal fishermen.
- Extractive performing extraction by hand in rural areas (except gold miner)
- Foresters who cultivate native or exotic forests with proper management.
- Aquaculturists with up to 2 ha of water surface or up to 500 m3 of water exploitation

in the tank.
- Indigenous people practising agricultural or non-agricultural productive activities.

• Guarantees: Free agreement between the parties. The Bank will adopt preferably:

Investment - Pledge scheduler or endorsement
Costing - Pledge of the crop, and/or endorsement. Groups A and B - only personal guarantee. I

GROUP A (*) Limit of up to R$ 20,000.00 per beneficiary exceptionally. General rule is to make at least 3 operations of maximum R$ 7,500.00 per transaction. Prerequisites of the settlement to hire operations: houses built, water for human consumption, access roads with regular traffic, which INCRA has granted the initial support of credit with the correct application. The 2nd and the 3rd operations, can only be effected if proven the correctness of the previous operation and the ability to pay.

4. What social groups are more vulnerable? Which public policies affect or promote certain change in these groups?

- Family farmers along the BR-163 (Santarém-Cuiabá) are under pressure of the expansion of the grain agriculture frontier and beef cattle due to the conclusion of paving BR 163 expectation, which will be a new export corridor in the north of Brazil.

- The expectation of new and large agricultural enterprises indicates that in the short term these family-based farmers will be harassed to sell their properties. These farmers expressed, during the interviews, to feel total excluded from public policies that may guarantee the conservation of Flona Tapajós. They would like to be included as part of this process.

5. How REDD+ programs are being applied? Are there successful experiences implementing the REDD + program?

There are many REDD+ programs in Amazon, but they are still being implemented on a pilot basis. In Flona there is no REDD + program yet.

The properties were visited seeking to identify the main production systems in the municipality.

In Rurópolis there farmer who works as main crop cocoa, but comes every year diversifying crops on each property.

REDD + Projects in the State of Pará □ REDD + Calha Norte Pará - Developed by Imazon, Conservation International and the Secretariat of Environment of Pará (SEMA)

- REDD project in São Félix do Xingu - Developed by The Nature Conservancy and the Department of Environment of Pará (SEMA)
- Ecomapuá REDD project, Ilha do Marajó - Developed by the Ecomapuá Conservation Ltda. Company and partners.
- REDD project Cikel - Developed by Cikel Company.

REDD + Projects in the State of Amapá □ Projeto REDD+ Jari/Amapá - it is a partnership between Biofílica Environmental Investments and the Orsa Group, to develop a business model based on environmental sustainability concepts, and with a proposed economic exploitation that values "standing forest" and contribute to the conservation of region.

REDD + Projects in the State of Amazonas □ Projeto de REDD da Reserva de Desenvolvimento Sustentável do Juma - aims to curb deforestation and forest degradation as well as their emissions in an area under great land use pressure in Amazonas State

REDD + Projects in the State of Rondonia and Mato Grosso □ Projeto Carbono Florestal Surui - aims to curb deforestation and their greenhouse gas emissions (GHG) in an area under strong deforestation pressure in the TISS.

During the visit to the farmers different crops were identified: cassava, annato, rice, corn, beans, peach palm, banana, native papaya, cocoa and pasture. Also, in the farm were identified 8 native brazilnut trees which had their fruits collected for consumption and sale of surplus in years of high productivity (Figure 1).

Figure 1. Rural Producer showing the peach palm and pumpkins collected in his property.

