
ROBIN
Role of Biodiversity in Climate Change Mitigation

# THE ROLE OF BIODIVERSITY IN CLIMATE CHANGE MITIGATION (ROBIN): A WHOLE SYSTEM APPROACH

**ROBIN aims to understand, measure and quantify biodiversity's role in mitigating climate change and in providing other benefits to people.**

## The issue

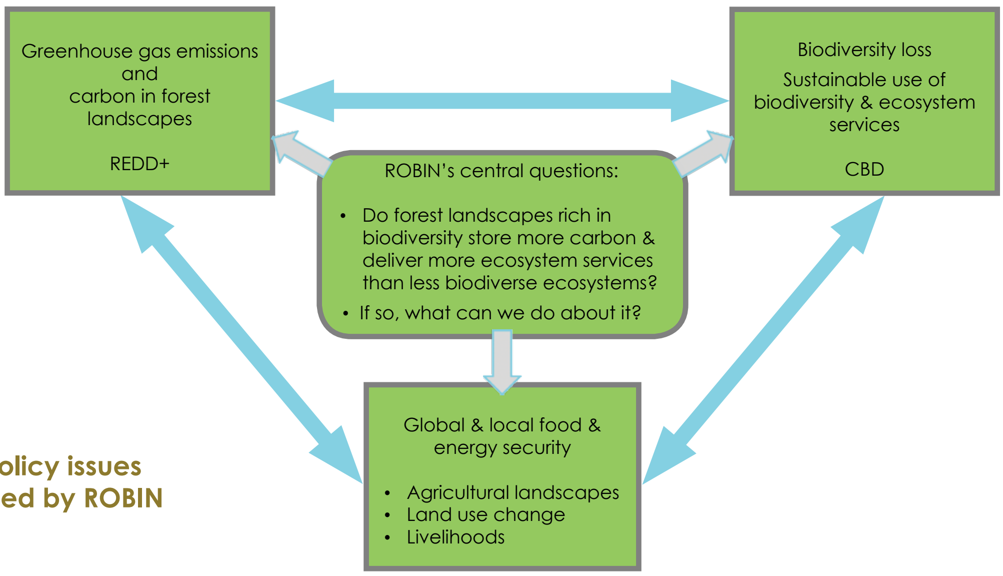
Tropical forest landscapes are hot spots for biodiversity and hold substantial stores of carbon. They are used by forestry, agriculture, nature conservation and other sectors, and they must provide for peoples' health, well-being and economic security. ROBIN tries to reconcile these many and potentially conflicting demands.

## The context

This issue is relevant to the Convention on Biological Diversity (CBD) and actions to protect biodiversity and enhance its benefits to people. It informs the UN programme on Reducing Emissions from Deforestation & Forest Degradation (REDD+) which aims to enhance forest carbon pools by supporting the conservation, sustainable management and restoration of forests. REDD+ includes social and environmental safeguards. ROBIN also considers land-use change in multi-functional landscapes and is relevant to food and energy security.

## ABOUT ROBIN

**ROBIN has assessed the role of biodiversity in terrestrial ecosystems in South and Mesoamerica in mitigating climate change. It has evaluated socio-ecological consequences of changes in biodiversity and ecosystem services under climate change.**




**Cross-policy issues addressed by ROBIN**

## Methods

ROBIN used data from **field studies** (Factsheet 2), **remote sensing**, land use and ecosystem **modelling** (Factsheets 4, 6) and **participatory** approaches. We worked at multiple scales (local, national - Mexico, Brazil, Bolivia and Guyana - and regional) using a common indicator framework. The ROBIN spatial data portal (http://robinproject.info/home/products/geoportal/) will provide access to many datasets.

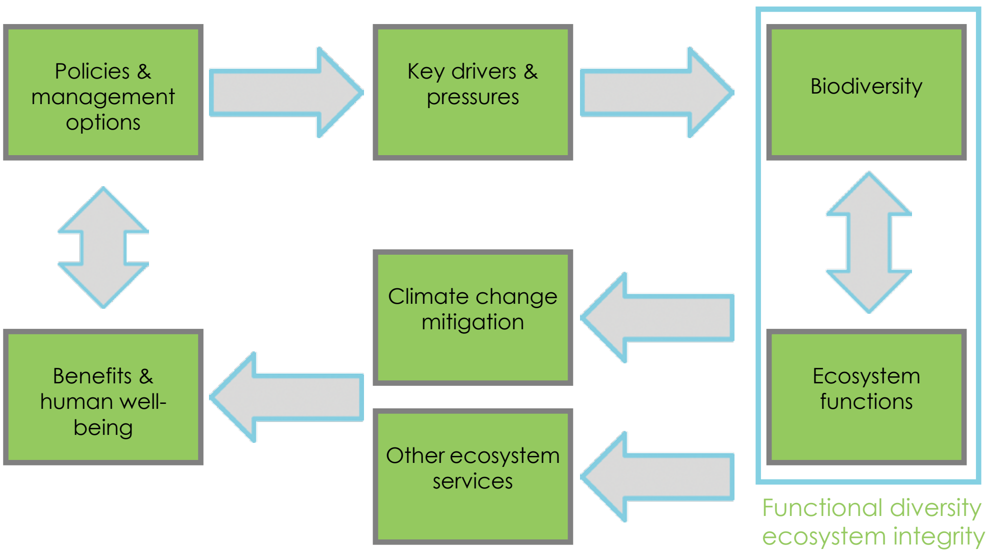
We used **scenarios** combining possible climate and land use futures with options representing how people and governments may affect climate change. We improved two ecosystem models (LPJmL-FIT and JULES) by including biodiversity more realistically. We tested the scenarios in the models to see how forest growth, crop yield, carbon storage and other ecosystem services may be affected by future climate and land use change.

We worked with a broad range of **local people** (farmers, foresters, government authorities, etc.) in three case study areas. We used Fuzzy Cognitive Mapping to explore issues relating to forest biodiversity, climate change and local needs. ROBIN developed two **decision-support tools** to help develop options that are relevant to their local or national situations, OPTamos (Factsheet 8) and QUICKScan (Factsheet 9).

## Some key messages from ROBIN's whole system approach

Managing logged & secondary forests for biodiversity will help increase carbon storage & resilience (Factsheet 11)

Payment for Ecosystem Services & REDD+ schemes should be linked to agricultural policies addressed at smallholders (Factsheet 5)




Biodiverse forests store more carbon & are more resilient to climate change (Factsheet 2)

Spatial trade-offs among ecosystem services change across scales & contexts

Functional diversity and ecosystem integrity can be monitored to assess carbon storage, biodiversity and other forest services (Factsheets 3, 7, 10)

### More information

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**Fact sheet 2**
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# BIODIVERSITY HAS A POSITIVE EFFECT ON CARBON STOCKS AND CARBON SEQUESTRATION

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## ABOUT ROBIN

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## Key findings

Diversity matters as it increases carbon stocks and carbon sequestration in tropical forests.

## Recommendations

- Biodiversity should be considered an integral component of policies and practices that will reduce the impact of climate change (e.g. REDD+), and not just a requirement related to co-benefits and safeguards.
- Mitigation initiatives in mature tropical forest should take into account possible trade-offs between carbon stocks and carbon sequestration in the decision process.
- Biodiversity proxies can be developed using remote sensing data to monitor changes in carbon stocks and biodiversity over large areas. These proxies would need to be verified with field data.

