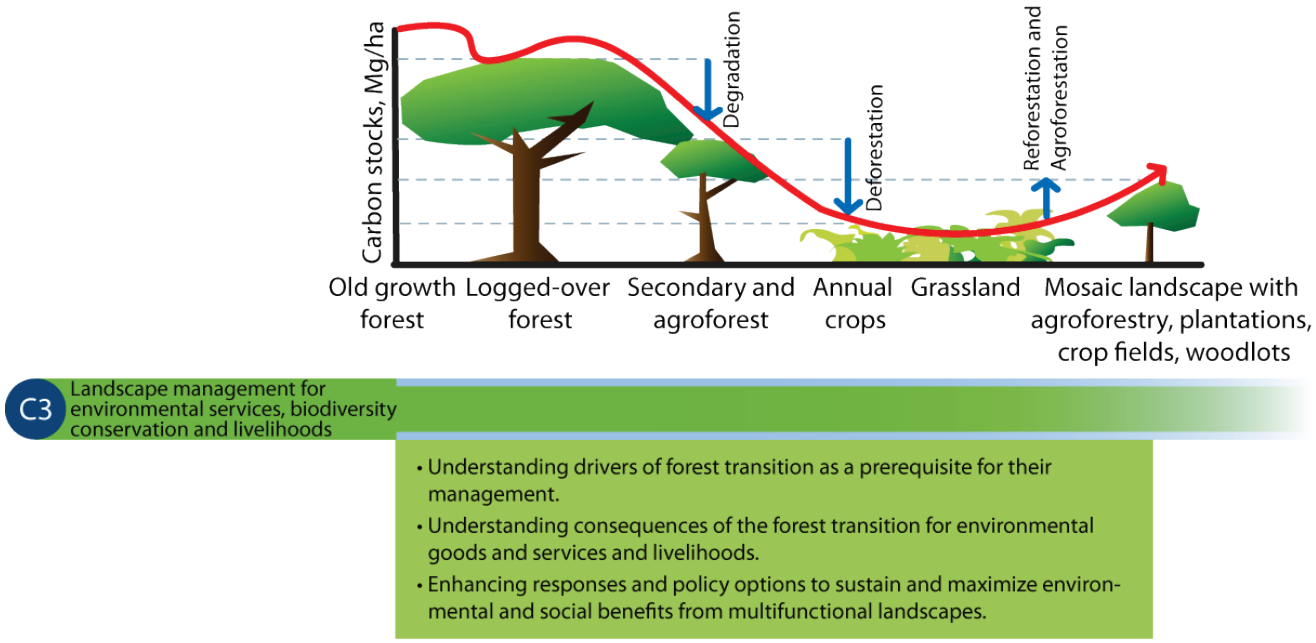
2.3 Component 3: Landscape management for environmental services, biodiversity conservation and livelihoods



2.3.1 Introduction

Using the "forest transition" as a conceptual framework, this component of CRP6 will analyze the localized driving forces (c.f. Component 5) behind the decline and recovery in ecologically functional forest and tree cover and consequences for livelihoods and landscapes. The key problem this component addresses is how to manage for multiple benefits and multiple stakeholders at the landscape scale. Within this research framework, we will investigate the institutional and policy options for reducing the conversion of remaining natural forests while not compromising rural livelihoods. In addition, bolstering collaborative governance mechanisms and increased local and national institutional capacity will contribute significantly to this aim.

To leverage the unique opportunity offered by the work of Component 3, it is essential to understand trends in forest and tree cover. Historically, forested countries have experienced phases of fluctuating forest area, shifting both the quantity and the quality of tree cover in landscapes. The progress of a country or region along the so-called "forest transition curve" has tended to mirror demographic change and often concomitant economic development. Depending on stakeholder perspectives, changes can imply environmental degradation or improvement.[73] However, various trajectories along the curve can lead to the suboptimal outcomes now experienced from the perspectives of rural communities and societal

[73] For example, according to the FAO Forest Resource Assessment (www.fao.org/forestry/fra/fra2010/en), Asia is the first tropical region to record a forest transition from a decrease to a net increase of forest cover. However, new tree cover through the development of plantation forestry based primarily on a few highly productive exotic species has little in common (other than the label "forest") with the biologically diverse vegetation that it replaces.

resilience, where tree cover loss lead to deficits in forest-based livelihoods and environmental goods and services, and biodiversity decline.

As a result, integrated landscape restoration efforts must be sensitive to terminology that connotes control of land and resource use by one side or the other.[74] A central challenge facing integrated landscape management is the institutional dichotomy between "forest" and "non-forest" land. For example, while conservation efforts continue to focus on the management of protected areas (PAs),[75] most of the world's biodiversity occurs outside PAs, primarily in fragmented landscape mosaics containing a range of land use categories. The traditional policy focus of forestry agencies on objectives related to "form" (e.g., percentage of forest cover maintained) must be transformed into objectives related to "function" and "quality" if the complex trade-offs between conservation and development outcomes are to be resolved.[76]

While the segregation of functions (e.g., strict protected areas adjacent to intensive agriculture) as an approach to natural resource management is possible, the reality is that the boundaries between land uses are often not clearly delineated. Hence, more integrated approaches are required. In addition, empirical evidence is needed to understand the longer-term trajectories and drivers of change (see Component 5), including those that are climate induced (see Component 4 and CRP7), that affect the functionality of landscapes on which human welfare depends. Holistic models are needed for the conservation of diversity, including intraspecific genetic diversity, integrating *ex situ*, *in situ* and *circa situ* (on-farm) approaches (see Component 2) that do not undermine communities' ability to achieve substantial improvements in their livelihoods.[77]

The future flows of environmental goods and services[78] from forested landscapes ultimately depend upon integrated approaches to management, use and conservation.[79] In developing countries, the non-market values present in fragmented landscape mosaics, such as environmental service provision, are often accorded little priority, and the sustainable productive potential of different land areas is often inaccurately assumed during land use planning. The inability to adequately assess such non-market values results in both damaging and inopportune loss of environmental services, as well as reduced productivity of marketed agricultural and forestry products. Managing for sustainable utilization and conservation

[74] Even the meaning of the term "forest" has become an arena for debate, with an emerging need to differentiate between "natural forest" (in various degrees of ecological disturbance/recovery and management, such as for wildlife and other non-timber forest products (NTFPs)), "plantations" (with or without differentiation between agricultural and forestry trees and tree crops, usually inferring monocultures or few-species mixtures), "mixed tree-based land use" (often referred to as agroforestry or reforestation/restoration) or conversion into pasture for livestock grazing.

[75] However, the CBD recently set a new target: "17% of terrestrial lands will be under formal protection by 2020". Hence, understanding the human, social, economic and biological impacts of this increased protection, and ultimate annexation, will require considerable research effort.

[76] Sunderland, T.C.H. et al. 2008. Conservation and development in tropical forest landscapes: a time to face the trade-offs? Environmental Conservation 34(4): 276–279.

[77] Xu, J. et al. 2009. Functional links between biodiversity, livelihoods, and culture in a Hani swidden landscape in southwest China. Ecology and Society 14(2): 20 [online] http://www.ecologyandsociety.org/vol14/iss2/art20/.

[78] For the purposes of this document, "environmental services" can be taken to include: provisioning (food, energy, biomass), regulating (water quality, pest and disease control, carbon sequestration), supporting (pollination, seed dispersal, nutrient cycling) and cultural (aesthetic, recreation, spiritual) services.

[79] Lele, S. et al. 2010. Beyond exclusion: alternative approaches to biodiversity conservation in the developing tropics. Current Opinion in Environmental Sustainability 2: 94–100.

outcomes requires explicitly investing in negotiating and managing the inherent trade-offs between the two through more effective land use allocation practices, as well as improved modalities for assessing and managing environmental services.[80]

The characteristics of landscape governance also play a key role in determining which goods and services are given priority and how benefits are distributed. The fate and history of many formerly forested landscapes have been determined by decisions to convert forestlands to agriculture, pasturelands or plantations, or to conserve them as protected areas,[81] often without due consideration of the interests or incentives of forest communities and farmers. Weak and unclear tenure and access right regimes have proven particularly problematic, and the perspectives of local women have counted for even less. The sustainable management and use of forest resources, as well as extensive agroforestry systems, have traditionally been excluded from formal land use planning, despite their importance to forest-dwelling people and farmers. At the global level, multilateral environmental agreements establish objectives, obligations and opportunities for national policies and strategies, but rarely harness or recognize the potential of community-managed forests and agroforestry to advance environmental objectives.

However, the increasing trend toward the decentralization of forest governance,[82] coupled with efforts to enhance transparency and public scrutiny of government and private sector actions, are improving the governance systems that affect multifunctional landscapes.[83] More collaborative and transparent governance mechanisms are needed to overcome the traditional lack of cooperation between science, government, corporations and local communities.[84] An integrated multi-stakeholder assessment process that reaches out to all relevant communities has to be the basis for meaningful change. In this regard, research into tenure and land rights undertaken as part of Component 3 will examine ongoing negotiation mechanisms and land tenure reforms in fully or partially forested landscapes that can contribute to improved landscape management. Our work will also illuminate how governance processes and institutions at local and landscape levels can be reformed to become more legitimate, to

[80] Wackernagel, M. and Rees, W.-E. 1997. Perceptual and structural barriers to investing in natural capital. Economics from an ecological footprint perspective. Ecological Economics 20: 3–24; Baumgärtner, S. 2007. The insurance value of biodiversity in the provision of ecosystem services. Natural Resource Modeling 20(1): 87–127; Hooper, D. et al. 2005. Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. Ecological Monographs 75(1): 3–35.

