Chapter 2.1.4 *

Landscape approaches to achieving food production, natural resource conservation, and the Millennium Development Goals

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The Rio Copan watershed in western Honduras is not unlike many agricultural landscapes throughout the developing world. A journey through this 800 square kilometer watershed reveals a mixture of small and mid-sized farms producing cattle, coffee, and subsistence crops. Residents here face many challenges: recent population growth has led to deforestation and water pollution, while agricultural productivity is generally low and poverty levels remain high, especially among the indigenous Mayan population.

Environmental degradation is both a cause and a consequence of these problems. Poverty has driven many local people to cut wood in the vanishing native pine-oak forests or to cultivate or graze hillsides that are too steep for these purposes. Such practices, in turn, contribute to silted rivers unsuitable for human or livestock consumption and to landslides that routinely close roads and isolate villages from needed goods and services for weeks or months at a time. To meet the Millennium Development Goals (MDGs) in the Rio Copan watershed will require not just new schools, new health centers, and new crop varieties; it will require a suite of coordinated activities, many of them focused on environmental restoration and natural resource management.

Fortunately, unlike many rural communities that address poverty issues piecemeal at the household or village level, Copan's communities have recognized that these challenges grow from—and, in turn, influence—key dynamics and ecosystem processes operating at the scale of the entire watershed, and sometimes beyond. For local leaders, the wake-up call that spurred this landscape-level thinking arrived suddenly, drenching them, quite literally, like a bucket of cold water from above. In 1998, Hurricane Mitch tore through the region, wreaking havoc not just on de-vegetated hillsides but on the farms, villages, waterways, and infrastructure below.

After taking stock of the extensive damage, the four municipalities in the watershed decided to band together to form a regional coalition aimed at preventing such devastation in the future, and at finding solutions to shared problems such as erosion, water pollution, and poor human health. They created a vision and plan for the watershed's future and, for the past several years, have been using this plan to target and guide externally-funded rural development activities. The problems and challenges in the watershed are not solved, but their root causes and interactions are now better understood. This knowledge encourages leaders to find solutions that do not trade off one landowner's wellbeing for another's, or one development objective for another, but that seek to maintain and restore the landscape's natural and human capital for the benefit of all.

INTEGRATING RURAL DEVELOPMENT AND NATURAL RESOURCE MANAGEMENT

Leaders in the Rio Copan watershed have learned through experience what thousands of scientists have documented over the past two decades: ecosystem services are critical to human wellbeing, especially in rural landscapes in developing countries. The Earth's natural capital of clean water, soils, fish, wildlife, and other resources provides about two-thirds of household income for the rural poor (MA 2005) and 26% of all wealth in low-income countries (World Bank 2006). Environmental causes are responsible for nearly one-fourth of the global disease burden, and more than four million children die each year from illnesses such as diarrhea, malaria, and respiratory infections that could be significantly mitigated by improved environmental management (Prüss-Üstün & Corvalán 2006). In light of the fundamental role of natural capital in supporting human wellbeing, it is especially worrisome that 15 of the 24 key ecosystem services upon which humans depend are being degraded or used unsustainably (MA 2005).

World leaders and major development funding agencies have acknowledged that environmental factors are either at the root of, or closely linked to, MDGs 1 through 6—those relating to food security, human health, education, and gender equality (Sachs & Reid 2006; DFID et al. 2002; DFID 2006). This connection means that much of the recent progress toward meeting the MDGs (UN 2008) is likely to be fleeting if the natural capital that underlies these improvements continues to decline (WRI 2005). Yet, despite these well-documented linkages, the treatment of the environment in the MDGs "…harkens back to old, outmoded ways of thinking" (WRI 2005:154). Rather than being framed as a cross-cutting theme that underlies the long-term achievement of other poverty alleviation goals, the environment is addressed only in MDG 7. And although the revised MDG targets and indicators issued in 2008 provide more specific measures of success for MDG7, these measures still fail to address many of the aspects of environmental management that are most relevant for sustaining the ecosystem services that are critical for poverty alleviation (WRI 2005; DFID 2006).

Unfortunately, this inattention to natural capital as a foundation of human wellbeing has been reflected in global funding priorities and implementation frameworks for poverty alleviation. For example, Poverty Reduction Strategy Papers (PRSPs)—the vehicle by which national governments formulate objectives for meeting the MDGs and establish their priorities for international aid—have often paid insufficient attention to the environment (Bojö et al. 2004; WRI 2005). This undervaluing of environmental factors is likely a result both of the stated priorities of the aid agencies themselves (World Bank & IMF 2005) and of the apparent tendency of some governments preparing PRSPs to favor more fundable infrastructure projects over environment and agriculture projects identified as priorities by local communities and district-level agencies (Swallow 2005). The general result, at the field level, has been an overly sectoral approach to rural development that neither integrates environmental and livelihood objectives nor adequately addresses the environmental drivers underlying development goals (Sanderson 2005).

In light of these shortcomings, many have argued that the rural development agenda must be re-formulated to integrate environmental sustainability at all scales, from international funding priorities to on-the-ground projects. This chapter suggests that such integration needs to include a strong focus on the landscape scale—the level at which many ecosystem processes operate and at which interactions among environment and development objectives are often mediated (O'Neill et al. 1997) (see **Box 1**). For example, in many landscapes, conservationists and rural development advocates have both targeted the same land or water resources for advancing their respective objectives—often with little communication or recognition of the conflicts between these aspirations (Wood et al. 2000; McNeely & Scherr 2003). In such situations, landscape-scale assessment, negotiation, planning, and monitoring can help identify actions and policies that increase synergies while decreasing tradeoffs (Palm et al. 2005). On the other hand, if tradeoffs are not explicitly acknowledged and addressed through negotiated solutions, sectoral programs and investments will move forward in isolation, leading to composite outcomes that are likely to be far sub-optimal, especially for less powerful stakeholders.

The purpose of this chapter is to explore the theory and practice of landscape approaches to sustainable rural development and to illustrate the ways in which this paradigm can be applied to address the MDGs. The chapter begins by introducing and reviewing existing landscape approaches. Next, we present the Landscape Measures framework, a landscape approach that we developed specifically for use in 'ecoagriculture' landscapes where food production is a key objective. We then introduce some tools for implementing the Landscape Measure approach, focusing on those that apply ecological knowledge and methods. We illustrate the use of such tools by elaborating on the Copan case study introduced above as well as a recent project in

Kenya. Finally, we conclude by identifying important actions for mainstreaming landscape approaches to help achieve the MDGs.

AN INTRODUCTION TO LANDSCAPE APPROACHES

Notwithstanding the limitations of current mainstream rural development priorities, many rural land stewards, non-governmental organizations (NGOs), researchers, and supporters have come to embrace the complexity of rural landscapes and have developed evidence-based management approaches that address the spatial, thematic, and human scope of the challenges themselves (Lal et al. 2001). We refer to these as landscape approaches and suggest that they have five defining characteristics: 1) a landscape-scale focus, 2) treatment of landscapes as complex systems, 3) management for multiple objectives, 4) adaptive management, and 5) management through participatory processes of social learning and multi-stakeholder negotiation. Each of these characteristics is discussed below.

First and most obviously, landscape approaches seek to address livelihood needs and environmental challenges at a landscape scale. There are many possible ways to define landscapes, but for management purposes it is helpful to define them functionally according to the objectives at hand and the physical extent of the features and processes that mediate these objectives (Buck et al. 2006). Precise boundaries are often ambiguous because the various biophysical gradients, socio-cultural attributes, and political jurisdictions found on the land operate at multiple scales and rarely coincide with one another. Thus, landscape approaches incorporate multi-scale linkages, helping to coordinate small-scale management efforts while considering relevant aspects of the landscape's regional and global context.

Second, landscapes are analyzed as complex systems—that is, assemblies of interconnected components that are expected to fulfill a specific set of purposes (Collins et al. 2007). Recent research on coupled human and natural systems has solidified the analytical foundations for understanding the reciprocal influences between humans and their environment at multiple scales (Liu et al. 2007). This field proposes increased emphasis on indirect linkages, feedbacks, and multi-temporal analysis when investigating or managing properties of interest such as the resilience and vulnerability of agroecosystems, which, by definition, encompass human goals, human behavior, and ecosystem dynamics. A range of methods for aiding in such analysis already exists, including system dynamics modeling, agent-based modeling, and various GIS-based tools. For example, Parker and colleagues (2003) illustrate how multi-agent system models of land use/land cover change can elucidate feedbacks between land stewards and the environment in the (very common) circumstance where landscape change is largely a composite outcome of numerous of household-level decisions. In practice, coupled systems thinking can help policy makers anticipate future trends, manage interactions among landscape components, and expose "blind spots" that can emerge from unanticipated feedbacks (Maarleveld & Dangbegnon 1999).

Third, landscape approaches manage for multiple objectives, among which there are likely to be both synergies and tradeoffs. Multi-objective management is essential when landscapes are expected to provide more than one type of product or service—as indeed most landscapes are—and when stakeholders disagree on the goals of management and their relative importance. Furthermore, indicators for the various management goals are likely to be non-commensurable ('apples and oranges') such that it is difficult to define any aggregate measure of landscape success even if the relative importance of each goal can be ascertained (Munda 2005; López-Ridaura et al. 2005). For this reason, multi-objective management is rarely amenable to the type of optimization algorithms that have transformed the management of single-objective initiatives such as maximizing corporate profitability or designing the most cost-effective system of nature reserves (Röling 2002). Instead, multi-objective initiatives are likely to be understood and reported using a combination of quantitative and qualitative metrics that track whether the landscape is progressing toward the sustainable provision of the desired environmental and socioeconomic outcomes (Buck et al. 2006).

