Forests, Trees and Agroforestry
Livelihoods, Landscapes and Governance

CGIAR RESEARCH PROGRAM ON Forests, Trees and Agroforestry

Sentinel Landscapes Data Analysis workshop (3–7 March 2014)
Venue: CATIE, Costa Rica.

The purpose of the workshop is

- for the network members and partners to meet, re-connect and discuss research questions, sampling designs and data analysis as part of the sentinel landscapes initiative;
- to familiarize participants with the latest developments in the CGIAR Research Program on Forests, Trees and Agroforestry (CRP-FTA), funding realities, and what both of these mean for the work of the sentinel landscape initiative;
- to develop a workplan for 2014 to ensure that the sentinel landscapes initiative is well prepared to enter phase II of CRP-FTA (2015-2016).

Workshop program

We will start every day at 08:30, and have flexible tea and coffee breaks and a sufficiently long lunch break. We expect to finish around 17:00 each day.

Days are organized in thematic sessions/panels

Monday morning	**Setting the scene** The purpose of the session is to familiarize participants with each other, the goals and objectives of the sentinel landscapes initiative and what to expect from the week. The session will include: • registration of participants – *Jacquie Muliro* • overview of the program of the week – *Anja Gassner* • logistical information – *Jacque Muliro* • introduction of participants and their backgrounds, research interests and expectations of the workshop - *all* • the role of the sentinel landscapes initiative in CRP-FTA – *Robert Nasi* • short recap on where we are in the process and what research questions we are trying to answer – *Anja Gassner.* **Partner perspective on sentinel landscapes** The sentinel landscapes theme is an important instrument for partners to shape the impact pathways of CRP-FTA. This partner panel is an opportunity for participants to learn from successful partnerships and will include the following presentations: • CATIE's key territory as part of the sentinel landscape initiative – *Eduardo Somarimba.* • Adding value to legacy data set: The tropical production tree observatory – *Plinio Sist.* • Joining efforts: Colocation of CRP research activities within Burkina Faso – *Michael Balinga.* • The Western Ghats Sentinel landscape: A platform to coordinate research efforts – *Siddappa Setty* and *G.M. Devagiri.*

Monday afternoon	**IFRI panel** The overall goal of the panel is to demonstrate the use of cross-national forest data for analysis of ecosystem services, tradeoffs and synergies, drivers of changes in forest biomass, and indicator development. The panel will present on the following: • Adaptive indicator development using social-ecological datasets – *Arun Agrawal, Heather Huntington and Anja Gassner.* • Using IFRI data to understand drivers of forest cover change in human dominated forest landscapes – *Peter Newton and Arun Agrawal.* • Tradeoffs and synergies among forest ecosystem services: A cross national analysis – *Ashwini Chhatre.* • An institutional approach to the study of conflict in forest commons – *Frank Van Laerhoven.* **Land health panel** The overall goal of the session is to demonstrate the use of the Land Degradation Surveillance Framework (LDSF) to model land health indicators across diverse landscapes. The session will include the following presentations: • Landscape based approaches for modeling of ecosystem health at multiple spatial scales – *Tor-G. Vagen*. • Modeling the effects of land use on soil health indicators: Cross-site comparisons – *Leigh Winowiecki.* • Distribution of functional tree groups in sentinel sites. – *Roeland Kindt.* • The landscapes portal: Spatial analytics and data sharing for the sentinel landscapes – *Tor-G. Vagen*.
Tuesday morning	**Working with sentinel landscape (SL) data I: Modeling land health** This will be a practical session for demonstrating the structure and properties of the land health datasets and providing participants with the opportunity to explore the types of analyses that were presented on Monday. Participants will conduct data analyses in R using data from Nicaragua and Burkina Faso SLs. Please download R (http://r-project.org) and RStudio (http://www.rstudio.com). Required packages: *lattice, nlme, lme4, MASS, ggplot2, raster. Facilitators: Leigh Winowiecki and Tor-G. Vagen.*

Tuesday afternoon	**Working with sentinel landscape data II: Integration of data sets** The goal of the session is for participants to understand how the different modules of the SL-methodology link together and what kind of information is produced. Example datasets from Nicaragua will be used. *Facilitators: Leigh Winowiecki, Tor-G. Vagen and Anja Gassner*.
Wednesday morning	**Working with sentinel landscape data III**: **Linking household data and village data** A fundamental question when doing landscape work is that of scale. Especially for socio-economic information, scientists are divided on whether to use village aggregates or individual household information. Using the data from Nicaragua we look at what additional information we obtained from the household survey in comparison to the village-level survey. The session will also have a special emphasis on social network analysis. *Facilitators: Mrigesh Kshatriya* and *Anja Gassner)*
Wednesday afternoon	**Field work** Taking advantage of CATIE's natural surrounds, we will spend the afternoon outside measuring trees and discussing various options of capturing spatial patterns and functional arrangements of trees in the landscape.
Thursday morning	**From landscape to farm level** Based on the work of the previous days we will revisit our research questions and identify which need additional information to be answered and which have not been adequately addressed by the methodology. We will spend the second half of the morning designing an on-farm inventory. Groups will discuss farm typologies for stratification and data to be collected at the farm level. *Facilitators: Anja Gassner, Tor-G. Vagen and Dave Harrison.*
Thursday afternoon	**Progress reports from teams** Each landscape team will give a 10 min presentation on the progress made so far for their landscape. Emphasis should be on introducing team members, the process and rational for site selection within landscapes, and discussion of options for village selection and household selection based on the experience from the two pilot sites. The session will also include a presentation from Sandrine Freguin Gresh on institutional mapping.

