Chapter 5
Response Options Across the Landscape

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Abstract: This chapter presents potential landscape-scale responses that attempt to reconcile the oft-competing demands for agriculture, forestry and other land uses. While there is no single configuration of land-uses in any landscape that can optimise the different outcomes that may be prevalent within a particular landscape, there are options for understanding and negotiation for the inherent trade-offs that characterise such outcomes. With increasing pressure on biodiversity and ecosystem services across many landscapes from the growing impact of human activities, hard choices have to be made about how landscapes could and should be managed to optimise outcomes. In a context where views on landscape-scale management options are often deeply entrenched and conflicts of interest are difficult to reconcile, consensus on what constitutes "success" may be difficult to achieve. Political economy and wider governance issues have often meant that a theoretically optimal landscape is unrealistic or unachievable on the ground. However, in this chapter we attempt to provide an over-arching framework for landscape approaches and how such approaches can contribute to both conservation and the achievement of food security and nutrition goals.

5.1 Introduction

Habitat loss, largely driven by agricultural expansion, has been identified as the single largest threat to *biodiversity*[1] (Newbold et al., 2014) worldwide. Agricultural activities are intensifying, and particularly in the tropics (Laurance, et al., 2014; Shackelford et al., 2015) due to increasing global demands for food, fibre and biofuels (OECD/FAO, 2011). As such, "global food security is increasingly trading off food for nature" Lambin (2012). This habitat loss is further compounded by *land degradation* and competition from other land uses such as urbanisation (Ellis et al., 2010). Between 2000 and 2010, in the developing world alone, it is estimated that land degradation and urbanisation consumed between 2.6 and 6.2 million hectares of arable land (Lambin and Meyfroidt, 2011).

The tropics host the majority of biodiversity-rich areas on the planet (Myers et al., 2000), and the realisation that we may be witnessing a sixth mass extinction (Barnosky et al., 2011) has been answered by a call to expand the extent of protected areas, particularly in tropical regions. Consequently tropical land is increasingly subject to competing claims (Giller et al., 2008) and reconciling these claims presents what are sometimes referred to as "wicked problems" (Rittel and Webber, 1973). A range of concepts and frameworks for implementation are now being discussed which aim to consider land-use change in forested *landscapes* in such a way that competing demands for food, commodities and forest services may be, hopefully, reconciled (e.g. Pirard and Treyer, 2010). There is abundant theory to underpin the desirability of establishing landscape "mosaics" (Naveh, 2001; Sunderland et al., 2008), where such competing demands are addressed in a more holistic, integrated manner.

"*Landscape approaches*" to achieving food production, natural resource conservation and *livelihood* security goals seek to better understand and recognise interconnections between different land uses and the stakeholders that derive benefits from them (Milder et al., 2012). Such approaches also aim to reconcile competing land uses and to achieve conservation, production and socio-economic outcomes (Sayer et al., 2013) and as such are now ubiquitous paradigms in the natural resource management discourse (DeFries and Rosenzweig, 2010). Furthermore, the environmental services that support the sustainability of agriculture are also sought through landscape approaches (Scherr and McNeely, 2008; Brussaard et al., 2010; Foli et al., 2014). However, the very complexity of landscape approaches defies definition (Reed et al., 2015), despite the clarion calls for such clarification.

In parallel, both in the North and in the South, industrial agriculture, the ultimate legacy of the Green Revolution, is being questioned as a model to achieve global *food security* sustainably (McLaughlin, 2011). This model may have been appropriate to the context of the 1960s and 1970s, when reducing hunger was the main goal, when water and nutrients were abundant, energy was cheap, and when *ecosystems* were able to detoxify agricultural pollutants. The global context today is very different with the growing scarcity of cheap energy (Day et al., 2009), water (Wallace, 2000) and nutrients (e.g. phosphorus, Cordell et al., 2009). The adoption of large-scale industrial agriculture has resulted in negative impacts on the environment (Conway, 1997; Cassman et al., 2003), public health (Fewtrell, 2004; Bandara et al., 2010) and even *nutrition* (Ellis et al., 2015), suggesting the paradigm itself needs to be challenged (Tilman and Clark, 2014).

In addition, industrial agriculture, with its narrow focus on a few crops (Sunderland, 2013; Khoury et al., 2014), has proven to be highly susceptible to shocks such as drought, flooding, pests and disease outbreaks, and market vagaries (Holling and Meffe, 1996; Swinnen and Squicciarini, 2012). In response to these challenges, various approaches have emerged using ecological concepts and principles to design sustainable agricultural systems (Gliessman, 1997). These approaches are based on the assumption that chemical and mechanical inputs can be replaced (at least partially) by biological functions (Doré et al., 2011; Cumming et al., 2014). Such functions are performed by the planned biodiversity (e.g. managed diversity of crop and livestock species), but also by the unplanned biodiversity (e.g. pollination or biological pest control), which

[1] All terms that are defined in the glossary (Appendix 1), appear for the first time in italics in a chapter.

is often crucial in these agroecological systems (Klein et al., 2007). The maintenance of unplanned biodiversity in agricultural landscapes is often due to dispersion from nearby (undisturbed) natural patches (Blitzer et al., 2012; Tscharntke et al., 2012). Natural areas may also provide nutrient subsidies to agricultural lands. For example, birds can be important vectors of nutrient subsidies from natural areas to agricultural lands (Young et al., 2010). This suggests the importance of landscape approaches not only for biodiversity conservation, but also for the design of sustainable agricultural systems.