[81] Given the recent CBD 2020 target that "17% of terrestrial ecosystems are to be protected", PAs will continue to be a major tool for biodiversity conservation; exploring ways to mitigate social conflict while enhancing benefits from PAs remains a pertinent research issue.

[82] Agrawal, A. et al. 2008. Changing governance of the world's forests. Science 320: 1460–1462.

[83] Ostrom, E. 1990. Governing the commons: the evolution of institutions for collective action. Cambridge University Press, New York; Ostrom, E. 2007. Going beyond panaceas special feature: a diagnostic approach for going beyond panaceas. Proceedings of the National Academy of Sciences USA 104: 15181–15187; Giller, K.E. et al. 2008. Competing claims on natural resources: what role for science? Ecology and Society 13: 34. [online] http://www.ecologyandsociety.org/vol13/iss2/art34/.

[84] Colchester, M. 2004. Conservation policy and indigenous peoples. Environmental Science and Policy 7: 145–153; Tomich, T.P. et al. 2004. Asking the right questions: policy analysis and environmental problems at different scales. Agriculture, Ecosystems and Environment 104: 5–18; Cash, D.-W. et al. 2006. Scale and cross-scale dynamics: governance and information in a multilevel world. Ecology and Society 11: 8. [online] http://www.ecologyandsociety.org/vol11/iss2/art8/; Kristjanson, P. et al. 2009. Linking international agricultural research knowledge with action for sustainable development. Proceedings of the National Academy of Sciences USA 106: 5047–5052; German, L.A. and Keeler, A. 2010. "Hybrid institutions": applications of common property theory beyond discrete property regimes. International Journal of the Commons 4: 571–596; Colfer, C. and Pfund, J.L. (eds). 2010. Collaborative governance of tropical landscapes. Earthscan, London.

increase the security of rights and to balance customary norms and formal policy and, ultimately, to provide insights into what kinds of land use rights lead to optimized outcomes for conservation and development.

2.3.2 Thematic focus

This component will have the following three main research themes (closely linked with research undertaken in other components of CRP6 and other CRPs):

1. understanding the drivers of forest transition at the landscape scale (e.g., demographic processes, infrastructure development, tenure reform, policy regulation and incentives, governance and power relations) and developing options for their mitigation (linked to Component 5 on global trade and investment);
2. understanding the consequences of forest transition for sustaining and provisioning environmental goods and services to benefit livelihoods of the poor and disadvantaged (linked with Component 1 on smallholder livelihood aspects, Component 2 on sustainable forest management and Component 4 on climate change);
3. integrating a network of learning landscapes in which local monitoring and evaluation, coupled with adaptive management, link stakeholder interests to actual performance and opportunities to change incentives at the landscape scale and, through cross-site comparison, at the national and regional scales.[85]

The Driver–State–Response framework (see Figure 2.4) points to the following broad groups of research questions.

1. How do national and local drivers interact to modify and/or sustain landscape composition (components/habitat types/land uses) and mosaic configuration?
2. What are the current state and role of biodiversity assets and environmental services in livelihood strategies in forest mosaic landscapes?
3. What institutional and governance frameworks define the occupation, use and management of such landscapes and guide the allocation of benefits and responsibilities?
4. What are the consequences of the landscape composition and spatial configuration for specific stakeholders?
5. How can stakeholders and their external supporters influence the structure of such landscapes (enhance productivity, better manage and protect resources, maintain services, balance trade-offs, etc.) to reduce conflict and enhance functionality?

[85] These landscapes differ from sentinel landscapes (see Annex 4) in that they represent existing and new landscape sites, some with long-term data sets, in which additional research will be undertaken as part of this component. A subset of these sites may be selected as sentinel landscapes, and will accordingly be closely aligned with relevant research outputs of all five components.

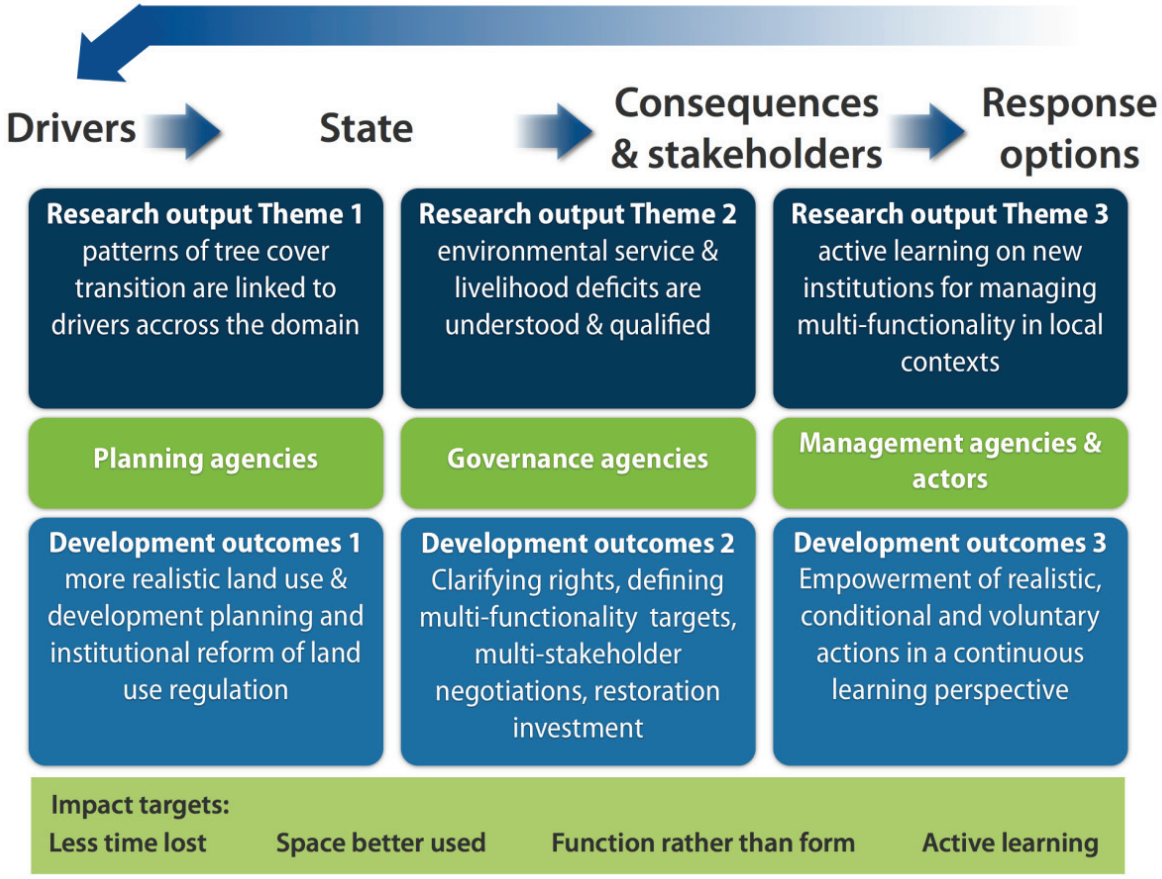


Figure 2.4 Driver–state–response framework

2.3.3 Objectives and expected outcomes (10 years)

The goal for this component is to provide knowledge and solutions for how society, across the various stages and patterns of tree cover transition, can best achieve the management of multifunctional landscapes. This research will be undertaken in a manner that balances the provisioning functions of ecosystem goods and services for local stakeholders and external markets with the maintenance of natural capital and social inclusiveness.

Within 10 years, research undertaken under the three research themes within this component will have contributed to the following changes.

1. In ***temporal*** terms: When dealing with tree-based systems across the transition, longer-term impacts should be expected, usually in the range of 10–30 years. However, research conducted under Component 3 of CRP6 will both reduce the conversion and degradation of forests and enhance the restoration/rehabilitation of forestlands. The restoration of tree cover and forest functions (including environmental services and biodiversity) will thus be accelerated while meeting the needs of poor and disadvantaged communities and contributing to national development.

   Relevant outcomes include the following. Local resource managers will have access to and be able to use cost-effective tools to appraise the likely impacts of changes in land use on watershed functions, biodiversity, carbon stocks and the economic

productivity of the landscape, and to restore forests and the services they provide. What historically has taken a decade, or longer, of intensive research and negotiation support could feasibly be replicated in a third to half the time.

2. In ***spatial*** terms, Component 3 of CRP6 will lead to: (i) an increase in the area of natural and sustainably managed (woody) vegetation with effective protection; (ii) an increase in the area of multifunctional zones that provide for production within forested landscapes while maintaining biodiversity assets and the provision of environmental services; and (iii) a decrease in the area of low-value, contested and formerly forested land that can be transformed into productive agroforestry/forest landscape mosaics.

   Relevant outcomes include the following. Land use planners and practitioners will use principles and methods resulting in clearer recognition of conservation and development trade-offs in land and rights allocation, notably tenure, leading to optimized biodiversity and livelihood outcomes.

3. In ***functional*** terms, Component 3 of CRP6 will enhance rural livelihoods and environmental service provisioning, while acknowledging that trade-offs must be ultimately recognized and negotiated. Environmental services will be integrated using appropriate criteria and indicators that reflect the drivers and consequences of tree cover transitions.

   Relevant outcomes include the following. Local and national agencies will identify environmental service flows and biodiversity assets, supporting efficient and effective conservation, management and marketing of, and rewards for, the provision of environmental services. Opportunities for ecological restoration will be fully used; trade-offs will be recognized and the contest over them will be eased by negotiation.

