



# Landscape dynamics, productivity and resilience



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Forests, Trees and  
Agroforestry

Landscape dynamics, productivity and resilience cover one of five key research domains in the CGIAR Research Program on Forests, Trees and Agroforestry (FTA). This work helps to enhance the contributions of forests, trees and agroforestry to achieve multiple sustainable development goals at scale.



# Why landscape dynamics, productivity and resilience?

Several important trends, such as increasing populations, changing diets and a need for environmental preservation, have led to increased competition for land and land uses, given limited land resources. Amid this competition, economic dimensions have often dominated over environmental and social aspects, short-term outlooks over long term, and global perspectives over local.

This research theme aims to understand the drivers of land-use changes, their dynamics, their consequences, as well as how decisions can be made regarding the role of forests and trees in the landscape, their distribution and types (species, modes of management). It also looks at how that can help achieve multiple objectives (production, nutrition, ecosystem services) within a landscape, and what tools and institutions are needed to facilitate such decisions and enable their implementation, given the various perspectives and interests of numerous and diverse actors.

FTA provides guidelines and tools (such as producer support programs, environmental and social responsibility guidelines, tools to guide investments, multistakeholder dialogues, vertical and horizontal integrations), that can be used to facilitate a multifunctional landscape approach. Such an approach deals with natural processes and human controls, such as natural resources management (NRM) and land tenure, in an integrated and multidisciplinary manner, combining a wide range of environmental factors (e.g. watershed health, biodiversity conservation and

habitat connectivity), economic factors (value chain dynamics), and social conditions and objectives with institutional and policy considerations.

Thus, this research theme coordinates internally with FTA's work on sustainable value chains at the meso level, jointly addressing tradeoffs and synergies relating to commodities, trade and enterprise. The theme also partners with the CGIAR Research Program on Water, Land and Ecosystems (WLE) as well as the Future Earth and the Ecosystem Services Partnership.

Regarding climate change, mitigation and adaptation objectives have largely been pursued separately. A landscape approach can enable integration and synergy between the two and thus enhance the effectiveness and efficiency of NRM. FTA provides a menu of practices associated with various systems and successful case studies, where multifunctionality of landscapes provide mitigation, adaptation, development and conservation benefits. In this respect, the research theme links with FTA's work on climate change, exploring aspects of climate smart landscapes as well as the linkages between agriculture and forests in the context of reduced emissions from deforestation and forest degradation (REDD+), and nationally determined contributions as they link to green economies. Collaboration also occurs between this research theme, FTA's climate change work, and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

## What is a landscape?

A landscape is a socioecological system that consists of a mosaic of natural and/or human-modified ecosystems, with a characteristic configuration of topography, vegetation, land use and settlements that is influenced by ecological, historical, economic, institutional and cultural conditions. It is therefore at the landscape level that key interactions among biophysical, socioeconomic and institutional factors occur and can be observed. A landscape is therefore a spatial unit where economic activities, natural resources, ecosystem services and their economic and social use can be considered together.

## What is the landscape approach?

As it relates to natural ecosystems, agriculture, forestry, energy, water, industry, transport, cities, related infrastructure and other land uses, and to the livelihoods they sustain, the landscape approach brings together stakeholders to transcend, within a landscape and across scales, traditional management, policy and governance boundaries. It provides concepts, tools and institutional solutions for stakeholders to identify, understand and address the complex set of interlinked environmental, social and economic challenges. It fosters evidence-based and inclusive prioritization, decision making and implementation. It promotes integration between policy domains and integration of policies and practices.

# Focus and key questions

Through this theme, FTA aims to enable an understanding of how multiple (and sometimes conflicting) sustainable development objectives can be optimally combined at landscape level, given the priorities of stakeholders. This is based, first, on an analysis of how ecosystem services underpin the ways that forests, trees and agroforestry can contribute to multiple Sustainable Development Goals (SDGs). Second, it aims to provide concepts and tools for stakeholders to identify, understand and address the complex set of interlinked environmental, social and economic challenges related to how natural ecosystems, agriculture, forestry, energy, water, other land uses and infrastructure can be combined to enhance overall productivity and resilience in landscapes. Third, it aims to provide institutional solutions and inclusive, learning-oriented and participatory decision-making processes to bring stakeholders

together to transcend, within a landscape and across scales, traditional management, policy and governance boundaries.