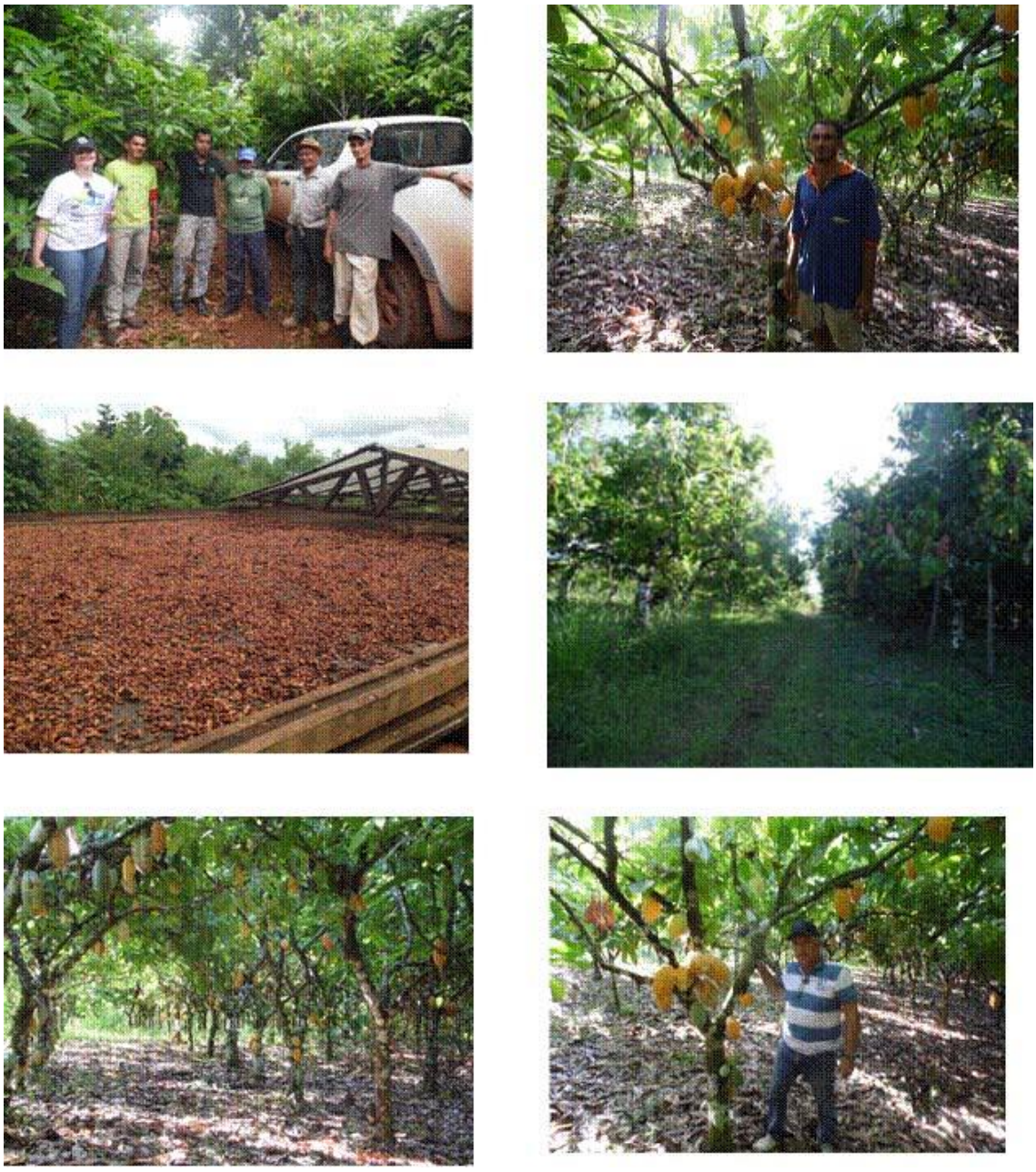


Figure 2. Leadership Project ROBIN / BR, technical CEPLAC and INPA, employees in the Project, during the field trip in Rurópolis at the property of Mr. Paraguayan.

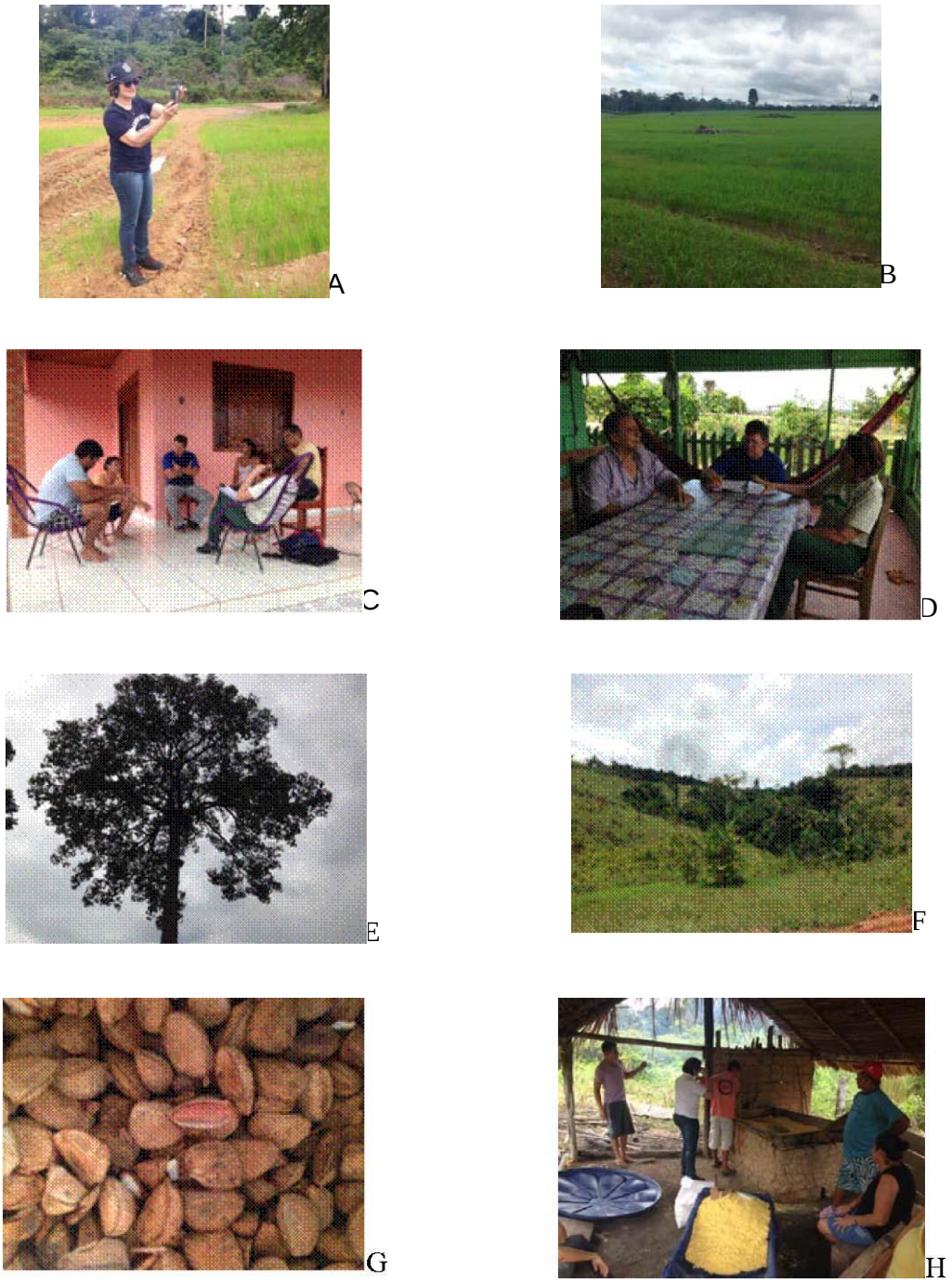


Figure 3. Images of rice crops in Rurópolis (A and B), talk with technicians from EMATER (C), interview with dairy and beef cattle producer (D), brazilnut tree (E), reviews of pastures and water springs (F), brazilnut fruit (G), cassava flour mill in family farmer (H)


A


B


C


D


E


F

Figure 4. Handmade way of Andiroba oil extraction (A), annatto fruit (B), banana (C), freerange chicken (D), area under maize deforested in 2013 (E), water spring inside the property, near corn area (F)

It was found that some producers have also cocoa and dairy cattle. INPA's collaborator made a demonstration of how the cocoa has high production of seeds in each fruit. Fruit size and the pattern of maturation were aspects observed by the team in the field (Figure 5).

Figure 5. The producer explains to the leadership of ROBIN/BR that his property is an example to other farmers for its high productivity production system.