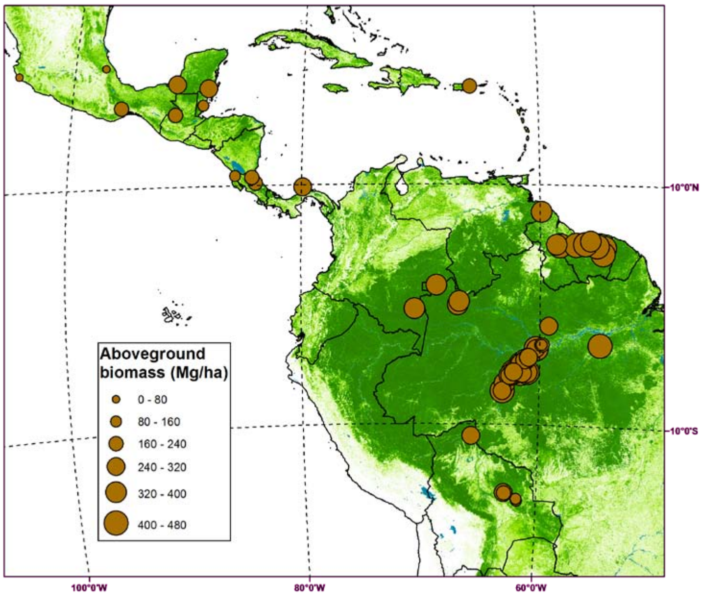
## Evidence

We carried out a series of studies in forest sites spanning the complete latitudinal and climatic gradient across the lowland Neotropics. In these studies we assessed how climate and soils determined forest diversity, and how the environment and diversity together influence forest carbon stocks (i.e. how much carbon is stored in the standing forest) and carbon sequestration (i.e. rate at which carbon is removed from the atmosphere and taken up in forest biomass).

We focussed on three components of diversity: taxonomic attributes (e.g. tree species richness), functional attributes (e.g. stem wood density) and structural attributes (e.g. stem diameter).

We found that in tropical forests the amount of carbon stocks increases with the average stem diameter and the number of large trees. Across large environmental gradients, tree diversity has a positive effect on the carbon stocks of tropical forests, in which sites with higher species richness show higher levels of carbon stocks.

All three components of diversity are important for carbon sequestration. Carbon sequestration was higher in forests dominated by trees with productive tissues (soft and cheap leaves, softer wood), and tall species. We also found that tropical forests with higher carbon stocks have lower rates of carbon sequestration.




**Map of vegetation cover in Latin America showing the location of the 60 study sites. The size of the circles shows the amount of aboveground biomass (Mg/ha)**

## ROBIN outputs


- Peña-Claros, M., L. Poorter, M. van der Sande, E. Arets, N. Ascarrunz, A. Boit, M. Hoosbeek, B. Sakschewski, K. Thonicke, M. Toledo. 2014. Quantifying the spatial relationship between biodiversity and climate change mitigation at different scales (site and regional), along environmental gradients (precipitation and soil fertility) in undisturbed forests and across land use intensities. ROBIN project report.
- Poorter, L., M. van der Sande, A. Alarcón, E. Arets, N. Ascarrunz, P. Balvanera, N.E.S. Beltrão, A. Boit, L. Dutrieux, M. Hoosbeek, J.C. Licona, , L.S. Lisboa, L.C. Maskell, L. Martorano, L. Mazzei de Freitas, T. Parr, L. Renteria-Rodriguez, A.R. Ruschel, M. Simoes Penello, J. Thompson, K. Thonicke, M. Toledo, M. Peña-Claros and 42 co-authors outside the ROBIN network. 2015. Diversity enhances carbon storage in tropical forests. Global Ecology and Biogeography. DOI: 10.1111/geb.12364.
- Finegan, B., M. Peña-Claros, A. de Oliveira, N. Ascarrunz, M. S. Bret-Harte, G. Carreño-Rocabado, F. Casanoves, S. Díaz, P. Eguiguren Velepucha, F. Fernandez, J. C. Licona, L. Lorenzo, B. Salgado Negret, M. Vaz, and L. Poorter. 2015. Does functional trait diversity predict above-ground biomass and productivity of tropical forests? Testing three alternative hypotheses. Journal of Ecology 103:191–201.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**Fact sheet 3**
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# MEASURES OF ECOSYSTEM INTEGRITY PROVIDE A HEALTH CHECK ON HUMAN LAND USE

## ABOUT ROBIN

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## Context and trends

National and international agencies need to develop adequate instruments to monitor the state of the environment and assess the effects of public policies. This is because the high costs arising from deteriorating natural resources and increasing environmental pollution are impacting on gross domestic product and peoples' quality of life.

Ecosystems such as forests provide goods and services that are the basis for economic development and social welfare, and are involved in processes of global interest such as climate change. Human activities modify the operating conditions of ecosystems.

The capacity for self-organization of a forest depends upon the level of integrity that it possesses. Thus, a key requirement in the path toward sustainability is to measure the integrity of ecosystems and understand the limits of disturbance they can tolerate that safeguard their ability to provide our desired ecosystem services.

## Policy relevance

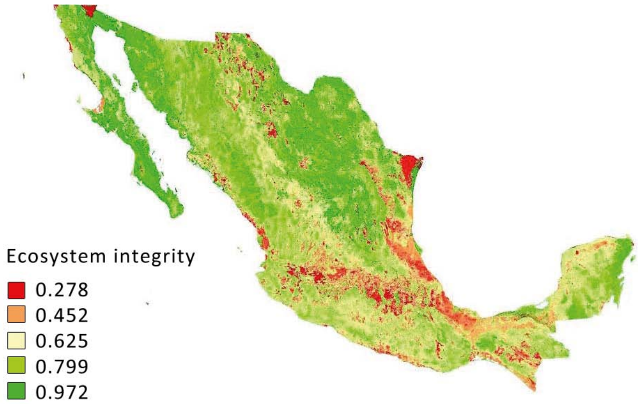
In the framework of international agreements to mitigate climate change, countries need to develop better instruments to monitor the state of the environment and better estimate the impacts of human actions.

The measurement of ecosystem integrity is a desirable option because it enables an integrated assessment of the impact of public policies on biodiversity and the capacity of ecosystems to provide ecosystem services.

From a biological point of view, a significant loss of biodiversity can be intepreted as an impairment to nature and a loss of natural capital. In our framework, it is equivalent to degradation of ecosystem integrity, which implies a direct alteration to the provisioning of ecosystem goods and services.