## Key research questions are:

- What are the current patterns and intensities of change in tree cover and ecosystem services?
- What are the consequences of such changes for ecosystem functions, services and sustainable development?
- How does landscape diversity contribute to human well-being and healthy diets?
- How can an efficient and fair landscape governance that influences generic drivers and/or community- and household-level incentives to increase multifunctionality emerge?

## What is FTA researching in landscape dynamics, productivity and resilience?

### This research is structured around four main clusters of activity:

1. Landscape observation and learning, to monitor and understand the extent and patterns of land-use changes in landscapes, their drivers and consequences.
2. Landscape mosaics, biodiversity and ecosystem services, to estimate the contribution of forest and tree-related ecosystem services to multiple SDGs, and options and scenarios for enhancing these ecosystem services, including tackling tradeoffs and leveraging synergies.
3. Landscape diversity for healthy diets, to examine how landscapes can best contribute to ensuring balanced provisioning of food and required nutrients for their inhabitants and beyond.
4. Adaptive landscape institutions, to devise technical and institutional innovations for better landscape governance.

### Landscape observation and learning

Landscapes change under the influence and interaction of multiple factors and drivers. These need to be properly identified, monitored and understood — both their underlying causes and their economic and social implications — in order to mitigate negative impacts on the environment and livelihoods, communities and households, and to harness potential benefits. This requires a comprehensive set of information and data on economic, social and environmental dimensions, geo-referenced, gender disaggregated and followed through time.

In most developing countries, data on land-use change, its extent, drivers and consequences is non-existent and, where available, is often partial and not continuous. This makes it difficult to have reliable indicators to guide effective action of different stakeholders in a landscape when it comes to deciding on land-use and land-management choices and related investments, and to monitoring progress.

This cluster sets out to mitigate this challenge through a study of the patterns and extent of land-use changes in selected landscapes. It will identify a set of potential landscapes, facilitate colocation of



△ Photo by Y. Ahmad/ICRAF

initiatives over time (building on the current portfolio of colocated projects) and jointly develop trans- and multidisciplinary data collection efforts in these landscapes to enable analysis and understanding of drivers, patterns, consequences and responses. The set of selected landscapes will aim to represent a range of pan-tropical agroecological biodiverse contexts.

Data collected through any joint efforts will provide indicators and feed into other FTA analysis of important aspects, such as actual tree cover change, trends over time, predicting future scenarios and advanced knowledge on effective land-use management intervention strategies.

In Africa, Latin America and Asia, millions of people depend on forests for their livelihoods and resilience. Moreover, millions of hectares of self-sustaining forest can be established on degraded lands. FTA data and evidence seek to inform practices and policies that can leverage this potential.

Countries need data and indicators to monitor sustainable development initiatives at the local and national levels. Research results in this work will be used to evaluate SDG performance and offer guidance on necessary adjustments to the means of implementation. The evidence will further inform donors and

development partners on where to focus their support for multiple impacts across landscapes and to help achieve multiple SDGs.

#### **Some key related research activities include:**

- Devising methods to orient FTA's place-based research so that it can be relevant to a multiplicity of different contexts and enable the generation of international public goods, such as by defining extrapolation domains, in particular those based on the representativeness of FTA's portfolio of sentinel landscapes.
- Facilitation of the collocation of projects around the portfolio of sentinel landscapes and joint data collection on a number of agreed areas, giving roles for local partners.
- Scenario studies and participatory development planning results within the sentinel landscapes set-up, aligned with national goals and international commitments, including the Aichi targets of the Convention on Biological Diversity (CBD), United Nations Convention to Combat Desertification (UNCCD) and United Nations Framework Convention on Climate Change (UNFCCC) modalities.