Finally, non-intensive agricultural land may host significant biodiversity within a given landscape (Benton et al., 2003; Clough et al., 2011). Multifunctional landscapes are often described as patches of natural habitat embedded in an agricultural matrix (Fischer et al., 2006). Implicitly, this division assumes that patches are biodiversity-rich whilst the matrix is depleted in biodiversity (Tscharntke et al., 2005). However, the matrix may be part of the habitat of several species (Wright et al., 2012). This is particularly the case if the matrix is structurally similar to the native vegetation, for example, tropical agroforests (Clough et al., 2011). In addition, in human-dominated landscapes, agriculture is often the dominant force maintaining open patches on which many species depend (Arnold et al., 2014). This is the case for example of open-habitat bird species, which have become totally dependent on agricultural land in many areas (Wright et al., 2012). In tropical *forests*, traditional *shifting cultivation* agricultural practices create patches of open grassy fallow in an otherwise homogeneous forest cover. The resulting landscape mosaic may be beneficial for several species. For example, shifting cultivation systems in Sri Lanka were found to provide a key food source to populations of endangered Asian elephant (Wikramanayake et al., 2004), but also led to serious issues of crop raiding (Mackenzie and Ahabyona, 2012).

Despite the utility of landscape approaches for both sustainable agriculture and biodiversity conservation, it should however not be seen as a prescriptive approach to spatial planning. Published principles for landscape approaches (Fischer et al., 2006; Lindenmayer et al., 2008; Sayer et al., 2013) should not be seen as a set of boxes to be ticked in the search for an agreed spatial plan but rather as a framework of approaches from which practitioners may draw in order to solve real problems on the ground. There are fundamental difficulties in identifying and agreeing on metrics to measure progress in solving wicked problems particularly if opinions differ on the optimal solution to a problem when no single metric can measure, or even define, "success", particularly when trade-offs are the norm (Sunderland et al., 2008). National level reviews of landscape and ecosystem approaches to *forest management* have revealed that this is still very much work in progress (Sayer et al., 2014). The application of landscape principles might eventually lead to a spatial plan accepted by stakeholders but landscapes are constantly changing under the influence of multiple drivers and end points in the form of long-term plans appear to be the exception rather than the rule (Carrasco et al., 2014).

Much of the theory and practice of landscape approaches is underpinned by the assumption that facilitation and negotiation will eventually allow for a consensus on a desired outcome. However, in reality there are often entrenched views, conflicts of interest and power plays as a result of which, true consensus is rarely achievable (Colfer and Pfund, 2010). Conflict between agriculture, at both industrial and small scales, conservation and other competing land uses (e.g. industry, urbanisation, tourism, recreation, dams, reservoirs) is often the subject of strongly contested activism with highly polarised positions (Sunderland et al., 2008). Landscape approaches sometimes appear to be advocated on the assumption that they can resolve these fundamental differences in a way that will avoid conflict, particularly with regard to achieving both food and nutritional security. In reality, any intervention will bring "winners" and "losers" as any rural community – including "traditional societies" living in or on the edge of forest habitats – is heterogeneous and characterised by various internal conflicts. Ignoring this heterogeneity and these internal conflicts may weaken local communities against the influence of new powerful stakeholders, for example logging and mining concessions (Giller et al., 2008).

Boys with *Parkia biglobosa* pods, Labe, Guinea.
Photo © Terry Sunderland

This chapter seeks to highlight the options related to the integration of agriculture, forestry and other land uses (Sayer et al., 2013; Sunderland et al., 2013). The intention is to identify landscape-scale policies, interventions and actions that may achieve this integration through land use change, recognising subsequent implications of forest loss and degradation on food security and nutrition. We also look at landscape configuration (including management systems, land sharing/sparing, intensification, productive landscapes, eco-agriculture etc.) and necessary synergies and trade-offs between different land uses (crops, livestock etc. but also other sectors), and *forests and tree-based systems.* Finally, we look at integrated and cross-sectoral options (that include forests and tree-based systems) for food security.