4. ***Institutionally,*** the knowledge and solutions generated under this component of CRP6 will support the delivery of forest and tree services through innovative rewards and incentives, particularly through payments for environmental services (PES) systems. These will support social and economic relations between external and local stakeholders that strive for reciprocity, and seek a balance of fairness and efficiency.

   Relevant outcomes include the following. Local and external stakeholders will negotiate and have access to a range of conditional and performance-based arrangements that support the provision and maintenance of environmental services and biodiversity assets in productive landscapes. Community involvement will be based on collaborative decision making aided by monitoring tools for strengthening meaningful participation in conservation and land use planning, especially by women and other disadvantaged groups.

2.3.4 Geographic priorities

We will identify the geographic priorities for this research component through a systematic process of portfolio analysis. The criteria will include the use of representational approaches for the establishment of landscapes that will strengthen the power of this research by spanning a range of climatic zones, forest types (biomes/ecoregions), human population density, associated livelihood strategies and collaborative governance approaches. A balance will be sought between humid and dry forest zones, as their primary environmental service issues differ. A detailed geographic priority-setting process will take place during the first

year of CRP6 implementation, building on and rationalizing existing research sites and networks.

At the regional level, priorities are:

- Latin America: Amazon Basin, Andean region
- Africa: Humid forests of the Congo Basin and West Africa; Miombo, Sahelian and other dry forests
- Asia: South, Southeast Asia

At the country level, priority countries where we expect to undertake research and demonstrate outcomes are:

- Latin America: Colombia, Brazil, Ecuador, Bolivia
- Africa: Cameroon, Democratic Republic of Congo, Ghana, Sierra Leone, Guinea, Burkina Faso, Mali, Uganda, Kenya
- Asia-Pacific: China, Indonesia, India, Vietnam, Cambodia, Laos

2.3.5 Theme 1: Understanding drivers of forest transition as a prerequisite for their management

Rationale

Landscape transformation, and thus qualitative and quantitative tree cover transition, is often driven by a wide range of factors. These may include, among others, demographic processes, infrastructure development, changing market dynamics, tenure reforms and policy regulations and incentives. Understanding the drivers of forest loss requires an assessment of the multiple interactions that shape forest transitions at the landscape scale and how they manifest in terms of patterns and process in different biophysical, spatial and institutional settings.[86]

The aims of this research theme are to:

- develop and share knowledge and replicable analytical methods on the spatial and temporal patterns of qualitative and quantitative tree cover transitions and the roles of national and local drivers of landscape change;
- provide analyses of the winners and losers (e.g., indigenous peoples, poor and disadvantaged, large-scale ranchers and farmers, elites, corporations, foreign investors, land speculators) in various phases of current transformations and of the existing and emerging opportunities to shift the balance between them; and
- identify and influence public policy and market-based instruments to enhance the institutional architecture, at multiple scales, for negotiating the trade-offs between biodiversity conservation, environmental service provision and economic development.

[86] This is in contrast to Component 5, which will assess and address the influence that external pressures from large-scale investments associated with global market demand and expanding domestic markets have on social, economic and ecological dynamics, primarily at national level. However, these factors can also have impacts at the landscape scale, and this synergy and complementarity between the two components will strengthen the overall impact of CRP6.

Methods and research approach

This component builds on current and emerging practices in the Global Earth Observation System of Systems (GEOSS)[87] science community through active cooperation at the landscape level, coupled with national and global syntheses of tree cover and forest change. The development and application of models that improve our capability to record and predict trends in land use and cover changes form an essential contemporary requirement of planning processes. Land use and cover change (LUCC) models that link drivers and actors to observable change[88] will be the main research method applied within this theme. An understanding, at the driver and actor levels, of historical, geographic, demographic, political and ecological contexts is a prerequisite both for any planned interventions and for the exploration of alternative scenarios for land cover change.

LUCC models are underpinned by a variety of research tools that assist in the mapping of local, public/policy and science-based interpretation of the landscape through "legends" of maps that have meaning across disciplines and stakeholders. The current terminology of "forest" and "forest-derived" land cover types is notoriously confusing and often inadequate for the formulation of policy instruments. Remote sensing and geographic information systems (GIS) technologies can provide both spatial and temporal framing, but these are only of use when accompanied by complementary research undertaken on the ground. This can include recording historical trends, participatory rural appraisals (PRAs), participatory border delineation and mapping exercises, multi-stakeholder analysis and policy and governance analysis aimed at developing a common platform for dialogue and analysis for local governance, national planning and international debate. Coupling these with quantitative techniques such as biodiversity assessment monitoring through permanent sample plot (PSP) methods and other biophysical approaches will provide the multi- and interdisciplinary methods required to understand both the drivers of forest loss and their impacts on biodiversity and, potentially, livelihoods.

The primary reasons for undertaking a scientific analysis of changes in land cover are the consequences of such change on a wide range of stakeholder interests and the various ways stakeholders can try to modify land cover change in their favor. The utility of concept-based models will depend strongly on the types of entry point the models provide for feedback.

Four main types of "feedback" are as follows.

1. Land use, or the direct benefits that agents derive from their impact on land cover: this usually involves direct learning and relatively short response cycles, although there is ongoing debate about how much an economic lens misses real motivations of different agents.[89]
2. Land use planning, or the attempts by stakeholders of land cover beyond the land user, to change the rules that are part of the set of drivers influencing land users.

[87] http://www.earthobservations.org/geoss.shtml
[88] Hersperger, A.M. et al. 2010. Linking land change with driving forces and actors: four conceptual models. Ecology and Society 15(4): 1. [online] http://www.ecologyandsociety.org/vol15/iss4/art1/.
[89] Villamor, G.B. et al. 2010. Diversity deficits in modelled landscape mosaics. Ecological Informatics doi:10.1016/j.ecoinf.2010.08.003

3. Agent-specific modifications of incentive structures that are conditional on performance, such as forms of PES and related institutions.[90]
4. Generic changes in rules and economic incentives through policy change that is expected to enhance environmental services and/or economic performance at the (sub)national scale.

A fifth component of the system (5) is at the interface of 1–4 in the form of Negotiation Support Systems,[91] in which multiple stakeholders, usually based on their own understanding and interpretation of the Drivers–State–Response relationship, negotiate a range of options to manage the trade-offs between their respective stakes.

CIFOR and the World Agroforestry Centre have completed more than a decade of research on the underlying causes of deforestation. This effort must now be shifted further down the research-development continuum and refocused on the impacts of land use change for livelihoods, for example to answer the question: "how do land use changes pay off, and where and under which circumstances?" With our global mandate and competences in both social and natural sciences, both institutions have a comparative advantage in carrying out comparative analyses. Such studies will inform decision makers at various levels about policies and conditions that favor or impede sustainable development and forest conservation. Deforestation remains a major topic on global and national agendas. Carefully targeted research will be able to reach the various constituencies and inform decisions regarding deforestation and the links to livelihood change.

Research questions

This research theme will explore and analyze the links between the drivers of land use and tree cover change at global/national/local scales, and identify opportunities to negotiate and influence the reversal of current degradation and acceleration of ecological restoration and rehabilitation, through both reforestation and agroforestry transformation.

Broad research questions (Component 3, Theme 1)	Gender-specific aspects of the research question	Examples of science outputs
• What are the major drivers and patterns of qualitative and quantitative tree cover transitions, and how do they vary with scale in space and time? • What are the consequences of commercial logging and forest conversion for migrant-based agriculture or plantations? • What is the impact of infrastructure development and how can negative consequences on the environment and	• How are the perceptions, appreciation and experiences of tree cover transitions influenced by gender? What are the gender impacts of such transitions? • How do different factors that influence transition, including governance arrangements, incentives and	Empirical (including time series) data sets of quantitative and qualitative tree cover transitions across continents Analysis of the links between the drivers of land use and tree cover change at global/national/local scales, including its relationship with: • demographic change, including changes in rates of urbanization, circular and other migration patterns, and human population density • road networks, and other

[90] van Noordwijk, M. and Leimona, B. 2010. Principles for fairness and efficiency in enhancing environmental services in Asia: payments, compensation, or co-investment? Ecology and Society 15(4): 17 [online] http://www.ecologyandsociety.org/vol15/iss4/art17/.
[91] van Noordwijk, M. et al. 2001. Negotiation support models for integrated natural resource management in tropical forest margins. Conservation Ecology 5(2): 21 [online] http://www.consecol.org/vol5/iss2/art21

Broad research questions (Component 3, Theme 1)	Gender-specific aspects of the research question	Examples of science outputs
livelihoods be mitigated? • How do local stakeholders interact with external ones in various stages of forest transition? • How do governance systems and their reform influence stages in forest transition at the forest/agrarian interface?	institutional reform, interact with gender dynamics to produce better outcomes?	infrastructure (e.g., pipelines, hydrocarbon fields, dams, mines) • processing industry (linked to Component 5) • national supply/demand and import/export data and overall economic development • forest categorization and forest policy regimes Identification of opportunities to negotiate and influence the reversal of current degradation patterns and acceleration of forest rehabilitation and agroforestry transformation

Research partners

The partnership arrangements will increase in complexity across the three themes from a more technical research approach in Theme 1, to a multidisciplinary approach in Theme 2 and then a more explicit multi-stakeholder, location-specific approach in Theme 3.