Fourth, landscape approaches are predicated on adaptive management: "…a formal, systematic, and rigorous approach to learning from the outcomes of management actions, accommodating change and improving management" (Nyberg 1999). Adaptive management is essentially the scientific method applied to real-world challenges. Resource managers begin by hypothesizing models of cause and effect, then test these models through specific interventions and policies, monitor the outcomes of these interventions, and use the resulting information to refine the causal models and improve the interventions. Over time, managers become more knowledgeable about the system and better able to respond to changing conditions, thereby increasing the resilience of ecosystems and communities in the face of natural and anthropogenic dynamics (Folke et al. 2002). Adaptive management has its intellectual roots and early experience in ecosystem management (Holling 1978) and is now widely viewed as the preferred approach for addressing complex natural resource management challenges amid incomplete information (Lee 1993; Salafsky et al. 2001). More recent formulations of this paradigm recognize that resource management is not simply a technical puzzle to be solved through better information, analysis, and planning. It is a social dilemma in which the perceptions, priorities, capabilities, and negotiation capacity of land stewards and institutions determine sustainability at least as much as the management practices themselves (Ison et al. 2007; Röling 2002). These ideas underlie the practice of adaptive collaborative management, which positions 'experts' and their technical tools in the role of facilitators or technical advisors to assist a process that is guided by stakeholders themselves (Buck et al. 2001; Colfer 2005).

This leads to the fifth and final characteristic of landscape approaches: an ongoing, participatory process of 'social learning' through which stakeholders iteratively discover and generate relevant knowledge, negotiate goals and objectives, implement management plans, and evaluate outcomes (Leeuwis & Pyburn 2002; Steyaert et al. 2007). In the context of adaptive management, social learning encourages stakeholders to articulate and discuss their understanding of reality and mental models of cause and effect when formulating goals, objectives, and plans (van Noordwijk et al. 2001). These understandings are refined over time based on evidence from project monitoring as well as external sources. Because it provides a built-in mechanism for incorporating new information and responding to novel circumstances, social learning is essential for ensuring the sustainability and resilience of human and natural systems (Röling & Wagemakers 1998; Olsson et al. 2004).

Contemporary uses of landscape approaches

We conducted a literature review to identify the ways in which landscape approaches have been used to address rural poverty and natural resource conservation challenges. This section provides a brief history of the development of landscape approaches and some leading examples of recent practice.

The roots of landscape approaches can be traced to the emergence of the sustainable development concept in the late 1980s (WCED 1987; Lele 1991). This framework ushered in a wave of Integrated Conservation and Development Projects (ICDPs) that included both rural development and environmental (particularly biodiversity protection) objectives. However, the outcomes of ICDPs proved generally to be disappointing. In many projects, the nexus between the development activities and conservation objectives was poorly conceived or fallacious: win-win solutions were assumed rather than acknowledging and addressing tradeoffs. Furthermore, local participation was often token, resulting in mis-directed efforts yielding transient benefits that evaporated when project funding ended (McShane & Wells 2004). Some observers blamed these failures on fundamental flaws in the integrated project model itself (Terbough 1999) while others argued that the basic ideas were sound but had not been fully embraced in most first-generation ICDPs (Brechin et al. 2003). In retrospect, we can say that these projects aspired to multi-objective rural land management but typically lacked most of the other attributes of landscape approaches, such as adaptive management in a social learning context. These omissions were often important causes of the projects' shortcomings.

The disappointing results of early ICDPs coincided with a growing awareness of ecosystem services and their role in sustaining society (Daily 1997; Costanza et al. 1998). This theme was echoed in the 1998 systemwide review of the Consultative Group on International Agricultural Research (CGIAR), which urged the 16 CGIAR centers to move beyond crop research to advance the field of natural resource management to support global food production (CGIAR 1998). Building on earlier formative work by the World Agroforestry Center and Center for International Forestry Research, the centers responded by adopting a program on Integrated Natural Resource Management (INRM), which they defined as a research and management approach that "…aims at improving livelihoods, agroecosystem resilience, agricultural productivity and environmental services [by] augment[ing] social, physical, human, natural and financial capital" (ICARDA 2005). While INRM is not specifically a landscape approach, it envisions management and analysis at multiple nested scales including that of the landscape (Campbell et al. 2001; Izac & Sanchez 2001). Recent INRM initiatives by several of the CGIAR centers have included a strong landscape emphasis and illustrate how 'action research' can facilitate stakeholder dialogue, planning, and management for conservation, food production, and livelihood objectives (Gottret & White 2001; Frost et al. 2006; Pfund et al. 2008).

Despite these promising initiatives, landscape-level planning and analysis does not yet play a significant role in mainstream agricultural investment, management, or policy. Nevertheless, there is some tradition of spatial thinking in agriculture, and this is gradually expanding to encompass larger scales and broader disciplinary foci. For instance, agricultural investment decisions are commonly made using spatially-sensitive methods such as agroecological suitability classification (based on factors such as altitude, rainfall, and soil type) and market analysis (based on transportation costs, access to inputs, value chain mapping, and distance to storage or processing facilities). Spatial zoning for agriculture is now becoming more nuanced, with certain agricultural uses contingent on the adoption of conservation management practices. Farmers are increasingly choosing to coordinate across sites to address challenges such as pest control, salinization, and limited availability of irrigation water. Such efforts are being supported by new scientific tools such as spatial modeling of nutrient flows, and by new policy instruments such as nutrient trading systems. The concept of foodsheds has encouraged more systematic spatial analysis of food supplies and value chains around major population centers (Kloppenburg et al. 1996). All of these approaches are beginning to increase the scale at which agricultural management is considered as well as the level of integration among production, conservation, and livelihood dimensions.

Concurrently, conservationists have begun to implement landscape approaches such as biological corridors, landscape-scale conservation planning, and green infrastructure planning to address the challenges of habitat fragmentation and ecosystem degradation in populous regions (Rosenberg et al. 1997, Benedict & McMahon 2006). Many such projects seek to address livelihood needs in concert with biodiversity conservation by engaging private and communal land stewards in transitioning to more conservation-friendly agriculture and livelihood strategies (e.g., Miller et al. 2001). A new generation of multi-objective landscape-scale projects by groups such as WWF and the Wildlife Conservation Society can be seen as a maturation of the ICDP concept to embrace genuine local participation and a broader set of spatial and temporal scales to address the poverty-biodiversity nexus (USFS 2006; Redford & Fearn 2007; COMACO 2009). For instance, the IUCN/WWF Forest Landscape Restoration initiative aims to restore ecosystem goods and services by increasing tree cover in degraded landscapes while engaging stakeholders to address institutional barriers at multiple scales (Barrow et al. 2002; Sayer & Buck 2008). A complementary process for landscape monitoring and adaptive management has also been developed, which uses the Capital Assets Framework (Carney 1998) to track multiple landscape variables and to use this information to aid in participatory decision-making (Sayer et al. 2007).

The preceding examples were of landscape approaches initiated by international NGOs and research centers. However, much of the impetus for landscape-level planning and management emerges from local and regional initiatives. For example, the practice of participatory watershed management arose as an alternative to ineffective top-down watershed planning. In this approach, priorities are negotiated at the watershed scale but implemented at the community level through micro-watershed plans focused on practices such as re-vegetation, soil management, and erosion control (Hinchcliffe et al. 1999; Kerr 2002). More generally, the concept of community-based natural resource management has been widely applied to forest, water, wildlife, rangeland and other common property or state-owned resources to secure tenure rights and support collective management and shared benefits (Borrini-Feyerabend et al. 2000; Leach et al. 1999). At a larger scale, the concept of territorial management has been used to assert local control over rural development processes, including land and resource use. This approach is best developed in Latin America, where it has been applied in the context of indigenous reserves as well as mainstream planning for rural areas (Sepúlveda et al. 2003).

Overall, our analysis revealed many instances of both community-led and externally driven initiatives that met three or four of the characteristics of landscape approaches described above, but relatively few that met all five. Of those cases that exhibited all five characteristics, most were being carried out in forested landscapes where the objective was to reconcile biodiversity conservation and poverty alleviation. To our knowledge, landscape approaches have rarely been applied to areas where cropland or rangeland is a major land use and where food production for a large local population is a central goal.

ECOAGRICULTURE AND THE LANDSCAPE MEASURES APPROACH

The lack of methods and tools for landscape-scale management and monitoring of agroecosystems was a frequent theme at the first Ecoagriculture Conference and Practitioners' Fair in Nairobi in 2004. Many of the researchers, government and NGO representatives, community leaders, donors, and farmers at the meeting were involved in implementing or promoting ecoagriculture—that is, efforts to simultaneously achieve food production, conservation, and rural livelihood goals at a landscape level (McNeely & Scherr 2003; Scherr & McNeely 2008). Conference participants could point to many examples where ecoagriculture principles had been implemented successfully. Yet, their ability to sustain, document, and scale up these successes was limited by the dearth of existing frameworks or processes for planning and monitoring ecoagriculture landscapes. What was needed was a landscape approach that spoke to the particular issues and challenges of ecoagriculture contexts where food production (cropping, livestock, agroforestry, or fisheries) comprises a significant portion of the land base and the local economy.

The Landscape Measures approach (LM), which we describe and illustrate in the remainder of this chapter, addresses this need. Developed as part of Ecoagriculture Partners' Landscape Measures Initiative (LMI), the LM consists of a set of processes and tools for negotiating, planning, implementing, and evaluating ecoagriculture practices and innovations (Buck et al.