## Opportunities

- Ecosystem integrity evaluation meets the policy requirement for biodiversity assessment and the implementation of international policies on biodiversity and mitigation of climate change.
- Ecosystem integrity helps to guide public policy, providing a platform for evaluating anthropogenic impacts on natural capital, and is sensitive to unwanted effects that are likely to be overlooked at first sight.
- It represents a reference point for different environments and geographical scenarios, with different levels of resolution.
- Ecosystem integrity can address the systemic complexity of multifunctional landscapes.
- The index of ecosystem integrity assesses both negative and positive effects on natural capital.
- It allows for driving particular actions under different environmental scenarios to achieve specific targets.
- The index of ecosystem integrity can integrate conventional biodiversity indicators.
- Ecosystem integrity is an integrated measure, unlike conventional approaches that address one variable at a time. It provides a more holistic way of assessing the state of nature while dealing with environmental problems.
- Ecosystem integrity provides a simple yet powerful tool for cross-sectoral policy assessment and innovation.




**Levels of ecosystem integrity in Mexico between 2004 and 2007**

## ROBIN outputs

- Equihua, M., García Alaniz, N., Pérez-Maqueo, O., Benítez, G., Kolb, M., Schmidt, M., Equihua, J., Maeda, P. 2014. Integridad ecológica como indicador de la calidad ambiental. In: C. Gonzalez, A. Vallarino, A. Low-Pfeng and J. C. Pérez (Eds) Bioindicadores: guardianes de nuestro futuro ecológico. Ecosur, INECC, México
- Garcia Alaniz, N., Schmidt, M., Equihua, M., Maeda, P., Equihua, J., Pérez-Maqueo, O., Flores, J., Villela, S., Serrano, E., Rodriguez, R., Leyva , J. Maximizing synergies between science and policy to cope with ecosystem degradation and biodiversity change: A national system for ecosystem monitoring. Environmental Science & Policy (submitted)

For more on Ecosystem Integrity, see Factsheets 7 and 10.

## More information

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# MODELLING ECOSYSTEM SERVICES FOR POLICY: CARBON STOCKS AND CARBON SEQUESTRATION

## Key findings

We looked at how much carbon (C) is stored and sequestered in Mexico, Bolivia and the Brazilian Amazon under current land use conditions, at the change in C stock and sequestration as a result of past changes in land use, and at the relevance of our results to the design of policies. Using models, we found that:

- Total country level carbon stocks were highest in the Amazon, followed by Mexico and Bolivia. Carbon uptake exceeded carbon release by a small amount in all studied countries.
- Carbon stocks and sequestration have decreased in all countries as a result of past land use changes.
- Total carbon stock value is two times greater than the value recognized by national price markets in the countries studied, while the eligible area for C sequestration credits is overestimated in the global market.

## Recommendations

- Estimations of the economic value of the carbon that tropical forests can store and sequester need to take into account different C pools and the difference between C uptake and release.
- The Lund-Potsdam-Jena managed Land (LPJmL) model can quantify, model and map ecosystem services related to the carbon cycle, which can be linked to biodiversity and climate change.

## Evidence

We modelled the supply and value of ecosystem services using the LPJmL model for the period 1980-2000. For carbon stock, supply is defined as the average amount of carbon stored in the terrestrial ecosystem. Three C pools were assessed: aboveground biomass (AGB), soil and litter. Carbon sequestration is defined as the ecosystem level balance, i.e. the difference between the amount of C that is taken up and the amount that is released. To calculate the economic value of C stock and sequestration, we considered the state of forest carbon markets in the studied countries.

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Modelled total C stock under current land use was highest for the Amazon, followed by Mexico and Bolivia. The fraction of total C stock from each pool differed between countries. We found that C uptake exceeded C release in all studied regions. Nevertheless, the final balance was quite small because we found large values for C release compared with uptake.

The modelled total C stock value showed that the national carbon price market underestimates the value of this ecosystem service in the three countries. For C sequestration values, which are based on actual ecosystem level C balance, we found large areas with negative C balance, which are ineligible for credits in the global market.



## ROBIN outputs


- Balvanera P, et al. Assessment of main trade-offs between biodiversity, climate change mitigation measures and other ecosystem services and human well-being at national scale and in local case study areas. ROBIN project report (2015).
- Quijas, S., et al. Modelling carbon stock and sequestration from a dynamic vegetation model for policy design. In preparation.


## More information

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**Fact sheet 5**
September 2015

# PES AND REDD+ SCHEMES SHOULD BE LINKED TO AGRICULTURAL POLICIES ADDRESSED AT SMALLHOLDERS

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## ABOUT ROBIN

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## Key findings

We compared 40 Payment for Ecosystem Services (PES) cases (including biodiversity, landscape, water, carbon) in Latin America and examined their rate of success according to criteria that are especially relevant for a developing country context. The most relevant factors for a successful PES scheme – that benefits ecosystem conservation and human wellbeing – were:

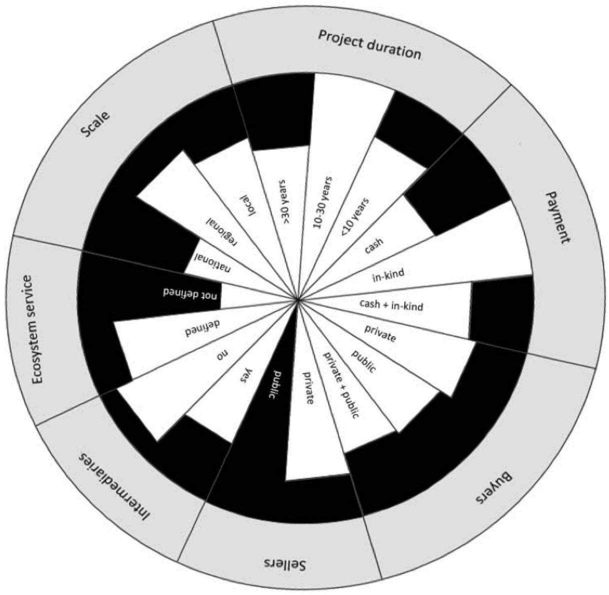
- The combination of livelihood improvement together with the provision of a critical resource
- Regional and local scale PES schemes with a duration between 10 to 30 years
- In-kind contributions rather than only cash payments
- Private actor involvement with no intermediaries.

## Recommendations

- PES and Reducing Emissions from Deforestation and Forest Degradation (REDD+) schemes should be managed by actors known and trusted by the community
- Always combine PES provisioning services with livelihood components that have a clear (communal) benefit
- Ensure medium- to long-term funding before starting a PES scheme
- Start local and/or regional pilots and conduct a rigorous impact evaluation before expanding the scheme.

## Evidence

To assess the success of PES schemes in Latin America we defined 'success' as a combination of (a) the extent to which the original goals of the PES scheme are met, and (b) the added value in terms of overall improvement in the ecological, economic and social conditions of the region, beyond intended objectives. The criteria used to analyse the PES cases were: (1) ecosystem being traded (i.e. biodiversity, landscape, water, carbon); (2) scale (i.e. spatial, temporal); (3) transaction types (i.e. cash, in-kind); and (4) actors involved (i.e. buyer, seller, intermediaries).




**Factors enhancing success rate of Payment for Ecosystem Services (PES) schemes**

The figure (left) displays the factors enhancing the success rate of PES schemes. We found that the potential characteristics of a successful PES scheme are:

- (a) **Ecosystem services being traded:** PES schemes that secure the continued provisioning and quality of a critical resource while positively contributing to local livelihoods are quite successful.
- (b) **Scale:** Local and regional scales are the most widely used, both with high rates of success. Concerning the optimal time frame, projects operating within a period between 10 to 30 years, are regarded as most successful.
- (c) **Transaction types:** The use of in-kind contributions reduces the probability of failure. Those transactions are preferable rather than using only cash payments.
- (d) **Actors involved:** There is a dominance of successful PES schemes where mostly private actors are involved. Also, schemes with no intermediaries between the buyers and the sellers tend to be more successful.