5.2 The Role of Landscape Configurations

5.2.1 Temporal Dynamics within Landscapes

Landscapes change over time and the spatial configuration of land uses is rarely static. Such changes are not only a result of anthropogenic pressures (such as *deforestation*), but can also be caused by natural ecological dynamics (e.g. Vera, 2000). Failure to understand these dynamics and their origins can lead to misguided management interventions, as in the case of Sahelian forest dynamics where it was assumed incorrectly that people were responsible for forest loss (Fairhead and Leach, 1996). Given this dynamism, in many forest landscapes it may be inappropriate to permanently delineate land uses in fixed spatial patches – often referred to as "zoning". However, finding workable alternative *governance* arrangements in such systems can be very difficult (Scott, 1999).

Mosaic of agriculture, agroforestry systems and forest in Chittagong, Bangladesh.
Photo © Terry Sunderland

In some cases, particular configurations of the landscape level social-ecological system, containing multiple different patches of land uses, may be more or less sustainable in the long term. For example, the best configuration to maximise production of a particular commodity (such as a *tree crop* like oil palm) in the short term may be a large monoculture, but this might degrade the productivity of the land and other *ecosystem services* in the long term. Similarly, the best configuration to maximise the abundance of a given species of interest today may be very different from the best configuration to maximise the abundance of the same species in a couple of decades, as *climate change* is driving shifts in species ranges (Parmesan and Yohe, 2003). The optimum configuration to produce the same desired outcome in the longer term might look very different. The fact that multifunctional landscapes are "moving targets' with "multiple futures" calls for adaptive management approaches (Holling and Meffe, 1996).

Related to adaptive management is the concept of *resilience*: "the capacity of a system to continually change and adapt yet remain within critical thresholds" (Stockholm Resilience Centre, 2014). Some landscape configurations may be better able to cope with emerging pressures in the future, such as anthropogenic climate change. A considerable literature argues that landscapes containing diverse social and ecological systems (multifunctional landscapes) are likely to be more resilient to change than more simple systems (e.g. Elmqvist et al., 2003; Tscharntke et al., 2005). Production landscapes that are configured to maximise resilience by mimicking the structure of natural ecosystems are sometimes referred to as "eco-agricultural" landscapes (Scherr and McNeely, 2008). In addition, the numerous ecological interactions between cultivated and natural patches of vegetation in landscape mosaics (see above) result in complex ecological networks and stabilise the functions of these landscapes. In comparison, ecological interactions in more homogeneous landscapes are limited, and the functions of such landscapes (including agricultural productivity) are more vulnerable to shocks (e.g. extreme climatic events) (Loeuille et al., 2013). Forests and tree-based landscapes also sustain the resilience of social systems: forest products are consumed more frequently in times of food scarcity and can provide crucial livelihood safety nets (Johns and Eyzaguirre, 2006; Powell et al., 2013)

5.2.2 Trade-offs and Choices at the Landscape Scale

Landscapes are complex systems that generate a range of social and ecological outcomes over time. These outcomes are not limited to food; they include biodiversity conservation, sources of income, provision of cultural, regulatory and social services and a host of other benefits. Different landscapes produce different combinations of these elements, dependent on biophysical (such as soils and rainfall) and social conditions (such as who has the right to manage and harvest what).

There is no single configuration of land-uses in any landscape that can provide all the different outcomes that people might find desirable. For example, the "best" landscape configuration for biodiversity conservation might include large areas of forest strictly protected from human use, but this might support the livelihood needs of only a very small human population or even displace previously resident people (Brockington and Igoe, 2006). This has often been the case in the establishment of protected areas in many parts of the world (West et al., 2006). For example, in Madagascar the expansion of protected forest areas has alienated people from previously common lands, a phenomenon that can restrict community access to forest resources, including food (Corson, 2011). In contrast, the "best" landscape for cereal production might contain very little or no forest at all. Other desirable outcomes, such as malaria mitigation (Mendenhall et al., 2013) or food security

Box 5.1

Novel technologies

New applications of technologies such as remote sensing and mobile phones, also contribute to improving the integration of agriculture and forest conservation within landscapes.
A few examples have been collected:

- The recently launched Soil Moisture Active Passive Observatory (SMAP) will be used in designing global early-warning systems and improving the precision of crop suitability maps (NASA website). This technology can improve climate and weather forecasts, allowing scientists to monitor floods and droughts and therefore better predict crop yields.
- In Kenya, through the Kilimo Salama initiative of Syngenta Foundation, farmers are able to purchase insurance via their mobile phone messaging service, which lowers the cost of insurance provision. With their crops insured, farmers can more readily experiment with higher-risk, higher-yield crops and stay assured that regardless of the weather, they will be able to feed their families (Rojas-Ruiz and Diofasi, 2014).
- In India, studies revealed that the introduction of mobile technology enhanced farmers' awareness of markets and prices and improved decision-making with regard to technology adoption. Challenges to further increase the adoption and utility of mobile technology include availability of content in local languages, compatibility of these languages with the handsets, overall literacy, retrieval costs of voice messages and the lack of transmission masts in remote areas (Mittal et al., 2010; Mittal, 2012).
- In East Africa, researchers linked scientists with a private sector communications firm that produces Shamba Shape-Up (SSU), a farm reality TV show broadcast in Kenya, Tanzania and Uganda. The show seeks and presents climate-smart agriculture (CSA) information, reaching an average monthly viewership of 9 million people across East Africa. Research shows a trend of increasing uptake of CSA practices, with an average of 42 percent of SSU viewers changing their practices, as well as benefitting Kenya's GDP through net soil fertility and net dairy production increase. In a further development, the company is expanding CSA platforms by linking SSU to a mobile/SMS/internet service allowing farmers to ask questions and receive technical advice from experts. (http://ccafs.cgiar.org/blog/communicating-behavior-change-how-kenyan-tv-show-changing-rural-agriculture)

(Thrupp, 2000; Chappell et al., 2013; Sunderland et al., 2013) may be best provided by more diverse landscapes.

With increasing anthropogenic and biophysical pressures on biodiversity and ecosystem services across many landscapes, choices have to be made about what is desirable and how landscapes should be managed (MEA, 2005; Laurance et al., 2014). Management regimes can serve to optimise trade-offs and synergies among different outcomes (Naidoo et al., 2006; DeFries and Rosenzweig, 2010), but there are always likely to be some trade-offs and opportunity costs (McShane et al., 2011; Leader-Williams et al., 2011). To address this problem, increasing attention has been given by researchers to the question of how to resolve trade-offs at the landscape scale to produce desirable outcomes for both biodiversity and production goals (e.g. Polasky et al., 2008).

5.3 Land Sparing and Land Sharing

The *land sharing / land sparing* framework is potentially useful for considering trade-offs between agriculture and biodiversity conservation (Balmford et al., 2005; Green et al., 2005; Garnett et al., 2013). One rationale for accepting the negative ecological consequences of land-use intensification on existing farmland is that natural habitats can be "spared" from further expansion of agriculture and as such will be sufficient for the maintenance of biological communities and ecosystem services. Meanwhile, integrating agricultural production and conservation on the same land ("land sharing" or "wildlife-friendly farming"), coupled with the likelihood of further expansion acts as an alternative solution for balancing trade-offs between production and conservation. However, the central question in the land sparing / land sharing debate is whether it is more favourable for biodiversity if desired increases in agricultural production are met by increasing the area of low yield farmland (land sharing) or by increasing the intensity of farming on existing farmland (land sparing).

To answer this question it is necessary to understand the relationship between biodiversity and agricultural production in landscapes. Empirical fieldwork in Ghana and India (Phalan et al., 2011), Uganda (Hulme et al., 2013) and Malaysia (Edwards et al., 2014) has consistently found that land sparing is the "better" strategy for reconciling biodiversity and food production targets, because many species cannot survive in farming systems of even the lowest management intensity (Ewers et al., 2009; Phalan et al., 2011; Balmford et al., 2012). More recently, it has been shown that with relatively modest and sustainable increases in productivity on existing farmland, Brazil could reduce deforestation caused by agriculture to zero (Strassburg et al., 2014). Pretty and Barucha (2014) also conclude that *sustainable intensification* can result in desirable outcomes both for enhanced food yields and improved environmental goods and services, yet Phelps et al. (2013) suggest that with intensification, productivity increases could incentivise further clearance of forest for agriculture. The majority of farmers in developing countries also lack the necessary capital to either intensify their farming systems or spare land for nature (Bennett and Franzel, 2013). Box 5.1 highlights some examples of novel technologies applied to better integrate agriculture, forest and food security in a landscape.

The land sparing/sharing framework and associated research have consequently generated some debate

(Perfecto and Vandermeer, 2010). Critics of the land sparing approach argue that the intensification of agriculture has a negative impact on biodiversity and ecosystem services, and that for "sparing" to work, intensification of agriculture in one place must be explicitly coupled with protection of natural habitat elsewhere, which rarely happens in practice (Chappell and LaValle, 2009; Perfecto and Vandermeer, 2010; Angelsen, 2010; Tilman et al., 2011). Links between the intensification of agricultural systems (through increased fertiliser application, pesticide use, animal stocking rates and irrigation) and *in situ* declines of biodiversity on farmland have been well documented (Green et al., 2005; Kleijn et al., 2009), even though biodiversity loss need not necessarily accompany increased agricultural yields across all systems (Clough et al., 2011). Meanwhile, the potential ecological impacts of "spillover" effects (Matson and Vitousek, 2006; Didham et al., 2015), from the agricultural matrix into adjacent natural systems (e.g. inputs of nutrient subsidies through fertiliser drift and down-slope leaching (Duncan et al., 2008), livestock access (Didham et al., 2009) and the spillover of predator or consumer organisms (Blitzer et al., 2012)) could likely compromise the effectiveness of land sparing strategies.