Friday morning	**Concept notes for research papers** Participants will allocate themselves to key research questions that can be answered using the data available to the sentinel landscapes team. We will spend the morning drafting concept notes for research papers to be written in 2014.
Friday afternoon	**Looking ahead** The sentinel landscape team is an integral part of CRP-FTA and it is important for all team members to understand funding and reporting realities that are linked to receiving funding from the Consortium. The aim of the session is to develop a workplan for 2014 that will ensure that teams receive funding for site-based research in 2015 and 2016. The session will include the following presentation and discussion topic: • Overview of CRP-FTA proposal extension and implications for sentinel landscapes – *Anja Gassner.* • Development of a workplan for 2014, with the goal to have an evaluation workshop for the sentinel landscape theme in early December 2014 – *all.*

Participants

Participants	*Organization*	*Landscape*
Robert Nasi	CIFOR	Method/coordination team
Anja Gassner	ICRAF	Method/coordination team
Mrigesh Kshatriya	CIFOR	Method/coordination team
Winowiecki, Leigh Ann	CIAT	Method/coordination team
Jacquie Muliro	ICRAF	Method/coordination team
Vagen, Tor-Gunnar	ICRAF	Method/coordination team
Harrison, Dave	ICRAF	Method team
Kindt, Roeland	ICRAF	Method team
Judy Loo	Biovesity	Method team
Suryadarma, Daniel	CIFOR	FTA Impact Assessment Team
Russell, Aaron	CIFOR	Mekong SL
Harrison, Rhett	ICRAF	Mekong SL
Balinga, Michael	CIFOR	Burkina Faso- Mali SL
Plinio Sist	CIRAD	Forest Observatory SL
Evran Rutishauser	CARBOFOREXPERT	Forest Observatory SL
Denis Sonwa	CIFOR	CAFHUT
Frederick Nkeumoe	ICRAF	CAFHUT
Siddappa Setty	ATREE	Western Ghats
G.M. Devagiri	ATREE	Western Ghats
Martin Reyes	ICRAF	Western Amazon
Jean Paul Benavides		Western Amazon
Alfa Simarangkir	CIFOR	Bormeno - Sumatra SL
Ayme Muzo	CIFOR	OIL PALM SL
Sandrine Freguin Gresh	CIRAD	N-H-SL
Eduardo Somarriba	CATIE	N-H-SL
Roger Villalobos,	CATIE	N-H-SL
Alfredo Canales	CATIE	N-H-SL
Jaime Peralta	CATIE	N-H-SL
Norvin Sepulveda	CATIE	N-H-SL
John Beer	CATIE	N-H-SL
Leida Mercado	CATIE	N-H-SL
Edwin Castellanos	IFRI	IFRI network
Franciscus van Laerhoven	IFRI	IFRI network
Eric Coleman	IFRI	IFRI network
Katia Fernandes	Columbiac University/CIFOR	Component 4
Maria Fernandez	Bioversity	Gender

Powell, Bronwen	CIFOR	
Tim Pagella	School of Environment, Natural Resources and Geography, Bangor University, UK	
Valbuena, Diego	CIAT	

Annex 4. Sentinel landscapes (FTA Proposal, February 2011)

Introduction

One of most innovative approaches proposed for CRP6 is to invest in the development of a set of "sentinel landscapes". This approach responds to a key recommendation from the 2009 Stripe Review of Social Sciences in the CGIAR[1][1] commissioned by the CGIAR Science Council to leverage and strengthen the CGIAR's competitive advantage in conducting long- term, comparative research. As envisaged for CRP6, research in sentinel landscapes would generate panel data to support the testing of hypotheses on drivers and impacts of land use change, as well as approaches to mitigate threats and maximize benefits both for environmental resilience and for the poor. Sentinel landscapes would also provide an instrument for integrating research and impact pathways, while building and exploiting potential synergies across all five of the components that comprise CRP6. These components seek to provide a range of benefits, including: increasing understanding of the needs of individual poor families at the level of timber stands or agroforestry farm plots (CRP6.1), generating ecologically sustainable forestry options for communities (CRP6.2), balancing the interests of multiple sectors of society with differing claims on multifunctional landscapes (CRP6.3; e.g., "learning landscapes"), identifying prospects for mitigating and adapting to climate change through forests and trees (CRP6.4) and creating a geographic context in which, for instance, to address the effects of globalized trade and investment on society and the environment (CRP6.5).