Type of research partner	Organization	Research partner contributions
Participating CGIAR Center	CIFOR	Contributes interpretation of forest types and forest policy domains, as well as human livelihood (poverty) perspectives for forest-dependent people
	World Agroforestry Centre	Contributes research on the drivers of forest transition (tree cover dynamics within broader land use change patterns) and its interface with agriculture at the landscape level
	CIAT	Quantifies and models agricultural drivers of forest transition
International level	CIRAD	Contributes expertise on forestry/agroforestry interface
	NASA	Undertakes analysis of land cover change
	IUCN	Provides comparisons of forest transitions (e.g., in LLS)
	GEOSS	Links the world's many stand-alone biodiversity monitoring systems and connects them to other Earth observation networks that generate relevant data, such as climate and pollution indicators
	IITA	Has shared interest in modeling agricultural drivers of forest transition—coordination with CRP1.2 via ASB partnership
	IFPRI	Has shared interest in modeling agricultural drivers of forest transition—coordination with CRP2 via ASB partnership
	Universities of Louvain-la-neuve, Macaully Land Use Research Institute, Gottingen, FOCALI university network in Sweden, University of Maryland	Analyze forest transition patterns in relation to drivers of change
	Forest Trends	Conducts case studies of forest transition and its relation to policies
	Rights and Resources Initiative (RRI)	Provides analysis of options for tenure reform and "boundary organization" interface with advocacy organizations and national policymakers
	WRI	Analyzes changes in forest cover and its relationship to

Type of research partner	Organization	Research partner contributions
		drivers and policies
	IMFN	Implements sustainable management of forest-based landscapes through the Model Forest approach
Regional level	CATIE	Conducts forest transition analyses in Central America and Amazon
	ICIMOD	Conducts land use change analysis in greater Himalaya subregion
	AIT	Conducts land use change analysis and research
	RECOFTC	Engages in research uptake and dissemination through training
Country or site level	FORDA (Indonesia)	Collaborates in analysis of national and local patterns of forest transition in Indonesia
	NAFRI (Laos), MARD (Vietnam)	Conduct research on land use planning processes
	Ministries of forestry (Guinea, Sierra Leone)	Engage in landscape management and restoration
	Embrapa (Brazil), LIPI (Indonesia)	Conduct land use monitoring
	Indonesian Soil Research Institute	Collaborate in analysis of national and local patterns of forest transition in Indonesia
	IRAD (Cameroon)	Undertakes forest transition studies
Private sector and NGOs	RSPO (Roundtable on Sustainable Palm Oil)	Conducts analysis of forest transition data in relation to proposed industry self-regulation
Private sector	IPOC (Indonesian Palm Oil Commission)	Conducts analysis of land use trajectories preceding oil palm and drivers of smallholder oil palm expansion in relation to emerging standards and policies

2.3.6 Theme 2: Understanding the consequences of the forest transition for environmental goods and services and livelihoods

Rationale

The role of the different spatial configurations of forests and trees in the provision of environmental services needs to be realistically assessed[92] so that appropriate incentives, property rights arrangements and regulatory approaches can be negotiated and updated through learning. Research shows that institutions and arrangements for the management of multifunctional landscapes should be assessed in terms of their efficiency (realistic, conditional, voluntary), fairness (pro-poor, pro-women, pro-untitled landholders, including objectively measurable equity) and environmental sustainability. Existing results show that there is potential for using new property rights arrangements and flexible policy instruments, often implemented through decentralized forms of government, to strengthen community forest management and provide incentives for farmers and ranchers to invest in agroforestry and other tree-based forms of land use.[93]

[92] Malmer, A. et al. 2010. Carbon sequestration in tropical forests and water: a critical look at the basis for commonly used generalizations. Global Change Biology 16: 599–604.

[93] Vandermeer, J.H. (ed.). 2003. Tropical agroecosystems: new directions for research. CRC Press, Boca Raton, Florida, USA; van Noordwijk, M. et al. 2004. Belowground interactions in tropical agroecosystems. CAB International, Wallingford, UK. Scherr, S.J. and McNeely, J.A. (eds). 2007. Farming with nature: the science and practice of ecoagriculture. Island Press, Washington, DC.

Mechanisms and contracts that provide conditional rewards for environmental services have the potential to provide farmers and ranchers with incentives to conserve forest patches and adopt restoration and agroforestry systems and other land uses associated with environmental stewardship, if the appropriate tenure and rights conditions are in place, thus promoting a greater degree of biodiversity conservation. The management of multifunctional landscapes requires research tools and management mechanisms that strike a balance between (1) the provision of goods and services; (2) short-, medium- and long-term resource and biodiversity conservation and use objectives; (3) efficiency and fairness; (4) the interaction of biology and policy in the pursuit of sustainable development of socio-ecological systems,[94] and the likely increasing vulnerability of tree performance in the face of growing climate variability.[95]

This research theme will explore questions directed toward developing tools for understanding the roles of trees and various forest types in providing a wide range of environmental goods and services, and in maintaining biodiversity in landscape mosaics. It will also develop tools for assessing trade-offs between these services and the direct benefits of subsistence and marketed goods. Research under this theme will provide methods and tools to assess and design PES schemes and other reward mechanisms and incentives for reconciling conservation and development objectives. Lessons learned from PES implementation can have considerable application for the design and implementation of other compensation or incentive schemes such as REDD+. Thus, there is close synergy between Components 3 and 4.

Methods and research approach

A wide range of methods are used for understanding the various consequences of land cover change for ecosystem functioning through "lateral flows" (water, sediment, biodiversity and landscape aesthetics). Current approaches in landscape ecology, ecohydrology and conservation biology will be combined with methods that have their foundations in social and economic science disciplines. For example, new approaches to ***biodiversity scaling in landscape mosaics*** have recently been proposed,[96] incorporating two important aspects of biodiversity in nature: ***scale*** and ***spatial variation*** in the supply of limiting resources. These concepts can be used to understand and forecast species diversity in ecological communities in landscape mosaics—an area in which the institutions involved in the implementation of CRP6 have extensive experience and continuing ambitions. In the context of CRP6 biodiversity-related research, a focus on trees and their functional diversity is appropriate, as trees provide infrastructure for the rest of the vegetation, are at the base of a major share of food webs and have intricate relations with pollinators and seed dispersal agents.

To determine the locally perceived relevance and value of environmental services, as well as the (potential) value for external stakeholders,[97] it will be necessary, in collaboration with local stakeholders, to develop indicators and effective monitoring systems to assess the environmental services provided by different systems (primary forests, agroforestry systems,

[94] Anderies, J.-M. et al. 2004. A framework to analyse the robustness of social–ecological systems from an institutional perspective. Ecology and Society 9(1): 18 [online] www.ecologyandsociety.org/vol9/iss1/art18/.
[95] Gebrekirstos, A. et al. 2008. Climate–growth relationships of the dominant tree species from semi-arid savanna woodland in Ethiopia. Trees 22: 631–641.
[96] Ritchie, M.E. 2010. Scale, heterogeneity, and the structure and diversity of ecological communities. Monographs in Population Biology 45. Princeton University Press, Princeton, USA.
[97] TEEB. 2010. The economics of ecosystems and biodiversity: mainstreaming the economics of nature: A synthesis of the approach, conclusions and recommendations of TEEB. http://www.teebweb.org/

mosaics of the two embedded with other land use types, etc.).[98] Such monitoring will guide decision making in landscape management and provide a basis for valuing such services and through incentive schemes, thereby creating political support for biodiversity-friendly land uses (see Box 2.4). Policy and governance research will be undertaken to determine tenurial arrangements in place within a particular landscape and, combined with multi-stakeholder analysis, provide further insights into power relations and equity issues that may need to be addressed.

Box 2.4 Payments and rewards for environmental services

Payments and rewards for environmental services (PES and RES) are widely seen as a way to provide land managers with incentives to opt for land use practices that maintain or enhance the level of environmental services (ES). Such services are expected, but have not typically been appreciated, by "downstream" or ES beneficiaries.[1] In the case of watershed services, the term "downstream" can be taken literally. However, where biodiversity conservation, landscape beauty or a reduction in net emissions of greenhouse gases are involved, the term is used as a metaphor.[2]

Many current and emerging mechanisms use the PES terminology, ranging from subsidies for forest owners paid from levies on water or hydropower users, trade in certificates of rights to pollute (based on certified emission reductions elsewhere), ecotourism and moral incentives to plant trees, to outcome-based contracts to reduce sediment loads of streams and rivers. Although all these mechanisms differ from a pure command-and-control approach, there is a need for more careful descriptors of mechanisms as a basis for comparisons of performance and for re-blending elements of both approaches to adjust to local context. Swallow et al.[3] proposed the term CRES (compensation and rewards for environmental services) for a broader set of approaches that have enhancement of ES as a common goal.

The discussion of the pros and cons of purely financial mechanisms is often antagonistic,[4] and the formulation of alternative paradigms is underway.[5] Both CIFOR and the World Agroforestry Centre have been among the early movers in the emerging fields of PES and RES, respectively.[6] This component of CRP6 will benefit from a closer relationship between the key scientists involved in these fields of study.

References:

[1] Asquith, N. and Wunder, S. (eds) 2008. Payments for watershed services: the Bellagio conversations. Fundación Natura, Santa Cruz de la Sierra, Bolivia; Porras, I. et al. 2008. All that glitters: a review of payments for watershed services in developing countries. IIED, London.
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[5] van Noordwijk, M. and Leimona, B. 2010. Principles for fairness and efficiency in enhancing environmental services: payments for environmental services or co-investment in environmental stewardship? Ecology and Society 15(4): 17. [online] www.ecologyandsociety.org/vol15/iss4/art17/
[6] Wunder, S. 2005. Payments for environmental services: some nuts and bolts. CIFOR Occasional Paper 42. CIFOR, Bogor, Indonesia; Wunder, S. 2008. Payments for environmental services and the poor: concepts and preliminary evidence. Environment and Development Economics 13: 279–297; Tomich, T.P. et al. 2004. Environmental services and land use change in Southeast Asia: from recognition to regulation or reward? Agriculture, Ecosystems and Environment 104: 229–244; van Noordwijk, M. et al. 2004. An introduction to the conceptual basis of RUPES: rewarding upland poor for the environmental services they provide. ICRAF Southeast Asia, Bogor, Indonesia.