Proponents of land sharing advocate the creation of multi-functional agricultural landscapes that generate and utilise natural ecological processes within a social and cultural context (Bolwig et al., 2006; Perfecto and Vandermeer, 2008; Knoke et al., 2009; Barthel et al., 2013). In turn, this approach has been criticised for promoting lower yields and therefore leading to further forest clearance for agriculture. It is also claimed that land sharing is only suitable for conserving only those species able to survive in human-dominated landscapes, namely generalist or common species (Kleijn et al., 2006; Jackson et al., 2007; Phalan et al., 2011). Meanwhile, others have criticised the entire framing of land sparing/sharing on the basis that it fails to consider broader social and ecological complexities such as other ecosystem services, food security and poverty (Fischer et al., 2014).

In reality the choice and distinction between land sparing and land sharing, while context dependent, is unclear. For example, what appears to be sharing at the landscape scale may look more like sparing at the local scale (Grau et al., 2013; Baudron and Giller, 2014). The framework offers a useful tool for thinking about choices in landscapes, but policymakers should recognise that there are important limitations to its use in real world situations (Perfecto and Vandermeer, 2010:, Fischer et al., 2014). Furthermore, such "landscape design" thinking might be intuitively appealing, but it faces a number of limitations in practice:

- Trade-off analyses tend to be incomplete, meaning that they neglect important issues (Fischer et al., 2014). For example, the "best" landscape for balancing forest conservation and food production may be very different from the "best" landscape to balance conservation, food and space for urban expansion.
- Results may be affected by the spatial scale of analysis. The "best" landscape configuration at one scale may be different at a larger scale. Additionally, landscape analyses often fail to incorporate flows of people and materials between landscapes (Phalan et al., 2011; Seto et al., 2012; Grau et al., 2013).
- The concept of idealised landscape design ignores the social and political realities on the ground (Fischer et al., 2014). Who owns what within the landscape, and who gets to decide what happens? Who benefits or loses from particular choices? What is the history and current status of the landscape? These political economy issues may mean that a theoretically optimal landscape configuration is unrealistic or unachievable on the ground.

The research reviewed in this section demonstrates the importance of thinking beyond the site scale by taking into account broader interactions between land-uses within landscapes. However, it also highlights the inherent complexity in any such analysis, and the trade-offs that are likely to exist between the desired outcomes of different stakeholders. Research at this scale is in its infancy, and faces daunting data and analytical deficiencies. Addressing these challenges will be a priority for the coming years.

A broader question is how far research can go in providing useful information about relationships between forest food systems and other land-uses at the landscape scale.

5.4 Landscapes and Localised Food Systems

Landscape approaches offer promise for solving some food-related problems that have proved to be more intractable than the basic task of producing more calories, such as improving access to food and nutrition through the provision of a diversity of products, and thus improving diets (Scherr and McNeely, 2008; Ickowitz et al., 2014).

Landscape approaches, especially those that are developed locally, are often more suitable for lands where previous agricultural intensification has been unsuccessful, for example on sloping lands and other areas that are marginal for conventional approaches. The diverse production activities that such systems comprise are often well adapted to the panoply of environmental, demographic, social, political and economic changes that is sweeping across much of the less-developed world. Diverse, locally-adapted production and resource management systems tend to increase the resilience of rural households in the face of such changes (Padoch and Sunderland, 2014).

It is estimated that 40 percent of all food in the less-developed world, and up to 80 percent if solely focusing on Africa and Asia (FAO, 2012), originates from smallholder systems, and many of these systems depend essentially on diverse landscape systems (Godfray et al., 2010). Smallholder farmers worldwide and throughout history have managed landscapes for food and other livelihood needs. Forests, woodlots, parklands, swidden-fallows and other tree-dominated areas are integral parts of many smallholder landscapes and household economies (Agrawal et al., 2013).

The greatest obstacle to including shifting cultivation in the new landscape paradigm, in the eyes of both development professionals and conservationists, is not necessarily the illegibility of its patchy landscapes or the complexity of its management, but its inherent dynamism. Change is what defines a system as shifting cultivation: annual crops are moved from plot to plot every year or two; as forests regenerate in one area, they are felled in another. Can so much dynamic change be tolerated in a "sustainable" landscape? (Scott, 1999). Can shifting cultivation be considered sustainable if it includes slashing and burning woody vegetation? These questions are inherent in complex socio-ecological systems and landscape dynamics and can only be addressed at a landscape level through an adaptive approach that is based on continual learning – two essential features of a landscape approach (Sayer et al., 2014; Holling and Meffe, 1996).