Background

The need for long-term research at specific sites first emerged in agroecological sciences where the processes studied were slow and impacts could only be perceived and measured after many years. In Europe, long-term agricultural experiments began in 1843 at the Rothamsted Farms in England. The record for the longest series of continuous observation goes back to the ice cover measurement on Suwa Lake in Japan, which has been conducted since 1443. The idea of "sentinel sites" emerged from the field of epidemiology and has since been extended to other scientific fields, including management of natural resources. For example, in 2009 the University of Minnesota's Ecosystem Health Program, in conjunction with the Smithsonian Institution Global Earth Observatory Network (SIGEO) and STRI's Center for Tropical Forest Science (CTFS)[2] held a workshop called "Long-Term Ecological Monitoring Plots as Sentinel Sites for Emerging Infectious Disease". The Africa Soil Information Service (AfSIS)[3] uses a similar terminology for studying "land health" in Africa.

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[1] CGIAR Science Council. 2009. Stripe Review of Social Sciences in the CGIAR. Science Council Secretariat, Rome. http://www.sciencecouncil.cgiar.org/fileadmin/user_upload/sciencecouncil/System wide_and_Ecoregional_ Programs/SSSR_for_web.pdf

[2] http://www.ctfs.si.edu

[3] http://www.africasoils.net/

The first formal long-term ecological research (LTER) sites were implemented in the United States in the 20th century, and today the International Long-term Ecological Research (ILTER)[4] network spans 38 countries, although with poor representation of developing countries. In the social sciences, similar long-term observations have been implemented in many disciplines (medicine, economics, education—generally at national scales and primarily in developed countries). Other comparable initiatives have flourished in developing countries starting in 1975 with the National Household Survey Capability Programme (NHSCP) launched by the United Nations. In 1980, the World Bank initiated the Living Standards Measurement Survey (LSMS), which collected information in more than 30 countries. Between 1987 and 1992, a similar program (Dimensions Sociales de l'Ajustement) assessed the impact of structural adjustment policies imposed on West African countries. With the increased attention given to poverty alleviation at the turn of the century, countless "observatories" or "rural observation posts" were created to document, measure and follow change in socioeconomic conditions at sites with sizes ranging from individual village to small region to country to group of countries.

However, combining long-term ecological research with social science research in a more holistic approach is a relatively recent idea. For instance, the integration of social science into LTER and the proposed change of acronym to LTSER (long-term socio-ecological research) were not formalized until 2005.[5] Expected impacts and interventions associated with climate change provide new urgency and justifications for the integration of ecological and social sciences. Research into people's adaptation to climate change will not be possible without a comprehensive network of LTSER sites.

LTSER sites have been used to monitor the evolution of ecosystems, to measure the impact of market fluctuations and policy interventions, and even to monitor the evolution of political parties. However, where they are most useful is in the monitoring of socio-ecological transitions. Socio-ecological transitions are fundamental changes in the relationship between natural and social systems.[6] They are one result of coevolution that merits special attention. Such transitions are particularly useful in understanding challenges to environmental and social sustainability—clearly burgeoning around the world. Recently, Sachs et al.[7] pleaded for the establishment of a global network to monitor the effects of agriculture on the environment across major ecological and climatic zones. Such a network would involve stakeholders—policymakers, farmers,

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[4] http://www.sitemaker.umich.edu/ifri/home

[5] Haberl, H. et al. 2006. From LTER to LTSER: conceptualizing the socioeconomic dimension of long-term socioecological research. Ecology and Society 11(2): 13. [online] http://www.ecologyandsociety.org/. vol11/iss2/art13/; Ohl, C. et al. 2010. Long-term socio-ecological research (LTSER) for biodiversity protection: a complex systems approach for the study of dynamic human–nature interactions. Ecological Complexity 7(2): 170–178. doi: 10.1016/j.ecocom.2009.10.002.

[6] Martens, P. and Rotmans, J. 2002. Transitions in a globalising world. Swets and Zeitlinger, Lisse, The Netherlands; Raskin, P. et al. 2002. Great transition: the promise and lure of the times ahead. Stockholm Environment Institute, Boston, USA.

[7] Sachs J. et al. 2010. Monitoring the world's agriculture. Nature 466: 558–560.

consumers, corporations, NGOs and research and educational institutions—coming together to develop a set of metrics that quantify the social, economic and environmental outcomes of various land use strategies. A network of monitoring organizations would then collect the appropriate information, and the resultant, freely available data could inform land use management, policy and research priorities.

What are sentinel landscapes?