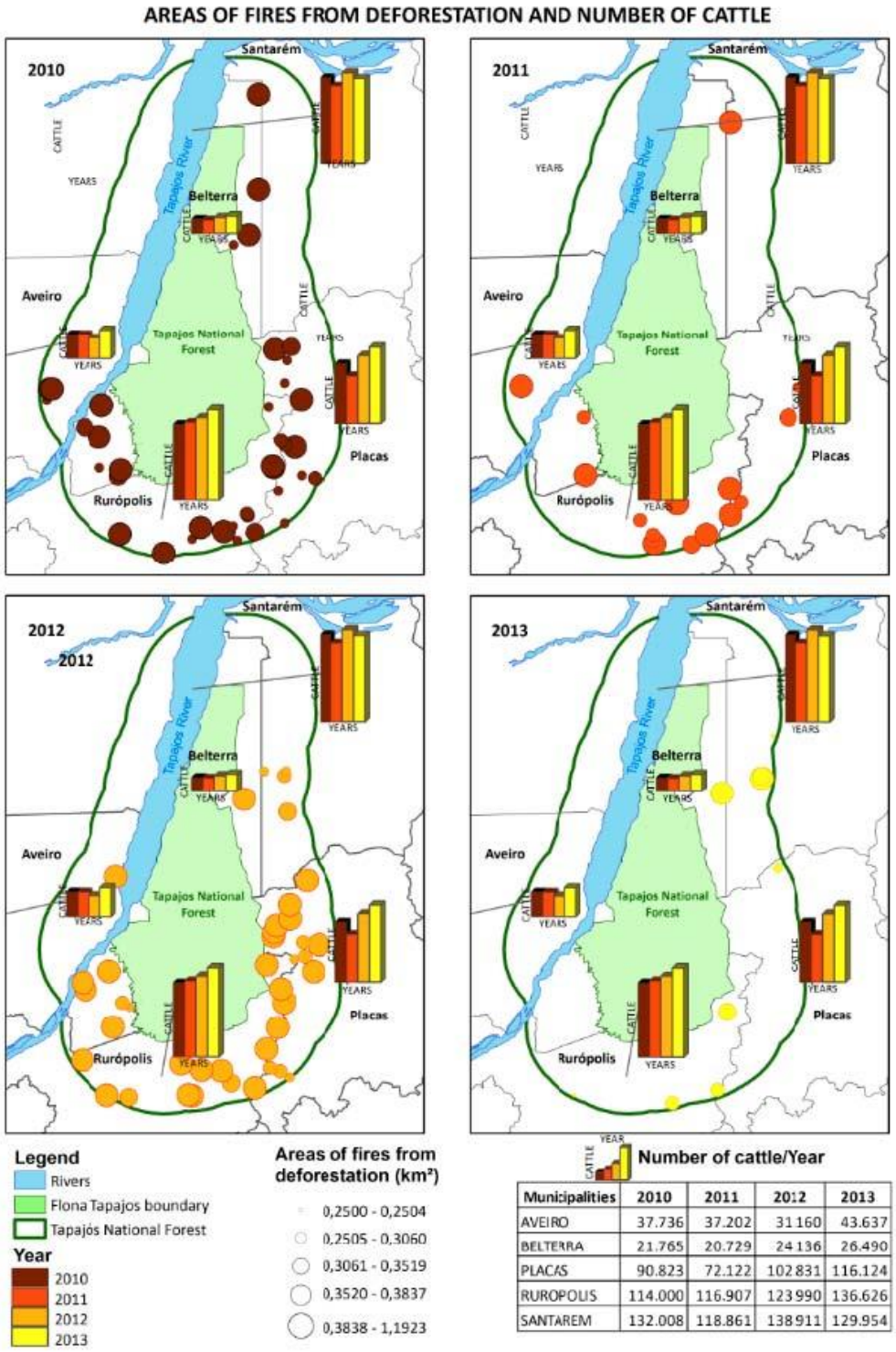
Colleagues of the Executive Committee of the Cocoa Farming Plan (CEPLAC) reported verbally that there are 681 producers in Rurópolis covered by the Program. Each producer who received funding programs used 4.76 hectares, and 30% of family farmers managed funds (PRORURAL, special FNO, PROCERA INCRA and PRONAF).

The program's goal was to expand Ruropolis areas with cocoa. In 2000 there is about 400 hectares of cocoa. In 2006 the cultivated area increased to 1,500 ha and in 2014 the program reached its target of 5,000 ha planted with cocoa. The producers interviewed expressed interest in continuing working with cacao plantations. Farmers said they are selling 1 kg of cocoa for $ 6.00 (six reais in 2015). During the cocoa harvest season there

is often need to contract need for cocoa harvest, the daily and the amount of $ 50.00 (fifty reais).

A fact that was highlighted by producers and CEPLAC technicians refers to Cocoa Festival in Rurópolis. This was unprecedented and remarkable for cocoa farmers in the municipality. The news of that time show that the Festival was attended by approximately 10,000 people (http://www.ceplac.gov.br/restrito/lerNoticia.asp?id=1653). The article reports that the advances of cocoa plantations in the state, with the expansion of areas and increased productivity were the main themes highlighted by the political and rural leaders at the opening of the 11th State Cocoa Festival held in Rurópolis in Tansamazônica region, from 15-18 September 2010. The partnership of Ceplac with public and private initiatives made possible the realization of these advances, allowing the incentive to increase production and industrialization of cocoa in the state, with the Pará as the second largest Brazilian producer of cocoa. The theme was: "Expanding the agriculture and conquer markets by quality".

Effective of cattle herd released by Agricultural Census of Brazilian Institute of Geography and Statistics (IBGE) from 2010 to 2013 and annual increments of fire based in the (INPE), between 2000 and 2013. It is worth to note that there was an increase of cattle herd in Rurópolis and Placas, but in Belterra and Aveiro they remained very close, indicating that there was no expansion of livestock in these two municipalities. The municipality of Rurópolis has the largest cattle herd, with 136,626 heads in 2013 (Figure 6). Possibly these hotspots are related to renovation of pastures. In addition, it is likely that some of these hot spots are from new open areas for cassava crops, corn, pumpkins, beans and watermelon on family farms.