Many shifting cultivation systems worldwide have adapted successfully to larger human populations, new economic demands and the directives of anti-slash-and-burn policies and conservation prohibitions. Such adaptation has taken a large number of pathways, of which the more active management of fallows has perhaps been the most important. Examples include the management of rich mixtures of marketable fruits and fast-growing timbers in Amazonia and the production of rubber and rattans in Southeast Asia (Sears and Pinedo-Vasquez, 2004; Cairns, 2007). These adaptations suggest that the sustainability of shifting cultivation systems emerges when it is seen at broader spatial and longer temporal scales: shifting cultivation, in common with many smallholder-influenced landscapes, is constantly mutable.

As exemplified in the case study in Box 5.2, productive, complex and dynamic landscapes in the Lao People's Democratic Republic and elsewhere, lend flexibility to household economies and contribute to appropriate responses to climatic and economic perturbations. Programmes of directed change, such as the one promoted by the Lao government, attempt to create distinct zones for agricultural intensification and forest conservation, but until now have failed to enhance sustainable resource management or local livelihoods.

Box 5.2

The long-term benefits of shifting agriculture: a case study from Lao PDR

An important study (Castella et al., 2013) analysed changes in the patterns of field-forest landscapes that occurred as environmental and socio-economic change transformed the territories of seven villages in the northern uplands of the Lao People's Democratic Republic over a period of 40 years. In this region, where a tradition of shifting cultivation had created intricately-patterned landscapes of forest, fallows and farms, such landscapes are now being radically altered by policies aimed at increasing forest cover and promoting intensive commercial farming. Shifting cultivation, with its complex landscapes, is deliberately being replaced with a land sparing model of agriculture. This is because the segregation of land uses is perceived as most efficient for achieving multiple objectives in the context of a growing population, and shifting cultivation is widely viewed as "primitive" by government and other institutions.

Based on extensive field research, however, Castella et al. (2013) found that by imposing strict boundaries between agricultural and forest areas, interventions in the name of land-use planning have had significant negative impacts on the well-being of rural communities and especially on their ability to adapt to change. Farm and forest products that previously were "intricately linked at both landscape and livelihood levels, are now found in specialized places, managed by specialized households" (i.e. the domestication of non-wood forest products) and collected by specialised traders. The authors argued that "this trend may have negative consequences for the resilience of the overall landscape as it reduces its biological and socio-economic diversity and therefore increases vulnerability to external shocks" (Castella et al., 2013).

5.5 "Nutrition-sensitive" Landscapes

Nutrition-sensitive approaches to agriculture and food security are gaining increasing acceptance as an important dimension of global food security policy (Ruel and Alderman, 2013; Pinstrup-Andersen, 2013), recognising that the ultimate solution to *malnutrition* lies in the consumption of sufficient quantities of nutritious foods (Burchi et al., 2011). While protein and calorie deficiencies are still widespread, the prevalence of micronutrient deficiencies outweighs that of hunger, and should be a public health, food security and agricultural priority (Allen, 2002). Most of the discourse surrounding nutrition-sensitive approaches focuses on the role of monoculture agriculture, overlooking the role of agroecological systems, wild foods and forests in contributing to nutrition and dietary adequacy (Powell et al., in press). Some recent work, however, suggests that the contribution of forests and tree-based agriculture to nutrition in particular may be substantial (Golden et al., 2011; Ickowitz et al., 2014; also see discussion in Chapter 2).

Malnutrition, including under-nutrition and over-nutrition together with the concomitant increases of non-communicable diseases in poor and middle-income countries are key developmental and political challenges for donors, governments and smallholders (Frison et al., 2011). Direct pathways to malnutrition include poor diet and infection often combined with lifestyle factors, which are determined by personal factors (e.g. physiology, psychology and knowledge), household factors (such as quantity, quality, seasonality and use of own food production, income and education), as well as broader structural social, cultural, political and environmental factors (such as inequality and access to productive resources, information etc.). Indirect pathways to malnutrition are important, operating through income,

Market sellers at the roadside, Nyimba, Zambia.
Photo © Terry Sunderland

education, equity and other factors that can have sustained and longer-term impacts.

The best way to address the challenge of under-nutrition and malnutrition is to coordinate activities across different sectors and different levels of scale: a more holistic "systems approach" (Frison et al., 2011; Powell et al., in press). There is a bidirectional link: while landscapes have an influence on the nutrition and health of the communities that depend on them (Golden et al., 2011; Ickowitz et al., 2014), the behaviour of people can also have an influence on the very well-being and long-term sustainability of integrated landscape systems themselves.

A number of landscape level factors lead to insufficient production, sale and use of nutritious food. These include internal factors such as poor productivity of the agricultural, aquatic and forestry systems; loss of *agricultural biodiversity* of the systems; access to markets and lack of knowledge and awareness on healthy diets (e.g. Powell et al., 2014); but also external drivers of land use and landscape change including environmental, institutional, social and political factors. A better understanding of these factors would help to reduce their impact on food security and nutrition.