[98] Schroth, G. et al. 2004. Agroforestry and biodiversity conservation in tropical landscapes. Island Press, Washington, DC.

One of the milestones in this theme will be the extension of existing ***tree*** databases (e.g., www.worldagroforestrycentre.org/resources/databases/agroforestree with information on tree utility and www.worldagroforestrycentre.org/sea/Products/AFDbases/WD/, a global reference for wood density information relevant for C-stock appraisals) to include a wider range of ecologically relevant properties, and linking these databases to operational data sets and site-level studies.

Box 2.5 CIFOR and World Agroforestry Centre landscape research methodologies

CIFOR: At the landscape scale, CIFOR has standardized a research methodology that it has implemented in many sites, often in collaboration with IUCN. The research method may be summarized as follows.

- Define the landscape: undertake PRAs and stakeholder analysis, identify all the stakeholders within the landscape and undertake participatory mapping to ascertain local perceptions of land cover and use.
- Collect baselines: assemble available background information (documentation, maps, etc.).
- Explore scenarios: what is happening within the landscape?
  - Clarify the historical context
  - Visualize the landscape
  - Develop simulation models
- Facilitate desired landscape scale outcomes (policy implications, catalogue incentives, rewards etc.).
- Identify indicators to measure progress.
- Monitor change.

Reference: Sayer, J. et al. 2007. Assessing environmental and development outcomes in conservation landscapes. Biodiversity and Conservation 16: 2677–2694.

World Agroforestry Centre: As a follow-up to the intensive studies at long-term sites, the World Agroforestry Centre has focused on replicable methods for improved natural resource management that can be used in a cost-effective and timely manner, once capacity at national and local universities and NGOs is enhanced. Methods include:

- understanding land use, poverty and drivers of change (DriLUC and PaPOLD);
- understanding agroforestry systems and their market links (RAFT, RMA and WNoTree);
- understanding the landscape and water flows (PaLA and RHA);
- understanding biodiversity in landscapes (RABA and QBS);
- understanding carbon stocks and GHG emissions (RaCSA and FBA);
- understanding tenure and resource use rights (RaTA and FERVA);
- understanding trade-offs and scenario analysis (Fallow/TALAS and RESFA).

Details and examples of applications can be found at: www.worldagroforestrycentre.org/sea/projects/tulsea/

New insights are also emerging on the interface of social norms and monetary instruments, regarding financial incentives (payments) for environmental services. CRP6 work can contribute new paradigms in this arena, based on direct experience of action research that tries to "make things work", while stimulating discussions with the scientific community. It will not be easy to move from analysis to action in this arena, unless fine-grained solutions in rural landscapes and tropical forest margins align with institutional change at the global level.

In such cross-scale analysis, the lack of economic research tools remain a challenge,[99] and partnerships in new fields such as experimental (behavioral) economics will need to be enhanced.

Different tools will be applied to promote multi-stakeholder dialogue and consensus building in order to enhance landscape-scale multifunctionality. Multi-criteria decision analysis will be carried out to assess the minimum set of institutional, organizational and policy conditions for promoting multiple-use forest management and minimizing trade-offs. Research will provide analyses of the range of property rights regimes that exist in diverse multifunctional landscapes and determine how they create, allocate and enforce entitlements and responsibilities among actors. Research will also identify tights allocation regimes that have potential to resolve existing conflicts, as well as governance processes and practices that have potential to enhance equitable access and benefit distribution from the productive elements of multifunctional landscapes.

Many forest-adjacent communities, including those residing close to production forests, are among the poorest and suffer from inequitable power relations compared with governments, civil society and the private sector. This research will seek to understand how communities can build cooperation and synergies, both internally and with external actors. Factors that strengthen or undermine collective action for sustainable use and/or securing rights within forested landscapes will be assessed, as will the extent to which communities are aware of their rights and responsibilities.

Research questions

Broad research questions (Component 3, Theme 2)	Gender-specific aspects of the research question	Examples of science outputs
How can "environmental service deficits" be quantified? • How do landscape-scale watershed services, carbon storage, biodiversity conservation and the sustaining of ecological functionality depend on the attributes of forestry and agroforestry systems as part of landscape mosaics across climatic, biogeographic, ecological and socioeconomic contexts? • What are the most effective methods for assessing environmental service provision and changes that result as a function of landscape-level disturbance? • What holistic combination of *in situ* (including managed forests), *ex situ* and *circa situ* (on-farm) conservation approaches are most effective for conserving key populations of priority species and their genetic diversity at the scale of landscapes?	How does preference for "quantifiable" environmental services (ES) vary between genders, based on perceived direct value of ES and foreseeable benefits, influencing level of participation?	Tools for determining and quantifying the environmental services at stake in various stages of tree cover transition Strategies and practices for managing tree species to conserve genetic resources today and for the future at the scale of landscapes Strategies and practices for sustaining ecological functionality in multiple-use landscape mosaics

[99] Bateman, I.J. 2009. Bringing the real world into economic analyses of land use value: incorporating spatial complexity. Land Use Policy 26S: S30–S42, doi:10.1016/j.landusepol.2009.09.010; Pascal, U. et al. 2009. Valuation of ecosystems services: methodology and challenges. Report to Review of The Economics of Ecosystems and Biodiversity. European Commission/UNEP/BMU-Germany.

Broad research questions (Component 3, Theme 2)	Gender-specific aspects of the research question	Examples of science outputs
• How can fairness and efficiency be combined in ways to reduce environmental service deficits? • How do outcomes of negotiations over conservation and development trade-offs vary in relation to such factors as stakeholders' negotiation capacity, scientific input and inclusiveness of participation and gender considerations? • How realistic are expectations that regulation of and incentives for enhancing tree-based watersheds, carbon storage and biodiversity services can enhance and sustain environmental services? • What are the trade-offs between efficiency, perceived fairness and measurable equity, and poverty reduction associated with alternative mechanisms for environmental service rewards for smallholder farmers, both men and women? • How can cross-sectoral policies and community-based forest policy limit or enhance the potential for environmental service rewards? • How can policies, tools, methods and approaches enhance the sustainability of financial flows, and improve governance and institutions? • Under what conditions and at what scales can PES schemes and related mechanisms produce positive outcomes for conservation and human well-being that are effective, efficient and equitable?	How do gender roles influence participation in negotiation of PES schemes? What approaches, including timing, sequencing and overall design of PES negotiation processes, are necessary for ensuring effective participation? How to understand, across the various cultural contexts, gender roles and representation in policy dialogues in light of integration? What are the gender-specific impacts of the implementation of ES schemes? How are benefits distributed between men and women, with what impacts on sustainability and livelihoods? What alternative options and arrangements can narrow and/or eliminate distribution gaps?	Adaptive landscape management in which local stakeholders are supported and enabled to enhance environmental service provision as well as their livelihoods Tested tools and governance mechanisms for managing the trade-offs between conservation and development at multiple scales
How can forestry and agroforestry initiatives best interact with the drivers of forest and landscape transitions?	How can forestry and agroforestry and the perspectives of women (and other marginalized actors) be included in policies? What strategies, and at what stages in the sequence of policy design, will ensure effective participation of women and other marginalized actors?	Overview of current policies for the agriculture–forestry interface that can be adjusted to maximize positive environmental and socioeconomic outcomes

Research partners

Type of research partner	Organization	Research partner contributions
Participating CGIAR Center	CIFOR	Leads analysis of consequences on forest-based biodiversity and related ES and livelihood issues; co-leads PES/RES research with a focus on Latin America, gender analysis of ES perceptions and institutional analysis of community-based resource management in forest margins and around protected areas (and its representation in models); co-leads research on tree and land tenure and associated rights
	World Agroforestry Centre	Leads analysis of watershed functions and consequences of trees-in-the-landscape for biodiversity and related ES; co-leads PES/RES research, with a focus on Africa and Asia; leads work on integrated assessment methods and agent-based modeling, which include livelihood options; co-leads research on tree and land tenure and associated rights; leads analysis of national-level institutions and their legal basis for use of economic instruments for ES enhancement
	CIAT	Quantifies and models agricultural drivers of forest transition
International level	CIRAD	Contributes expertise on forestry/agroforestry interface
	RRI	Conducts tenure and rights analysis
	IUCN/CEESP	Researches rights-based approaches to conservation
	CARE	Involved in livelihoods, tenure, rights and development
	IMFN	Implements sustainable management of forest-based landscapes through the Model Forest approach
	IITA	Has shared interest in modeling agricultural drivers of forest transition—coordination with CRP1.2 via ASB partnership
	IFPRI	Has shared interest in modeling agricultural drivers of forest transition—coordination with CRP2 via ASB partnership
	UNEP	Conducts trade-off analysis among environmental services in areas such as Mt Kilimanjaro, Lake Tanganyika
	DIVERSITAS	Provides access to global agrobiodiversity network and consequences of intensification and multifunctionality
	INBAR	Conducts ES analysis of bamboo- and rattan-based systems as part of broader landscapes
	Ecoagriculture partners	Identify criteria and indicators for eco-friendly agriculture in biodiversity-rich landscapes
	Katoomba group	Hold discussion forum on PES and its innovations
	IUCN	Develop innovative approaches to integrated natural resource management
	Conservation International	Function as hotspot alliance partner on innovative solutions for conservation in agriculturally used landscapes
	Universities of Alberta, Amsterdam (VU), Gottingen, Hohenheim, Utrecht, Wageningen, Leuven, Cambridge,	Analyze forest transition patterns in relation to drivers of change
	Macaulay Land Use Research Institute, SLU, ZEF	
	Sustainability Science Program at the Kennedy School of Environment at	Conducts analysis and synthesis of boundary organizations in natural resource management (NRM) negotiations and payments for ES