Municipalities	2010	2011	2012	2013
AVEIRO	37.736	37.202	31160	43.637
BELTERRA	21.765	20.729	24136	26.490
PLACAS	90.823	72.122	102831	116.124
RUROPOLIS	114.000	116.907	123990	136.626
SANTAREM	132.008	118.861	138911	129.954

Figure 6. Circles indicating hotspots and bar graphs containing the herd number, where the colours correspond to the evaluated years (period 2010-2013)

In addition to the farms visited records of different patterns of use and land cover (Figure 7) were held, documenting with photos and GPS location. It is worth noting that the participation of Embrapa Satellite Monitoring has been critical in obtaining the points with images capable of being georeferenced. The Figure 7 illustrates different landscape patterns in Flona Tapajos and surroundings. Particularly remarkable is the area of CONFLONA jurisdiction, which considers a buffer zone of 10 km. To assess differences in terms of patterns among the areas surrounding the Flona, the ROBIN project has adopted a zone of 30 km.

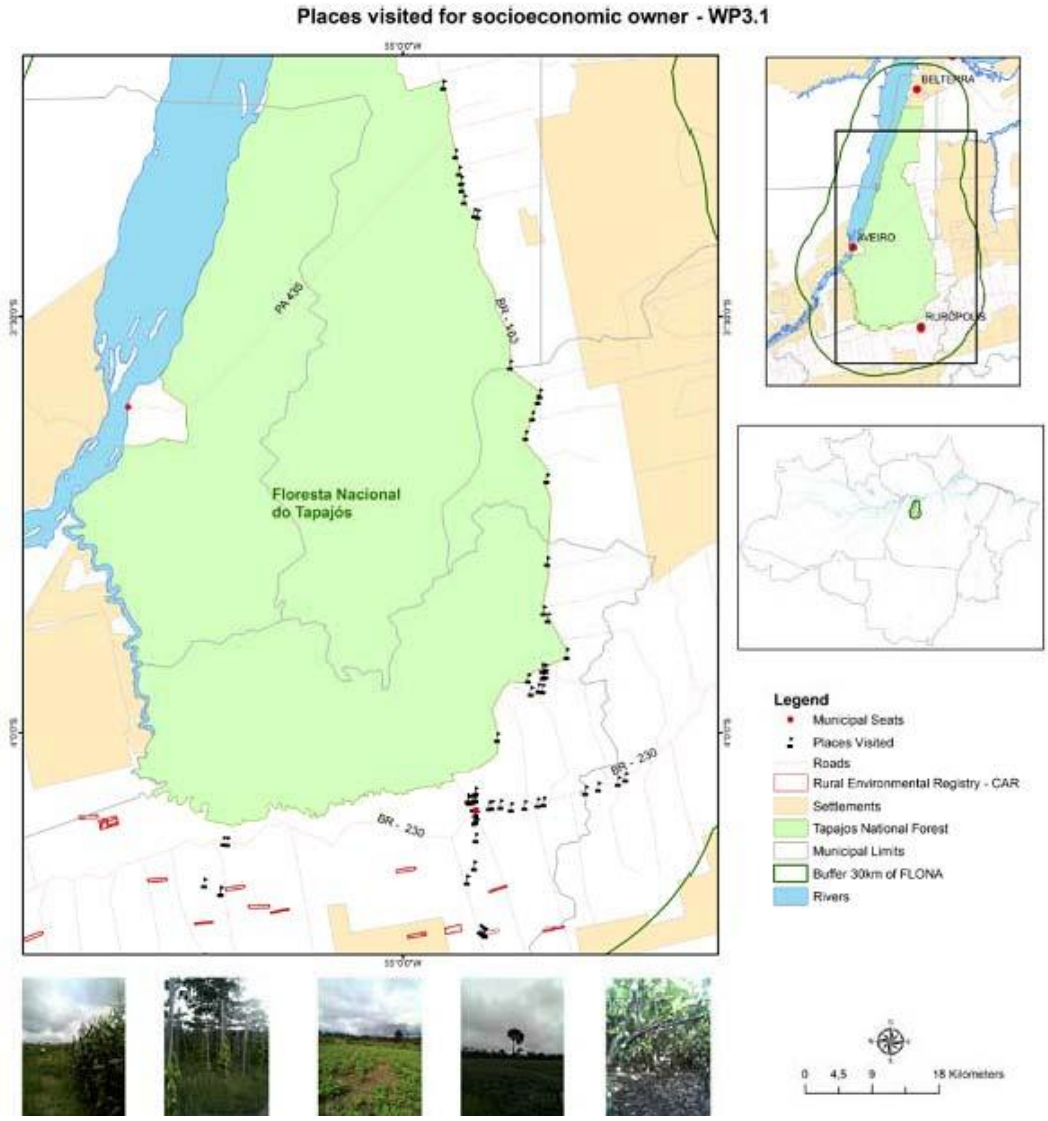


Figure 7. Locations visited and georeferenced on the area of influence of the BR 163 and Transamazônica, the area of influence, studied by ROBIN Project

There was a visit to COOPETRA (Cooperative Agro-Dairy Transamazon) in Rurópolis with the support of the technician from CEPLAC (Figure 8). In this cooperative, there was a brief presentation on the ROBIN Project, objectives of the visit and the type of information needed to make up the socio-economic survey of the municipalities surrounding the Flona Tapajós. The cooperative has infrastructure for a maximum storage of 6,000 liters per day, but on average it works with a daily volume of 4,000 liters. The 70 cooperative members sell to COOPETRA to R $ 0.70 per litter, collected from two to three collection days. The cooperatives receive information via leaflets and when necessary they attend meeting for adjustments of the milk collection and storage protocols on farms.

Figure 8. Visit to COOPETRA (Cooperative Agro-Dairy Transamazon) in Rurópolis

Main crops grown in farms visited: assai (*Euterpe oleracea*); rice (*Oryza sativa*); Andiroba (*Carapa guianensis*, Aubl.), banana (*Musa paradisiaca*); cocoa (*Theobroma cacao*); cashew (*Anacardium occidentale*); brazilnut (*Bertholletia excelsa*); coconut (*Cocos nucifera*); cumaru (*Dipteryx odorata*); cowpea (*Vigna unguiculata* (L.)); cassava (*Manihot esculenta*); mango (*Mangifera i*ndica); corn (*Zea mays*); black pepper (*Piper nigrum*); soybean (*Glycine max*); annatto (*Bixa orellana* (Bixaceae)). In Rurópolis the soybeans crops located in 600 ha areas and livestock predominance of beef and dairy (Figure 9 A-Ruropolis) and Soybean production has increased in the last years in Belterra (Figure 9 B – Belterra).

