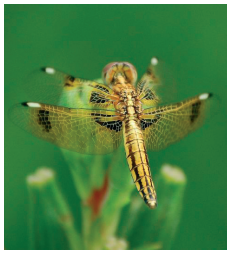
Secretariat of the Convention on Biological Diversity

CBD Technical Series No.



52

SUSTAINABLE USE OF BIOLOGICAL DIVERSITY IN SOCIO-ECOLOGICAL PRODUCTION LANDSCAPES

Background to the '*Satoyama* Initiative for the benefit of biodiversity and human well-being'

2010 International Year of Biodiversity
CBD
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UNITED NATIONS UNIVERSITY
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Ministry of the Environment
Japan

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'*Satoyama* Initiative for the benefit
of biodiversity and human well-being'

Acknowledgements

The Secretariat of the Convention on Biological Diversity, the Ministry of the Environment of Japan, and the United Nations University Institute of Advanced Studies would like to thank those who contributed articles for this volume of the Technical Series.

This document has been produced with the financial support of the Ministry of the Environment of Japan and the United Nations University Institute of Advanced Studies. The views expressed herein can in no way be taken to reflect the official opinion of the Secretariat of the Convention on Biological Diversity, the Ministry of the Environment of Japan, the United Nations University Institute of Advanced Studies or the editors.

Published by the Secretariat of the Convention on Biological Diversity. ISBN 92-9225-242-9

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Citation:
Bélair C., Ichikawa K., Wong B.Y. L., and Mulongoy K.J. (Editors) (2010). Sustainable use of biological diversity in socio-ecological production landscapes. Background to the '*Satoyama* Initiative for the benefit of biodiversity and human well-being.' Secretariat of the Convention on Biological Diversity, Montreal. Technical Series no. 52, 184 pages.

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Foreword

We are pleased to introduce this volume of the Technical Series of the Convention on Biological Diversity, which focuses on the sustainable use of biodiversity. Life is neither possible nor worth living without all the goods and services we derive from biodiversity, including, *inter alia*, the provision of our food and medicines, spiritual and cultural fulfilment, water and air purification, crop pollination, erosion control and the regulation of climate and natural disasters. Whether or not we continue to derive benefits from biodiversity will depend upon how we use it and how our activities impact our natural environment. Recent scientific assessments document that unsustainable use of the goods and services we derive from ecosystems, for example through deforestation, overexploitation of natural resources and unplanned urbanization, has led to biodiversity loss and degradation of ecosystem services with increasingly serious consequences for the future of nature and human well-being, food security, healthcare and human society in general.

The 193 Parties to the Convention and their partners are currently engaged in preparing a post 2010 biodiversity strategy aimed at re-establishing a harmonious relationship between man and nature through the sustainable use of biodiversity. They are conscious that they have to address in particular the loss of forest ecosystems and other natural habitats, overfishing and destructive fishing practices, management of areas under agriculture, aquaculture and forestry, pollution from excess nutrients, the protection and restoration of ecosystems that provide essential services and contribute to local livelihoods, climate change mitigation and adaptation, and desertification.

The strategic vision of how humans can live sustainably at the heart of the dynamic ecological systems that support life on Earth is reflected in many traditional socio-ecological production landscapes, such as the Japanese land-management practice of *satoyama*. This publication presents case studies and articles that describe relationships between humans and nature in socio-ecological production landscapes around the world. The examples highlight the various physical structures, management techniques and governance systems that characterize these landscapes, as well as the benefits they provide for biodiversity, the threats they currently face, and ways to address these threats. We hope that the international community can learn from such enlightened practices and adapt them, as appropriate, to current global changes.

We would like to thank all the authors of the case studies and articles and everyone who contributed to this publication, including the staff of the Japanese Ministry of the Environment, the United Nations University Institute of Advanced Studies, and the Secretariat of the Convention on Biological Diversity.

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Introduction

The urge for survival has led humans to explore their surrounding natural environment for usable resources and cultivation. This in turn has led humans to master the various uses of available natural resources, as well as to find the best ways of extracting them. On the other hand, humans have also learned about the negative impacts their activities can have on the natural environment, including natural resource depletion, decreased production and soil erosion, and that a balanced way of utilizing and managing land and natural resources is vital to ensure that the land continuously provides necessary natural resources. Over time, humans have gradually developed unique systems based on harmonious interactions with their natural environment. These sustainable systems have enhanced land management practices and made natural resource use more effective. These socio-cultural systems and associated traditional ecological knowledge are forces that have, over centuries, shaped and formed unique landscapes adapted to various geographical and socio-cultural backgrounds around the world. Such sustainable human-influenced landscapes, which have been known to be beneficial for biodiversity conservation and human well-being, are referred to here as socio-ecological production landscapes[1].

To conserve biodiversity, considerable efforts have been focused on preserving pristine environments, such as wilderness, where human activities are minimal. However, biodiversity conservation also involves human-influenced areas, such as socio-ecological production landscapes, which can contain rich sustainable practices and traditional knowledge. These landscapes are found throughout the world under various local names, such as *dehesa* in Spain, *muyong* in the Philippines and *chitemene* in Malawi. In Japan, such landscapes are termed *satoyama*, a combination of two words which denote mountains, woodlands and grasslands (*yama*) and surrounding villages (*sato*).

However, these landscapes are increasingly threatened in many parts of the world due to various pressures such as unplanned urbanization, industrialization and diminishing rural population. To tackle the critical issue, the Ministry of the Environment of Japan (MOE-J) and the United Nations University Institute of Advanced Studies (UNU-IAS) jointly initiated the *Satoyama* Initiative to promote activities based on fundamental principles and guidelines (such as the Ecosystem Approach) towards the long term goal of "realizing societies in harmony with nature." This Initiative covers a wide range of human-influenced areas, such as villages, farmlands, and adjacent woodlands and grasslands, which have been formed and maintained sustainably and which have the potential to contribute to both biodiversity conservation and human well-being.

This document is a collection of case studies and articles that address how relationships between humans and nature function in socio-ecological production landscapes around the world. The examples highlight the various physical structures, management techniques and governance systems that characterize these landscapes, as well as the benefits they provide for biodiversity and human well-being, the threats they currently face, and ways to address these threats. Case studies were submitted to the Secretariat of Convention of Biological Diversity (SCBD) and field studies were conducted for the UNU-IAS. Case studies were submitted to the SCBD by experts as voluntary contributions to a call made by SCBD in collaboration with MOE-J and UNU-IAS, as part of the in-depth review on the sustainable use of biodiversity in preparation for the fourteenth meeting of the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-14) and the tenth Meeting of the Conference of the Parties to the CBD (COP-10).

The first part of this document presents a selection of synthesis articles of relevance to socio-ecological production landscapes worldwide. An approach to addressing biodiversity conservation through the inclusion of human communities, and indicators to measure socio-ecological resilience, are presented. Based on four case studies from Suriname, Cameroon, Guyana, and Thailand, the characteristics of customary sustainable use of biodiversity by indigenous peoples, and the threats customary management systems are currently facing, are highlighted. Protected landscapes across North America, and the diverse governance regimes associated with these landscapes, are then explored. Finally, the opportunities and challenges in surveying the coverage and remains of cultural landscapes in Europe are presented.

The second part of the document presents 23 case studies of socio-ecological production landscapes around the world. These case studies cover 18 countries: Argentina, Australia, Bangladesh, Cambodia, Germany, India, Ireland, Italy, Japan, Kenya, Mexico, Peru, Portugal, Spain, Sri Lanka, Solomon Islands,

[1] Referring to the definition of the Japan Satoyama Satoumi Assessment for "*satoyama* and *satoumi* landscapes" as "dynamic mosaics of managed socio-ecological systems producing a bundle of ecosystem services for human well-being", the term "socio-ecological production landscape" has been applied to describe the target areas of the *Satoyama* Initiative.

Tanzania, and United States of America (figure 1). The case studies are representative of various climates, including tropical, sub-tropical, Mediterranean, and temperate climates, and geomorphic environments, including plains, hills, coasts and mountainous areas, or a mixture of these. In addition, they represent areas with diverse historical, cultural and socio-economic conditions, from subsistence communities in the remote mountainous villages of Peru to the urban fringes of metropolitan Tokyo, Japan.

In the final part, a synthesis article presents an overview the features of socio-ecological production landscapes based on the case studies collected here. The synthesis highlights the various physical structures, management techniques and governance systems that characterize these landscapes. In addition, it presents an overview of the benefits they provide for biodiversity, the threats they currently face, and ways to address these threats.

Figure 1. Location of the case studies

Overview Articles

Bridging managed and natural landscapes
The role of traditional (agri)culture in maintaining the diversity and resilience of social-ecological systems*

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*This is a revised version of a paper that will be published later this year as part of a special edition of the journal Management of Environmental Quality on 'Traditional agricultural landscapes and Community-Conserved Areas'.

1. Introduction

The recent shift toward the inclusion of communities in nature conservation signals a broadening perspective among conservationists. Earlier practices of fencing off pieces of nature as a way of 'mitigating' human impact proved costly, unsustainable, and dubious in terms of social and conservation impacts (Adams *et al*., 2004; Liu *et al*., 2001). With more than 1.1 billion people living within the world's 25 biodiversity hotspot areas -- in many cases within the 12 per cent of the world's land area that is under some form of protected area management (Cincotta and Engelman, 2000) -- such practices are also profoundly unrealistic. Many have called for an approach to biodiversity conservation that includes development needs and community participation as integral elements of both ecosystem and conservation management strategies (Adams *et al*., 2004; Agrawal and Gibson, 1999; Amend *et al*., 2008; Brown, 1992; UNESCO SC, 2008).

Exclusionary approaches to nature conservation were founded on the conception of "nature" and human society (and thus culture) as separate entities. This assumption ignored the role that indigenous and local communities have played in shaping many globally important and unique ecosystems through long and complex processes of co-evolution (Escobar, 1999). Still today, much of the world's biological diversity is in the custody of indigenous and local communities employing a variety of subsistence strategies to sustain their lifeways (Oldfield and Alcorn, 1987). Some of these strategies are compatible with conservation aims, while others are not. The conservation of protected areas in the future will depend on our ability to understand, harness and support those practices that are beneficial to the maintenance of the diversity and resilience of natural ecosystems.

A common framework for understanding these practices is needed to achieve a more concerted shift to participatory management practices that not only include communities, but also support and rely on their ways of using and maintaining landscapes. Studies in this field have most often addressed human activities in such ecosystems as disturbances or focused largely on the negative aspects of human activity (Foley *et al*., 2005; Green *et al*., 2005; Hansen *et al*., 2001; Maiorano *et al*., 2008; Western, 2001), resulting in a simplistic but pervasive view of all agriculture as inherently damaging to biodiversity and ecosystems. This means that traditional agriculture is not only threatened by the forces that drive the increasing homogenization and industrialization of agriculture, but also by dominant conservation practices. In order to counter this view, a clear distinction between the ecological impacts of traditional land use practices and those of more destructive activities such as logging, mining and industrial agriculture is needed.

The goal of this paper is to facilitate a conservation approach that (i) builds on the ecological and social synergies that exist in traditionally managed landscapes in and around protected areas and (ii) integrates conservation and social goals to achieve a reduction in the levels of marginalization of indigenous communities while preventing ecosystem degradation and biodiversity loss. Central to this approach is the notion of landscapes as coupled social-ecological systems, whose integrity and resilience depend on both their social and ecological components and the combined ability of these components to retain their structure and function after disturbances (Gunderson and Holling, 2002).

The paper, firstly, revisits the conceptual underpinnings of different approaches to nature conservation. Drawing on insights from political and historical ecology and systems theory, it demonstrates the ambiguities inherent in current conservation efforts and discusses the importance of the notion of socio-ecological systems to conservation. Secondly, it explains the functioning of social-ecological systems in a conservation context by outlining the various practices and conditions whereby indigenous and rural communities can have positive impacts on the integrity, richness and resilience of ecosystems and landscapes. Thirdly, it proposes indicators that take full account of the social and cultural dimensions of ecosystem functioning and that can be used (a) for the endogenous monitoring of the integrity and resilience of social-ecological systems by local communities, and (b) as a tool to help implementation

and monitoring of conservation approaches that aim to prevent and reverse the loss of biocultural diversity and to strengthen the social-ecological resilience of protected areas and agricultural biodiversity.

2. Harnessing (agri)culture for conservation

2.1. Context: Human–environment interactions – discourse and practice

Ecologists have traditionally sought to study ecosystems in their pristine state, away from the confounding influence of human activity (Gallagher and Carpenter, 1997). The conservation movement, from its onset, followed suit in the same spirit, focusing on preserving those wild areas in the world where "nature" conformed to the ideal of pristine or where it could revert to a wild state by the removal of human presence or impacts. This approach to nature conservation has resulted in a conservation discourse that is ahistorical (it misrepresents humans' role in the evolution of natural systems) and depoliticized (it ignores communities' rights to their territories and livelihood resources). A striking example of how human presence is seen purely as a threat in rainforest conservation are Lovelock's (2007) recent thoughts on storing nuclear waste in African rainforests in order to deter human incursions.

Scientific understanding of the relationship between human activity and ecosystem integrity has significantly advanced over the last decades. In an issue of Science dedicated to 'human-dominated ecosystems', the authors note that scientists now understand that nature, as we know it, is neither primordial nor pristine (Janzen, 1998; Vitousek *et al*., 1997). From climate to biogeochemical cycles and the distribution and abundance of individual species, nature is profoundly affected by human activity. Mainstream conservation practice, with a number of notable exceptions, has failed to internalize the notion that human and natural systems have often coevolved and that the former may not necessarily be incompatible with conservation goals. The old view that nature functions best without the interference of humans remains ingrained in the consciousness of "Big Conservation" and this continues to have profound consequences for the way in which conservation is practiced (Adams and Hutton, 2007).

2.1.1. Enduring fortress conservation

Since the establishment of Yellowstone National Park in 1872, saving primeval pieces of nature in as pristine a state as could be achieved, along with charismatic (mega)fauna has been an iconic cause of the conservation movement. The practice of fencing off large tracts of natural landscapes and ecosystems is rooted in a culture that, since Judeo-Christian times, has framed the interaction between the human and natural realm in terms of a struggle (Colchester, 2003). This view was often justified in the face of threats to nature from industrialized farming and logging, the oil, gas and mining industries: threats that are largely a question of national and global economic and environmental policies.

Increasing realization on the often negative socioeconomic impacts of protected areas has made this approach of "fortress conservation" more difficult to defend. Conservation practices have begun to acknowledge the livelihoods of human communities in protected areas, though the benefits are debated among conservationists (Berkes, 2004; Brosius and Russel, 2003; Western, 2001). Communities are allowed to remain within protected area boundaries as part of community-based conservation schemes, but their inhabitants continue to be seen as invasive, in need of mitigation (Fairhead and Leach, 2000). Even the concept of buffer zones, established as part of the United Nations Educational, Scientific and Cultural Organization (UNESCO)'s 'Man and the Biosphere' (MAB) program in the early 1970s, was intended to contain human activities within specified areas and keep them out of others (Colchester, 2003). Buffer zones have been seen as a compensation for exclusion. The frequent disappointments that characterize buffer zone experiments are often attributed to outside development or conservation agencies supporting activities that have little to do with traditional land use practices (Sayer, 1991).

The growth of the UNESCO MAB network (in 2009 it reached 553 reserve areas in 107 countries) and the growing attention given by the Food and Agriculture Organization of the United Nations (FAO), the Global Environment Facility (GEF), the International Union for Conservation of Nature (IUCN) and other global institutions to biocultural landscapes (see, e.g., Persic and Martin, 2008), as well as growing recognition of 'Globally Important Agricultural Heritage Systems' and 'Indigenous and Community-conserved Areas' signal an encouraging trend towards the recognition of local communities' role in conservation. Yet a diverging trend, one that redraws the sharp division line between human and nature and views them in an inclusive context, is taking place simultaneously (Brosius and Russel, 2003; Chapin, 2004; Colchester, 2003). The discontent with the dichotomizing division between "nature" and human society and the disruptions it is causing to livelihoods of indigenous, agrarian and pastoral communities has become a prominent feature of the current debate on protected areas and conservation. Today, the list of global wrongdoers

put forth by indigenous leaders includes not only ExxonMobil, Texaco and Cargill, but also the more surprising names of Conservation International (CI), The Nature Conservancy (TNC), the World Wildlife Fund (WWF), and the Wildlife Conservation Society (WCS) (Agrawal and Redford, 2009). Indigenous opposition to their activities overshadowed the World Parks Congress in 2003 (Brosius, 2004) and, one year later, 200 indigenous representatives at the meeting of the International Forum on Indigenous Mapping, stated that the "activities of conservation organizations now represent the single biggest threat to the integrity of indigenous lands" (quoted in Dowie 2005, p.2).

The field of political ecology offers a critical perspective on these trends and the generally problematic relationship between protected areas and human communities (Neumann, 2004). Building on an exploration of different meanings of 'nature', how these are constructed and by whom, and how they gain primacy in global discourse, it examines the roots of contemporary conservation practice.

Escobar (1999) writes that different forms of social organization (patriarchal, indigenous, capitalist, scientific) produce different ideas about what nature is and inform different and often competing strategies on whether and how it must be managed. This results not merely in a conflict over resources, but also in a struggle between knowledge systems, or, as Boillat *et al.* (2008) call them, ontological communities. Redford and Sanderson (2000, p.1364) illustrate: "conservation with use should not crowd out conservation without use as a policy objective (…) we do not agree that "forest people and their representatives…speak for the forest." They may speak for their version of a forest, but they do not speak for the forest we want to conserve."

The exclusive view of 'nature' held by the "modern-Western ontological community" is also the one espoused by some of the world's governments and conservation agencies. The international policy debate on nature conservation and its social impacts may be diverse (Adams *et al.*, 2004), but in practice western natural science analysis remains the universal tool of choice for defining conservation needs and actions (Adams and Hutton, 2007), increasingly supported by number of alliances between political, corporate and conservation entities[1] (Chapin, 2004). This de facto devaluation of indigenous forms of knowledge, culture and legal systems facilitates the appropriation of land and biological resources and associated knowledge for the purpose of commercialization and control (Ghimire and Pimbert, 1997).

Using the Arenal-Tilaran Conservation Area in Costa Rica as an example, Isla (2008) describes how, under the banner of 'sustainable development', the enclosure of large tracts of rainforests has enabled biopiracy and the commodification of the commons, effectively criminalizing the traditional resource uses of 118 communities in the area. Enclosure is aided by "debt-for-nature swaps" and "conservation concessions," a concept conceived by WWF and CI and pioneered with the International Monetary Fund and the World Bank, by which an indebted country cedes management over pieces of nature to foreign governments, conservation agencies, or corporations in exchange for payment or partial cancellation of national debt (Ellison, 2003).

A substantial number of individual studies show a continuing trend towards the exclusion and in some cases expulsion of local communities from conservation areas (Agrawal and Redford, 2009; Brockington and Igoe, 2006; Emerton, 2001; Muttenzer, 2008). The fact that, despite these measures, rates of biodiversity loss and environmental degradation continue to accelerate (Adams *et al.*, 2004; Liu *et al.*, 2001), provides sufficient reason to look for alternative approaches to conservation.

2.1.2. Historical ecologies, cultural landscapes and coupled social-ecological systems

"*Even the landscapes that we suppose to be most free of our culture may turn out, on closer inspection, to be its product*" - Simon Schama (quoted in Brockington 2002, p.23)

If the voice of indigenous and rural communities has been underrepresented in global conservation discourse, the same has long been true of their role in shaping and maintaining landscapes and ecologies (DeGeorges and Reilly, 2009). This mutual connection between nature and society forms the foundation of the field of historical ecology. Rival (2006) argues for the importance of using a diachronic analysis of ecological systems to account more fully for their structural and functional properties, especially how these have evolved in relation to the development of human societies. She refers to Posey and Balée (1989), who in their writings about indigenous land management strategies in the Brazilian Amazon challenge the view that human activity amounted to little more than the occasional disturbance of natural processes. People's adaptation to their environment involved an active and quite sophisticated modification of that environment, the

[1] Corporate partnerships listed on the websites of the main conservation agencies: Barrick Gold, Bunge, Chevron, DuPont, Harrah's Entertainment Inc., Rio Tinto, McDonalds and Kraft (CI 2009), Shell, Coca Cola, Union Carbide, Cargill, Wall Mart, Nike (WWF 2009), Domtar, Monsanto, Microsoft (TNC 2009).

consequences of which can still be seen today in the shape of the landscape and the composition of plant communities (Balée, 2000).

The view of landscapes as "the physical manifestation of the long-term human history of the environment" (Rival, 2006, p. S90) has been incorporated in the concept of 'cultural landscapes'. In academia the concept encompasses the full extent of manifestations of human-environment interactions, including associated uses, beliefs, ecologies, practices and traditions (Fowler, 2003). Seen in that broader sense, the term indeed applies to almost the entire world's surface (Vitousek *et al.*, 1997). In conservation circles, however, and more specifically the UNESCO World Heritage Committee that adopted the concept in 1992, cultural landscapes have been interpreted in a more narrow sense distinct from "natural" landscapes as "areas illustrative of the evolution of human society and settlement over time," (quoted in Persic and Martin 2008, p.8) that should moreover be selected on the basis of representativity and "outstanding universal value" (Fowler, 2003). While not intentionally elitist, this interpretation can be misleading when applied to superficially human-free landscapes, where the structure and function of ecosystems often nevertheless reflect less obvious human influences (Pickett and Cadenasso, 1995). Charismatic Uluru and the rice terraces of the Philippine Cordilleras classify as cultural landscapes, but the more subtle human imprints on Amazonian soil and plant communities described by Balée would not. Unless taken more broadly, the concept of cultural landscapes remains of limited use in accounting fully for the role of human agency in shaping ecosystems and landscapes.

Current approaches to conservation, particularly the management of protected areas, are largely based on the idea of a 'balance of nature', which views undisturbed (by humans) ecological systems as ordered and in a state of stable equilibrium (Wu and Loucks, 1995). The idea has been important in the formulation of conservation geographies (choice of territories, boundaries and scales of protected areas) and has contributed to the marginalization of human activities (Zimmerer, 2000). Now largely rejected by the scientific community, this view has been replaced with approaches and concepts such as nonequilibrium ecology, complex adaptive systems, and biocomplexity, all of which revolve around the understanding that ecosystems are in constant flux and that they are complex, non-linear and behave unpredictably (Wu and Loucks, 1995). Not only ecosystems, but also the current global context has to be understood as a result of a complex interplay between economic and political activities, environmental and climatic changes, and social and cultural transformations. It follows also that conservation practice must be phrased in terms of change and resilience, both ecologically and socially. Instead of promoting a conservation agenda based solely on contemporary patterns of biodiversity and ecosystems -- and the challenges with which they are faced -- current conservation efforts must anticipate future threats and accommodate the dynamic genetic and ecological processes of communities responding to change (Mace *et al.*, 1998).

The incorporation of human communities as a basic element in the analysis of ecosystems and landscapes adds further complexity, revealing properties that emerge from the interplay of behavioral, biological, chemical, physical, and social interactions between living organisms (Michener *et al.*, 2001) and are not apparent when these systems are studied separately (Liu *et al.*, 2007). These emergent properties (e.g., folklore, (agro)biodiversity, food sovereignty) are the tangible outcomes of the various ways in which communities interact with ecosystems and landscapes, discussed in the section below, and are central to the indicators of resilience in social-ecological systems presented later in this paper.

2.2. How do indigenous and rural communities help anchor biodiversity and strengthen ecosystem resilience?

The Millennium Ecosystem Assessment (MA) mentions agriculture as one of the principal drivers behind the degradation and depletion of ecosystem services. Soil erosion, eutrophication of water bodies, invasive species, large-scale land conversion and deforestation are some of the main impacts of an agriculture that needs to support an increasing number of people (MA, 2005). A predicted one billion additional hectares of natural ecosystems will be converted to agriculture by 2050, primarily in the developing world (Tilman *et al.*, 2001), and are likely to increase the tension in the relationship between agriculture and nature conservation.

Other sources, however, highlight the important role that certain forms of agriculture based on agroecological principles can have in sustaining wild species diversity and maintaining ecosystem services (Amend *et al.*, 2008; Gilpin *et al.*, 1992; Hajjar *et al.*, 2008; Oldfield and Alcorn, 1987; Scherr and McNeely, 2008). In the section below some of the mechanisms through which agricultural practices can help sustain the diversity and resilience of natural ecosystems are detailed with the use of selected examples. These mechanisms are essential to our understanding of social-ecological systems and serve as a basis for the indicators of resilience presented later.

This discussion is particularly relevant to the debate about the role of indigenous and local communities in biodiversity conservation and protected area management. These communities, in their traditional/ancestral environments, have to be considered intrinsic elements of social-ecological systems that are shaped by a long-term, continuous process of interdependency and co-evolution. We argue that traditional knowledge, culture, institutions and land-use practices, especially those related to agriculture, play an important role in the resilience of these systems.

2.2.1. Traditional (ecological) knowledge

Indigenous people often have detailed knowledge of local agro-ecological conditions, characteristics of plants and animals, resources and ecological processes in the ecosystems and landscapes on which they depend for sustenance and lifeways (Berkes *et al.*, 2000; Nabhan, 2000; Stave *et al.*, 2007). This knowledge is accumulated over hundreds and sometimes thousands of years as it is passed from generation to generation, but is also constantly adjusted to changing conditions and new experiences (Berkes *et al.*, 2000; Fernandez-Gimenez, 2000). It is place- and culture-specific and derived from interactions between humans, animals, plants, natural forces, spirits and land forms (Kassam, 2009).

Traditional ecological knowledge (TEK) can be seen as the memory of human-environment dynamics in social-ecological systems. The longer this memory, the more accurately traditional ecological knowledge can be expected to reflect the complexities of social-ecological interactions and facilitate communities' adaptation to changes in surrounding ecosystems. It is the basis for continued innovation and the sustainable use and conservation of resources, and thus central to the resilience of social-ecological systems. The extent to which TEK is sufficient to deal with the pace of current social, economic and environmental changes is unclear. Where changes are unlike the ones captured in the collective memory of a community, traditional knowledge by itself may be inadequate and direct a community toward adaptive responses that may be inappropriate and endanger ecosystems and/or livelihood security (Kassam, 2009). Nevertheless, scientists are beginning to acknowledge the important role this knowledge can play in the design and implementation of conservation projects.

- A number of studies describe the particular ways in which traditional peoples in diverse geographical areas understand ecological processes. A survey by Stave *et al.* (2007) among the Turkana people in Kenya shows the depth of their knowledge of local plants (105 specific uses for 113 woody plant species) and its relevance for ecological research and forest conservation. Nabhan (2000) highlights the importance of traditional knowledge to endangered species conservation and shows how the knowledge system of the O'odham and Comcáac farmer-gatherers in the Sonoran desert, U.S.A., is based on an elaborate understanding of the ecological interactions among locally occurring species, regardless of whether these are of direct economic benefit. Turner *et al.* (2000) show the complexity of the ecological knowledge of indigenous communities in British Columbia, Canada, exemplified by the use of ecological indicators and adaptive strategies for the monitoring, enhancement and sustainable harvesting of resources. They emphasize that in order to appropriately integrate traditional knowledge into current management systems, its use must be coupled with an understanding of and respect for the culture of the people in which the knowledge is situated.

2.2.2. Cultural values

Traditional knowledge is embedded in complex cultural systems (Berkes *et al.*, 2000). Culture can be understood as an expression of the interaction over time between communities and their natural, historical and social environments. These environments not only satisfy people's material needs for food, fodder, water, medicines and other natural resources, but also provide the bases for ethical values, concepts of sacred spaces, aesthetic experiences, and personal or group identities derived from the local surroundings (Kassam, 2009). Social, ethical and spiritual relationships thus have an ecological foundation; and the practical manifestation of cultural values can have consequences for the ecological system (*ibid.*). Failure to recognize this interaction means ignoring the role that cultural practices play in the shaping of landscapes and the maintenance of biodiversity and ecosystem services.

- In the eastern Himalayas, numerous areas considered sacred by the indigenous Tibetans are found in habitats with greater species richness, diversity and endemism than surrounding areas and have an important role in the conservation of unique ecological systems and old-growth forests (Salick *et al.*, 2007). Sacred spaces can be recruitment areas for populations of seed-dispersing birds and bats that are of importance to the regeneration of surrounding ecosystems (Gadgil *et al.*, 2000), provide habitat for birds controlling insect outbreaks on adjacent crop fields, and may serve as seed banks for locally adapted crop varieties and medicinal plants (Berkes *et al.*, 2000). A botanical survey in a Nigerian sacred grove documented 330 plant species as

compared to only 23 in surrounding areas (Warren and Pinkston, 1998). Unruh (1994) documents six cases in North and West Africa and India where trees with sacred values are spared and protected, and thereby effectively released from competition with other trees used for firewood or building. In Borana (Ethiopia) symbology, the Sycamore tree represents the Borana elders; it cannot be cut and so creates a microenvironment that facilitates the growth of other plants (Bassi and Tache, 2008).

• A very particular way in which the protection of territories that are of important cultural value to indigenous groups benefit from human presence is illustrated by Klubnikin *et al.* (2000). The Altaian people of Siberia opposed a government-initiated dam project that would destroy much of their sacred and cultural landscape, undermine livelihoods and degrade natural resources. Especially in the current global context where land conversion and natural resource extraction remain some of the most important drivers of ecosystem degradation, communities' will and ability to take political action are an important mechanism for nature conservation.

2.2.3. Social institutions

Traditional knowledge about the use of plants, landscape management and ecological processes becomes integral to organizational and institutional structures that shape the interactions of people with the landscape and regulate the use of resources (Bavikatte and Jonas, 2009; Olsson *et al.*, 2004). Indigenous institutions have always been important in facilitating collective action and co-ordinated natural resource management (Ghimire and Pimbert, 1997; Dennis *et al.*, 2007). Norms, taboos, prohibitions to harvest and other regulations are social mechanisms that, while not intentionally 'conservationist', do often have the function of natural resource and biodiversity conservation.

• Niamir-Fuller (1998) describes the social-institutional mechanisms that allowed pastoral groups in Sahelian Africa to utilize environmental variability without adversely affecting ecosystem functions. Their management systems include herd relocation based on the continuous monitoring of grasslands and the setting aside of special no-grazing zones that are used in the case of emergency. Similarly, Mongolian nomads manage their grasslands according to temporal and spatial variability in forage availability (Fernandez-Gimenez, 2000).

• In the 'Borana Conserved Landscape' in Ethiopia, access to the diverse and extremely rich ecological zones and resources was traditionally regulated through customary norms, laws and beliefs. Together these ensured the viability of the pastoral landscape (Bassi and Tache, 2008). Disruption of the Borana system of governance as a result of their marginalization by government policies has resulted in a deterioration of the landscape (*ibid.*).

• An example of how different social institutions create different landscapes is provided by Kepe and Scoones (1999). They describe how the actions of modern and traditional institutions associated with grassland uses in the Mkambati area of South Africa cause shifts in dominant species and grassland states. These grasslands are not merely the product of climate and geology, but largely also of human choice and action.

• Sometimes social institutions are not sufficient to ensure the conservation of resources. On the Maluku Islands of Indonesia, prohibitions of entry, harvest, or hunting in community-controlled areas are regulated through the ancient *sasi* institution. According to a study by Zerner (1994) the reinvigoration of *sasi* in a contemporary context has contributed to improved resource management. More recent work by Novaczek *et al.* (2001), however, shows that *sasi* does little to protect fisheries against externally driven threats such as commercial fishing.

2.2.4. Livestock grazing and landscape management

Landscapes that have co-evolved with or have been altered by human activities often depend on the continuation of these activities to maintain the presence of certain species and ecosystem services. Livestock, a keystone species in such systems, can be important in the maintenance of ecosystem states by suppressing dominant species, allowing others to flourish, and preventing the succession of grasslands.

• Vast areas of the Tibetan Plateau previously regarded as wilderness, are in fact cultural landscapes. Forest patterns do not depend on site-specific climate conditions, as previously thought, but are shaped by pastoral activities instead (Winkler, 2000).

• The extent to which human activity shapes landscapes is evident in the Mediterranean Basin, where practices such as forest clearing, cropping, wood-cutting, grazing and fire management have created a high degree of landscape and biological heterogeneity (Bartolomé *et al.*, 2000). In the Monteseney Biosphere Reserve in Spain, the ceasing of such activities has negatively effected biological and landscape diversity, for example by allowing woody species to take over the open and diverse landscape (*ibid.*).

• Similar observations were made in Vattenriket, a wetland in Sweden protected under the Ramsar Convention, where conservation measures that preclude human interference had unintended consequences. After having been used for grazing for hundreds of years, the wetland became overgrown when livestock were removed from the area. This led to the understanding that grazing is essential for maintaining certain wetland systems and showed the importance of the history of human-environment interactions to ecological functioning (Olsson *et al.*, 2004).

• In contrast to the indiscriminate use of fire in land conversion for agricultural purposes, indigenous fire management may have an important ecological function. In the *cerrado* (savannas) of Brazil, the Krahô have for thousands of years used fire as a way of managing a mosaic of burned and unburned patches in the landscape (Mistry *et al.*, 2005). Together with wildfires, this practice is an important part of the ecology of the *cerrado*; it maintains a balance between grasses and woody vegetation and assists in nutrient recycling and germination. In Australia, Aboriginal fire management plays an important role in the maintenance of biodiversity on the Arnhem Land plateau. The benefits of this management system are abundant and diverse animal and plant foods, but also the fulfillment of social and religious needs (Yibarbuk *et al.*, 2001).

2.2.5. Agricultural practices, land management and use

Many traditional management and agricultural systems serve the purpose of maintaining ecosystem functioning and contribute to the conservation of biodiversity through a number of practices, including social mechanisms of exchange and the use of more varieties and species (Dennis *et al.*, 2007; Hajjar *et al.*, 2008). For example, indigenous agroforestry systems such as tropical gardens host significant diversity and have a complex design that increases their productivity and resilience (Gliessman, 2000).

• Traditional shade coffee plantations adjacent to forest ecosystems can harbor a high diversity of plants, insects and birds. Roberts (2000) found that ant swarms in such plantations in Panama attract a total of 126 bird species. Habitats associated with Philippine rice terraces that have been under cultivation for thousands of years still harbor unique species of plants (Nozawa *et al.*, 2008). Pusadee *et al.* (2009) show how the diversity and distribution of rice landraces used by the Karen people of Thailand is explained by cultural practices and social dynamics between communities. This enhances the crop's evolutionary flexibility and maintains the adaptive capacity of the local food system.

Agricultural systems, in turn, crucially benefit from neighboring "wild" ecosystems and the biodiversity contained within them. Pollinator diversity, pest control, reduced soil erosion and genetic material necessary for the continuous improvement of crop landraces are among the most important ecosystem services sustaining traditional agriculture.

• Wild relatives of cultivated crops have been used as sources of resistance to diseases, insects, and nematodes, to widen adaptation, improve resistance to environmental stresses, and to increase crop yield (Harlan, 1976). Crop landraces maintained in traditional farming systems occupy an intermediate spot between these wild relatives and elite varieties used in commercial agriculture. Yam (Dioscorea rotundata) takes an important place in West African societies and is still actively domesticated from wild populations in nearby bushes or forests visited for hunting (Mignouna and Dansi, 2003; Vernier *et al.*, 2003). This process of intravarietal adaptive diversification contributes towards the long-term evolution of the species (Dumont and Vernier, 2000). A study in Benin and Nigeria, shows that 3–14 per cent of farmers that were interviewed are domesticating or have recently domesticated yams and that the knowledge of wild yams is still alive even among farmers who have never domesticated yam (Vernier *et al.*, 2003). The same study showed that in regions where yam production is commercialized, the practice of domestication is decreasing.

The variety of agricultural practices employed by indigenous and local communities is important in the creation and maintenance of landscape mosaics. Fire and water management, erosion control, settlement, soil enrichment, etc., help create ecosystem niches with conditions favorable to the diversification of landscapes and the evolution of species.

• Guinea's Kissidougou savannah forests were assumed relics of a more extensive forest, long since degraded by local people. Fairhead and Leach (2000) showed how, instead, agriculture practiced by the Kissi and Kuranko helped create these forests. By altering soil conditions, moderating wildfires, and through their preference for tall trees they altered the balance of interacting factors and conditions that determine the ecological shift from savannah to forest.

• Different sources suggest that pre-Hispanic occupation of Amazonian sites has affected the composition and diversity of its ecosystem (Balée, 2000;

Bush and Silman, 2007; Heckenberger *et al*., 2007; Rival, 2006). Balée (2000) concludes that soil enrichment as a result of agriculture, coupled with landscape disturbance around settlements, created ecological niches that allowed the genetic plasticity of plant species to be expressed more fully than in unmodified environments.

• The people of the Tajik and Afghan Pamirs were historically confined to an extremely barren mountain environment. Through ingenuous management of water resources and elaborate use of wild plants they have created diverse agricultural systems (Vavilov, [1939] 1997). In neighbouring Kyrgyzstan, pastoral communities that began to settle during Soviet times but have very little agricultural background are beginning to restore the wild walnut-fruit forests from which they traditionally gathered fruits (the progenitor of modern apple varieties, *Malus sieversii*, originated in these forests). The seeds of wild fruits are sowed out in home gardens, selected for desirable traits, and replanted in the forest, facilitating both natural regeneration and continued evolution of wild fruit species (Van Oudenhoven, unpublished data).

• Rotational farming, or swidden agriculture practiced in tropical areas around the world, is characterized by a high diversity of cultivated species and varieties (Peroni and Hanazaki, 2002). Often misunderstood to be unproductive, destructive, and the cause of environmental degradation, studies haven shown that, when properly practiced, these systems can be ecologically sound (Diemont and Martin, 2009; Dove, 1983; Weinstock, 1983).

• Figure 1 shows the ingenuity of a traditional Karen rotational farm in the north of Thailand. It illustrates how knowledge intensive farming practices that are well-adapted to local environmental conditions maintain ecosystem and biodiversity services, including conservation benefits, and create heterogeneous landscapes.

2.3. Indicators of social-ecological resilience

The mechanisms presented above illustrate i) how coupled social-ecological systems are characterized by a two-way interaction in which human communities adapt to their environment and change that environment in the process, ii) how traditional agricultural and land management practices can influence the resilience of social-ecological systems, and iii) that the resilience of these systems derives from ecological characteristics (biodiversity, habitat, ecosystem services) and social ones (institutions, networks, education), as well as from the link between these natural and human components.

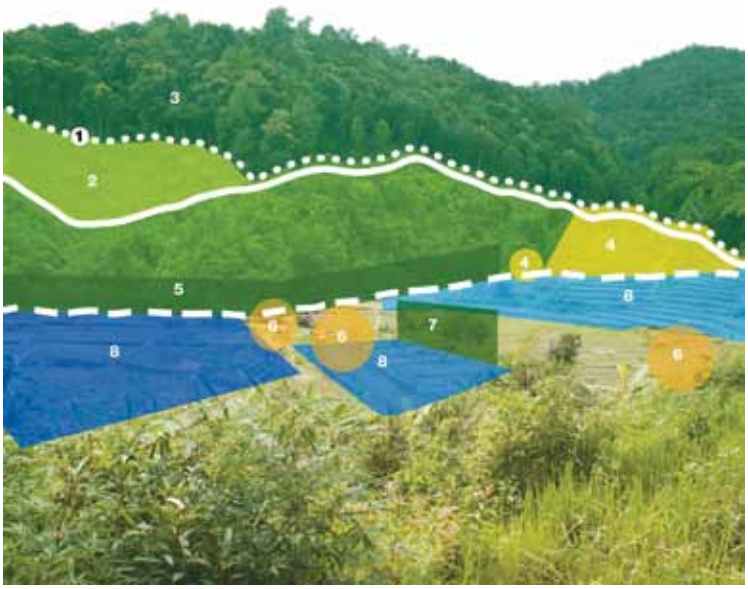

Figure 1. (based on P. Trakansuphakon, pers. communication).
1 - **Forest line firebreak**, also providing a pathway for wildlife. Transition zone between forest and cultivated land provides niche habitats high in biodiversity.
2 - **Fallow land** in the third year of recovery, also acting as pasture for livestock whose manure helps enrich the soil. Mycorrhizal fungi associated with the root of the Pada tree are essential to soil nutrient accumulation facilitate forest regeneration (Yimyam et al., 2008).
3 - **Sacred forest** is strictly conserved and acts as the primary reservoir of resources (water, wild plant and animal species). Hunting and gathering are allowed but farming is not.
4 - **Home garden** providing subsistence crops (vegetables, fruit etc.) as well as a few banana trees. A nursery contains rice before it is transplanted into the main paddy field.
5 - **Trees** along stream bed provide shade which prevents the stream from drying out. Their roots keep soil together, preventing erosion.
6 - **Livestock** is allowed to graze in the paddy field only after harvest and until the rice is planted.
7 - **Wind breaks**, trees planted in a row protect paddies from the wind and prevent soil erosion.
8 - **Rice fields** - paddy rice is grown in the terraced and lowland fields while drought tolerant upland rice is planted in the swidden area.

Table 1. Social-ecological indicators

1. Retention and acquisition of indigenous knowledge	Widespread use of knowledge
	Transmission of knowledge across generations (Persistence oral traditions (songs and stories), existence of education system that teaches local knowledge)
	Geographical diffusion of knowledge (exchange of knowledge between different communities)
	Documentation of knowledge
	Acquisition of knowledge: innovation and experimentation
2. Use of indigenous and local languages	Number of speakers
	Existence of education in the indigenous and local languages
	Existence of community media (e.g. radio) in indigenous and local languages
	Percent of children learning the indigenous and local languages
3. Demographics	Level of emigration from traditional territories
	Number of generations interacting with the landscape
4. Cultural values	Folklore associated with cultivated and wild plants and animals
	Cultural practices: ceremonies, dances, prayers, songs and other cultural traditions
	Persistence and respect of sacred sites
5. Integration of social institutions	Existence/continuation of traditional land tenure systems, indigenous governance, customary laws and the degree to which they are applied to the management of resources
	Acceptance of social institutions across generations.
	Use of traditional exchange and reciprocity systems (e.g. seed exchange, etc)
6. Food sovereignty and self-sufficiency	Availability of safe, nutritious and culturally appropriate food in sufficient quantity and quality.
	The abundance and use of traditional foods, seeds and medicines in the local production system.
	Intensity of fertilizer, insecticide and/or herbicide use on agricultural land
	Contribution of traditional subsistence activities to indigenous communities' economy (as opposed to out-migration for labor).
7. Multiple uses of land and plants	Multiple uses of a species (food, material, soil nutrient enrichment, shade, etc.)
	Diversity of cultivated crops and varieties: grains, fruits, legumes, vegetables, tubers.
	Diversity of food sources gathered from the wild: roots, berries, mushrooms, fish, meat.
	Number of traditional cultivars or species preferred for distinct uses.
	The use of traditional medicine.
	Diverse agricultural systems: intercropping, agroforestry, silvo-pastoral integrated farming and cultivation systems.
8. Complexity and intensity of interactions with the ecosystem	Diversity of components in the landscape that are used and maintained by communities: forests, riparian forests, fishing grounds, pasturelands, home gardens, cultivated fields, orchards, fallows.
9. Conservation of resources	Rates of landscape degradation and land conversion.
	Degree to which depletion of use of water, soils, forest, pastures is prevented
	Monitoring of resource abundance and ecosystem changes.
	Conservation of agricultural and wild biodiversity.
	Mechanisms for the total or partial protection of species and habitats; harvest restrictions.
10. Degree of autonomy; indigenous rights	Access to indigenous lands, territories, natural resources, sacred sites and ceremonial areas.
	Recognition of indigenous institutions by both external entities and community members.
	Existence of legal frameworks for indigenous veto over the use of indigenous lands.
	Levels of threat from, e.g., illegal encroachment, privatization, government expropriation, forced resettlement
	Practice of free, prior and informed consent in development activities.
	Recognition and respect of sacred sites by local communities, governments, and development industries.

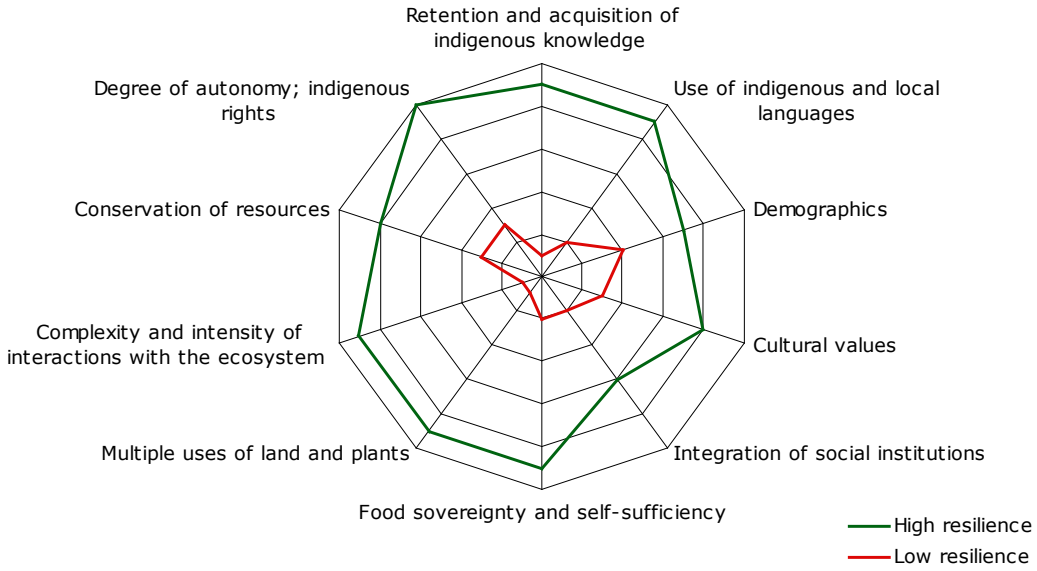

Figure 2. Using indicators to measure the resilience of social-ecological systems

On the basis of the described mechanisms, a set of indicators was developed (table 1). Their implementation would permit the monitoring of the extent to which these mechanisms are used and adjusted to changing conditions and so offer an indication of the resilience of social-ecological systems. Yet 'measuring' social-ecological resilience is challenging, particularly because in order to clarify features that contribute to it, institutional and organizational processes must be understood as carefully as ecological ones (Olsson *et al.*, 2004). Conventional indicators of ecosystem health (species richness, nutrient and water recycling, soil productivity, etc.) fail to capture its social dimensions and only rarely provide historical depth. They overlook a system of traditional ecological knowledge which is practical, attuned to local ecology and embodies a complex of (socio-cultural) interactions pertinent to ecosystem functioning and resilience.