While there is evidence that increased income and improved food security are correlated at the national scale, evidence is beginning to emerge showing that incomes from diverse landscapes may be used in a nutritionally-sensitive manner (Ickowitz et al., 2014). The interactions between urban and rural populations have profound implications on livelihoods, markets and wellbeing. The layers of these relationships need to be understood and supported when positive, and mitigated when shown to reduce resilience.

5.6 Landscape Governance

There are diverse uses and understandings across disciplines of the term "governance" (Kozar et al., 2014). At its core, the term denotes the inclusion of multiple non-state actors in deliberating and deciding society's most pressing issues and their solutions, and refers to new spaces where increasingly complex problems can be solved by multiple types of actors (Kozar et al., 2014). Landscape governance is thereby concerned with the institutional arrangements, decision-making processes, policy instruments and underlying values in the system by which multiple actors pursue their interests in sustainable food production, biodiversity and ecosystem service provision and livelihood security in multifunctional landscapes.

As people living in and around a particular landscape seek from it a wide range of qualities and benefits, the divergent values and interests of multiple types of actors at different levels create new challenges for landscape governance. Throughout the world, innovative efforts are being pursued to couple the sustainable governance of ecological resources and human activity within a common framework. These efforts seek to realise multiple ecosystem services and livelihood benefits for diverse stakeholders within the same geographic location. At the same time, advances in the study of socio-ecological systems (Liu et al., 2007) and the corresponding practice of integrated landscape governance (FAO, 2005; Scherr et al., 2013) is rooted in the growing recognition that nature conservation need not necessarily pose a trade-off with development.

Rather, investments in conservation, restoration and sustainable ecosystem use are increasingly viewed as potentially synergistic in generating ecological, social and economic benefits and therefore providing solutions to the "wicked" problems identified earlier in this chapter (de Groot et al., 2010; see also discussion in Chapter 6).

As inhabitants of landscapes and other practitioners continue to experiment and innovate with the scaling-up of landscape approaches from their diverse entry points, emerging institutional issues of multi-level and multi-actor governance and their incongruity within administrative and jurisdictional boundaries pose an imminent challenge to successfully realising multiple outcomes from multi-functional landscapes.

Consensus across multiple fields, spanning ecological, political and geographical disciplines, concludes that a core challenge for addressing complex problems bridging social and ecological systems is effective governance at multiple levels. Yet the inhabitants of landscapes and other practitioners struggling to implement landscape approaches often focus on one level, whether international, national, regional or local (Nagendra and Ostrom, 2012). Multilevel decision-making for the governance of landscapes helps to link actors and address the complex issues that arise in governing social-ecological systems (Görg, 2007). However, the way in which the issues of scale and multi-actor governance are conceptualised and the manner in which solutions for viable governance systems are designed are both emergent and variant.

Effective governance structures in multifunctional landscapes remain elusive, giving rise to questions such as: what functions will be located where, what rules determine who has rights to what resources at what time, and how to enforce those rules. Who decides such questions based on what values, and who is included and excluded from activities and benefits linked to different functions are also key challenges within the management of complex landscapes.

Decision-making processes that can accommodate diverse values, interests and knowledge while balancing the influence and power among different types of actors can help to formulate a common vision and maintain it in the face of dynamic socio-ecological change in the landscape. Robust institutions capable of traversing scales and levels can contribute to providing the mechanisms and incentives by which public, private and civic sector actors can cooperate to realise their desired outcomes.

Colfer and Pfund (2010) identified recurring issues that are likely to impinge on any efforts to work collaboratively with tropical forest communities and landscapes. These include, governmental policies with complex, diverse and often unpredictable effects, varying interfaces between customary and formal legal systems, differences in the use and governance of agricultural production and *non-timber forest products (NTFPs),* and the potential even within collaborative governance for harm (win-win solutions are unlikely always to be an option and many argue that trade-offs are the norm) (Giller et al., 2008).

Cattle grazing in *Borassus aethiopium* savannah, Senegal.
Photo © Terry Sunderland

Based on a comparative study of pantropical landscapes, Colfer and Pfund (2010) conclude that there are six key issues that represent governance constraints at the landscape scale: 1. the powerful duo of government and industry (for example, oil palm expansion); 2. risks linked to national policies (for example, the focus on men and timber in forest management, without complimentary income-generating and gender-balanced activities); 3. complexities of pluralistic governance (such as differing relations between hinterland groups and governments); 4. differences in cultural significance and governance of NTFPs and other forest products, including differentiation in roles between sexes and among social groups; 5. discontinuity between national laws and swidden *agroforestry* systems; and 6. new potential dangers for hinterland people from international sources (such as risks of exclusion linked to international encouragement of proliferation of protected areas).