2006). Like other landscape approaches, the LM is predicated on stakeholder-driven adaptive management embedded in a social learning process (see **Figure 1**). However, the LM is designed around the four major goals of ecoagriculture: 1) conserving biodiversity and ecosystem services, 2) producing food, 3) improving rural livelihoods, and 4) building effective institutions for cross-sector planning, analysis, and action. As such, the LM includes monitoring tools and methods specifically oriented toward these goals and toward measuring and negotiating the interactions among them.

The Landscape Measures framework

One of the salient challenges of working at a landscape scale is to incorporate the important goals, processes, and dynamics into adaptive management without getting mired in excessive detail and layers of complexity (Lynam et al. 2007). To address this challenge, the LMI conducted a year-long consultative process that engaged scientists and practitioners from diverse disciplines and sectors in conversations about how to track change across multiple dimensions at landscape scale (Buck et al. 2006). One outcome of these conversations was a set of "20 Questions" about landscape performance that represented the key variables that are likely to be important in ecoagriculture landscapes worldwide (Buck et al. 2006; see **Box 2**). The 20 Questions offer tangible criteria for assessing progress toward the four broad goals of ecoagriculture. In turn, stakeholders can answer the questions by selecting and evaluating context-appropriate indicators and means of measure (see **Table 1**). Because many of the 20 Questions focus explicitly on the interactions among conservation, food production, rural livelihoods, and supporting institutions, they can help spur cross-sector dialogue and encourage stakeholders to negotiate tradeoffs among competing interests rather than avoiding such important conversations.

The 20 Questions provide a useful complement to the MDG goals, targets, and indicators for monitoring the performance and sustainability of rural landscapes. Whereas the targets for MDGs 1 through 6 are focused on specific human wellbeing outcomes, the 20 Questions help elucidate some of the ecological drivers that undergird long-term human wellbeing in rural landscapes. In addition, the 20 Questions offer a more detailed framework for monitoring MDG 7 (environmental sustainability) by focusing on local and landscape-scale ecosystem structure and function. The LM thus helps to address recent calls for improved monitoring of ecosystem services in assessing progress toward the MDGs—for example, by tracking soil fertility, hydrological function, and the maintenance of biodiversity, as well as the ways in which local people value, utilize, and sustain such ecosystem services (WRI 2005).

The LM is designed to be used in all phases of the adaptive management cycle, including goal setting, planning, and monitoring (see **Figure 1**):

Goal setting and stakeholder negotiation. The framework and 20 Questions provide a 'roadmap' to landscape multi-functionality, identifying those functions that local and external stakeholders typically expect a landscape to fulfill. In our experience, nearly all of these 20 factors have proven relevant in landscapes across a diverse range of contexts. By providing a broad view of what would constitute successful landscape management, the framework can also help ensure that goals are not skewed too far toward or away from any single interest group. Under-represented stakeholders are given greater legitimacy in negotiations while all participants are encouraged to consider landscape processes or objectives that may be outside their ordinary purview.

Landscape planning. In rural landscapes in developing countries, there is a significant history of spatial planning for single objectives or projects (plantation forestry, large-scale agriculture, conservation networks, and so forth), but much less experience with multi-functional landscape planning (Selman 2002). Such planning can identify and promote synergies among disparate landscape objectives to a much greater degree than sectoral plans that optimize for a single outcome. Essentially, multi-functional landscape planning for ecoagriculture is the process of making the 20 Questions spatially explicit by establishing land and resource use parameters that can be implemented locally. The resulting spatial plans will often have a high proportion of multi-use zones (such as agroforestry or rotational grazing), substantial integration of activities on the landscape, and a relatively fine spatial resolution, reflecting the knowledge-intensive, ecosystem-based management that is proposed (Scherr et al. 2009). Integrated planning can also help ensure that sectoral plans are consistent with broader goals and will register positively against multiple criteria in the LM framework. Although landscape planning requires technical expertise, the process need not be controlled by outside experts; indeed, facilitated multi-objective planning processes can be an effective vehicle for engaging diverse stakeholders to influence management and policy outcomes (Wollenberg et al. 2000).

Landscape monitoring. One constraint to the use of ecosystem-based approaches to poverty alleviation is the inadequacy of environmental monitoring systems in many parts of the developing world (WRI 2005:161). Tracking landscape change requires going beyond project-based evaluation monitoring that focuses on a small set of landscape variables that the project expects to influence. Instead, monitoring should track all key system components such that it can reveal unexpected results of interventions as well as complex interactions of policy or management changes with other landscape dynamics. The LM helps define the scope of landscape monitoring by identifying a series of objectives for which stakeholders can select context-appropriate indicators for measuring progress over time. Data on these indicators then feeds back into the social learning process, expanding the base of information upon which future plans and decisions are made (Sayer & Campbell 2004).

Implementation process

As with other landscape approaches, the LM is implemented through a process of social learning and negotiation among landscape stakeholders to adaptively manage land, natural resources, capital assets, and market and policy structures. Consistent with the multi-scaled nature of landscapes, adaptive management must engage participants at many levels. Local participation and leadership are essential, but external stakeholders and higher-level agencies must also be represented to the extent that they have a legitimate interest in the landscape. Processes that fail to engage external actors who have the will and power to exert significant influence (such as agri-business companies or international NGOs) are naïve and unlikely to be successful. Instead, conflict and trade-offs between local and external interests must be acknowledged and clarified so that negotiation can occur.

Implementation of the LM usually requires a 'landscape facilitator'—individual(s) or organization(s) who work on a systematic and sustained basis to convene stakeholders, guide negotiation, manage information, and promote collective action (Laumonier et al. 2008; Buck & Scherr 2009). Steyaert and Jiggins (2007) define facilitation as "…a combination of skills, activities and tools used to support and guide learning processes among multiple interdependent stakeholders [to] bring about systemic change in complex situations…." Ideally, the landscape facilitator should be a neutral party that is dedicated only to the social learning process itself, as guided by the 20 Questions—not to any specific outcomes. Truly disinterested parties are rarely available as they have little incentive to participate; instead, facilitators are often drawn from the ranks of NGOs and research organizations, which often have a disciplinary or normative bias, if not a deliberate agenda. In these cases, facilitators must be scrupulous in acknowledging their biases and working to subordinate them to the larger process.

One key role of the landscape facilitator is to integrate stakeholders' disparate knowledge systems, data needs, and ways of communicating and using information. Past experience indicates that for scientific information to support sustainable development, greater efforts are needed to bridge the realms of knowledge generation and decision-making by ensuring that information is credible, salient, and legitimate to decision makers (Cash et al. 2003; Dietz et al. 2003). Yet, farmers, government agencies, and international donors each have very different conceptions of credibility, salience, and legitimacy. Furthermore, knowledge of rural landscapes can be rooted in many different epistemologies. Landscape level innovation systems integrate experiential or 'tacit' knowledge—gained by people who live in the landscape and are intimately familiar with aspects of its workings over time—with evidence of phenomena that are revealed through scientific inquiry and likely to be less visible to local people. Combining these approaches can provide a richer understanding of the landscape, and one that is credible to local and external stakeholders alike (Bell & Morse 2001).

Although the LM is predicated on significant coordination among sectors and scales in rural landscapes, the goal is not to establish a centralized landscape 'secretariat' but rather a web of activity nodes that are knit together by shared purpose, shared information, and dedication to evidence-based decision making. These nodes come together from time to time to negotiate and establish broad-level goals, formulate plans, identify needed collaborations, and share monitoring results to understand the interactive effects of different projects and programs on the landscape. Actual management and policy interventions are carried out at a range of scales—from the household to the region or beyond—but these interventions occur within the context of the landscape planning and monitoring process (see **Figure 2**).

Ecologically-based tools for implementation

To aid in the implementation of the LM, we assembled, developed, and tested a set of tools for landscape planning and monitoring. These are described in an online portal for practitioners known as the Landscape Measures Resource Center (LMRC) (LMI 2009). Some of the more promising tools draw on recent thinking in the field of ecology to quantify the performance and resilience of rural land-use systems to advance conservation, food production, and livelihood goals. Given this book's focus on the contribution of ecology to rural development, here we highlight some of the LMRC monitoring tools in which ecological science offers an especially valuable perspective.

As discussed above, a key challenge of multi-stakeholder adaptive management is to bridge different types and uses of knowledge by different landscape actors. One way to do so is through landscape monitoring programs that incorporate both scientific and community knowledge (Place & Were 2005). For example, several of the methods in the LMRC combine social learning with scientifically rigorous sampling and analysis methods to add external credibility to community-generated datasets while bringing local relevance to monitoring data demanded by outside donors and program evaluators. A second challenge is to generate sufficient knowledge about multi-faceted landscape systems with limited funding and personnel resources. We therefore advocate approaches that derive additional value from existing monitoring efforts, employ participatory monitoring, and take advantage of new low-cost data collection and analysis tools.

One such method—repeat ground-based photo-monitoring—can be a cost-effective way to track changes in vegetation and land use when aerial imagery is unavailable or unaffordable (Lassoie et al. 2006). In this method, scientists use stratified sampling to establish points throughout the landscape from which digital photographs are taken in all directions. The photos are analyzed according to a standard protocol that yields quantitative descriptors, which are entered into a database. As the photo points are re-visited over the course of months and years, the data begin to reveal trends in land use, agricultural management, vegetation condition, and other factors. The digital photographs themselves can be taken by local people, providing a credible and easily interpretable data source for household- and village-level adaptive management while generating 'research quality' data through systematic aggregation across the network of photo points. More generally, participatory monitoring and evaluation can often yield data that are widely credible if it follows a scientifically designed protocol (Bonney et al., unpublished manuscript).