Figure 9 A. Soybeans crops located in 600 ha areas and in Ruropolis

Figure 9 B. Soybeans crops located in Belterra

TABLE 1 - LINE FNO AMAZON SUSTAINABLE RURAL FINANCE - AMAZON BANK

AGENT FINANCIAL	LINE OF CREDIT	ACTIVITIES FINANCIAL	BENEFICIARIES	FINANCED LIMIT INVESTMENT DEFRAYAL	FINANCIAL CHARGES	TIME FRAME	
						SHORTAGE	DURATION
BANK AMAZON	FNO AMAZON SUSTAINABLE RURAL	Agriculture Livestock Forestry Aquaculture Capture and fish processing Agrobusiness	Mini, small, medium and large farmers	FUNDING: Mini - R $ 160,000.00 Small - R $ 1,330,000.00 Medium and large - R $ 10,000,000.00 Investment: Unlimited, depends on the activity of payment support.	4.12% (up to 31/12/2013) regardless of the size of the beneficiary	Up to 6 years. For crops of long cycle of maturation, until 8 years .	Fixed or mixed investment up to 12 years; For long maturation cycle cultures up to 20 years; Investments semi fixed up to 10 years; Agricultural funding - 2 years. Livestock funding - 1 year. Vehicle up to 5 years including grace period - 1 year.

TABLE 2 - PRONAF FINANCING LINE - BRAZIL BANK

AGENT FINANCIAL	LINE OF CREDIT	ACTIVITIES FINANCIAL	BENEFICIARIES	FINANCED LIMIT INVESTMENT DEFRAYAL	FINANCIAL CHARGES	TIME FRAME	
						SHORTAGE	DURATION
BANK OF BRAZIL	PRONAF (National Program of Support to the Medium Rural Producer)	Individual investments or for goods and services required for the project, As long as directly related to productive activities and services. EX: construction, renovation or expansion of improvements and permanent installations; implementation of permanent crops	Landowners, squatters, renters and partners has at least 80% of your gross income Annual originating in agricultural activity or rural mining. Have gross income Annual to $ 1,600,000.00	FUNDING: Up to R$ 600,000.00 INVESTMENT: Up to R $ 350,000.00 per beneficiary crop year.	4,5% p.a.	Costing up to 1 year Investment up to 3 years	Costing up to 2 years Investment Up to 8 years

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TABLE 3 - LINES PRONAF FINANCING - BANK FROM AMAZON AND BRAZIL BANK

GROUPS	CLASSIFICATION BY INCOME	CREDIT LIMIT (*)	MODE	COST INTEGRATED	FINANCIAL CHARGES	PERFORMANCE BONUS		WITHDRAWAL DURATION	ATER RATE	WARRANTIES
						P / OPERATION	P / PRODUCER			
GROUP A	settlers of NARP which does not hired PROCERA or Pronaf limit "A"	R $ 20,000.00 (*) + 1,500.00 / Assist. Tec.	investment		0.5 % a.a.	40% principales / ATER 44.186% w / As. Tec.	-	Up to 10 years w / up to 5 grace	6,97 7%	Guanranty without suretyship obligation
GROUP A /C Already has a contract. The 1st operation Group A and not has a contract. operating defrayal .	-	To $ 5,000.00 (Up to 3 no operation exceeding total R $ 5,000.00)	defrayal	-	1,5 % a.a.	It does not include	-	Agricultural up to 2 years old. livestock and agribusiness up 1 year.	2%	Guaranty without suretyship obligation.
GROUP B	Income to $ 10,000.00 annual does not hire a permanent employed	To $ 2,500.00 per operation	investment Funding (except agricultural activities. May have cost associated up to 35% the value of financing	-	0,5% a.a.	25% each operation up to the amount cumulative funded R $ 7,500.00	-	Effective until 2 years old.		Guaranty without suretyship obligation. .

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TABLE 4 - FUNDING CREDIT

GROUPS	CLASSIFICATION BY INCOME	CREDIT LIMIT (*)	MODE	COST INTEGRATED	FINANCIAL CHARGES	PERFORMANCE BONUS		WITHDRAWAL DURATION	ATER RATE	WARRANTIES
						P/ OPERATION	P/ PRODUCER			
GROUPS "B", "E F" Or "V" except Group "A"	income Up To R $ 360,000.00 at least (50% of income Have come from the Rural property).	Up to R $ 10,000	PRONAF FUNDING (harvest)	-	1,5% p.y.	-	-	Agricultural funding: Up to 3 years real-palm Up to 2 years- Cult. biannual Up to 1 year- Other culture Costing Livestock: Aquaculture up to 2 years Other activities by 1 year	2%	suretyship obligation. Lien Mortgage
		Over $ 10,000 to R $ 30,000		-	3% p.y	-	-			
		Above R $ 30,000 to R $ 100,000		-	3,5% p.y	-	-			

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TABLE 6 - INVESTMENT CREDIT AGROINDUSTRIA

GROUPS	CLASSIFICATION BY INCOME	CREDIT LIMIT (*)	MODE	COST INTEGRATED	FINANCIAL CHARGES	PERFORMANCE BONUS		WITHDRAWAL DURATION	ATER RATE	WARRANTIES
						P / OPERATION	P / PRODUCER			
PRONAF - agrobusiness (investment)	1 - family producers. 2 - Rural Family business -legal person Formed to processing and marketing of agricultural products or provide rural tourism services, at least 80% of the processed benefit prodution, is produced by its members. 3 - Cooperative or Associations at least 60% of its active participants are farmers and that at least 55% of processed production, processed or marketed come from associated framed	Individuals: Up to R $ 150,000.00 p / beneficiary. Corporate: Rural Family Development: up to R $ 300,000.00, observing the individual limit R $ 150,000.00, by socio listed on DAP issued for the enterprise. Cooperative or Association: Up R $ 35,000,000.00 to the limit of R $ 45,000.00 per cooperative / associated listed on the DAP issued to the	investment processing Industrialization of production agriculture, and forestry and extractive products or crafts and rural tourism.	Associated working capital limited to 35% of the funding for investment.	1% pa for farmers or family business in up operations R $ 10,000.00 For cooperatives / associations with operations up to R $ 1,000,000.00 Limited to R $ 10,000.00 for associated. 2% pa in other cases, within the limit of R $ 40,000.00 per member.	Nope offers	-	Up to 10 years. grace up to 3 years and may extend up to 5 years of grace if necessary.	2%	Pledge, mortgage and suretyship obligation.