The indicators presented here are intended to be used by scientists and communities as a tool to help in the implementation and monitoring of community-based approaches to nature conservation. They can help us understand to what extent protected area designations such as 'Biosphere Reserves' and 'Community Conserved Areas' empower or inhibit efforts to reverse the loss of biocultural diversity, and guide efforts at improving them.

These indicators are tentative and may be adapted to and applied in different study areas; they can be used alongside classic indicators of ecological health. The way in which social-ecological indicators are employed by communities and conservation scientists will be different. Indigenous communities may use them to monitor the impacts of conservation schemes on traditional livelihoods and lifeways, or, once a 'baseline' has been established, the tool can be used at regular intervals to monitor social-ecological dynamics and define priorities for community and conservation action (see, e.g., Moreno *et al.*, 2006). To scientists involved in the management of protected areas, on the other hand, these indicators can help elucidate whether and how communities, in their day-to-day interaction with landscapes, contribute to the maintenance of biological diversity and ecosystems' ability to respond to stresses and change. In contributing to the development of a common language between traditional and scientific communities, the approach can deepen the understanding of human-environment interactions and how these may be harnessed in a conservation context.

The graphical depiction of the indicators as a web in figure 2 renders the complex way in which they are interrelated. Links can be directly or indirectly causal, or may follow cyclic patterns of positive feedback. A loss of traditional knowledge, caused by the extinction of local languages that encode the co-evolution of rural communities and ecosystems (Nabhan, 2000) or the disappearance of oral traditions of knowledge transmission, can cause, among any number of changes, the disintegration of traditional social-ecological systems, landscape degradation and loss of biodiversity, further eroding traditional knowledge in the process. As explained by Kassam (2009), retention of indigenous knowledge is dependent on its use; it is not embedded in people's minds, but in the environment with which they engage.

Similarly, simplification in agricultural production systems often leads to an increasing reliance on external agricultural inputs (seeds, pesticides and fertilizers) to compensate for the loss of ecosystem services (Altieri, 1999). This reduces the need to maintain ecosystem services in and around cultivated fields and can trigger a loss in biodiversity and associated knowledge, undermine food sovereignty, and cause groundwater pollution, soil depletion and erosion.

3. Conclusion

We have attempted to outline an approach to nature conservation that bridges the 'natural' and managed elements of landscapes. Protected and agricultural areas represent the two main categories of land use by humans. Understanding how and where the two can form synergies is necessary both for future conservation efforts and for preventing the destruction of the unique knowledge, practices and culture that characterize traditional systems of land management. Historical shifts in ecology and other scientific disciplines towards a systemic view of the environment, in which humans are seen as part of the ecosystem, have prepared the ground for such a conservation approach (Berkes, 2004).

This paper has focused on an important barrier preventing the more widespread adoption of 'human-centered' conservation practices, namely the lack of a common framework for understanding the impact of human practices on biodiversity and landscape conservation. The (mostly positive) examples that were used to illustrate the mechanisms underlying human-environment interactions are not to suggest that all indigenous people and local communities everywhere conserve biological diversity. Rural societies are undergoing rapid change and increasing pressures to use new technologies and produce marketable commodities have upset traditional patterns of land management and use (Ghimire and Pimbert, 1997). However, traditional communities in which the integrity and diversity of language, social institutions, cultural traditions and land use practices are maintained very likely also contribute to the diversity and resilience of their surrounding ecosystems. The indicators developed in this paper can be applied to determine the degree to which this conclusion is borne out in any individual case.

It is at this point important to reemphasize that a fundamental prerequisite to appreciating the contribution human communities make to conservation efforts is the notion of landscapes as dynamic, evolving social-ecological systems in which core conservation values relate to resilience and not to species or ecosystems fixed in time. As long as elements in the conservation community continue to adhere to static views of nature, any disturbance, whether human-induced or not, will be treated as a threat. While 'nature' in such approaches lends itself well to being 'protected' and 'managed', it is too easily put at odds with agriculture and other forms of land use and, by extension, with community-based conservation schemes in which communities have real autonomy and responsibility in their interaction with landscapes.

It is probably naive to expect a set of social-ecological indicators to reverse the marginalization of indigenous and local communities in protected areas. Yet knowledge is power, and where the framework presented above can help traditional communities and conservation scientists to collaboratively generate knowledge about nature and its conservation, it becomes a mechanism for empowerment.

Acknowledgements

The authors thank J. Brown and L. Packer for their suggestions in improving this paper and J. Thompson for her editorial help.

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Customary sustainable use of biodiversity by indigenous peoples
Case studies from Suriname, Guyana, Cameroon and Thailand

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1. Introduction

The *Satoyama* Initiative is a timely effort to bring the world's attention to the fact that "*protecting biodiversity entails not only preserving pristine environments, such as wilderness, but also conserving human-influenced natural environments, such as farmlands and secondary forest, that people have developed and maintained sustainably over a long time*" (http://satoyama-initiative.org/en/about). In fact, focusing on highlighting the positive interactions between human societies and biodiversity and the rich variety of landscapes derived from this interaction during the evolution of humankind may well be one of the most refreshing actions proposed for the CBD's post-2010 journey.

From the initial discussions about the *Satoyama* Initiative there is no unified definition used to describe such landscapes, but the term "socio-ecological production landscape" is proposed to refer to the targeted areas of the initiative. "*These are generally characterized by a wise use of biological resources in accordance with traditional cultural practices that are compatible with conservation and sustainable use*" (http://satoyama-initiative.org/en/satoyama-like-landscapes/#more-110).

Although the initiative is new, it should be developed and implemented complementarily with existing Articles and activities of the Convention, especially with Article 10(c), which states that Parties shall: "*(…) protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements*" (http://www.cbd.int/convention/articles.shtml?a=cbd-10). The authors believe that the main content and nature of the *Satoyama* initiative and Article 10(c) are very similar as both aim to protect and encourage customary sustainable use that provides positive outcomes for biodiversity and human wellbeing.

In this paper indigenous peoples and support organisations from Suriname, Guyana, Cameroon, and Thailand provide insight in the sophistication of their local management systems, in particular their customary law systems, which guide wise use of biological resources. They also describe the threats that their customary management systems are facing. They end by providing recommendations to local and national governments about actions that should be taken in order to improve support for these age-old sustainable management systems and to effectively implement Article 10(c). The issues raised in the paper by these "10(c) case studies" should enrich the discussion on the development and implementation of the *Satoyama* Initiative.

This paper is based on case studies that were produced in each of these countries between 2004 and 2008. In the same "10(c) series", similar studies were carried out in Bangladesh (with the traditional resource users of the Sundarbans) and in Venezuela (with the Sanema and Yekwana peoples), but given space constraints, only the case studies from Suriname, Guyana, Cameroon, and Thailand are specifically explored in this contribution. All full reports are available online for further reading (http://www.forestpeoples.org/documents/conservation/bases/10c.shtm). All case studies were produced by trained community researchers and with involvement of as many community members as possible. Complementary to these reports, the communities have also produced participatory land and resource use maps combining traditional knowledge with Global Positioning System (GPS) and Geographic Information Systems (GIS) technologies. These maps illustrate the extent and scope of indigenous territories and the significance and importance of the territories and resources for the livelihoods of indigenous and local communities. The project has also employed a complementary approach between traditional knowledge and "modern" science and technology when trying to promote action for biodiversity conservation (such as training of community para-biologists in Venezuela).

2. Locations and communities

2.1 Suriname

The Lower Marowijne region is located in north-eastern Suriname, which is part of the Amazon.

A complex mosaic of savannahs and forests make up the landscape of the Wapichan territory in South Rupununi (Guyana)

The area is situated on the lower part and estuary of the Marowijne river, which flows into the Atlantic Ocean, creating a very diverse and rich ecological environment with coastal mangrove forests, elevated swampy forests (containing high species diversity of palms), and elevated dry land forests further land inwards. The area is home to eight indigenous (Amerindian) communities belonging to the Lokono and Kaliña peoples; approximately 2000 people in total. The case study, entitled *Marauny Na'na Emandobo/ Lokono Shikwabana* ("Marowijne: Our Territory" in the Kaliña and Lokono languages respectively), was produced by the KLIM, the organisation of Lokono and Kaliña in Marowijne, which has united the traditional leaders of all eight communities since 2003.

2.2 Cameroon

The first case study in Cameroon was prepared by a Cameroon non-governmental organization, the Centre for Environment and Development (CED), and the Baka people near Mekas, located on the western side of the Dja Biosphere Reserve. The forest peoples in Cameroon, pejoratively referred to as "Pygmies", are considered to be the first inhabitants of the Cameroon forest, and are divided into three main ethnic groups: the Baka, the Bakola/Bagyeli and the Bedzang. The Baka are the largest group. Their common feature is their attachment to the forest. The Baka communities of Canton Dja are not recognised as distinct socio-administrative entities. Rather, they are dependent on the Bantu villages to which they are culturally and socially attached. Since the research with the Baka of Canton Dja, more "pygmy" communities in southeast Cameroon (including Ba'aka, Baaka and Baka peoples) have documented their customary sustainable resource use in their territories that overlap the Boumba-Bek and Nki National Parks, which were established more recently (in 2005). Their experiences are also included in this paper.

2.3 Guyana

In Guyana the case study focused on the Wapichan indigenous peoples of south-west Guyana. Their territory in the south Rupununi region features a complex mosaic of savannahs and forests, which encompasses two major ecosystems: a savannah-grassland ecosystem that forms part of the Rio Branco – Rupununi savannah; and an extensive tropical forest ecosystem with a variety of vegetation types. The climate in the region in marked by a seasonal drought (September – January) and a pronounced rainy season which creates extensive flooding of low-lying savannah areas (April - July). The indigenous population in the South Rupununi numbers around 8395.

2.4 Thailand

The study area in Thailand is situated in the highlands of the western part of Chomtong district, Chiang Mai province, in northern Thailand. It is located in the Thanon Thongchai Mountain range and is covered with tropical forest very rich in biodiversity. Seven main highland indigenous groups live in Northern Thailand, among whom the Karen (15 villages, 7,200 people in the case study area) and Hmong (4 villages, 1,500 people in the case study area). They all have different languages, culture, customs, traditions and beliefs. The area consists of four watersheds with a variety of forests such as evergreen and mixed, pine and dipterocarp forest. The case study *Indigenous Knowledge, customary use of natural resources and sustainable biodiversity management: case study of Hmong and Karen communities in Thailand*, has been produced with support of IMPECT, the Inter-mountain Peoples' Education and Culture in Thailand Association. To reduce the length of this paper, only the Karen case study is referred to here.

3. Customary use of biological resources

Customary use refers to the use of resources by indigenous and local communities in a way that has developed over generations, based on experiences with places and species within the territory, seasons and climate conditions, methods of harvesting, hunting, fishing, or gathering, and methods of producing or processing resources into materials and artefacts. Customary use is thus closely linked to traditional knowledge and local culture, and also very closely connected to a particular territory. Some examples of customary use from the case studies are provided below (for many more examples and their full description please refer to the respective case studies).

3.1 Agriculture

The Kaliña and Lokono of Suriname practice agriculture using an age-old technique called rotational

farming or shifting cultivation. Agricultural plots are generally used for 2 years and then are left fallow for a number of years to regenerate. Bitter cassava is the most important crop grown. The Kaliña and Lokono have many ways of telling if the soil is fertile. For instance, they say "many awara trees are a sign of fertility". They often use joint labour in the farming plots called *moshiro* or *majoeri*.

Among the Wapichan people of Guyana, the same type of agriculture is practiced, and *Kanuzu* "bitter cassava" is also the staple crop. Shifting agriculture is practised over large areas that enable farmers to only re-use the land after considerable fallow periods. Wapichan farmers can also tell something about the fertility of the soil by the types of wild plants growing there. Similar to the Kaliña and Lokono, the Wapichan also carry out large agricultural tasks by hosting and taking part in a traditional *manoru* "collective work party". Several Wapichan households in the Rupununi have also reared their own cattle for generations.

For the Karen of Thailand, having enough rice to eat is the highest self-sufficiency goal. There are gardens, wet rice fields, swidden fields and cash crops in Karen communities. The *kheu* (swidden field) is an area of land cultivated for one year. Upland rice is the main crop but other crops are also grown that can be harvested for the entire year, such as taro, other tubers, corn, squash, cucumber, chili, and eggplant. As the *kheu* regenerates, the trees grow and there is much natural diversity, which attracts wildlife and provides edible wild foods. The Karen classify various soils, for instance *Haw kho su* (black soil) which is suitable for growing crops, such as sweet potato and chili. The Karen also use *Ta ma deu ma ka* (labor exchange) to help each other in farming. They also have domesticated animals and use the forest to graze their animals.

3.2 Hunting

For the Baka of Cameroon, hunting is not only a traditional livelihood activity; it also fulfils a social and cultural function. In the social hierarchy of the Baka, elephant hunters have a privileged position. The Baka distinguish two main types of hunting expeditions: the great hunt, which is for large game (elephant, boar, gorilla, chimpanzee, etc.) and is mostly practised during the long rainy season (*Sokoma*), and the small hunt, which involves small mammals and other rodents, and is mostly carried out in the dry season. Traditionally, hunting is carried out with assegais (crossbows). In addition to the lance (*mbɛnga*), the other tools used during the great hunting expeditions include hatchets (*kôbà*), knives (*nlɛmba*), bellows (*kômbà*), and the *mbomo*

Community rice harvesting by the Karen people in the highlands of northern Thailand.

contained in the *sawala*, used to make fire. Older methods include hunting with a net, and hunting by pursuit (with trained dogs).

The Kaliña and Lokono hunt for game animals like peccaries, tapirs, armadillos, and deer. Traditionally, hunters used bows and arrows (*L. Sarapa*) or a lance (a type of spear). Nowadays almost every hunter uses a hunting rifle. The hunters often erect scaffolding (*K. soela doepo*) near fruit trees that are likely to attract game, and wait there until the animals come. They do this in particular for nocturnal animals. The hunters have an extensive knowledge of the forest and must be able to read the "signs" in the forest. "*You have to know the forest: the animals' tracks and also their scent*", the hunters say. They know from experience which are the best spots for hunting, such as places where forest fruits (*podosiri* and *maripa*) fall and are eaten by the game, or at the upper courses of the creeks.

The Wapichan study documented 86 different wild meats that are eaten. Some of the most frequent animals hunted for food are the *aro* (savannah deer), the *sokoru* (agouti), *oran* (laba), *bakuru* (bush hog) and *kapashi* (armadillo). Most Wapichan hunters also own one or more hunting dogs that are used to flush out and retrieve game. Their ancestors used the kobin (blow-pipe) and poisoned darts to hunt monkeys, birds and small game. Today, blow pipes have been replaced by the shot gun, but the bow and arrow is still regularly used by Wapichan hunters. Trapping techniques used by earlier generations are still used today as is the ancient method of *watapukara* (beating up) game towards waiting *baichainao* (marksmen) who stand at agreed *zaudap kiizai* (waiting points) with a bow or shotgun.

3.3 Fishing

Fishing is an important source of subsistence for the Kaliña and the Lokono of the Lower Marowijne. They fish in the river, the sea, the creeks and the swamps throughout the whole year, although

the fish populations differ depending on the season and the fishing ground. The Lokono and Kaliña have many different fishing techniques. They mostly use the drift net (follet), but there are many other traditional methods, such as *Adaloko*, a hollowed-out tree trunk with an opening on one side. At low tide the trunks are lifted up and there are often fish inside. The Kaliña and Lokono also know how to use and prepare several plants to stun the fish. These contain intoxicating substances that are poisonous to the fish but do not affect human health so that the fish can still be eaten. The use of this method is bound by rules (see section 6).

The Wapichan people customarily use all the major and minor rivers, creeks, streams, lakes and ponds throughout the territory for fishing. The most common techniques involve the use of *kabao na'iki kobao zunaa* (hook and line), *kobawuzii* (fishing rod), and *somara na'ki bairii* (bow and arrow). At the start of summer, fish trapped in drying pools and streams are also collected by hand, with nets or through the use of poison. In these pools, they also use the method of *maradapaan* (stirring up silt) with their hands to bring fish to the surface to be caught. Traditional Wapichan fish poisons are also used to catch fish in pools in rivers and creeks in the savannah and bush. Similar to the Kaliña and Lokono, fishing with poison is carried out according to a number of customary norms and rules.

Fishing is mostly practised by Baka women during the *Yaka* season. The damming (or *gouma*) method is practised during the low water period. It is a team activity (up to as many as ten women) and the technique is to build a dam of mud across the bed of the running water in which fishing is to take place both downstream and upstream. The water in the contained portion is drained by one group of women while a second group searches the basin for fish, crabs and sometimes shrimps. This work is carried out to the rhythm of the women and children's songs.

3.4 Gathering materials and foods and use of wood

The forest also provides food in the form of forest fruits, materials for a variety of utensils, and medicinal plants. The Kaliña and Lokono have their own weaving techniques. Traditionally, weaving is used to make various utensils, such as a *matapi* (cassava squeezer) or *manaré* (*L. mokoro* or *tjiriki*), a sieve. Materials for weaving include *warimbo*, *awala-alempo* (top of the young awara palm), *kamina* (a forest liana; *K. kereresjimo*) and the top of the Mauritius palm (*K. meresji alempo*). In the Lower Marowijne various types of clay are collected by the Kaliña and the Lokono and used to make pottery. Traditionally, the indigenous women make their hammocks according to a technique passed down from generation to generation. The traditional hammock is made of cotton (*K. maloe*). The Kaliña and the Lokono also make use of a variety of species of wood that grow in the forest. Wood is mainly used for firewood for cooking and as a construction material for boats, houses or for wood-carving.

The Wapichan study has documented no less than 140 different wild foods, including fruits, nuts and fungi that are customarily gathered by the Wapichan people. Detailed knowledge of the location of fruit-bearing palms and trees is passed down from generation to generation. The territory also contains over 250 useful materials that are used for constructing houses, boats and a wide range of traditional Wapichan craft items, food processing utensils and household tools. Favoured construction and craft material sites are reached by specific lines or via existing hunting and fishing lines. Forests, wetlands, mountains and savannah habitats in *Wapichan wiiz* (Wapichan territory) are also home to a rich variety of plants and animals that the Wapichan people use to make traditional *kasarai* (medicines).

The Karen build houses from wood. They also use wood for other purposes in their daily life, including basketry. Baskets are usually made out of green bamboo and rattan. The production of natural dyes is another form of indigenous wisdom that makes use of forest resources. The women use natural resources, such as tree bark, to make dyes. There are many types of plants and trees that the Karen use for medicinal benefits. They are used as pharmaceutical preparations for curing and preventing diseases as well as providing extra energy.

Baka harvest most of their food resources through gathering and picking. They gather a great variety of products in the forest such as wild fruits (bush mango, *Moabi*, *Mvout*, etc.), mushrooms and several varieties of wild yams. Honey harvesting is of

Forest honey collected by the Baka, Cameroon.

great importance to the Baka. The Baka distinguish several types of honey depending on the melliferous insect involved. Baka honey harvesting techniques are highly developed and involve a number of different tools such as hatchets (*kôbà*) and a smokehouse made of a lighted clump of grass. In addition, *mofouab* and *koko*, two herbaceous plant species, help protect the harvester from bee stings when rubbed on the body. The honey collected is preserved in a container made for this purpose from *moko* leaves.

4. Spiritual connections with the natural world

All case studies demonstrate that spiritual beliefs and cosmological views guide the care for territories and resources. Below are abstracts from the case studies that describe how the communities view their relationship with the natural world.

The beliefs of the Karen are based on the philosophy that everything has an owner, God (*Yawa*), who created all things. For natural things, the Karen use *ta* ("thing") as a prefix which has the special sense of "things that are unseen", a supernatural force or power that creates all the natural things that are essential to the world and are interrelated, supporting each other directly and indirectly. All natural resources have a *ta* as its owner or master. The Karen honour the *ta* as the owner of all natural resources for all time: humans are not the owners of natural resources, but should be responsible users. Similarly, wildlife is sometimes referred to as *ta mi la*; or *as cha po kaw po* or *tap o ka pga pu*, meaning "animals that no one controls or owns".

According to the Kaliña and the Lokono everything on earth, as well as things that Westerners consider non-living such as stones, clay and water, is alive and connected. All animal, plant and fish species, as well a stones, creeks and rivers have a spirit that protects them and that humans should take into consideration. Preserving the right balance between man and nature is of prime importance.

Similarly, many Wapichan customary norms are underpinned by a belief that the whole territory is populated by spirit beings. The Wapichan explain in their case study: "each species or family of animals and plants is believed to have their own spirit *dokozuu* (grandfather) or *tapiki* (keeper). These keepers watch over their offspring and oversee their movements and welfare. We believe that the spirit keepers of the animals *wamakarodapa kandon* (feel hurt) when their children are wasted or tormented. This is why we cannot punish, waste or abuse these beings", the Wapichan assert.

The Baka believe in God the creator, *Komba*, who moulded all things and all beings from a shapeless but living matter. It is his spirit or the spirit of the forest, *Enjengui*, who protects man but also presides over his life, his death and his rebirth as a Forest Spirit. For the Baka, the forest fulfils many economic, social, cultural, religious and recreational roles.

5. Customs and rituals related to natural resource use

Due to the spiritual relationship the communities have with their environment, they have certain customs and rituals when they are interacting with the natural resources. Some customs could be described as "seeking permission and good fortune"; others simply demonstrate unwritten agreements related to being respectful and avoiding upsetting spirit beings. Below are a few examples.

From early times Kaliña and Lokono hunters have followed different traditional practices to ensure that they get a good catch and that everything goes well for them in the forest. Before the hunter leaves his home and goes into the forest, it is customary to sprinkle some water and to talk to the spirits that they may remove all evil from his path and that he may have good fortune. Similar rituals are followed in the farming plot. The Kaliña and Lokono also comply strictly with the rule that menstruating women are not allowed to go to their agricultural plot and may absolutely not go near water to prevent them from upsetting spirits. Fishermen may not urinate or defecate in the water. They may not curse, allow blood to enter the creek or throw dishwater, pepper, oil or fish remains into the creek. Nor may they throw fish intestines into the water, otherwise, they say, this will chase the other fish away. These have to be buried of left out for the vultures. The same applies to the sea.

The Wapichan have similar rituals in the farming plots. Before felling trees, it is customary to "appeal to the tree spirit keepers". Fishermen may not provoke the fish keeper spirits and other water spirits. They may also not wash land turtles in the water. Extraction of forest materials sometimes involves communication with the spirit owners of these resources. Conversations with the spirit owners of medicines and charm plants, for example, are accompanied by the ritual use of tobacco in which they "appeal" to the spirit and "ask" for permission to take the plant. When Wapichan go hunting, animals may not be "toyed" with. There is a saying *Ipai wunui aonaa turuu ibaniko* which means "do not torment game".

Before Karen use natural resources, they also perform certain activities to contact the supernatural protector to ask permission and its blessing. The ritual "Propitiating the Lord of the Land" (*pha thaw me kho*), for example, shows their respect for the Lord

of the Forest and the Lord of the Mountain to inform them about the villagers' intentions in entering the forest to hunt. Within the agricultural system, there are many rituals related to the soil for different purposes, such as asking for blessings, warding off threats, propitiating fire, nurturing the rice soul, and propitiating the field to chase out evil. The Karen also have taboos against defecating or urinating in water, throwing rocks in water, and sticking poles in mud, for fear of angering or hurting *na thi*, the Lord of the Water. When hunting, no loud or coarse noises should be made in the forest on a hunting trip in order not to demean its sanctity. Herbal medicines should not be collected on certain days (e.g. on a day that a child in the village is born or on a day that someone in the village has died). Furthermore, women should not collect herbs while they are menstruating. If any of these taboos are broken, the medicinal herbs gathered will lose their sacredness and have little or no power. In order to gather the herbs, permission must be asked of the Lord of the Land and tobacco or coins left in place of the herbs.

The Baka perform a hunting rite to make the hunter invisible while hunting large mammals, in particular the elephant. The rite entails a divination session where the diviner *ngàngà* reads from the flames of a large log how the hunt should be conducted and the direction to take. The *mònjòyì* dance, performed collectively, enables the hunters to become invisible. The *mòkàtò* ritual is a rite performed following a series of unfruitful hunting expeditions, which are believed to be caused by disorder, misunderstandings and disputes in the community. Another pre-hunting ritual is one intended to attract the spirits' attention by showing them the effects of penury. The rite of initiation to the Forest Spirit, which marks the passage from adolescence to adulthood, is the most important rite in the life of young Baka men: it is during these initiation ceremonies that the youth learn about life in society, the craft of the hunter and the mysteries of religion.

6. Customary laws and rules for sustainable use

There are many unwritten rules and laws that apply to the sustainable and sensible use of resources in these communities. These are intended to make sure that over-use is prevented and that there will be sufficient or – even better – plentiful resources for future generations. Below are some examples from the cases, grouped under a number of main common rules.

6.1 Do not waste or overuse (take only what you need)

Several rules were documented in the form of quotes from Kaliña and Lokono hunters and fishers. For instance:

> *A pingo is a big peccary. If you've gone far away to hunt, you can only shoot one, because you can't carry more, so it's useless to shoot more (...) because you'll] end up leaving it behind.*

The same rules apply to the use of plants and wood:

> *You may not cut wood just like that without making use of it; You may not cut open the forest for no reason. The land must genuinely be cultivated.*
>
> *I use everything, down to the last shavings. I use the leftovers to repel mosquitoes [with the smoke].*

The Wapichan have many similar general rules, such as: *madi waap i tap kuo* (do not act without reason), and *madiwaaitapkao* (do not practice wasteful activities). For hunters, fishermen, farmers and gatherers, some rules are:

> *Do not kill all; kill only what you need and can consume (hunt only when there is no meat).*
>
> *Do not punish hunting grounds (do not over-hunt); do not waste the land; cut only enough for your capacity and needs; do not use the land foolishly.*
>
> *Do not cut farms where there are many trees with edible fruits; extract all useful craft and construction materials before burning; do not fell bountiful and sweet fruit trees (bitter and low yielding trees may be felled) and do not fell fruit-bearing Ité trees (older, dying and unproductive palms may be felled).*

Heads of farming settlements feel a duty of sensible use and protection towards the natural resources within and adjacent to their home area. According to custom they cut fields to the size that they are able to use effectively.

Karen women and children taking part in the ritual ceremony *Lue Pwa* in conjunction with the setting up of a community aquatic biodiversity conservation area, Mae Ya watershed, northern Thailand

When the Karen look for food, they do so according to the season and divide periods for consuming certain forest products appropriately. When one kind of edible plant is abundant in the forest, they do not consume much of other types of produce. They only collect what they need to eat. Collecting more than necessary is viewed as wasteful. Traditional hunting rules place limits on the catch and prevent over-hunting. No more animals can be taken than can be eaten at one time. A really important thing is to prevent forest fires, since this can destroy the forest ecology. When building a house, the main principle used to choose trees is that they must be of an appropriate size and must be easily and conveniently cut without destroying the surrounding ecology.

6.2 Make sure a resource can recover

As with the rules intended to prevent overuse or waste, there are also commonly understood and practiced rules that prescribe that all used resources must be able to recover – this is of course also related to the rule "don't use all".

The Wapichan apply the traditional practice of rotational farming, hunting, and fishing. Young Wapichan farmers are taught by the heads of the farming settlements that they should *mariniya'ataan* (leave off) fields and let them *sookapkidan* (rest) after a few harvests of cassava so the soil is not punished. The same principle also applies to hunting or fishing (using different hunting grounds and different pools or fishing grounds). In the case study, the Wapichan explain: "*Traditionally our grandfathers sent messengers to neighbouring villages to find out where and when they last used a specific hunting area. If the area intended for hunting had been used recently, they would decide to go elsewhere. This way they used to rotate their hunting grounds. Our village Toshaos still follow this method today when they organise village hunts*".

The Wapichan have the custom to, wherever possible, harvest fruits or other materials without felling the tree. Fruit is traditionally harvested by climbing the trees, building a platform or using a gaff to bring down fruit. When cutting timber trees, they take care to ensure that they fall without damaging younger timber trees growing nearby. Another tradition is to protect areas with a local abundance of craft, medicinal or construction materials that are scarce elsewhere. As a rule, those collecting craft and construction resources only cut the mature materials that are ready for use and leave young plants or trees to grow on for future use. Fish poison may not be left in the creeks, fish traps should be dismantled after use, and fish moving upstream to spawn cannot be caught.

Similarly, the Kaliña and Lokono say:

Avoid pregnant game because if you shoot the mother, next time there will be fewer young. We leave the small ones (animals) alone and choose the older ones from the group.

You may not cut down a tree that is too small; also, wood species that have just started to grow may not be cut down. They have to be protected.

Warimbo stalks must be cut a bit above the ground. The roots then remain intact. After a while these roots grow again into a full-grown warimbo.

Based on their experience in natural resource management, the Karen have found that if they clear brush and trees in the rainy season, the plants will die. Therefore, they do this in the dry season. The Karen also never destroy water sources. They do not disturb springs or the area around a spring. Collection of forest plants must be dispersed, rather than always from one area. For example, when collecting bamboo shoots (used for basketry), one should not collect from only one clump but rather from many clumps in order that some shoots will grow into mature bamboo. The same goes for collecting herbal plants (herbal medicines). Only the amount that is needed will be collected. If three of any large animal have already been killed, no more of that kind can be killed for the rest of the year. It must be shared among the community. Another rule is that no hunting of forest animals is allowed during the breeding season. The Karen will not fish between June and August. This is the period when the fish spawn so the fishing prohibition allows a greater number of fingerlings to develop.

Traditional Baka hunting and gathering practices are also aimed at sustainability. The Baka damming fishing technique is highly selective as it allows the harvesting of only those fish of an appropriate age and size for consumption, while the young fish are left in the rivers and streams to ensure their reproduction. The sustainability of this technique is enhanced by the fact that the catch is intended only for personal consumption and the volume fished remains fairly low as women ensure a sufficient amount of fish are left in order to allow for stock renewal during their river rotation. Hunting with the *assegai* (crossbow), the traditional hunting method, is compatible with conservation activities and sustainable management of wildlife given its high selectivity. The Baka never kill females and the growing young ones.

6.2 Avoid taboo, sacred or otherwise special areas or species

The Kaliña and Lokono have certain animals and plants that are to be avoided altogether. These in-

Sea turtles are a protected species for the Kaliña and Lokono (Suriname)

clude *tapijt* snakes (boa constrictors), manatees, dolphins and river otters. Sea turtles also fall within the category of animals that may not be killed because it is believed that the grandfather (guardian spirit) of the sea turtle will become angry and will make the guilty person, or his family members, ill. Within the indigenous territory of the Lower Marowijne there are also certain places that count as sacred or spiritual sites. These areas are either completely avoided or only visited for hunting or fishing during the day, not at night, or alternatively only entered by a *piay* (shaman). Various trees, such as the *takini*, *kumaka* (kapok tree), *uremari* or *urewari*, and the *kwasini* (fig/forest cotton) may never be cut down, because evil spirits live in these trees and if you cut that tree, that spirit will do you harm. The juice of the *takini* is drunk and the bark of the *uremari* is used to make the cigars that the shaman uses during his sessions.

The Wapichan also have certain "sensitive places" in their territory that are occupied by spirit keepers and other spirits. These should not be disturbed. Places such as big lakes, certain mountains, areas with rock engravings, rocky outcrops and some mineral springs are especially sensitive. Wapichan tend to avoid these areas that they call *akaa ki kiizai* (dangerous places). If someone wishes to visit such an area, then ritual precautions must be taken. Failure to follow the proper procedures can cause a person to *shokordianni amazada* (offend the spirits in a place). Fishermen also avoid certain stretches of river and some perennial *baoko* (deep pools) inhabited by *kadorari* (water spirits). Trees that are considered "spiritually dangerous" are avoided and the rule says "do not feel such trees".

There are some forests that the Karen have declared as *pga ta deu* (taboo forest), which cannot be used to perform any activity that will disturb the ecology. The people believe that powerful spirits known as *ta meu or ta kha* inhabit the forest and are there to protect it. The *thee kho me* is forest surrounding the headwater springs above agricultural areas. These are areas of fertile forest that are moist all year. It is believed that the spirits of the forests and mountains inhabit these areas, that they are the source of the headwaters. These areas are conserved and not used for agriculture. It is forbidden to disturb or perform any activity in any of these areas. Equally, the Karen have seven categories of water based on their spiritual beliefs, such as *Thi mae ker la* (crystal water basins) *Thi per thaw* (springs) *Na u ru* (water coming out of a hole). Each of these places has its own spirits and rules for use and protection.

Some particular species, such as the sacred fig, the banyan, and *Hopea odorata* are believed to have fierce lords. The Karen also believe that this is the tree of human life. The Karen consider some animals *acho aker maw ko* (high status), such as tigers, barking deer, jungle fowl, wild cattle. Great care must be taken in hunting these high status animals. The Karen believe that representatives or spirits of the animals, or water and land spirits, can take the form of these animals, hence their high status. The Karen also have taboos and customs regarding the use of various types of firewood.

7. Control mechanisms

Although the rules, or "indigenous customary law", have not been written down in most communities (until the research done for these case studies), most community members know and respect them. Nevertheless, there are several control mechanisms that ensure compliance with the rules.

7.1 Dependency

The fact that communities are traditionally dependent on the resources for their very survival is in itself a potent stimulus for sustainable use. As the Karen say: "*not conserving these resources is like destroying your own life*". For the Karen it is essential to rely on forest resources for their livelihood. The Wapichan people also say that they have a responsibility to *karodopan* (care for) the land and its resources in order to maintain abundance for present-day communities and for future generations, who they call *wa daini nyao ati'i nii* (those coming behind us). Fishermen from the Suriname study said "*if you kill all those fish, what will you eat tomorrow?*"

7.2 Internal control

Internal controls by traditional institutions or elders (for instance warnings and sanctions), or control (or criticism) among community members are also effective.

The Karen have "guardians" of the regulations who operate at many levels. At the community level, the

guardian is the village leader called *hi kho*, who is a traditional leader and the main guardian of the village code. For example, when the planting season arrives, the *hi kho* will set the date and time and prepare the New Year ceremony, called *nee saw kho*, in advance by telling the people in the community to prepare themselves. After this, the *hi kho* reminds them to act well, to work hard and not to create situations that bring trouble to the community. When the time comes to choose the area to plant the swiddens, this is done with respect paid to the natural resources, which are requested to share their bounty and help build good things for the families and the community.

Among the Kaliña and Lokono, the customary rules are also enforced by internal control. The village administration also plays an important role in complying with and enforcing traditional rules.

In the eastern and southern part of the Wapichan territory, there are owners of personal hunting lines. A *kaponaa tin pia'o* (hunting line owner) is recognised as the person who cut a particular line (or his descendant). This person has prior rights over access to his hunting line, as well as a responsibility for sharing its use and for overseeing the proper exploitation of the associated *tiwaapa kiizai* (hunting ground). They keep a watchful eye on who is using their line and try to check on the contents and size of game bags if hunters pass by on their return home. Local line owners thus fulfil a monitoring role as they assess the abundance of game through personal observation and through their knowledge of the rough numbers and kinds of game killed along a line over a certain period of time. If a hunter takes too many animals, line owners explain that they feel "hurt" and will advise the hunter to be more moderate in the future.

In the western and northern parts of the territory, where there are few individual lines, hunting is mostly centred on particular mixed hunting and fishing areas known as *tapaoraz,* which are reached via community lines. These hunting and fishing areas are associated with local family heads, who live in the vicinity and traditionally watch over and care for the game, fish and other useful resources in their area. These local leaders are sometimes referred to as *pidan tapaoraznao* (people of the hunting and fishing grounds). These leaders are respected members of the communities who have an intimate knowledge of the resources and wildlife in their neighbourhood, and hold important spiritual knowledge about the locality. Traditional decision-making processes are today articulated with elected Village Councils and District Toshaos Councils , which functions to manage collective affairs. If rules on resource use are broken, traditional sanctions may involve ridicule, ostracism, verbal chastisement in public, or imposed village labour, coupled with a warning from the Toshao.

7.3 Role of spiritual beliefs

Many Kaliña and Lokono believe that if the balance between man and nature is upset, by incorrect or excessive use, there will be "spiritual sanctions" in the form of diseases, accidents or misfortune that the violator or his family may suffer.

> *If you do not comply with the rules, the following things may happen: you become ill, you lose your way and never return home; or you have an accident in the forest.*

The shaman, who is called the *piay* among the Kaliña and semechichi among the Lokono, plays an important role in maintaining this balance. He (or she) is the person who has contact with the spiritual world and through the medium of his or her guardian spirits or guide spirits (K. *jakoewa*) discovers whether someone has acted wrongly or made a mistake. The shaman then acts as intermediary, with the help of these *jakoewa*, to seek forgiveness for the violation committed.

The Karen, for example, have the rule that trees that are used as offerings for the spirits of the cows and buffalo (*ta peu jaw a thoo*) are not allowed to be cut or used for anything else. If anyone breaks this taboo, s/he will be punished by the guardian spirit or the spirits of the forest and mountain.

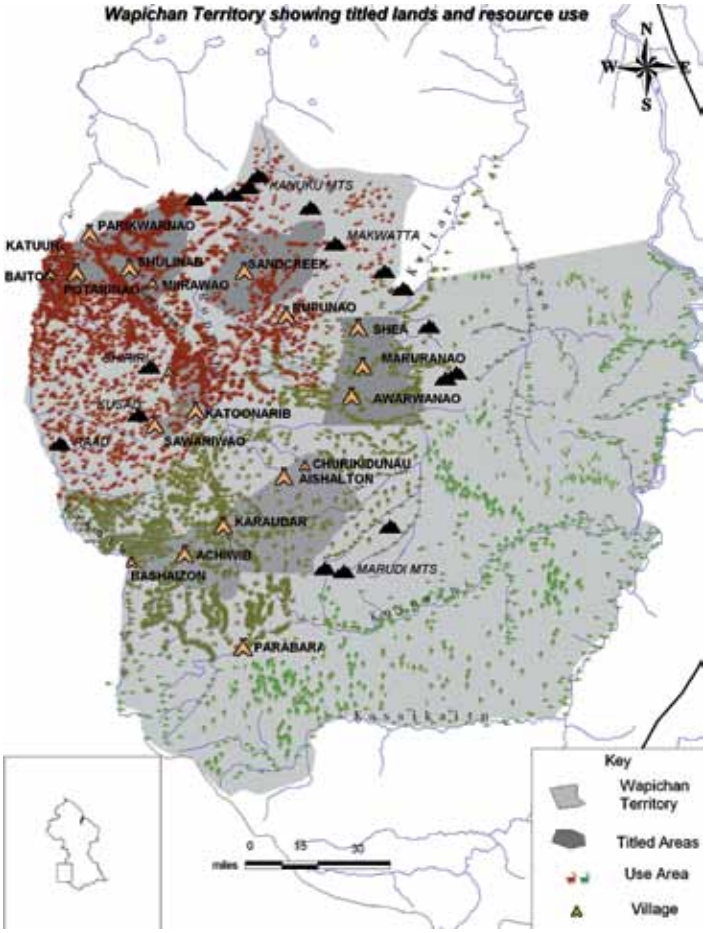
The Wapichan also believe that those who break customary norms risk spiritual punishment from environmental spirits that may cause illness and misfortune. Respect for cultural norms on proper social behaviour also stems from the widespread and complex belief in supernatural *kanaimo* spirits who bring sickness and death on those who have wronged them.

8. Challenges and threats to customary sustainable practices

The customary sustainable practices described above are in many cases under pressure or threat, due to various reasons. Some key issues and challenges are summarised below.

8.1 Lack of secure land and resource rights

Secure rights to land, territories and resources, including access, control and management of those resources, represent a fundamental requirement for the communities to maintain and practise their customary use and traditional knowledge in their daily



Map of the Wapichan territory, showing the traditional territory in light shaded grey and the limited titled areas in dark grey. © Wapichan communities

interaction with biodiversity. Customary use and practices cannot be disconnected from the resources in their traditional lands and territories.

In the highlands of Northern Thailand, the lack of title to agricultural and residential lands is one of the main problems affecting the Karen and Hmong peoples and causing insecurity in resource management. This is a result of Thai laws that have placed certain areas under the direct administration of government agencies, such as the laws concerning National Reserve Forests, National Parks, Cabinet resolutions and the Land Act. These laws have created obstacles for highland communities to claim their rights. A number of articles of the 1997 Thai Constitution do provide legal protection for communities to participate in the use and conservation of natural resources and support indigenous peoples' access to natural resources and biodiversity, but in reality, there is little political will to reform national laws to bring them in line with the Constitution and the CBD. The government continues to strictly enforce outdated forestry laws, sometimes even resulting in the arrests of indigenous peoples and the relocation of communities out of the forest.

In Suriname the indigenous territories are legally classified as State lands. The State formally owns, governs and manages them. Indigenous peoples' right to collectively own, control and manage resources is not recognised in Suriname's laws. In some villages (individual) titles are issued to outsiders. City dwellers come to own the best properties along the river, leading to reduced access to the river for community members to moor boats, fish, bathe or wash clothes.

Lack of secure land and resource rights is also a major and long-standing livelihood issue affecting the seventeen Wapichan communities in the study area. In 1976, ten Wapichan communities received title to part of their lands. These titles were issued without regard for Wapichan traditional occupation and use of their lands and resources. As a result, five communities do not have title to land, while the rest have title to only parts of their traditional lands. More than half of the Wapichan's major and minor settlements and a large part of their customary farmlands, hunting, fishing and gathering grounds lack the protection of legal land title. The leaders point out that the current land titles are too small to provide an adequate land base to enable their people to practise their sustainable traditional livelihood. A problem for example is that farmlands within titled land are becoming exhausted.

The Baka predominantly face problems resulting from the fact that major parts of their traditional lands have been made into protected areas, leading to a serious reduction in lands they can access and use (see section 8.3).

8.2 Lack of recognition of customary laws and institutions

As we have seen under the section on control mechanisms, customary institutions (such as village councils) enforce customary laws and make sure they are respected. If these are not respected and recognized by national or local governments and laws, which is often the case, customary practices may become undermined.

For instance the traditional authority of the Kaliña and Lokono has never been legally recognized by the national government. Nor is the traditional, unwrit-

The *moungoulou* is a traditional Baka hut constructed to suit a nomadic lifestyle

ten law recognized. As a result the village leaders are unable to enforce their rules vis-à-vis outsiders such as sport hunters who shoot game and then leave it behind to decay. The new Amerindian Act also precludes legal recognition of the collective jurisdiction of the District Toshaos Councils over the full extent of traditional Wapichan lands and territory.

8.3 Imposed protected areas and conservation policies

The establishment of protected areas without respect for forest peoples' rights and their full and effective participation is posing challenges to indigenous and local communities in terms of both access and management of biological resources. This again has major impacts on the customary sustainable use and related knowledge of the communities in these areas.

In Cameroon, the Forestry Law imposed restrictions on most Baka activities around or inside the Dja Biosphere Reserve. Wildlife Reserves in Cameroon are areas set aside for the conservation, management and pure propagation of wild animal life, as well as for the protection and management of its habitat. Hunting is forbidden, except by authorisation of the Minister responsible for Wildlife, as part of duly approved management operations. Human dwelling and other human activities are regulated or forbidden. These provisions greatly restrict the Baka's access rights to the forest resources of the Dja Biosphere Reserve. If in theory the Pygmies are free to hunt within the reserve using traditional methods, in practice, the Baka of the Canton Dja in Bengbis are subject to daily harassment and persecution by forest guards. The recently established Boumba-Bek and Nki National Parks (2005) largely exclude the Baka communities in southeast Cameroon from the park area. Denied access to, and use of, their ancestral territories, the Baka have had their livelihoods, health, culture and knowledge, severely affected.

In Northern Thailand, the establishment of two national parks which partly overlap the traditional territory of the Hmong and Karen indigenous peoples (Doi Inthanon and Ob Luang National Parks) caused many problems for the Karen and Hmong's customary use practices in those areas. The Wild Animal Conservation and Control Act of 1960 created areas for the conservation of forest animals by banning people from occupying, cutting trees, or clearing land on which their livelihoods depended. The National Park Act of 1961 created more areas where people were not allowed to perform any activity. When these national parks were created, communities living in those areas were not informed or consulted, leading to significant problems, including conflict between lowlanders, highlanders and national park authorities in the late 1990s. The National Forest Preserve Act of 1964 allowed local officials to demarcate the boundaries of protected forest themselves without consultation with members of the public, effectively turning many villagers into illegal trespassers. Customary practices, such as rotational farming, were banned. Only during the past five years, due to the community mapping project and the 10(c) study carried out by the communities as well as a joint management pilot project promoted by the government, has a successful co-management agreement been reached in the case of the Ob Luang National Park. This local success, however, has not been translated into reform of the national protected areas legislation.

Two protected areas have also been established in the territories of the Kaliña and Lokono communities in Marowijne (Suriname), without informing the communities or seeking their consent. This has been having negative effects on the communities' use and access of the concerned areas. In Guyana, no proper participatory process has been set up to develop a management plan for the proposed Kanukus Mountains Projected Area (KMPA) with the Wapichan people, despite the fact that half of the park overlaps the Wapichan's territory.

More detailed studies have been produced specifically on the issue of protected areas and indigenous peoples' rights in Suriname, Thailand and Cameroon, and are available online. (Suriname: http://www.forestpeoples.org/documents/conservation/wcc_suriname_pa_review_oct09_eng.pdf, Cameroon: http://www.forestpeoples.org/documents/conservation/wcc_cameroon_pa_review_jul09_eng.pdf, and Thailand case study forthcoming.) Case studies from other countries (such as Panama, Uganda, Malaysia and the Philippines) can also be found here together with other information on the

issue (http://www.forestpeoples.org/documents/conservation/bases/parks_base.shtml).

8.4 Lack of recognition and respect for the importance of customary sustainable use for biodiversity protection

The case studies demonstrated that customary sustainable management of natural resources is often ignored in conservation or development policies and programmes as these do not support or promote communities' traditional ecological principles and knowledge about sustainability and conservation. Lack of appreciation of customary sustainable management of natural resources frequently results in top-down natural resource management and conservation approaches that exclude and undermine customary practices. In the long term, this can undermine the vitality of these systems. In many cases, the situation is even worse; biodiversity loss is unjustly (or due to ignorance) blamed on indigenous peoples and local communities' activities and therefore customary use and management are severely restricted or even eradicated.

In Thailand, the practice of swidden agriculture by indigenous peoples is depicted as "destructive to the forest" since water shortages have started to become a serious problem. Highlanders, however, observe that they have practiced swidden agriculture for hundreds of years without the streams running dry and that water shortages have only started to become a serious problem after the introduction of water-thirsty fruit plantations in the lowlands and new agricultural systems and pine plantations in the highlands. Under pressure from government policies, many highlanders have reduced or abandoned swidden agriculture, and adopted chemically-dependent cash cropping, which, as the Karen say, is disturbing the natural environment. Cash crops use much more water than swidden fields, which had water-retaining plants such as wild banana. Abandonment of the swidden method has further led to a decrease in plant varieties, a decrease in the health of certain species, and problems of weeds taking over the paddy fields.