Based on the above, decision support tools are needed for sites and objectives for the restoration of forests, at the landscape and local scale, tested and adopted in a set of priority countries.

## Landscape mosaics, biodiversity and ecosystem services

Agricultural intensification has increasingly led to a loss of non-cultivated habitats and simplification of the landscape, and the elimination of important agro-ecological infrastructures leading to biodiversity loss, which in turn reduces the ecosystem services on which agriculture depends.

This cluster seeks to understand complex relations between ecosystem services as affected by tree cover loss or gain, and human well-being. Analyzing these interactions will provide a basis to examine and provide information on their effects on biodiversity, water quantity, quality and regularity flow. Tree cover changes also have a direct impact on climate. As such, this work interacts with FTA's work on climate change and value chains, as well as with WLE. This knowledge and evidence will be used to mobilize action, as well as inform tradeoffs and synergies required for sustainable use of ecosystem services in meeting optimal human and development needs.

Well-meaning interventions on restoration are often faced with challenges of sustainability and scaling. This largely stems from a lack of alignment with local realities and possibilities. Work in this cluster explores whether and to what extent 'restoration' is feasible, including ways climate change adaptation can be built into traditional 'steady-state' or seemingly permanent restoration concepts.

FTA analyzes the consequences of landscape changes with a focus on multiple pathways of anthropogenic influence as identified in the previous cluster. Questions of 'so what' and 'who cares' are addressed here with respect to the quantity and quality of various ecosystem services. Another focus is the tradeoffs and synergies

between the services (provisioning, regulatory, aesthetic and cultural) under multiple conditions.

Tree cover changes have a direct impact on climate, while the various interactions in the landscape inform efforts on value addition. As such, this work interacts with FTA's work on climate change and value chains, as well as with WLE.

#### **Examples of related research activities include:**

- Assessment of effects of tree cover change on rainfall patterns and variability at regional and continental scales, combining global circulation models with qualified tree cover data, quantified water balance data and dendrochronological evidence.
- Development and application of tools for inclusion of local knowledge and gender perspectives in landscape restoration.
- Synthesis of options for achieving Aichi targets of biodiversity conservation through managed transition zones around protected areas, landscape connectivity and ecological corridors and development zoning, utilizing the full spectrum of forest, tree and agroforestry land-use systems.
- Valuation studies that relate human and social capital benefits across scales to changes in forest and tree cover as indicators of ecosystem services in local contexts, as contributions to national and international debate — including the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).
- Assessment of potential contributions of different oil palm diversification (in Brazil) and forest rehabilitation (in Vietnam/Indonesia) for landscape multifunctionality.



## Case Study 1: A tool for planning low emissions development at subnational level

A low emissions development strategies planning tool, Land Use Planning for Low Emissions Development Strategies (LUWES), was developed, tested and used in multiple settings at landscape scale (with landscape scale explicitly considered as a subnational jurisdictional/planning level of governance) under various Norway, EU and World Bank funded initiatives (REALU/SECURED, REDD ALERT and Opportunity Costs Analysis Methods Manual), and as part of FTA and the ASB Partnership.

The purpose was to estimate emission reduction potential, costs and benefits under multiple development scenarios for planning, decision making and learning purposes. LUWES provides a set of tools and principles that allow for a participatory approach involving all stakeholders at the landscape level who participate in land-use planning and decision making. The tool allows stakeholders to work out scenarios on how best to reduce emissions while at the same time deriving livelihood, economic and social benefits.

The Indonesian National Development Planning Ministry approved LUWES for use in government planning processes. It has been used by 30 of Indonesia's 33 provinces. LUWES has also been applied at a national level in Panama, at a regional level in Ucayali, Peru, and at a municipal level in Cameroon, with benefits observed. This tool is being further developed to address the full suite of ecosystem tradeoffs and benefits in landscape-level planning.

## Landscape diversity for healthy diets

At different scales, from village to global level, quality of diets is linked to the quality of the landscapes that fundamentally provide for them. Landscape diversity is key to dietary diversity and therefore to good nutrition.