A second method in the LMRC toolkit achieves the opposite type of knowledge transfer, taking data that are collected for external evaluators and making them relevant to local land stewards to use in adaptive management. On eco-certified farms throughout the world, large amounts of data are collected annually to meet the auditing requirements of various certification systems. Yet much of this information is filed away, never to be used by land stewards in the service of improved management. For these data to be useful to landscape stakeholders, they must be entered into appropriate information systems, aggregated, analyzed, and communicated effectively. For example, monitoring data on agrochemical usage, cover cropping, or soil erosion potential could be spatially plotted in a geographic information system (GIS) to visualize trends across space and time. This information could then be combined with downstream water quality monitoring data to track the relationship between on-farm practices and watershed-level ecosystem services. Again, approaches from the field of ecology can be used to help establish appropriate sampling protocols, aggregation methods, and analysis techniques.

Central to the LM is the use of integrative indicators that provide answers to several of the 20 Questions at once. An important integrative indicator in almost every landscape is the composition and configuration of land use and land cover. Basic land cover maps can be created by interpreting aerial imagery or by compiling data from field surveys or repeat ground-based photography. Maps can then be analyzed quantitatively to derive key measures of composition (e.g., area under native forest) and structure (e.g., degree of interspersion of complementary or conflicting land uses). Often, these measures can be further extrapolated to estimate outcomes related to food production, species viability, hydrological functions, and other key landscape parameters.

Given the great interpretive power of such composition and structure measures, landscape design principles have been proposed as heuristics for maintaining ecological integrity in the context of endeavors such as regional planning (Forman 1995; Dramstad et al. 1996; Lindenmeyer et al. 2008) and agroecosystem management (Fischer et al. 2006; Harvey 2008). We believe that similar principles and proxies could be developed for other objectives of landscape multi-functionality, including increased agricultural production, decreased disease burden attributable to environmental factors, and other goals related to the long-term fulfillment of the MDGs. Recent work on ecosystem service mapping has begun to relate landscape composition, ecological integrity, livelihood potential, and economic value in a spatially explicit manner (e.g., Troy & Wilson 2006; Egoh et al. 2008). These efforts suggest how GIS-based analyses can be used to track many of the 20 Questions with relatively fine spatial and temporal resolution.

A final tool that we wish to highlight is the use of systems dynamics modeling—computer applications that allow a user to simulate complex systems by tracking numerous interacting variables over time (Sterman 2000). Although system dynamics modeling is based on a mechanistic view of systems, its great advantage is that it can account for much higher levels of complexity than is possible through human intuition and *ad hoc* methods, making it valuable for landscape approaches. Key applications include understanding causal relationships in the landscape, identifying high-leverage 'pressure points' for landscape change, determining thresholds at which dramatic changes may occur, exploring alternative scenarios through participatory modeling, and measuring the success of interventions by comparing actual landscape outcomes to simulated outcomes under alternative management programs (Campbell et al. 2001; Sandker et al. 2007).

CASE STUDY 1: APPLYING THE LANDSCAPE MEASURES APPROACH IN COPAN, HONDURAS

The Copan case study illustrates the application of the Landscape Measures framework to conduct a broad-reaching baseline evaluation of landscape conditions, elucidate and prioritize community needs, and track progress toward all four ecoagriculture goals. Honduras currently has the highest poverty rate in Central America (70%) and ranks 115 out of 170 countries globally in the index of human development (Programa Estado de la Nación 2008). The Copan region is somewhat insulated from the worst poverty due to the significant tourism revenue associated with local Mayan ruins. Ironically, however, the most impoverished landscape residents remain the Chorti Maya, whose ancestors built these temples. As such, the landscape contains a diverse mix of stakeholders, ranging from wealthier landowners concentrated around the colonial town of Copan Ruinas—whose income is principally drawn from ecological and cultural tourism—to coffee and cattle farmers and the *campesinos* they hire to work their lands, to the Chorti Maya, who are largely segregated from the Mestizo majority and work as farm laborers or depend on subsistence agriculture.

As discussed earlier, Copan already has some institutional capacity for carrying out landscape approaches to natural resource management and community development. A regional governing body known as the MANCOSARIC represents the watershed's four municipalities and works to improve basic human services while facilitating adaptive co-management with an emphasis on improving flows of ecosystem services and reducing risks from natural hazards such as flooding and landslides. The MANCOSARIC also helps empower local governments to take responsibility for natural resource stewardship through integrated watershed management.

In 2007, the MANCOSARIC and its partners decided to implement the Landscape Measures approach and the 20 Questions to provide a baseline evaluation of the watershed that would help them understand the current status of the landscape, identify priorities, and refine current landscape management plans. The landscape was particularly suitable for such evaluation because of the existence of the MANCOSARIC governing body, which was well positioned to utilize the information generated. The evaluation also promised to offer a wider perspective on the region and a staring point for initiating critical discussion on stakeholder priorities.

The baseline evaluation conducted by Bejarano (2009) was designed to synthesize useful information from pre-existing studies while generating strategic new data to answer some of the 20 Questions deemed most critical by local stakeholders. Consistent with the Landscape Measures approach, many landscape performance measures were derived or extrapolated from land use patterns and dynamics. In this regard, the MANCOSARIC was fortunate to have a 1-meter resolution IKONOS satellite image of the landscape taken in 2007 that was classified into land uses at the plot scale (Sanfiorenzo 2008). This land use map provided a foundation for much of the landscape evaluation, allowing stakeholders to analyze information on production, conservation and livelihood indicators in a spatially explicit manner to understand where interventions and improvements were most needed.

One application, for example, was the interpretation of land use patterns to estimate the provision of ecosystem services throughout the watershed (see **Figure 3**). While land use is not a precise proxy for such services, prior study has yielded enough information on the relationships between land use, biodiversity conservation, and carbon storage to help identify hotspots where ecosystem services have been eroded and where restoration efforts could address both conservation and livelihood goals. The spatially explicit nature of these maps facilitates negotiation by identifying specific property owners and municipalities that could benefit from interventions.

While landscape composition and structure metrics were an important part of the landscape evaluation, it was critical to supplement these measures with household interviews and plot-level field studies to answer many of the 20 Questions. For example, one of the surrogate measures for Conservation criteria 1 and 3 (Box 2) was to ask farmers when they had last seen a wild deer. Representative patches of each forest type in each community were also surveyed to evaluate vegetation structure and evidence of degradation from grazing, timber or fuelwood extraction, and other human interventions. This study indicated that forests are more degraded in Cabañas—where the economy is heavily based on natural resources—than in Copan Ruinas, a larger town with a more diversified economy.

The evaluation of livelihood indictors was primarily based on household interviews (45 per municipality), but these were spatially stratified and located with GPS coordinates to allow spatially explicit analysis of the relationships among multiple goals. Interviews revealed household members' education levels, production activities, agricultural yields, farm income, total income, and other factors. Results were integrated with those from earlier household surveys focusing on farm-level conservation practices and access to water and energy resources. Both sets of interviews also assessed the degree to which local social service and resource management entities were providing households with services, training, or sharing of ideas—or even the degree to which farmers were aware of relevant projects. These data helped define the effectiveness and sphere of influence of local institutions relative to their mission and objectives. The data also revealed spatial patterns of wealth and poverty—including both current income and capacity to improve and adapt household livelihood strategies. Again, the evaluation documented greater levels of poverty and need in the more resource-dependent communities outside of the tourism nexus (and MANCOSARIC headquarters) in Copan Ruinas.

The landscape evaluation reported answers to each of the 20 Questions individually but also amalgamated outcomes into the four basic 'axes' of ecoagriculture to help frame stakeholder discussion about landscape priorities (see **Figure 4**). This type of synthesis is rife with challenges and value judgments (How do you weigh each indicator? Can landscape outcomes be traded off against each other, or must some or all objectives be met at a basic level?). But rather than forming an insurmountable barrier, such value questions can provide a starting point for dialogue about synergies and tradeoffs among disparate objectives.

In addition to providing a baseline assessment of landscape performance, the evaluation also explored various policy alternatives for improving outcomes to several of the 20 Questions. Framing policy analysis in terms of the 20 Questions is an alternative to sectoral analyses that predict the direct results of interventions while ignoring their indirect or feedback effects. For example, Sanfiorenzo (2008) conducted landscape modeling to evaluate the effects on biodiversity of proposed policies for reducing erosion, landslides, and water pollution in the landscape, which hinder progress toward several of the MDGs. A baseline analysis evaluated forest patch size, fragmentation, and functional connectivity of the existing landscape from the perspective of the genus *trogon*—forest dependent birds that are also highly sought after by ecotourists. Existing forest cover in the landscape was both limited (comprising only 22% of the 680 km^2 landscape) and highly fragmented into 145 isolated patches. Sanfiorenzo (2008) then evaluated the effects of three potential possible policies: 1) enforcing the Honduran law to protect 10-meter forested buffers alongside all rivers and streams, 2) converting steep slopes (14-40%) to agroforestry systems such as shaded coffee or pasture with high tree density, and 3) revegetating all very steep slopes (>40%) to natural forest or timber plantations. The models revealed that riparian buffers would decrease the number of isolated forest fragments from 145 to less than 40, while the three policies in combination would increase suitable trogon habitat from 22% to 38% of the landscape. The analysis not only sheds light on several of the 20 Questions (e.g., C1, C4, P4, L3, and L5); it also identifies the most promising target areas for restoration.