Guyana developed and adopted a National Biodiversity Strategy and Action Plan (NBSAP) in 1999. It does note the need for more research on "traditional methods" of sustainable use of biological resources, but does not recognise the contribution of the indigenous peoples of Guyana to the sustainable use and conservation of biological resources. Instead, the existing national policy tends to see indigenous peoples' resource use primarily as a potential threat to biodiversity and the environment.

Mining concession impacting on traditional lands of Kaliña and Lokono in Marowijne, Suriname

In Suriname, the value of traditional knowledge in biodiversity conservation and management is hardly taken into account in official circles. On the contrary, in many official documents and management plans for the national protected areas, the state announces strategies to "educate" indigenous and local communities on conservation issues and sustainable use.

In Cameroon, the Baka's tradition of sustainable use and management of the resources has not been acknowledged when the Boumba-Bek and Nki National Parks recently gained recognition as "areas of high natural biodiversity". In the plan to manage the national parks, the traditional knowledge and practices of the Baka are not considered or incorporated. Unfortunately, rather than seeking to understand the particularities of the methods used by indigenous peoples to manage forest resources, the Baka are expelled from their lands.

8.5 External pressures on traditional lands

Apart from imposed protected areas, all the communities involved in the case studies are facing other external pressures that impact on their access and use of (parts of) the territories, such as mining, logging, and commercial use. Destruction of areas and/or reduced access to resources leads to a decline in customary sustainable use and traditional knowledge.

In Marowijne in Suriname, unsustainable commercial bauxite mining and logging take place in important community use areas used for hunting, gathering, and fishing. As a result of the construction of roads and the noise of the heavy equipment, as well

as outsiders coming into the area to hunt, the game is retreating further into the forest. In addition, where logging is taking place on a commercial basis, the game population is dropping. Game also diminishes where certain tree species that bear forest fruits are cut down. Another problem is the illegal fishing boats from Guyana that regularly fish in the Marowijne River estuary. They use nets that are kilometres long, which result in overfishing.

Wapichan traditional lands in the Rupununi are currently under threat from mining, agricultural development (large-scale rice and soya farming), oil exploration, logging concessions and illegal hunters and cattle rustlers from Brazil. Mining in particular is a major problem and is already causing adverse environmental impacts on (untitled) Wapichan lands. Mining activities are causing deforestation and river pollution and there are growing concerns about new mining concessions. Further threats are posed by a major paved highway planned under the Guyana-Brazil "interconnection" road project sponsored by the Initiative for the Integration of Regional Infrastructure in South America (IIRSA).

Karen villages suffer negative impacts from government policies as well. This trend began decades ago with the Thai government's policy of promoting the cultivation of opium in the highlands as a means of collecting tax revenues from opium production. During the past two decades, as opium became demonized, international money was poured into the region to eradicate it and train the indigenous peoples to grow chemically-dependent cash crops. All these external interventions have caused severe impacts on customary sustainable practices.

Indigenous peoples' right to Free, Prior and Informed Consent (FPIC) is important to protect customary sustainable use from external threats such as extractive industries that destroy areas, or deny access to areas, where communities practice customary use. However, in many countries FPIC is not institutionalised (not reflected in national laws) and not applied (and not fully understood).

8.6 Mainstream education and assimilation policies

In the case studies, the communities describe that when they transmit traditional knowledge, three aspects are particularly important: language; access to areas; and learning by doing. Local languages are especially essential as they capture the particular knowledge the communities have related to the natural resources and their use. The Baka for instance have many terms for particular kinds of elephants and honey, which cannot be translated or explained in another language. Education in their own language and on issues that relate to their environment and related knowledge and practices are therefore vital to maintain customary sustainable use and traditional knowledge. Many current education systems however, are aimed at assimilation and are enforcing non-indigenous languages on indigenous children in the schooling system. This can lead to the loss of indigenous languages, local knowledge and related practices.

Education in Suriname is almost entirely conducted in a language foreign to the communities (Dutch) and a foreign culture (town culture). Education also makes it less easy for the children to accompany their (grand)parents to the field to obtain practical experience (e.g. during hunts, while fishing or farming). As a consequence, traditional rules risk being lost. In Guyana, any use of Amerindian languages in class was forbidden under previous school rules for many years. This weakened the use of the mother tongue among younger people, who have come to use English as their first language.

External interventions aimed at assimilation of indigenous peoples in to mainstream society in general ("development", "education", Christianisation, etcetera) are equally undermining the indigenous communities' traditional management systems.

This is probably most visible among the Baka. Traditionally, they lived in small camps in the forest, moving every three to four days. Under the impact of the policy of sedentary settlement instigated by the colonial administration and pursued after independence, they have gradually settled along the pathways in Bantu villages. Governments have also made many efforts to convert the Baka hunter- gatherers into farmers, which is more suitable for a sedentary lifestyle. This, combined with the influence of conservation projects and the introduction of money as a medium of exchange, has considerably influenced the lifestyles of the Baka and their customary sustainable management practices.

Trapping, for instance, is not a traditional Baka practice, and is also incompatible with the traditional lifestyle of the Baka, which is based on mobility. However, the Baka have now learned to use this method from their neighbours. It is a way for them to escape the notice, and avoid the reprisals, of the forest guards. Such traps do not discriminate between the age or size of the animal, unlike hunting with an assegai or crossbow which permits the hunter to choose his prey. Moreover, each hunter sets more traps than he is able to monitor so some animals captured in traps decompose and are uselessly lost. Equally, the sustainable assegai method

is threatened by the introduction of firearms, another destructive method. With the use of firearms, the hunt also loses its cultural aspect and becomes a purely economic pursuit. The Baka do not own any firearms themselves but are paid to hunt for the owners of the weapons. Other unsustainable practices that are taken over from non-Baka neighbours include line and poison fishing.

Since the early 20th century Wapichan people have adapted to new institutions like churches and schools in their communities. These institutions have brought changes in the settlement pattern as the villages have become larger and more permanent. Such institutions undoubtedly brought some cultural impacts. Some churches, for example, have sought to forbid their congregations from using traditional shamanic healing services, which has undermined the public role of the *marunao* (shaman) in some communities. In Suriname, the religions that have been introduced in the villages have also impacted on traditional knowledge. Similar to the Wapichan, traditional beliefs and practices were forbidden for long, and many people who became Christians no longer know or uphold traditional rituals and practices. Moreover, the growing influence of the monetary economy (everything costs money nowadays) is also playing a role in the decline of traditional knowledge and culture as youth increasingly look for jobs to earn a fixed income.

The Karen have also seen many trends of so-called "development" from outsiders, who view tribal people as "backward, lazy, or generally underdeveloped". All of these policies share a common objective: to change the lives of highland communities to conform to the expectations of outsiders. An important "solution" proposed by outsiders is the cultivation of only a few cash crops. As a result, great changes to the Karen way of life and methods of production have occurred. These modern agricultural practices are known to be ecologically harmful and are not in line with traditional agricultural practices. The introduction of religions different from people's traditional beliefs has also had an impact on the communities' customary use and traditional practices. Some villages have been influenced by Christianity, which has resulted in discontinuation or an initial devaluing of the communities' traditions beliefs and practices, although over time, many groups adapted their new beliefs to the traditional beliefs of the communities.

9. Conclusion: recommendations to enhance customary sustainable use

The community researchers involved in these studies have elaborated the following recommendations to enhance customary use of biodiversity and the implementation of Article 10(c):

1. Take measures to recognise and respect indigenous peoples' rights to their lands and resources.

2. Recognise the role of customary law and traditional institutions and freedom to use customary laws related to biodiversity use rather than rules or laws imposed by others.

3. Recognise the right of indigenous and local communities to fully and effectively participate in natural resource management and decision-making.

4. Take concrete actions to acknowledge the value of customary practices and traditional knowledge in relation to biodiversity conservation and sustainable use, for example by reviewing and reforming national policies and laws to make them compatible with, and to support, the protection of customary use and traditional knowledge.

5. Ensure that free, prior and informed consent (FPIC) becomes a well-understood and generally applied principle in all matters affecting indigenous peoples' lands and territories.

6. Address all cases where protected areas have adversely affected indigenous peoples' customary sustainable use.

7. Educational policies and programmes should be culturally appropriate and should promote the use and revitalisation of indigenous languages and traditional knowledge.

8. Use the United Nations Declaration on the Rights on Indigenous Peoples as the basis for the full and effective implementation of Article 10 (c) of the Convention. It provides a framework for respecting the fundamental human rights of indigenous peoples, and provides a legal and environmental basis for protecting and encouraging customary sustainable use.

Protected landscapes and *satoyama* in North America: Diverse landscapes, diverse governance models

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1. Introduction

Protected landscapes are cultural landscapes that have co-evolved with the human societies inhabiting them. Protected areas based on the interactions of people and nature over time, they serve as living models of sustainable land and resource practices. Protected landscapes are rich in biological diversity and other natural values not in spite of but rather *because of the presence of people*, whose traditional patterns of land use have proven sustainable over centuries. It is this complex mix of cultural and natural values, of tangible and intangible heritage, that makes protection of landscapes so vital, and at the same time so challenging.

We can understand landscape as a "meeting ground" – a place where nature and culture are intertwined – and a place that holds the past and the present, as well as tangible and intangible values (Phillips 2005). As expressed succinctly by William Cronin, author of *Changes in the Land* and *Uncommon Ground* in a recent speech: *All landscapes are natural. All landscapes are cultural. All landscapes have histories*. (Cronin 2005)

Landscapes are shaped by the inter-relationships between humans and their environment. In turn, the natural setting has shaped how people live, their settlement patterns, livelihoods, cultural practices and beliefs – indeed their very way of life. It follows that taking a landscape approach to conservation must embrace this complex diversity – recognizing natural as well as cultural values, tangible and intangible heritage, history and present-day uses. It must be inter-disciplinary, inclusive and able to sustain traditional connections to the land. It must be able to engage people in stewardship of the places where they live and work.

Despite the challenges inherent in such an approach, protection of landscapes is emerging as a key element in the conservation of biodiversity. While protected landscapes should by no means be seen as an alternative to more strictly protected areas, they are an important complementary element, and an essential part of protected area systems. These landscapes provide important habitats for biodiversity and, in many cases, are rich in agro-biodiversity. In situations where conservation objectives are being met over a large area of land, protected landscapes can help to link more strictly protected areas to each other and to the broader landscape. They are particularly appropriate in areas where biodiversity and cultural practices are linked, and where management practices must accommodate traditional uses, land ownership patterns, and the need to sustain local livelihoods.

2. Overlap of protected landscapes with the *Satoyama* concept

At the Fifth World Parks Congress in 2003 (Durban, South Africa) the Protected Landscapes Task Force of IUCN's World Commission on Protected Areas convened a three-day series of workshops reviewing experience from all over the world with protected landscapes. These sessions at the World Parks Congress greatly contributed to our understanding of how the protected landscapes model is being expressed in diverse regions of the world and its relevance to current and emerging conservation challenges. As a result of these discussions the idea of a "protected landscape approach," began to emerge. A short excerpt from the book *The Protected Landscape Approach: Linking Nature, Culture and Community* (Brown *et al.* 2005) introduces the concept:

> *The protected landscape approach links conservation of nature and culture, and fosters stewardship by people living in the landscape. While grounded in experience with Category V Protected Landscapes/ Seascapes, this approach is broader than a single protected area category or designation. Rather, it relies on different tools and designations to achieve protection, and on an array of processes and traditional systems to sustain people's relationship to the land. The protected landscape approach recognizes that the cultural and natural values of landscapes are inextricably linked, and embraces the central role of communities as stewards of these landscapes. It puts them at the heart of management of these protected areas, sharing in the benefits and responsibilities of conservation. It is an inclusive approach, relying on participatory processes and partnerships that link a diverse array of stakeholders in stewardship and sustainability.*

The principles of the "protected landscape approach" (2005) are congruent in many ways with the principles and perspectives identified by the *Satoyama* Initiative (*Satoyama* Initiative, 2009), beginning,

of course, with their shared focus on a harmonious relationship between humans and nature. Both recognize the inextricable linkages between cultural and natural values of landscapes and the importance of sustainable management or resources and ecosystem service. Both emphasize the importance of traditional knowledge systems and practices, and both embrace participatory approaches that engage different stakeholders in stewardship of landscapes.

3. Case studies: Diverse landscapes, diverse governance models

This summary paper explores examples of protected *Satoyama*-like (or socio-ecological production) landscapes from North America, illustrating diverse governance regimes for the management and stewardship of these protected landscapes. It is beyond the scope of this paper to attempt a comprehensive review of experience with protected landscapes in North America, nor to represent the diverse geography of this vast continent. This paper discusses a few examples of protected landscapes from the United States and Canada that embody the qualities of *Satoyama*-like landscapes, noting that an experience from Mexico is represented in this volume by another paper.

Bearing in mind the overlap of *Satoyama-like Landscapes* and *Protected Landscapes*, the examples presented here feature places that are considered – either formally or informally – as protected areas. Importantly, the stewardship of these areas happens in different ways, with different models for decision-making and management. Each of the cases presented here represents a different governance regime: i) by government, ii) as a collaborative endeavor between government and partners, iii) by private entities, or iv) by communities.

Table 1 shows the correspondence between the IUCN Protected Area Management Categories and the different governance regimes. The landscapes describe here correspond most closely with Category V: Protected Landscapes and Seascapes (Dudley 2008).

Considering these diverse governance regimes is very much in line with the *Satoyama* Initiative's perspective regarding a wide range of stakeholder participation in management. All of the examples featured here rely on partnerships among diverse actors and institutions. Even the two cases describing landscapes managed by government involve numerous partnerships, illustrating an emerging trend within parks management agencies such as the United States National Park Service (USNPS) and Parks Canada toward increasing reliance on partnerships and collaborative approaches (Tuxill and Mitchell 2001, Mitchell *et al.* 2002, Brown *et al.* 2003). Table 1 includes the case studies according to governance type.

3.1 Marsh-Billings Rockefeller National Historical Park

Marsh-Billings-Rockefeller National Historical Park in Vermont (northeastern United States) is a cultural landscape that is managed by the federal government, working closely with local partners. Located among rolling hills, pastures and forests west of the Connecticut River Valley, the park encompasses 550 acres of managed woodland on the slopes of Mount Tom, as well as grasslands, waterways and working farmland. Inspired by the writing of George Perkins Marsh, author of *Man and Nature*, the park's theme is the history and present-day practice of conservation stewardship. The park was named for three families who cared for this landscape over several generations: George Perkins Marsh who lived there in the nineteenth century and whose writing has influenced the environmental movement; Frederick Billings, who restored the then-degraded landscape through progressive forestry and farming techniques; and Billings' granddaughter Mary and her husband Laurance S. Rockefeller, who were active with conservation projects locally and nationally, and who donated their property to the US National Park Service (Diamant *et al.* 2007).

When the park opened to the public in 1998 it was with a mandate to maintain and build upon its long legacy of forest stewardship. The park claims the oldest professionally managed forest in the United States and the continued management of this forested land is an important part of the park's mission.

Marsh-Billings-Rockefeller National Historical park protects a cultural landscape in Central Vermont (USA) encompassing managed woodlands, grasslands, waterways and working farmland.

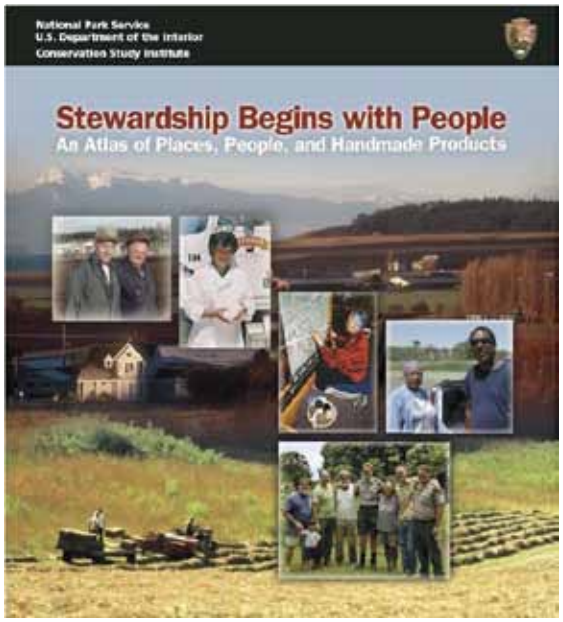
Table 1. Matrix of IUCN Protected Area Management Categories and governance regimes.
The case studies presented here are placed in the matrix: 1 - Marsh-Billings Rockefeller National Historical Park, 2 - Cuyahoga Valley National Park, 3 - Canyon de Chelly National Monument, 4 - The Estran region of Quebec's Gaspé Peninsula, 5 - Appleton Farms, 6 - The Community forests of New England, * (with partners). Governance Matrix adapted from Dudley (2008)

GOVERNANCE TYPE	PROTECTED AREA MANAGEMENT CATEGORY						
	Ia. Strict Nature Reserve	**Ib. Wilderness Area**	**II. National Park**	**III. Natural Monument**	**IV. Habitat/ Species management**	**V. Protected Landscape/ Seascape**	**VI. Sustainable Use of Natural Resources**
A. Governance by government	Federal or national ministry or agency in charge					1/2*	
	Sub-national ministry or agency in charge						
	Government-delegated management (e.g., to an NGO)						
B. Shared governance	Transboundary management						
	Collaborative management (various forms of pluralist influence)					3	
	Joint management (pluralist management board)					4	
C. Private governance	Declared and run by individual landowners					5	
	…by non-profit organizations (e.g., NGOs, universities)						
	… by for-profit organizations (e.g., corporate owners, cooperatives)						
D. Indigenous peoples and local communities	Indigenous peoples' PAs and territories – established and run by indigenous peoples						
	Community conserved areas – declared and run by local communities					6	

As the park management writes:

> *Today, the woods that cover Mount Tom stand as both a model of scientific forestry practices and a beloved public resource. The [US] National Park Service provides stewardship of the land, emulating the property's earlier owners and utilizing current best practices for forest stewardship activities. The trails and carriage roads Billings built on the mountain in the nineteenth century to encourage the public to view his managed forest, have welcomed visitors to Woodstock and members of the local community ever since…Continued responsible stewardship of the park's forestlands will ensure that they will remain intact for subsequent generations to observe. In this woodland landscape, ecologists of the future may discover the same inspiration that George Perkins Marsh found as a child, a connection between human action and the health of the natural world.* (http://www.nps.gov/mabi/parkmgmt/forest-management.htm)

An exciting aspect of the park's approach is the application of contemporary conservation ideas and innovations – such as value-added forest products and third-party certification – to the long-term stewardship of this historic forested landscape. Recognizing the growing importance of third-party certification in fostering responsible forestry worldwide, the park sought independent evaluation and



As part of its commitment to exploring the connections between traditional and sustainable products and land stewardship, Marsh-Billings-Rockefeller National Historical Park, in cooperation with the Conservation Study Institute, has produced an Atlas of "Places, People and Handmade Products," with examples from all over the United States.

verification of its own exemplary forestry practices. In 2005, Marsh-Billings-Rockefeller National Historical Park became the first US National Park to be awarded certification by the Forest Stewardship Council (Diamant *et al.* 2007). It is now producing many items from the wood harvested sustainably on-site. The value-added aspect of woodworking and craftsmanship being demonstrated at the park offers an important example for rural communities in northern New England, which now have to find alternative forest products, because most paper mills have moved away to other parts of the country. Thus the project demonstrates for visitors and other land-managers (including those within the US National Park Service) the potential of adding value to products through certification and association with a special place and how this, in turn, can reinforce responsible land stewardship.

3.2 Cuyahoga Valley National Park

Another example from within the US National Park System of a *Satoyama*-like landscape being managed by government – again, in cooperation with many partners – is the Cuyahoga Valley National Park in northeastern Ohio. It protects a largely agricultural landscape dominated by small-scale farms along the Cuyahoga River and the Ohio & Erie Canal. An Act of Congress established the park in 1974 to "preserve and protect for public use and enjoyment, the historic, scenic, natural, and recreational values of the Cuyahoga River" and to maintain, "needed recreational open space necessary to the urban environment" (NPS 2001).

Twenty-two miles of the Cuyahoga River weave through this landscape, forming the backbone of the park. The Cuyahoga River Valley is characterized by a mosaic of diverse habitats that have been shaped by the varied physical environment of the river valley, its location at the nexus of two geographic zones (the Appalachian Plateau and Central Lowlands) as well as the influences of human activity over time. Thus, the CVNP landscape encompasses riparian habitats, as well as deciduous forests, wetland habitats and agricultural lands ranging from currently cultivated lands to older field habitats in various stages of succession. It is rich in biological diversity, including over 900 plant species, as well as 19 species of birds, 91 aquatic macro-invertebrates, 43 fish, 32 mammals, 22 amphibians, and 20 species of reptiles (http://www.nps.gov/cuva/naturescience/index.htm). This diversity in an area that includes cultivated land is all the more significant given the park's proximity to the urban environments of Cleveland and Akron.

Today, the park includes a complex network of land ownership and management practices. Of the park's over 33,000 acres, only about 19,000 acres are actually owned by the federal government, with the remaining land being owned by other public entities, as well as private landowners and non-profit institutions. The creation of the Cuyahoga Valley Communities Council, with representation from the surrounding communities and park and school districts, has played an important role in maintaining communication and a positive working relationship

In cooperation with local farmers, Cuyahoga Valley National Park has launched the Countryside Initiative to support small-scale, ecologically friendly agriculture within and outside of park boundaries. Seasonal farmers' markets are helping farmers develop new and sustainable markets for their products.

The canyon floor of Canyon de Chelly National Monument (Arizona, USA) has been farmed almost continuously by indigenous peoples for millennia, resulting in unique agro-biodiversity. This protected landscape is managed collaboratively by the US National Park Service with the Dine (Navajo) people.

between the USNPS and local communities (Brown *et al.* 2003).

While agriculture has long played an important role in the history of the Cuyahoga River Valley, it is only recently that the USNPS has recognized the preservation of "rural landscape" character and values as a priority. The early response to loss of farmland in the area of the park (due to development pressures, particularly for housing) was to purchase these properties to protect them from future development. Recognizing the limitations of this approach, and the need to ensure the perpetuation of agricultural land use and traditions, the Cuyahoga Valley National Park management launched a rural landscape management program, called the Countryside Initiative. The goal of this initiative is to sustain the agricultural heritage of the valley in a way that is consistent with best environmental practices and USNPS rural landscape management objectives and through this value-added economic strategy, to preserve the remaining agricultural land and buildings. (Debo and McMahon 2001).

In a precedent-setting partnership between the park, non-profit organizations and farmers, the Countryside Initiative advances environmentally friendly and economically viable approaches to agricultural practices within a national park setting. As part of this strategy 1,350 acres within the park (approximately 5 per cent of its total area) are being made available through long-term leases for sustainable, small-scale family farms that require farmers to consider ecological, cultural and aesthetic values in producing diversified crops, livestock and other products. In addition the Initiative is providing support with value-added strategies, networking with other farmers in the Cuyahoga Valley and the development of new markets, including introduction of seasonal farmers' markets (Diamant *et al.* 2007).

3.3 Canyon de Chelly National Monument

Canyon de Chelly National Monument in Arizona in the southwestern United States is an example of governance by collaborative management. It is a dramatic cultural landscape, with spectacular archaeological sites, striking geological features, and traditional uses that continue in the present day. In one of the first examples of shared stewardship involving the US National Park Service (USNPS), the USNPS manages Canyon de Chelly in collaboration with the Navajo, or *Diné* people, who have lived in this area for centuries. Established as a unit of the system in 1931, all of the monument's 83,840 acres lie within the lands of the Navajo Nation. The US National Park Service and the Navajo Nation work in partnership to manage the archeological, historical, and scientific resources of this protected landscape, and to help sustain the community of Navajo people who live and farm in the canyons today.

For millennia the canyon floor has been farmed almost continuously by the indigenous peoples of this region, and this long history of farming has created a rich legacy of agro-biodiversity, in particular fruit tree varieties. Native peoples – including ancestral Pueblo Indians, the Hopi, and the Navajo (*Diné*) -- have lived in Canyon de Chelly for as long as 5,000 years. Within the steep sandstone walls of Canyon de Chelly are cliff dwellings, rock drawings, and other ancient sites that tell stories of what may be the longest continually inhabited place on the Colorado Plateau. Archeological remains and numerous pictographs illustrate and highlight a well established livestock tradition, principally raising goats and sheep with smaller numbers of cattle and horses. The ancestral Puebloan people began farming in the region 2,500 years ago. Down through the centuries native peoples cultivated a variety of fruits, some of which the Spanish introduced to the Southwest in the sixteenth and seventeenth centuries. Archeolog-

Canyon de Chelly is a dramatic cultural landscape with striking archaeological features and traditional uses that continue to the present day.

ical evidence suggests that as early as the seventeenth century the Hopi, and later the Navajo, planted orchards in the canyons, including peach, plum, apricot, and apple trees as well as grapes. These fruit tree varieties are specially adapted to the conditions of a canyon valley in this area of the Colorado Plateau.

The last 150 years have seen tumultuous destruction of the orchards, gradual reestablishment of peach trees, and more recently environmental deterioration and a decline in orchard productivity. During the American Civil War the Navajo were forcibly relocated from Canyon de Chelly, and US Cavalry troops destroyed the hogans, Churro sheep, and orchards that were the foundation of *Diné* agriculture. When the Navajo were finally granted sovereignty in 1868, they returned to Canyon de Chelly, bringing with them Churro sheep and replanting the orchards, which have become enduring symbols of cultural survival and renewal.

Today, well over a thousand Navajo live in the canyons and farm the canyon floor, while also providing guide services for park visitors and working in surrounding communities. They tend nearly 500 heirloom fruit trees, grow corn and alfalfa, and raise cattle and Churro sheep. While the agro-biodiversity values of this cultural landscape have been affected by a number of factors over the past two centuries, today Canyon de Chelly National Monument, the Navajo Nation, and other partners are working together to restore the canyon's watersheds and other resources that support the *Diné* farming traditions and way of life (Diamant *et al.* 2007; Brown and Diamant 2008).

3.4 The Estran region of Quebec's Gaspé Peninsula

Located on the northeastern coast of Quebec (Canada)'s Gaspé Peninsula, with the abrupt plateaus of the Appalachian mountain range as a backdrop, the Estran region is a mosaic of coast-line, forest and farmland. Its long history of complex land uses, in which farming, forestry and fishing activities have been closely linked, has resulted in a unique rural landscape and in agro-biodiversity unusual in a region this far north. Encompassing four municipalities, and extending some 60 kilometres along the Gulf of St Lawrence, the Estran region is an example of a large landscape whose stewardship is largely in private hands.

The Estran region has a unique context for agro-biodiversity, due to its agricultural history as well as its specific climatic conditions. The climate is tempered significantly by its proximity to the sea and the geography of the region includes valleys with milder micro-climates, conducive to growing crops and forest species, including groves of Sugar Maples. The latter are of particular importance in the region and include two types of groves: Sugar Maple-Yellow Birch forest, as well as Sugar Maple-White Birch forests. Both exist at the northern limit of their respective ranges. Wild biodiversity in the Estran region is supported by the diversity of habitats, and this diversity is closely linked to traditional agricultural practices. Recent inventorying of agricultural lands within the region have documented considerable floristic biodiversity, as well as habitat for birds and many mammal species.

Based on these distinctive landscape values and the associated biodiversity, including agro-biodiversity, the residents of Estran have recently considered designation of the region as Quebec's first *paysage humanisé* (or "living landscape"). This designation is a new kind of protected area in Quebec in keeping with the IUCN Category V management objectives, and is modeled after other protected landscapes such as Regional Nature Parks in France and Belgium. The designation has been introduced by the province in

A mosaic of coast-line, forest and farmland, the Estran region on the northeastern coast of Quebec's Gaspé Peninsula has many distinctive landscape values, including unique agro-biodiversity.

an effort to increase biodiversity conservation, particularly on private lands, while encouraging sustainable rural development. While efforts to pursue *paysage humanisé* status in the Estran region are currently on hold, this active resident-driven process is an indication of the value the communities place on their special landscapes (Blattel *et al.* 2008).

3.5 Appleton Farms – An example of private governance by a land trust

Land trusts are crucial actors in the protection and stewardship of landscapes in North America, particularly in a region like New England (the six northeastern-most states), where the majority of land is privately owned. A land trust is a private non-governmental organization created with the aim of conserving land, either through direct acquisition of properties and/or through negotiation of agreements with landowners, including legal agreements (e.g., conservation easements) and other management agreements (Mitchell 2006). While the land trust movement originated in New England in the late nineteenth century, in recent decades the movement has grown dramatically with the emergence of new land trusts throughout the United States and Canada. New networks such as the Canadian Land Trust Alliance signal the growing importance of the land trust model in Canada.

Established in 1891, the Trustees of Reservations is the oldest land trust in the world. With a mission *to preserve, for public use and enjoyment, properties of exceptional scenic, historic, and ecological value in Massachusetts*, it now serves as a steward of over nearly 25,000 acres of land throughout the state. The Trustees of Reservations manages over 100 properties in Massachusetts, a diverse array of sites protected for their historic and cultural values, as well as their natural values (http://www.thetrustees.org/about-us/our-mission).

An excellent example of one of its properties is Appleton Farms (Ipswich, Massachusetts), a cultural landscape sustaining traditional agriculture, including heritage crops and livestock, as well as, grasslands, woodlands and wetlands. It claims the mantle of being America's "oldest continuously operating farm" (dating back to 1636), and a portion of the property is currently under cultivation, with products marketed locally through an active, extremely popular Community-Supported Agriculture (CSA) program.

The Appleton Farms protected landscape plays an important role in biodiversity conservation, due to its diversity of habitats, along with its crucial role in making linkages in the broader landscape to other adjacent forested and agricultural land. Its grasslands provide habitat for one of New England's largest populations of bobolinks and meadowlarks, and its wetlands are important for migrating marsh birds as well as reptiles and amphibians, including certain rare species. Resident mammals include deer, fox, coyote, mink and fishers, and the property is important for migratory birds including several raptor species (http://www.appletonfarms.org).

Appleton Farms also offers a good example of the many ways a *Satoyama*-like landscape can contribute to "human well-being." In addition to its role in nature conservation and environmental services, it offers many social benefits to the local community, including place-based education programs, recreational opportunities (such as trails for walking and winter sports), and its Community-Supported Agriculture program.

3.6. Indigenous and Community-Conserved Areas (ICCAs)

Looking to Mexico, one can find a wide array of examples of Indigenous and Community Conserved Areas (ICCAs). Much progress is being made in recognizing these areas, through recent amendments to the national legislation to reinforce the status of

Appleton Farms in Massachusetts, a property of the Trustees of Reservations, is an example of a cultural landscape being managed by a land trust.

communally protected areas and consolidate certification of voluntarily protected areas. This has been especially true in the case of the Mexico's *ejidos* – groups of communal landowners. In a forthcoming paper in the journal Management of Environmental Quality (Martin *et al.* (in press) present the findings of a 2009 inventory of ICCAs in the state of Oaxaca. Their survey documented 126 sites of community conservation in Oaxaca covering more than 375,457 ha. These ICCAs include protected communal areas, certified community reserves, forestry management protected areas, symbolic cultural sites and wildlife management areas.

3.7. The Community forests of New England

The community forests of northern New England (northeastern United States) offer an example of how the ICCA model is being applied in rural areas of northeastern North America. There is a long history of town ownership of forested areas in New England, going back to early European settlement in the 1600s. Town forests were initially created for purposes such as watershed protection and timber production, while over time recreational, educational, ecological and aesthetic benefits became increasingly important considerations. The extent of town ownership of forest in northern New England is significant: for example one study (Lyman in press) estimates that 120 towns in the state of Vermont own some 32,375 hectares, 188 towns in New Hampshire own 41,683 hectares and 170 towns in Maine own 60,703 hectares.

Beginning in the 1980s globalization of the forest products industry resulted in a large-scale transfer of forested land in northern New England to increasingly distant ownership, whether timber investors or, in the case of recently conserved land, national and international conservation NGOs. According to Lyman (in press), the result has been a disconnection of the traditionally close relationship between the forest products industry, local people and communities.

There are, however, many examples of community forests rooted in the tradition of community-based conservation. For example, the Paul Doherty Town Forest is a 2,023-hectare tract of land in the towns of Gorham and Randolph (New Hampshire) encompassing an important watershed in the White Mountain. Having acquired the land in 1936 to protect its water supply, the town expanded its management goals over the last thirty years. The forest now produces income through timber harvesting and provides an outdoor classroom to the town's public schools. A Forest Advisory Committee appointed by the town's governing body provides management oversight (Brown *et al.* 2006).

The Community Forest Collaborative, a consortium of three NGOs based in the region, analyzed the current and potential role of community forests across New England in contributing to landscape-scale conservation, community development and economic development (http://www.northernforest.org/community-forests.shtml). The collaborative reviewed five sites from the region (in the states of Maine, New Hampshire and Vermont) that illustrate different approaches to acquisition, management objectives and values.

The Collaborative identified many ways in which community forest projects are having an influence on community life in New England. One is "community well-being," including supporting environmental services important to human activity (water supplies, energy, recreation), as well as many less tangible aspects, including character, culture, traditions and social capital.

The Community Forest Collaborative also identified a number of ways that community forests contribute to conservation across the forested landscape. Beyond their contribution at the local level is the important role community forests play in larger landscape-scale conservation, by buffering and linking existing protected areas. The Randolph (New Hampshire) Community Forest is one example; it links two sections of the White Mountain National Forest, a federally protected area. The Farm Cove Community Forest is a significant component in a mosaic of land protection, in this case a 404,686-hectare conserved landscape of contiguous forestland extending from eastern Maine, in the United States to western New Brunswick in Canada. Other contributions related to local capacity for conservation include the role of community forests in leveraging partnerships, expanding funding for conservation and promoting stewardship and monitoring of conservation lands (Community Forest Collaborative 2007; Lyman in press).

4. Conclusions

With diverse histories going back to different time periods, each of the examples discussed here must adapt to changing conditions. These and other protected *Satoyama*-like landscapes in North America face on-going challenges. These include:

- fragmentation of the wider landscape due to unplanned development,
- changing demographics in rural areas,
- decreasing viability of small-scale agriculture in many regions and accompanying pressure on farmland for other uses (e.g., housing development),
- dramatic changes in local resource-based economies (e.g., the relocation of forestry operations

from New England to other regions),
• homogenization of landscapes due to globalization and associated loss of "community character and vitality, and
• global climate change.

On the other side of the ledger are a number of trends that hold much promise for the future of these landscapes. These include: a growing reliance on participatory approaches to conservation, and the increasing role of partnerships to conserve and manage protected areas. Protected Areas management agencies, as well as others in the North American conservation movement (for example, NGOs such as Land Trusts), are increasingly recognizing the connections between nature and culture. This development can be seen in the emergence of new designations (such as *paysage humanisé* in Quebec and National Heritage Areas in the United States) that address the need to protect and sustain cultural landscapes. A related example of progress in bridging the "nature-culture divide" is the growing interest in traditional knowledge systems and practices. Finally, recent progress in documenting ICCAs in North America (e.g., the ICCAs in Mexico and Community Forests in New England) recognizes and highlights the important role of indigenous and local communities in conservation.

Works in progress, protected landscapes in North America are playing an important role in the vitality of communities and cultural heritage, as well as the conservation of biological diversity at a landscape scale. As stewards, indigenous and local communities bring their wealth of knowledge, traditional management systems, innovation and love of place to managing these special landscapes.

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Surveying the coverage and remains of the cultural landscapes of Europe while envisioning their conservation

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1. Introduction

Cultural landscapes are the result of the historical transformation of natural ecosystems through farming, the adoption of successive management practices in areas selected for certain land uses, and the development of structures to increase the efficiency of the agricultural and forestry production system. The result is a patchy pattern of combined cultural and natural elements with varied forms, sizes and textures, an anthropic ecosystem of biotic and abiotic components, including human populations, and a set of intangibles, which include knowledge, values and beliefs. In cultural landscapes the influence of human action in shaping the environment surpasses the effect of natural processes.

The unprecedented rate of and the extent of land use changes experienced in the last fifty years in Europe and worldwide, driven by rapid economic growth, technological boom, industrialization, urbanization and associated urban sprawl, and mass tourism, led to a high demand of land and natural resources and a rapid, and sometimes irreversible, loss of cultural and natural values. Drivers of landscape change are not local anymore.

Conventionally, emphasis has been placed on protecting wilderness and natural ecosystems for their biodiversity and valuable ecosystems at risk, while rural areas, which have acted as buffers of the former, have been left aside for long and their values threatened.

2. A complex and varied landscape mosaic

A great heterogeneous and complex set of landscapes can be observed across Europe. This is not only due to the high diversity of biomes (figure 1), which range from the Atlantic vegetation in the western coastal areas to the steppe in the flat plains of the Northern Black Sea, from the Mediterranean vegetation around the coterminous sea to the Boreal regions in the northern regions; but is also produced by the intensive occupation of the land and the complexity of the continent's historical processes.

In addition, the state of developmental, or the degree of transformation, is heterogeneous, and very dependent on regional, or local, economic wealth. Some countries which recently accessed the European Union (EU) have an agricultural and forestry economy which is not competitive in terms of returns at the European scale, but still holds value that have been lost in countries with industrialized farming. The same applies to marginal regions within countries with a longer history of belonging to the European Union, at the cost of a sharp decline in their rural population, ageing, and share of their agricultural sector.

The best land for agriculture –as determined by topography, soil properties and water availability- was eventually transformed into farmland and cultural landscapes were gradually constructed, but the processes of land use densification, urbanization, intensive farming and afforestation have left relicts of traditional cultural landscapes. As observed by Dannenbeck *et al* (2009), these remaining landscapes "…are mostly associated to pastoral grazing systems and only some associated to arable land occur in Southern Europe, marginal both to commercial agriculture and principal urban areas…". They are particularly associated to poorer lands in peripheral and less developed regions of Europe.

There is a contrast between the regions which, once they have lost a great part of the cultural and natural values of anthropic landscapes, let alone natural areas, become aware of this loss and promote policies to revert the process, at the cost of higher investments. In this context programmes of landscape inventory, characterization, assessment and protection are taking place. Meanwhile, other less developed regions or countries are taking steps to become more competitive by increasing agriculture efficiency, and consequently rapidly transforming their cultural landscapes.

3. Identifying and classifying European landscapes

Various approaches have been adopted and efforts made in different fields to identify, classify and characterize the landscapes in Europe. All have in common the purpose of setting up the baseline to adopt specific policies for protection and have faced common challenges: to comprehend the diversity and homogenize the heterogeneous criteria in information collection and information availability throughout a continent with multiple countries, notwithstanding the economic, social and political integration led by the European Union.

Classification is very dependent on the existing and accessible information of a number of environmen-

Figure 1. Biogeographical regions of Europe
(European Enviromental Agency, 2002)

tal and human variables at a large geographical scale, and the capability of analyzing it. At present, insufficient environmental data is not a major difficulty but the heterogeneity and the differences in the interpretation of criteria used at the national scales to avoid border effect, the lack of socio-economic data exploitable as a continuous variable, and the drawbacks of combining the human and natural dimensions have led to unsatisfactory results. Usually, classifications emphasize the natural components of the landscape but, at the same time, minimize their cultural dimension, as Jongman *et al.* (2009) recognize. The existing classification systems adopt approaches which range from land use classification to the identification of potential vegetation or environmental zones.

The initiatives examined here have significantly contributed to the European-wide dimension of landscapes, and include the Pan-European Biological and Landscape Diversity Strategy (PEBLDS), signed within the framework of the United Nations Economic Commission for Europe (UN/ECE); the European Landscape Convention (ELC) promoted by the Council of Europe; the Dominant land cover types of Europe elaborated by the European Environment Agency (EEA), and the Cultural Landscapes and Cultural Landscape Ecosystems in Europe identified within the framework of the PAN European Thematic Network.

3.1 The Pan-European Biological and Landscape Diversity Strategy (PEBLDS)

The PEBLDS strategy was endorsed by the third ministerial conference Environment for Europe of the UN/ECE environment ministers, which was held in Sofia, Bulgaria, in October 1995. The conference followed the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro and was the European response to support the implementation of the Convention on Biological Diversity (CBD), which entered into force in December 1993. The innovative character of this strategy derives from its double integrated focus on landscape and biological diversity, recognizing that biodiversity and landscapes can only be conserved under the same goals and initiatives, and from its European-wide geographical dimension. PEBLDS recognizes the decline in diversity, the number and range of a wide variety of species, habitats and landscapes, and particularly the reduction in area and increase in fragmentation, despite efforts made to mitigate the process. In order to strengthen the coherence and the effectiveness of the measures adopted at the national level in a fragmented political framework, a call for pan-European coordinated action was made.

The two main goals of the strategy, to be achieved within 20 years (1996-2016) and implemented through a series of five years action plans (PEBLDS, 1996), were to:

- Conserve biodiversity and landscapes of European importance, and
- Integrate biodiversity conservation and sustainability into the activities of all relevant socio-economic sectors.

Based on the analysis of the reports Europe's Environment: *The Dobříš Assessment* (Stanners and Bourdaeu, 1995) and IUCN's *Parks for Life: Action for Protected Areas in Europe* (IUCN, 1994), 11 action-themes were defined. Among all, action theme 4 should be highlighted for its interest in the protection of landscapes and the establishment of specific objectives:

- The identification, assessment and evaluation of existing and threatened landscapes, that might facilitate the designation of priorities in conservation,
- The elaboration of policy guidelines for conservation,
- The elaboration of a code of practice for public-private partnership,
- The establishment of an action plan for increasing public awareness, and
- The study of the potential economic contribution of traditional landscapes, by incorporating additional functions, such as ecotourism and traditional crafting.

Following PEBLDS, the subsequent key step was taken in the fifth UN/ECE ministerial conference *Environment for Europe* held in Kiev, Ukraine, in 2003, when biodiversity and landscape targets alike were outlined.

3.2 Landscapes of Europe (LANMAP2), the hierarchical classification

Adopting some of the preceding principles, particularly the first, Mücher *et al* (2010), from the research institute Alterra (a component of the Wageningen University), have been working on the classification of European landscapes. The outcome is *Landscapes of Europe* (LANMAP2), a hierarchical classification of the continent at four levels with increasing degree of complexity. The more general and coarsest classification, level 1, merely used climate as the discriminating variable to differentiate 8 classes; the second level, with 31 classes, was defined by climate and elevation; the third level, followed from the integration of the variables climate, elevation and substrate, has 76 classes. Finally, the more detailed taxonomy, level 4, differentiated among 350 landscape classes and fragmented Europe into 14000 mapping units.

The cartographic database of LANMAP2 was later used as the takeoff for landscape character assessment within the European project ELCAI (The European Landscape Character Initiative).

3.3 The European Landscape Character Initiative (ELCAI)

The expert network Landscape Europe, supported by European Union research funding, launched the European Landscape Character Assessment Initiative (ELCAI). Its objective was to review the approaches put into action to identify the attributes of relevant landscapes in 14 European countries through questionnaires and the role played by public policies. It concludes that inconsistencies (minimum mapping unit, landscape types and data format) among products are meaningful enough to hinder harmonisation at the European level.

One major contribution of the initiative, and of its final report, has been the compilation and examination of European landscape maps produced at the national and international levels (Wascher *et al*. 2005), along with two global examples. These are the *World Map of Present-Day Landscapes* developed by Milanova *et al*. (1993) and the *Global Anthropic Landscapes Map* produced by the US Department of Agriculture Natural Resources Conservation Service (US Department of Agriculture, 2000). According to Wascher *et al*. (2005) the first case in point did not succeed to identify landscape types, while the second is prominent for its purpose of measuring grades of human impact, by introducing population density as a proxy variable for human land occupation and alteration. This is a valuable approach for landscapes are the product of human action and they can be differentiated not only by their components but also by the intensity of intervention.

3.4 The European Landscape Convention (ELC)

The European Landscape Convention (ELC), also known as the Florence Convention, was adopted on 20 October 2000, and came into force on 1 March 2004 within the framework of the Council of Europe. It aims "…to promote landscape protection, management and planning, and to organise European co-operation on landscape issues." In this avenue it differentiates among national measures and responsibilities and international mutual assistance and exchange of information. Article 1 provides an important foundation to advance those goals: "Landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors." The principal goals identified were:

- The identification and assessment of European landscapes, in order to protect, plan and manage them properly,
- The definition of landscape quality objectives, which should be the result of the dialogue between decision-makers and citizens, by promoting public participation in the design and implementation of the different policies, and
- To facilitate the European-wide transboundary cooperation in scientific knowledge, education, training and information exchange, in order to enhance the effectiveness of the measures taken.

3.5 Dominant land cover types of Europe

The European Environment Agency (EEA) published on 11 November 2008 a map of the land cover types of Europe, based on CORINE Land Cover 2000 (CLC2000) (figure 2). Produced jointly by the European Commission and the European Union member states at that time, CLC2000 is the result of the interpretation and classification of land uses and land cover from satellite images, using a minimum mappable unit of 25 hectares and conceived to be used at a scale of 1:100 000. Classes are based on spectral response, size and texture of patches; implying that crops and cultures, and mosaic patterns produced by cultural practices have been captured. The 44 land cover and land use classes have been merged into seven land cover types that, although apparently exiguous, still show the complexity of the landscape collage built by small geographical units.

Figure 2. Dominant land cover types of Europe
(European Environment Agency, 2008)

The number and land use types mapped using this approach has as its main advantage the identification of the principal land uses found in the succession from pristine natural landscapes through land use intensification.

However, despite its European coverage, its application is more limited due to the geographical gaps seen for countries such as those of the European Free Trade Association (EFTA) (Switzerland, Norway and Iceland), Kosovo and Eastern Europe countries (Belarus, Ukraine, Moldova and Russia), Turkey and the Caucasus.

3.6 Cultural Landscapes and Cultural Landscape Ecosystems in Europe

The PAN European Thematic Network on Cultural Landscapes and their Ecosystems, supported by the European Commission under the Fifth Framework Programme (FP5), adopted a slightly different approach to identify and describe the European landscapes with a higher value, by emphasizing their cultural dimension and management practices. The publication titled *Cultural landscapes of Europe* (Krzywinski *et al*, 2009), an outcome of the work completed within the network, brings conspicuous examples throughout the continent, particularly from Western and Central Europe. It looks like the network has more successfully addressed the aforementioned first objective of action theme 4 of the Pan-European Biological and Landscape Diversity Strategy (PEBLDS).