Type of research partner	Organization	Research partner contributions
	Harvard University	
	Tropenbos	Improves knowledge, and individual and institutional capacity for better governance and management of tropical forest resources
Regional level	CATIE	Coordinates research in Central America
	RECOFTC	Adopts research and disseminates through training
	WOCAN	Researches gender aspects of community-based NRM
	De la Salle University, Philippines	Researches gender aspects of emerging PES/RES institutions
	Heart of Borneo Initiative	Provides compensation scheme development, sustainable financing
Country or site level	FORDA (Indonesia)	Collaborates in research in specific sites
	NAFRI (Laos), MARD (Vietnam)	Researches land use planning processes
	Ministries of forestry (Guinea, Sierra Leone)	Conduct landscape management and restoration
	Embrapa (Brazil), LIPI (Indonesia)	Conduct land use monitoring
	FFI (Indonesia)	Develops environmental services compensation schemes
	FRIM (Malaysia)	Evaluates environmental services
	IRAD (Cameroon)	Conducts forest transition studies
Private sector	Bridgestone	Identifies criteria and indicators for eco-friendly rubber production
	Mars Inc.	Identifies criteria and indicators for eco-friendly cacao production

2.3.7 Research Theme 3: Enhancing responses and policy options to sustain and maximize environmental and social benefits from multifunctional landscapes

Rationale

Under what circumstances is it possible to reconcile conservation and development objectives in forested landscapes? What needs to be done to create appropriate conditions for this reconciliation? A new generation of integrated conservation and development initiatives, using approaches variously termed as the "landscape approach" and the "ecosystem approach", are being implemented to address these problems.[100] Existing evidence suggests that such projects should: (1) be implemented at multiple scales; (2) address the problem of trade-offs by quantifying them, providing platforms for multi-stakeholder negotiations and using instruments such as PES; (3) pay greater attention to organizational and institutional aspects during implementation; (4) give greater weight to extra-sectoral and non-local drivers of change; (5) use adaptive management; and (6) mainstream participatory action approaches.

[100] Sayer, J. et al. 2007. Assessing environmental and development outcomes in conservation landscapes. Biodiversity and Conservation 16: 2677–2694.

The combination, sequence, timing, form and quality of interventions at the various scales are all important in influencing outcomes.

Adaptive management implies both "experimentation" and "learning" components of these conservation and development interventions, especially where the opportunity is taken to compare experiences and learn across sites. Research will target identifying and negotiating trade-offs between conservation and development,[101] as well as identifying and understanding the factors influencing implementation success and failure.

A specific interest in CRP6 at the interface of Components 2 and 3 is how forest ecosystems can be managed for conservation alongside production functions. Research aimed at developing guidelines, to be used at the "management unit" level in Component 2, will be viewed in a wider landscape context in Component 3. This will allow holistic models to emerge for the conservation of biological diversity, especially intraspecific diversity, including *ex situ*, *in situ* and *circa situ* (on-farm) approaches that do not undermine communities' ability to improve livelihoods.

Research under this theme includes examining ongoing negotiation mechanisms and land tenure reforms in fully or partially forested landscapes that can contribute to improved landscape management by recognizing the trade-offs between conservation and development, and by improving prioritization of land use. Research will illuminate ways to reform governance processes and institutions at local and landscape levels to make them more legitimate, to increase the security of rights and to balance customary norms and formal policy. The work will yield insights into what kinds of land use right lead to optimized situations for both conservation and development, and will produce tools and approaches for assessing trade-offs, mitigating conflicts and conducting multi-stakeholder negotiations.

Methods and research approach

The "learning landscapes" approach implies that key stakeholders in target landscapes are learning; at the same time, scientists are learning about what these stakeholders learn—this can remove bottlenecks elsewhere. Such "social learning" is used to frame logical but challenging requirements for evidence of (1) individual changes in understanding; (2) shifts in understanding in wider social units or communities of practice; and (3) attribution of (1) and (2) to social interaction processes. Methods will thus be a combination of quantitative and qualitative approaches that include focus group discussions and self-reflections as well as "hard" data, such as the use of remote sensing to determine changes at the landscape scale over time (c.f. CRP6.3.1). Methods used in this theme are a trade-off between "product" and "process" -oriented traditions. Product-oriented traditions emphasize quantitative approaches that scale across space and time and can feed into forecasting and scenario development. They are generally seen as good science and replicable, but may have a problematic outcome/impact pathway. The focus of process-oriented traditions is on multi-stakeholder learning; these approaches emphasize outcome and impact, but may be weaker on scientific content and replicability.

[101] Sunderland, T.C.H. et al. 2008. Conservation and development in tropical forest landscapes: a time to face the trade-offs? Environmental Conservation 34(4): 276–279.

An important consideration in selecting and managing "learning landscapes" for this component is to balance the level of engagement of researchers in support of change (including influencing local policy reform) with the continued opportunity to interpret the ongoing processes of change of relevance for a broader set of landscapes. While "sentinel landscapes" (see Annex 4) will serve more as "observatories", the "active learning landscapes" described here will involve more direct researcher participation in local action. This approach opens opportunities to use sentinel landscapes for formal impact assessment of work undertaken in this theme; however, in practice, the line between *sentinel* and *learning* landscapes will not always be very distinct.

Landscape studies provide powerful tools to examine how society-wide changes, such as changing macroeconomic conditions, infrastructure development, land tenure and agrarian reforms, influence the development and sustainability of particular agricultural strategies or production systems, and thereby reveal the pressure they have on forest resources.

However, these approaches often provide no information about the implications for livelihoods and the social distribution of benefits of economic growth, or about the differentiated implications of emerging land uses for forest goods and services. Hence, the challenge is to link landscapes to livelihood approaches, and to interpret them within a broader context of factors shaping the interplay between economic development and landscape change. Although there has been a great deal of research on the causes of deforestation and forest degradation, much remains to be learned about viable solutions to emerging problems. For example, can policies be developed that can enhance people's livelihoods by stimulating particular agricultural strategies and land use practices, while mitigating pressures on forest resources? NGOs, district officials and other key stakeholders need tools and appropriate information (such as scenario building, trade-offs assessment and opportunity costs analyses) to assist them in making decisions for the optimized management of multifunctional landscapes, allowing for integration of land use management, conservation and socioeconomic planning. These tools will further raise awareness among national and local decision makers about the pace, magnitude and location of landscape changes, and potential implications of such changes for forest goods and services.

Research questions

Broad research questions (Component 3, Theme 3)	Gender-specific aspects of the research question	Examples of science outputs
How can multi-stakeholder, multifunctional landscapes evolve from a conflict-dominated state to one that involves negotiation and use of opportunities for synergy—with positive environmental and social outcomes? How do the outcomes of negotiations between conservation and development trade-offs systematically vary in relation to such factors as negotiation capacity of various stakeholders, scientific input and	Do conserved and other forests have different values and accessibility for men and women? What kind of conflicts may occur within communities and how might their nature and intensity vary by gender? What options exist for conflict management and resolution that draw upon the relative strengths of men and women? How can different abilities to participate and negotiate, including bargaining power, between men and women be accounted for and addressed?	Identification of principles, methods and processes for optimizing conservation and livelihood values from the allocation of land use rights within forest landscapes Collaborative decision-making and monitoring tools for strengthening community involvement and meaningful participation in conservation and land use planning, especially by women and other disadvantaged stakeholders

Broad research questions (Component 3, Theme 3)	Gender-specific aspects of the research question	Examples of science outputs
inclusiveness of participation?	How to facilitate equitable land use rights allocation and women's ability to maintain rights? What kinds of safeguards are required in rights allocation processes to ensure equitable and effective rights and access?	
How can conservation and livelihood objectives be reconciled at the landscape scale?	How do species uses differ between user groups and how should these be taken into account in conservation and management? How to resolve conflicting uses between multiple users within and among communities? How to empower women by recognizing and strengthening their role in and livelihood benefits from resource management? What might be the unintended consequences of such empowerment and how can such consequences be mitigated and/or avoided? What suite of incentives, knowledge and resources is required to enhance reserve managers' gender sensitivity?	Identification of improved modalities and approaches to effectively support conservation in forest landscape mosaics Participatory models for reserve managers to identify how reserve dwellers use particular resources and threaten long-term sustainability of targeted species; monitor current uses; and develop guidelines for conservation and sustainable management of species and populations of value

Research partners

Type of research partner	Organization	Research partner contributions
Participating CGIAR Center	CIFOR/World Agroforestry Centre	Jointly convene and participate in research in a number of focused "learning landscapes", experimenting with new ways of balancing goods and service provision in multifunctional landscapes
International level	CIRAD	Contributes expertise on forestry/agroforestry interface
	IUCN/CEESP	Provide a framework for a "rights-based approach" to conservation
	IMFN	Implement sustainable management of forest-based landscapes through the Model Forest approach
	Diversitas	Assesses biodiversity in agricultural landscapes and the anthropogenic drivers of biodiversity change
	IUCN	Convenes global network of "learning landscapes" through LLS
	WWF, CARE	Lead a number of landscapes with PES experiments
	IFAD	Mainstreams RES approaches in regular agricultural development projects
	Tropenbos	Improves knowledge, personal capacity and institutional capacity for better governance and management of tropical forest resources