A sentinel landscape is essentially a site or a network of sites, geographically or issue-bounded, in which a broad range of biophysical, social, economic and political data are monitored, collected with consistent methods and interpreted over the long term. Classically, a long-term monitoring site fulfills three major roles: record, analyze and alert. The first role is documentary (scientific knowledge), where every relevant item of data is recorded and tracked. The second role is explanatory, where information collected contributes to building comprehension of various phenomena. This role is closer to an experimental model for the measure of a known or supposed dynamic, such as the impact of a policy or a change in commodity prices on poverty alleviation or forest conservation. In some cases, such data may be more actively used, for instance in adaptive natural resource management. The third role is predictive, typically to inform decision making, through long-term surveillance of thresholds and alert levels.

Baseline data are critical for gauging temporal dynamics as well as the magnitude and character of transitions. Because social and ecological change happen over long periods, it is valuable to explore the past for different sources of data/evidence to detect and discern those transitions. The impacts of successive waves of investment and disinvestment in land use, for example, can be observed only through historical examination. Looking backward is also critical for examining the impact of historical legacies[8] on present-day socio-ecological systems. Examination of such legacies also provides a means to explore the unintended consequences of human action, in environmental and social terms, that generated "surprises" that were not or could not have been foreseen.[9] Historical data combined with present-day and continuing monitoring can be used as an empirical basis for scenario building. This would also provide the means for long-term analysis and provide a solid empirical basis and opportunity for scenario and model validation—ultimately to guide practice, management

[8] Foster, D. et al. 2003. The importance of land-use legacies to ecology and conservation. BioScience 53: 77–88; Wardell, D.A. and Lund, C. 2006. Governing access to forests in Northern Ghana: micro-politics and the rents of non-enforcement. World Development 34(11): 1887–1906

[9] Holm, P. 2005. Becoming aware of the sea's potential richness. Newsletter of the International Human Dimensions Program on Global Environmental Change (IHDP) 2/2005: 12–13. (

and policy.[10]

The outputs of a sentinel landscape can include:

- descriptions of a state or process;
- basic data collection (for surveillance);
- understanding of a phenomenon, including causality; and
- experimentation, especially to provide recommendations, suggest interventions and assess their efficiency (e.g., adaptive management). (

Researchers at sentinel landscapes can:

- provide information or data to stakeholders for its further use;
- analyze the information recorded;
- use the results of the observation and/or analysis for dissemination or for further intervention; and
- assist decision making by providing indicators and predictive modeling tools.

Why is there a need for sentinel landscapes?

Long-term data are essential for addressing scientific challenges such as linking biophysical processes to human reactions and understanding the impacts of those reactions on ecosystems. The major justification for sentinel landscapes is the need for a common observation ground where reliable data from the biophysical and social sciences can be tracked in consort and over time so that long-term trends can be detected, and society can make mitigation, adaptation and best-bet choices.

Traditionally, ecologists tended to prefer to study environments that have experienced minimal impact by human activities as a window into "properly" functioning ecosystems. For their part, social scientists have tended to neglect the study of human influence on nature. Ethno-ecologists were the first to work at the interface, but still with a clear preference for studying human societies living in little-disturbed ecosystems such as hunter–gatherers in tropical forest environments. Today, the imperative of sustainability challenges science to embrace new interdisciplinary approaches that cut across traditional disciplinary boundaries. To understand and address land use change, linking local and regional ecologies with changes in the behavior and consumption patterns of their inhabitants has become unavoidable. Society and nature interact on several spatial and temporal scales, a process termed "coevolution" by those who approach it with a long

[10] Leemans, R. and Costanza, R. 2005. Integrated history and future of people on earth (IHOPE). Newsletter of the International Human Dimensions Program (IHDP) 2/2005: 4–5; Wardell, A.D. and Reenberg, A. 2005. Framing field expansion strategies in the savanna biome: land use and land cover dynamics in and around the Tiogo forest reserve, Burkina Faso. In: Mistry, J. and Berardi, A. (eds) Savannas and dry forests: linking people with nature, 19–52. Ashgate, Aldershot, UK

time perspective.[11] The analysis of coevolution needs common observation sites to transcend the boundaries of individual biomes and to encompass landscapes in which users of forests, farmland and water bodies interact.

In both natural and social systems, research has to cope with processes of markedly different velocities occurring at the same place and time. It further has to account for the cyclical or recurrent properties of some processes, and for feedback and nonlinearity.[12] Change, by definition, encompasses time. Changes in ecosystems often happen only slowly and gradually, and as such can only be measured over long periods—sometimes decades or more. Historical perspectives increase our knowledge of the dynamics of forest landscapes and provide a frame of reference to assess contemporary patterns and processes.[13] Similarly, major societal changes are generally slow—indeed, sometimes take generations. The role of education, the impact of sensitization campaigns and the adoption of innovations are often lengthy processes. Similarly, a one-time snapshot assessment of poverty is inadequate, as forest-dependent communities can move both into and out of poverty in the absence of safety nets.