The geographical baseline utilized in the study is the map of homogeneous environmental zones of Europe, identified by Metzger *et al.* (2005). Using an approach similar to LANMAP2 these authors stratified the territory at two levels, in the first place using 84 classes, which subsequently where grouped into 13, and at a second level employing statistical procedures, reaching what they term Environmental Zones (EnZs). 20 environmental variables were used, although basically of climatic character, and clusters were found based on the identification of principal components. The database on Cultural Landscape and their Ecosystems (Cultbase) comprises both classes (table 1) and attributes, particularly management practices, of specific cultural landscapes with a high cultural value and biodiversity, which escaped from urbanization and industrial farming and where sustainable management is still applied or has continued until recently. Pressures, vulnerability, generation and processes of change are also described for each landscape, an analysis that may be very helpful for the development of indicators, monitoring and policy implementation.

Table 1. Landscape types
(PAN European Thematic Network)

Arable land	**Cultural grassland**
Field systems Garden systems Shifting cultivation systems Vineyards	Alvar grassland vegetation Grazed grassland Mown and/or grazed fen land Mown and/or grazed orchards Mown grassland (or mixed mown and grazed) Steppic grassland
Managed mires	
Blanket bogs Raised bogs	
Managed woodlands	**Managed scrublands and heathlands**
Coppice, coppice with standards, coppice for fruit production Dehesa, *montado* Grazed woodlands Managed alder carrs	Broom fields Dry heathlands Garrigue Maquis, macchia Wet heathlands

3.7 Permanent European Conference for the Study of the Rural Landscape (PECSRL)

In the same vein, the network PECSRL was established in 1957 at an inaugural conference held in Nancy, France, as an international group of landscape researchers convened to discuss the unifying concept of the past, present and future of European landscapes. The international PECSRL conference, organized every two years, serves as a serial meeting point to improve interdisciplinary cooperation among researchers and practitioners in the fields of landscape research, policy and management.

4. The impact of the European Union policies on landscapes

National and European Union sectoral policies alike, as recognized by the European Spatial Development Perspective, together with global market processes, i.e. commodity or fuel prices and commodity stock fluctuations, are having an impact on rural landscapes and generate short- mid- and long-term land use changes and their spatial configuration. Therefore it is not exclusive to agricultural policy, as programmes oriented to industry, infrastructures, or the environment are also having an impact on the structure of the economic activity and on the directions of change. Although its effect may be more limited, because landscapes do not hold comparably rich natural values, some examples of influential environmental regulation include:

- Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds, which mandates that member states must conserve, maintain or restore the biotopes and habitats of birds,
- Nitrates Directive (91/676/EEC), concerning the protection of waters against pollution caused by nitrates, has the objective of reducing water pollution caused by nitrates from agricultural sources, induced by intensification,
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, which mandates that member states must designate special areas of conservation and special protection areas, or the
- Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy (Water Framework Directive), which seeks to achieve a good status of all waters and their management based on river basins.

Half of European Union land is farmed and thus, in practice, the Common Agricultural Policy (CAP) has been indirectly acting as a landscape policy. CAP, initially formulated to increase agricultural productivity and reach both food security and a standard of living to European Union farmers, was based on an integrated system of measures which sought to maintain commodity prices and has been providing production subsidies.

Without such a primal goal, it has made substantial progress in its environmental dimension at the Helsinki European Council (December 1999) first, recognizing the multifunctional character of agriculture, and then at the Göteborg European Council (June 2001), when the European Union Sustainable Development Strategy was adopted. The two environmental pillars of CAP are cross compliance and agri-environment measures, and national agri-environmental schemes. The cross compliance mechanism links direct payments to compliance with basic environmental standards and the maintenance of land in good environmental conditions by farmers. It is compulsory and establishes a reference level for agri-environment measures. Its strength comes from the capability to encourage farmers to protect and enhance the environment on their farmland by adopting environmentally-friendly farming techniques, for which they are compensated for the derived additional costs and income loss. Among the measures, those with a likely impact on landscape include:

- extensification and low-intensity pasture systems,
- diversification,
- integrated farm management and organic agriculture,
- preservation of landscape and their historical features, and
- conservation of high-value habitats and their associated biodiversity.

In a close realm, the Council of Ministers of the European Union responsible for spatial planning agreed upon the European Spatial Development Perspective (ESDP) in Potsdam in 1999. The main goal of ESDP was to set up the foundations of a European Union common policy in spatial planning in order to reach a geographically-balanced development, mitigating spatial disparities based on land use and infrastructure planning. It recognizes the important role of agriculture as a factor of landscape transformation and uniformization and it identifies the new functions of rural areas and the increasing pressure of mass tourism over ecosystems and landscapes. The strategies envisaged by ESDP include:

- the coordination of development measures, particularly in transboundary European Union regions, underscoring the importance of the INTERREG Initiative,
- the partnership between towns and their country-

side in a polycentric Europe,
• acknowledgement of natural and cultural heritage as a development asset, particularly cultural landscapes and historical paths, and
• the restoration of landscapes where human management has been neglected.

According to Jansen *et al.* (2009), landscapes are evolving in divergent directions. While in marginal areas they advance from open to more fragmented landscapes, in commercial farming areas, particularly lowlands and urban fringes, structures are being removed to more efficiently use machinery. Thus, landscapes tend to increasingly become more simple and homogeneous, losing their singular cultural and natural values. When ecological succession occurs, a decline in species and habitats associated with farming practices are observed.

As a general remark European landscapes are being threatened by internal and external processes of:

• marginalization, land abandonment, and out migration in some areas which causes severe decline in farming population and ageing,
• an opposite process of industrialised farming in other areas, which implies:
  - uniformization with single crop production,
  - land use intensification, and farming without fallow,
  - crop/management substitution, and mechanised farming,
  - intensification of nutrient application, and
  - removal of structures.
• afforestation and encroachment by scrubland and woodland and an increase in large wildfires,
• mass tourism, and
• urbanization, urban sprawl and the development of major infrastructures.

In order to change the contemporary course or attenuate landscape transformation it is necessary to understand them as complex systems with mixed land uses, material and immaterial components, micro and macro elements, which are not always easily mapped, multiple stakeholders, intimately connected with other systems, and as the outcome of a historical accumulative process. Conservation and management of cultural landscapes have to be based on ensuring their survival by involving farmers and local residents alike in the identification of local knowledge, their needs and multiple conflicting interests, and by efficiently planning and implementing the strategies adopted. Local populations have been the builders and agents of change, and should continue to be both the developers and stewards of cultural and natural values.

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Case Studies

Case studies from Africa

The communal forest, wetland, rangeland and agricultural landscape mosaics of the Lower Tana, Kenya: A socio-ecological entity in peril

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1. Introduction

Kenya is a water-scarce country with an annual renewable supply of about only 650 cubic metres per inhabitant per year and over two-thirds of the country arid or semi-arid (less than 500 millimetres annual rainfall). Kenya is demographically dynamic and characterised by a strong urbanisation trend. As a result, water demand for city and town-based domestic uses, irrigation and industry is increasing rapidly, as is the competition for water between different sectors (often with contradictory policies). The main losers in this equation are the more diffuse rural-based traditional water use (e.g. small-scale agriculture) and the environment. At the same time funding for hydro-meteorological monitoring and analysis and for water infrastructure (including catchment management) is lagging behind while extreme events (floods and droughts) have increasing economic (Mogaka *et al.* 2006), social and environmental costs.

The Tana is the most important river in Kenya in terms of discharge, varying between 90 and 300 cumecs (cubic metres per second) or between 2.7 and 10.2 billion cubic metres per year. The Tana River (figure 1) takes its sources in the highlands (greater than 3000 metres in altitude) of the Aberdares and Mount Kenya just north of the capital Nairobi and flows for about 1000 kilometres to its mouth at Kipini on the Indian Ocean. In the upper catchment the river produces about 70 per cent of Kenya's hydropower which in itself contributes about 70 per cent to Kenya's total electricity output. Once the river descends below 200 metres altitude it meanders through a floodplain that is about 5 kilometres in width and 300 kilometres in length before entering the Tana Delta at Garsen. The last 60 kilometres of these riverine floodplains, situated between the northern limit of the Tana River Primate Reserve (approximately 1° 48' S, 40°8' E) and the Garsen-Witu road bridge over the Tana River (approximately 2°17' S, 40°8'E), are the subject of this case study (figure 2).

2. Study area

The riverine forests, wetlands and surrounding rangelands of the Lower Tana have for centuries constituted a multi-user and multifunctional area of high socio-economic value for a number of indigenous and local communities (Terer *et al.* 2004) and have maintained exceptional biodiversity value. The forests are remnants of the vast Miocene (23-5 million years B.P.) forests that covered Africa from West to East before drier spells, starting around 2.8 million years B.P. (Menocal 2004), split them up into separate blocks that went along their own evolutionary paths, contributing to the high level of endemicity, in spite of occasional reconnections during the wet phases of the Pleistocene. The forests along the Lower Tana are part of the biodiversity hotspot (Myers *et al.* 2000) of the Eastern Arc and Coastal Forests of Eastern Africa (Burgess & Clarke 2000) and therefore a global conservation priority.

The forests are characterised by the presence of numerous endemic or restricted-range species of plants (Luke *et al.* 2005), primates (Jong & Butynski 2009), birds (Owino *et al.* 2008), amphibians and reptiles (Malonza *et al.* 2006) and without doubt of other taxonomic groups that have so far been insufficiently studied. The Lower Tana River itself also harbours a number of endemic fish species (Seegers *et al.* 2003). What characterises these wetland forest ecosystems is their functional dependence on floods (Andrews *et al.* 1975) for forest regeneration and productivity (Hughes 1990), groundwater recharge, deposition of fertile loams and clay that constitute an agricultural

Figure 1. Kenya and the Tana River with as an inset the study area (adapted from Maingi and Marsh 2002)

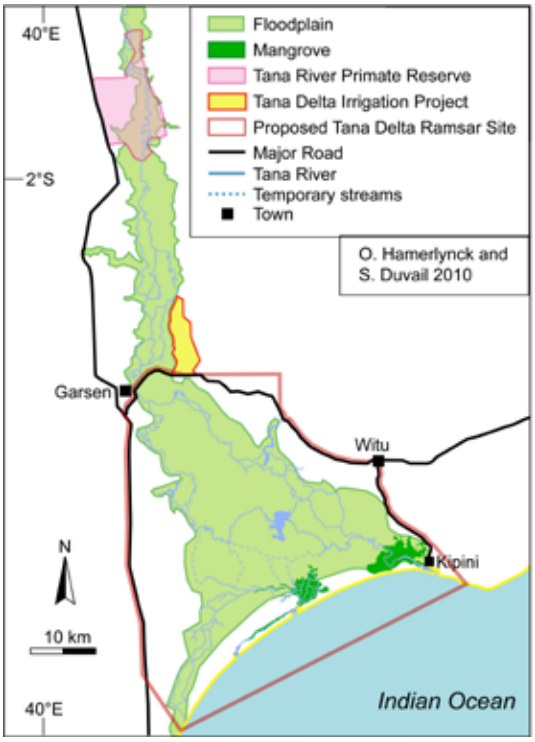

Figure 2. Map of the Lower Tana Floodplains and Delta

resource, fisheries productivity, etc. Thus the flooding regime is key to the ecosystem services they provide for human well-being.[1]

The riverine forests cover only an estimated 2600 hectares (Mbora and Meikle 2004b) and are of a very patchy nature with about 70 separate entities recognized. The forest patches range from 1 to 500 hectares but most are less than 50 hectares and they are separated by agricultural land, grassland and bushland. Five main vegetation types are recognized in the forest (Hughes 1990):

- evergreen forest on sandy levees, characterised by *Ficus sycomorus*, *Sorindeia madagascariensis* and *Sterculia appendiculata*
- evergreen Acacia forest at the outer limit of the forest belt, characterized by *Acacia eliator*
- clay evergreen forest on moist floodplain soils dominated by *Diospyros mespiliformis* and *Garcinia livingstonei*
- point-bar vegetation on the low-lying sandy inner banks of meanders developing into *Populus ilicifolia* forest
- oxbow pioneer vegetation dominated by *Terminalia brevipes* and/or *Spirostachus venenifera*.

[1] Based on the findings of the Millennium Ecosystem Assessment (2005), human well-being can be defined as the freedom of choice and action to achieve basic material for a good life, health, good social relations and security. Well-being is at the opposite end of a continuum from poverty, a pronounced deprivation in well-being.

Over 300 plant species have been recorded from the forests of which about 60 are tree species and two of those are considered globally endangered (*Cynometra lukei* and *Megalochlamys tanaensis*). Over 20 per cent of the plant species are of conservation concern and six are considered globally vulnerable: *Oxystigma msoo*, *Angylocalyx braunii*, *Dalbergia vaciniifolia*, *Chytranthus obliquinervis*, *Diospyros greenwayi* and *Pavetta linearifolia* (Luke *et al.* 2005).

The flagship conservation species in the area are two endangered primates (Jong and Butynski, 2009): the Tana River Red C*olobus Procolobus rufomitratus rufomitratus* and the Tana Mangabey *Cercocebus galeritus* (estimated population size of about 1200 individuals). In 1976 an area of about 17,000 hectares of floodplain and adjacent terrace was gazetted as the Tana River Primate Reserve (TRPR), primarily to conserve these species.

Administratively the study area is situated in the Coast Province but a substantial proportion of the rangelands with which it strongly interacts through mobile livestock and pastoralists is in the Northeastern province, in particular the Ijara District. The floodplains and forests of the study area are in the former Tana River District (38,782 square kilometers, 232,488 inhabitants, average 6 inhabitants per square kilometer). This district was recently split into three separate districts:

- the southern Tana Delta District (of which the Garsen Division covers part of the study area)
- the central Tana River District (with most of the study area in the Wenje Division and a lot of the western rangelands in Galole Division)
- the northern Bura District.

Statistics are not yet available for the separate new districts so reference will be made continuously to the "Greater Tana River District", comprising the three new districts. The southeastern part of the study area is adjacent to the rangelands of the northern part of Lamu District. All these areas are highly

Lower Tana landscape with oxbow lake, forest, floodplain grassland and river branches

food insecure because of erratic rainfall. Arable land in the Tana River District is only three per cent of total surface area with the rest rangelands. Some 35204 hectares of land in the district has been equipped for irrigation but virtually all these large-scale highly centralized projects have not been operating properly for many decades and only 700 hectares was cultivated in 2009 (Ngumbi *et al*. 2009). In addition to conceptual, technical, and institutional deficiencies the main cause of failure is generally poor governance e.g. for the 100 million $US resettlement/ irrigation scheme in Bura (Ledec 1987, Maingi and Marsh 2006, Mwega 2008).

Both provinces, coastal and north-eastern, are characterised by very low indicators of human well-being with particular stresses caused by biodiversity loss and limitations on food production, water and fuel supply (Wong *et al*. 2005). Human Development Indices (HDI) in the area are among the lowest in Kenya. For example, within Coast Province the average HDI is 0.518, very close to the national average of 0.532, but the Tana River District ranks last with 0.307 (e.g. adult literacy rate is only 43 per cent, while the national average is 69 per cent). Similarly, Gender-related Development Index (GDI) is abysmally low with 0.378 compared to the 0.539 average for Coast Province and 0.627 nationally. The Human Poverty Index (HPI), which includes the percentage of underweight children, adult illiteracy, lack of access to safe drinking water, life expectancy (per cent not surviving after 40) and lack of access to medical care stands at 53.5, to be compared with the Coast Province HPI of 43 and the national 36.2 (UNDP 2006).

3. Climate and hydrology

Annual rainfall declines rapidly when moving inland from the coast, from an average of about 1000 millimetres (1050 millimetres at Malindi some 85 kilometres SSW of the river mouth at Kipini and 960 millimetres at Lamu some 75 kilometres NE of Kipini) to 520 millimetres at Garsen (45 kilometres inland) and 325 millimetres at Garissa (250 kilometres inland). There are two rainy seasons with the main rains between April and June (about 45 per cent of the annual rainfall at Garsen) and the "small rains" in November-December (about 25 per cent of annual rainfall). All other months have on average less than 50 millimetres of rainfall. The area is hot all year round with average monthly minimum temperature 22.6°C and average monthly absolute maximum temperature 34.1°C at Garsen (1976-1987). In such areas open water evaporation easily exceeds 2000 millimetres per year, more than 4 times annual rainfall. Though rainfall is obviously important for the development of the vegetation in the rangelands around the floodplains, the most important water supply for the floodplains themselves comes from the Tana River which is characterised by a double flood peak linked to the similar pattern of two distinct rainy seasons in the upper catchment. According to Maingi and Marsh (2002), the construction of the series of hydropower dams in the upper catchment has resulted in a decrease in the peak flow in May and an increase in the dry season flows from December to March (figure 3). The resulting reduction of flooded surface area, flood peak duration and meandering dynamics is likely to have negatively affected floodplain productivity and forest regeneration.

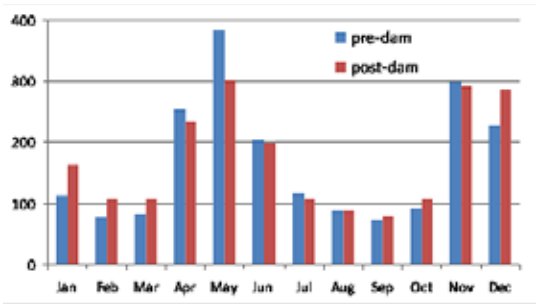

Figure 3. Average monthly discharge at Garissa in cumecs (cubic meters per second) in the pre-dam (1941-1979) and the post-dam (1982-1996) periods (adapted from Maingi and Marsh 2002)

4. Population and socio-cultural aspects of land use

The north-eastern coast of Kenya was, according to linguistic studies, originally the home of Khoisan-speaking hunter-gatherers, but all traces of their presence have disappeared. They were superseded about 4000 years ago by Eastern Cushitic speaking hunter-gatherer groups such as the Boni and about 2000 years ago by the Dahalo. The origin of the Watu, an Oromo speaking group originally confined to areas west of the Tana River, is unclear. Either they are local groups that took up Orma culture when the latter arrived in the seventeenth century or a group that migrated with them (Stiles 1981). A very small number of these hunter-gatherers still reside in the study area, usually in a separate small settlement of a few huts in association with other groups, traditionally with the Orma. Historically they played an important role as elephant hunters, providing ivory for export. They are now very marginalised.

The characteristic floodplain farming community are the Pokomo, a bantu-speaking group of sedentary farmers who have been present in the area for at least 6 centuries and who traditionally cultivate various levels of the floodplain with crops adapted to its particular flooding frequency, height and dura-

Small-scale fisheries in the floodplains, river branches and oxbow lakes of the Tana are an important source of animal protein and income for local communities

tion and groundwater level. Thus on the sandy levees they grow mango trees, banana, beans and vegetables, in slightly lower areas on mixed soils maize dominates and rice is cultivated on the black-cotton soils of the depressions in a system very similar to floodplain cultivation along the Rufiji River in Tanzania (Duvail and Hamerlynck 2007).

The surrounding rangelands have traditionally been exploited by Cushitic speaking semi-nomadic Orma (referred to as Galla in the nineteenth century literature) or nomadic (Wardei, Somali Galje'el clan) pastoralists that have arrived in successive waves. There is a tendency for them to become progressively more sedentary and take up some farming and even fishing. The milk herds stay around the permanent settlements all year round, exploiting the floodplains and the delta, and the "dry" herds move out to the rain-fed pasture in the surrounding rangelands.

Politically the Lower Tana was part of the Witu sultanate of Zanzibar and initially claimed by Germany as a protectorate but handed over to the British East African Protectorate in 1890 and thus, at independence in 1964, integrated into modern Kenya. However, the area has always felt distinct and physically isolated from the rest of the nation by the Tana River and floodplains. People still say they are going to "Kenya" when leaving the area. The area has also been characterised by decades of insecurity and low-grade armed conflict, initially linked to the so-called *shifta* wars of the 1960s but increasingly politicised using citizenship, ethnicity and religion as convenient banners for temporary alliances and divisions that can support calls for modern types of land ownership (in contrast to traditional use rights) or increase electoral clout (Kagwanja 2003).

5. Traditional natural resource management

As the Tana River flows through semi-arid lands its water is a highly precious commodity attracting different types of use. Historically, complementary and mutually beneficial resource exploitation strategies between the various user groups have always regulated rights of access to key resources, especially during the dry season. Elders of both Pokomo and Orma groups would jointly perform the required rituals after which the Orma could access water-points and floodplain pasture (Kagwanja 2003). In combination with low population density and sufficiently regular and extensive flooding these practices have allowed the different ecosystems to thrive and maintain the exceptional biodiversity. Thus nineteenth century explorers that travelled along the river described "an impenetrable jungle" and "beautifully foliaged trees covered with creepers fringed both banks of the river" (Gedge 1892, cited in Hughes 1984). Indeed, the forests, and especially the clay evergreen forest are considered a highly valuable resource even today (Luke *et al.* 2005). About a hundred plant species from the forests are commonly used by local people, especially for technology (43 species) and construction (34), traditional remedies (23) and food (15) and the main impact on forest structure is the use of large trees for canoes or beehives (Medley 1993), honey being particularly important to the Pokomo. Because of the shifting and meandering nature of the river and the forest use practices, the forest always has different stages of succession and is characterized by dynamic carbon storage (Glenday 2005). Though they need large trees, Red Colobus seem to prefer forest edges over mature forest (Mbora and Meikle 2004a) and the semi-terrestrial Tana Mangabey are well adapted to a landscape mosaic with alternating small fields, bush and forest at different stages of maturity.

According to Terer *et al.* (2004) the floodplain wetlands and in particular the oxbow lakes (recession agriculture of sorghum and millet, fishing, reeds for roof thatch, fresh water, grazing) are also considered of high value, as is the Tana River itself (water for various uses including irrigation, transportation, sand for building and as a protective barrier against bandits). As can be seen from figure 4, the floodplains have a very important function also in the attenuation of flood peaks through the overspilling of the banks, storage on the floodplains and in the oxbow lakes, infiltration into soils raising the groundwater level, etc. thus protecting downstream areas from their destructive power.

Though hunting is illegal in Kenya the rich wildlife associated with this mosaic of different forest types, wetlands, rangelands and small-scale agriculture continues to provide animal protein. Elephants have

Table 1. Ecosystem services in the Lower Tana

Provisioning services	
Food	Recession agriculture, small-scale flood irrigation, mobile livestock keeping, capture fisheries, collection of wild plant and animal food products
Fiber	Timber for canoes and construction, beehives, roof thatch and weaving products from palms, wood fuel
Clay	Construction of mud houses, brick-baking, pottery, fertilization of soils
Genetic resources	Not studied, potentially some traditional crop varieties
Biochemicals, natural medicines and pharmaceuticals	Important role of forests for local medicinal products, honey and palm wine
Freshwater	Surface water for various uses and groundwater recharge (subsurface waters are in general saline)
Regulating services	
Air quality regulation	Dynamic forests in different life stages with efficient carbon fixation, barrier to wind erosion
Climate regulation	Evapotranspiration by forests, oxbow lakes, etc.
Water regulation	Reduction of flood peak between Garissa and Garsen (see figure 4)
Erosion regulation	Riverine forest slows bank erosion and stabilises meanders
Water purification and waste treatment	Absorption of nitrogen, reduction of sediment loads by deposition in the floodplains
Disease regulation	Not studied
Pest regulation	Not studied
Pollination	Not studied but most probably important
Natural hazard regulation	Resilient ecosystems continue to provide services during climate extremes
Cultural services	
Cultural diversity	Different livelihood strategies complement each other e.g. fertilisation of fields by livestock, provision of wild foods and milk in exchange for farming produce
Spritual and religious values	Not as strong as in the Mijikenda of the more southern coastal forests but there is a strong emotional affinity with the traditional landscapes
Knowledge systems	Elaborate traditional knowledge under threat (sedentary lifestyle, schools, wage jobs, outmigration to towns)
Educational values	Teaching of bush practice and traditional pharmacopeia
Inspiration	Many locals enjoy transect walks and being in the bush
Aesthetic value	Both traditional and modern
Social relations	Rituals by elders of various communities for access to resources
Sense of place	People who received land at Kipini in compensation have remained attached to their ancestral lands, return of livestock keepers to abandoned TDIP land (Wardei)
Cultural heritage values	The Pokomo claim they brought the Red Colobus with them from Central Africa
Recreation and ecotourism	Good potential but issues with the security situation, access, infrastructure and human capacity (language, training of local guides)
Supporting services: soil formation, photosynthesis, primary production, nutrient cycling and water cycling underlie all the other services and are usually not included to avoid double counting in ecosystem valuation	

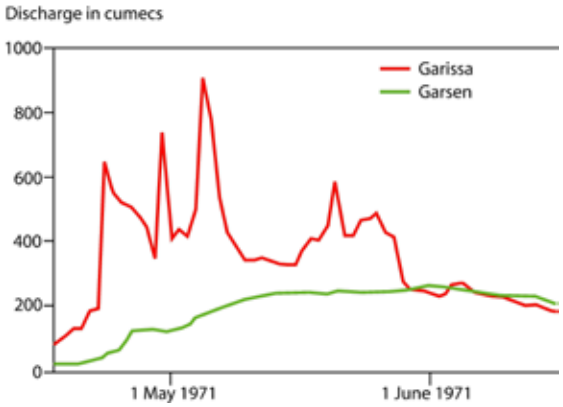

Figure 4. Flood peak attenuation by the floodplains between Garissa and Garsen: example of the 1971 flood peak (adapted from TARDA 1986)

virtually disappeared during the late 1980s, because of intensive poaching, but various ungulate species are still quite abundant in the area and human wildlife conflict, especially with buffalo, is a major complaint of the local communities when interacting with the Kenya Wildlife Service.

In summary, since time immemorial the area has provided a wide range of mostly flood-dependent ecosystem services to the different users (table 1). This dynamic equilibrium and the human well-being dependent on the services are increasingly threatened through a large number of indirect and direct drivers of change (figure 5).

6. Threats to ecosystem functioning and human well-being

6.1 Indirect drivers of change

Rural Kenya continues to have a highly dynamic demography with on a total fertility of on average 5.2 children/woman (in comparison to 3.1 in urban areas) and, though still declining the predicted transition to lower fertility seems to be slowing (Opiyo 2003). In 1966 the "Greater Tana River District" had 42,700 inhabitants but this figure may be less reliable than later surveys and would therefore overestimate growth rates. In 1979 the population was 92,000, growing to 181,000 in 1999 and 232,500 in 2005, or an annual population growth rate of 3.6 per cent (to be compared with the national average of 2.6 per cent).

6.2 Direct drivers of change

Land use change, i.e. the conversion of communal land to either nature protection (e.g. the Tana River Primate Reserve) or large-scale irrigation (e.g. the Tana Delta Irrigation Project) in combination with the demographics but without great advances in technology or economic processes, e.g. poor market access (the road between Garsen and Garissa is not tarmac and often impassable during rains) has increased the pressure on the natural resources while floodplain productivity declined in the face of reduced flooding (Maingi & Marsh 2002). The net result has been continued conversion of forest to agricultural land and a decline of the quality of the remaining forest habitat.

On the basis of a 1982 feasibility study funded by the Netherlands, the Tana and Athi Rivers Development Authority (TARDA) envisaged the development of a total of 16,800 hectares of irrigated land in both the Lower Tana floodplains and the delta, called the Tana Delta Irrigation Project (TDIP). However, an Environmental Impact Assessment (Ecosystems Ltd. 1985) highlighted numerous negative environmental impacts and pointed to serious flaws in the design and economic analysis of the project. The Netherlands therefore stopped all funding for project implementation (Hirji and Ortolano 1991). However TARDA refused to acknowledge the findings of the EIA and proceeded to obtain 6 million Yen (approximately 50 million American dollars) funding from the Overseas Economic Cooperation Fund (OECF) through the Japan Bank for International Cooperation (JBIC) and, in 1988, a first polder of about 2000 hectares was created between the water abstraction point on the Tana River at Sailoni and the Garsen-Witu road (see figure 2). With increased understanding in the international donor community that participatory processes were key to successful project implementation (Chambers 1994) one may wonder why a highly centralised top-down approach was again used for TDIP. The project was implemented as an estate system where TARDA was in charge of infrastructure, production, marketing and sales, administration, operations and maintenance. Thus TDIP did the ploughing, harrowing, sowing, harvesting, provision and distribution of seeds, fertiliser and chemicals etc. while a small number of locals were employed as casual workers for weeding, bird and wildlife scaring, sluicegate management and surveillance. Though infrastructure was only completed in 1997, production started in 1993 and was about 2.5 metric tonnes of polished rice per hectare, much lower than projected 6.5 tonnes and without a significant impact on rice production within Kenya (JBIC 2001). After mechanical harvesting by TARDA, the local communities benefited mostly from collecting the leftover rice grains in the fields (Lebrun *et al.* in press). The construction of the embankment and the exclusion of a large area of floodplain from flooding caused an increase of the water level upstream which destroyed the perennial crops of traditional farms. The embankment, in combination with the shift of

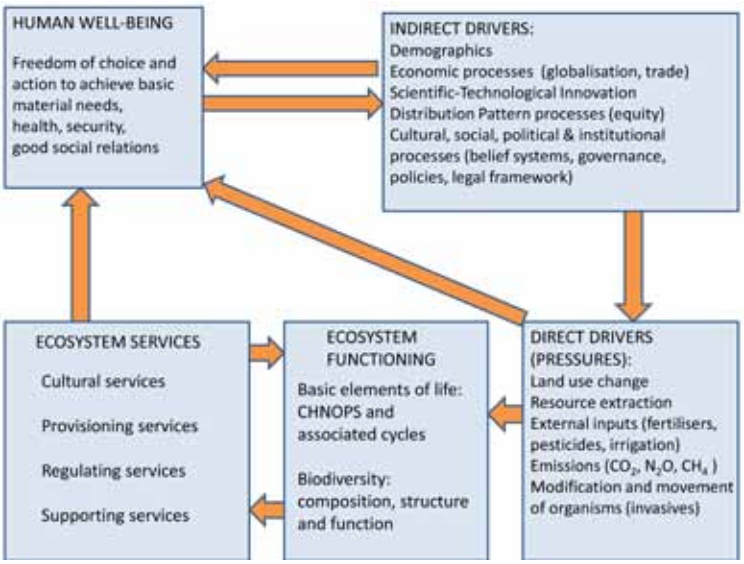

Figure 5. Conceptual framework of the interlinkages between biodiversity, ecosystem services, human well-being and the drivers of change (adapted from the Millennium Ecosystem Assessment 2005)

the dominant flow from the eastern to the western channel, reduced flooding of the forests and lakes to the east of the TDIP between Sailoni and Lango la Simba. The irrigation scheme collapsed totally during the 1997-1998 El Niño floods and human well-being in the area is extremely low with a very high percentage of vulnerable people (Luke *et al.* 2005).

Therefore, the priority accorded to the development of one ecosystem service, the provisioning of food, mainly for the benefit of a parastatal organisation rife with governance issues, has led to the loss of a large number of services that benefited directly to the local communities. In addition, the loss of the land in the TDIP polder, where the traditional users are considered squatters on their ancestral lands (court cases challenging this are still pending), has increased the pressure on the remaining flooded forests to the West of the TDIP while the forests and lakes to the East no longer receive significant flooding and have seen their productivity decline steeply. Forest cover has declined by 37 per cent in the area with a concomitant reduction in the quality of the remaining patches (Luke *et al.* 2005). Resource extraction has therefore clearly exceeded regeneration capacity. In addition *Prosopis juliflora*, which was introduced at the Bura irrigation scheme, is rapidly spreading in the abandoned TDIP area and the rest of the Lower Tana, further reducing the carrying capacity of the rangelands.

Similarly the World Bank/ Global Environment Fund investment of 6.7 million American dollars in the Tana River Primate Reserve between 1996 and 2001 has not succeeded in arresting the decline in forest cover though the loss (29 per cent over 21 years) was slightly less pronounced inside than outside (38 per cent) of the reserve (Moinde-Fockler *et al.* 2007). In theory, people that abandoned their fields in the TRPR would be compensated by land in the forests east of Kipini. However, most people who have accepted the compensation and have deforested land in the Kipini area seem to continue to also exploit their plots within the TRPR. The final evaluation of the intervention (World Bank 2005) qualifies the outcome as unsatisfactory, the sustainability as unlikely, the institutional development impact as modest and judges that both bank and borrower performances were unsatisfactory. One of the reasons evoked is that the project focussed too narrowly on the conservation of the two primate species.

One of the lasting impacts of both projects seems to have been the creation of deep resentment in the local communities against development/conservation projects and their implementing agencies i.e. TARDA and KWS.

7. Prospects

In collaboration with development partners, the Kenyan Government is currently investing massively in the rehabilitation of the food provisioning service of the irrigation schemes along the Tana River. From the above it is clear that the top-down sectoral approach used so far, both in agricultural development and nature protection projects, has shown its limits and that a fundamental change towards a more holistic and participatory approach, that looks at a much wider set of ecosystem services both at the river basin scale and at the local level, and that analyses their links to human-well being with particular emphasis on vulnerable groups, is required. A proposal for the rehabilitation of the biodiversity-rich forests in and around the TDIP has been formulated (Luke *et al.* 2005) but has so far received neither funding nor much support from civil society. Investing in the rehabilitation of environmental infrastructure, i.e. the forest, wetland, rangeland and agricultural landscape mosaics of the Lower Tana will improve the resilience of the ecosystems and this will secure the livelihoods of the local communities in the face of climate change and other threats. There is no reason why the rehabilitation of the irrigation schemes

should not go hand in hand with investment in environmental infrastructure. In fact, through managed flood releases, part of the irrigation water could usefully re-establish flooding of forests and wetlands to simulate the traditional multi-user multi-functional landscape as was done e.g. in the Deltaic floodpains of the Senegal River (Hamerlynck and Duvail 2003). Such interventions would need to be based on solid knowledge, including re-investing in hydro-meteorological assessment and monitoring. On the basis of these updated findings it may be necessary, at the river basin scale, to re-evaluate the management of the hydropower dams with appropriately timed managed flood releases that should perhaps strengthen the short rains-associated floods that, from an ecological perspective, seem to be better timed for productivity. The production kick-started through that early flooding phase in November and December can more easily be sustained during the more reliable long rains. Large long rains-associated flood releases may not be required (nor possible in the case of declining rainfall in the catchment) every year but, in order to ensure adequate forest regeneration and maintain wetland ecosystem functioning, may have to be practiced every three years. Local knowledge may guide these early flood-release experiments and lessons can be learned from them in a participatory manner.

It would be beneficial to all if, in both the design and implementation of the interventions, an ecosystem approach could be used which, from the outset, involves all stakeholders and follows a coherent stepwise implementation along the lines proposed by Borrini-Feyerabend *et al.* (2004).

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The Maasai's shifting modes of subsistence (Kenya)

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1. Introduction

Kenya has over 80 per cent of its land as semiarid region. Its main vegetation is savanna (Mizuno, 2005). Many human populations live in the savanna area. According to a definition of *satoyama*, "the land has a function to prevent overuse and is a place where people live a life by sustainable use of local natural resources"; savana is considered to have similar characteristics with Japanese *satoyama*. East Africa has been hit by severe drought in recent years. This severity has "never been experienced before", as a village elder says, and this issue has to be taken in consideration when discussing community use of natural resources. In Loitokitok, Rift Valley province, the Maasai, nomadic herdsmen whose diet has traditionally been composed of only cow milk and blood, have started farming recently. Although the farming is practiced only in one part of the tribe, we interviewed them about their past traditional lifestyle, their reason for starting farming, and problems and future expectations.

2. Survey Location and Method

The survey was conducted in Entonet location, Loitokitok division, Kajiado district, Rift Valley province. The area is located on the north side of the foot of Mount Kilimanjaro. It is suited for agriculture due to the availability of irrigation and wells receiving underground flow from the mountain (figure 1). A roadway from Nairobi to this area is under construction and it is expected to become a prospective agricultural area. Amboseli National Park is in the vicinity. With the cooperation of the community leaders and the Entonet ward councilor, we held a workshop with 21 representatives from each age group, including female participants, in Namelok village of Entonet. The discussion topics included life in the savanna, the reasons for starting farming, and future expectations (figure 2). We also visited local irrigation farming sites and non-irrigation farming plots.

Figure 1. Farmland in Loitokitok Division

3. Survey Results

3.1. Introducing the Maasai and their use of natural resources

The Maasai is a nomadic tribe which lives in the region spanning from Tanzania to western Kenya. The Maasai people respect and depend on cows, which provide them with most of their essential needs, such as milk, blood, meat, fat, and hide. Natural resources that Maasai utilize are plants found in savanna for cattle breeding and firewood and medicinal plants for their own use. The deterioration of savanna directly affects the Maasai's lives.

3.1.1 Coming of age ritual

A male Maasai becomes an adult at the age of 18. In the past, a male who turned 18 was circumcised and added to the lion hunters as a rite of passage. The Kenyan government has since banned lion hunting and men under the age of forty do not have the experience of hunting a lion. Hunting lions is only permitted when a lion attacks cattle. As a result, the present day coming of adult ritual is comprised only of circumcision and one or two months of communal life in the woodland after the circumcisinon.

3.1.2 Traditional diet

The Maasai's diet has been solely dependent on cow blood, milk and meat. The Maasai extract about two litres of cow blood from the healthiest cow. The ways to consume the blood include drinking it raw, mixing it in milk and drinking it, or mixing it in oil and warming it up to eat the loosely solidified product. The milk is consumed raw or fermented for about three days in a gourd and eaten. Meat is eaten only on special occasions such as following a birth, when a man is circumcised, for a wedding, for a funeral, or when practicing communal life in the woodland as a warrior. Traditionally, the Maasai did not eat vegetables. Also, it is a taboo to hunt a wild game other than lions. A woman in her fifties in the village ate something other than cow for the first time in 1961. That year was hit by severe drought and the government provided bags of maize flour via air-

plane. Recently, food other than cow-oriented food is becoming popular in Maasai villages; however, for the elderly males, consuming even chicken does not seem to be a favourable habit.

3.1.3. Medicinal plants

The Maasai use some wild plants for medicinal purposes. Table 1 shows some examples of medicinal plants mentioned by the workshop participants. These plants are essential medicine and include remedies for malaria, abdominal pain, menstrual cramps, delivering the placenta, haemostatics, laxatives, anthelmintics, and eye drops. There is one example in table 1 which became inappropriate for use because its effect became too intense once the diet of the Maasai, and their constitution, changed. Except for this plant, other plants are still in use today, even though people have recently begun to use modern pharmaceutical products as a hospital was built in the area.

3.2. Reasons for starting agriculture

The Maasai settled in Namelok in 1974. They started farming due to population increases, drought, and favourable government policies. Once they settled in, their population increased so they could not sustain themselves solely on the cows that they had. This caused them to begin cultivating land in the 1990s. Also, drought became more and more prominent after the 1980s. Many of the wild plants disappeared and occasional heavy rainfall had washed away the soil. An elderly Maasai commented, "before 1980s, drought came but for short periods. Recent droughts are longer and more severe than what we experienced in the past." The Kenyan government began to implement policy measures in 2001 in which the Maasai in the area were allocated either ten acres of non-irrigated farmland or five acres of irrigated farmland per household. People in Namelok received irrigated land and since then have begun full-scale agriculture.

Figure 2. Participants of the workshop in Namelok village

We must note that those Maasai have not entirely abandoned their traditional way of living based on cattle breeding (figure 3). Since the introduction of agriculture, they have accepted to change their traditional lifestyle, but it was not intended. Especially for elderly Maasai, cows remain the most important asset in their life to this day. Many of the Maasai who received ten acres of non-irrigated land have opted to sell the land for cash income and did not go into practicing agriculture and maintained their cattle breeding lifestyle. This seems to represent their attitude which shows that shifting traditional lifestyle is not easy.

3.3. Present Conditions for Agricultural Production

3.3.1. Irrigated Farmland

Water from the source is provided once a week for four hours (figure 4). Main crops are tomato (August to November), beans (December to February), maize (occasionally onion or left fallow) (March to July), and they rotate those crops. Cattle manure is used as fertilizer and weeding is done by hand with harrow. If brokers do not visit the village, they would go to Nairobi or Mombasa for a market. Some issues associated with irrigated agriculture in Namelok are that there is no reliable market, there is limited knowledge of suitable means to treat crop diseases, and there is a lack of professionals who can lead them to address these problems.

Despite these issues, the younger generation has a positive view of agriculture. They are willing to work in the field and to obtain cash income. They hope for the expansion of agriculture in the future. Women do not have a negative view of agriculture even though agriculture requires more work hours than cattle breeding.

3.3.2. Non-irrigated Farmland

The non-irrigated farm owner we interviewed in Loitokitok was from the Kikuyu tribe. He purchased the land from the Maasai via other friends. He owned 36 acres of farmland and cultivated maize and beans. Crop diseases were treated with pesticides and crops were sold at neighbouring market. He was trying to cope with drought by drilling a well. Loitokitok is blessed by underground flow from Kilimanjaro, and is becoming a major agriculture district in Kenya. Kikuyu tribe has originally practiced agriculture so that it is not difficult for experts like them to make sufficient harvest here.

4. Conclusions

4.1 External Difference and Essential Analogy Between Savanna and Japanese Satoyama

In savanna, one can see an unchanging, vast flat

Table 1. Maasai medicinal plants

Maasai name	Scientific name[1]	Part of plant used	Efficacy	Remarks
Olkiloriti	*Acacia nilotica*	root	Many diseases	IUCN status: 'Least Concern'
		leaf	Malaria	
Olmame		root	Kisonono (Gonorrhea[2])	
Olmukutan		root	Malaria	Due to the change from a cow-based diet to a diet involving a variety of food sources, people became more fragile physically. The medicinal effect of this plant has become so intense that they have stopped using it.
		leaf	Anthelmintic	
Olemit		root	Malaria	
Olkisikoni		root	Allergy	
Osokonoi		leaf	Upset stomach	
Olkonyil	*Rhamnus prinoides*	root/leaf	Kidney disease/Refiner	
Esukuroi		leaf	Eye-drops	
Entulelei	*Solanum mauense*	fruit	Hemostatic	Sodom apple (English)
		root[1]	Malaria, Chest pains[1]	
Empere-Epapa		root	Abdominal pains	
Olmairo-ngiro	*Plectranthus kamerunensis*	root	Cramps	
Olosukii	*Zanthoxylum usambarense ?*	leaf	Aperitive for child	
Olekikareta		root	Ejection of placenta	Carried by midwife

1: Beentje H.J. (1994) Kenya Trees, Shrubs and Lianas. National Museum of Kenya
2: http://www.etsumi.jp/africa/kiswahili/majina/magonjwa.html

land stretched to the horizon. Cultivated fields also expand to wide area. However, if observed more closely, one can find water, houses, and corrals in the scenery so it is not the same as large scale intensive farms or unpopulated primary woodland. This type of landscape is externally different from those seen in Japan or Indochina where one sees a mosaic structure of about one hectare each of secondary forest, paddies, rivers and villages. People in Kenya have lived in this land by raising cows, collecting medicinal plants, fetching water, and raising a family despite the continuous threat of lion attack. In terms of quality of lifestyle, the savanna life has the same essence with that of present Indochina or Japanese *satoyama* sixty years ago. If a *satoyama* landscape is defined by its mosaic predisposition, the importance is laid more on whether necessary essence is present rather than the size of a patch.

4.2. About Traditional Knowledge and Modern Scientific Knowledge

The Maasai depicted in this report present both traditional lifestyles of cattle breeding by utilizing savanna's natural resources and modern irrigated agriculture to generate income. Traditionally, the Maasai depended on a diet based solely on cow blood, milk and meat, and collected natural resources from the savanna only for firewood and medicinal uses. They kept their rule to hunt no other wildlife than lions - their predators - by raising lion hunting warriors. It was a perfect mechanism in the savanna to coexist with wildlife and to enable the sustainable use of resources. However, the influence of a market economy, changes in wildlife management, and drastic environmental changes have caused this traditional lifestyle to become ill-suited for the present situation. The Maasai are seeking means to maintain their cows under never-experienced drought. Also, they are seeking farming techniques or knowledge to tackle the problems associated with their new agriculture business. Modern scientific knowledge should answer them. And a structure to introduce this knowledge to farmers is inevitable.

4.3. About Creation of New Commons

Proposals have been made for business model called "creation of new commons", which incorporates local ecosystem such as flora, fauna, landscape or culture depending on them into business without disturbing the resources. For example in Namibia, a foreign non-governmental organization encouraged local villagers to conduct ecotours, in which tourists observe elephants living in the floodplain forest of seasonal streams. It has become a major income source for the villagers and they have since changed their lifestyle of living on dwindling cattle breeding to tourism (Yoshida, 2007).

The Maasai have so far proceeded cautiously with agriculture. The elders have retained a leading role

Figure 3. Feeding stalks and leaves of maize to a gaunt cow

Figure 4. Irrigated farmland in Namelok village

which ensures solid bonding of the community. Their traditional way of living by cattle breeding is almost unfeasible because of recent drought; nonetheless, they try to maintain the cattle while proceeding with agriculture which is a more practical cash income source. This can be considered a dual economy (Konaka, 2006). There is little chance of an external business model of selling ecosystem services to be admitted in this village for now. The Maasai are not willing to transform their traditional lifestyles. What they wish for most is the technology and knowledge to cope with the present drought condition. The young generation has hopes for educational opportunities from this income. When we talk about the creation of new commons, it does not have to be a business model incorporating the ecosystem service. It can be a human resource support system or information network to support the local traditional lifestyles.

The Maasai have kept their interdependence with wildlife in the savanna without eliminating them. This has enabled the area to accommodate diverse wildlife, despite not being designated as a conservation area. This environment is sustained to this day by Maasai's traditional lifestyle of coexisting with wildlife. It is likely that the current savanna environment of relatively high biodiversity will change when Maasai's traditional living changes. In general, when a land is not used sustainably, its biodiversity tends to decrease. The Maasai people introduced in this report is now at the crossroad of changing their lifestyle. Their wish is to continue traditional cattle breeding, and yet it can no longer sustain their life in current condition. To support the Maasai's wish to continue nature friendly life directly relates to saving the biodiversity in savanna from deterioration.

This study was commissioned by the Ministry of the Environment, Japan

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How farmers in Kitui use wild and agricultural ecosystems to meet their nutritional needs (Kenya)

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1. Introduction

The Kamba villages of Kitui in east-central Kenya occupy a fragile agrarian landscape at the border of the drylands and deserts of northern and north-eastern Kenya. The Kitui landscape has experienced pronounced climatic changes with growing water scarcity, less predictable rainfall, and shorter growing seasons in the past ten years. The response has been (i) increasing reliance on a broader set of resources found in the biodiversity of local ecosystems, (ii) a growth in local institutions to maintain and acquire knowledge about biodiversity management, and iii) increased reliance on active management of distinct ecologies within the Kitui agrarian landscape, e.g. greater use of forest resources, more movement of trees into cultivated zones, growing mix of livestock and cropping activities, and increasing use of gardens to produce indigenous food crops and bringing gathered foods plants under cultivation. The various ecologies of the Kitui landscape are managed and integrated to provide food security and even new market opportunities as individual cropping systems and intensive livestock practices prove less and less secure. The resurgence of local knowledge and institutions is a key factor in coping with environmental change. Kitui villagers' active links with outside sources of knowledge that can be incorporated into their bio-cultural system has given needed technical support and pride in their landscape management systems.