Type of research partner	Organization	Research partner contributions
Regional level	CATIE	Coordinates research in Central America
	ICIMOD	Conducts land use change analysis in greater Himalaya subregion
	RECOFTC	Engages in research uptake and dissemination through training
	Heart of Borneo Initiative	Engages in compensation scheme development, sustainable financing, long-term research
	CARPE	Engages in landscape-scale implementation in Congo Basin
	WWF Lower Mekong	Engages in landscape-scale conservation and development in Lower Mekong
	CARE	Works with livelihoods, tenure, rights and development
Country or site level	FORDA (Indonesia)	Collaborates in research in specific sites
	NAFRI (Laos)	Researches land use planning processes
	MARD (Vietnam)	Researches land use planning processes
	Ministries of Forestry (Guinea, Sierra Leone)	Conducts landscape management and restoration
	Embrapa (Brazil), LIPI (Indonesia)	Conducts land use monitoring
	FRIM (Malaysia)	Conducts environmental services evaluation
	IRAD (Cameroon)	Conducts forest transition studies
	CI (Indonesia)	Conducts West Papua landscape assessments
	WCS (Cambodia and Laos), WWF (Cameroon, CAR and Gabon), FFI Cambodia	Carry out landscape-scale conservation and development
	National RUPES committees and networks in Indonesia, Philippines, Vietnam and Nepal	Identify national-scale regulation and legislation bottlenecks linked to "focused learning" sites
	Many site-level partners such as WARSI in Indonesia	NGOs involved at site level and in scaling-out to province/national scale
Private sector + NGOs	RSPO (Roundtable on Sustainable Palm Oil)	Conduct analysis of forest transition data in relation to proposed industry self-regulation
Private sector	Various drinking water companies	Potentially invest in environmental service provision

2.3.8 Sentinel landscapes

Details of the rationale for establishing a CRP6 network of sentinel landscapes are provided in Annex 4. The particulars of how this network will be implemented will be resolved during the first year of this program's implementation. Most or all of the individual sentinel landscapes within such a CRP6 network will likely be research sites for this landscape-oriented component. Given its focus on this scale, CRP6 Component 3 will work with other component research teams to integrate knowledge generated, for instance, at the scale of individual farmer plots (CRP6.1), timber stand harvesting by communities (CRP6.2), climate change mitigation and adaptation strategies (CRP6.4) and the impacts of global trade and investment (CRP6.5) and to build understanding of how these factors play out in individual landscapes.

We will benefit from this network to undertake long-term research to monitor the impacts of exogenous and endogenous change at the landscape scale, and test the durability of options to sustain livelihood and environmental resilience. Subsequently, we will develop and apply field-tested and standardized research protocols to allow global comparative studies of forest transition stages, economic and demographic conditions and climatic/biophysical determinants of environmental services and livelihood options, building on the learning landscapes approach of Theme 3 of this component. Finally, via the overall coordination with other CRPs that CRP6 will provide (see Section 4 on program support) we will link with researchers in other CRPs in exploring development questions at the scale of landscapes (see Annexes 3 and 4).

2.3.9 Impact pathways

We expect to produce impacts (see Figure 2.5) primarily by developing and disseminating methods and policy strategies under the auspices of international treaties and policy frameworks (e.g., CBD, IPBES) and by conducting capacity building with our partners for user groups including planning agencies (Theme 1), forest and land use governance agencies (Theme 2) and landscape management agencies and actors (Theme 3). (See Section 3.1 for gender-specific impact pathways.)

To achieve our desired results, we will apply a range of strategies. Our work, spanning a wide network of landscapes, will cover the primary dimensions of variation for longitudinal (long-term) research where existing data sets and partnerships can be used to monitor the impacts of exogenous and endogenous change at the landscape scale. This will provide key information and knowledge for policy and practice partners. To enable global comparative studies of forest transition stages, economic and demographic conditions and climatic/biophysical determinants of environmental services and livelihood options, we will develop and apply field-tested and standardized research protocols. Negotiation Support Systems[102] will be used to influence and facilitate change among multiple stakeholders at local scales. Finally, for scaling-out, diagnostic approaches will be packaged into replicable appraisal methods that will be used for train-the-trainer events. The initial stages of their application will typically be supported by universities, NGOs and government agencies.

Risks remain in the overselling of oversimplified approaches linked with quantitative impact indicators that are not broadly supported (voluntary) or not feasible (unrealistic) and that do not have operational indicators for achieving the conditionality necessary for PES and RES. This component is designed to deal with these key risks through its focus on quantifiable indicators and cause–effect relations, while documenting experience on the use of PES and RES for conditional, outcome-based forms of rewards.

[102] van Noordwijk, M. et al. 2001. Negotiation support models for integrated natural resource management in tropical forest margins. Conservation Ecology 5(2): 21 [online] http://www.consecol.org/vol5/iss2/art21.

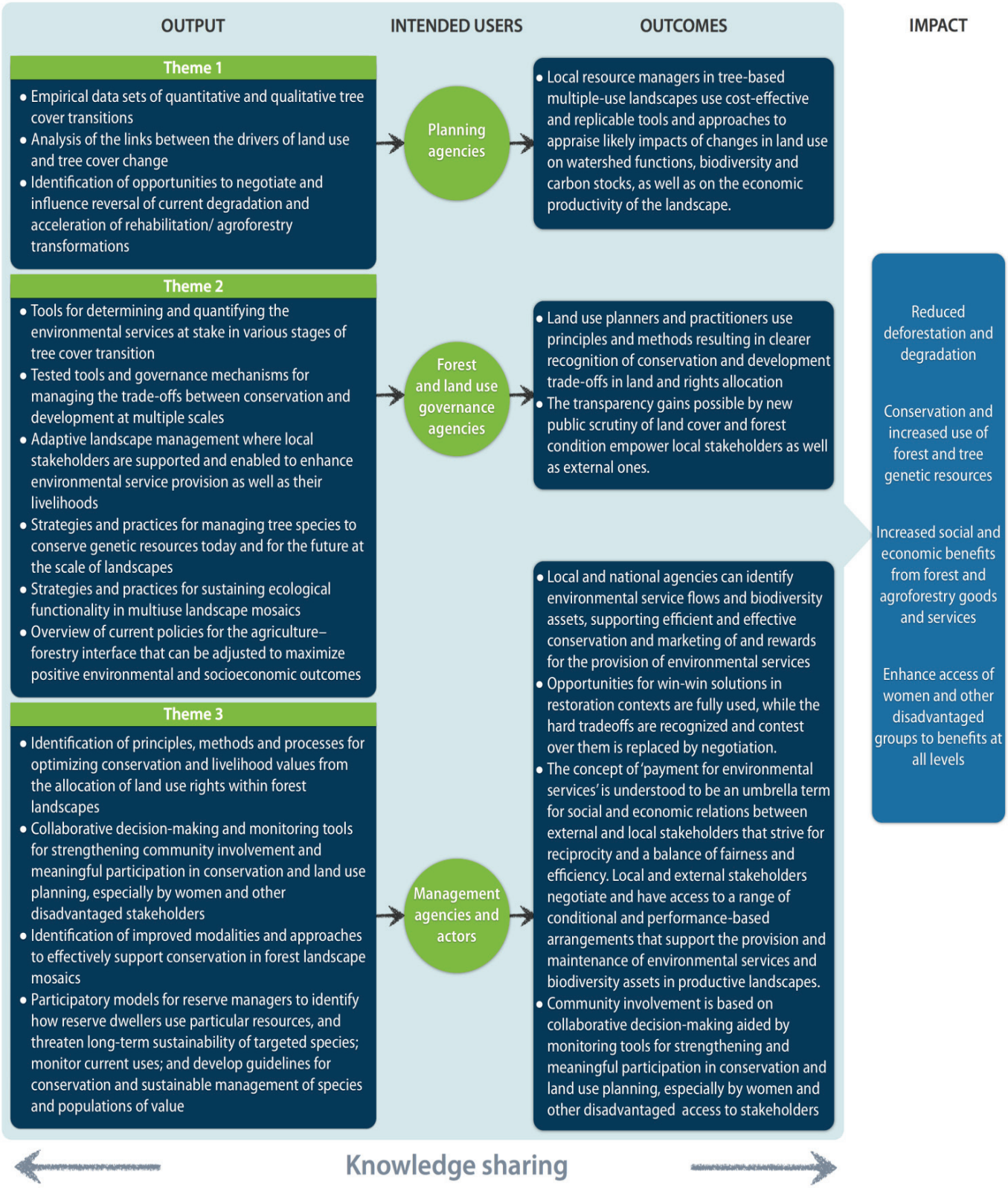

Figure 2.5 Impact pathways for Component 3

Box 2.6 Examples of potential impacts of Component 3

The benefits of improved and integrated landscape management can include maintenance and even increases in many different environmental goods and services, leading in turn to increased rural incomes, food security, biodiversity conservation and carbon storage. Following are some examples.