Assessing climate change impacts on forest-dependent communities provides a particularly compelling example of the need for long-term observations. Communities might well be affected by climate change mitigation policies before they can detect the real effects of climate change on their environment. Adaptation to change in different circumstances might take many forms, from major modification of farming systems to outmigration and, as a result, consequences could vary from increased deforestation to reforestation of abandoned agricultural land.

In addition, in the broad context of globalization, this is a time of rapid social and economic transition with major consequences for the environment, as discussed throughout this proposal. The economies of developing countries are increasingly becoming monetized. Even in the remotest rural areas, households have new and increasing needs and wants. Subsistence agriculture has given way to new commodities and to new farming systems. Where land and capital are available, more intensive systems replace former, more biodiversity-friendly systems with considerable impact on the natural environment. Off-farm work has become the main source of income of many households, and processes of deagrarianization have been well documented in, for instance, Southeast Asia.[14] Where off-farm work is not available or insufficient, younger

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[11] Norgaard, R.B. 1994. The coevolution of economic and environmental systems and the emergence of unsustainability. In: England, R. (ed.) Evolutionary concepts in contemporary economics, 213–225. University of Michigan Press, Ann Arbor, USA.

[12] Gunderson, L. and Holling, C.S. (eds) 2002. Panarchy: understanding transformations in human and natural systems. Island Press, Washington, DC.

[13] Wardell, D.A. et al. 2003. Historical footprints in contemporary land use systems: forest cover changes in savannah woodlands in the Sudano-Sahelian zone. Global Environmental Change 13: 235–254.

[14] Rigg, J. and Nattapoolwar, S. 2001. Embracing the global in Thailand: activism and pragmatism in the ear of deagrarianization. World Development 29(6): 945–960.

generations opt for circular migration, urbanization or even international migration.[15] Increased urbanization may result in reduced pressure on agricultural lands as city dwellers reinvest in agricultural activities in their villages of origin, with a preference for commodities, such as forestry plantations, that provide good returns and need little daily attention. In rural areas of Africa and Asia, where international migration has become a preferred option, the age distribution of local populations becomes skewed, the labor force is disrupted and the local economy becomes dependent on remittances. Understanding the processes and consequences of these and other factors would clearly benefit from long-term, site-based research.

Last but not least, there is a major need for reliable long-term data especially in developing countries, where basic information is often neither available nor reliable. Despite considerable efforts to improve data collection, budgetary constraints often disrupt the collection of data, impede storage and prevent dissemination. Observations over a long period would serve for internal comparison "before vs. after", and for external comparisons with other sites (similar or not) where alternative "treatments"—new economic incentives, altered governance arrangements, technical innovations—have been applied. In contrast to traditional ecological research sites (commonly protected environments with minimal anthropogenic impact), the socioeconomic and environmental information provided by researchers to other stakeholders during long-term observation can have a direct influence on decision making, and in turn might affect outcomes. This kind of research is clearly not neutral but dynamic, and provides direct opportunities for the assessment of its impact.

The burdens associated with ecological change now weigh heaviest on developing countries, which could be intensely affected by climate change. To best track and evaluate the impact of these changes on the terrestrial biosphere and its inhabitants, long-term research sites established across dominant biomes and climates, and across dominant social organization and governance types, are ideal. These will provide the means not only to understand change at local levels, but also to help us make broader findings through comparative approaches across social and environmental circumstances and trends. Some long-term studies are already underway (see below), but their number is insufficient to cover the huge diversity of countries and to address the spiraling and increasingly complex stresses.

For whom is a network of sentinel landscapes useful?

Longitudinal data collected at sentinel landscapes are potentially useful for a broad range of stakeholders. Ensuring that data are appropriately interpreted and shared is the responsibility of the scientists who designed the research, assisted by specialists (potentially community- based para-technicians) who can fill in for the scientists where the observation post produces routine indicators for a specific use. The stakeholders who

[15] See, for example: Cordell, D.D. et al. 1996. Hoe and wage. A social history of a circular migration system in West Africa. Westview, Boulder, CO, USA; Gidwani, G. and Sivaramakrishnan, K. 2003. Circular migration and the spaces of cultural assertion. Annals of the Association of American Geographers 93(1): 186–213.

are entitled to claim ownership and usufruct of the data include:

1. the target population, i.e., the people directly concerned or the rightful owners of the conserved patrimony who, paradoxically, in the past have often not had access to such data, basic or analyzed (one reason why considering such sites as passive "observatories" may not be optimal);

2. the designers of the observation post and the collectors of the information;

3. the developers of the information who analyze and make data accessible to others and (who distribute them to a wider audience; and

4. sponsors or authorities that use the information further upstream (e.g., to inform broader policy and practice). (

