1.2 Productive landscapes: what role for forests, trees and agroforestry?

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Introduction

It is hoped that in 2015 world leaders will agree on a set of Sustainable Development Goals and set targets for progress on poverty reduction, security of water, energy and food, climate resilience, livelihoods, governance and gender equity. These goals can be met at least in part by productive landscapes that include forests, trees and agroforestry (Mbow, van Noordwijk et al. 2014). An important part of the agenda are the opportunities and challenges of balancing trade-offs in managing for productive and sustainable landscapes that provide integrated local, national and global benefits (Sunderland, Ehringhaus and Campbell 2008).

The international research community has made significant efforts to increase understanding, deliver information and engage with partners who link research to action (Clark et al. 2011). For instance, the Consultative Group on International Agricultural Research (CGIAR) Research Program on Forests, Trees and Agroforestry (FTA)[1] pays explicit attention to these issues at the landscape scale. This article outlines the basic concepts behind productive landscapes and presents hypotheses on positive and negative tree cover change. It also introduces the research approach, toolboxes and the local and international partnerships that have been developed.

CONSIDERING THE LANDSCAPE AS A SYSTEM CAN BUILD ON A RICH EXPERIENCE IN WATERSHED MANAGEMENT AND BIODIVERSITY CONSERVATION.

Multiple interests in productive landscapes

The current interest in the landscape approach has been articulated in the context of watershed management and biodiversity conservation, where protected areas cannot be managed in isolation without an understanding of the influence of the landscape "matrix" (Pfund et al. 2011). The landscape approach is also being advocated to deal with climate change (IPCC 2014; van Noordwijk et al. 2011).[2] The world's remaining natural forests can be effectively protected and managed only if stakeholders understand their interactions with the drivers of change —

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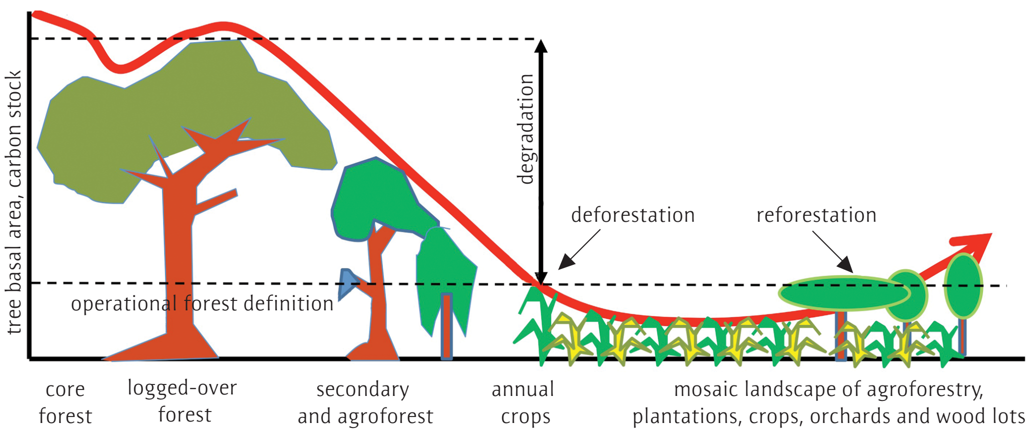
which are primarily agricultural — and the opportunities for trees on farms and in plantations to replace natural forests for the provision of timber and non-timber forest products (van Noordwijk, Agus et al. 2013; Minang and van Noordwijk 2013). In "climate-smart" landscapes the issues of vulnerability, adaptation and mitigation are also important, and synergies between them are sought (Duguma et al. 2014).

Central to the FTA programme has been the forest transition curve (Figure 1), which was formulated two decades ago and has been fundamental to the Alternatives to Slash and Burn (ASB) partnership for the tropical forest margins (Minang, van Noordwijk and Kahurani 2014). The transition curve can be seen as an environmental Kuznetz curve ("things have to get worse before they change for the better"), as a statement about changes in space ("theory of place"), in time or in institutional context ("theory of change"), with some predictive value.