Reflecting on the LM evaluation in Copan, the approach at first glance seems similar to standard assessment methods—such as Rapid Rural Appraisal—that combine interviews and other forms of baseline data collection to identify needs and priorities. However, on closer examination, several key differences emerge. One is the use of an integrative framework to steer communities and field technicians to consider the possible importance or feedback effects of issues that have been neglected locally. Second is an emphasis on land use and landscape patterns as durable—though manageable—underlying drivers of many of the socioeconomic themes that are often the focus of rural appraisals. Third is a focus on quantitative indicators that can be readily and cost-effectively measured on a regular basis to track both the direct and indirect effects of landscape interventions, as well as the feedbacks between these interventions and exogenous policy and market forces. Based on the cost of the initial assessment, we estimate that repeating LM evaluations every 2-3 years as part of a landscape planning and adaptive management program would cost $50,000 to $70,000. As the MANCOSARIC has learned, however, such up-front investment can pay for itself many times over by helping to attract and target foreign assistance to communities that have a clear vision for the future and understand which projects and interventions will help them achieve this vision.

CASE STUDY 2: APPLYING THE LANDSCAPE MEASURES APPROACH IN KIJABE, KENYA

The second case study documents the use of the 20 Questions and two participatory evaluation tools within the Landscape Measures Resource Center as a basis for initiating dialogue about landscape dynamics and priorities. The case takes place in the Kijabe landscape on the eastern slopes of the Aberdare Mountains, just northwest of Nairobi, Kenya. Here lies the Kikuyu Escarpment Forest, a hotspot for plant and bird diversity that is also the watershed supplying water to more than a million of Nairobi's inhabitants. The landscape is a mosaic of ancient forests, tree plantations, and diverse agricultural plots, supporting a mixed agricultural economy and extensive tea production. However, recent population growth had led to increased pressure on the forest: cattle and sheep were killing seedlings, residents were cutting wood for charcoal production, and illegal loggers were exploiting the forest.

Recognizing the dependence of local livelihoods on the health of the forest, local leaders, with financial support from BirdLife International, established the Kijabe Environmental Volunteers (KENVO) to educate, train and support local residents in forest conservation and restoration efforts. KENVO began with a seedling initiative that organized landscape residents to plant and protect native trees to restore the ailing forest. By raising and selling the trees to KENVO, women and youth groups were able to earn income while supplying their farms with useful agroforestry trees. Meanwhile, a growing contingent of innovative farmers was building on KENVO's ideas by diversifying and intensifying their production systems to integrate small animals, bees, and fish farming and by utilizing organic wastes to enhance soil fertility. As these farmers increased their incomes and were able to realize prized education and health benefits for their families, others took notice and the ideas began to spread.

By 2007, KENVO had enjoyed significant success, ridding the area of illegal loggers and spawning numerous community-led forest restoration groups where none had existed before. KENVO's founder, David Kuria, remarked on residents' deep pride in these achievements but emphasized that "for conservation in this area to succeed, communities must continue to benefit."

Participatory landscape evaluation

In this context, KENVO was interested in using the Landscape Measures approach to re-assess its strategic direction and provide local stakeholders a forum in which to express their needs and priorities. For its part, Ecoagriculture Partners' Landscape Measures team sought to apply and evaluate the 'landscape performance scorecard' and 'institutional performance scorecard' tools, which it had recently designed for a Ugandan landscape with similar land use and livelihood dynamics. Both scorecards are based on the 20 Questions and offer a format for discussion and participatory evaluation of these questions to initiate dialogue on landscape dynamics.

KENVO convened a group of 22 stakeholders for a five-hour workshop at its strategically-located office and meeting space in the landscape. About two-thirds of the participants were farmers, while others represented public agencies of forestry and natural resources, agriculture and livestock, and social services as well as leaders of church groups and other local organizations. KENVO's multi-lingual professional staff issued the invitations, arranged for teas and lunch to be provided, and co-led the workshop with Landscape Measures Initiative (LMI) staff. The LMI team prepared color-coded copies of scorecards, data capture forms, and written instructions for the exercise.

The group began by translating each of the 20 Questions (see **Box 2**) into terms that made sense in the Kijabe landscape, a process that involved discussing various local examples that were meaningful to participants. Next, each participant filled out a copy of the landscape performance scorecard, which required evaluating each question on a five-point scale for the Kijabe landscape. The group then prepared for the institutional scoring exercise by brainstorming to identify all public, private, civic, or hybrid organizations that they considered to have an effect on the landscape's current status and future direction. Using a similar scorecard format, participants scored each institution based on its fulfillment of its mission and its contribution to the objectives articulated in the 20 Questions. The meeting facilitators entered all scorecard data into a Microsoft Excel data capture form, computed summary results, and generated illustrative spider diagrams of the results, all of which were projected for the group to view. Discussion ensued about the results and what they implied about the landscape's current balance among conservation, food production, and livelihood performance. Following the meeting, a group of Kenyan participants met with the LMI team to review the workshop process, assess the relevance and usability of the scoring tools, and determine whether the landscape perspective was helpful or viewed by participants as abstract and irrelevant.

Outcomes of the landscape evaluation

The landscape evaluation process exceeded the expectations of KENVO and the LMI team in three respects. First, the level of engagement and application of participants' knowledge to the tasks at hand were impressive and inspiring. Participants devoted much more time and effort to the institutional scoring than we had anticipated, producing an institutional map of the landscape that KENVO and its members have used subsequently in publications, presentations, and discussions with collaborators.

Second, the exercise stimulated creative thinking and discussion about strategic new directions for KENVO's activities. For example, the landscape scorecard made evident the fact that Kijabe was performing better with respect to conservation goals than livelihood goals. Reflecting on this result, participants realized that recent external investment in the landscape had been driven for some time by the agendas of conservation groups whose aims were to restore forest habitat for wildlife. While participants were proud of their conservation achievements, they articulated a need to pursue parallel improvements in food production and livelihood security. This discussion generated a list of concrete steps toward which the group agreed to organize, including improving farmers' access to markets for specialty products and securing credit for new enterprises. Results of the institutional scoring exercise stimulated participants to target private sector organizations—particularly companies dealing in agricultural products—for recruitment into KENVO's activities. They also used the newly-created institutional map to explore the potential of linking organizations to create agri-eco-tourism enterprises that would benefit entrepreneurs and the community by taking advantage of the landscape's strategic location and dramatic views into the rift valley.

A third outcome of the exercise was KENVO's decision to invest in the development of additional tools and analyses for assessing landscape performance and promoting 'landscape literacy' among residents and stakeholders. This decision stemmed partly from a growing realization—supported by the landscape scoring process—that important conservation benefits and other ecosystem services were being provided in the agricultural mosaic itself, not just in the Kikuyu forest. With encouragement and a modest seed grant from Ecoagriculture Partners, KENVO's leaders generated sufficient resources to commission the National Museums of Kenya to conduct a biodiversity inventory in the agricultural portions of the landscape to complement the previous inventory of the forest. KENVO also commissioned a socio-economic study of farming households to increase their understanding of local livelihood strategies and generate baseline information against which change could be measured over time. And KENVO worked with the Ecoagriculture Working Group at Cornell University to create a land use/land cover map that they could used to communicate with residents about land use dynamics and opportunities for forest restoration to provide conservation and livelihood benefits.

Conclusion

The post-workshop evaluation revealed that the landscape and institutional scoring tools—and the process by which they were implemented—were relevant and worthwhile. Participants were visibly engaged throughout the workshop and contributed impressive knowledge and insight from their individual perspectives. The discussion and use of the scorecards ran smoothly, with no apparent confusion, and the resulting baseline evaluations were judged to be credible by the people and organizations who participated. At the same time, however, the landscape evaluation did not merely reiterate what participants already knew. New information was brought forward through the multi-stakeholder forum and, more importantly, participants were able to organize and understand existing knowledge in new ways that made the trajectory, opportunities, and threats in the Kijabe landscape more apparent. This new understanding helped generate ideas about KENVO's future priorities for landscape level planning and management while solidifying KENVO's commitment to continuing to invest in strategic landscape information to support such planning and management. A further measure of impact, to be assessed later, would be KENVO's repeat use of the scorecard tools to evaluate changes in landscape performance attributable to its programs and to other factors.

TOWARD MAINSTREAMING OF LANDSCAPE APPROACHES

The case studies from Honduras and Kenya illustrate the ways in which landscape-scale negotiation, planning, and monitoring will be crucial for meeting the MDGs on a sustained basis in rural landscapes. As documented in this chapter, landscape approaches have begun to be used in recent years, but further work is needed to continue to develop the science and practice of multi-stakeholder, multi-objective adaptive management at the landscape scale. Mainstreaming landscape approaches will also require the adoption of favorable policy, market, and institutional frameworks at the national and international levels. Many of these changes will entail substantial re-allocations of power, authority, and resources, and could take years or decades to achieve. Key actions needed to support landscape approaches include:

1) Shift power over land and resource management to landscape-level institutions that have (or can develop) the capacity to carry out such management. Continued devolution of government authority will be an important part of this process in many countries.

2) Legitimize and provide sustained support for multi-stakeholder processes in landscapes. Re-orient government line agencies toward a service role in which they provide technical resources and facilitation for these processes and subsequently incorporate landscape-level goals and plans into agency priorities and programs. Recognize roles for business, NGOs, farmers' organizations and citizen groups in implementing action and tracking progress based on these plans.

3) Expand opportunities for training and knowledge sharing around landscape-scale analysis, planning and monitoring, moving beyond fixed-curriculum extension to include

demand-driven programs and peer-to-peer networks, with learning across sectors. Support action learning through partnerships between practitioners and researchers.