This cluster of activity explores ways in which landscape diversity management through forests and tree-based systems/agroforestry can contribute to healthier food systems and diets, and therefore food security and nutrition. It seeks to provide evidence, knowledge and information on the practices, mechanisms and strategies through which forests and trees on farms, and related value chains, can enhance food systems and diets under different conditions and contexts including rural–urban food system linkages.

It analyses how trees contribute to various components of healthy diets in rural and urban contexts, and the ways in which these can be influenced by changing tree-cover related landscape-level patterns, including land-use transition, agricultural intensification, shifting cultivation, home gardens, cropland–forest mosaics and forest management intensities. This cluster also assesses how inland water fish, insects, bush meat and wild indigenous tree products can form parts of diverse diets in rural and urban contexts, compatible with sustainable harvest intensities.

The evidence generated is used by land planners, decision makers, development agencies and communities for developing interventions, implementing them and evaluating failures and successes as a basis for further learning.

The overall objective is to provide means for an increase of on-farm production of a diversity of fruits, nuts, vegetables and legumes, and increased amounts of collected wild resources including wild fruits, vegetables, bush meat, mushrooms, insects and fish from forests. It also aims at increased value capture by producers/collectors of nutrient-rich food, reduced post-harvest losses of wild and cultivated nutrient-rich food, and increased incomes and employment. Finally, it targets increased dietary diversity of low-income rural and urban consumers using a variety of nutrient-rich wild and cultivated foods available during economic, social and/or environmental shocks.

### Examples of related research activities include:

- Stocktaking of statistical datasets that link dietary diversity to species-level and genetic diversity of agricultural and associated landscapes, and process-level models that interpret this in terms of availability, access and behavioral patterns, setting priorities for further work by FTA and partners.
- Analysis of priorities and options for developing capacities of value-chain actors (including input suppliers, producers, processors, retailers and traders) on production, post-harvest handling, processing, marketing and consumption of nutrient-rich foods derived at landscape scale.
- Impact study of the effectiveness of interventions by development partners aimed at supporting dietary diversity through diverse landscapes.
- Protocols for the analysis of nutritional variation in the seeds of *Parkia biglobosa* along an environmental gradient and soil types in Burkina Faso.

## Adaptive landscape institutions

In most landscapes, various interventions to meet SDGs tend to be conducted in parallel, driven by different stakeholders with varying interests. However, in the landscape, what happens in one sector impacts on other sectors and hence there is a need to integrate actions by multiple stakeholders. This cluster of activity aims to provide ways for institutionalizing, on the ground, the landscape approach, in a bid to create appropriately informed governance schemes and evidence-based environments for collective decisions, to manage tradeoffs and maximize synergies between various actors and sectors, and have other complex dynamics well considered in order to achieve multiple objectives.

Investments for restoring ecosystem services tend to be uncoordinated, unaware of enabling or disabling laws and policies, and largely driven by the perspectives of the investors rather than ecosystem and community needs. An integrated approach will promote synergy, avoid duplication of efforts and provide opportunities for shared learning.

There are many ways by which ecosystem services can be restored within landscapes in terms of both different desired changes (restoration to forest or agroforest, use of ecosystem-services friendly agroforestry practices) and different types of intervention needed (regulations, incentives or markets for ecosystem services). There is a need to devise processes and institutions to help stakeholders understand the range of possible options available in a landscape and to make decisions given multiple objectives.

On top of this, there is growing concern over the need to provide attractive employment and livelihood perspectives for young people in agriculture and forestry. Many countries are confronted with an aging population of farmers and/or an increasing active population with high rates of youth unemployment. Youth need platforms that can launch their entrepreneurial skills, creativity and ambitions with a focus on providing profitable solutions for food security and environmental management. To create impact, interventions also need to enhance gender equity.

FTA assesses the enabling conditions and elements including improved local governance and related instruments (e.g. land-use plans, green economy plans), and examines how policy instruments and incentives (including payments for ecosystem services) can be

deployed to enhance the achievement of multiple objectives on the ground; FTA also aims at better conceptually defining the role of research in support of and embedded into these processes, in contact with stakeholders, including through action research.