2. Landscape, geography and climate

The research was conducted in Kitui area, Eastern Province of Kenya, which is located about 170 kilometres east of Nairobi. The research area comprises Kitui hills and surrounding lowlands and runs roughly in a south-north direction covering an area 50 by 30 kilometres. The area, which was previously in one district (Kitui) is now shared by four administrative districts - Chuluni, Kitui, Kitui West and Migwani -- following recent subdivisions.

The Kamba people who occupy the area are mixed farmers, growing a variety of crops and raising animals, mainly goats, cattle, donkeys and occasionally sheep. Agriculture is predominantly subsistence. The central highlands of Kitui are relatively wetter and better for crop cultivation, hence the population here is higher than in the rest of the region. Population densities are high in and around the main towns – Kitui, Migwani and Kabati -- and also in the wetter highlands with densities of 250 to 300 people per square kilometres. The dry lowlands are generally sparsely populated with some areas having as low as 10-15 people per square kilometre.

Kitui area as a whole is largely a low, undulating plateau rising gently from 300 metres in the east and southeast to about 1,200 metres in the west. The plateau is interrupted by several rock outcrops, hills and ranges, the most prominent being Kitui and Mutitu ranges, with Mutonguni (1641 metres) and Mutitu (1638 metres) peaks being the highest. These two form the peaks of two parallel ranges that run in a general north-south direction and are separated by a deep valley drained by Thua and Ikoo rivers. The sides of the valley are extremely eroded with gorges several hundred metres deep in some sections.

The physiography of the area affects humidity and virtually all spheres of life including agriculture, nature of crops and varieties grown, the time when they get ready for harvesting, land sizes, population densities, and access to markets and so on. The area falls in three main ecological zones:

i) The lowland area, including the Tiva Valley at 1000-1100 metres above sea level and the Thua Valley at 670-900 metres above sea level.

In Inyuu village, fruits of berchemia come into season in the months of February and March when the mango season is already over. Berchemia grows naturally but is managed both in cropland and in the wild.

ii) Midlands, at 900 to1150 metres, including the medium altitude areas and Kitui town, Mulundi and Matinyani. They are warm with good rainfall. The zones rise steadily in altitude towards the north (Migwani side).

iii) Highlands at 1150 to 1641 metres: This constitutes a small portion of the research area. Rainfall is good and temperatures generally cool.

Much of Kitui region is semi-arid, receiving 500-700 millimetres of rain a year. The Kitui hills, however, which constitute a small area of the region, are the wettest, receiving an annual rainfall of about 800-1000 millimetres. Rainfall is bimodal with peaks in April (long rains – locally called *Uua*) and November (short rains called *Nzwa* or *Mbua ya mwee*). The short rains are more reliable and have a better distribution. The periods falling between June to September and January to March are usually dry. Rainfall reliability is estimated at only 40 per cent. Precipitation patterns are uneven both in space and time with evaporation rates reaching 100 per cent.

Most of the land in Kitui is therefore subject to frequent droughts, crop failures and famine. Although the plateau and the hills are dissected by numerous streams, these are only seasonal, flooding when it rains but dry for the most part. Most streams drain into Thua to the east of Kitui hills and Tiva to the west of the hills. These rivers run southeast and later east to empty in flood plains far to the east before joining River Tana, the largest in the country. In spite of the numerous streams, the region as a whole has an acute shortage of water. Much of the population has to turn to fetching water from wells dug in sand beds of these steams often after walking for long hours and carrying it on their own backs or those of donkeys or in carts pulled by oxen.

Much of Kitui's population is dependent on subsistence agriculture. This is mainly as a result of frequent rain failure. In the wetter zones, which are expected to have a stable food situation, the productive capacity of the land is low and population pressure is high. Despite its dry nature, the district presents a number of opportunities. It is rich in traditional food resources and plant diversity is high. The local population has largely held on to its traditions and therefore has a rich knowledge of the local resources. Guided by their indigenous knowledge, local people use these wild plant resources for food, medicine, fuel, cosmetics, fibre, timber, local teas and other uses.

Generally the soils of Kitui district are dominated by dark red clays and sandy loams with pockets of black cotton. The highlands have deep well-weathered clay soils, but these are often poor due to overcultivation (since 1700s) and extreme erosion, which in some parts has exposed the bedrock. Most foothills have a gentle slope and sandy to sandy-loam soils. The Yatta Plateau, the extreme west of the district, has black-cotton soil and lies in a dry zone.

A child eating tamarind fruits at Inyuu village, Chuluni District

In the dry zones, *Acacia* and *Commiphora* bushlands and occasional woodlands dominate. Much of the natural vegetation in these areas is still intact as land parcels owned by individual families are still large. The land is used as pastureland and crop farms. The relatively cooler, more humid slopes of the hills have varying vegetation types mainly with *Terminalia brownii* and *Acacia polyacantha* as as the most conspicuous trees. Soils are well-watered sandy to sandy-loam soild. The higher slopes and mountains are dominated by planted exotic trees, mainly Australian blue gum (*Eucalyptus* spp.), grevillea (*Grevillea robusta*), cypress (*Cupressus* spp.) and pine (*Pinus* spp). There are three small gazetted forests on mountain peaks.

3. Research objective and method

The research presented here aimed to find out how people in Kitui use local biodiversity from the Kitui ecosystem to ensure a reliable supply of important nutrients to the household throughout the year. The population targeted in research consisted of 300 households distributed in 20 villages. The research

carried out during a series of field trips conducted in 2008-2010 looked at diversity of foods grown or gathered, the farming system's food sources and diversity in household diets.

3.1 Tools

A number of tools were used to gather this data, including a food frequency questionnaire (FFQ) and 24 hour recall, a market survey, an in situ survey and a socio-economic questionnaire. A detailed farming system and agrobiodiversity survey was carried out among 50 households. The survey involved visiting homesteads and walking in the fields in the company of a knowledgeable person who provided information. The research was aimed at determining the level of agrobiodiversity, the presence of farms other than home gardens and the characteristics of these farms. The research examined the number of farms each household had, the distance to the farm etc. The aim was to establish how the farmer spreads out his/her risks as a survival strategy.

Plant diversity lists were generated through focus group discussions, open-ended interviews with individual farmers, observations of the fields and markets, and collection and identification of plant specimens. Plant species and varieties as well as the associated local knowledge mentioned by the respondents were recorded. Photos of the plants were taken and voucher specimens were collected using a plant press, then identified at the East African Herbarium of the National Museums of Kenya. Market research entailed visiting six key local markets on regular basis for a period of one year and recording the occurrence of any traditional foods sold.

3.2 Research design

A study area measuring 50 by 30 kilometres and covering a section of Kitui hills and the surrounding lowland area was identified. Twenty representative villages were identified in this area as research sites. The villages were selected in such a way that they represented the three agroecological zones in the area, from a dry (450 millimetres rainfall), sparsely-populated area to a sub-humid (1000 millimetres rainfall) and densely-populated one. Fifteen households were selected randomly for food consumption research. An agrobiodiversity survey focused on an average of three households per village.

4. Results

4.1 Agrobiodiversity

Kitui region has a rich diversity of plant resources. The local population has largely held on to its knowledge of local resources. Guided by their indigenous knowledge, local people use local plant resources for food, medicine, fuel, cosmetics, fibre, timber, local teas and so on. Although the more important crop species such as maize, beans and pigeon peas are grown in all ecological zones, some zones have unique crop species, varieties and farming systems. Farmers benefit from the various agroecosystems in a number of ways: firstly, by individual families having farms in the different agroecosystems; secondly, by accessing foods from other agroecosystems in the market; and thirdly, by accessing food and fodder directly from their kins living in other agroecosystems. The three main agroecosystems in the research area can therefore be envisioned as one mega system where the benefits from any single agroecosystem are spread to all households in each agroecosystem.

4.2 Number of farms cultivated by households

Of the 48 households interviewed, 36 (75 per cent) had more than one farm. The commonest number of farms was two, while the highest was five. Households in densely populated areas had the highest frequency of multiple farms.

Ownership of multiple farms is a strategy of enhancing food security in the household. Although the main motivating factor could be land pressure, it can be seen that the second and third farms are often in different habitats, e.g. by a stream or different agroclimatic zone. This can be seen as a way not only of enhancing production but also of diversifying the crops the household can grow. Only eight household had second farms that were far away (from 2 to 30 kilometres), mostly in different agroecological zones.

4.3 Markets

There are five main towns in the study area that provide a market for produce from the region: Kalundu (Kitui), Kavati, Tulia, Migwani and Inyuu. Each of these has a designated market day within the week. Kalundu, the largest, has two market days in a week. Markets provide the local residents with an opportunity to access agrobiodiversity from all the ecological zones in Kitui. How the different agroecological zones complement each other can be demonstrated by the ripening of mangoes and other fruits. In the hot lowlands of Inyuu, mangoes ripen from mid December and the season is over by early February. In the highlands of Kitumbi and Mutonguni, the mango season starts in February and ends in early April. The markets therefore get a constant supply of mangoes for a straight five months, from December to April, while the season for individual agroecological zones hardly exceeds two months.

4.4 Seasonality

Other than the variations in agroecological zones, local residents at any agroecological zone also take

advantage of the different maturation seasons for different crops. In the subhumid areas, for example, the mango season starts in January giving way to guava season, which in turn gives way to the orange and muu (*Vitex payos*) season. Here wild and cultivated fruits complement each other. Some wild fruits come at a time when cultivated fruits are out of season.

In the eastern lowlands of Inyuu, cultivated fruit species are fewer and therefore dependence on wild fruits is higher. Mangoes are the main cultivated fruit. The mango season starts early in November due to the high temperatures and is followed by a season of wild fruits, such as nzaaya (*Berchemia discolor*), baobab (*Adansonia digitata*) and ndootoo (*Meyna tetraphylla*). Dependence on wild fruit is higher in the lower highlands of Inyuu and Nzambani.

To summarize, the main fruits used in Inyuu over the year include mango from November to January, wild fruits (ndootoo, baobab, nzaaya) from February to March, and tamarind from July to October. The main cultivated fruits in Kitui, in order of importance, are mango (December to March in the midlands and November to January in the hot lowlands), orange (March to June), Avocado (July and August), Custard apple and Passion fruit. Important wild fruits include Matoo (*Azanza garckeana*), Nzaaya (*Berchemia discolor*), Muu (*Vitex payos*) and Nzumula (*Tamarindus indica*).

4.5 Resilience among the people of Kitui

In Kitui, resilience has been built through deep knowledge and practices that make the most of the local agricultural and wild biodiversity for home consumption and for sale.

4.5.1 Vegetables

A number of vegetables are grown spontaneously/naturally on the farm and are also gathered from the wild. Kikoe (*Commelina africana*) sprouts fast after the rainy season before cowpeas, the main vegetable, has grown enough for harvesting. Kikoe grows well under trees and other places known to the family, especially the mother. Other vegetables such as muchicha (mainly *Amaranthus dubius*) grow spontaneously on the farm but are also cultivated.

4.5.2 Fruit trees

Wild fruits such as muu are used when in season for consumption and sale. Naturally growing fruit trees provide an important contribution in fruit consumption, particularly in the drier areas where, with the exception of mango, most other fruit trees are lacking. The wild fruits are important, particularly among children. About eight species of fruit receive special management if grown on the farm. Fruits of the three of the species (tamarind, black plum and baobab) are also sold, providing income particularly for the woman.

A girl drawing water from a well made by scooping out sand from a dry stream bed, Tiva village, Kitui District

4.6 Management of naturally-growing fruit trees

Although many types of fruits are cultivated in Kitui, the mango is most important and is available in most households. The mango season lasts from December to March, after when there is little cultivated fruit available from the farm. The wild fruit, muu, comes at the end of April and lasts until July, hence filling a void. Tamarind ripens soon after that and lasts until October.

These important trees are often left standing while others are cut, e.g. for charcoal or to give way to a new farm. When they grow in crop land, these are often taken care of. These trees are maintained and managed for fruit but also for the other benefits they provide.

4.7 Making use of the different agroecosystems to grow food

Farms are located in different ecosystems and habitats. Farmers often maintain a home garden, a kitchen garden and a garden located in a valley where there is water (*kyanda*). In *kyanda*, farmers grow crops that need large amounts of water, including taro (*Colocasia esculenta*) and sugarcane (*Saccharum* spp.). A kitchen garden makes use of waste from the household. Vegetables and also other crops such as pumpkins are commonly grown here. Most farmers have more than one farm with some farmers having as many as five located in different ecosystems and occasionally the farmers has several farms. In this way, farmers exploit different ecological types and by doing so they spread the risk of crop failure. Some distant farms can be up to 50 kilometres away so that farmers have to relocate for long periods to

work there. Farms usually have different ecological conditions, including soil types, moisture and general agroecology.

Kitui region has six agroecological zones owing to differences in altitude. These support various crop species, varieties and biodiversity in general. Due to such differences, a crop like mango ripens at different times of the year in different areas. In the lowland areas of Inyuu (700 metres), the mango season starts in November and lasts through January. In Kitumbi in the highlands (1400 metres), however, the season starts in January and last until late March. This then means all farmers living in the Kitui ecosystem can access mango for a longer period than they would if the ecosystem was not varied. They can also access a higher diversity through the market.

4.8 Farming systems

4.8.1. Mixed farming

The people of Kitui practice mixed farming – they cultivate crops and keep animals. These two systems support each other as produce from the farm is gathered for animals and in turn animal waste is used to enrich the soil. Animals also help provide additional nutritional security from products such as milk to the household. Most pasturelands are in the lowland areas but these are affected most severely by extreme dry weather. In such conditions, animals depend on the highlands for the supply of fodder.

Families maintain cropland and a grazing or wild area with less intense management. From the wildland on the margins of the cropland, the families graze their animals but also gather fuelwood, building material, plant medicine and wild fruit and vegetables.

4.8.2. Mixed/inter cropping

Within individual farms, the farmers grow a variety of crops in a mixed or intercropped fashion. Cereals are planted together with legumes as well as root/tuber crops and vegetables. This practice has certain advantages, including protection of the soil through cover crops such as pumpkins, gourds, sweet potato and creeping types of cowpea (ndamba). Other advantages include nutritional benefits from the different food groups – legumes, cereals, fruit vegetables and other micronutrient-rich foods such as pumpkins

4.8.3 Biodiversity

Maize is the dominant crop in most zones and it is normally intercropped with legumes and occasionally root crops. The more drought-resistant cereals, sorghum and pearl millet, do better than maize in the drier zones but farmers insist on maize as it is less laborious to cultivate and more "modern." Common legumes are beans, pigeon peas, cowpeas and lablab beans. Common root crops are cassava, sweet potatoes, cocoyams (along valleys) and various cucurbits (gourd (*Lagenaria siceraria)*, watermelon (*Citrullus lanatus)*).

Fruits and wild root/tubers are particularly important to children, who pick them as they come home from school or when in the field looking after animals or fetching firewood and water. Adults tend to eat a smaller number of fruits, mainly those that were ranked high in preference. Knowledge of edible fruits and root/tuber species was therefore widespread among children.

4.8.4 Markets

Extra food may be sold in local open markets. Farmers occasionally sell their produce as retail in the market but more often they sell to women sellers who then do the retail work. Most types of foods grown in Kitui may be sold. The main reasons for sale of produce include school needs, household needs such as fuel, utensils and others like transport, health and social functions.

4.8.5 Social activities in food production

In Kitui, women and occasionally men traditionally come together to form self-help development groups called *myethya*. The majority of the groups

A woman selling edible gourds and cowpea leaves in Kalundu market, Kitui town

are composed of women, and hence the term 'women's groups'. The main activities in recent times include tree planting, soil erosion control activities and income generating activities. Group members meet about once in a week. A typical group has about 20-30 members. Most women belong to such groups.

4.8.6 Threats to local species and local knowledge

Many of local natural fruit trees are threatened by short-term needs of some households who cut them for charcoal or timber, usually for sale to buy food in times of food shortage. The associated indigenous knowledge is also threatened, as much of it is lost together with the loss of the species.

A member of Kyanika Adult Women's group working in a group farm. The crop is an early maturing pigeon pea.

5. Conclusion

Kitui's diverse mosaic landscape provides a fertile ground for innovation and adaptation to growing uncertainty. The Kitui agrarian landscape has six ecozones; they contain two types of gardens, crop fields, forest groves, pastures, forests flood plains and water harvesting sites. Together, they are managed as part of a single agricultural system that maximises biodiversity to produce food from wild and cropped areas, as well as domestic and wild animals. This has allowed people to cope with increasing risks to field crops such as maize. Continuing domestication and increased cultivation of indigenous food plants such as gourds, pigeon peas, and trees are yielding new products with growing market potential.

Local institutions have proved to be essential in the coping strategies and management of Kitui's mosaic landscape. Collective work groups and self help groups combine both traditional forms of collective labour and land management as well as new groupings to tap into new technologies and knowledge. The experience of Kitui is evidence of the need to support knowledge-intensive agriculture in biodiverse landscapes as a way to cope with environmental change and uncertainty. Local knowledge is acquired and maintained by institutions that are deeply embedded in local culture and are governed by customary rules as well as formal organisational rules that are derived from community development models. The importance of local and traditional knowledge is growing and well recognised within the community. It includes indigenous knowledge passed down from earlier generations to ethnobotanical and agronomic knowledge obtained through linkages with outside institutions. The entry point for interaction with outsiders remains the indigenous customs and knowledge held by senior Kitui women and men. A key feature of the maintenance and rise of local institutions for managing agroecosystems is the lead role played by women.

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Changing land-use in the fragile Lake Nyasa catchments of Tanzania: A lowland-highland nexus

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1. Introduction

Land use change as a result of population and development pressures continues to be the major driver of land cover change in most parts of Africa, and in Tanzania in particular. Among the areas affected by unprecedented land cover degradation are the upland catchments, which subsequently impact lowland areas.

Since the late 1980s, catchments in the Matengo highlands have been subjected to undue pressure primarily due to severe deforestation from extensive and uncoordinated farming activities in a form of slash-and burn-agriculture. These activities have considerably increased forest degradation, resulting in increased sedimentation in the rivers and the lake itself due to increased erosion, thereby disturbing aquatic biomes. Consequently, dwindling livelihood opportunities and general dismay of socio-ecological production systems in lowlands-highlands have been observed. The local populations in both regions have had to diversify their livelihood strategies.

The relationship between land use in the upland catchments and the state of livelihoods and the environment in the lowlands is explored here. Specifically, degradation of the Matengo highlands of southwestern and southern Tanzania, which contain the Lake Nyasa catchments and numerous rivers that feed into Lake Nyasa, is examined. The study was conducted at Lowland-Highlands of Mbinga District, Tanzania situated at the southwestern part of the country located between 9°30'–14°40'S and 33°50'–33°36'E. The paper highlights the effect of catchment degradation and alternatives that lowland-highland people have made in response to the changing environment. Diachronic information on livelihood and environmental dynamics along Lake Nyasa and in the Matengo Highlands was collected through extensive field surveys and farmers exchange visits. Farmers' exchange visits between the Nyasa and the Matengo allowed villagers to share insights and experiences in an attempt to establish mutual strategies for sustainable local resource management.

2. Overview of land use in the Matengo highlands

The significance of the Matengo highlands stems not only from their role as the catchment of Lake Nyasa, but also from being the home of industrious coffee farmers in Tanzania. The highlands are also known for their world class unique indigenous cultivation system known as Matengo pits (*Ngolo*) and their Ntambo land holding system, managed by a traditional socio-political organisation known as

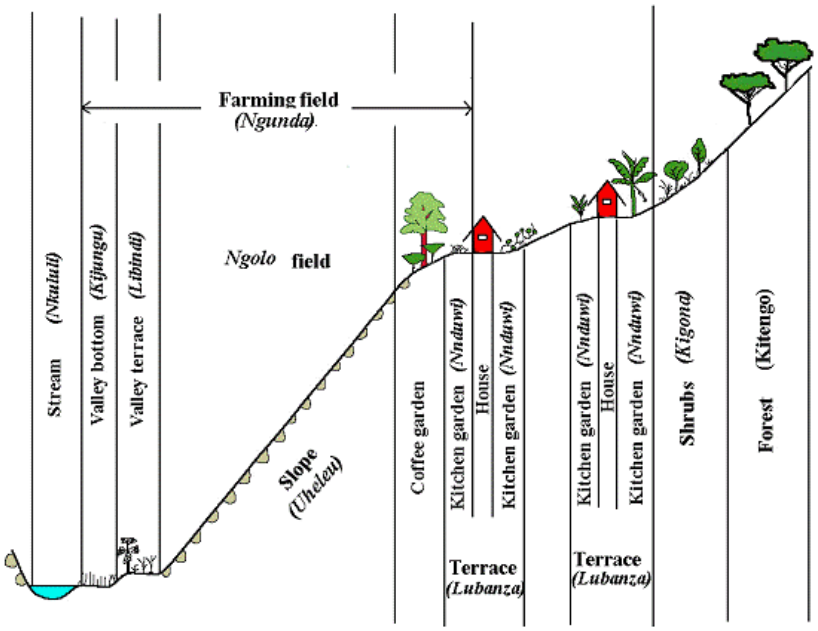

Figure 1. Land use in the model *Ntambo.* Adapted from MWARP (1998) and Nindi (2004)

sengu (MWARP, 1998). Ngolo literally means a pit surrounded by four-tied ridges and the pit acts as a reservoir (rain water harvest technique) by intercepting and prevents destructive effect of surface runoff in the cultivated steep slopes (Mattee *et al.*, 1996 in MWARP, 1998). *Ntambo* is a unit on the mountainside that is circumscribed within two river streams. It is also considered as a socio-geographic unit managed by a patrilineal extended family that established a small village (*musi*). *Musi* was promoted and maintained by a customary system referred to as *sengu*. *Sengu* was a system whereby people of the same ancestry would eat together under the leadership of the head of that lineage, usually an elderly man. *Sengu* allowed for the exchange of ideas related to land use. Everyone in a *ntambo* had to adhere to the word of the head of the *musi*.

In its origin form, the Matengo maintained natural forests (*kitengo*) and shrubs or fallow (*kigona*) at the upper part of the Ntambo while establishing their hamlets at the mountain terrace (*lubanza*) (figure 1). Home gardens (*nduwi*) and coffee farms normally characterized homesteads of the Matengo. Matengo pits (*Ngolo*) were constructed on steep slopes (*uheleu*) for planting maize, beans and wheat on rotational basis and they utilized valley bottoms to cultivate food crops during the dry-season and for household water supply.

In essence, the evolution of Ngolo system of cultivation is related to the process of the Matengo ethnic group formation (Kato, 2001). Before the invasion of Ngoni war tribesmen and Yao slave traders around the eighteenth century, the Matengo appear to have lived unmolested and followed the ordinary methods of slash-and-burn cultivation (MWARP, 1998). The incursions by Ngoni and Yao pushed the Matengo into restricted mountain natural caves and steep slopes where they could defend themselves, or became inaccessible by the invaders (Kato, 2001). The *Ngolo* intensive system of cultivation was thus invented as a method of survival on the steep hillsides and probably as a strategy to ensure that fertile soils were not captured by their archenemy, the Ngoni. Temu and Bisanda (1994) reported that *Ngolo* farming practice evolved among the Matengo over 200 years ago.

This peculiar system plays the multi-functional agronomic roles of improving underground drainage, providing for *in situ* crop rotation of food crops between bean and maize/wheat, cassava and fallow, maintaining soil fertility by composting grass, weeds, and crop refuse, systematic use of grass fallow, and protecting the land against erosion (Allan, 1965 echoed by Kato, 2001). Stenhouse (1944), echoed by Nindi (2004), describes the Matengo hillside cultivation as striking in appearance, showing an orderly layout, with straight-cut edges, and the surface of the fields curiously pitted (figure 1). The impression gathers force that this cannot be native cultivation; but it is. Pike (1953) reported by MWARP (1998) pointed out that these industrious cultivators evolved a system with a technique both methodical and simple by which they cultivate incredibly steep hillsides and yet keep erosion levels almost non-existent. The Ngolo is simple and almost foolproof; no instruments of modern science were ever employed.

Coffee cultivation is not only the mainstay of the household income but it also supports other farming systems including the *Ngolo* cultivation system. This perennial crop, alongside trees such as banana and *Grevillea robusta*, provide important vegetation cover in the steep slopes of the highlands, thereby helping conserve these fragile landscapes.

Heightening population pressure (approximately 100–120 people per square kilometre compared to the estimated district density of 34 people per square kilometre) and recent economic policies of open market have disrupted the coffee economy in the area putting the *Ntambo* land management, and associated cultivation systems and the socio-ecological systems, at jeopardy. The construction of shallow *Ngolo* and use of conventional ridges aligned either along or across the slope (malonga and mitumbila, respectively) is increasingly replacing *Ngolo* on steep slopes in the area, putting food production levels and environmental status in risky. In such a situation, agricultural practices and livelihood in the highlands proved difficult hence the immediate alternative included the invasion of forest frontiers of the Miombo woodlands where slash-and-burn agriculture can be conducted with minimum inputs. This situation has contributed to vegetation cleansing both in the mountains and in the water catchments, leading

Water held in the Matengo pits

to severe erosion in mountain slopes (Itani, 1998) and siltation of rivers and Lake Nyasa. Calder *et al.* (1995) reported that Lake Nyasa catchment forest decreased from 64 per cent to 51 per cent between 1967 and 1990 while Nindi (2004) recorded unprecedented decline in forest cover in some selected villages of Matengo highlands from over 90 per cent in 1984 to less than 20 per cent in 2000.

Prior to the mid 1980s, the Matengo had an adaptive mechanism of migration into frontiers when populations reached carrying capacity in the Mountain Area. Normally, after three or four generations, a Matengo extended family would allow some of the family members to migrate to 'new land' and open up farms, and live their permanently, initially practicing slash-and-burn agriculture and later resorting to their intensive indigenous ngolo cultivation system. In the new land as well, they followed their traditional *ntambo* land holding practice commonly bought with income from the sale of coffee. Thus, the Matengo managed their natural landscape largely through income from coffee sales.

3. Overview of land use along Lake Nyasa

Lake Nyasa, situated in the south-western part of the United Republic of Tanzania, is the ninth largest lake in the world and the third largest in Africa. Lake Nyasa is home to 15 per cent of the world's freshwater fish species, with more than 600 endemic species in total (Chafota *et al.*, 2005 in Nindi, 2007). The lake also lies within a flyway of migratory birds that feed along its shores on their route between Africa and Europe. The lake's fish populations are a major source of animal protein for surrounding populations and nearby town centres. The lake is shared by Tanzania, Malawi, and Mozambique. On the Tanzania side, numerous rivers such as the Kiwira, Ruhuhu, Lumeme, Ruekehi, Lwika, Mbamba Bay, Likumbo, and Chiwindi emerge from the Livingstone, Kipengere, and Uporoto Mountains and the Matengo Highlands to feed the lake and form the catchments that support aquatic life.

Land use along Lake Nyasa is typified by miniature cultivation plots of cassava, paddy, groundnuts, and other minor crops. Mound cultivation is com¬mon for cassava and ground nuts, whereas flat seedbeds are used for cultivat¬ing paddy fields. The agriculture along Lake Nyasa is solely rain fed; extensive wetlands along the lakeshore remained intact until the last two decades, and the few wetlands under cultivation have been supported by rivers flowing from mountain catchment forests.

Three main ethnic groups occupy the lake on the Tanzania side. The Nyasa (Nyanja), consisting of two

Lake Nyasa scenery

smaller groups, Mwela and Mpoto, occupy primarily the eastern part of the lake that extends to Mozambique. The Manda and Kisi dominate the northern part of the lake that extends to the Kyela District, Mbeya Region.

Fourteen major rivers pour their waters into the lake, but only one river, the Shire (on the Malawi side), flows out to sea. Thus, despite its large size, Lake Nyasa does not have a high volume of outflow. Of the approximately 68 cubic kilometres of water that enter the lake annually, only about 16 per cent flow out the Shire; the remainder evaporate directly from the lake surface (Bootsma *et al.*, 1996; 2003). The dominance of precipitation and evaporation in the hydrologic cycle means that the lake is very susceptible to changes in climate.

3.1 Socio-political organisation and customs along Lake Nyasa

The Nyasa are historically non-hierarchical Bantu people originating from a collection of sovereign patrilineal and matrilineal groups of equivalent status and diverse origins. Before the *ujamaa* (African socialism) villagisation programme of the mid-1970s, the settlement pattern was characterised by collections of households of common ancestry within each hamlet. This led to the formation of *mudzi* (a small village), similar to *musi* in the Matengo Highlands. The traditional *kumbi* organisational system controlled the *mudzi*. Social order, norms, and values of the *mudzi* were managed by the *kumbi* social organisation (similar to the *sengu* in the Matengo Highlands) under the leadership of a male elder of the extended family.

Agriculture, fishing activities, and the fishing environment all shaped the sociopolitical organisation among the Nyasa people. Descendants of the same ancestor, under the leadership of a male elder, would come together along the shoreline and build a small hut known as a *kumbi*, which was used by men pri-

marily for discussion about the social welfare of the extended family while waiting for those who had gone fishing. Various family activities occurred at the *kumbi*, including social teachings for younger generations and the handling of extended family matters. It was the responsibility of *kumbi* elders to scruti¬nise, arrange, or decide land plot allocation, farming activities, land dispute set¬tlements, marriages, and the like. In the case of interlineage dilemmas such as shortages of rain, occurrence of unusual disease or death, or collective juvenile delinquency, elders of various *kumbi* would meet, normally at night, for discussion and action.

It was the responsibility of the *kumbi* elders to conduct rituals related to declining fish catches or to calm the devastating lake tides (*mwela*). Herbs (*mbatawata*) soaked in clay pots (mbiya) were commonly used in rituals (*kupema*). To gain collective power in rituals, kumbi elders sometimes consulted women who were known to have spiritual power or practice witchcraft. It was believed that such powerful women could hide fish or influence high tides if fishermen did not send them fish. These women used witchcraft to influence their recognition in a male-monopolised council *kumbi*. When fish catches continued to decrease or mysterious events haunted the community and rituals were of no help, elders of various *kumbi* would join together and appoint representatives who travelled to neighbouring countries to bring back witchdoctors (*chikanga*) to unveil the secret behind the mischief in the village(s).

The *kumbi* social organisation lasted only until the mid-1970s, when the Tanzanian government enacted the villagisation programme. The villagisation programme disrupted this stable and deep-rooted social organisation by displacing descendants of the same ancestors to distant localities isolated from the lakeshore where they could not form *kumbi*. Elders lost their ritual performing power to new and inexperienced formal village organisational leaders. Villages along Lake Nyasa were among those most strongly hit by the villagisation programme (possibly because they had no strong cash crops), as was as the case with their neighbours in the Matengo Highlands. As *kumbi* collapsed, *kuombaliza* and *kupema* also began to decline, and by the late 1980s, with the monetarisation of the rural economy, these systems were effectively crushed. Currently, with the declining fish catch, *kuombaliza* remains little more than a story to tell younger generations, and *kupema* is kept within each household.

4. Recent evolution of livelihood and environmental dynamics along Lake Nyasa

Until the 1970s, fishing activities dominated the livelihoods of the people along Lake Nyasa. *Kuombaliza* shaped the fish gift giving that maintained social organisation under *kumbi* leadership. However, the late 1970s and early 1980s were marked by declines in fish catches. In their interviews, people associated this situation with multiple factors ranging from environmental degra¬dation in the catchment areas to overfishing to the breakdown of social organisation after the villagisation programme, which, through rituals, maintained fishing practices in the lake. The villagisation programme also led to an unnecessary concentration of people along Lake Nyasa, which created a land shortage and led to the use of the previously undisturbed wetlands (*makata*), disturbing fish breeding zones along the rivers and near shore.

Coincident with the villagisation programme, the Matengo farmers in the upland catchment area accessed large quantities of highly subsidised agrochem¬icals for maize and coffee farming through the National Maize Programme. Application of such agro-chemicals to steep slopes possibly led to the seepage of chemicals into the rivers that opened into Lake Nyasa, a situation that destroyed aquatic life in the rivers as well as along the lakeshore. People reported that it was at this time that villagers began to notice an unprecedented number of fish deaths along rivers and the lakeshore. After the mid-1980s, however, the changing land use in the highlands and catchment degradation was largely influenced by economic destabilization and the resulting collapse of the Mbinga Cooperative Union (MBICU) subsequent to the liberalization of the coffee market (Nindi, 2004; Mhando, 2005). Collapse of the MBICU negatively impacted the ability of the Matengo farmers to access chemical fertilisers to support production in their discrete mountain farm plots. In addition, tumbling of the coffee production and market in the 1980s increased pockets of poverty, preventing Matengo farmers from buying *Ntambo*, and led to the vast and abrupt creation of new farms on virgin land in adjacent frontiers where the use of agro-chemicals was not necessary. Cultivating ridges under slash-and-burn system on such steep and rugged slopes, coupled with intense and erratic rains, provoked intensive soil erosion and sediment runoff to river valleys.

It must be noted that the recent deforestation of the Matengo highlands due to influx of the Matengo farmers to the frontiers does not follow the traditional *Ntambo* land holding system. The land tenure shifted from permanent *Ntambo* land holdings to hiring of farm plots in the new land. This led to new land use and land management system. New farming

pattern established in the frontiers are in a way that only farms can be seen in the area without any human settlements around. Since their aim is just new farm plots, Matengo farmers can hardly engage into environmental conservation in the new land adding more missiles to environmental degradation. Forest degradation deforestations of these highlands/catchments, thus, not only pose threat to socio-ecological and political organizations in the highlands alone but as well as to the natural environment and livelihoods of the people residing in subsequent lowlands.

Severe deforestation of the catchments has appreciably increased sedimentation in the rivers and the lake itself due to increased ero¬sion, thereby disturbing aquatic biomes. As a result, fishing, the backbone of the local livelihood, has declined substantially. Unfortunately, this unprecedented deforestation coincided with the weakening of indigenous social organisations that supported fishing and promoted social stability, putting the future of the area and its fishing industry in question.

In discussions, people lamented the fact that uncoordinated and rapid deforestation of Mount Livingstone led to changed river regimes, increased flood¬ing and lake sedimentation, destroyed aquatic biomes, and further deterioration of the livelihoods and physical environment of the people residing along Lake Nyasa.

During the survey, locals stated that various rivers (e.g., the Mbamba Bay, Lwika, Maliwa, Lumeme, Luekehi, and Likumbo) had changed from perennial to seasonal rivers, that their sizes and water volumes had significantly shrunk, or that their flow directions had changed greatly since the late 1980s. They mentioned that a large iron bridge over Luekehi River at Tembwe near the lake had shifted to Nangombo (about 5 kilometres away) due to torrential flooding in the mid-1990s. This flooding had broken the former bridge, turning the river into three streams and leading to more government expense. It also necessitated shifting the road that connected Mbamba Bay and other villages along the way to the Mozambique border. The Mbamba Bay River bridge, which was made of iron bars, is now overrun by culverts due to the reduced river volume caused by increased sedimentation.

Table 1. Changing water levels in Lake Nyasa and land use changes in the Mount Livingstone catchment area (%).
Source: Own data extracted from satellite images

	1984	**1994**	**2000**
Deep water (Lake Nyasa)	41.13	23.54	24.09
Shallow water (Lake Nyasa)	2.83	20.39	20.11
Forest	16.96	9.84	8.16
Open forest	10.62	10.97	10.70
Shrubs	11.47	16.63	14.92
Grassland/ scattered trees	13.82	14.31	15.29
Cultivated fields	3.15	4.31	6.73

Similarly, the strip of the Lake Nyasa shore that extends from Liuli to Chiwindi (on the border with Mozambique) has undergone an increase in population, and deforestation of the upper catchment is rampant due to the influx of the Matengo farmers. The increased population relies directly on subsistence agriculture for food. The high population density along the lakeshore and in the catchments has resulted in the expansion of subsistence agriculture to marginal lands, including wetlands and steep hill slopes. The Matengo Highlands are one of the most densely populated areas in the Mbinga District. Associated impacts of the burgeoning human population coupled with uncoordinated macro- and micro-economic support systems are unsustainable agricultural practices and deforestation.

5. Annotated effects of Lake Nyasa catchment degradation

With increased degradation of the catchments, flooding could become common and destructive for a lake with a high degree of precipitation/evaporation in its hydrological cycle. Kidd *et al*. (1999) reported that a small increase in precipitation/evaporation could result in flooding such as occurred in 1979/1980 in Lake Nyasa; a small decrease in this ratio could result in the basin becoming closed with no outflow, as was the case in 1915 and 1937. In recent years, the water level of Lake Nyasa has been declining (table 1). According to Kidd (1983), approximately 25 per cent of the lake catchment is within Tanzania; however, land use within Tanzania may have a disproportionate effect on the lake, because annual rainfall (and therefore river input) is greater at the northern end of the lake. Ibid (1983) contended that approximately 20 per cent of annual river inflow to the lake comes from the Ruhuhu River in Tanzania. Historic data on river regime dynamics are very sparse, and the earliest measure¬ments of atmospheric nutrient deposition were made in 1990/1991 (Bootsma *et al*., 1996). Thus, the monitoring of rivers and atmospheric inputs would provide a more sensitive analysis of temporal change.

Torrential flooding of Luekehi River that originates from the Matengo highlands and reaches Lake Nyasa

Nevertheless, historic limnological data suggest that the lake may be responding to changes in land use within its catchment (Ibid, 1996).

Changes in land use in catchment areas not only affect erosion and nutrient inputs to the lake, they also appear to have a significant effect on hydrology within the catchment. A review of historic data of Lake Nyasa water levels, rainfall records, and land use change by Calder *et al.* (1995) indicated that between 1967 and 1990, forest cover in the Lake Nyasa catchment decreased from 64 per cent to 51 per cent. This loss of forest resulted in increased water input to the lake due to a decrease in terrestrial evapotranspiration rates. As a result, lake levels in the early 1990s were approximately one metre higher than they would have been had this deforestation not occurred. The implications for terrestrial systems and for streams and rivers are likely negative, because stream flow tends to be less stable in deforested catchments.

It is likely that deforestation of the catchments and increased pollution influ¬enced the decline in fish catches in the rivers and in the lake itself. *Labeo mesops* (*nchila*), a large silvery fish that favours open sandy beaches, may have been affected by this degradation. During the 1940s, this species supported the second largest fishery on the lake (Lowe, 1952 in Nindi, 2007). Its population has declined dramatically, and it is now quite rare in Lake Nyasa, likely due to degradation of the river systems where it once spawned (Turner, 2004; Snoeks, 2004). It seems that some species, such as *Synodontis*, breed in river floodplains but spend most of their lives in the lake; thus, their disappearance could be linked to river degradation. The disappearance of small sucker mouth catfish (chimbumbu: *Marcusenius discorhynchus*), which are adapted to fast-flowing rivers and are rarely seen in the main lake, is evidence of the relationship between river degradation and fish species disappearance. Other fish species that might be disappearing as a result of lake and river degradation include *Clarias gariepinus* and *Mascusensis livingstoneii*, which also spawn in rivers and floodplains or in shallow weedy areas (Eccles, 1992).

Degradation of lake edges may also have disrupted populations of *Aplocheilichythys johnstonnii* (tiny lampeye killifish), which are found in sheltered weedy areas around the edge of the lake (Snoeks, 2004). Turner (2004) argued that many non-cichlids of Lake Nyasa spawn within rivers and are particularly vulnerable to overfishing during spawning runs and to alterations of the river regime flows, which can lead to flash of floods and siltation of eggs. These factors have also likely led to declines in the populations of larger migratory species such as *Labeo* sp. (*chambo*) and *Opsaridium* spp. (e.g., *mpasa*). This corroborates formal and informal discussions in which informants revealed that some fish species abundant up through the 1970s, such as *chimbumbu, ningwi, kuyu, mpasa,* and *sanyika*, had disappeared. Bootsma *et al.* (2003) reported that the degradation of lake and river systems has supported the presence of the potentially toxic algae *Cylindrospermopsis raciborski*, which could affect zooplankton and fish production. For instance, in October 1999 a massive fish kill occurred along the western shore of the lake (the Malawi side), and toxic algae were one possible cause of this kill.

An indication of the extent of the lake erosion was provided by a comparison of the concentration of dissolved organic carbon (DOC) and particulate organic carbon (POC) in tributary rivers. In undisturbed rivers, the DOC con¬centration is generally about 10 times higher than the POC concentration. In contrast, in many Lake Nyasa tributaries, the POC concentration is much higher than the DOC concentration (Ramlal *et al.*, 2003), suggesting exceptionally high erosion rates within the catchment. Not only do these erosion rates result in accelerated nutrient inputs to the lake, but the high-suspended sediment loads in rivers increase the turbidity of near-shore waters. Data collected by Duponchelle *et al.* (2000) indicated that greater turbidity led to decreased body conditions of rock-dwelling cichlids in Lake Nyasa, and the work of Seehausen *et al.* (1997) on Lake Victoria showed that increased turbidity can lead to a loss of biodiver¬sity among cichlids.

In addition to catchment erosion, one challenge is the large proportion of atmospheric nitrogen and phosphorus entering Lake Nyasa. Although there are no historic data against which recent measurements may be compared, a global comparison indicated

that atmospheric deposition rates of nitrogen and phosphorus in the Lake Nyasa region are among the highest in the published literature (Bootsma *et al*., 1996). There are several possible causes of these high deposition rates, including large amounts of biomass burning (largely from slash-and-burn agriculture in the Matengo Highlands and on Mount Livingstone) that occurs in this part of Africa as suggested by Andreae (1993), and the increased exposure of soil to wind erosion promoted by burning and deforestation though elsewhere can also be influenced by overgrazing.

Continued increases in fishing pressure, along with changes in plankton community structures and water quality due to lake sedimentation, may lead to a decline in biodiversity or even species losses if preventive action is not taken. Total fish catch is difficult to estimate due to the large number of uncoordinated small-scale fishermen and the limited capacity of the government to collect sufficient catch data. Thompson (1995) estimated that on Malawi side, the total annual catch was approximately 30,000 tonnes, whereas Lewis & Tweddle (1990) estimated that the annual catch of one species alone, *Engraulicyppris sardella* (*usipa*), may have exceeded 50,000 tonnes. The majority of the artisanal fishery yield is made of *Copadichromis* spp. (*utaka*), *usipa*, and *Lethrinops* species (*chisawasawa*). Populations of numerous economically valuable fishes have declined dramatically in Lake Nyasa, especially in the southern arms of the lake where fish catches have historically been the greatest. Yields of catfish (*Bagrus* and *Bathyclarias* spp.), *Opsaridium microlepis* (*mpasa*), *Labeo mesops* and *L. cylindricus* (*nchila*), and *Oreochromis* spp. (e.g., *chambo*) have decreased and currently make up less than 20 per cent of the total catch (resulting in declining fish consumption; FAO, 1993; Turner, 1995; Irvine *et al*., 2002). In Malawi, for instance, fish consumption has declined from 14 kilogram per person per year in the 1970s to less than 6 kilogram per person per year (State of Malawi, 2002). Although the diversity of pelagic cichlid species in the near-shore communities is high by any standards (Ribbink *et al*., 1983), it is logical to assume that with increased degradation of the catchments and pollu¬tion of the lakeshores, the biodiversity of such species is also in danger.

People living along the lakeshore pointed out that populations of large animals such as crocodiles and hippopotami have also disappeared or remained in very limited areas after the degradation of their natural habitat along rivers. This situation has denied the lakeshore communities both heritage and tourist attractions and has brought poverty to thousands of

A village along Lake Nyasa threatened by upland degradation

households along Lake Nyasa. Most of these animals have migrated to Mozambique, where the catchment is intact to a greater extent and the river ecology is more favourable.

These factors have all contributed to the destruction of both livelihoods and the environment along Lake Nyasa, whose revitalisation and management requires a multidisciplinary approach. Based on these trends, the major threats to the Lake Nyasa ecosystem are the degradation of the catchment areas and suboptimal agricultural practices, which have caused destruction of the river systems and lake through sedimentation. Following the collapse of their main livelihood (fishing), people living along the lake have had to find alternative means of survival. Livelihood diversification has included changing their eating habits and altering fishing and agricultural activities.

6. Livelihood diversification

Due to the declining fish catch and the inability to buy "good" fish (such as *chambo, mbufu, sanyika, kampango*, and *mpasa*), elders now eat culturally referred as inferior fish species such as *chidongo* (*Pseudotropheus* spp.) and *nkoolokolo* (*Synodontis njassae*), which in former times they would not have considered. These changing eating habits may prevent elders from insufficient protein consumption. Off-shore fishing has also become inevitable, as fishing near shore has proved futile. Whereas some men try fishing in deep waters, others must travel up to less degraded shorelines of the neighbouring country, Mozambique. Both fishing styles and fishnets are changing. The *gonga* fish net is replacing the old style *chilimila*, and the government has prohibited the use of small net mesh to conserve biodiversity in the lake. After the breakdown of *kuombaliza*, the fish–money relationship between fishermen and those who gather at the shore has dominated. Women's involvement in fish trading has increased despite smaller trading

volumes; women no longer wait for fish at home but interact with men buying fish on shore.

Some people, especially those in Mbamba Bay and Liuli villages, are involved in the commissioned trading of ornamental fish, which targets near-shore cichlids primarily in rocky habitats. There is not yet enough information to determine the impact of this trade on local livelihoods. The decline in fish has also changed the dancing tradition; at present, the traditional dances (*kioda* and *mganda*) involve mostly nearby groups whose members dance and return home on the same day, no longer requiring the host to prepare special food and drinks for the guest friends as used in old days when fish-catch was plenty.

The use of former wetlands (*makata*) for rice cultivation and dry-season gardening has increased, although the farm size per household has remained small. This is due in part to increasing market demand for rice and produce such as tomatoes, onions, Chinese cabbage, *Amaranthus* spp., mangoes, coconut, and sugarcane. Although the cultivation of otherwise intact wetlands and gardening very close to riverbanks ensure food security and income in the short term, they have long-term environmental implications such as further drying up of the wetlands, degradation of riverbanks, and sedimentation of the lake. Cassava and cassava flour are currently highly traded farm products, and finger millet farming is gaining in popularity, especially in villages on the slopes of Mount Livingstone.