Figure 1. Forest transition curve



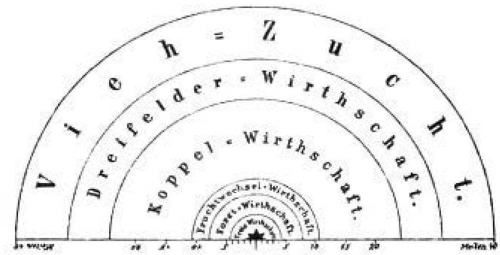
Note: Based on multiple hypotheses on temporal, spatial and institutional patterns as well as cross-linkage of relationships at a landscape scale

The transition curve can be interpreted as a testable hypothesis related to spatial and temporal dynamics. It also provides a framework for understanding relationships at the landscape, regional and national scales, where various stages of transition can coexist.[3]

The often-cited von Thünen's (1842) economic geography concept (Figure 2) describes a prevalence of trees close to the village, as firewood was essential and not easily transported over larger distances, followed by open field agriculture, grading into remaining wilderness at a greater distance. This spatial pattern is still recognizable in many parts of the world where home-gardens associate trees with the places where people live. Von Thünen located *Forst Wirtschaft* (production forestry) in the second circle, close to the centre of economic activity, because of its importance as an energy source, and because of transport costs. Natural forest or even remnants of such were already absent from the European landscapes known to von Thünen in 1842.

Figure 2. Spatial organization of productive landscapes around a town

Note: As represented by von Thünen (1842) for a self-sufficient state: a zone of *Freie Wirthschaft* providing vegetable, dairy and other products with short shelf life is surrounded by an (agro) forestry *(Forst Wirthschaft)* zone providing wood fuel and other tree products with high transport costs, before zones of crop rotations *(Fruchtwechsel*, *Koppel Wirthschaft*, *Dreifelder)* and animal husbandry *(Vieh Zucht)*.



Given their respective landscape positions, how do various types of land cover with trees interact in terms of income, productivity, food diversity and security, the management of the flows of water and other ecosystem services, the movements of plants and animals, and local influences on climate? Can a better understanding of the processes in a complex landscape mosaic support the emergence of more integrated and adaptive solutions?

This perspective of a landscape interacts with one that starts by recognizing a diversity of actors and stakeholders and their conflicts and opportunities in order to move toward more negotiated, and agreed, actions. It interprets a landscape as a dynamic feedback system. This leads to a focus on the governance mechanisms that link the drivers of change to the consequences at the landscape scale of land-use decisions that affect the provision of various ecosystem services. Conceptually, this is the core of FTA landscape analysis. It is supported by experience in countries and landscapes that are in very different stages of forest transition and development.

Testable hypotheses on tree cover transitions

Pattern

Any evidence of forest transition depends on what is — and what is not — included in the concept of *forest* (see "operational forest definition" in Figure 1). Major qualitative changes in the type of vegetation, from natural forest to planted forest, are rarely evident in commonly used national forest statistics. A more objective parameter, tree cover, has been documented as declining over time (Meyfroidt and Lambin 2011). At a global scale, the percentage of agricultural land with at least 10% tree cover was documented to increase after the year 2000 (Zomer et al. 2014). Indeed, at the national scale, many countries in Europe, North America and more recently Asia report increases rather than decreases in the total coverage of all categories of forest.

The inflection points have historically occurred at almost any human population density and percentage of forest cover (Köthke, Leischner and Elsasser 2013). However, increases in forest area have to date been achieved in association with outsourcing food and fibre production to other areas; on average, 50% of the reported gain in forest area at the national scale may be leaked[4] in terms of an increased external footprint (Meyfroidt et al. 2013). At the sub-national scale leakage can be even greater.

Underlying drivers

A recent analysis of quantitative studies of drivers of deforestation and factors associated with forest protection (Busch and Ferretti-Gallon 2014) summarized evidence that agriculture (proximity to existing agriculture, agricultural prices) has a strong association with deforestation, as do factors associated with development (proximity to roads, proximity to urban areas, rural income support, markets and population density). The factors most strongly associated with reduced (or negative) deforestation are protected area establishment,[5] terrain features such as elevation and slope, the presence of indigenous peoples, poverty and high timber prices.

The association with poverty is a specific concern for all those who hope that development and forest protection can be combined. It is necessary to proactively prevent the association of reduced poverty with increased conversion of forests. Human migration and onflicts as well as post-conflict reconstruction are associated with many of the factors that increase deforestation. They provide the means (i.e., the labour force) and rationale as well as the policy imperative for forest conversion, in a complex interplay of local people (including elites), companies, national and local governments, and planned and spontaneous migrants (Galudra et al. 2013).

Although there is a general expectation that greater gender equity in decision-making would increase conservation, current experimental evidence challenges this hypothesis (Villamor et al. 2013). Among the more promising approaches to reducing deforestation and resource over-use are the enhancement of indigenous and local property rights and local value-addition, in conjunction with the long-term protective effect of higher timber prices, which encourage the domestication of useful forest species (Mpanda et al. 2014). Such domestication can, however, lead to conservation failure if it stimulates migrant flows.

Consequences

Is having more trees always better? The positive and negative consequences of qualitative and quantitative change in the tree cover of landscapes are generally well understood. The restoration of tree cover through agroforestry can be a source of production and food security (Mbow, Neufeldt et al. 2014). There is recent evidence that areas with up to at least 50% tree cover are positively associated with child health through better nutrition and dietary diversity (Ickowitz et al. 2014).