## ROBIN outputs


- Grima, N., Singh, S., Smetschka, B., Ringhofer, L. (2015) Payment for Ecosystem Services in Latin America: Analysing the Performance of 40 PES cases, submitted to Ecosystem Services
- Ringhofer, L., Singh, S., Smetschka, B. (2013) A report on current approaches to climate change mitigation in Latin America, project report for ROBIN – Role of Biodiversity in Climate Change, Social Ecology Working Paper 143.
- Singh, S., Smetschka, B., Ringhofer, L., Grima, N., Petridis, P., Biely, K. (2015) SMCE Toolkit OPTamos software tool (Deliverable 3.2.1.)


## More information

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**Fact sheet 6**
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# MODEL INDICATES BIODIVERSITY HAS A DIRECT EFFECT ON CARBON STOCKS AND FOREST BIOMASS RESILIENCE

## ABOUT ROBIN

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## Key findings

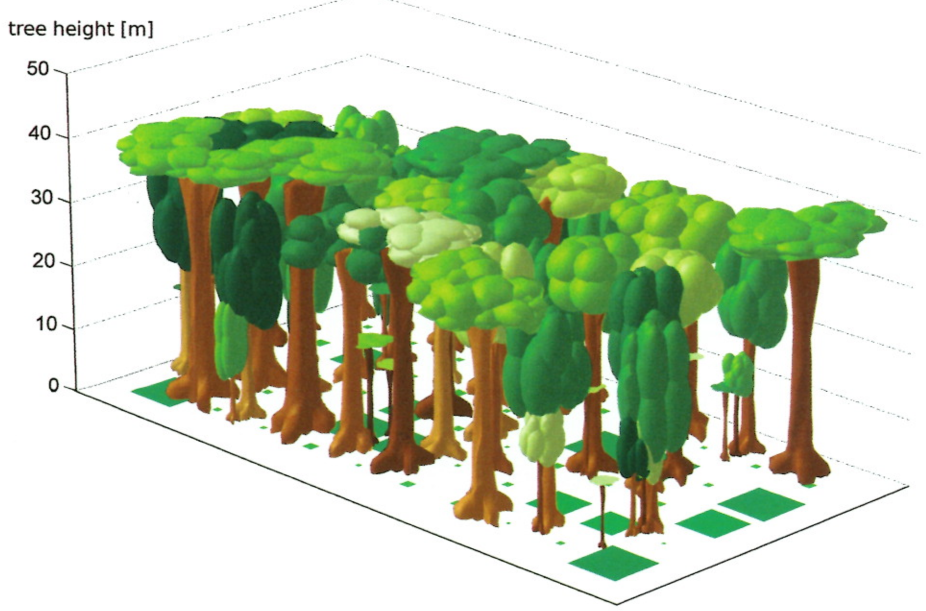
Through our computer modelling, we have found compelling evidence that the biodiversity of the Amazon can ensure its resilience under climate change.

Model simulations show that a naturally diverse forest is able to recover its biomass and height structure after several hundred years under projected future climate conditions. The positive effects of biodiversity on biomass are, however, limited by the strength of climate change.

## Recommendations

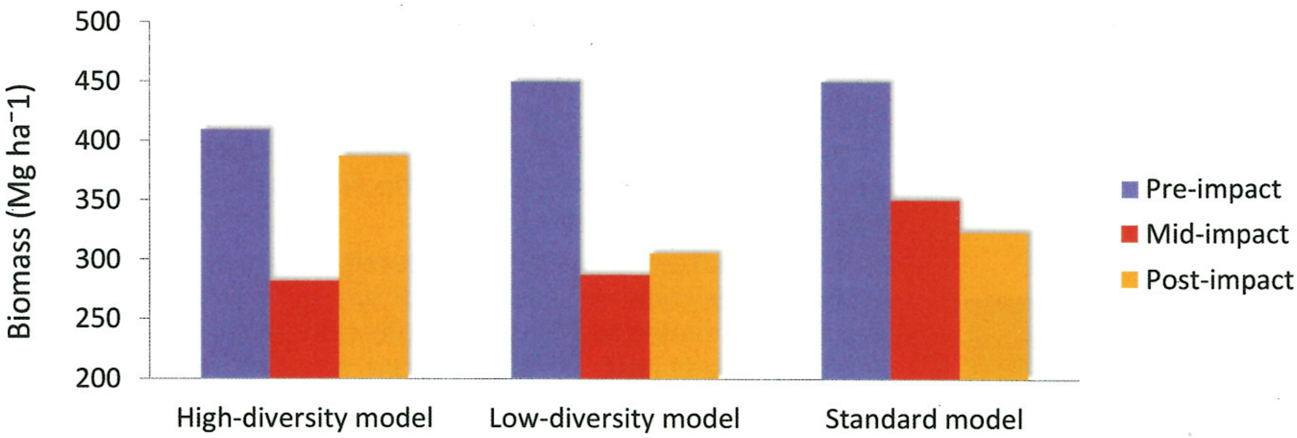
- Biodiversity is an effective means to mitigate climate change in the Amazon basin and beyond, and should no longer be reduced to a co-benefit of ecosystem conservation
- The adaptive capacity of trees should be an integral part of ecosystem model forecasts that evaluate the future status of tropical forests as a carbon source or sink.

## Evidence




**The LPJmL-FIT model simulates individual trees competing for resources in forest patches**

We demonstrated that tropical forests are able to adapt to a changing climate using a new terrestrial biogeochemical model (LPJmL-FIT) that simulates diverse forest communities on the basis of individual tree growth. Our results provide the first evidence that plant trait diversity acts as an insurance against climate change impacts across large spatio-temporal scales by maintaining biomass resilience.




**Simulated biomass of a forest site in the Amazon with different levels of biodiversity. Forest recovery after severe biomass reduction through climate change occurs only when biodiversity effects are incorporated in the model**

## ROBIN outputs


- Sakschewski, B., von Bloh, W., Boit, A., Rammig, A., Kattge, J., Poorter, L., Peñuelas, J., Thonicke, K. (2015). Leaf and stem economics spectra drive diversity of functional plant traits in a dynamic global vegetation model. Global Change Biology, doi:10.1111/gcb.12870
- Sakschewski, B., von Bloh, W., Boit, A., Poorter, L., Peña Claros, M., Heinke, J., Joshi, J., Thonicke, K. Amazon forest resilience emerges from plant trait diversity. Submitted to Nature Climate Change
- Thonicke, K., Blyth, E., Cisowska, I., Sakschewski, B., Boit, A. (2014). Joint land use and vegetation scenarios covering observation sites as well as regional-wide application under future climate conditions. ROBIN project report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**Fact sheet 7**
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# ECOSYSTEM INTEGRITY ASSESSMENT SERVES AS A COMMON APPROACH FOR MULTI-SECTORAL PUBLIC POLICY IN LATIN AMERICA

## Context and trends

There is a clear and urgent need to cope with ecosystem degradation and biodiversity change. Crude estimates suggest that the monetary value of ecosystem services provided by ecosystems in some Latin American countries might well exceed its annual gross domestic product (table overleaf).