Keeping pigs to sell or as security is now common in most households as a livelihood diversification strategy. Although pigs are kept indoors in most parts of Tanzania, along Lake Nyasa they are tethered or free to graze. Local breweries, which in former days operated free of charge, have also become monetarised, and women are highly involved in this business. The brewing and selling calendar is carefully scrutinised by revenue collectors appointed by the village government. The establishment of a market day, small shops and kiosks, motorcycle and bicycle rentals in village centres are also among the new developments in the area. Youth from different parts of the country dominate these activities, possibly because their dynamic nature includes travelling and physical fitness. Recent famines in bordering countries have attracted appreciable export trading of cereals (maize and beans) and cassava from Tanzania. Although the Nyasa people are not big food exporters, their youth can earn money by working as guards, porters, or crop collectors at various supply points.

The function of the local government and the church has also been important in trying to diversify

A group photo of lowland-highland farmers after a joint meeting to inaugurate their partnership in resource management

people's livelihoods. The popular Anglican Church and the Mbinga District council have both engaged in irrigation projects for rice production in some wetland areas along Lake Nyasa. The success of these two projects will help to improve income and food security. People living along the lake have also diversified their labour organisations, introducing new systems while maintaining the old. For instance, church choir groups have surfaced as another form of labour. Besides fulfilling church obligations, choir members help one another in various farm activities. Thus, the community is working together to realise the stability of both its spirituality and its livelihood.

Despite such diversification, the livelihood, social organisation, and environment along Lake Nyasa are still at a crossroads. What is needed is a participatory and collaborative approach that recognises the indigenous nature of the people and the focal features of the area.

7. Lowland-highlands joint initiatives towards catchments conservation

Having seen devastating environmental concern and its implications for people's livelihood, farmers from both ecosystems (lowland and highlands) decided to form a partnership that could improve the lake basin. Various farmers exchange visits between these two ecosystems have been conducted to actualize their partnership. Sokoine University of Agriculture Centre for Sustainable Rural Development (SCSRD) and Mbinga district council supported this farmers' initiative. The participation of Matengo farmers was essential, as their mountain farming activities were to a large extent responsible for the current debilitating state of the Lake Nyasa catchment environment.

Another potential benefit for participating mountain farmers was that the Matengo social organisa-

tion and traditions resembled those of Lake Nyasa. The reciprocal labour organisation in Matengo, ngokela, is analogous to the *chiyao* along Lake Nyasa; *musi* is similar to *mudzi*, and *sengu* is akin to *kumbi*. Both ethnic groups also participate in *kioda* (for women) and *mganda* (for men). In both areas, gift giving (*matola*) among women is a common feature that reinforces hospitality. Their rituals, ceremonies, and even some elements of their languages are similar to an appreciable extent, which could have been a result of the influence of the Ngoni invasion in both areas in the nineteenth century. Such a situation underscores areas for possible future collaboration.

Farmer group initiated under this partnership were involved in bee keeping, tree planting, fish culture, hydro-mill (grain milling machines propelled using hydro-power), introduction and use of improved stoves aimed at reduction use of fuelwood. All these activities aimed at conserving the Lake Nyasa basin. There is continued expansion (qualitative and quantitative) of these activities not only within founding villages (model villages) but also outside villages since were introduced in 2002.

In terms of qualitative and quantitative progress, farmer groups have increased in number and diversified their activities into pig farming, dairy cattle and bee keeping, tree planting, and local brewing. In implementing these activities, farmer groups have always been involved in tree and fodder planting and hence refraining from conducting bush fires, which also help to sustain the natural environment. Some groups have also opened bank accounts not only for safekeeping of the money but as well to identify themselves before the financial institutions that can help them diversify the groups' activities through loans. Besides, farmer group activities in the model villages seem to have been diffusing throughout their communities and even outside. Group activities have been permeating from a few leading villagers, e.g. "high educated and/or the governing class/status", to "ordinary villagers". These progresses of diversifying and diffusing their activities are essential for sustainable rural development.

8. Conclusion

Since the late 1980s, the Matengo highlands have been subjected to undue pressure primarily due to severe deforestation from extensive and uncoordinated farming activities in a form of slash-and burn-agriculture (Nindi, 2007). These activities have considerably increased forest degradation hence declined both natural resource and agricultural prosperity leading to dwindling local peoples livelihoods, both in the highlands and lowlands surrounding Lake Nyasa. To adapt to changing environment, lowland and upland farmers have the potential to form a network that can help them organize various joint-activities for the purpose of conserving the lake catchments and diversifying their livelihoods. Joint-farmer group activities include tree planting, bee keeping, hill slopes soil conservation, and establishment of fish ponds. These activities have the ability to influence regeneration of degraded forests due to their economic, environmental, and nutritional benefits attached to them. The inter-ethnic partnership by resource-poor farmers as a strategy to livelihood transformation and landscape conservation is an intriguing new phenomenon in the project area.

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Case studies from the Americas

The *ayllu* system of the Potato Park (Peru)

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1. Introduction

The Potato Park is a unique model of holistic conservation of the Andean traditional landscape with a focus on conservation of agrobiodiversity (Argumedo, 2008). The Park is located in a known microcenter of origin and diversity of potatoes, one of the world's major food crops, which has been nurtured for centuries by the deeply rooted local food systems of Quechua peoples. The Potato Park initiative seeks to conserve the landscape and nurture the diversity of native crops, particularly of the potato, and their habitat, as well as enhance the interrelations between native crops and the physical, biotic, cultural environment, and to use such interactions to create multiple livelihood options for local people.

The Potato Park is a locally managed Indigenous Biocultural Terriory using the Indigenous Biocultural Heritage Area (IBCHA) model developed by Asociación ANDES. The IBCHA model involves a community-led and rights-based approach to conservation based on indigenous traditions and philosophies of sustainability, and the use of local knowledge systems, skills and strategies related to the holistic and adaptive management of landscapes, ecosystems and biological and cultural assets. An IBCHA incorporates the best of contemporary science and conservation models and rights-based governance approaches, including the IUCN's Category V Protected Areas (Philips, 2002), as well as positive and defensive protection mechanisms for safeguarding the Collective Biocultural Heritage (CBCH) of indigenous peoples[1].

The international conservation community is beginning to appreciate the need for new approaches to landscape conservation, based on local cultural and ecosystem contexts (Brown & Mitchell, 2000). This case study aims to illustrate an example of such a local approach and highlights how a traditional Andean system is promoting a reciprocal relationship between the people of the Potato Park and their environment, enhancing the conservation and sustainable use of biodiversity, local livelihoods/human well-being and the ecological integrity of a landscape that is the product of a relationship over millennia.

Potato and other crop fields in the Potato Park

2. Introducing the *ayllu*

The Potato Park is based on the *ayllu* approach. While most studies describe *ayllu* as a political and socio-economic system, few systematic analyses of the ayllu as an ecological phenomenon exist. We understand the *ayllu* as a community of individuals with the same interests and objectives linked through shared norms and principles with respect to humans, animals, rocks, spirits, mountains, lakes, rivers, pastures, food crops, wild life etc.

The following case study examines the *ayllu* from an ecological perspective with a particular focus on its importance for the management of landscapes and biodiversity. This interpretation and use of the *ayllu* concept offers the opportunity to appreciate the continued interactions between Andean peoples and the environment. Since prehispanic times, the co-evolutionary relationship of the mountain environment through management of biocultural resources has produced the *ayllu* cultural landscape. While more recent political trends have displace the *ayllu* as a political, economic and administrative system, as a cultural landscape it continues to be nurtured by Andean peoples.

The main objective of the *ayllu* is attainment of well-being. Well-being is defined as *Sumaq Qausay*, the ideal that is sought after by men and women, that translates into social, economic and political well-being through a full life. It expresses a relationship

[1] CBCH includes cultural heritage, i.e. both the tangible and intangible including customary law, folklore, spiritual values, knowledge, innovations and practices and local livelihood and economic strategies, and biological heritage, i.e. diversity of genes, varieties, species and ecosystem provisioning and regulating, of indigenous communities which are often inextricably linked through the interaction between local peoples and nature over time and shaped by their socio-ecological context (ANDES, 2007)

between human beings and their social and natural environments. It means to be in equilibrium with one's natural and social surroundings and to maintain reciprocity between all beings, including *Pacha Mama* (Mother Earth).

The *ayllu* system during the Incan empire was defined based on parentage, and each *ayllu* was made up of an independent group with three levels of administration: the family level, the group of families that shared the same territory and a larger organizing unit that mobilized all groups. The territorial space of each *ayllu* was based on the resource needs of each group. Organization within each *ayllu* was determined by ecological zones within the territory, thus establishing division of labour and responsibilities among groups and families. Products from different ecological zones were exchanged based on family and group needs.

Verticality, the control of a number of economic niches at different altitudes, is a principle of Andean life. The sharp vertical changes of the Andes create microclimates within relatively short distances. Peoples and even individual communities or families in pre-Columbian times strove to control a number of ecological zones where different kinds of crops could be raised. A community might reside in the altiplano growing potatoes and quinoa, an Andean grain, but might also have fields in lower valleys to grow maize, and pastures miles away at a higher elevation for their llamas, and even an outer colony in the montana to provide cotton, coca, and other tropical products. In fact, access to a variety of these ecological zones determined pre-Columbian patterns of settlement and influenced the historical development of the Andean world.

Still today, the landscape is organized by ecological zones and the exchange of products allows for the fulfilment of livelihoods needs across the zones. Agrarian cycles are used to organize collective labour in each zone so that productivity is maximized by using the available labour force to its full potential. Social organization is based on the exchange of labour and agricultural products between the zones. The principle of *ayni* (reciprocity) is thus fundamental in ensuring that each ecological zone is as productive as possible, contributing to *Sumaq Qausay* of the *ayllu*.

3. Overview of the Potato Park

The Potato Park is located within the Cusco Valley, covers at total of 9280 hectares, and has a population of 3880 inhabitants. First human settlements in the area are dated at some 3,000 years ago. Human populations have been co-evolving with the Cusco Valley since then. Archaeological and historical re-

Table 1. Land use zones in the Potato Park

Land Use Zone Elevation	Diversity and Use	Percentage of total area
Rotational potato fields	Scattered in a mosaic-like pattern. Crops: potatoes and native tubers of mashua and oca. Native medicinal plants including, *Aciachne pulvinata*, *Alchemilla pinnata*, *Paranephelius uniflorus, Galium eparine* also grow in this area.	33.81%
Bushes Between 3900 and 4100 meters above sea level	Are conformed by the woody plant families of: *Asteraceas, Berberidaceas, Lamiaceas, Fabaceas, Scrophulariaceas, Cariophyllaceas*, which also serve medicinal purposes.	9.78%
Crop lands in permanent production (*chakras*) All altitudes	The crops cultivated here have been adapting to the landscape and changing climate, exemplified by the lima bean and barley that have been continually being displaced into higher altitude zones.	13.07%
Non-native forest zones	Species: Eucalyptus (*Eucaliptos globulus*), Cypress (*Cupresus macrocarpa*) and Pine (*Pinus radiata*).	2.6%
Wetlands Generally above 3950 meters above sea level	Habitats of medicinal plants such as *Hypsella reniformes, Isoetes andicola, Hipochaeris* sp. Provide fodder for animals, as well as sacred places where supernatural occurrences take place.	0.52%
Native forests	Two main species: *Polylepis incana* (Queuña) and *Citarexylum denticulatum* (*Cheqche*) are protected. Provide ecological niches for various birds including: *Q'ente, Chequillo, Pinchi Tanka, Chaiña, LLut'u* (Source: Orestes Castañeda, Potato Park technician). Important medicinal plant species are found, including: *Ch'uka (Medicago* sp*), Yahuar chonka (Oenothera rocea), Pinco pinco (Equisetum* sp*).*	0.01%

cords have named several successive cultures that have inhabited the valley, such as the Markavalli, Chananpata and Sawasiras, among others. In general, it is known that successive cultures had highly organized societies, based on principles of solidarity and respect. The Incas later founded their empire in Cusco, bringing their ancient traditions and religion to a large population, based on the principle of *ayni*, reciprocity. The sacred city of Cusco became the centre of Incan culture. For millennia, ancient Andean principles of reciprocity and interconnectedness have guided the interactions of people with the environment, producing the Andean landscape.

The European invasion and colonization of Peru had profound consequences for Andean landscapes, resource use and maintenance of sustainable food and economic systems for livelihoods. Today indigenous communities are confronting the impacts of colonialism by regaining their strength and inspiration from their own native identity and unique association with the land. Their survival is attributed to their endless patience and a profound spiritual reverence for the *Pacha Mama* and their ecological *ayllu*, and to their knowledge and innovation systems, which are based on sophisticated understanding of their mountain environment. This has provided them with an indigenous environmental ethic which has fuelled a conscious effort to preserve their environment and has propelled the creation of new mechanisms to conserve and sustain their natural resources. The case of the communities of the Potato Park demonstrates the deliberate efforts of Quechua communities to maintain diversity in domesticated and non-domesticated plants and animals, which characterizes Quechua farming systems, providing an important opportunity for a dynamic maintenance of genetic resources and landscapes.

Authority for the Park is shared between the villages, each of which elects one Chairperson to coordinate the work of the Association and concerted efforts are made to integrate traditional spiritual values, beliefs and understanding into the management.

3.1 Agrobiodiversity

The main subsistence activity in the Potato Park is agriculture and animal husbandry (table 1). 13.07 per cent of the park area (approximately 1,133 hectares) is used for permanent agriculture of corn, tarwi, potatoes, beans, barley, and other crops. 33.81 per cent of the park area is made up of tundra, or land that is resting. Crop rotation occurs every three to nine years. First, farmers cultivate potatoes, masha and oca, then the land is left fallow. During fallow periods, many medicinal plants can be found in these plots.

The Potato Park is a centre of origin of the potato (CIP, 2008). The region is home to eight known native and cultivated species and 2,300 varieties, of the 235 species and over 4,000 varieties found in the world. Also found in the region are 23 of over 200 wild species found in the world. The genetic diversity found within just one plot in the area can reach up to 150 varieties (Chawaytire community, Potato Park). Apart from potatoes, other native Andean crops such as olluco, beans, maize, quinua, wheat, tarwi, mashua and oca are produced. Beyond crop production for consumption, agriculture is also responsible for producing wool, medicine and wood. Other important functions of the agricultural system include food security, conservation, development and livelihoods and water conservation. Complementary economic activities include animal husbandry; sheep, cows and camelids.

The landscape of the Potato Park is the result of millennia of interactions between human populations and the environment and has been described by scholars as the product of 'common-field agriculture' (Godoy, 1991). 'Common-field agriculture' is a form of collective land management in which an assembly of farmers coordinates the production of crops and livestock grazing in managed fallow spaces among the designated sectors of a community: households have rights to parcels of land dispersed within common fields which are used by all for grazing and collection of resources such as wood. The spatial and sequential organisation of land use in the Andes has been shown to be pivotal to maintaining a high biodiversity in the landscape (Godoy, 1991). This conceptualisation of Andean land management illustrates how productive activities organised collectively result in a landscape with high agrobiodiversity. Similarly, some have interpreted it as based on a landscape concept of space-based rotation and social organisation for access, providing a focus on the landscape as both environmental and productive, and social and cultural (Zimmerer, 2002). The biocultural system[2] approach of the *ayllu* system begins from an indigenous perspective, based on the Andean holistic worldview that recognises interconnectedness across all spheres of the cosmos, including the spiritual dimension. The landscape is much more than the product of agriculture; it is the product of holistic management.

3.2 Social organisation

There are six Quechua communities in the Potato

[2] A complex socio-ecological system with interconnected parts that is characterised by high biocultural diversity and is the product of a coevolutionary interaction between people and the environment in a particular locality.

Park. In 1993, the total population of the Potato Park was 3880 inhabitants, with a population density of 444 inhabitants per square kilometre. There is a small majority of women (50.2 per cent). 51.6 per cent of the population is between the ages of 15 to 64. 28 per cent is between the ages of 4 to 14, and 16 per cent of infants are younger than 4 years old. The communities rank in fourth place for extreme poverty and sixth regarding absolute poverty (RONAA, 2003).

The majority of the population is indigenous to the region, with only one per cent of the population being immigrants. There are two identifiable types of economic migration out of the Park: seasonal temporal migration and permanent migration. Seasonal migration is mainly undertaken by the heads of families who migrate to Quillambamba and the Cusco areas from January to April, during the period of least agricultural activity in the high altitude zones. These migrants work in coffee plantations and as labourers. There is however a small portion of mainly adult males from some communities that permanently work as porters for tourists hiking the Inca Trail to Machu Picchu.

3.3 Subsistence activities

The Potato Park communities have developed subsistence mechanisms and social relations through adapting with their natural environment. The family unit is the productive unit and the vehicle for processing and planning future activities. Families in the more isolated communities continue to develop their productive activities with a focus on food security, using traditional technology and crops (such as potatoes), and conserving as much diversity as possible. Those living in more open communities supplement their agricultural activities with commercialisation of products and artisan work, or working outside of the Park, as porters for example.

The majority of subsistence activities are based on diversifying uses. For example, native potatoes are transformed into *chuno* or *moraya* for consumption, seeds, sale or barter. Agricultural products are used based on the priorities and values of the communities: (i) the best products are set aside for maintaining social relations, rituals and family consumption, (ii) products that are not as high quality are used for seed, barter and sale, (iii) the least desirable products are used for transformation or for animal feed, and (iv) the undesirable products are fed to the animals.

Women play an important role in the process, as they are the most knowledgeable in selection criteria and characteristics for the different uses. Women also manage the quantity of different types of product used. They are therefore 'experts' on both qualitative and quantitative value of their products, and can set a value on them for bartering purposes. Barter is mainly used at the household level, and women play a big part in managing the barter system.

Women participating in a workshop in the Potato Park

3.4 Resilience of the natural environment

The Potato Park landscape came about through the interactions between local indigenous peoples, their mountain environment and the biocultural resources. The Potato Park landscape thus emerged from the natural resource management systems of Quechua people. In the historical review of the Potato Park landscape, it is possible to see how the indigenous biocultural system survived the colonial and modern attempts to displace Quechua people through land grabbing and the marginalization of Quechua social, cultural and economic life and customary laws, practices and institutions. Though the *ayllu* was dissolved as a social and political entity during this time, it remained an indigenous cultural landscape. The *ayllu* landscape not only survived but it adopted the best of the newcomers' resources and practices. This approach strengthened its main features, enabling it to reproduce itself, forming a rich mosaic of productive and natural areas that provide habitats for all the beings with whom they share their territory.

Resilience is understood through the Andean awareness of complex and chaotic interactions producing order. Supporting adaptation becomes an important aspect of management. The high diversity found in the landscape supports adaptive capacity to build resilience. Andean ecosystems are complex, with multiple interacting parts creating a diverse topography. Non-linear interactions create chaotic behaviour through extreme changes in conditions such

Restaurant co-managed by the six communities of the Potato Park

as extreme weather, providing a sense of disorder within the Andean natural environment. However, order emerges out of the complex interactions and traditional practices. Order in the Andes is interpreted through the Andean principle of equilibrium, which is understood as emerging out of constant change. It is the product of a flow of vital and cosmic energy moving dynamically. The holistic worldview recognises that all elements continue on a cycle that is continuously renewed, and they are intermingled; the economic, social, physical all are part of the same dynamic interactions. This is most obviously appreciated through ritual practice in which offerings to deities allow the reestablishment of the cosmic energy – they ensure that the principle of reciprocity is maintained.

Andean principles of equilibrium and reciprocity facilitate natural and social order – illustrating a profound awareness of chaotic and complex systems and non-linear dynamics. Resilience of complex systems is maintained through supporting their adaptive capacity which gives them the ability to deal with perturbations without losing their key functions. According to the Andean worldview, disasters, or loss of resilience, are the result of a loss of reciprocity. Reciprocity guides interactions and build resilience in the natural and social environments. The relationships are based on intimacy, respect, understanding and communication, establishing adaptive and creative mechanisms for dealing with changes and novel situations without reducing future options.

4. Integration of local traditional ecological knowledge in the Potato Park

One of the goals of the Potato Park has been to establish an alternative development model, which is inclusive, and supports cultural identity and conservation of biocultural heritage.

4.1 Economic collectives

ANDES and the Potato Park worked together in establishing several economic collectives with the objective of conserving and sustainably using biological resources and achieving a creative and solid economy based on those resources. The collectives include the Potato Arariwas (a seed repatriation and conservation collective), the gatronomy Qachun Waqachi collective, the Tika Tijillay women's video collective, the Naupa Awana craft collective, the Willaqkuna guides collective, and the Sipaswarmi Medicinal Plants Collective.

Indigenous women in the rural areas of Peru are often marginalized in health, education and legal services, as well as in opportunities for employment. The rich biological resources and associated traditional knowledge are in danger of disappearing due to the lack of recognition of the rights of indigenous women. Today, the production of herbal medicines provides safe low cost medicines for families in the Potato Park, and the production and processing of herbal products for sale to tourists also provides additional income generating opportunities for local women. Their traditional knowledge is promoted and protected through the use of a multimedia database. All of the products made by the women are based on their traditional knowledge using local medicinal plants, while elements of western medicine are also introduced, such as first aid, preventative medicine and treatment options which harmonize with traditional medicine.

4.2 Biocultural databases

The Park has developed Local Biocultural Databases based on the traditional Andean system of Khipus. Khipus were used during prehispanic times to collect and store information, including information related to biological resources. The result of applying the Khipus system to biocultural databases is an adaptive system that allows capture, registration, storage and administration of indigenous knowledge based on Andean traditional science and technology. It is a tool that can be used to conserve, promote and protect local knowledge, thus becoming useful in facing political, social and technological challenges that are all too common in this era of globalisation. The methods and tools used are suited to oral and visual knowledge models. They include audiovisual information, matrices of biodiversity, Geographic Information Systems (GIS) and free software. Local protocols based on customary laws are used to regulate access to the information.

4.3 Schemes for passing on various traditional wisdom to the next generation

An important strategy used in the Potato Park for analysis, discussion and debate for generation of new knowledge and wisdom is the use of Thematic Study Groups, to propose alternative solutions to local conservation and development problems for general well-being. More specifically, their objective is to systematically gather and analyse existing local knowledge and to generate new knowledge through dialogue. Local traditional knowledge platforms are also used as organisational structures and mechanisms to facilitate horizontal transmission of knowledge, experiences and wisdom from farmer to farmer, and community to community. They also support local governance systems based on Andean principles of reciprocity, duality, solidarity and respect. They are facilitated by local techinicians and their participation with collective groups such as the study groups and the business groups that participate in other aspects of conservation and development.

4.4 Participatory mapping

Visualizing indigenous people's spatial knowledge through cognitive maps has been an important part of the Potato Park action research efforts. Participatory mapping in the Potato Park has focused on capturing the spatial knowledge of local people such as location, size, distance, direction, shape, pattern, movement and inter-object relations as they know and conceive it to develop Cognitive Maps, which are internal representation of their world and its spatial properties stored in their historic memory.

5. Planning for the purpose of optimizing ecosystem services

5.1 Multi-layered land use/ mosaic type of land use

The entire landscape of the Potato Park is a mosaic of land use zones, formed by practices of land use such as those highlighted in the previous section. Field terraces (FOTO) spread from the bottom of the valley all the way to the steep mountainsides. Common native forest species are interspersed with exotic eucalyptus forest. Other areas include communal grasslands containing the following species. Bushes near bodies of water regulate the water table, limiting the evapotranspiration by covering the soil. Near the top of the mountain terrain, rotational native potato fields are scattered in a mosaic-like pattern. The fields are in rotation for periods of three to nine years and during their first years of cultivation potatoes are yielded, while in proceeding years the other native tubers of *mashua* and *oca* are cultivated prior to allowing the soil to rest. Crop lands in permanent production (*chakras*) represent are found throughout the vertical zones. The crops cultivated here have been adapting to the landscape and changing climate, exemplified by the lima bean and barley that have continually been displaced into higher altitude zones. The constant adjustment and relocation due to the adaptability of food crops has therefore necessitated that the human populations live in higher altitude zones.

5.2 Dynamic management of land and resources

In an effort to strengthen the resilience of their socio-ecological system in 2004 the Association of Communities of the Potato Park signed a landmark Agreement with the International Potato Centre (CIP) on the Repatriation, Restoration and Monitoring of Agro-biodiversity of Native Potatoes and Associated Community Knowledge Systems. The objective of this agreement was to restore the genetic diversity of the native potato in the area and promote its conservation and sustainably use. Thus far, the agreement has led to the repatriation of 492 varieties of potatoes held by CIP. These varieties have been reintroduced in the area, and have positively affected local food security, economic development, cultural revival and farmer's rights. This project resulted also in the development of a Dynamic Conservation approach that links in-situ and ex-situ conservation strategies in one dynamic, mutually supportive strategy. This has strengthened the model of the Park as a holistic and effective approach for the conservation and sustainable use of plant genetic resources for food and agriculture.

5.3 Application of the concept of adaptive management

Adaptive management is an approach to environmental management that recognises dealing with uncertainty and change as necessary when dealing with complex systems (Holling, 1978; Lee, 1993). The approach advocates for systematic experiments to be undertaken, developing alternative hypotheses, supporting adaptive learning to deal with constant change. *Ayllu* management can be called an active adaptive management system due to an explicit focus on learning as a vehicle for improving practice. Moreover, it is inherently adaptive, because of the focus on processes and relationships. The holistic framework that keeps it all together requires that processes become the focus of management. *Ayni* as a guiding principle serves this purpose, as well as uniting the spiritual with the practical.

5.4 Cyclic use of natural resources

An example of how resources are reused and recycled in the Park is the practice of organic fertilization

and seed collection. Organic fertilizer is obtained from family livestock or from livestock belonging to other families of the community, or from the forest. This method of obtaining fertilizer is only incorporated in potato cultivation, while the cultivation of *oca* and *papalisa*, as well as the grains, planted in the same space in the next agricultural cycle and the one following that, benefit from the residual effect of this initial fertilization.

6. Conclusions

The Potato Park, as an example of revitalising the *ayllu* cultural landscape, has generated social, cultural, environmental, economic and political benefits to the communities. Communities have strengthened their intercommunity networks, generating synergies through creating intercommunity groups. These include the economic collectives, and the Association of the Communities of the Potato Park, bringing together all of the communities for decision-making. Women, as a major interest group have a leading role in implementing action in the Park, and their participation in decision-making is being strengthened currently. Similarly through participation in economic collectives they also contribute to family economies. Culture is strengthened through implementation of the Potato Park because it reinforces the role of local culture through institutions, promoting regeneration of community identities. Other positive impacts include the restitution of genetic variability of native potato crops, repatriation and restoration of the cultural landscape; agro-ecotourism generating income and incentives for conservation and the promotion of regional ordinances.

This study was conducted as part of the program activities of the Satoyama Initiative, United Nations University Institute of Advanced Studies.

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Land use and biodiversity patterns on chacras in northeast Argentina

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1. Introduction

While extremely long longitudinally, Latin America alone covers a broad range of latitudes and accompanying climates, from tropical in the north to polar in the south. Argentina, which is situated at the southern tip of South America, is a major agricultural producer, and is therefore home to many secondary natural environments such as farmland. At the same time, there are four natural World Heritage sites in Argentina. It is a treasure chest of diverse natural features, from subtropical forests to glaciers. The present report draws upon the example of subtropical areas around Iguazú National Park (province of Misiones), which is one of the most renowned specimens of nature in the country, and illustrates how the natural resources on areas of family-owned land is managed in a sustainable manner, resulting in the maintenance of a high degree of biodiversity.

2. Overview of the area and survey

2.1 The natural environment of Argentina

Argentina has an area of 2,780,000 square kilometres, placing it as the second largest country in Latin America and eighth in the world. It extends about 3,800 kilometres from north to south, and has climates ranging from subtropical to polar. It is an agricultural nation, with beef cattle, wheat, corn, and soybeans among its major products. Much of the population is concentrated in the north, and conversely the south has a lower population density. Most of the country has been developed as farmland, with forests now only covering about ten percent of the country.

2.2 The natural environment of Misiones

The province of Misiones, which occupies an area of about 30,000 square kilometres, is located in the northeast of Argentina and protrudes out in a peninsular shape, flanked by the neighbouring countries of Brazil to the east and Paraguay to the west (figure 1). Climatically it is subtropical. The northern part of the province harbours the country's only remaining subtropical forest (the Selva Paranaense). At about 70 percent, forest cover is higher in Misiones than any other province. In addition to vast untarnished natural expanses, one can also see many plantations. In the northern part of Misiones, the cultivation of yerba mate (*Ilex paguariensis*), which is used to prepare the traditional mate drink, is quite popular.

Figure 1. Andresito city, Misiones province, Argentina

Nature reserves and other protected parkland make up approximately a third of the province. At the northernmost point of the province are the famed Iguazú Falls. The falls and the surrounding areas are part of Iguazú National Park.

2.3 Survey methods

The survey that formed the basis for this report was conducted from the 18 to 25 November 2009, and targeted mainly the province of Misiones, but also included Argentina's capital Buenos Aires and the state of Paraná in Brazil. Members of the government of the Argentine Republic, the provincial government of Misiones, the town of Andresito, and people at the Argentine Natural History Museum and the Argentinean office of the Japan International Cooperation Agency (JICA) were interviewed. In addition, field surveys were conducted during which landowners and National Park officials in the Cabure-i area of Andresito, Misiones were asked about the history of farming methods and land use in the region, and the issues they currently face. Furthermore, visits were made to Paraná, Brazil, which has

similar climatic and topographical characteristics as Andresito but little forestland and very different patterns of land use. On-site surveys were performed by Ginzo Aoyama and Mitsuhiko Toda of the Japan Wildlife Research Center.

3. Survey results

3.1 Chacras

A chacra refers to a farm-centred land use paradigm commonly seen in Argentina in which land is broken up into plots according to purpose, which results in a kind of mosaic pattern when seen from above. A chacra is basically a piece of land owned and managed by a single family. The focus of a chacra is the family house and farmland, but chacras often have secondary forests or tree rows, plantations, natural sources of running water, etc. In its narrowest sense, the word "chacra" means "farm", but it connotes not large-scale farming operations, but rather the distinctive mosaic-patterned small farms interspersed with secondary forests and other such features.

3.2 The history of the development of chacras and their present status

Until around the turn of the last century, in the region where the borders of Argentina, Brazil and Paraguay intersect, there existed a vast primeval forest called Selva Paranaense. The bulk of the primeval forest, however, was subsequently lost, becoming a victim of the pressures to develop farmland. Now only a 60,000 hectare tract, located mostly in Misiones, Argentina remains. (Information from the Iguazú National Park Visitors' Center)

Incorporated in 1980, Andresito, Misiones is a relatively recent town. Chacras in Andresito were developed in the 1960s, before the incorporation of the town. The virgin forest that was present till then was cleared to make way for agriculture and secondary forests. There were political motives behind this development, namely, the government of the Argentine Republic encouraged the settlement of the northern part of Misiones as a way to curb the influx of illegal immigrants from Brazil and Paraguay. People were urged to settle in the area through enticements of land provided by the government, and were then encouraged to manage and monitor the land they settled on. (The above information was obtained through interviews with the mayor of Andresito).

3.3 The sustainable use of land in chacras

3.3.1. The structure and composition of chacras

One family manages and maintains one chacra. Typically, chacras in Misiones are nearly square-shaped, spanning 250 metres on each side, consist of about six hectares and contain a secondary forest, farmland, and farmhouse. Chacras in the town of Andresito are generally larger than those of other areas, with single families occupying lands of about 15 hectares.

To give readers a better idea of how land is used on chacras, we shall illustrate one example of a chacra in Andresito's Cabure-i area, which was part of the current survey (figure 2 and 3). The overall land area of this chacra is 15 hectares, which is in line with the average for the town of Andresito. The farmhouse is located near farmland, and the entirety is surrounded by secondary forest/tree-line formations. In the northern part of this chacra are located a stream and ponds. The farmland yields rich harvests of mandioca plants (*Manihot esculenta*, or cassava). Mandioca are often cultivated in savanna-type climates, and although it does not occupy a substantial part of Argentina's agricultural products, it is commonly seen in the markets of Andresito, which is characterized by a subtropical climate. These mandioca can be harvested a mere two months after planting. Two varieties (white and black mandioca) are grown on this farm, in addition to a wide variety of produce, including citric fruits, strawberries, lettuce, tomatoes, and onions.

Figure 2. Illustration of the chacra (left) and a cross section (right) (© JWRC)

Figure 3. Landscape of a chacra in Andresito

The secondary forests surrounding the fields are not used much, except occasionally as fuel. The pond at the north end of the chacra is currently not being used, but there are future plans to cultivate carp, tilapia, pacú (*Piaractus mesopotamicus*, freshwater fish in the characid family), or other fish.

3.3.2 The labor that maintains the chacras

The 15-hectare chacra introduced here is managed by the landowner, who happens to be a woman (figure 4). She sometimes pays residents of Andresito to work on her farm. Most other chacras are managed and maintained exclusively by family members or with the help of a few outside workers.

3.3.3 The biodiversity of chacras

While they cannot compare with primeval forests, these chacras, with their diverse mosaic-like environments, do ensure a high level of biodiversity. Between farmland and secondary forests are hedge-like rows of trees that serve as excellent habitats for species of butterflies and lizards. Within the secondary forests, which are as tall as about 15 metres (though they include species of trees that can grow to a maximum of 40 metres), one can observe stratified structures consisting of overstoreys, understoreys, and shrub layers that offer a broad spectrum of habitats. Many chacras have natural sources of water such as streams and ponds, which double as crucial habitats for frogs, freshwater turtles, etc.

The creatures most prominent in the Cabure-i area of Andresito are listed in table 1 (Information obtained from a Iguazú National Park coordinator).

4. Issues and new initiatives

4.1 Purchases by large corporations and the decline of mosaic-patterned land use

In the state of Paraná, Brazil, there exist vast fields dedicated to growing soybeans alone. The town of Andresito has also begun to feel the effects of land acquisitions by major corporations as well as the advent of the single-crop farming of yerba mate and other crops. There are concerns that chacras and their unique style of mosaic-patterned land use may rapidly be lost. In addition to domestic Argentinean companies, foreign companies are beginning to acquire land. In order to prevent further corporate land acquisition, it is important for landowners to gain sufficient income from the operation of their chacras.

4.2 The economic life of chacra farmers

In Andresito, a much larger land surface is allocated per family than the average land acreage per family in Misiones as a whole, which has perpetuated the diversity of products grown there. In the past, there were instances of illegal logging operations in Iguazú National Park and the nature preserves around it. To address this problem, projects were implemented by both JICA and the Spanish Agency for International Development Cooperation (Agencia Española de Cooperación Internacional para el Desarrollo, or AECID). The goal of these projects was to treat areas around preserves as buffer zones and improve the economic conditions of the people living in these areas, thereby eliminating illegal logging and creating sustainable relationships between area residents and the preserves.

The biggest challenge in fostering self-sustaining and economically independent lifestyles for area residents is developing and expanding sales routes for agricultural products derived from chacras. A union was established in the Cabure-i area that supplies the neighbouring Iguazú region, a major tourist destination, with processed mandioca, green leafy vegetables, and other products. The government of the Argentine Republic has also set aside a budget for federally employed rangers to consult and liaise on agricultural issues. These efforts have made it possible to address these challenges through a union framework, which would not have been feasible on an individual farm/family level.

Figure 4. Interview with a chacra landowner (woman to left).

Table 1. The biodiversity of chacras

Group	Example of common species	Common name in Spanish
Tree	*Enterolobium contortisiliquum* *Cecropia adenopus* *Patagonula americana*	Timbo Guayubira
Mammal	*Cerdocyon thous* *Procyon cancrivorus* *Felis wiedii*	Zorro de monte Aguara Pope Gato tirica
Bird	*Coragyps atratus* *Glaucidium brasilianum* *Pitangus sulphuratus*	Jote de Cabeza negra Cabure Pitogue
Reptile or Amphibian	*Bothrops neuwiedii* *Tupinambis teguixin* *Bufo paracnemis*	Yarara chica Teyu Sapo cururu
Butterfly	*Morpho achillaens* *Phoebis cipris* *Phoebis philea*	

For mandioca and green leafy vegetables which are not normally suited for transportation over long distances, initiatives were designed by the union to deliver these products to nearby Iguazú, a much-visited point of consumption, and achieve a steady chain of distribution. The union has also invited agricultural specialists to lead seminars for farmers, teaching them about distribution mechanisms and processing methods.

4.3 Sustaining chacras into the future

The chacras of Misiones lie between an urban area and a nature preserve and serve as a buffer zone for both. It can also be said that these chacras are a model of a sustainable yet practical paradigm of land usage in the sense that they allow for sustained agriculture yet at the same time maintain the integrity of regional biodiversity. Furthermore, this region is relatively flat, temperate, and moist, making it ideal as farmland. In the neighbouring Brazilian state of Paraná, many forests have already been razed, to be replaced by immense soybean fields. During the interviews conducted for this report, some scientists predicted that the chacras of Misiones will similarly be sacrificed over a very short period of time.

In order to preserve the picturesque presence of chacras, it is necessary for farmers to remain and continue to managing and cultivating their land. The most significant challenge is achieving a steady distribution of agricultural products from the chacras and the income they generate. In addition, it is important for landowners themselves, together with governmental bodies, researchers, and other stakeholders, to recognize that chacras may be just as important as the surrounding wildlife preserves for maintaining biodiversity, and that they are of great significance in terms of their aesthetic contribution to the unique landscape of the country. Based upon this fundamental recognition, these sectors should come together to work at preserving these exquisite landscapes for future generations.

This study was commissioned by the Ministry of the Environment, Japan

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The sustainable use of biodiversity in paddies and fields of Louisiana

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1. Introduction

The United States occupies the better part of an entire continent, and its geography is marked by diverse natural climates that include major mountain ranges, expansive prairies, and climates that span tropical to subtropical zones. The U.S. is a major agricultural producer; much of its land is dedicated to farming for wheat, corn, soybeans, and other agricultural products, and the country harbors well-developed large-scale farming enterprises. The current paper presents a case study of efforts aimed at the sustainable use of secondary natural features and the conservation of biodiversity in a particular region of the U.S., St. Martin Parish, Louisiana (figure 1 and 2).

Louisiana comprises about 130,000 square kilometers, roughly 110,000 square kilometres of land and 20,000 of water. About 57,000 square kilometres of that is forest. The northern part of the state is bordered on the east by the Mississippi River. The river then cuts through the southern part of the state, which faces the Gulf of Mexico. To the west it borders Texas, and to the north Arkansas. Louisiana has thriving agriculture, forestry and fishing industries. Its chief products include timber, rice, sugarcane, and aquatic products (Louisiana is by far the world's largest producer of crawfish). In addition to these, the state has well-developed chemical, petrol, and tourist industries.

Information in Louisiana was collected chiefly through interviews conducted from December 2 through December 11, 2009, in the St. Martin Parish area. The surveys were performed by Mitsuhiko Toda and Takashi Inoue of the Japan Wildlife Research Center with the assistance of Stefan Ottomanski of Nagao Natural Environment Foundation.

Figure 1. St. Martin Parish in Louisiana State, U.S.A. © JWRC

2. Biodiversity conservation in paddies combining wetland crop cultivation and crawfish harvesting

2.1 Working wetlands

The term "working wetland" in Louisiana refers to the fact that the state's wetlands (paddies) serve multiple functions: they are used to cultivate rice and harvest crawfish, and also provide waterfowl habitat. In St. Martin Parish, for example, farmers allow crawfish cultivated in paddies to be fed on by birds, thereby using the wetlands in a sustainable way and preserving biodiversity in the area.

2.2 Changes in land use in St. Martin Parish

The land subject to the current study was at one time a forest, and the grandfather of the current farmer/landowner originally made his living through forestry. With the construction of levies along the Mississippi River in the 1920s, it was transformed into a wetland, after which it was used for paddy farming. Subsequently, the crawfish that thrived in the paddies were used as a source of food, but in the 1960s, with the introduction of rice farming, the crawfish came to be cultivated for commercial purposes. In recent years, in light of unstable rice prices, crawfish are cultivated together with paddy agricultural products as a means to mitigate the business risks associated with growing only rice.

2.3 Rice production

The farm in this case study is run according to the guidelines of the Louisiana Master Farmer Program. It consists of a roughly 400-acre tract of wetland that is used mainly for the paddy farming of rice.

Rice cultivation begins in the spring (March); seeds are for the most part sown directly using a planting

Figure 2. Study site in St. Martin Parish

Figure 3. Juvenile crawfish

tractor, and occasionally using a small aircraft. Harvesting is done once or twice a year. The first harvest takes place in July, and depending upon how the rice has grown, there may be a second harvest, either in October or November. After seeds are sown, the water level in the paddies is maintained at a depth of two inches for about two weeks. This depth is not only ideal for wading birds (e.g. the American White Ibis; *Eudocimus albus*), it is also effective for controlling weeds. The water depth is raised to four to six inches in conjunction with the growth of the rice plants, and is drained just before harvesting. The water is delivered to the paddies via pumps from the settling ponds designed to let the silt that has runoff from sugarcane fields settle.

Rice is planted without tilling the land every year for three consecutive years, and is harvested around five times during this duration. In the fourth year the fields are filled with water and left to lie fallow, after which they are tilled and planted again. The rice produced is a long-grain variety that yields about 8,000 pounds per acre at the first harvest and 3,200 pounds in the second. The price for unprocessed rice is around 22 U.S. dollars a barrel.

2.4 Crawfish cultivation

Purchased crawfish (*Procambarus clarkii*) are released into paddies around May and June, when the rice planted in March has matured to a certain extent. Releasing crawfish into paddies at this timing affords them a certain degree of protection via the rice plants and lowers the levels of predation by waterfowl (figure 3). The released crawfish reproduce before the first harvest. Crawfish grow by about 20 percent every time they shed their shells, but their maturation is affected by climatic and other conditions. The released crawfish grow by feeding upon aquatic insects and tadpoles that inhabit the paddies. They become cannibalistic when other sources of food are insufficient, so in the interest of maintaining a high level of biodiversity in the paddies, much care must be taken when using pesticides or fertilizers. Although the water is drained from the paddies immediately prior to harvesting, the crawfish survive the harvest by taking refuge in holes they dig in the paddy mud.

Crawfish are harvested after the rice, and the decision regarding whether to harvest rice a second time or harvest crawfish is made depending on factors such as the quality of the rice, rice prices, and crawfish prices. This sometimes means that rice is not harvested a second time. A crawfish harvest will generally yield 1,000 pounds per acre, with prices fluctuating somewhere between 30 cents to 3 U.S. dollars per pound.

Crawfish are harvested using specialized traps (figure 4). Two types of traps with mesh sizes of about 2 centimeters are used so as not to capture crawfish that are too small. When water is added to the paddies, a screen is placed at the point of intake that keeps out bluegills and other fish that prey upon crawfish.

2.5 Biodiversity of the paddies and surrounding areas

At the farm that was studied, many aquatic animals are used as a food source for humans, including frogs (frequently found in irrigation canals and caught at night), American Alligators (*Alligator mississippiensis*), and Snapping Turtles (*Chelydra serpentina*). The Mourning Doves (*Zenaida macroura*), Bobwhite Quail (*Colinus virginianus*), and other birds are hunted for food. Many birds that are either predators or competitors to the crawfish have been observed in the paddies, and if one were to place emphasis only on the productivity of crawfish cultiva-

Figure 4. Crawfish trap

Figure 5. American White Ibis *(Eudocimus albus)*

tion, such birds would be a nuisance. Despite this, at the site studied, paddies are used sustainably with the birds being allowed to feed upon the crawfish. Crawfish predators include herons, ibises, spoonbills, and gulls, while crawfish competitors include ducks and swans.

Also observed during the study were the American White Ibis (figure 5), the Great Egret (*Casmerodius albus*), the Snowy Egret (*Egretta thula*), the Great Blue Heron (*Ardea herodias*), the Mallard (*Anas platyrhynchos*), the Bald Eagle (*Haliaeetus leucocephalus*), Fire Ants (*Solenopsis invicta*), tadpoles among others.

3. Conclusion

3.1 The use of secondary natural resources in Louisiana

Natural areas have conventionally been converted into farmland based on the notion that nature is something to be conquered, but over the past two decades views of nature and ways to utilize it have begun to change. Large-scale sustainable farming is also gaining a foothold through decisions to plant crops other than corn, which imposes a significant burden upon the soil, on land traditionally used as cornfields, and to reduce or eliminate the use of pesticides and other agrochemicals. It should also be noted that the practice of hunting, which is a "consumptive" way of utilizing natural wildlife, is on the decline, while "non-consumptive" utilization, e.g. bird watching, is on the rise.

3.2 Efforts at conserving or rehabilitating the natural environment

Examples of programs to conserve or rehabilitate natural environments in the United States include the Wetland Reserve Program (WRP) and the Conservation Reserve Program (CRP). These programs are designed to provide assistance in rehabilitating and protecting natural environments in areas of poor farmland.

The main goal of the WRP is to conserve and rehabilitate wetlands to serve as habitats for waterfowl. The program is voluntary and operates under 30-year easements. The CRP, on the other hand, is chiefly a reforestation program with the goal of preventing soil erosion that targets areas ill-suited to farmland. In addition to these, there is also the Environmental Quality Incentives Program (EQIP), which provides farmers with incentives for improving the environmental quality of their land.

The Louisiana State University Agriculture Center is appealing to the government to offer support for farms, such as the one described here, that utilize and conserve wildlife and natural resources such as crawfish, waterfowl, and water (levels and quality). The conservation of biodiversity in farming should also raise the level of biodiversity in areas surrounding wetland farms in Louisiana.

This study was commissioned by the Ministry of the Environment, Japan

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Forest management through community-based forest enterprises in Ixtlán de Juárez, Oaxaca, Mexico

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1. Introduction

In Mexico, deforestation and land degradation due to population growth, past agricultural policies, expansion of the agricultural frontier, over-exploitation, poorly regulated tourism, accelerated economic development, and arbitrary settlement policies have been having a serious impact on terrestrial biodiversity.

As a party to the Convention on Biological Diversity (CBD), Mexico recognizes its obligation with regards to the conservation and sustainable use of biological diversity. However, the erosion of biodiversity and natural resources in Mexico has significantly surpassed the outcomes of the conservation initiatives that have been undertaken by the governmental sector. This has led to the exploration of new opportunities for expanding conservation work by integrating stakeholders other than governmental agencies. In fact, community-based biodiversity conservation in Mexico has expanded rapidly and is also increasingly influencing the policy-making processes due to growing recognition of its importance by state and federal-level conservation agencies, non-governmental organizations and academic institutions.

2. Regional Overview

The Sierra Norte Region of the State of Oaxaca is recognized as the most important region of Mexico for biodiversity conservation, given its high degree of biological richness and endemism (Ovideo, 2002). The ecosystems represented in the area harbor a vast and highly dense number of species of flora and fauna which has attracted the attention of the international scientific community. The region is recognized as a World Heritage biodiversity "hotspot" with more than 8,400 plant, 736 bird, 190 mammal, 245 reptile and 1,103 butterfly species. Endemism is also high and there are many rare endangered animal and plant species, including several species of the Cycadaceae family. Although the region is rich in biodiversity and its importance has been recognized, it has increasingly faced the risks of deforestation and other human interventions, as seen in other regions of Mexico.