In summary, observation posts in a network of sentinel landscapes would be privileged locations for the collection of long-term data sets and the dissemination of scientific results to benefit farmer groups, NGOs, administrators, development projects, donors, government agencies and the broader scientific community, among others. They would further be excellent locations for fostering dialogue among stakeholders and for addressing contentious issues such as the sustainable exploitation of a disputed natural resource. Last but not least, they would provide excellent locations for assessing the uptake of research results and for overall impact assessment. (Our comparative advantage and existing sites (According to the authors of the Stripe review, the CGIAR appears: (uniquely positioned to lead an effort focused on long-term monitoring and analysis of rural communities and agro-ecosystems in the developing world if it can establish effective funding and management mechanisms – as should be feasible under a core-funded Mega-Program – and create incentives and funding for the protocol standardization, meta data compilation and results dissemination necessary to create a true international public good from the data collection and analysis efforts. (The proponents of CRP6 have direct experience in deploying biophysical and social science researchers working in teams in the same location over long periods; some of these locations would be candidate sentinel landscapes (see Box A2.1). The ASB benchmark sites[16] and the Malinau Research Forest (Kalimantan),[17] for instance, would likely meet selection criteria developed for socio-ecological observation posts. In addition to interdisciplinary data collection, most of these sites have been active locations for participatory research with local (communities, capacity building at village and district levels, dissemination of technical information and material, and stakeholder consultation and future scenario building.

[16] http://www.asb.cgiar.org/about_us/.□

[17] Gunarso, P. et al. (eds) 2007. Managing forest resources in a decentralized environment: lessons learnt from the Malinau research forest, East Kalimantan, Indonesia. CIFOR, Bogor, Indonesia.

Box A2.1 Current long-term landscape-scale sites or networks where CRP6 centers are already working, and which could be candidate sites for a future CRP6 Sentinel Landscape network

- Two World Agroforestry Centre initiatives on "rewards for environmental services" have a network of 10 project sites plus 15 associated sites in which active learning at local level is coupled with the development of replicable diagnostic tools. The number of direct beneficiaries averages 30,000– 50,000 people per site. (http://rupes.worldagroforestry.org/# in Asia and http://presa. worldagroforestry.org/ in Africa).

- The Landscape Mosaics Project, a collaborative effort between CIFOR and the World Agroforestry Centre that focuses on changes in how multifunctional landscapes are managed along the forest transition, includes five distinct geographic regions in the following countries: Cameroon, Tanzania, Madagascar, Indonesia and Laos. These sites cover between 620 km2 and 1750 km2.[1]

- CIFOR partners in the implementation of IUCN's Livelihoods and Landscapes Strategy (LLS). Working in 25 landscapes representing 11 distinct geographic regions, LLS is a global initiative that examines the rights and access of the rural poor to forest products in the context of the entire landscape in which people and forests interact (www.iucn.org/about/work/programmes/forest/ fp_our_work/fp_our_work_initiatives/fp_our_work_ll/).

- The ASB Partnership for Tropical Forest Margins has been able to maintain a long-term research presence in sites in Peru, Cameroon, Indonesia, Philippines and Thailand with opportunities to combine research for and on development (http://www.worldagroforestrycentre.org/af2/node/157).

- CIFOR is a member of the International Model Forestry Network (http://www.imfn.net/). The IMFN is a global community of practice whose members and supporters work toward a common goal: the sustainable management of forest-based landscapes through the Model Forest approach. With 58 sites in 25 countries, Model Forests are based on an approach that combines the social, cultural and economic needs of local communities with the long-term sustainability of large landscapes in which forests are an important feature.

- The DIVERSITAS global network of agrobiodiversity research sites intersects in Jambi (Indonesia) with current CRP6 partners (http://www.diversitas-international.org/index.php?page=cross_agro).

- CIFOR's current network of "learning landscapes" includes the Tapajos region of Brazil, the Tri- National de la Sangha in Central Africa, the Fouta Djallon (Guinea/Sierra Leone), three diverse landscapes in Indonesia and several sites in the Lower Mekong.

- The Malinau Research Forest in East Kalimantan has been the focus of long-term multidisciplinary, multi-institutional research coordinated by CIFOR. It provides a comprehensive baseline data set of biological and socioeconomic significance and would possibly be a suitable "sentinel landscape". (http://www.cifor.cgiar.org/publications/pdf_files/Books/BGunarso0801.pdf)

  □Reference:□[1] Colfer, C. and Pfund, J.L. (eds). 2010. Collaborative governance of tropical landscapes. Earthscan, London.

How would establishing a network of sentinel landscapes benefit CRP6?

As mentioned above, developing a network of sentinel sites is a key recommendation of the Stripe review:

The panel strongly recommends renewed emphasis on multidisciplinary social science research on productivity growth by and for the poor, perhaps especially on ex ante research prioritization, on long-term, field-based data collection in a range of sentinel sites in order to identify and measure changes in the behavior and well-being of rural peoples, especially the poor.