GROUPS	CLASSIFICATION BY INCOME	CREDIT LIMIT (*)	MODE	COST INTEGRATED	FINANCIAL CHARGES	PERFORMANCE BONUS		WITHDRAWAL DURATION	ATER RATE	WARRANTIES
						P / OPERATION	P / PRODUCER			
agrobusiness Family (funding) (1)	Family producers Rural Family business cooperatives and associations	1 - Individual up to R $ 10,000.00. 2 - Family Resort rural- legal person: up to R $ 210,000.00 - respecting limit R $ 10,000.00 per member. 3 - Associations: up to R $ 4,000,000.00 limit per member up R $ 10,000.00. 4 - Cooperative singular: to $ 10,000,000.00 limit per member £ 10,000.00. 5 - Central Cooperative: up to £ 30,000,000.00	defrayal		4,0 % p.y.	Nope offers	-	Up to 12 months.	2%	Pledge, mortgage and suretyship obligation.

TABLE 7 - INVESTMENT CREDIT AGROINDUSTRIA

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GROUPS	CLASSIFICATION BY INCOME	CREDIT LIMIT (*)	MODE	FINANCIAL CHARGES	PERFORMANCE BONUS		WITHDRAWAL DURATION	ATER RATE	WARRANTIES
					P / OPERATION	P / PRODUCER			
PRONAF Cota-Part	Family farmers afilliated to the producers cooperative who has at least 70% of its active participants as beneficiaries of PRONAF.	1- Single: up to £ 20,000.00 2- Cooperative to R $ 20,000,000.00 within the limit individual.	Payment of shares - shares Investment cost and working capital.	4% p.y.	Nope offers	-	Up to 6 years. Grace to be defined by institution financial	2%	pledge and suretyship obligation
PRONAF WOMEN (1) Up to 3 funding per family unit of group B, A.The / C and A / F project previous compliant **	women farmers regardless of marital status.	Groups A, A / C and B: up to R $ 2,500.00 up to R$10.000,00 Above the R$10.000,00 Group "V"	investment	Groups A, A / C and B: 0.5% p.y. 1 % p.y. 2 % p.y.	Groups A, A / C and B: 25% for each plot. until the limit of R $ 7,500.00 Nope Guests Nope Guests	-	Groups A, A / C and B: up to 2 years. Other up to 10 up to 3 years grace or up to 5 years depending on the project.	2%	"A", "A / C" and "B" Guarantee without suretyhip obligation pledge
PRONAF YOUNG MAN	Young farmers (as) family, between 16-29 years who have the least 100 hours of courses or stages	Up to R$ 15,000.00.	investment (one operation credit for beneficiary)	1% a.a.	Nope offers		Up to 10 years, with up to 3 years shortage depending on the technical project. it might be Large w / up to 5 years old.	2%	Guarantee staff without suretyship obligation

TABLE 8 - INVESTMENT CREDIT AGROINDUSTRIA

TABLE 9

GROUPS	CLASSIFICATI ON BY INCOME	CREDIT LIMIT (*)	MODE	FINANCIAL CHARGES	PERFORMANCE BONUS		WITHDRA WAL DURATION	ATER RATE	WARRANTIES
					P / OPERATION	P / PRODUCER			
PRONAF FOREST (Up to 2 funding Unity family) (2)	farmers family. framed in PRONAF	Up to R $ 35,000.00 (exclusive to Systems agroforestry) except beneficiaries framed in groups "A", "A / C" and "B" Other purposes: up to R $ 25,000.00. Beneficiaries: Groups "A, B and A / C "up to R $ 15,000.00	investment (1)	1% a.a.	Nope offers	-	Up to 20 years with lack up to 12 years old. For the others dependent on the conditions of ripening project; or shortage 8 years old or under 12.	2%	Personal guarantee without approval
PRONAF Agroecology	farmers family	Credit limits up to R $ 10,000.00 Above R $ 10,000.00. up to R $ 150,000.00	investment in agroecological Production and organic productionS ystems	1 % p.y. 2 % p.y.	Nope offers		Up to 10 years with grace period of 3 years Reaching up 5 years grace period	2%	Personal guarantee without approval

TABLE 10

GROUPS	CLASSIFICATION BY INCOME	CREDIT LIMIT (*)	MODE	FINANCIAL CHARGES	PERFORMANCE BONUS		WITHDRAWAL DURATION	ATER RATE	WARRANTIES
					P / OPERATION	P / PRODUCER			
PRONAF ECO Renewable energy: use of solar energy, biomass, wind, mini mills biofuel technologies environmental , etc. Environmental Sustainability. Renewable Energy Environmental Sustainable up to 2 Financing Unit Family Palm or rubber up to R $ 80,000 conditioned to compliance with the Zoning of agricultural climatic hazards (ZARC).	farmers family	Up to R $ 10,000.00 Above R $ 10,000.00 to R $ 150,000.00 Oil palm and rubber: Up to R $ 8,000 / ha Oil palm and rubber up to R $ 15,000 / ha R $ 10,000.00 to R $ 80,000.00	investment	1% p.y. 2 % p.y. 1 % p.y.	Nope offers	-	Mini-mills under 12 years with up to 3 years of grace. other cases up to 10 years with 3 grace, may reach up to 8 years. Rubber up to 20 years and up to 14 Palm years old	R$ 50.00 per ha / year during the 4 early years implantation	pledge ,guarantee and suretyship obligation