- *Forest-based pollination services for agricultural productivity.* As natural habitat for bees, bats and other critical taxonomic groups, forests, agroforests and other tree-based systems provide pollination services to adjacent agricultural areas. Studies suggest that forest-based pollinators can substantially increase coffee yields and quality. In one case from Costa Rica, coffee yields and the quality of beans on sites close to forests and forest edges were 20% and 27% higher, respectively, than on sites far from forests. This difference in productivity translated into an additional farm income of approximately US$60 per hectare.[1] Maintaining forests and viable forest fragments in landscape mosaics can thus increase agricultural productivity and rural incomes.
- *Co-management for improved incomes and biodiversity conservation.* The Landscape Management for Improved Livelihoods (LAMIL) project in Guinea supported co-management of forests between local forest committees and the Department of Forests and Fauna[2]. As a result of better management, the area affected by fire each year was reduced by around 80%, and wildlife populations were restored. Assistance to farmers in buffer zones in the form of improved farming and agroforestry practices and improved varieties of crops and trees contributed to increases in average household income of more than 25%, with many villagers able to increase their incomes by a factor of three or more. Co-management has also resulted in collective community benefits, as proceeds from forest harvests have gone into construction of community schools and wells.
- *Tenure clarity for REDD+ revenues and carbon storage.* One condition for payments for environmental services (PES) is the need for a clear "seller" of those services, requiring similarly clear land tenure rights. However, some 24% of all land in Brazil and more than 50% in Indonesia (the two countries with the highest rates of deforestation) are characterized by unclear or insufficient tenure rights. As a result, PES-related approaches to REDD+ mechanisms are hindered as a climate change mitigation strategy. Projections indicate that about 67% of all deforestation will occur in these areas, hence limiting the feasibility of PES to approximately one-third of its potential to reduce deforestation.[3] The development of policies and strategies to clarify tenure rights in Brazil and Indonesia would thus have a dual benefit: potentially millions of smallholders living in these areas would become eligible for a new source of income as environmental service providers, and REDD+ investments would reduce emissions from deforestation[4].
- *Wildlife management for increased food security.* In at least 62 countries worldwide, wildlife and fish together constitute at least 20% of the animal protein in rural diets. In some rural areas in Central Africa, bushmeat constitutes up to 80% of protein and fat in local diets. While the extinction of significant forest mammals is of concern from an ecological point of view, the impacts of wildlife depletion on food security can also be dramatic. Protein malnutrition would likely increase rapidly as many African countries do not produce sufficient quantities of non-bushmeat protein to feed their populations.[5] Improved strategies for sustainably managing these ecosystem goods at the landscape scale could significantly improve food security.
- *Clean and sustained sources of water.* The influence trees and forests have on the total water yield of a catchment is generally negative, but quality of surface and ground water and regularity of river flow are generally positively related to tree cover. The relationship between forest cover and flooding risk is an area of ongoing public debate and scientific analysis[6].

References:

[1] Ricketts, T. et al. 2004. Economic value of tropical forest to coffee production. Proceedings of the National Academy of Sciences USA 101(34): 12579–12582.
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[3] Börner, J. et al. 2009. Direct conservation payments in the Brazilian Amazon: scope and equity implications. Ecological Economics 69: 1272–1282.
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2.3.10 Milestones

Working milestones for Component 3 are as follows.

Year 1: Organizations key to achieving impact pathway are confirmed as partners. Partnerships are formalized through MoUs/subcontracts, etc. Platforms for negotiation are established to underpin the "feedback process". Baseline data are collated (e.g., synthesis of current agent-based spatially explicit modeling frameworks in relation to forest and tree cover transitions); research methodologies are developed and tested. Long-term implementation research strategies are agreed. Ongoing research and other activities are aligned with CRP6.3 as appropriate. Research sites (including for sentinel landscapes) are selected in consort with other CRP6 components and key partners.

Years 2–4: Research activities are undertaken and results validated through peer-review publication. Multi-stakeholder analysis provides feedback on progress on achieving outcomes

Years 5–6: Research outcomes; for example: use of improved methods for evaluating environmental services leads to improved assessment and calculation of reward mechanisms; land use planners and practitioners adopt new approaches that result in clearer conservation and development trade-offs in land and rights allocations; improved modalities and approaches that effectively support conservation in forest landscapes are identified and implemented. Research outputs are adopted and further disseminated by lead CG-centers, partners and research targets (e.g., CBD, IPBES).

Years 7–9: Continued monitoring (including multi-stakeholder analysis) in both learning and sentinel landscapes provides evidence of improved land use practices, more equitable tenure and resource rights and improved livelihoods.

Year 10: Observable decrease in forest and tree loss and increase in forest cover (due to both restoration and agroforestry). Continued feedback informs future research efforts.

We emphasize that the milestones listed above are preliminary and subject to refinement during the initial project start-up, and as part of a rolling annual planning process over three years. In practice, a 3–4-year project cycle is frequently most appropriate as lessons are learned, new priorities emerge and situations change in individual landscapes and globally. We are targeting a 10-year project design, but suspect that delivery of the full potential impacts will likely require a longer time horizon (see also Annex 4 on sentinel landscapes).

2.3.11 Role of partners

This component will build on the solid foundation of partnerships developed in previous and ongoing research undertaken by the CGIAR centers involved in CRP6. The World Agroforestry Centre, and the ASB Partnership for Tropical Forest Margins that it convenes, has long-term research underway analyzing environmental service dynamics, incentives to influence agroforestry transformations and the links between the drivers of land use and tree cover change at global, national and local scales along with opportunities to influence agroforestry transformation.

Another example is CIFOR's landscape-scale research on conservation and development trade-offs (which includes the joint CIFOR/World Agroforestry Centre Landscape Mosaics initiative, as part of the joint Biodiversity Platform, collaboration with IUCN's Livelihoods and Landscapes Strategy (LLS) and the International Model Forest Network), sustainable forest management, and smallholder and community forestry. CIAT has also undertaken extensive research on forest–farmland margins.

Table 2.3 Illustrative list of policy and knowledge-sharing partners for Component 3.

Levels/types	Policy and practitioner partners*	Roles/contributions	Knowledge-sharing partners	Roles/contributions
International level	CBD	Key international instrument for sustainable development	Panos	Uses scientific content in training journalists
	FAO	State of the World's Forests: annual forest cover assessment	WOCAN	Promotes institutionalization of gender perspectives in NRM-related organizations
	FSC	Investigates the potential role of certification of environmental services	De la Salle University, Philippines	Gender aspects of emerging PES/RES institutions
	IPBES	Mechanism proposed to further strengthen the science–policy interface on biodiversity and environmental services		
	GEOSS	Links stand-alone biodiversity monitoring systems and connects them to other Earth observation networks, such as climate and pollution indicators		
	RRI	Analysis of options for tenure reform and "boundary organization" interface with advocacy organizations and national policymakers		
	IMFN	The sustainable management of forest-based landscapes through the Model Forest approach		
	Katoomba Group	Discussion forum on PES and its innovations		
Regional level	COMIFAC	Translates research results into policy guidance for Congo Basin governments	CATIE	Uses content in graduate curriculum
	OTCA	Translates research results into policy guidance in Amazon Basin countries.	RECOFTC	Capacity building for community forestry and devolved forest management
	Heart of Borneo Initiative	Compensation scheme development, sustainable financing		
Country or site level	Ministries in charge of forest, forest resources and environment e.g., FORDA (Indonesia), NAFRI (Laos), MINFOF (Cameroon)	Land use planning policy and implementation	IPB/LIPI	Science and policy links to education and curriculum development
	Ministries, agencies in charge of gender and community development e.g., MARD (Vietnam)	Sustainable rural development	Environmental education organizations e.g., Living Earth Cameroon	Community outreach of research outputs

2.3.12 Prioritization

This component of CRP6 is pivotal to the program, not only for building understanding, but also for linking the landscape-scale impacts of drivers (CRP6.4, 6.5) to consequences and management options (CRP6.1, 6.2). The logic of drivers–state–response implies that priorities cannot be set easily at the thematic level in this component as all three themes are needed. A fully effective CRP6.3—that accomplishes all of its objectives—will require a suite of research landscapes across the global tropics to capture social and ecological variation. The scale and rate at which we will build this program will depend on the availability of funds, appropriate partners and other resources. Greater investment will enable a finer scale of research, whereas budgetary limitations will reduce it to more coarse-scale coverage, with less reliable conclusions. The stronger our financial support, the more rapidly we will be able to achieve our overall outputs targeting specific outcomes and impacts, as well as integrate better with other CRP6 components. Planning and prioritization will be undertaken through the rolling annual planning process over three years (continuing the CGIAR Medium Term Planning mechanism at center and CRP levels) with the engagement of the Component Implementation Team and broader CRP6-wide elements. We envisage the following two main strategies to prioritize the rollout of Component 3.

- The *scale of operations*: Work will need to start in all three themes from the initiation of CRP6 to ensure continuity of currently funded activities, enabling the effective and timely production of key outputs. However, if unavoidable budget restrictions prevail, it may be possible to delay the delivery of certain outputs as cost-saving measures over the first years of this program, pending more detailed analysis by the Component Implementation Team.

- The *number of landscapes* in which we conduct research: An ideal research design, from a global comparative study perspective, would require a number of replicates in each cell of a multidimensional matrix encompassing forest types (e.g., ecoregions), human population density, livelihood strategies and governance approaches. However, from a prioritization perspective, we would aim first to fill out the matrix with research underway in at least one landscape per cell in order to capture broad global variation. Subsequently, we would add research in replicate landscapes as more funds and other resources became available to enable us to produce more robust outputs. Rather than direct replication, additional sites would allow a finer resolution in a hierarchical typology of landscapes. In practice, the typology itself will be subject to review and revisions as more data become available. Further, selection of additional sites will depend on research design criteria, as well as partnerships opportunities and co-funding.

A full prioritization strategy will follow the initial Component Implementation Team meeting during the first semester of CRP6.