All five CRP6 components (see descriptions above) will be implemented by multidisciplinary teams researching various elements of the forest transition framework. Using sentinel landscapes for at least a portion of the research under each component would give a strong boost to the integration of research across components and limit the risks of "research silos". Each multidisciplinary team would monitor the selected sentinel landscapes to observe key ecological, economic and social processes in order to discern changing patterns of resource availability and use, and welfare outcomes within regional-scale ecosystems, market-sheds and populations. Each landscape would support both qualitative and quantitative ecological and social science research using the best current approaches to mixed methods in research design. This framework would promote comparative analysis at multiple scales, from intensive studies specific to a single location to national-, ecoregional- and international-level analysis using large-scale samples (e.g., to support global comparative research). This would allow the generation of high-value international public goods (IPGs) when conducted within a robust conceptual framework and research design.

As highlighted in the Stripe review:

The resulting data series would feed into research prioritization based on ex ante impact assessment in response to evolving constraints and opportunities in the system, including commodity-specific research prioritization. The sentinel sites would also provide natural locations for careful ex post impact assessment based on longitudinal monitoring and, where appropriate, randomized controlled trials using repeated experimental designs to more convincingly establish the impacts of CGIAR (and other) interventions.

We aim to:

- identify a coherent set of sentinel landscapes for 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; and
- 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. (Preliminary criteria and research design features expected of a sentinel landscape network (

The network would ideally:

- ensure sufficient standardization of data collection and analysis methods across regions, major habitat types and socioeconomic contexts to ensure comparability and representativeness of results;
- build a research network and convene regular inter-regional meetings to engage in explicitly comparative analysis to identify global patterns;
- feed aggregated information into global-scale analyses and use them to influence the global forestry and agroforestry research and development agendas;
- provide an opportunity to link and collaborate with other long-term research sites being established within other CRPs of the CGIAR.

Following in part Douthwaite et al.,[18] we consider that a network of sentinel landscapes should:

- allow the blending of both "hard" and "soft" science in such a way as to develop technical solutions and processes that work and are adopted at the local level, and then to scale these experiences out and up;

- support the central role of social and experiential learning through a number of tools, including monitoring and evaluation, based on commonly agreed indicators, and modeling future scenarios to support negotiation and decision making;

- allow reasonable access and adequate security to enable long-term research;

- allow scaling-out (spread of innovation or transmission of knowledge within similar stakeholder groups beyond the sentinel landscapes) and scaling-up (institutional expansion from "pilots"/local to decision makers/global);

- offer a good level of "representativeness" of the site/network to permit extrapolation relative to the issues/trends/parameters of interest (e.g., similar forest type, common drivers of change, etc.);

- be subjected to strong and rapid change for some anthropogenic reasons, so that equilibriums resulting from a long history are threatened or brutally ruptured (although having sites distributed across the full range of change pressures would provide useful insights). (The research and monitoring design at such sites should:

- consider from the outset the aggregation, maintenance and dissemination of data;

[18] Douthwaite, B. et al. 2005. Ecoregional research in Africa: learning lessons from IITA's benchmark area approach. Experimental Agriculture 41: 271–298.

- allow diachronic (from t_0 to t_n) as well as synchronic (controls/treatments) comparisons;

- blend hard and soft sciences and support the creation of knowledge networks;

- be practical and flexible in considering the key problems to be solved or key (trends/changes to be monitored (allow for "surprises"); and

- be simple and start small with a budget fully secured for the minimum necessary time to produce expected results considering "slow" and "fast" variables.

- Sentinel landscapes would also provide natural locations for carefully controlled ex post impact assessment (EPIA). Explicitly integrating ex ante and ex post impact assessment under a single CRP would increase the demand for and uptake of high- quality EPIA research and reorient a system that currently risks overburdening researchers with demands to generate what are too often small-scale, limited-quality, one-off EPIAs that lack external validity, and thus are not effective in generating IPGs. (

Prospective collaborations

The following are among a number of existing networks that are undertaking long-term monitoring. This set provides a pool from which to draw lessons learned, as well as for exploring opportunities for collaboration and synergy with a CRP6 sentinel landscape network.

- The International Long-Term Ecological Research (ILTER) network groups 38 countries with projects focusing on documenting, analyzing and explaining ecological patterns and processes operating over long time spans and broad ecological gradients. In particular, one mission of ILTER is to detect signals of global environmental change. Since 2005, the ILTER network has become a network of LTSER sites, now integrating social sciences.
- The International Forestry Resources and Institutions (IFRI) [19] network is comprised of 12 collaborating research centers (CRCs) located around the globe with a database containing information, collected since 1992, on forest ecology, livelihood, governance arrangements and forest user groups for more than 250 sites in 15 countries.
- The International Model Forest Network (IMFN)[20] is comprised of all member Model Forests in existence or under development around the world. It is organized into regional networks; of which the most relevant for CRP6 include the Ibero-American MFN and the Asia and Africa Model Forest Initiatives.
- The Center for Tropical Forest Science (CTFS) is a global network of forest

[19] http://www.sitemaker.umich.edu/ifri/home
[20] http://www.imfn.net/

research plots and scientists dedicated to the study of tropical and temperate forest function and diversity. The multi-institutional network comprises more than 30 forest research plots across the Americas, Africa, Asia and Europe, with a strong focus on tropical regions.