4) Clarify and adjust land and resource tenure arrangements so that households and communities are motivated and able to implement concepts or plans that emerge from landscape-level adaptive management processes.

5) Create more equitable approaches to the governance of natural resources so that corporate and government interests are required to participate in multi-stakeholder planning processes rather than shortcutting such negotiations through inside channels. This applies to both common-pool resources such as forests and oceans and privately-owned resources whose management affects public goods like water supply and biodiversity.

6) Eliminate market-distorting policies and subsidies that hinder evidence-based management of water, soil, crops, and land use. Establish markets for ecosystem services to internalize externalities associated with the management of rural landscapes, and encourage public and private procurement of agricultural products from farmers using ecoagriculture practices.

7) Re-align the priorities of government agencies, donors and NGOs to incorporate environmental sustainability and ecosystem management into agricultural and rural development programs, and to track human welfare in a way that accounts for the stocks and flows of natural capital that support rural livelihoods.

Historically, the link between environmental sustainability and the wealth of rural communities has been widely ignored or neglected, especially in the fertile, productive landscapes that supply much of the world's food. Technological innovations, inexpensive farm inputs, large subsidies from nature, and the relief valve of the agricultural frontier have all held crisis at bay in many rural landscapes. Going forward, however, we expect this picture to change. As population pressures mount, suitable vacant land diminishes, and productivity gains from technological innovation plateau in post-Green Revolution areas, healthy ecosystems will become increasingly fundamental to human wellbeing. As the margin of error for meeting livelihood needs in rural landscapes shrinks, the demand for effective landscape approaches will grow. Acting now to develop the science, the tools, and the institutional support mechanisms for landscape-scale adaptive management will ensure that such processes are fully functional at the time they are most needed.

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Box 1. Why use a landscape perspective to address food security and rural poverty?

The reasons for working at a landscape scale stem not only from the biophysical realities of how natural resource-dependent systems function, but also from the growing interdependence and interconnectedness of rural regions. Motivations include:

1. **Scale of key ecological functions and processes.** Recent scientific research has demonstrated that flows of water, nutrients, sediment, plants, animals, and disease organisms in agricultural regions often operate beyond the farm or village level to encompass the entire landscape (Forman 1995). Many of these flows are critical to human wellbeing, providing ecosystem services such as clean water for human consumption, irrigation water, and natural pest control. Major threats, such as insect-borne diseases, crop and livestock predation, and various natural disasters, are also mediated at the landscape scale.

2. **Scale of key institutional frameworks.** In many developing nations, government authority and social programs have been devolved to smaller units of government operating at the district level (Molnar et al. 2007). At the same time, villages, communities, and NGOs are increasingly forming partnerships, networks, and alliances to addressed shared objectives (Pretty & Ward 2001). Both trends create opportunities to analyze and address challenges at a landscape scale. Conversely, inaction or ineffective policies at the landscape or sub-regional levels can keep rural households mired in "poverty traps" even when effective action is taken at the farm or village scale (Barrett & Swallow 2006). Thus meso-scale institutional arrangements are especially important in determining whether rural communities can spring out of self-reinforcing poverty traps.

3. **Changing face of the rural agricultural economy.** Throughout the world, the role of subsistence farming is in decline, while market-linked agriculture becomes more widespread, even among small farmers. This trend is being reinforced by development and aid agencies, many of whom emphasize market access and rural enterprise development in their programs (WRI 2008). As rural communities become more tied to one other, more dependent on physical infrastructure and regional markets, and more influenced by global economic forces, it is necessary to widen the lens through which rural livelihoods are understood and advanced.

4. **New market opportunities.** Markets are beginning to place value on rural land uses that

protect or enhance ecological values. Eco-certification allows producers to receive price premiums for ecologically friendly production practices, while payments for ecosystem services compensate land stewards for protecting carbon stocks, biodiversity, or watershed functions. These new market opportunities will shift incentives for rural land managers and motivate a greater focus on management at the landscape or watershed scale, where many ecosystem services are mediated.

5. **Climate change.** Resulting largely from anthropogenic forcing mechanisms, climate change is occurring faster and more dramatically than at any time in recent history. Without greater emphasis on resilience, adaptation, and regional cooperation to accommodate shifting patterns of agricultural suitability, water availability, and habitat quality, these rapid climate shifts could easily undermine local development or conservation successes (Fairhead 2004).

6. **Increased emphasis on resilience and adaptation.** The reality of climate change combined with ecologists' recognition of ecosystems as dynamic, non-equilibrium systems has led to an increased interest in resilience and adaptation as important objectives for rural landscapes (Sayer & Campbell 2004). As population growth and ecosystem degradation combine to create increasingly thin margins of error for human wellbeing in many landscapes, the ability to re-evaluate circumstances and adapt management solutions based on new information will be critical for human wellbeing (Diamond 2004). Doing so requires the continual development and use of knowledge at appropriate scales within an adaptive management framework (Röling & Wagemakers 1998; Plummer & Armitage 2007).

Box 2. Twenty questions for assessing the performance of ecoagriculture landscapes.
Conservation Goal: The landscape conserves, maintains, and restores wild biodiversity and ecosystem services.
Criterion C1: Does the landscape contain an adequate quantity and suitable configuration of natural and semi-natural habitat to protect native biodiversity?
Criterion C2: Do natural and semi-natural habitats in the landscape approximate the composition and structure of the habitats historically found in the landscape?
Criterion C3: Are important species within the landscape biologically viable?
Criterion C4: Does the landscape provide locally, regionally, and globally important ecosystem services?
Criterion C5: Are natural areas and aquatic resources degraded by productive areas and activities?
Production Goal: The landscape provides for the sustainable production of crops, livestock, fish, forests, and wild edible resources.
Criterion P1: Do production systems satisfy demand for agricultural products (crops, livestock, fish, wood) by consumers inside and outside the landscape?
Criterion P2: Are production systems financially viable and can they adapt to changes in input and output markets?
Criterion P3: Are production systems resilient to disturbances, both natural and human?
Criterion P4: Do production systems have a neutral or positive impact on wild biodiversity and ecosystem services in the landscape?
Criterion P5: Are species and varietal diversity of crops, livestock, fisheries and forests adequate and maintained?
Livelihoods Goal: The landscape sustains or enhances the livelihoods and wellbeing of all social groups who reside there.

Criterion L1: Are households and communities able to meet their basic needs while sustaining natural resources?
Criterion L2: Is the value of household and community income and assets increasing?
Criterion L3: Do households and communities have sustainable and equitable access to critical natural resource stocks and flows?
Criterion L4: Are local economies and livelihoods resilient to change in human and non-human population dynamics?
Criterion L5: Are households and communities resilient to external shocks such as flooding, drought, changes in commodity prices, and disease epidemics?
Institutions Goal: The landscape hosts institutions that support the planning, negotiation, implementation, resource mobilization, and capacity-building needed to integrate conservation, production and livelihood functions.
Criterion I1: Are mechanisms in place and functioning for cross-sectoral interaction at landscape scale?
Criterion I2: Do producers and other community members have adequate capacity to learn and innovate about practices that will lead to integrated landscapes?
Criterion I3: Does public policy support integrated landscapes?
Criterion I4: Are market incentives conducive to integrated landscapes?
Criterion I5: Do knowledge, norms, and values support integrated landscapes?

Source: Buck et al. 2006; LMI 2009.

Table 1. Hierarchical framework of the Landscape Measures approach (LM) for identifying and tracking progress toward landscape objectives. Similar to other recent methods for landscape evaluation (e.g., CIFOR 1999; LAC-Net 2006), this hierarchical approach helps ensure that all major system components are considered while leaving room to interpret these components in relation to the landscape's specific biophysical and socio-cultural context.

Hierarchical level	Selection process	Description
Goals	Universal; part of the LM framework	Comprises the four broad goals of ecoagriculture: sustainable food production, viable rural livelihoods, conservation of biodiversity and ecosystem services, and effective supporting institutions.
Criteria	Universal; part of the LM framework	The 20 Questions, which enumerate five specific sub-goals for each of the four ecoagriculture goals.
Indicators	Place-specific; selected by stakeholders	Tangible factors or characteristics in the landscape that are measured to reveal how well each criterion is being fulfilled. Stakeholders select indicators that are relevant to the landscape context and to their specific objectives.
Means of measure	Place-specific; selected by stakeholders	Methods or techniques for evaluating indicators, such as land cover analysis or household interviews. Stakeholders select means of measure that are appropriate to the desired level of precision and availability of monitoring resources.

Figure captions

Figure 1. Key roles of the Landscape Measures approach (LM) for guiding adaptive management for food production, conservation, and livelihoods in rural landscapes. The standard adaptive management cycle is depicted in gray, while key LM processes and tools for each phase of the cycle are shown as black ovals.