Usually a large number of governmental agencies are entrusted with the mandate of studying, safeguarding, and/or monitoring terrestrial, marine, and freshwater ecosystems including their biodiversity. This leads to a complex system of national programs with different constraints, operational requirements, and calendars. There is a clear need to consolidate the existing systems in a nationally and internationally coordinated and adaptive approach.

Ecosystem integrity (EI) is a suitable approach since it facilitates an integrated assessment of the impact of public policies on biodiversity as well as the capacity of ecosystems to provide ecosystem services needed for society.

## Policy relevance

The ecosystem integrity approach:

- enables national and local governmental agencies to evaluate public policy and promote adaptive management
- generates key and standarized scientific information and policy-relevant tools for maximizing resources
- considers non-carbon benefits of biodiversity
- promotes conserving biodiversity and optimum levels of sustainable use by evaluating effectiveness of public policy.

## Evidence

- Governmental agencies in Mexico with the mandate of studying, safeguarding, and monitoring ecosystems and their biodiversity have adopted this approach*.
- This approach shaped the National Biodiversity and Ecosystem Degradation Monitoring System currently implemented in Mexico at a national level.

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- This approach is currently being discussed and explored outside the ROBIN project by Chile, Colombia and Peru within the Pacific Alliance.
- Within ROBIN the approach is being considered and tested in Bolivia and Brazil.
- See also Factsheets 3 and 10.

## Opportunities

- International initiatives (CBD, UNFCCC, IPBES) recommend the integration of ecosystem-based approaches into their national policies and programmes.
- The Ecosystem Integrity approach supports coordination among national governmental agencies by addressing: (i) national goals related to sustainable use of biodiversity (ii) laws on natural resources, wildlife and their habitats**, and (iii) individual mandates of the agencies involved.

| Land cover | Area (ha) | Flow value per ha per year ($) | Total flow value per year per land cover in Mexico (Billion $) |
|---|---:|---:|---:|
| Cropland | 7,265,149 | 5,600 | 40.45 |
| Grass/Rangelands | 138,271,119 | 2,900 | 396.98 |
| Tropical forest | 19,847,991 | 5,300 | 104.48 |
| Temperate/Boreal forest | 26,880,681 | 3,000 | 80.99 |
| Swamps/Floodplains | 1,539 | 25,700 | 0.04 |
| Tidal Marsh/Mangroves | 184,732 | 193,800 | 35.81 |
| Urban | 370,348 | 6,700 | 2.47 |
| Desert | 97,391 | 0 | 0.00 |
| Lakes/Rivers | 1,269,969 | 4,300 | 5.42 |
| Ice/Rock | 1,654 | 0 | 0.00 |
| **Total** | **194,190,573** | | **666.63** |

**Crude estimates suggest that the monetary value of ecosystem services provided by ecosystems in México might well exceed its annual gross domestic product**

*the National Commission for the Knowledge and Use of Biodiversity (Comisión Nacional para el Conocimiento y uso de la Biodiversidad, CONABIO); the National Forestry Commission (Comisión Nacional Forestal, CONAFOR), and the National Commission of Protected Areas (Comisión Nacional de Areas Naturales Protegidas, CONANP), which belong to the Ministry of the Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales, SEMARNAT).

**Examples: General Law for Sustainable Forest Development; General Wildlife Law; Official Mexican Standard on species protection (NOM-059-ECOL-2010); General Law on Climate Change; General Law of Ecological Equilibrium and Environmental Protection.

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**Fact sheet 8**
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# OPTamos – A DECISION SUPPORT TOOL FOR NATURAL RESOURCE AND LAND USE MANAGEMENT

## ABOUT ROBIN

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## Introduction

Sustainable resource and land-use management is a complex goal with many competing interests and stakeholders involved. Multi-criteria evaluation methods can help to integrate stakeholder expertise and scientific knowledge.

In ROBIN we have developed OPTamos - Options for Participatory Transformation and Management of Sustainable Land Use – an online computer tool to support decision-makers.

OPTamos needs information on:

- possible land management options in a specific region
- criteria stakeholders consider relevant for decision making
- relative importance of options and criteria.

Introducing this information into OPTamos makes it possible to run an evaluation and obtain a ranking of preference for the different options.

## Who is ROBIN's OPTamos tool aimed at?

Land managers, decision makers, consultants, and researchers working at local and sub-national level may benefit from its use, since results from OPTamos can be used by those stakeholders in order to enable discussion, promote participation, and enhance the acceptance of measures.

## How was OPTamos developed?

We developed the tool by deriving land use options, decision guiding criteria, and their relative importance from stakeholder workshops in Latin American case studies, and comparing those options to national policies and supporting measures like Payment for Ecosystem Services and REDD+ schemes.


| Criteria | Preserving the forest | Establishing pasture | Establishing corn plantation | Inconsistency ratio | % of importance |
|---|---|---|---|---|---|
| Minimizing capital needed | 72,73 | 20,20 | 7,07 | 0,06 | 13,48 |
| Maximizing income | 6,67 | 37,33 | 56,00 | 0,09 | 46,30 |
| Maintenance of soil fertility | 74,07 | 19,18 | 6,75 | 0,09 | 34,72 |
| Minimizing labor input | 72,73 | 20,20 | 7,07 | 0,06 | 5,50 |
| | 42,61 | 27,78 | 29,61 | | |

OPTamos results are presented graphically and in a table

## More information and access to OPTamos

- Singh, S., Smetschka, B., Ringhofer, L., Grima, N., Petridis, P., Biely, K. (2015). SMCE Toolkit – OPTamos software tool (Options for Participatory Transformation and Management of Sustainable Land Use). ROBIN project report
- Singh, S., Smetschka, B., Ringhofer, L., Grima, N., Lazos, E., Gerritsen, P., Manners, R. (2015). SMCE Implementation – Options for Participatory Transformation and Management of Sustainable Land Use (OPTamos). ROBIN project report
- To use OPTamos visit http://robin-decisionsupport.aau.at

## More information

www.robinproject.info

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ROBIN
Role of Biodiversity in Climate Change Mitigation

# A DECISION SUPPORT TOOL FOR ADDRESSING CLIMATE CHANGE AND BIODIVERSITY POLICY OPTIONS IN LATIN AMERICA

## ABOUT ROBIN

**ROBIN has assessed the role of biodiversity in terrestrial ecosystems in South and Mesoamerica in mitigating climate change. It has evaluated socio-ecological consequences of changes in biodiversity and ecosystem services under climate change.**

## Context

Sustainable forest management depends on effective policies addressing forest carbon stocks, protection of biodiversity and ecosystem services, and human livelihoods in the wider landscape. QUICKScan is widely used for facilitating participatory decision-making and has been used in many countries to explore policy questions at national and regional levels.