- The Man and the Biosphere Programme (MAB)[21] has an interdisciplinary research agenda and capacity-building initiative that aims to improve the relationship of people with their environment globally. Launched in the early 1970s, it notably targets the ecological, social and economic dimensions of biodiversity loss and the reduction of this loss. It uses its World Network of Biosphere Reserves as vehicles for knowledge sharing, research and monitoring, education and training, and participatory decision making.
- The International Sentinel Plant Network[22] currently in development would connect ex situ plant collections at botanic gardens around the world that are capable of serving as early warning systems to help predict and prevent the incursion of new pests (insects, pathogens or plants) and/or invasive species. (It might also prove useful to increase collaboration with the following global research programs: International Geosphere Biosphere Program (IGBP), International Human Dimensions Program (IHDP), Global Land Project and the Global Earth Systems Governance Program. The new Satoyama (UNU-Japan) set of sites and some of the Globally Important (Agricultural Heritage Systems (GIAHS; an FAO initiative) could be of special interest for the interface between forestry and cropland.

Finally, it will be extremely useful for a sentinel landscapes network in CRP6 to explore links, opportunities for synergistic research and monitoring, and cost savings with other longitudinal site-based research approaches being developed as part of several of the other CGIAR CRP proposals. For instance:

- Benchmark Sites – CRP1.1. Integrated agricultural production systems for the poor and vulnerable in dry areas.

- Action Sites – CRP1.2. Integrated systems for the humid tropics (e.g., in Central America, Peru, Cameroon, Ghana, Indonesia, Thailand, Philippines and Vietnam).

- Sentinel Sites (linked to CGIAR Benchmark Sites) – CRP5 Water, Land and Ecosystems. This CRP's work will further include major river basin/watershed long- term research (e.g., Mekong). (

Way forward and budgetary implications (We envisage a stepwise approach, depending on funding availability.

[21] http://portal.unesco.org/science/en/ev.php-URL_ID=6393&URL_DO=DO_TOPIC&URL_SECTION=201.html
[22] http://www.bgci.org/usa/sentinel/

Year 1

- Undertake a detailed analysis of existing networks: lessons learned, impacts and opportunities for collaboration
- Convene a workshop for CRP6 participating centers and partners to define needs (sites, data, methods, collaborations, modi operandi) and criteria for site selection, objectives, and research and monitoring design (see Box A2.2)
- Establish one (or several) working group(s) on methods to design a minimum set of common methods to use across sites
- Visit candidate sites and develop official partnerships and protocols with relevant partners (

Year 2

- Develop database and data management procedures
- Establish the baselines:
    - analyze existing information and available data
    - carry out specific measurement campaigns as needed
- Provide support to Component Implementation Teams to initiate research at the sites

Years 2–6

- Coordinate research undertaken by Component Implementation Teams at sentinel landscapes, at both site and global levels

Year 6

- Measure changes since Year 2 and analyze and interpret trends and changes
- Develop EPIA reports

An initial estimate of the human and financial resources required to carry out these activities is summarized in this proposal's budget section.

Box A2.2 Questions to be addressed at the proposed CRP sentinel landscapes network conceptual and design workshop

During the workshop to be held during the first year of CRP6's implementation, we will need to address the following key issues in order to frame the design of a future sentinel landscape network.

- What lessons have been learned (design, priorities, locations, partnerships, impacts) from other ☐long-term site-specific research networks to inform our discussion?

- What are the relevant problems or trends (likely differing between components) that can be addressed through long-term research at a network of sentinel landscapes?

- What criteria for selection of landscapes would be optimal to meet the different needs of the various CRP6 research components?

- What model(s) to base the sentinel landscape research design on?

    - Non-bounded network of specific study sites/sampling units (e.g., households) remeasured at regular intervals (e.g., IFRI, PEN, Smithsonian-type forest dynamic plots)
    - Fixed-size area monitored by remote sensing with ground truthing complements (e.g., AfSIS sentinel landscapes)
    - Benchmark area approach (e.g., IITA Ecoregional Program, ASB Benchmark sites, Landscape Mosaics project)
- What collaborations and networks need to be developed?
    - within and across CRP6 components
    - with other CGIAR CRPs (e.g., CRP1.1, CRP2, CRP5)
    - with other existing long-term monitoring networks (may enhance long-term sustainability and economies of scale, but may constrain design and landscape placement)
- What interventions and who intervenes?☐
    - Under what conditions can sentinel landscapes without interventions be justified?☐
    - What are the respective roles of research organizations and other partners in interventions?
    - How to deal with the effect of interventions on the natural development of the sentinel landscapes, i.e., how to separate the study of effects of interventions from the study of the natural impacts of exogenous and endogenous change at the landscape scale?