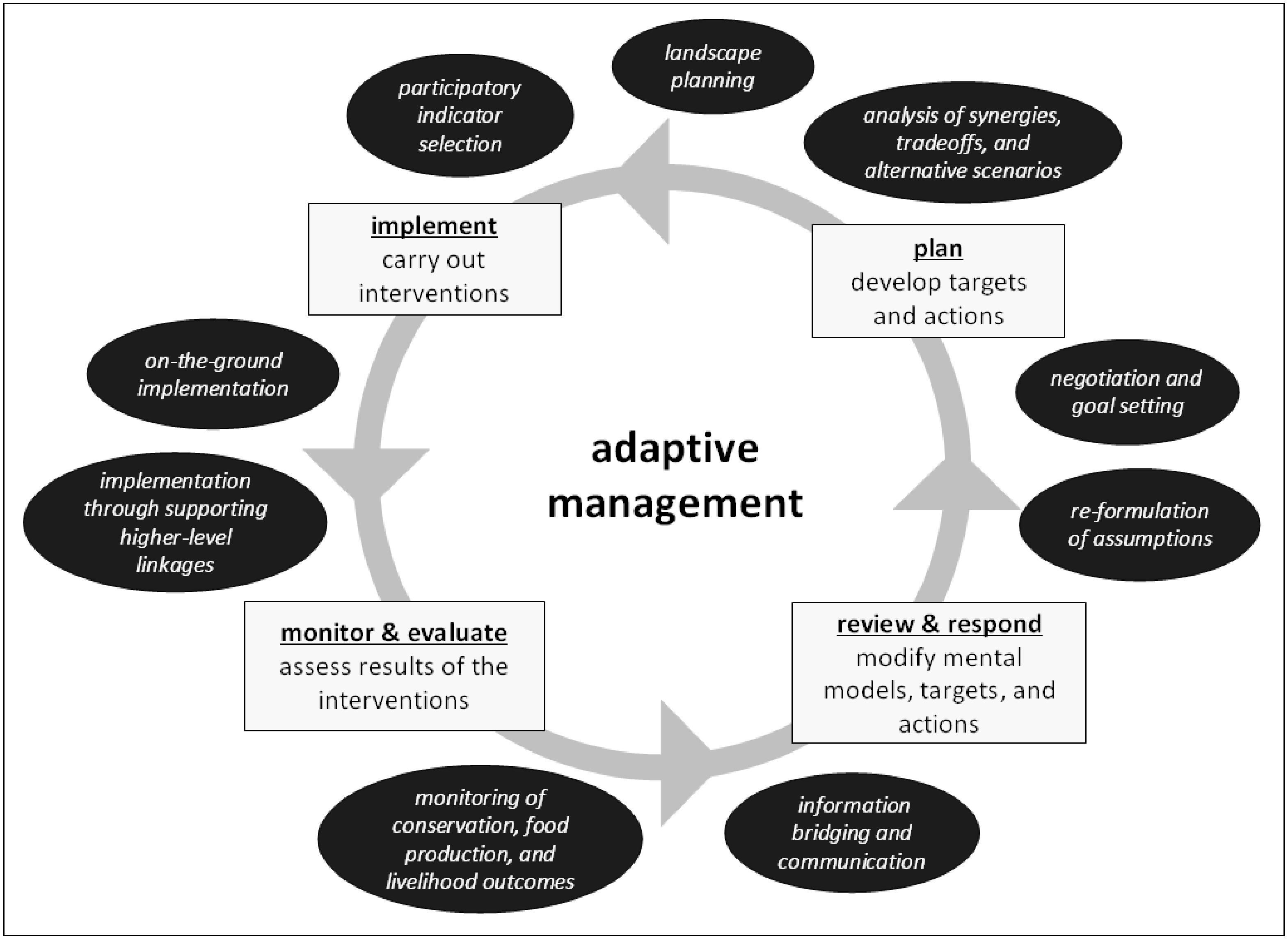
Figure 2. Idealized representation of the interactions among stakeholder groups in the Landscape Measures approach (LM). Moving from left to right in the diagram: (1) A wide range of actors—operating at multiple scales—have a stake in rural landscapes. Many of these groups are already linked to each other through social networks, joint projects, and so forth, and the LM can strengthen or augment such linkages. (2) These diverse actors come together to participate in the LM under the auspices of a landscape facilitator. Negotiation and social learning supported by technical analysis lead to the formulation of an integrated, multi-functional landscape plan. (3) Landscape actors then incorporate information, insights, and agreed-upon goals and objectives from the broader LM process into their geographically- and sectorally-focused activities, programs, and plans. These activities are implemented on the ground and communicated to stakeholders operating at other scales (especially donors and policy makers). Over time, the relationships depicted here are sustained and strengthened in an iterative process, while the resulting plans and activities are frequently revisited in light of new circumstances, new priorities, and new landscape monitoring data.

Figure 3. Current status of the provisioning of carbon sequestration (a) and biodiversity conservation (b) in the Copan landscape based on estimates of the capacity of each land use to provide each of these ecosystem services. The highest ecosystem service values are shown in green, intermediate values in pink, and lower values in red. Indices of carbon sequestration and biodiversity conservation were adapted from Murgueitio and colleagues (2004).

Figure 4. Spider diagram indicating current conditions in each of the four municipalities in the Rio Copan watershed with respect to each of the four principle axes of ecoagricultural development (food production, conservation, livelihoods and institutional support). These indices are derived from mixed methods including household interviews, ecological field sampling, and land use analyses, as described in the text. The diagram provides a simplified performance evaluation to help assess progress toward community goals, set priorities for future projects, and

evaluate progress over time. Abbreviations in the figure refer to the names of the four municipalities: SR = Santa Rita, SJ = San Jerónimo; CR = Copan Ruinas; CA = Cabañas.

Figure 1



landscape planning
participatory indicator selection
analysis of synergies, tradeoffs, and alternative scenarios
implement
carry out interventions
plan
develop targets and actions
on-the-ground implementation
negotiation and goal setting
adaptive management
implementation through supporting higher-level linkages
re-formulation of assumptions
monitor & evaluate
assess results of the interventions
review & respond
modify mental models, targets, and actions
monitoring of conservation, food production, and livelihood outcomes
information bridging and communication

Figure 2

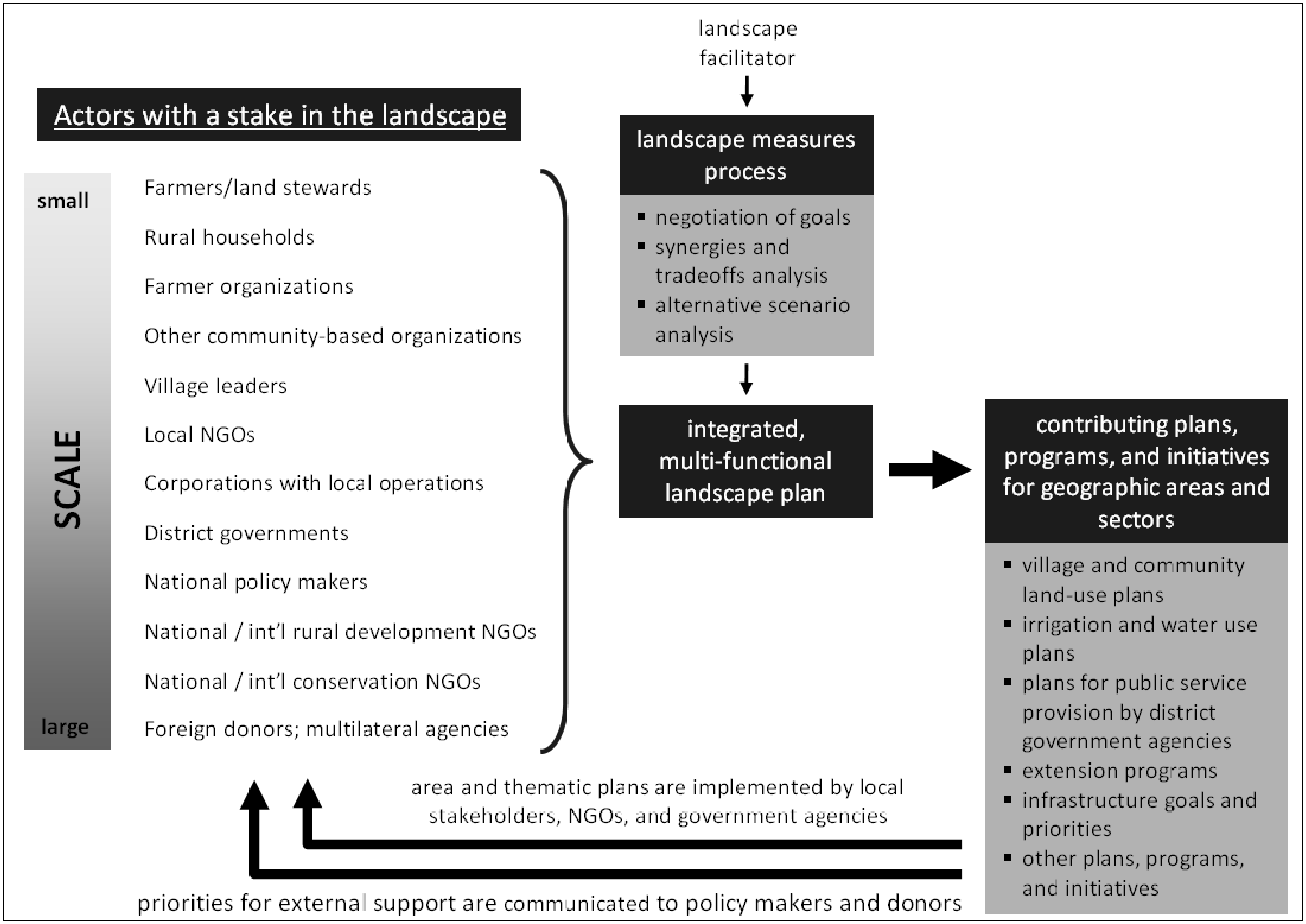
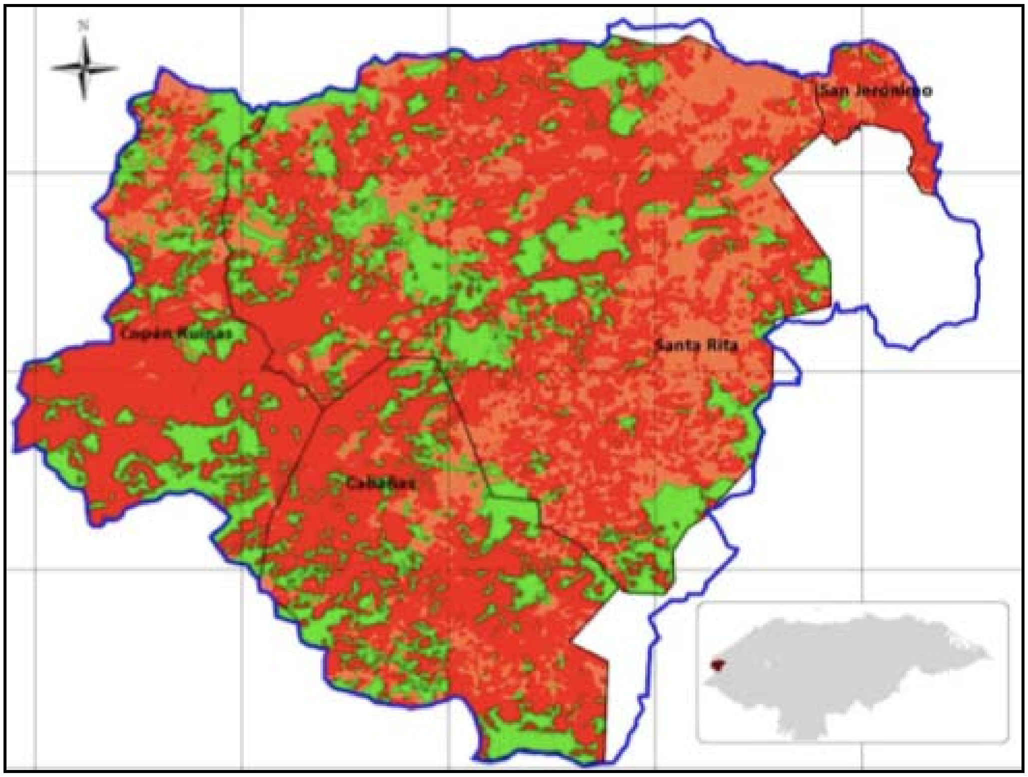