Tree diversity is generally declining on the left side of the forest transition curve, although it is important to distinguish between remnant, spontaneously established and planted trees as contributors to tree diversity (Ordoñez et al. 2014). The consequences of change in tree cover to watershed functions have been much debated. The consensus among hydrologists is that, contrary to popular perceptions, tree planting (especially with fast-growing species) tends to increase water use beyond its positive effect on infiltration. This reduces dry-season flows unless the soil was strongly degraded and is rapidly recovering (Ghimire et al. 2014). When the probability of recycling of terrestrial evapotranspiration as rainfall elsewhere is included in the assessment, however, the net effects of landscape-scale tree cover protection and enhancement may be positive, depending on location (van Noordwijk et al. 2014).

Response options

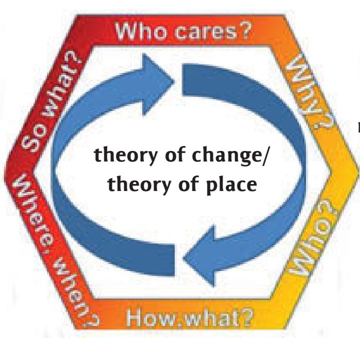
Analysis of the consequences of current changes in tree cover needs to be accompanied by negotiation and action from stakeholders to identify appropriate responses. Drivers, not symptoms, need to be addressed in order to achieve lasting impacts. Figure 3 provides a systems perspective, posing six key questions that can jointly help stakeholders understand the dynamics of landscapes and the way in which information about and awareness of the positive and negative consequences of tree cover change can lead to effective feedback that helps drive change.

Figure 3. Six key questions

Who cares? Who is affected by or benefits from the changes in tree cover and associated ecosystem services? How are stakeholders organized and empowered to influence the drivers?

So what? How do ecosystem services (provisioning, regulating, cultural/religious, supporting) depend on tree cover and the spatial organization of the landscape?

Where are remaining forests and planted trees? Since **when**? How does tree cover vary in the landscape (patterns along a typical cross-section, main gradients), and how has it decreased and increased over time?



Why is land use what it is? What are the drivers of current human activity and what are the levers (regulatory framework, economic incentives, motivation) for modifying future change?

Who makes a living here, what is ethnic identity, historical origin, migration history, claims to land-use rights, role in main value chains, and what are the key power relations?

How are forests and trees used? W**hat** land-use patterns, with or without trees, are prominent in the landscape and provide the basis for local lives and livelihoods? What value chains are based on these land uses?

FTA as a research programme is associated with networks that build on negotiation support rather than decision support (van Noordwijk, Lusiana et al. 2013). There are still high expectations that economic incentives in the form for payments for environmental services (PES) will be part of the overall solution. FTA, through further analysis of multiple PES scenarios (van Noordwijk et al. 2012; Namirembe et al. 2014), explores the relations and possible synergy of feedback loops between local and external stakeholders of landscapes, and tries to nudge land use in a direction that is desirable or at least acceptable to all.

Conclusions

By considering the landscape as a system — where multiple functions and stakeholders interact with a changing climate — stakeholders can build on a rich experience in dealing with watershed management and biodiversity conservation. Although external stakeholders may be focused on issues such as greenhouse gas emissions, water flows or globally important biodiversity, local priorities may be livelihoods and rights to key resources. These views often clash initially. A combination of social exchanges (respect and recognition in exchange for commitment) and economic incentives (investment and payments in exchange for verifiably improved environmental quality) need to be carried out. Current research efforts that see landscapes as dynamic socio-ecological systems build on a strong foundation in many contributing disciplines. Meeting multiple sustainable development goals simultaneously, however, will be a major challenge that justifies new efforts to link knowledge to action in more effective ways.

Endnotes

1. The FTA is currently implemented by CIFOR, ICRAF, Bioversity, CIAT, CIRAD and CATIE. See www.cgiar.org/our-research/cgiar-research-programs/cgiar-research-program-on-forests-trees-and-agroforestry.
2. See IPCC, 2014. Agriculture, Forestry and Other Land Use (AFOLU); chapter 11 in Working Group III – Mitigation of Climate Change. http://report.mitigation2014.org/drafts/final-draft-postplenary/ipcc_wg3_ar5_final-draft_postplenary_chapter11.pdf.
3. The specific spatial sequence of land cover types without and with trees may vary according to technology, transport costs and institutional history.
4. The term *leakage* refers to the shift of agricultural production and associated deforestation to other locations.
5. According to Dewi et al. 2013, however, this externalizes land pressure.

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