In ROBIN we produced data to assess the impact of climate-related policy options and land use change in different socio-economic contexts in Brazil, Bolivia, Mexico and Guyana. We have used the QUICKScan tool to integrate this information, with a focus on REDD+ policies aimed at preventing loss of carbon, while at the same time safeguarding biodiversity, and protecting valuable ecosystem services. Features include:

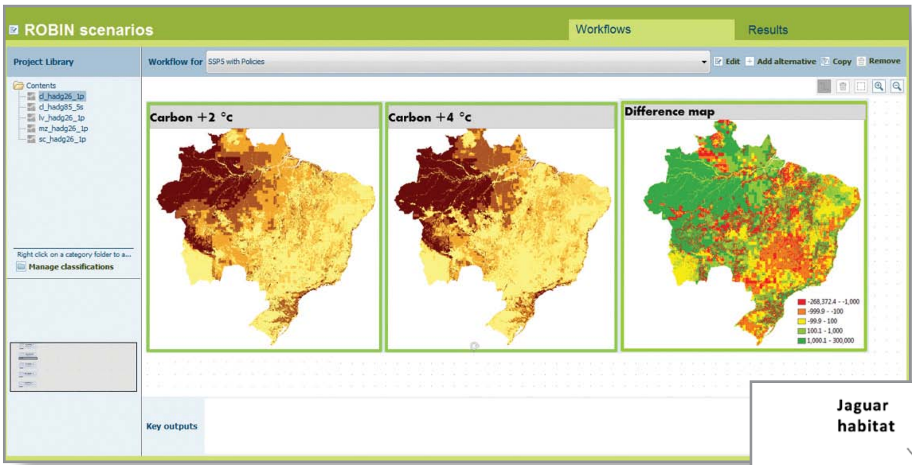
- Key indicators for biodiversity, ecosystem services and human well-being
- Visualisation of trade-offs among indicators
- Shows where sustainability limits are crossed.

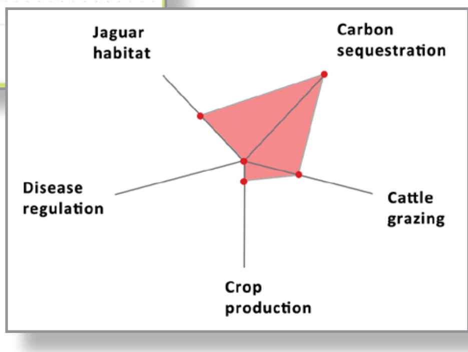
## Key questions the tool can address

- How will future policies affect land use in Latin America?
- What impacts will climate change have on ecosystem services?
- What are the trade-offs between biodiversity and ecosystem services in Latin American countries?

## Who is the QUICKScan tool aimed at?

- Policymakers and resource managers can use the tool to obtain information and rapidly assess policy options
- Scientists and decision-makers can use the tool to make sense of complex information on a spatial basis.




**Uses of QUICKScan:**
**Above - comparing scenarios for carbon stock**
**Right - scenario outcomes for five ecosystem services**

## To learn more about QUICKScan

- Jones, L., Verweij, P., Winograd, M., Smetschka, B. (2014). Development and testing of indicator evaluation tool. ROBIN project report
- More information about the QUICKScan system is available from www.quickscan.pro

## More information

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**Fact sheet 10**
September 2015

ROBIN
Role of Biodiversity in Climate Change Mitigation

# ECOSYSTEMS WITH LOWER INTEGRITY STORE LESS CARBON AND PROVIDE FEWER ECOSYSTEM SERVICES

## ABOUT ROBIN

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## Context and trends

The REDD+ mechanism addresses the reduction of emissions from forest deforestation and degradation, currently estimated to contribute to over 15% of global emissions.

The Convention on Biological Diversity (CBD) is fostering an international commitment to biodiversity based on ecological conservation as a frame for its sustainable use.

Ecosystems with high integrity have higher biodiversity and better condition compared with similar ecosystems with less integrity.

There is mounting evidence suggesting that ecosystem condition relates directly to its capacity to capture and store carbon as well as the provision of other ecosystem services.

Forests subject to some degree of degradation, like secondary forests, may show a transitory large capacity to absorb carbon while developing.

## Policy relevance

The complexity of ecosystems means they provide us with a variety of goods and services simultaneously. They do so just by keeping themselves functional and structurally whole.

We propose that a reasonable policy for increasing and maintaining carbon storage in a given ecosystem would involve the measurement, management and conservation of ecosystem integrity. This will help us to recognize the nature and value of multi-functional ecosystems and landscapes, and build sustainable territories.

## Evidence

Ecosystem integrity, as documented in Mexico with ground and remote sensing data, is correlated with changes in forest ability to absorb and store carbon as well as to the capacity to provide other ecosystem services (See factsheets 3 & 7).

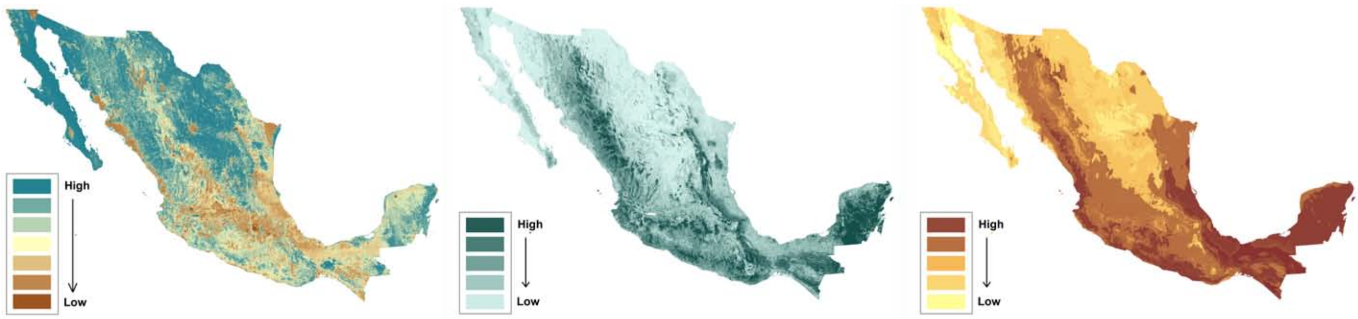
Ecosystem integrity in Mexican forests positively correlates with carbon storage (in terms of biomass, see figure). For example, forests in the peninsula of Yucatan show both high values of ecosystem integrity and high values of biomass. On the other hand, forests close to the coast in the Gulf of Mexico show low

values of ecosystem integrity and also low values of biomass.

The relationship between ecosystem integrity and carbon storage in other types of ecosystem does not necessarily follow the pattern observed in forests. For example, arid lands in central Mexico have high values of ecosystem integrity but low biomass production, because of their intrinsic limitations (water stress), that only permit slow vegetation growth. So, our model of ecosystem condition is flexible enough to describe the ecological potential for carbon storage of different biomes.

## Opportunities

- The evaluation of ecosystem integrity allows an assessment of the "health" of ecosystems relative to their "pristine" condition in the same location and, depending on the data used in its calculation, can take into account structural, functional and taxonomic components of biodiversity.
- Documenting ecosystem integrity dynamics is key to our understanding and our ability to better design suitable public policies to face the challenges of climate change and the construction of a sustainable culture.
- The analysis of ecosystem integrity versus carbon storage can be extended to other countries.