TABLE 11: SEEING THE WOOD FOR THE TREES- BRAZIL 'S FOREST CODE, SELECTED PROVISIONS

	Current law	As approved by Congress	As promulgated by the president
Specially protected areas	Riverbanks protected to 30-500 metes depending on the river's width. Other biodiverse or erosion-prone areas also protected	Most special protections reduced; some removed entirely	Riverbanks still protected, but in narrower strips: 5-100 metres. Mangrove swamps protected, but activities such as shrimp farming allowed around theur edges
compulsory forest reserve	Amazon: 80% cerrado (savannah): 35% Everywherw else: 20% specially protected areas cannot coun towards th total percentagem	Specially protected areas coun towards the total. Amazonian states with little overall deforestation can cut the reserve to 50%. Smallholders exempt from reforesting areas cleares before june 2008.	Specially protected areas count towards the total. Small farmers who deforested illgally, in whatever region, need only reforest 20% of their land. Others must compl in full
amnesty	na	All penaltes from before june 2008 written off. No new penalties for farmers who sign up for a vagueand leisurely compliance process	Only small farmers have any exemption from reforestation. Everyone else can escape fines only by complying
Environ-mental registry	na	Landowners must register their properties, but infractions largely penalty-free	Landowners must registr and comply with the code within five years or face fines denial of bank loans

TABLE12: MAIN CHANGES IN THE BRAZILIAN FOREST CODE

Themes	Forest code of 1965	Forest code of 2012
Legal reserve	area: at amazon (Amazon free for exploration): 80% in forest area, 35% in cerrado; 20% in other regions and biomes. Calculation: statutory reserves excepts APPs. Registration: Register Office.	Area at amazon: 80% in forest area, 35 % in cerrado, 20% in other regions and biomes. Calculation: includes APPs booking buildings up to four fiscal modules need not reconstruct the RL. Registration: don't need. Permission economic exploitation of NR with permission of national systemo environmental (sisnama)
Permanent; Preservation; Areas	Calculation: Protection of native vegetation from riverbanks, lakes and springs, having as parameter the full period. Economic Acivities: Floodplains, wetlands, forests of slopes, mountain tops, and areas above 1800 meters altitude cannot be exploited for economic activities	Calculation: Protection of native vegetation from riverbanks, lakes and spngs, having as parameter the rgular water level. Economic activities: floodplains, wetlands, forest of slopes, mountain tops, and areas above 1800 meters altitudes may be used for certain economic activities.
Riparian	Width of the river: Until 10 meters: 30 meters of riparian. Between 10 and 50 meters: 50 meters of riparian. Between 50 and 200 meters:100 meters of rioarian. Between 200 and 600 meters: 200 meters of riparian. Bigger than 600 meters : 500 meters of riparian. Border of mesa: 100 meters of riparian. Removal of vegetation: requires authorization from the federal executive for the suppression of native vegetation in APP and for situations where the execution of works, plans, activities or projects of public utility or social interest.	Width of the river: Until 10 meters: 30 meters riparian rivers of up to 10 feet wide is required, when consolidated in APP of up to 10 meter wide river area reduces the width of the forest to 15 meters. Between 10 and and 50 meters: 50 meters of riparian. Between 50 and 200 meters: 100 meters of riparian. Between 200 and 600 meters: 200 meters of riparian. Bigger than 600 meters:500 meters of riparian. Border of mesa: 100 meters of riparian. removal of vegetation: Allows the removal of vegetation in APPs and consolidated activities until 2008, provided by public utility or social interest of low environmental impact, including agroforestry activities, ecotourism and rural tourism. Other activities is PPAs may be permitted by the state through the environmental adjustment program (PRA). The removal of native vegetation springs, dunes and-salt marshes may anly be given in case of public utility.
Consolidated rural area	Does not include the concept of consolidated area. Recomposition, regeneration and compensation are mandatory.	Establishes the concept of consolidated rural areas homes up to four fiscal modules need not restore the native vegetation.
Amnesty	Penalt three months to one year simple imprisonment and a fine from 1 to 100 times the minimun wage.	Exempts landowners from fines and penalties under the law in force for irregular use of protected areas until july 22.2008

GLOSSARY

Aveiro: Brazilian municipality located in the southwest mid-region of the State of Para with a surface of 17158 km² Para with little more than 15 thousand inhabitants (IBGE, 2010).

Belterra: Brazilian municipality located in the southwest mid-region of the state of Para with little more than 16 thousand inhabitants (IBGE, 2010).

BR-163 road: is a highway in Brazil, going from Cuiabá, the capital city of Mato Grosso state, to Santarém in the state of Pará. It runs through 1,780 km (1,110 miles) in the heart of the Amazon Basin

Buffer zone: the area around a conservation area, where human activities are subject to specific rules and restrictions in order to minimize negative impacts on the unit of conservation (IBAMA, 2012).

Capoeira: an area of a forest that was slashed and burnt to be cultivated or with another purpose.

Conservation Units of Integral Protection: cannot be inhabited by man, and admitted only the indirect use of its natural resources. There are five types of conservation units of integral protection: 1) ECOLOGICAL STATION (preservation of nature and conducting scientific research); 2) BIOLOGICAL RESERVE (aim to preserve full of natural resources within their boundaries, without direct human interference or environmental changes); 3) NATIONAL PARKS (preservation of natural ecosystems of great ecological significance, allowing the development of scientific research and development activities, environmental education and interpretation, recreation and eco-tourism); 4) NATURAL MONUMENTS (preserve rare natural sites, natural or scenic beauty) and 5) WILDLIFE REFUGES (protect natural environments where conditions to ensure the existence and reproduction of species or communities of local flora and fauna resident or migratory). (WWF, 2012a)

Conservation Units of Sustainable Use: admit the presence of residents and the principal aim is reconciling nature conservation with sustainable use of natural resources. There are seven types of conservation units of sustainable use: 1) AREAS OF ENVIRONMENTAL PROTECTION (public or private lands, respected constitutional limits may be established rules and restrictions for the use of private property located in an AEP); 2) AREAS OF SIGNIFICANT ECOLOGICAL INTEREST (generally of small extent, with little or no human occupation, with extraordinary natural features or which houses rare examples of regional biota); 3) NATIONAL FORESTS/FLONA (areas with forest cover of predominantly native species and aim basics sustainable multiple use of forest resources and scientific research); 4) EXTRACTIVE RESERVES/RESEX (areas used by traditional extractive populations whose livelihood is based on the extraction or subsistence 31 agriculture and the creation of small animals); 5) RESERVATIONS FAUNA (natural areas with native species of fauna, terrestrial or aquatic, migratory or resident); 6) RESERVATIONS FOR SUSTAINABLE DEVELOPMENT (natural areas that harbor traditional populations, whose existence is based on sustainable systems of exploitation of natural resources

developed over generations. These traditional management techniques are adapted to local ecological conditions and play a key role in protecting nature and maintenance of biological diversity) and 7) PRIVATE RESERVES OF NATURAL HERITAGE (private areas in order to conserve biological diversity). (WWF, 2012b)

Eastern Amazon: States that compose Eastern Amazon: Pará, Maranhão, Amapá, Tocantins and Mato Grosso.