Most of these issues demonstrate the global variety and variation over time in contexts, peoples, and regimes governing natural resources. Such diversity and dynamism reinforces the desirability of: a) strengthening and supporting their involvement in their own governance and b) tailoring any interventions to the specificities of any locale. Indeed, implementation of the latter probably requires the implementation of the former. Thus formal governmental shortcomings strengthen the argument for stronger citizen involvement, to serve as monitor and ultimately provide some constraint on such power.

5.7 Conclusions

The ability to create change in policy and practice in the context of landscape approaches to land management is currently impaired by a dearth of scientific evidence. While there is a growing body of evidence, our understanding of how forests and landscapes with tree cover contribute to food security and nutrition and the provisioning of healthy and nutritious foods to local and global food systems remains limited. Greater attention to the production of and access to nutrient-dense foods is needed in the debate on the respective benefits of land sharing versus land sparing which has focused to date on the impacts of staple crop yields (one important aspect of food security) on biodiversity and forest conservation.

Future work on forests, and food security and nutrition should also focus on linking the health of forests and landscapes to *food sovereignty* (which encompasses food security, the right to food and healthy diets, as well as the right to control over one's own *food system* (Pimbert, 2009) to help mitigate nutrition transitions while contributing to sustainable management of wildlands. The concept of food sovereignty has been widely accepted by many indigenous groups (e.g. http://www.indigenousfoodsystems.org/food-sovereignty), and it is seen as a potential mechanism and argument to enhance greater autonomy of indigenous communities over their local food and agricultural systems as well as their wider landscapes and bio-cultural environments.

The need for local food systems is clearly demonstrated by the fact that current global food production is more than adequate to feed the entire global population, at least in terms of calories (Stringer, 2000; Chappell and LaValle, 2011), while more than 800 million people are undernourished (FAO, 2009). Clearly, producing large amounts of food in the North is not enough to guarantee food security in the South. A main reason for this is that the agricultural production from the North is subject to multiple demands, not only from the food sector, but also from the livestock (Goodland, 1997) and energy sectors (OECD-FAO, 2011).

Enhanced food sovereignty will help ensure local people have control over their own diets and are engaged in efforts to improve the nutritional quality of their diets. Such community level engagement will be particularly important for those people facing a nutrition transition and the burden of malnutrition. Community level engagement with local food and agricultural systems additionally creates a setting ideal for engaging communities for more sustainable management of these food and agricultural systems and the wider landscapes in which they reside.

Although food security is dependent on issues of sustainability, availability, access and utilisation, and not production alone, it is evident that a "new agriculture" (Steiner, 2011) needs to be found to feed the world's population both efficiently and equitably. It needs to produce food where it is needed i.e. in areas where agriculture is dominated by small farms (e.g. two thirds of African farms are smaller than two hectares (Altieri, 2009)) and where negligible quantities of external inputs are used (agriculture "organic by default", Bennett and Franzel, 2013). Thus, *agroecology* (i.e. the application of ecological concepts and principles in the design of sustainable agricultural systems, Gliessman, 1997) appears well suited to these geographies. As such, the United Nations' (2011) vision of an "agro-ecological" approach that combines biodiversity concerns, along with food production demands, provides a more compelling vision of future food production.

The integration of biodiversity conservation and agricultural production goals must be a first step, whether through land sharing or land sparing, or a more nuanced, yet complex, multi-functional integrated landscape approach. However, conservation and restoration in human dominated ecosystems must strengthen connections between agriculture and biodiversity (Novacek and Cleland, 2001). In such landscapes, characterised by impoverished biodiversity and in particular "defaunated", depopulated of their medium and large size vertebrates (Galetti and Dirzo, 2013), agriculture may represent an opportunity, and not necessarily a threat, for conservation and ecosystem restoration. When native large vertebrates are lost, several ecological functions such as the maintenance of habitat heterogeneity, nutrient cycling and seed dispersion are impaired (Owen-Smith, 1988; Hansen and Galetti, 2009). Domestic livestock may mimic ecosystem functions once provided by wild herbivores (Wright et al., 2012), and restore the ecological integrity of landscape mosaics. In extreme cases, domestic livestock has been used to restore biodiversity and ecosystem functions of landscapes that previously lost large native vertebrates, most famously in the Oostvaardersplassen in the Netherlands (Vera, 2009).

Managing landscapes on a multi-functional basis that combines food production, biodiversity conservation and the maintenance of ecosystem services should be at the forefront of efforts to achieve food security (Godfray, 2011). In order for this to happen, knowledge from biodiversity science and agricultural research and development need to be integrated through a systems approach at a landscape scale. This provides a unique opportunity for forestry and agricultural research organisations to coordinate efforts at the conceptual and implementation levels to achieve more sustainable agricultural systems. As such, a clear programme of work on managing landscapes and ecosystems for biodiversity conservation, agriculture, food security and nutrition should be central to development aid.

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