**Ecosystem integrity and plant biomass in Mexico**

**Left: Ecosystem integrity**
**Centre: Biomass**
**Right: Correlation between ecosystem integrity and biomass**

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ROBIN

Role of Biodiversity in Climate Change Mitigation

# THE POTENTIAL OF HUMAN IMPACTED FORESTS

## ABOUT ROBIN

**ROBIN has assessed the role of biodiversity in terrestrial ecosystems in South and Mesoamerica in mitigating climate change. It has evaluated socio-ecological consequences of changes in biodiversity and ecosystem services under climate change.**


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## Context and key findings

Human-impacted forests - secondary forests regrowing in abandoned agricultural areas and forests managed for timber - have higher net carbon sequestration rates than old-growth forests.

## Recommendations

Secondary forests and forest managed for timber sequester large amounts of carbon, and therefore, they should be considered in:

- REDD+ policies and implementation on the ground
- the assessment of the Amazon as a global carbon sink. Here additional information is needed on total area covered by these forests, land use change dynamics and logging intensity
- the creation of biomass recovery maps that identify areas with high carbon sequestration potential for REDD+ programmes, or areas with high potential success for natural regeneration or restoration activities.

Our findings need to be applied carefully to avoid putting pressure on old-growth forests, since old-growth forests remain the best areas for protecting carbon stocks and diversity.

## Evidence

We analysed aboveground biomass (AGB) recovery during secondary succession in 45 forest sites across the Neotropics. Secondary forests are highly productive and resilient, as biomass stocks increase rapidly during initial stages of secondary succession. Above-ground biomass recovery after 20 years was on average 122 Mg/ha, corresponding to an annual net carbon uptake of 3.05 Mg C/ha/yr, 11 times the uptake rate of old-growth forests.

After 20 years biomass recovery varied 11-fold (from 20-225 Mg/ha) across the Neotropics. The recovery rate increased with water availability (higher local rainfall and lower climatic water deficit).

We also analysed the rate at which forests managed for timber recovered their biomass stocks using data from permanent sample plots established in 10 sites across the Amazon Basin.

These sites are part of the Tropical Managed Forests Observatory (www.tmfo.org). Under the current timber harvesting intensities of 10 to 30 m³/ha, logged Amazon forests recover their initial carbon stock in 7 to 21 years. This corresponds to an average annual net carbon uptake of 1.33 Mg C/ha/yr, 4.5 times the uptake rate of old-growth forests. The rate of recovery of carbon stocks after selective logging depended almost exclusively on logging intensity, that is, on the amount of tree biomass removed or killed during timber harvesting.


**A tropical forest landscape in which shifting cultivation is practiced. Secondary forests may grow rapidly after the area has been abandoned for agriculture**

## ROBIN outputs


- M. Peña-Claros, L. Poorter, M. van der Sande, E. Arets, N. Ascarrunz, A. Boit, M. Hoosbeek, B. Sakschewski, K. Thonicke, M. Toledo. 2014. Quantifying the spatial relationship between biodiversity and climate change mitigation at different scales (site and regional), along environmental gradients (precipitation and soil fertility) in undisturbed forests and across land use intensities. Report of ROBIN project.
- Rutishauser E., B. Hérault, L. Mazzei, M. Peña-Claros, M. Toledo, P. Sist, and 18 other authors. 2015. Rapid tree carbon stock recovery in managed Amazonian forest. Current Biology 25: R787-788.
- L. Poorter, F. Bongers, P. Balvanera, M. Peña-Claros, M. Toledo, D. Rozendaal, and 60 other authors. Biomass resilience of Neotropical secondary forests. In review.
- van der Sande, M.T, M. Peña-Claros, N. Ascarrunz, E.J.M.M. Arets, J.C. Licona, M. Toledo, L. Poorter. Drivers of biomass change in a Neotropical forest: testing for niche, mass-ratio, and environmental effects. In review.


## Acknowledgements


The analysis on secondary forests was possible through collaborative work with over 60 researchers that work in Latin America, and the analysis on managed forest through researchers involved in the Tropical managed Forests Observatory (www.tmfo.org).


## More information

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**Fact sheet 12**
September 2015

ROBIN
Role of Biodiversity in Climate Change Mitigation

# TOWARDS A BETTER SOCIO-ENVIRONMENTAL RESPONSE TO CLIMATE CHANGE BY UNDERSTANDING MULTIPLE STAKEHOLDERS' PERSPECTIVES

## ABOUT ROBIN

**ROBIN has assessed the role of biodiversity in terrestrial ecosystems in South and Mesoamerica in mitigating climate change. It has evaluated socio-ecological consequences of changes in biodiversity and ecosystem services under climate change.**

## Context and key findings

In order to collectively shape a better socio-environmental future in response to climate change, it is necessary to discuss transformations of socio-ecosystems over the last fifty years and identify the most important drivers. It is also necessary to determine the local and regional winners and losers from land use changes.

Through workshops with stakeholders in Mexico's Cuitzmala watershed region, we found that the most important drivers were:

- tropical colonization during the 1960s driven by the national government in response to land reform pressure by peasants
- conflicting agricultural and environmental policies
- land grabbing by large landowners
- wood concessions by the national government since the 1940s
- credits from the Interamerican Bank of Development to encourage cattle raising in tropical lands
- hunting and fishing exploited by people from other regions
- prices of agricultural products
- market behaviour provoking the expansion of commercial agriculture and the reduction of subsistence agriculture.

From these processes, the main beneficiaries were large landowners, the wood concessionaries, some cattle raisers and local authorities. On the contrary, small and medium *ejidatarios*, indigenous *comuneros*, and small private landowners, on the one hand, and socio-ecosystems on the other hand, were the most affected, becoming very vulnerable to economic and socio-environmental disasters. Local and regional authorities, and government officials, took advantage and controlled the rural population through the credit system.

The stakeholders felt they could only explain their present, and build a future together, by understanding their past. Due to mistrust, past land grabs, lack of respect for norms and sanctions, and weak social cohesion, the region's rural population is highly vulnerable, since peoples' social capital has been strongly diminished.

## Recommendations

- Construct future socio-environmental scenarios with local and regional stakeholders and discuss how each factor can affect social structures and responses.
- Coordinate environmental, social, and agricultural policies at the local and regional level to avoid tensions and contradictions leading to more deforestation and forest degradation.
- Encourage open, transparent and meaningful dialogue with and between local, regional, and national stakeholders. Create local committees to assure real participation.
- Establish new policies based on the development of concrete territories, taking into account past land use transformations and the socio-cultural and economic history.

## Evidence

We held six participatory workshops in the Cuitzmala watershed south of Jalisco with local, regional, and national stakeholders: indigenous *comuneros*, *ejidatarios*, fishermen, small and large landowners practicing commercial or subsistence agriculture, cattle raising, and/or logging. We also invited local and regional authorities and government officials, the indigenous institutions (CDI), the tourist Ministry, tourism entrepreneurs and representatives from mining companies.