In the last few years, community-based biodiversity protection and conservation, in particular forest conservation activities, in Oaxaca have expanded in number, geographic coverage and diversity of approach.

Ixtlán de Juárez

3. Policy Reformation and Concerns about Environmental Conservation

Until 1986, the incentives for sustainable forest and natural resource use were perverse since commercial wood extraction relied upon a system of industrial concessions or inefficient state laws. During that period, there were little incentives for long-term sustainability or diversification of natural resource utilization. Although indigenous communities or *ejidos* (communities located on land granted to landless peasants after the Mexican Revolution) had legal ownership of much of the country's forestland, they were not able to utilize their own lands freely due to the pressure from the commercial use. Adding to that, past agricultural policies promoted the clearing of forests for subsistence and commercial agriculture or cattle-rearing. In the early 1990s, a series of policy reforms in the agricultural sector eliminated previous distortions in prices, livestock and input subsidies, and trade policies, and reformed the land administration system to strengthen land markets, while preserving *ejido* and indigenous community tenure. As part of this sectoral reform, a new Forestry Law was passed in 1986 and revised in 1992, providing the legal framework for indigenous community and *ejido* management of forests within their boundaries, based on a Forest Management Plan requiring government approval.

Once rural communities in Mexico acquired legal rights over their territories and natural heritage, they also developed local statutory powers for decision-making on natural resource utilization, especially on

the use of forest resources. These powers are embodied in community statutes, which are legally recognized under the political constitution in Mexico and are based on the implementation of effective conservation and sustainable use activities at the community level.

4. Community-based forest management in Ixtlán de Juárez

Community-based forest management (CBFM) in Ixtlán de Juárez was examined here for multiple reasons. CBFM comes in many forms that combine the socio-economic control resulting from a community forest structure with ecosystem-based forest management. Ecosystem-based resource management recognizes whole systems and integrated ecological, social and economic considerations at various scales across the landscape. For these reasons, community-based forestry is highly expected to contribute to the maintenance of forest cover and other ecosystem processes while providing economic benefits to the community. In addition, the community has applied their traditional governance system in managing the landscape. It is expected that community forests provides aesthetic benefits, wildlife habitat, watershed protection, sustainable management of timber and endemic specific conservation through traditional forest resource utilization.

4.1 Integration of Traditional Governing Systems and Modern Forest Management

The Ixtlán de Juaréz municipality has adopted a traditional local governance system distinct from the state or national government system, called the *Usos y Costumbres* (Uses and Customs) system. *Usos y Costumbres* is rooted in indigenous systems of community service that give particular importance to elders, open assemblies, and consensus. The *Asamblea General* (General Assembly) consists of community members and is the maximum authority that decides on all issues related to the local community, including forest management.

Local governance structures have contributed to efficient decision-making on major issues related to natural resource management, including the definition of rules governing access to forest resources, the planning and construction of road networks, the production of sawn timber and the obligation of community members to participate in forest conservation activities.

4.2 Community-based Forest Enterprises as the Forest Conservation Method

In this area, community-based forest enterprises (CBFEs), like logging businesses, have made a great contribution to forest conservation. Forest resources, especially trees, used by CBFEs are strictly controlled under the Forestry Management Plan drawn up by the community and authorized by the state government. In fact, locations where trees can be extracted and where they must be protected are clearly stated in the plan, which the logging operators must follow.

The profits from the CBFEs are reinvested to provide social benefits such as roads, school buildings and rural medical centers, as well as into the enterprise's infrastructure such as trucks, sawmills, cranes, etc. They are also distributed equally among community members. The way in which profits are reinvested is decided by the *Asemblea General* (figure 1).

Forest resources are utilized in accordance with the Plan as well as under the governance of the *Asemblea General*. Simultaneously, the community generates economic and social benefits through such forest management.

4.3 Links between Various Stakeholders

Although the community manages their forests through autonomous decision-making in Ixtlán de Juaréz, the federal government also has to get involved in forest management through regulatory and supportive institutions such as the Ministry of the

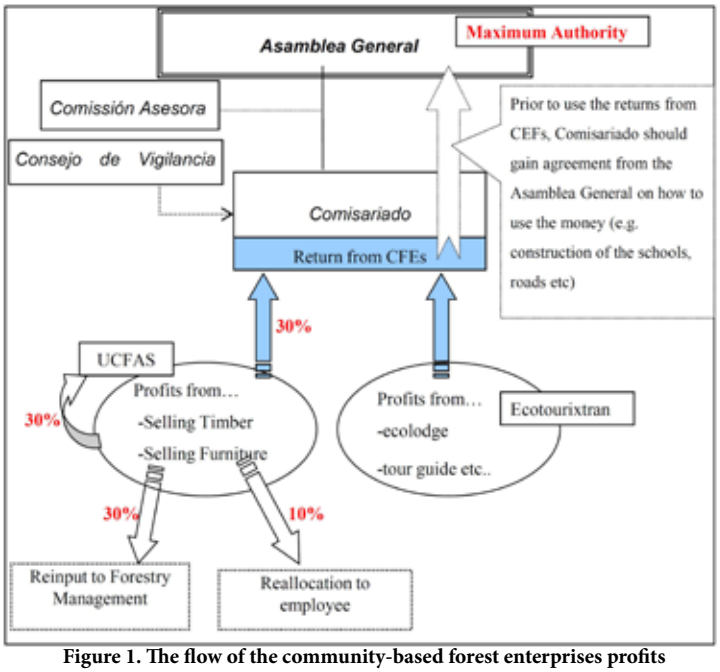

Figure 1. The flow of the community-based forest enterprises profits within the community

Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales*, SEMARNAT) and the National Forestry Commission (*Comisión Nacional Forestal*, CONAFOR). While SEMARNAT is a normative body that engages in forest regulation, CONAFOR is responsible for all activities related to the promotion and preservation of the country's forests. The community has a good relationship with the government sector. Consequently, it has received subsidies from the government to engage in forest conservation activies. Also, the community receives support from various non-governmental organizations (NGOs). The World Wildlife Fund (WWF) is one of the main international NGOs that has offered to provide training to strengthen the capacity of local forest technicians and consultants, and has promoted and developed community-based ecotourism.

A review of the literature and a field study indicates that CBFM in Ixtlán de Juárez has been operated effectively by the community, based on their traditional decision-making structure and in cooperation with various stakeholders. CBFM makes it possible not only to utilize forest resources in a sustainable way, but also to provide socio-economical benefits to the community. Therefore, the case of Ixtlán de Juárez highlights one of the ways to foster forest conservation and provide socio-economic benefits to the community in a sustainable manner.

This study was conducted as part of the program activities of the Satoyama Initiative, United Nations University Institute of Advanced Studies.

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Case studies from Asia

Kandyan homegardens: A promising land management system in Sri Lanka

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1. Introduction

Kandyan homegardens located in the mid-country region of Sri Lanka, predominantly in the district of Kandy but also in Matale, Kegalle, Kurungalle and Rathnapura districts, represent a centuries old sustainable system of production based on a highly diversified portfolio of perennial mixed cropping comprising a variety of tree crops with multiple uses and to a lesser extent livestock (figure 1). This traditional, complex and risk-averse multi-story production system comprising several perennial food crops, fruits, vegetables, roots, tubers, medicinal plants, sugar crops, spice crops and timber crops has continuously provided high levels of nutritional and diet diversity to households while medicinal species, spices and tree species provide substantial additional income. While similar to other homegarden systems in other parts of the world, Kandyan homegardens are unique in the high levels of functional plant diversity they contain. The farmers and households with Kandyan homegardens have also tended to have a better livelihood from a broader range of market and subsistence products compared to those with other homegarden systems. In addition to these important economic and social benefits, the Kandyan homegarden system also provides key ecosystem services and habitats for a range of flora and fauna. Kandyan homegardens provide connectivity and linkages to other agricultural and natural landscapes, and this in itself is important for biodiversity conservation and adaptation, and will become more important under a changing climate, particularly as the risk of population fragmentation and the need for geneflow and species dispersal and migration increase. Kandyan homegardens may well provide the quality matrix through which such linkage and connectivity may occur. For these reasons, past, present and future, this important system will continue to be important for the contribution it makes to sustainable diets and livelihoods as well as enhanced conservation of globally important biodiversity.

Figure 1. A Typical Kandyan homegarden in Sri Lanka

2. Background and Landscape

The mid-country wet zone area of Kandy district, Sri Lanka, is typically covered by sloping land and valleys. Kandy district covers 1,906 square kilometres or 2.9 per cent of total land area of the country (IUCN, 2007). The altitude of the area ranges from 400 to 650 metres above sea level and rainfall in the area varies from 2,000-2,500 millimetres/year. Day time temperature in the area varies between 24-26 degrees Celsius and relative humidity changes from 65-80 per cent during the day to 75-90 per cent at night. The Kandy area harbours a relatively high population density in the country with an average of 704 people per square kilometre (IUCN, 2007). Originally, much of the area of the district was covered by natural forests but, due to various reasons, natural forest cover (including sparse forests) of the district is now limited to less than 17 per cent (IUCN, 2007). Much of the natural forest has been cleared and a plantation crop based agroecosystems were established in the highlands during the colonial era. To this day, tea and rubber based agroecosystems are the dominant land use category of the district. Low land valleys have been cultivated with mainly paddy and in some instances vegetable crops. The other main land use category in the area is homegardens. The homegardens in Kandy district are termed Kandyan home (forest) gardens. Thus, it is clear that according to the biophysical limits and socio-economic characteristics of the area, several land use systems have been developed and collectively these represent a unique landscape of ecosystem mosaics covering both wild and cultivated areas. The Kandyan homegardens in many instances represent the bridging or linking land use category throughout this mosaic.

3. Kandyan homegardens

Kandyan homegardens represent a long-established indigenous and dominant form of land use in Kandy district. It provides a fine example of the development of a highly adapted, diversified and economically and environmentally viable form of land use in the country (Jacob and Alles, 1987; Pushpakumara, 2000). Kandyan homegardens are agroforestry land use systems in which multipurpose trees and shrubs are found in close association with perennials or annual agricultural plants and/or animals simultaneously on the same piece of land. They are near households and often close to a source of water, the quality of which they also contribute to as a key ecosystem service. Kandyan homegardens are mainly managed through family labour with locally appropriate technologies that rely on rich local knowledge systems. They provide a year-round wide range of products such as staple foods, many kinds of fruits, vegetables, spices, fuelwood, fodder, timber, medicinal plants, and sometimes livestock products. Homegardens are important for the maintenance of unique agricultural biodiversity in Sri Lanka, by for instance ensuring the conservation of a diversity of fruits and vegetables, spices (pepper, cloves and nutmeg among others) and medicinal plants on which indigenous medical practitioners and system depend. Key ecosystem services such as erosion control, carbon sequestration, soil fertility replenishment and ensuring water quality are provided as well as other important services such as aesthetically pleasant living conditions, cultural identity; and cash income (Jacob and Alles, 1987; Pushpakumara, 2000). Currently, Kandyan homegardens have become crucially important to Sri Lanka, and in particular in the Kandy district, as they provide products and services similar to natural forests, income, and an attractive living environment to household members.

Table 1. Characteristics and climatic data of Kandyan homegardens

Characteristics	Range
Size of homegardens (ha)	0.05-2.5 (mean = 0.4 ha)
Altitude (m amsl)	400-1050
Rainfall (mm)	2000-2500
Temperature (°C)	24-26
Relative humidity (percent)	65-80 (day) and 75-90 (night)
Population density (Per km²)	500-699
Family size (numbers)	2-9
Number of vertical canopy strata	3-5
Canopy coverage (%)	45-98
Ground coverage (%)	50-90
Dominant soil type	Reddish brown latosolic to immature brown loam
Slope of land (%)	10-40
Number of species per homegarden	37-143
Number of woody taxa per homegarden	11-39
Tree species density per ha (over 5 cm dbh)	92-3736
Plant species density per ha (including annuals)	654-5663
Dominant natural vegetation of the area	Tropical wet evergreen forests
Land tenure	Mainly privately owned

Sources: Jacob and Alles, 1987; McConells and Dharmapala, 1973; Perera and Rajapaksha, 1991; Pushpakumara, 2000.

3.1 Biophysical and socio-economic features of Kandyan homegardens

Kandyan homegardens are the fruits of farmers' conception, investment and long term planning. They are usually carefully structured systems where crops, trees, herbs, shrubs, animals and people are structured and temporal components each have a precise place and a well-established function (Jacob and Alles, 1987; McConnell and Dharmapala, 1973; Pushpakumara, 2000). The composition and structure of plant and animals species in Kandyan homegardens are probably a result of a combination of farmer selection, natural evolution, and occasional recommendations by researchers and extension workers. It is widely accepted that the system evolved over time under the influence of resource constraints to optimise the productivity of land. Kandyan homegardens are typically established in sloping areas of mid-altitudinal areas (table 1). About 70 per cent of the households in the area have homegardens. They are usually managed as a small holding with an average land area of 0.4 hectares. Kandyan homegardens are prominent only in wet zone area with high rainfall. Despite the small average size of the management units, Kandyan homegardens are characterized by high species diversity and a multi-storied structure, which results in intimate plant association with a virtually closed canopy. Dense, multi-storied arrangements with a combination of mixed but compatible species are among the most significant characteristics of Kandyan homegardens (figure 2).

Kandyan homegardens make optimal use of light and other resources by having plants which have different canopy configurations and different requirements for light, nutrient, water and space in the

system. In the Kandyan homegardens, the structure and composition mainly determine the level of production. The layered structure and the composition of the homegardens is dynamic, and changing according to uses and cropping seasons, but with the overall structure and functions largely maintained. The dynamic nature of the system is illustrated by age classes of tree species, which include seedlings, sapling and mature trees in production. Annuals are cultivated based on the season throughout the year.

With respect to management, Kandyan homegardens are remarkable in that they require a relatively small amount of labour from members of the household to manage the tree-crop-animal unit. They are maintained by integrated practices using farm generated (internal) resources with minimal requirements for external inputs such as fertilizer and pesticides. Labour utilization is equally divided between males and females with few activities being exclusively the domain of either sex (Jayawardena and Jayatilake, 1998). Kandyan homegardens are economically important for owners since they provide a considerable amount (30-50 per cent) of household income. Kandyan homegardens are considered a sustainable production system since they are able to conserve basic resources of production in the long-term and at the same time contribute significantly to socio-economic wellbeing of households as well as maintaining ecological integrity (Perera and Rajapakse, 1991).

3.2 Kandyan homegardens and nutritional security

Kandyan homegardens provide sustainable production of various foods and direct access to them and increase the nutritional quality of meals and diet. They also enhance the ecological integrity of the catchment area which contributes to maintaining water quality. Their low requirement for external inputs, such as fertilizers and pesticides, adds to this. (Pushpakumara, 2000).

Kandyan homegardens provide a low cost, sustainable strategy for increasing household food and nutritional level by providing a steady supply of various types of edible products and more importantly direct access to them. They are traditionally designed to provide basic complementary food and material products necessary for daily life. The combination of trees, crops and livestock with different production cycles and rhythms provides a relatively uninterrupted supply of food products, which helps to increase the self-reliance of households (Pushpakumara, 2000). There may be peaks and slack seasons for harvesting various products from the homegardens depending on the climate and other environmental characteristics. However, there is usually something to harvest daily from most Kandyan homegardens.

Kandyan homegardens contain a wide variety of crops and trees. A significant factor of tree and crop components is the diversity of fruits and other food producing plants and trees (Hitinayake *et al*., 1996; Jacob and Alles, 1987; McConnell and Dharmapala, 1973; Perera and Rajapakse, 1991; Pushpakumara, 2000; Pushpakumara and Silva, 2008). Table 2 summarises examples for different products from Kandyan homegardens. Tree, herb and climber species and their uses are reported by Hitinayake and Ekanayake (1999), Hitinayake *et al*. (1996), Jacob and Alles (1987), McConnell and Dharmapala (1973), Perera and Rajapakse (1991), Pushpakumara (2000) and Pushpakumara and Silva (2008). Poultry and cattle are the common livestock component

Table 2. Different products provided from Kandyan Homegardens. Source: Pushpakumara (2000)

Products	Examples
Food items	Breadfruit, cassava, coconut, jakfruit, maize, sweet potato, taro, yam
Fruits	Amberella, avocado, banana, carambola, cashew, citrus (many kinds), cocoa, custard apple, durian, guava, jackfruit, mango, mangosteen, orange, passonfruit, papaya, pineapple, pomegranate, rambutan, rose apple, sapodilla, sour soup.
Ornamentals	Anthurium, cacti, crotons, begonias, orchids, palms, roses, ferns
Timber trees	*Alastonia, Alibizia, Berrya,* Coconut, *Filicium, Gmelina,* jakfruit, mahogany, *Melia, Michelia, Pterocarpus*, teak
Medicinal plants	Most herbs and trees in Kandyan homegardens are medicinally used
Vegetables (including leafy vegetables)	*Amaranthus,* brinjal, cabbage, leafy vegetables, okra, pumpkin, *Sesbania grandiflora*, spinach, water spinach, wing bean
Spices	Cardamom, chillies, cinnamon, cloves, coriander, curry leaf, ginger, lemon grass, nutmeg, pepper, rampe, turmeric
Cash crops	Anthurium, avocado, cacao, cloves, coconut, coffee, mahogany, mangosteen, Michelia, nutmeg, pepper, teak.
Animal products	Local breeds of chicken, eggs, goat and cow milk.

(Perera and Perera, 2000), although only 15 per cent of householders rear livestock.

Most Kandyan homegarden production is for home consumption, but any marketable surplus can provide a safeguard against future crop failures and also additional income. Kandyan homegardens provide a considerable amount of household income (30-50 per cent), mostly through the production of timber and cash crops from homegardens (table 2). This income is very particularly useful during off seasons and droughts.

Fuelwood, the major domestic energy source for over 90 per cent of rural people, is becoming scarce in some locations, and as a result prices of fuelwood have increased substantially. Lack of fuelwood impedes cooking and can contribute to only partial boiling of water; these in turn reduce the digestibility of food and may increase health hazards. However, the continuous supply of an adequate amount of fuelwood from Kandyan homegardens minimises these health risks and in turn contributes to achieving proper nutrition.

3.3 Kandyan homegardens and biodiversity conservation

Kandyan homegardens have evolved over thousands of years to include a rich array of cultivated plants including grains, vegetables, fruits, spices, medicinal plants, timber trees and also livestock (table 2). High level of plant species diversity has been reported by Hitinayake and Ekanayake (1999), Hitinayake *et al.* (1996), Jacob and Alles (1987), McConnell and Dharmapala (1973), Perera and Rajapakse (1991), Pushpakumara (2000) and Pushpakumara and Silva (2008). It is reported that more than 200 useful plant species have been conserved in Kandyan homegardens. Jacob and Alles (1987) and McConnell and Dharmapala (1973) suggested that the species density and diversity of Kandyan homegardens compare to that of natural forests in similar elevations and climates. They have become repositories of germplasm of numerous species (Pushpakumara, 2000; Pushpakumara and Silva, 2008). It is widely accepted that the Kandyan homegardens involve biodiversity-friendly land use practices in which help conserve on-farm agrobiodiversity. Further, the homegardens provide locations for initial domestication of wild crops, trees and animals. Kandyan homegardens are not isolated management units, they always complement other agricultural activities, such as permanent rice farming and thus contribute to a landscape mosaic which link agricultural land and wild areas. In doing so, Kandyan homegardens provide an expanded habitat for a wide range of species, from soil microlife to beneficial

Figure 2. Structure and composition of a typical Kandyan homegarden in Sri Lanka

insects, including pollinators, and from crops and trees to mammals, birds and other wildlife. In addition, they also provide a vital refuge for native flora and fauna (NARESA, 1991; Pushpakumara, 2000).

The high biodiversity of Kandyan homegardens are mainly due to availability of a variety of habitat niches in over-storey, under-storey and ground layers. Rotting logs, leaf litter, scrubs, presence of various levels of shade, conservation of and storage of water and interconnected homegardens which occupy a large area, are mainly attributed to the high level of niche specialization found therein. One advantage claimed by Kandyan homegardens is that it can bring into land use systems some biodiversity benefits associated with natural forests which are often refuges for pollinators, insects and birds which perform important biological control functions. Thus, most conservation programs in Sri Lanka now include homegardens as a component. However, Kandyan homegardens should not be considered as a replacement for the conservation of native tropical forests. The author is of the opinion that they can play an important role in the *ex situ* conservation of germplasm selected by farmers over generations providing field gene banks. Kandyan homegardens are typical examples for the conservation of trees, crops, herbs and other species, including livestock, through their sustainable utilization.

It is suggested that the bird and soil fauna associated with Kandyan homegardens is large and comparable to adjoining natural forests (Senanayake, 1987). Kandyan homegardens shelter small mammals, birds, bats, and insects which play an essential role in biological processes such as pollination, natural hybridization, and seed and fruit dispersal. The presence of a high level of fruit tree diversity, various niche specialization, feeding materials, nest specialization and very low level of disturbances

have been attributed as the reason for high level of faunal diversity in Kandyan homegardens. Twelve mammal species belonging to five orders and seven families have been recorded in Kandyan homegardens in association with fruit trees (Hitinayake and Ekanayake, 1999). A total of 35 birds belonging to five orders and 14 families have also been observed in Kandyan homegardens, including five endemic species (Hitinayake and Ekanayake, 1999) whereas Gunawardena (1998) recorded 53 bird species in Kandyan homegardens, including eight endemic species of which some species are rare. Twenty species of butterflies belonging to four families have also recorded in Kandyan homegardens by Hitinayake and Ekanayake (1999) whereas 29 butterfly species have been observed by Gunawardena (1998), including endangered species. Thus, Kandyan homegardens are considered as good sites for bird watching and observation of butterflies.

3.4 Kandyan homegardens and environmental conservation

The contribution of Kandyan homegardens to sustainable management of land has been widely studied, in particular to combat widespread land degradation including soil erosion, soil structural degradation and acidification. Kandyan homegardens provide environmental conservation such as protection of natural forests, increased multi-layered vegetation cover leading to pleasant living environment, erosion and pollution control and fertility replenishment, in addition to food and nutritional security and biodiversity conservation. Kandyan homegardens also provide cultural identity since traditional systems based on indigenous knowledge and species are part of the cultural patterns of the community. Further, it is generally suggested that trees have a positive effect on the global carbon balance, by means of carbon sequestration. The practice of Kandyan homegardens are also helpful in preventing fires, as the lower vegetation, where fires usually take place, is controlled in Kandyan homegardens.

Figure 3. Agroforestry raises tree cover to 50 per cent in this landscape where natural forest cover is less than 10 per cent

In Sri Lanka, the contribution of homegardens to the supply of timber and fuelwood to meet the domestic and industrial needs has been well-recognized (FSMP, 1995; Jacob and Alles, 1987; McConnell and Dharmapala, 1973). Homegardens and other forms of agro forestry systems supply over 50 per cent of national timber and 80 per cent of the fuelwood needs. Since natural forestry will continue to be allocated predominantly for the protection of biodiversity and watersheds, agroforestry particularly homegardens, rubber, coconut and forest plantation will continue to be relied up on to supply fuelwood and timber. The recent projections indicate that non-forestland provides about 73 per cent of the total sawlog demand of the country, of which 48 percent comes from homegardens (Gunathilake, 1974). Further, over 80 per cent of the total biomass fuel demand of the country can be met by non-forestlands, of which 38 percent are from homegardens. Nearly 62 per cent of Kandyan homegarden owners dependsolely on their homegardens for fuelwood (Perera and Rajapaksha, 1991). Those examples suggest that homegardens are the most important single source of timber and fuelwood amongst the non-forestlands (Gunathilake, 1994). Thus, Kandyan homegardens prevent the forests from deforestation by providing forest products. Among the under-utilized Kandyan homegardens, timber may be the most promising commodity for the future.

Forest cover in Sri Lanka has declined from 70 per cent at the beginning of the country to 44 percent in 1956. Forty years later, 1997, the forest cover was only 21 per cent (IUCN, 2007). Despite all efforts both by the government and the non-governmental organizations, deforestation continues to threaten us. The present estimates indicate a further decline up to 17 per cent in the year 2020 (FSMP, 1995). The consequences of deforestations are serious and well-known.

Natural forest cover in Kandy District is only about 17 per cent of the total land area, which is below the national average (21 per cent). However, the vegetation cover of the area excluding natural forests is about 31 per cent due to the presence of well-connected Kandyan homegardens. Thus, natural forests together with homegardens provide almost 47 percent of vegetation cover to the Kandy area, which is a high value in terms of associated environmental benefits of perennial crops in the area (figure 2).

Human health is directly linked to and dependent on the state of health of the ecosystems that support them. A wide range of economic and biographical

factors affect human health. Kandyan homegardens around homes in highly populated areas create healthy, comfortable, attractive and pleasant micro climate conditions. This is very important since the Kandyan homegarden is a place where children play and people meet. Plants, mainly ornamental species create an atmosphere appropriate for the relaxation of household members. Pollution is minimized in Kandyan homegardens due to the application of low level of chemical fertilizer and avoiding the use of pesticides, which in turn, increases the amenity and aesthetic value of the system. Thus, spending a few hours per day in a Kandyan homegarden can add more years to one's life and help in overcoming stress. Therefore, it is a very important site for tranquillity of the human mind, since it does not have the hot humid climate and the polluted air associated with urban areas. Hot humid climate and pollution have been identified as some of the salient factors for over exertion, fatigue and depression (Pilapitiya, 1994). Thus, the management of homegardens is a cost-effective strategy to improve human health. Further, interconnected Kandyan homegardens which occupy a large area increase the aesthetic value of the landscape.

Further, many Kandyan homegardens are attractive places for tourists. This aspect is exploited in Tourist Kandyan homegardens and Spice Gardens where the owners introduce tourists to plants and their products which include species, local herbal drinks, medicinal plants and related treatments which are popular among visitors (Nanayakkara, 1994) (figure 3). This is an example of the ability of local people to respond to business opportunities by using traditional tree growing customs.

Soil erosion and land degradation are widespread in Sri Lanka and occur in all climatic zones at different intensities. However, soil erosion is more acute in many parts of the wet zone, especially in the mid and upper country where slopes are often very steep with high population density (NEAP, 1999). Soil erosion in the hilly watersheds not only harms local crops and leads to abandoned land, costly investments in fertilizer application, but also reduces power generation and irrigation capacities by reducing water storage capacity through the deposition of silt. The major causes of soil erosion in the wet zone, mid and up country are the cultivation of crops on steep slopes without any conservation measures, inappropriate land use systems and soil and water management practices, deforestation and mining activities. The process of degradation is further aggravated due to increasing human and livestock population which reduce the land to man ratio. Thus, to reduce

Figure 4. Spice gardens – commercial Kandyan homegardens

the soil erosion in the area, proper land use planning and policy decision with desirable land management systems are required. Studies for specific sites indicate that soil erosion is minimal (only 0.05 tonnes per hectare) in Kandyan homegardens under deferent slopes and comparable to the value obtained for natural forests (FSMP, 1995; Krishnarjah, 1982). This suggests that Kandyan homegarden is one of the best land management systems to minimize soil erosion.

The multi-strata canopy of Kandyan homegardens protects the soil from the direct impact of the rain. Their dense mixed vegetation, ground cover and accumulated litter layer reduce water runoff and control soil erosion. It is also reported that practicing of Kandyan homegardens leads to improvement of soil physical and chemical properties with rehabilitation of degraded sites (Nissanka *et al.*, 2000). The presence of Kandyan homegardens has a significant advantage because the Kandy district is one of the most important water catchments in Sri Lanka.

4. Future implications and link to *Satoyama* Initiative

Substantial threats exist to the biodiversity, both wild and cultivated, of Kandyan homegardens. Urbanization and population increase, coupled with development strategies that do not internalize the economic value of the biodiversity they contain or the ecosystem services they provide, have had a significant impact on homegardens. Additionally, unplanned land use, pollution and fragmentation contribute to loss of agricultural biodiversity. A growing number of medicinal plants are becoming increasingly rare and under threat of extinction; currently around 80 wild plant species with medicinal properties are considered threatened, largely as a result of the growing demand. The traditional homegardens have been a repository for agricultural biodiversity for thousands of years. Climate change consideration is also important because it not only represents a

significant additional threat to the landscapes which the homegardens occupy but, it will also require a substantially increased use of agricultural biodiversity to maintain resilience and adaptability in agro-ecosystems. Strengthening and enhancing the Kandyan homegarden systems in the coming years so that they continue to provide quality ecological habitats and other social and economic functions, and connect wild and other cultivated habitats, will be important for the future adaptation of this globally important landscape.

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Village small tank system: An integrated landscape for adaptation to a changing climate

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1. Introduction

Sri Lanka is covered with an irrigation network of thousands of man-made lakes and ponds, traditionally known as 'tanks' (after '*tanque*', the Portuguese word for 'reservoir', also known as '*wewas*'). Sri Lanka's heritage of irrigation consists of two main traditions. The 'Greater Tradition' or the *Mahasammatha* follows the construction and management of thousands of village small tanks systems; and the 'Lesser Tradition or the '*Chulasammatha*' follows the construction and management of large storage reservoirs and canal complexes. The small tank system has historically contributed to village food security, livelihoods and environmental and biodiversity protection as well as community cohesion and well-being, and most likely developed as an adaptation to patterns of rainfall. Collectively the tanks form a series of water bodies along small water courses in a cascading system. They have been constructed to ensure water is managed efficiently and to deal with the vagaries of irregular rainfall. It is believed there are about 12,500 small tanks scattered throughout the dry zone and reports indicate that they have an irrigation potential of about 100,000 hectares (Gunasena, 2000)

An even greater number of households and farms are intertwined within and dependent on small tank systems creating a mosaic of wild, cultivated and settled landscapes. In fact it is believed that rural settlements evolved close to tank reservoirs, which became the focus for structuring the community and for evolving traditions and codes of conduct, to safeguard the natural resources in the vicinity of habitations. Some tanks are functional while others remain abandoned and there are many social, economic, environmental and physical reasons for this. Several of these tank systems are thousands of years old and almost all show a high degree of sophistication in their engineering, construction and design.

The small tank system consists of an organised series of reservoirs which increase in size in the direction of the water flow down a valley, the water being trapped in reservoirs created by constructed earthen bunds. The initial tank in the sequence is usually rain-fed. The rain received by the upper catchment of this tank is captured and reserved. Water from this tank is fed through a network of channels to cropping areas below, through rice fields to homegardens and through subsequent tanks. This connected series of tanks and system of water flow is often referred to as the 'Cascade System' and is considered an important indigenous land and water management system with considerable potential for rehabilitation to deal with expected increased drought as a result of a changing climate. It was developed as a result of rigorous field testing of indigenous knowledge and is considered a unique system of rainwater harvesting. This type of tank system captured all or most of the rainwater received in the area during the short season of "*Maha*" rains (*Maha* is the main rainy season of the dry zone of Sri Lanka and it brings heavy rains from the North-East monsoons to the dry zone during a short spell from November to February.) In addition to ensuring the supply of irrigation water to crop fields, these tanks help maintain the moisture content in the soil during the dry season through infiltration. Furthermore, during dry periods, these tanks are often the only source of water for livestock and wild animals; they also maintain a considerable

Basawakkulama wewa (Abaya Wewa Ancient Reservoir)

diversity of wild flora in addition to agrobiodiversity. In fact many small tank systems are home to a rich and unique biodiversity. The water supply to these tanks are from rainfall and catchment runoff, hence the total annual rainfall determines the tank water supply. The tank density also influences water supply to the small tanks. Rainfed and irrigated cropping in the dry zone are being gradually transformed due to the settlements and cultivation of cash crops.

2. Diversity of small tank types

Several different types of tanks can be distinguished each filling a particular niche and function, some of which had nothing to do with irrigation per se but all of which had a critical role to play in the overall practice of irrigation agriculture. It was, for example, traditional to build a *forest tank* (*Kulu Wewas*) which was constructed in the upper catchment of the village tank. This tank, however, was rarely used to actually irrigate land and instead its express purpose was to provide water for wild animals in order, to reduce the likelihood that they would descend into downstream farms and destroy the crops or interfere with agricultural activities in search for water, filter the debris and silt of water flowing through the catchment before entering the village tank (This is important to avoid siltation of the village tank) and capture the rainwater within the catchment in order to feed the village tank through seepage during the dry spells.

The second type of tank was the *mountain tank*, which were built to provide water for '*chena*', or slash-and-burn agriculture. *Chena* cultivation is a traditional practice, in which land was never over used or repeatedly cultivated season after season and year after year. Land was left to rest and covered again with plants and leaves to enable it to accumulate vegetable manure. Mixed crop cultivation in *chena* lands enabled leguminous crops to restore nitrogen in the soil for other food plants. Knowledge of when to expect long or short rainy seasons enabled farmers to plan appropriately which crop was suited for a particular season. Further, traditional indigenous knowledge of farmers on soils and pest control and their relationships with water management enabled the people to mix the different crops and decide the planting time of selected crops. In *chenas* they mainly use annual crops. Erosion control tanks, or '*pota wetiye*', were designed so that any silt was deposited before entering the main water storage tanks. Several erosion control tanks were associated with each village irrigation system. All were built in such a way that they could easily be de-silted.

The fourth type of tank was the *storage tank*. Traditionally there were two storage tanks; one was in use whilst the other was being repaired or maintained. For that reason, such tanks were known as 'twin tanks'. These tanks were in turn connected to a large number of *village tanks*, of which there was one for each village that depended upon a particular irrigation system.

It was recently discovered that over 80 per cent of the small tanks were organized as cascading systems within micro- and meso- catchments. 'Tank Cascade Systems' - an ancient, small-scale but widespread traditional irrigation technology is observed in the Dry Zone of Sri Lanka and during the wet season tanks provided water for farming, largely rice cultivation. Facilitation of irrigation water over long distances needed efficient control over distribution and allocation between the upstream and downstream users of the system. Smooth functioning of all hydraulic structures required efficient maintenance. Irrigation depending on micro-catchments required careful watershed management to reduce sedimentation and ensure catchment water yields (Gunasena, 2000). Organization of small tanks into a cascading sequence within micro-catchments allowed greater efficiencies in water use. Drainage from the paddy fields in the upper part of the cascade flowed into a downstream tank for reuse in the paddy fields below. System management required community effort, coordination social harmony among upstream and downstream farmers. A breach in the upper-most tank bund through neglect or excess water would threaten the collapse of the entire sequence of tanks below. Similarly, if the capacity of a tank was increased arbitrarily by one village raising the bund or the spillway, it could inundate the lowermost paddy fields in an upstream village. Interdependency between villages in a cascade required well coordinated local management of land and water resources. Land ownership of the paddy tract is distributed among villagers in a manner so that each farmer could have similar access and right to the irrigation water. Decentralised decision making on cultivation of a portion of paddy tract sharing proportionately among farmers in water shortage seasons is a good example of social unity and cohesion and recongnition and management of a common resource(Dharmasena, 1994). This arrangement is called "*Bethma*" method of sharing natural resources which is a unique feature of village small tank system (Senanayake, 2006).

A socio-economic survey of over 400 small tanks in the *Kala Oya* Basin dry zone area, where about 400,000 people are engaged in farming highlighted they are used for cultivation of rice and other crops (valued per total inundated tank area of 216-39 American dollars per hectare per year for individual

crops) and watering of livestock (335 American dollars per hectare per year) as well as domestic uses by provision of water for bathing, washing of clothes and general household water supplies (1469 American dollars per hectare per year). Additional valued services included fish for consumption (351 American dollars per hectare per year), religiously important lotus flowers for use in temples and rituals (72 American dollars per hectare per year), lotus roots and other wild edible foods (107 American dollars per hectare per year). Non-valued ecosystems services were determined as hydrological functions, nutrient retention and purification. Collectively it was estimated that these uses and services amounted to an average value of American dollars 425 per household with the benefits most significant for poorer households (Vidnage and Kallesoe, 2004).

Typically the small tank system maintained three distinct types of land use – paddy field, *chena* and homegardens. These tanks not only support the irrigation needs of farming households but a variety of other uses including drinking, bathing, cooking and fishing. The tanks and the paddy fields occupied the valleys, where low humic gley soils with poor drainage had limited use other than for bunded paddy cultivation. The either side of the village tank located in the middle area between the ridge tops and valley bottoms was used for rain-fed *chena* farming, where reddish brown earths proved ideal for many subsidiary seasonal food crops. Although in the modern context, *chena* cultivation has potential to wastes resources, in Sri Lanka's early history long fallow periods were practical and allowed vegetative and soil regeneration, and use was sufficiently infrequent to avoid serious soil erosion and environmental damage. Moreover, village farmers spared large trees to provide shade and places for watch-huts. Small trees were lopped at breast height to enable them to sprout again at the end of the rainy season. Even during the Dutch period, introduction of cinnamon in *chena* lands was apparently undertaken to enrich forest with cinnamon trees rather than to grow it as a monoculture. Close to the valley bottoms polycultural home gardens were constructed containing multiple-use plant species that supplied many of the needs of villagers. Around the hamlets and home gardens in between the forest and the hamlets a cleared area in maintained to minimize the threats from wild animals. In this area only large trees are allowed to grow, all the undercover is cleared by means of free range grazing of cattle. The villagers use this area as a common place for their social, sport and other cultural and religious activities. Therefore, this area is named as "*tis bambe*" (common ground).

3. Threats to the existence of the small tank systems

In recent years it is felt that land clearance due to shifting cultivation and development activities have contributed significantly to a drastic decline in forest cover in the catchment areas of small tank systems which have impacted on the quality of soils and a general decline of viable villages and settlements and a large number no longer have an adequate catchment area. Further, many are located far from settlemeets or are isolated in nature reserves and lack approach roads. Such factors lead to the abandonment of tanks and the fact that they may become economically non-viable. The other main threats to this system are use of chemical agricultural practices, farm mechanization, shifting of farmers from food crops to cash crops etc.

The main constraint to the development of small tanks has been changes that took place from their traditional management, which overlooked the beneficiaries, the farmers. The management system has been changing over the years with little regard to the farmers living under the minor irrigation schemes or the villagers were tanks are so important. The attempt to improve the cropping under these tanks have largely been unsuccessful due to insufficient storage, lack of labour and marketing facilities. However small tanks are highly relevant to the rural development programmes, considering their agricultural, socio-economic, environmental benefits, nutrition and food security. Under these programmes modernizing the agricultural production systems within a cascade will have expanded potential ensuring their economic, social and environmental sustainability (Gunasena, 2000).

4. Current Relevance

The current relevance of restoring the ancient cascade irrigation technology is seen in view of adverse impacts of global climate change and the possible

Ancient village tank in intermediate zone

increase incidence of extreme climatic events such as droughts and floods. In the context of increasing drought or flood, improvement of the tank cascade systems may prove beneficial in view of its time-tested and known buffering capacities such as bio diversity, crop diversity, sustainability and soil and moisture conservation. At present in the areas of cascade systems, there is a higher prevalence of poverty and as a consequence some out-migration from the affected rural areas to cities. These tendencies may be checked to some extent through enhancing the potential for improving productivity through rehabilitation of the tank systems. Further, the higher prevalence of malnutrition among rural communities could also be mitigated through improved tank fishing and animal husbandry allowing for and promoting greater dietary diversity to combat known micronutrient and macronutrient deficiencies among the poorer members of society in tank areas. Reintroduction of organic farming which prevailed over 2500 years in this country in village small tank systems will open up new niche markets enhancing the economic status of village farmers. However, health issues related to drinking water, eating tank-fish contaminated by agrochemicals (e.g. Cadmium) received by tanks, including kidney failure and malaria would have to be addressed, monitored and remedied. This problem could be resolved by reintroduction of eco-friendly organic farming practices. The ecological issues related to the clearance of village forests and unsustainable land use may be addressed through better planning based on the tank cascade system principle. The break-down of old social order (cohesion, kinship, leadership, norms and values) may not be easily restored and such social capital was critical for the ongoing management and maintenance of the tank system. However, the situation may be improved with innovative approaches learned through careful study of traditional social structure that are conducive to the modern age in which we live. In the place of traditional institutional arrangements new robust but flexible structures would have to be nurtured and which could match the historical village based management approaches.

5. Conclusions

The land use associated with tank cascades demonstrated a profound knowledge of resource management in a challenging environment essentially transformed from natural ecosystems into agro-ecosystems. Integrated land and water resources management in ancient times is reflected in the zonation of land use within the micro-catchments. Cascading tank systems have fulfilled a multitude of roles and functions including: operating as an ideal indigenous rainwater harvesting technology; a soil moisture and groundwater maintaining technology; a soil erosion and siltation control technology; a system that ensured the maintenance of ecological balance, linking the wild and cultivated; a system that promoted social cohesion and harmony, community leadership and general social capital; a system that accommodated spiritual development and which promoted egalitarian attitudes, a system that allowed communities to adapt when seasons were difficult during droughts; a system that nurtured the development of drought insurance through crop diversification, animal husbandry and fragmented land ownership; and that provided opportunities for inland fishing and enhanced human and animal nutrition. Such a multifunctional traditional irrigation system is surely worthy of studying, preservation, enhancement and popularization especially as a system highly relevant to future drought management and adaptation in a changing climate.

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The *owita* agroecosystem

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1. Study Area

The *owita* agroecosystem is a unique peri-urban land use system with specific soil type found between the rice paddies and the uplands of the wet zone of Sri Lanka. Plots are usually about a quarter to a half-acre in size and are owned by subsistence farmers in villages, mainly in the Colombo (south of Colombo city), Kalutara and Galle districts of the country. The *owita* characteristically has a high ground water level throughout the year and there is always a shallow perennial stream flowing through it or alongside. These land lots are used to grow a mixture of crops, which are used to ensure the food security of households (figure 1). The *owita* system is an integral part of the village land use system and livelihoods, consisting of paddy farming and home garden cultivation.

The *owita* system described in this case study is found in the Western Province of Sri Lanka, in a village named Jamburaliya, which is located about 20 kilometres southeast of Colombo near the southern border of Colombo district. This village is close to the north of the suburban town Piliyandala as shown in the map below.

The population density of the three districts where *owita* systems are found is highest among the districts in Sri Lanka being: 3304 per square kilometre, 673 per square kilometre and 613 per square kilometre for Colombo, Kalutara and Galle respectively. The population growth is 1.1 to 1.5 per year in Colombo and Kalutara districts and 0.6 to1.0 per cent in Galle district. The majority of the inhabitants in all three districts are Sinhala Buddhists while considerable numbers of Sinhala Catholics, Muslims and Tamils (Hindus/Catholics) are also found in all three districts.

Areas under the agro-ecological sub regions where the *owita* system is found have been predominantly inhabited by lower middle class people and peasants. Even the lower middle class households, where at least one of the family members usually held government employment, maintained an *owita* to supplement their food requirements. Peasants used *owita* to earn their living partially, in addition to supplementing their daily food requirement. The lower middle class usually had small plantations of rubber coconut or cinnamon for their livelihood and the peasants worked in these plantations to earn their living.

While all the modern comforts are found in the major cities and their suburbs in the region, traditionally there was no state-provided water supply or electricity in the village areas. Inhabitants used to draw drinking water from shallow wells characteristic of each family's land lot, which were located at a higher elevation than *owita*. Water for bathing and washing usually came from communal wells located close to the *owita*. Recycling of organic waste is still the norm in these areas as most of the land lots are spacious enough for such purpose. In every village or close-by, a traditional medical practitioner was available (usually an ayurvedic doctor) and education was provided through the temple and state schools. Most of the medicinal plants prescribed by traditional doctors were also found in the ecosystem. The *owita* system to a certain degree contributed to social and community cohesion, however, population pressure is forcing the system to decline.

2. Natural Environment

Traditionally Sri Lanka is divided into three major climatic zones based on rainfall distribution: a wet zone, dry zone and intermediate zone. The wet zone receives a mean annual rainfall of over 2500 millimetres without any prominent dry periods. In the low country wet zone of Sri Lanka there are five agro-ecological sub regions. The *owita* system is mainly found in sub-regions where rubber, coconut, cinnamon and mixed home gardens and paddy cultivation predominate land use systems. The terrain is rolling and hilly and major soil groups are red yellow podzolic soils and low humic gley soils. The annual rainfall is more than 2,200 millimetres. Five land

Perennial water stream along side *owita* and different crops found in a *owita*

use forms can be found in the agro-ecosystems and include: 1. Paddy fields; 2. *Owita* system; 3. Home gardens; 4. Small plantations of rubber, coconut or cinnamon, and 5. Forest areas or shrubland. All cultivation in this system is rain-fed and the forests and plantations usually sustain the water supply in the system throughout the year (figure 2). The forest areas are just remnants of the natural forest which once covered the region.

The relatively higher areas of undulating lands found in this system are planted with rubber or cinnamon plantations while the spacious home gardens located slightly lower level are planted with coconut, jack, bread fruit, mango and other fruit trees. The valley consists of paddy fields running towards a lake and the *owita* is located between the home gardens and paddy fields. Paddy cultivation follows two seasons a year and the *owita* are cultivated throughout to supplement the families' diet.

3. Biodiversity

The wet zone of Sri Lanka has the highest biodiversity in the country. Although rubber and cinnamon plantations have reduced biological diversity since their introduction, the forest remnants and the system as a whole still harbours substantial biological diversity. Most importantly, a unique agro-biodiversity, although threatened, still remains in the system.

The perennial stream, originating from communal wells for bathing and washing purpose, runs through *owita* and rice paddies and harbours unique freshwater fauna and flora. Using temporary obstructions across these streams, a water supply system was created throughout the *owita* land. In addition, temporary reservoirs were used to soak dried coconut leaves to make them un-brittle and suitable for weaving into mats. These coconut leaf mats were used for roofing, walls and even covering *owita* for protection. These temporary obstructions across the streams were usually broken periodically to prevent sedimentation and maintain clean water flow.

It is typical to find the following plants in most *owita* systems; 1. A 'puwak aramba' (few trees of Areca nut, *Areca catechu*), 2. Bulath kotuwa (Betel, *Piper betle* vines section), 3. Pan wila (*Cyperus corymbosus*), 4. Kohila kotuwa (*Lassia spinosa*) 5. Few clumps of banana (very short Cavendish type variety call 'Bin kesel'), 6. Katurumurunga tree (*Sesbania grandiflora*) and 7. Clump of sugar cane. Main categories of crops cultivated in owita includes root and tubers [taro (*Xanthosoma sagittifolium*), innala (*Plectranthus rotundifolius*), yams (*Dioscorea*), sweet potato], leafy vegetables [Mukunuwenna (*Alternanthera sessilis*), Tampala (*Amaranthus dubinus*), Kohila, Katurumurunga], low country vegetables (Okra (*Abelmoschus esculentus*), Brinjal (*Solanum melongena*), Labu (*Lagenaria sciceraria*), Cucumber (*Cucumis sativus*), Bitter gourd (*Momordica charantia*), yardlong beans (*Vigna sesquipedalis*)], banana (var. Bin kesel, Ash plantain and Ambul).