Ecological value: Non-monetary assessment of ecosystem integrity, health, or resilience, all of which are important indicators to determine critical thresholds and minimum requirements for ecosystem service provision.

Economic behavior: The way in which economic agents reveal their preferences through economic activity.

Economic growth: An increase in economic prosperity measured, for example, as an increase in per capita gross domestic product (GDP)

Economic valuation: The process of expressing a value for a particular good or service in a certain context (e.g., of decisionmaking) in monetary terms.

Eco-regional planning: Planning that is undertaken on an eco-regional rather than national basis.

Ecosystem: A dynamic complex of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit. (MA, 2005a) For practical purposes it is important to define the spatial dimensions of concern.

Ecosystem accounting: The process of constructing formal accounts for ecosystems.

Ecosystem degradation: A persistent reduction in the capacity to provide ecosystem services. (MA, 2005a)

Ecosystem integrity: Implies completeness or wholeness and infers capability in an ecosystem to maintain all its components as well as functional relationships when disturbed.

Ecosystem management: An approach to maintaining or restoring the composition, structure, function, and delivery of services of natural and modified ecosystems for the goal of achieving sustainability. It is based on an adaptive, collaboratively developed vision of desired future conditions that integrates ecological, socioeconomic, and institutional perspectives, applied within a geographic framework, and defined primarily by natural ecological boundaries. (MA, 2005a)

Ecosystem process: Any change or reaction which occurs within ecosystems, either physical, chemical or biological. Ecosystem processes include decomposition, production, nutrient cycling, and fluxes of nutrients and energy. (MA, 2005a)

Ecosystem services: The direct and indirect contributions of ecosystems to human

wellbeing. The concept ‘‘ecosystem goods and services’’ is synonymous with ecosystem services.

Ecotourism: Travel undertaken to access sites or regions of unique natural or ecologic quality, or the provision of services to facilitate such travel.

Environmental Protection Area: an extensive area with a degree of human occupation, endowed with attributes abiotic, biotic, aesthetic or cultural especially important to quality of life and well-being human populations, and aims to protect the basic diversity biological, discipline the occupation process and ensure the sustainability of use of natural resources.

FLONA Tapajós (National Tapajos Forest): Site study of ROBIN project in Brazil. Flona preservation area created overlapping INCRA settlement areas and traditional riverine areas. National Forests are public domain. Private property is expropriated which is resisted by prior resident populations who can only use land in the form of concessions involving formal management systems. Limits: North – Belterra town - BR163(km 50)/East – BR163 (Cuiabá-Santarém road)/West – Tapajós river/South – Gupari river near BR230 (Transamazônica road) km 211.
IBAMA- Brazilian Institute of Environment and Renewable Natural Resources (2012). Avaiable on: <http://www.ibama.gov.br/servicos/glossa rio>
IBGE- Brazilian Institute of Geography and Statistics (2010). Available on<http://www.ibge. gov.br/ cidadesat/topwindow.htm?1>

Legal Reserve Areas: Area located within a rural property or possession, discounted the APP, necessary for the Sustainable use of natural resources, conservation and rehabilitation of ecological processes, biodiversity conservation and protected, and protection of native fauna and flora. Legal Reserve must be 80% in areas of humid forest of the Legal Amazon; 35% in areas of Cerrado located at the Legal Amazon; 20% in areas of forest or other native vegetation in the other regions of the country.

Permanent protect area (APP): protected area in terms of arts. 2 and 3 of this Brazilian Forest Code, covered or not by native vegetation, with the environmental function of preserving water resources, landscape, geological stability, biodiversity, gene flow of wild fauna and flora, soil protection and ensure the well-being of human populations.

Placas: Brazilian municipality located in the Low Amazon mid-region of the state of Para with little more than 24 thousand inhabitants. (IBGE, 2010)

Quilombolas: Afro-Brazilian slaves and their descendants who live in small hinterland settlements called quilombos. Originally most of them escaped from slave plantations that existed in Brazil until abolition in 1888.

Riparian Forest: vegetation that surrounding streams, large rivers, lakes and water bodies. These forests play important ecological roles, such as habitat, providing food for aquatic and terrestrial fauna.

Ruropolis: Brazilian municipality located in the Southwest mid-region of the state of Para with little more than 40 thousand inhabitants (IBGE, 2010).

Santarém: major economic and financial center of the western portion of the State of Para with almost 300 thousand inhabitants. Located at the Low Amazon mid-region (IBGE, 2010).

Scale: The measurable dimensions of phenomena or observations. Expressed in physical units, such as meters, years, population size, or quantities moved or exchanged. In observation, scale determines the relative fineness and coarseness of different detail and the selectivity among patterns these data may form. (MA, 2005a)

Secondary vegetation: resulting from natural processes of succession, after suppression all or part of the primary vegetation for shares anthropogenic or natural causes, occurring trees remaining primary vegetation.

Social costs and benefits: Costs and benefits as seen from the perspective of society as a whole. These differ from private costs and benefits in being more inclusive (all costs and benefits borne by some member of society are taken into account) and in being valued at social opportunity cost rather than market prices, where these differ. Sometimes termed ‘‘economic’’ costs and benefits. (MA, 2005a)

Tapajós river: river that rises in the Brazilian state of Mato Grosso, bathes the state of Pará and flows into the Amazon River, still in the state of Pará. The Tapajós river was named by the Tapajós Indians, a tribe of Native Americans from Santarém.

Varzea: wetlands waters with large amounts of sediment suspended originated in the Andean region, under frequent erosion. Have pH near neutral, and considered naturally fertile. The floodplain landscape changes from the aquatic to the terrestrial phase according to the river dynamic and the rainy season.