landscape facilitator
Actors with a stake in the landscape
small
SCALE
large
Farmers/land stewards
Rural households
Farmer organizations
Other community-based organizations
Village leaders
Local NGOs
Corporations with local operations
District governments
National policy makers
National / int'l rural development NGOs
National / int'l conservation NGOs
Foreign donors; multilateral agencies
landscape measures process
negotiation of goals
synergies and tradeoffs analysis
alternative scenario analysis
integrated, multi-functional landscape plan
contributing plans, programs, and initiatives for geographic areas and sectors
village and community land-use plans
irrigation and water use plans
plans for public service provision by district government agencies
extension programs
infrastructure goals and priorities
other plans, programs, and initiatives
area and thematic plans are implemented by local stakeholders, NGOs, and government agencies
priorities for external support are communicated to policy makers and donors

Figure 3

a)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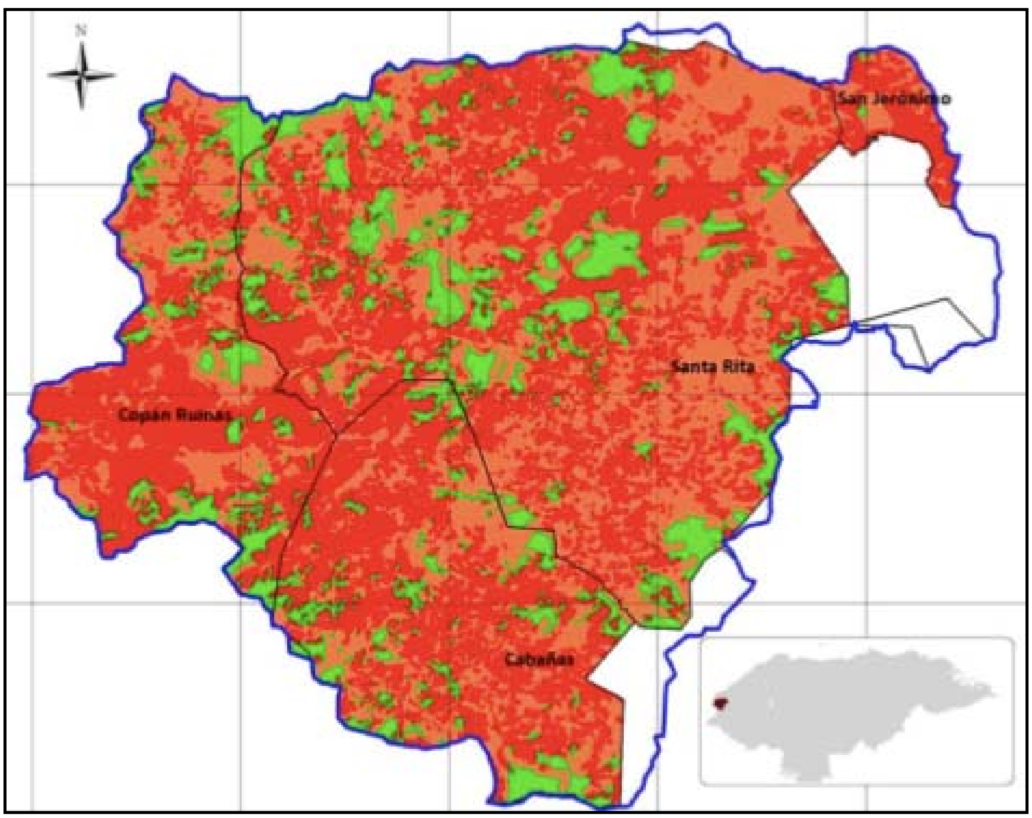
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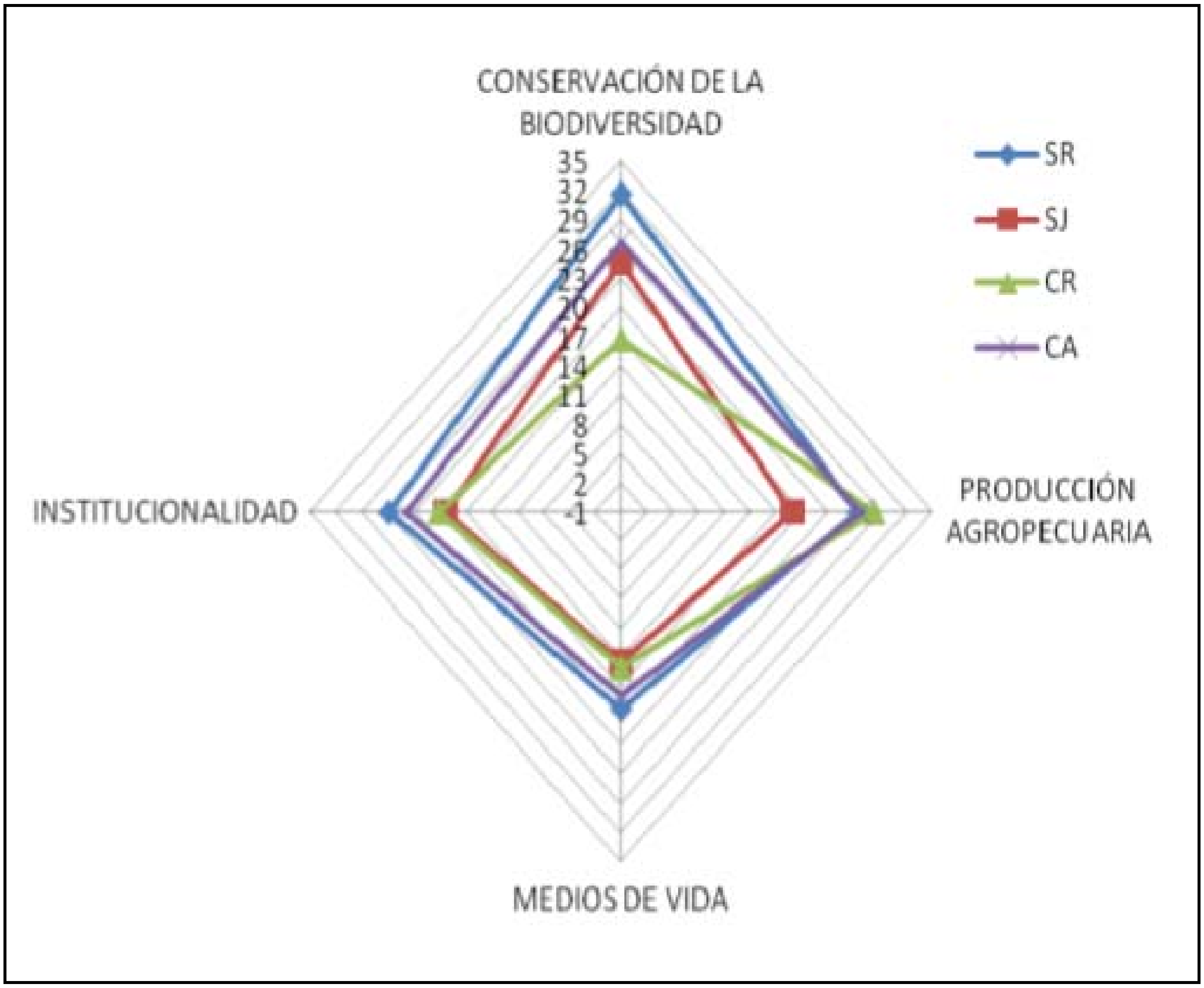
Figure 4



CONSERVACIÓN DE LA BIODIVERSIDAD
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