Some of the questions that guided the workshops were: How has the region changed in the last 50 years and why? Who were the actors involved? Who were the winners and losers? What have been the advantages and the disadvantages of these changes? What government programs/policies have had most impact on biodiversity loss and climate change in the region over the last 50 years? How do they perceive their socio-environmental future?

We found that social, political and environmental issues are strongly interdependent. To be effective, environmental policies such as REDD+ must be embedded in the socio-economic framework. For example, loss of biodiversity and deforestation will increase unless problems such as joblessness, lack of medical services, low incomes and low agricultural prices are addressed.

## ROBIN outputs


- Lazos, E. et al., “Entre Promesas y Esperanzas: Actores regionales de la Costa Sur de Jalisco y la construcción de su futuro socioambiental” In: Perló, M. & S. Inclán (Ed.) La Prospectiva en México. Ed. UNAM, México (In press)
- Gerritsen, P. et al., “Voces de la Tierra Pródiga: Testimonios Campesinos sobre las Transformaciones Socio-ambientales en la Costa de Jalisco, Occidente de México” In: Macías, A. Voces rurales en Latinoamérica, Ed. Plaza y Valdés, México (In press)


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ROBIN
Role of Biodiversity in Climate Change Mitigation

# ENVIRONMENTAL POLICIES SHOULD BE INTEGRATED WITH AGRICULTURAL AND DEVELOPMENT POLICY TO BE SUCCESSFUL

## ABOUT ROBIN

**ROBIN has assessed the role of biodiversity in terrestrial ecosystems in South and Mesoamerica in mitigating climate change. It has evaluated socio-ecological consequences of changes in biodiversity and ecosystem services under climate change.**

## Context and key findings

Three series of stakeholder workshops were performed in the case study areas of Guarayos (Bolivia), Flona Tapajós (Brazil) and Chamela (Mexico) to map local present and future environments, and select options for integrating biodiversity in climate change mitigation. Analysis of the workshops showed that:

- Scale matters: Zooming down to the local scale demonstrates the link between socio-economic and environmental issues.
- Stakeholder's perceptions of the present environment were similar across the case study sites: biodiversity losses, deforestation and poverty were expected to continue in the immediate future. However, visions of a sustainable future diverge with Brazil focusing more on societal and institutional development and Bolivia on technical and agronomic factors.
- Stakeholders selected institutional and political coordination as their preferred option for biodiversity conservation and climate change mitigation.

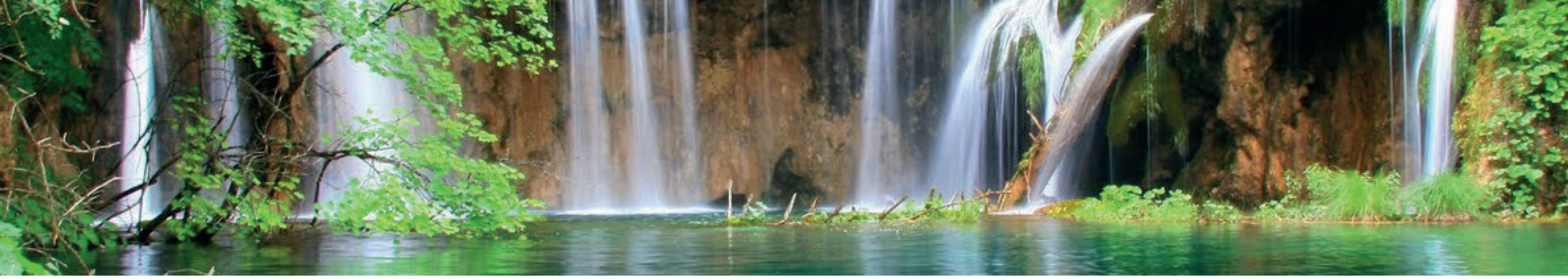
## Recommendation

Policies across multiple sectors should be gradually integrated. Stakeholders repeatedly demanded that economic development, agricultural and conservation policies should be integrated and coordinated.

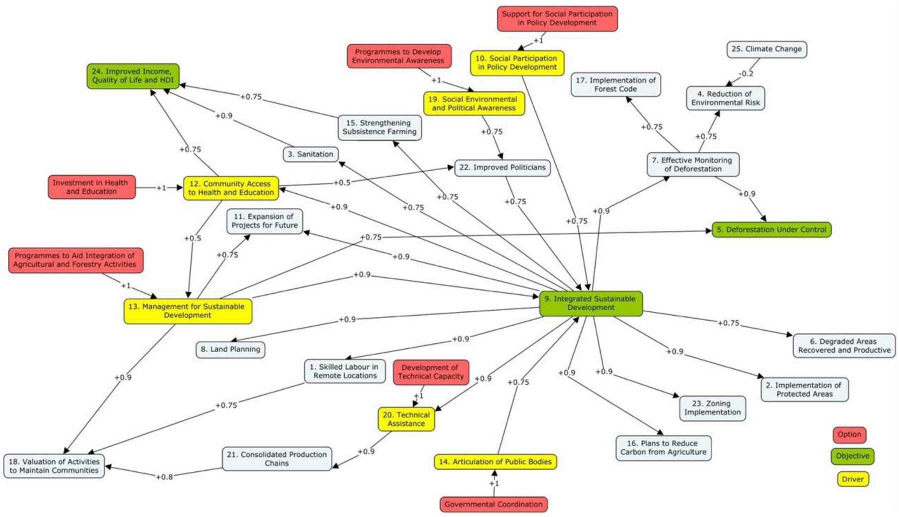
## Evidence

In the 1st workshop, the present situation in each case study site was mapped using Fuzzy Cognitive Mapping (FCM). Stakeholders identified deforestation as the central factor in the mapping, with agricultural expansion considered as being one of the strongest causes of deforestation in each site.

In the 2nd workshop, stakeholders were asked to develop a FCM of the future (2050) based on contextualised IPCC-guided socio-economic scenarios. Stakeholders developed two diametrically opposed local scenarios of each case study site: positive (good life/desired) and negative (bad life/undesired). The future positive maps were driven by factors such as access to health and education and articulation of public bodies (Brazil); access



to credit, institutional coordination and new infrastructure (Bolivia) and responsible, functional government and training and education (Mexico).




**An example of a Fuzzy Cognitive Map produced in a workshop**

In the 3rd workshop, in Bolivia and in Brazil, potential options to mitigate climate change and conserve biodiversity were selected. Options were initially selected from the future positive FCMs developed from the 2nd round of workshops and were prioritised using the Analytic Network Process (ANP). Stakeholders selected and characterised additional options and prioritised them using participatory voting. Stakeholders in Bolivia selected technical training, programmes to assist subsistence farmers and improving implementation of land use as the most preferable options. However, in Brazil governmental coordination, investment in health and education, and programmes to aid integration of agricultural and forestry activities were seen as the three most important options.

## ROBIN outputs


- Varela-Ortega, C., *et al.*(2014). Methods and Results from the first and second round of local stakeholder meetings. Deliverable D3.1.3. ROBIN project. European Commission.
- Varela-Ortega, C., *et al.* (2015a). Identifying options for integrating biodiversity conservation and climate change mitigation: A multi-scale perspective. Deliverable D3.1.4. ROBIN project. European Commission.
- Varela-Ortega, C., *et al.* (2015b). 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.



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