FTA's work looks to strengthen gender and youth innovations through institutional capacity to increase their ownership and voice in natural resource management as well as paying specific attention to environmental justice concepts and their application in local institutions. This will allow for critical reflection on current generic theories of change and the diverse roles of agency for change, while also taking into account political economy and political ecology aspects of the constraints to guiding policy and enhancing landscape governance.

Multiple methods, tools and approaches are developed. Central to the process are inclusive and participatory approaches (landscape democracy), alongside decision and negotiation support and capacity building tools. This cluster also links with other FTA work on property management and governance. It further provides a platform for an exchange of lessons learned across FTA. It also serves as a link to the other three clusters of activity by collecting, synthesizing and packaging results and information into formats that can be shared as evidence for policy making and other intervention efforts by various actors.

### Examples of research activities envisaged in this cluster include:

- Assessment of legal frameworks and formal institutional constraints to the management of mosaic landscapes in Burkina Faso.
- Practitioner guides on lessons shared in Africa, Asia and Latin America covering socioeconomic, ecological and governance dimensions of PES concepts, with case studies that show diversity of contexts and the relevance of local reinterpretation of ideas and concepts.
- Reflection on the multiscale character of the 'common but differentiated responsibility' phrase that so far has been primarily used at international negotiation tables but that may increase space for local adaptive landscape management.
- Compilation of lessons learned at landscape scale across learning landscape networks for reporting on Aichi targets to CBD.

### Case Study 2: Changing mindsets and landscapes in South Sulawesi, Indonesia

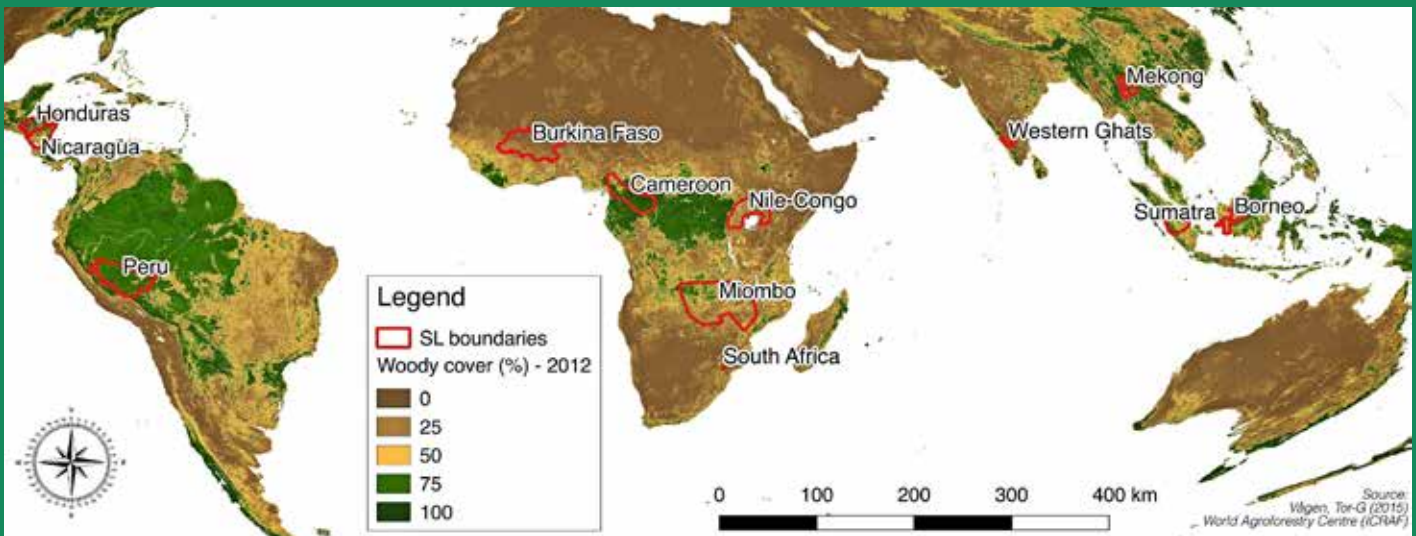
South Sulawesi in Indonesia has faced multiple environmental, livelihood and development challenges. A US\$9.3m project titled Agroforestry and Forestry in Sulawesi: Linking Knowledge to Action (AgFor), co-funded by Global Affairs Canada, implemented by the World Agroforestry Centre (ICRAF) and the Center for International Forestry Research (CIFOR) under the FTA umbrella, sought to address these challenges, which included:

- Low diversity of rural livelihoods systems, high dependence on exotic commodity crops and the ensuing exposure to risk
- Suboptimal watershed management, with soil erosion, sedimentation, landslides and floods
- Lack of land tenure titles for women, poor and marginalized people, with little awareness of, or access to, channels for certification or clarification of land status
- Weak local governance and weak community participation in land-use planning

After four years, the project has brought about change in several districts by:

- Implementing new strategies for sustainable livelihoods and conservation developed by AgFor in Bantaeng, Bulukumba, Jeneponto and Gowa. For example, through training in agroforestry and forestry, farmers could consistently improve their farm livelihoods, with gradients of intensity from intensive rice fields to natural forest, while also providing ecosystem services that benefit not only themselves but also the wider community
- Enabling recognition of the Kajang indigenous people of Bulukumba within an enhanced inclusive and participatory governance framework
- Successfully developing and applying a method for assessing agroforestry coping and adaptation strategies for climate change and market variability called the Capacity-strengthening Approach to Vulnerability Assessment (CaSAVA). CaSAVA is now applied by other FTA projects in other countries

# Sentinel landscapes



**Figure 1. Ecological zones in relation to forest transition, with areas prioritized for FTA sentinel landscapes.**

In order to answer the main research questions as well as those in each research cluster in their local contexts, FTA identified a network of landscapes, called ‘sentinel landscapes’ and seen as a priority for representing broad agroecological zones (Figure 1) for joint and colocated research.

## Who does FTA work with?

In this research theme, FTA’s partner institutions seek to achieve multiple environmental, economic and social development objectives in landscapes, hence they work with parties implementing key conventions such as the CBD, UNFCCC, UNCCD and the corresponding targets as espoused in the SDGs.

The political commitment in the Bonn challenge for forest landscape restoration has led to government initiatives, such as the 20x20 initiative for Latin America, for which FTA partners were among the founders. FTA partners are also actively participating in the AFR100 Restoration initiative in Africa.

National agricultural and forestry research organizations constitute an important group of partners for FTA landscape theme activities, with linkages to national extension systems as well as local policy and action networks.

**This research theme also engages in strategic partnerships with existing consortia and partnerships of relevance, including:**

- Ecosystem Services Partnership (ESP)
- Landscapes for People, Food and Nature (FPFN)
- The Ibero-American Model Forest Network
- Future Earth and Global Land Project Network
- The national networks of Tropenbos International
- ASB Partnership for the Tropical Forest Margins
- Rewarding Upland Poor for Environmental Services they provide (RUPES) and Pro-poor Rewards for Environmental Services in Africa (PRESA) networks

Further partnerships will be developed strategically to increase the likelihood that a relevant enabling environment will emerge, with organizations including the International Institute for Applied Systems Analysis (IIASA), Stockholm Environment Institute (SEI), World Resources Institute (WRI), International Union for Conservation of Nature (IUCN), World Wildlife Fund (WWF), The Nature Conservancy (TNC) and the Ibero-American Model Forest Network.

▽ A woman holds a seedling in Indonesia. Photo by ICRAF



Cover: The village of Nalma, Nepal, lies in the hills stretching on one side toward the the Himalayas. Much of the available land is used for rice fields, gardens or housing. Photo by M. Edliadi/CIFOR

The CGIAR Research Program on Forests, Trees and Agroforestry (FTA) is the world's largest research for development program to enhance the role of forests, trees and agroforestry in sustainable development and food security and to address climate change. CIFOR leads FTA in partnership with Bioversity International, CATIE, CIRAD, ICRAF, INBAR and TBI.

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