Rice paddies in this system used to be cultivated with traditional rice varieties specifically adapted for the conditions prevailing in the area. In addition, rice-associated flora consisted of a variety of medicinal plants like Lunu-wila (*Bacopa monnieri*), Neera mulli (*Hygrophila schulli*) and Kikirindi (*Eclipta prostrata*).

4. Crop production

The whole family participates in owita cultivation. Farmers attend more during slack periods of paddy cultivation. Most of the activities are during the afternoon starting around 3.00 pm when the entire family has free time after attending to other day to day work. The cultivation takes place in such a way that every time after attending to owita work, some ingredient for the day's meal is collected from owita. Cash crops like betel leaves, root and tubers and extra produce are periodically sold in the local market or to produce collectors, or shared with neighbours.

There are no estimates on production from the *owita* system but it is safe to assume that most of the betel leaves produced in Sri Lanka for local consumption and export still come from *owita* systems. This system has been neglected since Sri Lanka started adopting a free market economy. However, the government's present encouragement of local food production has revived cultivation in this area and provided an opportunity to revive *owita* practice. In particular, the paddy fields have already been cultivated but *owita* are still neglected. The Department of Agriculture and Ministry of Environment and Natural Resources of Sri Lanka have proposed a new project to study the *owita* system in detail and con-

***Owita* landscape**

serve the traditional knowledge and local varieties found in the system *in-situ.*

5. Land utilization and Natural Resource management

Of the five land use forms mentioned above, Paddy fields and *Owita* are found in the low-lying areas of the system consisting of low humic gley soils while the other three forms, home gardens; small plantations of rubber, coconut or cinnamon; and forest areas or shrub lands, are found in red yellow podzolic soils. The red yellow podzolic soils effectively filtered the rainwater into the ground and tapping of the shallow water table for clean drinking water was the norm for people in the area. In addition people extracted from the system, food including freshwater fish, fuel wood, medicinal plants and building material.

Owita received very little external input for production. Nutrient recycling occurs through the utilization of cow and manure for cultivation. Other traditional practices adopted in the system include the use of plants such as Keppetiya (*Croton aromaticus*) for crop disease control, Godapara (*Dillenia retusa*) and Weraniya for the preparation of trellises for betel vines, and Beli-patta (*Hibiscus tiliaceus*) for the preparation of durable cords.

Hitherto, the *owita* remains a neglected but unique and sustainable system that can be revived to improve the livelihood of people in these areas. It is necessary to conduct further studies to gather more detailed and scientific information on the *owita* system to utilize this sustainable system to improve human well-being in peri-urban areas.

Land use and natural resource utilization and management in Kampong Cham, Cambodia

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1. Introduction

Agriculture plays an important role for sustainable land use and appropriate natural resource management in Cambodia, as more than 70 per cent of the total population is a farmer. Most Cambodian households depend on agriculture and its related sub-sectors, including livestock raising, fisheries and aquaculture, for their livelihood. Cambodian agriculture produces a wide variety of crops, however, paddy rice is the major crop.

An examination of the history of Cambodian agriculture shows the evolution of rice production, particularly in the last decade. Rapid development of agricultural technologies has significantly increased the amount of agricultural products. However, the majority of farmers have come to apply agricultural chemicals, such as chemical fertilizers, herbicides or pesticides to maintain high levels of crop yields. The overuse of agricultural chemicals has damaged many aspects of natural resources.

In Wat Chas village, Prey Chhor district, Kampong Cham province, an interview and questionnaire survey was conducted from 25 October to 3 November, 2009. The total 60 hectare area of Wat Chas village includes 48 hectares of rice fields, 5 hectares of vegetable orchards and 7 hectares of woodlands and settlements. The total population is 484 inhabitants and no school exists in the village. Most lowland farmers cultivate rice during the rainy season and keep the land bare after harvest. In upper lands, farmers are cultivating vegetables of qing geng cai (*Brassica rapa* var. *chinensis*), Chinese cabbage (*Brassica campestris*), mustard spinach (*Brassica rapa* var. *perviridis*) and Chinese celery (*Apium graveolens*). Farming systems dependent on synthetic chemicals, deforestation, mono-cropping and plant residue burning have been pointed out as non-sustainable. Regarding the practice of plant residue burning, it has been carried out by farmers in Wat Chas village because it is a very cheap and easy way to clear residues and to prepare for the next cultivation. However, the heat from burning kills various beneficial microorganisms and soil organisms. The nutrient components in plant residues are also lost through burning. Attention has therefore been focused on achieving sustainable land use and appropriate natural resource management.

The forest land in Wat Chas village has decreased due to the human activities in the last 40 years, since the civil war. In particular, during the period of Khmer rouge from 1975 to 1979, people were forced to move from cities to rural or remote areas in order to construct water reservoirs, irrigation systems and clear the forest for agricultural purpose. Much of the biodiversity and many ecosystems were destroyed in large areas, including the area of Wat Chas village or its surroundings. Presently, small areas of woodlands were left around the dwellings. Most trees such as neem, coconut, palm, mango, jack fruit, rubber or bamboo in the small woodlands are available for villagers and provide benefits. Additionally, some species of trees or herbs were re-planted around the dwellings.

2. Utilization/management of land and natural resources

Land use in Wat Chas village can be divided into three types: residential land, paddy field and upland field for vegetable cultivation (figure 1). The main natural resources can be seen in the diversity of plants.

The dwellings in residential land are surrounded with small woodlands or home gardens, in which there are many varieties of plants, including ones that are edible or used in cooking. Also, small upland fields for vegetable cultivation existing in small

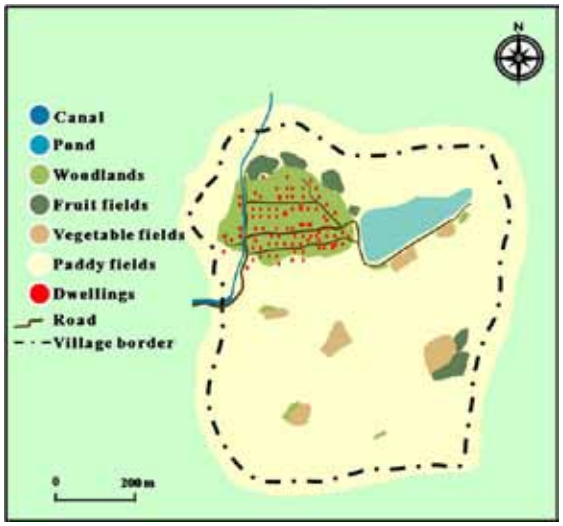

Figure 1. Land use map in Wat Chas village

Figure 2. Farmer collecting rice straw for composting

Figure 3. Compost box filled with plant residues

mounds in paddy fields constitute a typical landscape of Wat Chas village, although the flat land is covered with paddy fields. In addition, the natural forests can provide the villagers many beneficial things such as firewood, wood for construction, foods and herbs for medicine.

Another important natural resource is organic fertilizer. In Wat Chas village, 74 per cent of villagers work full-time in agriculture, especially in rice and vegetable production, and 93 per cent of farmers apply chemical fertilizers at a yearly average rate of 227 kilograms per hectare. Agricultural chemicals, such as chemical fertilizers, herbicides or pesticides, have had negative impacts on the natural environment, the health of farmers and economic viability (the economic viability has decreased as farmers have had to make large expenditures on agricultural chemicals).

Organic fertilizers, such as compost or farmyard manure, have also been applied. Farmyard manure is available year-round for application to agricultural fields, because 91 per cent of households breed cattle.

The scientific results from many studies (Allaire, 2004, Evanylo *et al.*, 2008, Elmaz *et al.*, 2004 and Pinamonti, 1998) have shown that composting is one way to recycle natural resource waste, and it can easily be applied by farmers. For these reasons, composting technique has been introduced to the farmers in Wat Chas village in hope that it will contribute to decreasing the use of burning practices and the expenses spent on chemical fertilizers. Compost, a kind of organic fertilizer made from plant residues and farmyard manure, is an effective material for improving the physical and chemical properties of soils. It helps increase soil organic matter, enhance aggregation and conserve soil moisture. As the materials for composting, such as plant residues, weeds or farmyard manures, can be found in and around the village (figure 2), 65 per cent of the households are composting with 24 compost boxes in Wat Chas village (figure 3). One compost box can produce 4.8 cubic meters of compost as box size is on average 1.6 meters by 3 meters by 1 meter (width*length*height).

Dwellings in residential land are surrounded by small woodlands or home gardens. Figure 4 shows the landscape of the dwellings, and all plants in it are summarized in table 1.

Even in paddy fields, trees and small upland fields for vegetable cultivation were observed in Wat Chas village. Figure 6 and table 2 show the landscape of trees and small upland fields for vegetable cultivation in paddy fields. Although the landscape in the village looks flat and less undulating, the villagers mound soil in paddy fields. The mounds are used to grow vegetables, which cannot grow under shallow groundwater table or flooded conditions.

Moreover, some upland fields are suitable to grow vegetables in Wat Chas village. There are four farmers conducting the multi-cropping; recently they converted their farming system from mono-cropping to multi-cropping (figure 5). Multi-cropping is the practice of growing two or more crops in the same space during a single growing season. It has

Figure 5. Multi-cropping field

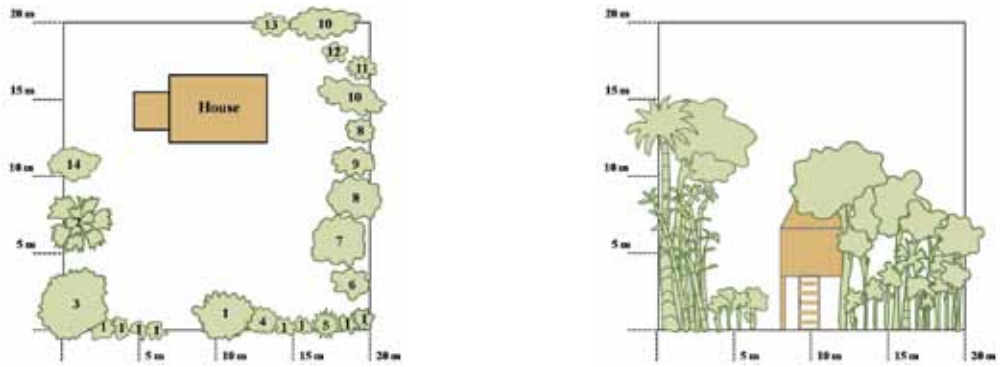

Figure 4. Top and side views of dwellings in Wat Chas village

Table 1. Plants found in dwellings (numbers correspond to those in figure 4)

No.	Name of plant	Utilization
1	*Combretum quadrangular* (COMBRETACEAE)	Construction, Firewood, Others
2	Palmyra palm: *Borassus flabellifer* (PALMAE)	Food, Construction, Firewood, Others
3	Bamboo : *Bambusa* sp. (GRAMINEAE)	Food, Construction, Firewood
4	*Bombax anceps* (BOMBACEAE)	Others
5	Papaya: *Carica papaya* (CARICACEAE)	Food
6	Hose-radish tree: *Moringa oleifera* (MORINGACEAE)	Food, Medicine
7	Mango : *Mangifera indica* (ANACADIACEAE)	Food
8	Jack fruit : *Artocarpus heterophyllus* (MORACEAE)	Food
9	Guava : *Psidium guajava* (MYRTACEAE)	Food
10	Banana: *Musa* sp. (MUSACEAE)	Food, Bio-pesticide
11	Star gooseberry : *Phyllanthus acidus* (EUPHORBIACEAE)	Food
12	*Feroniela lucida* (RUTACEAE)	Food
13	*Leucaena leucocephalade* (LEGUMINOSAE)	Food, Firewood
14	Unknown tree	-

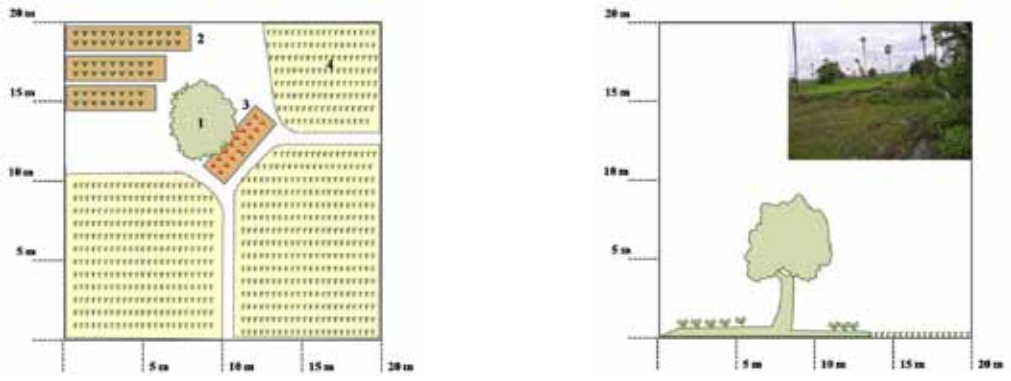

Figure 6. Top and side views of small upland field in paddy field in Wat Chas village

Table 2. Plants found in small upland field in paddy field (numbers correspond to those in figure 6)

No.	Name of plant	Utilization
1	Mango: *Mangifera indica* (ANACADIACEAE)	Food
2	Mung bean: *Vigna radiata* (LEGUMINOSAE)	Food
3	Chinese cabbage; *Brassica pekinensis* (CRUCIFERAE)	Food
4	Rice: *Oryza sativa* (GRAMINEAE)	Food

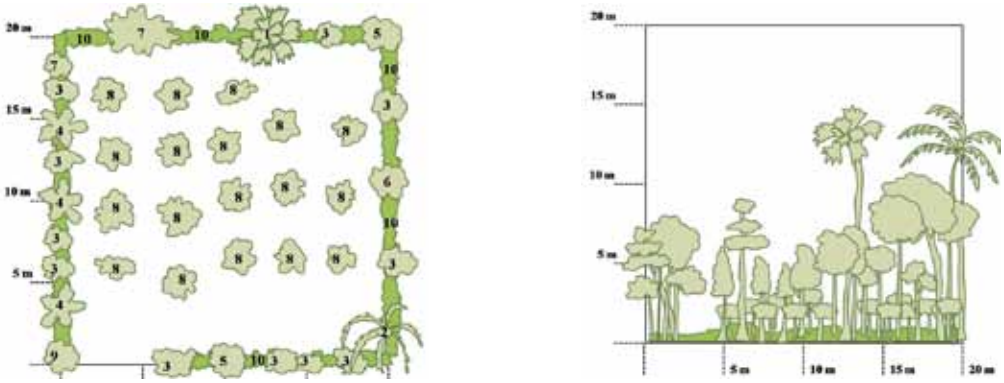

Figure 7. Top and side views of multi-cropping field in Wat Chas village

Table 3. Plants found in multi-cropping field (numbers correspond to those in figure 7)

No.	Name of plant	Utilization
1	Palmyra palm: *Borassus flabellifer* (PALMAE)	Food, Construction, Firewood, Others
2	Coconut: *Cocos nucifera* (PALMAE)	Food,
3	*Sesbania grandiflora* (LEGUMINOSAE)	Food, Firewood
4	White silk cotton tree: *Ceiba pentandra* (BOMBACACEAE)	Others
5	*Bombax anceps* (BOMBACEAE)	Construction, Firewood, Others
6	*Hymenodictyon exelsum* (RUTACEAE)	Construction, Firewood
7	*Leucaena leucocephalade* (LEGUMINOSAE)	Food, Firewood
8	Mango: *Mangifera indica* (ANACADIACEAE)	Food
9	*Erythrina stricta* (LEGUMINOSAE)	Others
10	Bellyache Bush: *Jatropha gossypitolia* (EUPHORBIACEAE)	Others

various styles of cropping, such as double-cropping, intercropping or relay cropping. It is an efficient way to use agricultural lands. Some of these systems provide year-round coverage of crop land, thus can reduce soil erosion and sustain humus topsoil. Multi-cropping systems increase the competitive edge of the cash crop and, in some cases, reduce the amount of herbicides required for weed control. The landscape of the multi-cropping field in Wat Chas village is summarized in figure 7 and table 3.

3. Conclusion

After the interview and questionnaire survey, and the workshop on the *Satoyama* Initiative on 4 November 2009 at Wat Chas village, the villagers decided to pay more attention to sustainable use and the management of natural resources, in particular to sustaining the variety of plants in woodlands around the dwellings.

At the moment in Wat Chas village, there are 24 compost boxes, 10 organic farms, and one commercial duck farm with 500 ducks. By engaging in various activities with respect to the sustainable use and management of natural resources, Wat Chas village will become a model case of sustainable agriculture of Cambodia.

This study was conducted as part of the program activities of the Satoyama Initiative, United Nations University Institute of Advanced Studies.

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Agroforestry homegardens in rural landscapes of Bangladesh

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1. Introduction

Agroforestry homegardens are age-old and traditional land use systems maintained by at least 20 million people throughout rural Bangladesh. In this farming system, deliberate planting and management of multipurpose trees and shrubs is followed in intimate association with annual and perennial agricultural crops and, invariably, livestock, within the compounds of individual houses, the whole crop-tree-animal unit being intensively managed by family labor. A wide array of outputs for a multitude of purposes, including fuel, shelter, structural materials, fruits and other foods, fodder, resins and medicines are produced throughout the year (Leuschner and Khaleque, 1987; Millat-E-Mustafa *et al*., 1996; Rahman *et al*., 2005). Usually homegardens occupy the highest flood-free land adjacent to the homestead. A typical homegarden consists of bare space, cultivated space, pond and agricultural land. Usually the cultivated space is located surrounding the house- in front of the house as a front yard and behind the house as a back yard.

Satoyama, on the other hand, is mostly understood as a concept and a widely accepted definition of *Satoyama* is still lacking. *Satoyama* is a Japanese term used to refer to agricultural woodland. Although there are structural differences between Japanese *satoyama* and tropical homegarden systems, many functional characteristics are common to both, as summarized by Kumar and Takeuchi (2009). *Satoyama* in a 'concrete' sense means coppice woodland, but in an 'abstract' sense refers to a landscape mosaic of agricultural land, settlement, water reservoirs, wildlife habitat and so on (Kumar and Takecuchi, 2009), and provides a wide array of provisioning (e.g. food, timber), regulating (e.g. carbon sequestration, flood control) and cultural (e.g. aesthetics) services. This 'abstract' sense creates an opportunity of overlapping ground between *satoyama* and homegarden agroforestry systems. Homegardens strictly may not be *satoyama* in terms of structure, but they are a '*Satoyama*-like' landuse from functional perspectives[1] in most cases.

[1]The homegardens of India, Thailand, Sri Lanka and Indonesia frequently came up as examples of *Satoyama*-like landscapes/landuses by several authors/participants during meetings and symposiums related to the International *Satoyama* Initiative (ISI) held in Tokyo, Nairobi, Kuala Lumpur and Kyoto.

This article summarizes the structural and functional characteristics of agroforestry homegarden systems of rural Bangladesh and discusses biodiversity conservation potential and ecosystem services offered. The article is based on a study carried out in the villages of Bangladesh's northern region, which is prone to moderate to severe drought due to long-term climate variability and change. Data collection methods included a semi-structured questionnaire survey, an inventory of species, interview with key informants, several focus groups, and informal discussions.

2. Regional overview

Bangladesh is a country of the south Asian subcontinent situated in the subtropics. The climate of Bangladesh is greatly influenced by the presence of the Himalayan mountain range in the north and the Bay of Bengal in the south. Climatically, Bangladesh is located in tropical and subtropical zones, influenced mainly by latitude. The hill region, being comparatively of low altitude, does not exhibit well-marked altitudinal zones. The mean annual rainfall varies from as low as 1500 millimetres in the western region to as high as 5000 millimetres in the northeast and eastern region. About 80 per cent of the rainfall in the country occurs during monsoons. The average temperature during summer is around 28 degrees Celsius, with a maximum of about 40 degrees Celsius. The average temperature during winter is around 18 degrees Celsius, with a minimum of 7 degrees Celsius. Although Bangladesh is predominantly a riverine country, droughts are not uncommon, and are seen to occur in a cycle of five to ten years

A typical homegarden in Bangladesh

especially in the northern and northwestern part of the country (BBS, 1994).

The total area of Bangladesh is approximately 14.40 million hectares, of which 12.46 million hectares are land surface and 0.94 million hectares are rivers and other inland water bodies. Among the landuse categories, agriculture accounts for about 64 per cent of the total land area and forest area, which includes classified and unclassified village woodlots and rubber gardens, accounts for 17.8 per cent of the country's land area (GOB, 1992).

One of the peculiarities of forest resources distribution of Bangladesh is that the resources are very eccentrically distributed. It will be surprising to learn that 28 out of 64 districts have no public forests at all (GOB, 1992) and more than 90 per cent of the government forests are concentrated within 12 districts in the east and southeastern region of the country. On the basis of geographical location, climate, topography and management principles, the forests of Bangladesh can broadly be classified into: hill forests, mangrove forests, plain land Sal forests, unclassified state forests, coastal forests and homestead forests (homegardens).

3. System description

Homegardens exhibit remarkable variation in structure, species composition, area allocated for production and level of dependency on this farming system. The structural characteristics vary from region to region depending on the local and regional physical environment, ecological characteristics, degree of commercialization, local socioeconomy and socio-cultural variations.

Homegarden vegetation at maturity can be vertically stratified into two distinct layers: ground layer and tree layer. Both can further be classified into two sub-layers; ground layer into grasses and shrubs and tree layer into top storey and lower storey. The plants of the ground layer include grasses, herbs, small shrubs and climbers. The lower storey of tree layer constitutes small to medium size (3 to 8 metres in height) species, such as papaya, lemon, jujube and banana, while the top storey, usually greater than 8 meters in height, constitutes of species such as betel nut, palmyra palm, fan palm, coconut, mango and jackfruit. Of course any of the species mentioned above may belong to either the top or lower storey, depending on their growth rate at any stage of maturity.

It is difficult to identify a pattern of spatial distribution of trees and other components. The psychology of the farmers, while deciding the planting site, depends on function of the species, planting space available, crown coverage at maturity and required intensity of management. The vegetable crops and shrubby fruit species (e.g. lemon) are grown immediately beside the kitchen. Small fruit trees are grown very near to the living quarter. The inner yard and the outer yard are both kept vacant for easy movement and to facilitate drying of agricultural crops and residues collected for animal feed. The timber species are grown along the boundaries of the outer yard. Ornamental species, although rare, are found to be planted along the entrance of the outer yard. Bamboo clumps are always kept far from the living quarter, mostly outside the outer yard. Cattle sheds are built at one end of outer yard. Ponds are situated in a place that can be easily accessed by neighboring people as well. Agriculture land starts from the edge of homestead boundary and vegetables are grown in the nearest plots of cropland so that females may have frequent access for harvesting for immediate cooking.

4. Biodiversity and its conservation

The homegardens of Bangladesh are the greatest reservoir of biodiversity and thus frequently referred to as 'biodiversity islands' of the country. The various habitat and vegetation types produce an abundance of plants, animals, birds and insect biodiversity. These 'manipulated' ecosystems support diversity at species and genetic levels in different habitat types. Das (1990) recorded a total of 149 tree species in the homegardens. In a recent study, Kabir and Webb (2008) recorded 419 plant species in 109 families, 146 of which were trees. However, Khan and Alam (1996) provided a detailed taxonomic enumeration of 148 trees and 45 shrubs available in Bangladesh homegardens (table 1).

Drought-prone northern Bangladesh, our study area, holds 56 species of trees of various use categories (figure 1). Mango (*Mangifera indica*) is the most common fruit bearing species utilized for timber and fuelwood. Others of the same use category include *Artocarpus heterophyllus*, *Cocos nucifera*, *Averrhoa carambola*, *Lychi chinensis*, *Syzygium cumini* and *Ziziphus mauritiana*. Timber species, mostly exotics, are also popular among the farmholders. Commonly available timber species are *Acacia auriculiformes*, *Albizia procera*, *Dalberzia sisoo*, *Eucalyptus camaldulensis* and *Switenia macrophylla*. Species popular for having medicinal value are *Azadirachta indica*, *Emblica officinalis*, *Terminalia arjuna* and *Terminalia belerica*. Various parts of these medicinal plants are used in traditional health care and healing of rural people.

Table 1. Vegetation of various life forms available in the homegardens
Source: Khan and Alam (1996); Rahman *et al.* (2005)

Life form		Species
Woody plants	Hedge plants	*Duranta repens, Pithecellobium dulce, euphorbia antiquorum, Opuntia dillenii*
	Vegetation of ponds	*Eichhornia crassipes, Pistia stratiotes, Lemna perpusilla, Trapa bispinosa*
	Epiphytes and parasites	*Vanda tessellata, Rhyncostylis retusa, Hoya parasitica, Dischidia nummularia*
	Climbers and twiners	*Lablab purpureus, Basella rubra, Tinospora cordifolia, Stephania japonica, Piper betel*
	Vegetable crops	*Colocasia spp., Alocacia indica, Curcuma domestica, Zingiber officinalis, Amaranthus gangeticus, Cucumis sativus, Vigna sinensis*
	Ornamental plants	*Canna indica, Cestrum nocturnam, Clitoria ternatea, Codieum vagiegatum, Jasminum sambac, Lagerstroemia indica*
Trees	Timber produces	*Albizia procera, Calophyllum inophyllum, Carallia brachiata, Cassia fistula, Acacia auriculiformes*
	Edible fruit bearers	*Mangifera indica, Artocarpus heterophyllus, Cocos nucifera, Anacardium occidentale, Annona squamosa*
	Medicinals	*Melia azadarachta, Aphanamixis polystachya, Cicca acida, Crataeva magna, Feronia limonia*
	Fuelwood producers	*Aphania danura, Areca catechu, Bamboos, Casuarina equisetifolia, Delonix regia, Eucalyptus camaldulensis*
	Fodder	*Erythrina fusca, Cajanas cajan, Fucus hispida*

5. Benefits of the system

Homegardens with a number of components such as fruits, vegetables, bamboos, spices, poultry and fishery products ensure a year round supply of a wide spectrum of food and construction materials. Besides ensuring household food and nutritional security, this large variety of homegarden products also contributes to income security when sold in the nearby market during economically hard times.

A number of products and services derived from homegarden system are utilized on a shared basis within the rural society. For example, homestead vegetation provides firewood to its owner as well as to the neighboring families who can rarely afford to buy from market. After harvesting agricultural crops the bare croplands become a community land for cattle grazing. Backyards of homegardens serve as a social meeting ground for elders, playgrounds for children and resting spaces for tired passersby. Not all families have their own pond and thus available ponds are shared to take baths and wash clothes and household articles among those who have no alternative. Sharing of fruits, vegetables and seedlings within and outside community people is a common phenomenon. Other common pool resources within the village landscape include canals, streams and natural water bodies that are used by community members for fishing, irrigation and so on.

Beside the above-mentioned tangible benefits, the homegarden systems also provide a range of ecosystem services, such as soil erosion control, amelioration of microclimate, influencing local water table, provision of habitat for wild and domesticated flora and fauna, and the like (figure 2). Recent research

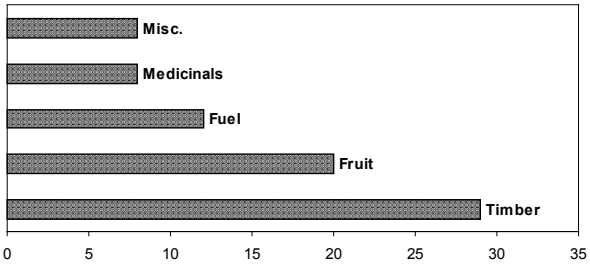

Figure 1. Number of tree species in various use categories in the homegardens

findings also show the potential of carbon sequestration, thus contribute to reduce atmospheric carbon (Kumar, 2006).

It is well established that tree-based homestead and cropland agroforestry systems have some obvious advantages over other production systems since these can maintain production in a wide range of climatic condition. Bangladesh's northwestern region, our study area, is particularly prone to drought due to long-term climate variability and change (FAO, 2006). Agroforestry homegarden farming systems in this drought-prone region provide a healthy ecosystem for humans, animals, birds, livestock and miscellaneous flora and fauna. These multistrata agroforestry homegardens play a critical role in moderating microclimate through soil water conservation, reducing effects of heat stress and thus influencing local air temperature and acting as a barrier against soil erosion through reducing wind speed and surface run-off in this drought-prone area (Alam, 2008; FAO, 2006).

6. Sustainability issues

A homegarden system is sustainable when it maintains several characteristics: it should be able to maintain productivity through diverse crops for meeting subsistence and cash needs of the households, should enhance social and gender equity, should be based on traditional wisdom, and should ameliorate the surrounding environment (Huxley, 1999; Torquebiau, 1992; Kehlenbeck and Maass, 2006). The homegarden farmers of Bangladesh never 'eat their seed corn', i.e. maintain sustainable harvesting of agroforestry products. Thus sustainable use, reuse and recycling of resources in the homegardens are consistent with 'The Threefold Vision' of the *Satoyama* Initiative. Also consistent with the concept of Japanese *Satoyama*, relationships exist between different components of agroforestry homegarden systems in Bangladesh. For instance, animal dung is used in fertilizing crop lands, and the crop residues, in return, are converted to animal feed; the fallen leaves of trees increase soil fertility that result in increased crop production and so on. These interrelationships are maintained by humans for the improvement of the system and benefits of rural livelihood. A positive relationship between human and nature exists in this way for time immemorial in rural ecosystems.

The homegardens are a result of the traditional human-nature relationship within the rural landscape and their contribution to the country's overall food security and poverty alleviation through sustainable management and utilization of agriculture, forestry, animal husbandry, poultry and fishery is immense. The management of these socio-ecological integrated production systems is mostly based on traditional ecological knowledge base (TEK) that has been passed on from older generations. In poultry, animal husbandry and fishery, however, modern scientific knowledge has been integrated with TEK.

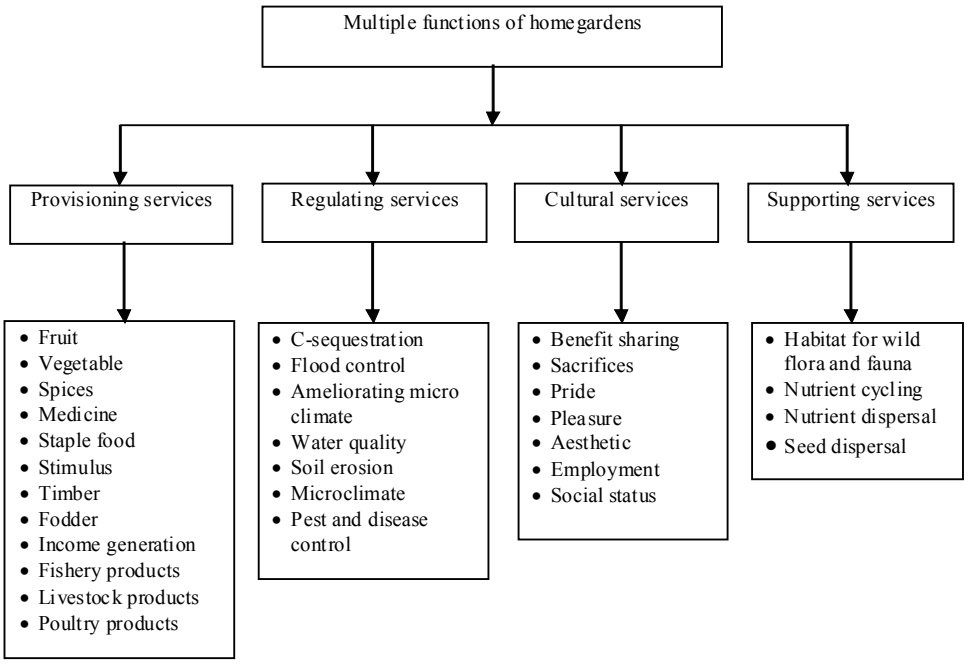

Figure 2. Ecosystem services provided by the agroforestry homegardens

Farmers' dependency on internal inputs is another indicator of system sustainability. Cow dung, corn straw and kitchen and agricultural residues are sources of organic manure for the agricultural lands. Planting materials such as seedlings, seeds and cloning materials are mostly collected or produced from local sources. Family members provide labour throughout the year for light to moderate management operations.

7. Concluding remarks

Major threats underpinning biodiversity and sustainability of homegarden systems include land fragmentation due to population increases, an affinity for exotic species, decreased land area for homegardening due to household infrastructure development and the impact of urbanization and migration to urban centers, among others. The development and adoption of high-yielding varieties of agricultural crops has resulted in the erosion of crop biodiversity. Furthermore, the main objective of maintaining homegardens, as discussed earlier, is subsistence production and sale for cash income. Hence economic well-being will reduce dependency on the homegardens that will ultimately cause deterioration of homegarden systems. Such transformations in homegarden systems is consistent with gradual deterioration of Japanese *satoyama* caused by large-scale urbanization, recreational facility development and changes in local demography and socio-economy (Takeuchi *et al*., 2003; Kobori and Primack, 2003). As a strategy to halt such transformations in homegarden ecosystems, it is important to raise awareness among the farmers through adequate education on sustainable maintenance, conservation and utilization of the resources. Nongovernmental organizations (NGOs) with their strong grassroot-level networks can mobilize their capacity for such awareness-raising and provide environmental education. Finally, activities and projects for implementation of Convention on Biological Diversity (CBD) obligations, now mostly confined in national forests of the country, should be extended to rural landscapes, which are important reservoirs of biodiversity for plants, animals, insects and birds.

Acknowledgements

We would like to thank Prof T Miyaura (Ryukoku University, Japan) and Dr K Harada (University of Hyogo, Japan) for providing inputs in improving content of this article.

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Homegardens: Sustainable land use systems in Wayanad, Kerala, India

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Wayanad district is part of the Kerala State lying in the southern tip of peninsular India (figure 1). The area falls on the edges of the Deccan plateau and is unique because of its higher elevation (700 to 2100 metres above mean sea level) compared to rest of the plains in the state. This district has a purely agriculture-dependent economy and is among the most underdeveloped regions in India. The social fabric of the district is distinctly different from the rest of Kerala, with the highest proportion of aboriginal tribes, a low sex ratio and an environmentally very fragile ecosystem. The Wayanad district covers an area of 212,560 hectares and encompasses 780,619 inhabitants, which account for 5.48 per cent and 2.08 per cent of Kerala State, respectively (2001 census). Aboriginal tribes form 17.4 per cent of the total district population.

The gross cropped area of Wayanad covers 97.82 per cent of the geographical area and is mainly dominated by cash crops. The major plantation crops (tea, coffee, pepper and arecanut) together constitute 38 per cent of the cropped area. Coffee, which covers a total area of 67,429 hectares, is grown as under crop in the homesteads of more than 80 per cent of small and marginal farmers of Wayanad district. Pepper, the second most important crop in the district, is also grown in homegardens. Of the total estimated 155,855 land holdings in the district of Wayanad, 83 per cent belong to either small or marginal farmers.

Figure 1. Location of Wayanad

Since Wayanad is a largely montane area that receives high annual rainfall within a short span of three to four months, land performs important hydrological and watershed functions. A large number of people living in the adjoining areas receive most of their water supply from rivers originating from this area. Thus, the soils and waters of this region sustain the livelihoods of many people. The geographic setting of Wayanad makes it highly sensitive to environmental stresses.

The area falls entirely within the Western Ghats of India, which was one of the eighteen biodiversity hot spots proposed originally by Myers (Myers *et al*., 2000). The area is characterised by high levels of species endemism. The forests here are globally important as they house endemic flora and fauna, which include 229 species of plants, 31 species of mammals, 15 species of birds, 52 species of amphibians. Among these, 55 species are critically endangered, 148 species are endangered and 129 species are vulnerable as per IUCN classification. Moreover, a number of cultivated food plants have their wild relatives in these forests. Among spices, black pepper, cardamom, cinnamon and curcuma have their wild relatives largely in these wet evergreen forests.

The forests of Wayanad are unique and important because they represent a transition zone from the moist Cullenia-dominated forests in the south Western Ghats to the northern drier dipterocarp forests. However, a large proportion of Wayanad landscape is mainly comprised of tea and coffee plantations which have resulted in the severe fragmentation of its forests. Conserving these forests is a big challenge due to this fragmentation and the prospect of increasing degradation due to overexploitation.

In addition to rich biodiversity, Wayanad is home to diverse social, religious, and linguistic groups. The high cultural diversity of rituals, customs and lifestyles has led to the establishment of several religious institutions. The six main tribal communities who live in Wayanad are the Paniyan, Adiyan, Kattunaickan, Mullu Kuruman, Urali Kuruman and Kurichian. Each of these tribal groups are characterised by their own unique social and cultural characteristics (figure 2).

The district of Wayanad is characterised by homestead farming at the subsistence level and small holder plantations. Paddy, the staple food of the region, is cultivated on 11,331 hectares. Paddy-based cropping systems involve paddy, vegetables and banana (figure 3). The uplands in the area adjoining the wetlands are characterised by homestead farming with coffee and pepper. Coffee-based cropping systems involving coffee, pepper, and ginger along with many trees are the most prevalent land use patterns. In traditional agroforestry systems composed mainly of homegarden, the native tree composition of farmlands were largely left intact, while only the understory plants were replaced by crops. This system lies contiguous with the natural forests and provides unhindered habitat for wildlife species in the area due to the diversity in plant species and high shade.

The majority of farmers in Wayanad are small, marginal, and tend to grow multiple sets of crop in their farmlands. Traditionally, inhabitants of this area have not depended on forests or community-owned lands for their biomass requirements. One of the reasons was the absence of such community-held lands, unlike many other places in the world. Farmers maintain a spectacular variety of plants in their homegardens to meet their varied needs. A typical homegarden represents an operational farm unit which integrates trees with field crops, livestock, poultry and/or fish, having the basic objective of ensuring sustained availability of multiple products such as food, vegetables, fruits, fodder, fuel, timber, medicines and/or ornamentals, besides generating employment and cash income. Homegardens form a dominant and promising land use system and maintain high levels of productivity, stability, sustainability and equitability (Kumar *et al.*, 1994). Homegardens that resemble a forest-like multi-storey canopy structure are deliberately planned to mimic a natural forest and thus lack a discernible planting pattern. Physiognomically, homegardens exhibit a multi-tiered canopy structure somewhat similar to that of tropical evergreen forests. Jose (1992) studying the homegardens of the region, estimated an overall Simpson's diversity value of 0.834 for various components of the homegardens which was comparable to that of evergreen forests (0.90). Mean density of trees in homegardens has been estimated to be as high as 116 trees per hectare (Kumar *et al.*, 1994).

Homegardens are considered to be highly evolved land use systems that differ considerably from household to household in terms of the number of trees and shrubs present and the species diversity and planting pattern (Kumar *et al.*, 1994) . Homegardens have long been important multi-purpose agroforestry systems in the area that combine ecological and socio-economical sustainability for the farmers (Peyre *et al.*, 2006).

Figure 2. Traditional tribal dwelling

Homegardens play an important part in the food security of the region as they supply varied products throughout the seasons. Tubers, vegetables, fruits and spices from homegardens make up a significant part of the nutritional requirements of the households. Diversity in crops from homesteads results in a range of outputs from a given area which increases self-sufficiency and reduces economic risks associated with adverse climatic, biological and market impacts on particular crops. In densely populated or heavily degraded areas without sufficient staple crop fields, like in Wayanad, homegardens also provide large portions of staple foods (Kehlenbeck *et al.*, 2007). Another important function of homegardens is the generation of cash income. Most of the income from homegardens is from the marketable surplus derived from perennials such as fruit trees. Income from homegardens can account for more than 50 per cent of a household's total income (Trinh *et al.*, 2003).

The high degree of biodiversity present in homegardens is unique and totally distinct from the biodiversity present in natural forests. The biodiversity conserved in these highly interacting contexts is the result of generations of conscious selection made by farmers and has the imprints of their choices. Moreover, these components are in most cases the last refuges for species that are useful but not commercially viable for cultivation.

Various studies have indicated that homegardens normally contain high commercial timber volume and fuel wood volume which meet a substantial proportion of the society's demands. Homegardens also meet a significant portion of households' energy requirements. (Kumar and Nair, 2004) Most of the

cooking fuel requirements are met from twigs and other forms of litter collected from homegardens. Oils extracted from varied sources, like coconut and sesame, used to serve as the source of lighting fuel in traditional homesteads before the advent of electricity. The green leaves and cowdung from homegardens used to be the major source of chemical energy in the household and the fodder from the homegardens fed to the cows used to serve as the major mechanical energy source used in farming.

In addition to production value, homegardens have important social and cultural functions. At times they serve as a status symbol and the aesthetic value partly outweighs the productive function. The exchange of homegarden products and planting material is common in many traditional societies. Some plant species in homegardens are necessary for religious ceremonies. As mentioned, most of these plant species are not cultivated as they are not commercially viable. Most traditional medicinal plants are also encountered in homegardens. Homegardens also fulfil ecological functions, particularly in landscapes where large, monotonous, and monofunctional agricultural fields dominate. The multilayered vegetation structure of homegardens, which resembles natural forests, offers habitat for a diverse community of wild plants and animals (Albuquerque *et al*., 2005 and Hemp, 2005). This structure appears to contribute substantially to the sustainability of homegarden systems.

Homegardens save agricultural lands from degradation resulting from intensive agriculture and maintain or increase site productivity through nutrient recycling and soil protection. Farmers derive a variety of services and products out of these homegardens. Homegardens increases the value of output per unit of land through spatial or inter-temporal inter cropping of trees and other species. Homegardens also help farmers by supplying raw materials (such as leaf compost) to agriculture. Homegardens also spread the need for labour inputs more evenly seasonally, thus reducing the effects of sharp peaks and troughs characteristic of tropical agriculture. Homegardens thus help farmer utilise family labour as a part-time activity in households without requiring a change in occupation for the landholder. The technology involved in homegardens is simple, labour intensive, and requires little outside technical or financial support. Tree components of homegardens have many useful characteristics as 'assets' for the poor, such as low investment cost, rapid appreciation, divisibility, flexible harvesting time and are available to meet unforeseen contingencies.

Despite these advantages, homegardens rank quite low in the economic calculations as the marketable surplus produced by them is quite low. Lower economic returns are forcing many farmers to shrink their homegardens and make space available for more remunerative mono-crops. The process of modernisation includes a decrease in tree/shrub diversity, gradual concentration on a limited number of cash-crop species, an increase in ornamental plants, gradual homogenization of the homegarden structure and an increase in use of external inputs (Peyre *et al*., 2006). Traditional homegardens are subject to different conversion processes linked to socioeconomic changes to the point of them becoming irrelevant or even extinct (Kumar and Nair, 2004). This change is principally attributed to an increase in the importance of socio-economic factors (e.g., commercialisation) over time, with a decrease in the importance of agro-ecological characteristics (Kehlenbeck *et al*., 2007). For example, many agro-ecological characteristics, such as low fertility, can be altered with technologies, such as the application of fertilizer. Various scientists have voiced concerns that socioeconomic changes and related adoption of modernised managerial systems cause a negative conversion process of homegardens in this region (Jose and Shanmugaratnam, 1993; John and Nair, 1999; Santhakumar, 2002). Studies reinforce the general fear of the loss of traditional characteristics of homegardens and their gradual demise into cash crop production systems (Peyre *et al*., 2006).

A large proportion of the poor depends on ecosystem services from the forests and agricultural lands for their survival. In Wayanad, biodiversity and ecosystems contribute to food security and nutrition, providing the raw materials that underpin health, both formal (*ayurveda* system) and informal (tribal

Figure 3. View of landscape of Wayanad with its traditional lowlands, which were used to grow paddy, and uplands with homesteads. Conversion of paddy fields with crops like banana and coconut is seen in the foreground. The vegetation of the higher elevations is part of government reserved forests.

systems). For many families, agriculture (mostly subsistence) is the main occupation and these families have limited access to alternative sources of income. These families inhabit marginal, less agriculturally productive land, where harvest is more vulnerable to deterioration in soil and water quality. People depend on the forest and homegardens for a variety of needs. Though the nature and the mode of extractive dependence have changed over time, people's dependence on forests continues. The tribal population is almost fully dependent on these natural resources for their survival and any deterioration to these resources will have a telling impact on their livelihood.

The landscapes of Wayanad are a mosaic of forested lands managed by the state as reserved forests or wildlife sanctuaries and agricultural lands adjoining forested areas. The favourable role of these landscapes and production systems, however, has been receiving more attention recently. It is now recognised that the traditional farmers have not only conserved biodiversity of great economic, cultural, and social value, but have also enhanced it through selection and value addition. For example, the potential of traditional land use systems to serve as sinks (soil and biomass) of atmospheric CO2 is getting attention of late.

However, agriculture in Wayanad is facing many problems today. Agricultural production and productivity have decreased drastically over the years in Wayanad due to various reasons. The area was in the news for the high number of suicides by farmers attributed to losses in farming. Many micro and macro level factors have been cited as reasons for failure on the agriculture front in this area, including policy changes, institutional factors, socio economic factors, geographical peculiarities, climate change effects, poor investment in agriculture and poor infrastructural facilities.

There is potential to strengthen formal and informal institutions to save the farming and traditional land use systems of the area. There exist a large number of informal institutions in the form of tribal clans that strongly influence public opinion and the political decision-making process. However, integrating these institutions with the newly crafted formal institutions remains a challenge. The People's Biodiversity Register (PBR) is an example of one such attempt under the "local self governmental" institutions (Panchayaths) to document and conserve biodiversity. More efforts like these are needed to document and understand the dynamics of these landscapes for their conservation and continued maintenance.

This study was conducted as part of the program activities of the Satoyama Initiative, United Nations University Institute of Advanced Studies.

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Regional circulation that combines biogas power generation with agriculture and livestock husbandry in Kyoto, Japan

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1. Regional profile

Kyotango City, Kyoto, Japan, is an agricultural and mountainous village area located approximately 90 kilometres from Kyoto City and 450 kilometres from Tokyo.

The area has been associated with active interaction with countries in Eurasia for centuries. It has many historic remains and ruins, such as tumuli constructed from the third to seventh centuries. This area has been the stage of a variety of human activities since then. The population of Kyotango City was 80,160 people in 1960. It decreased to 62,723 people in 2000 and is expected to decrease to 48,691 people in 2030. The main industries of Kyotango City are agriculture, silk textile industry, machinery and metal manufacturing industry, and tourism. Changes in the industry structure, population outflow, and aging society have been part of the reasons for the overall stagnation of the local economy.

Most of Kyotango City is mountainous or hilly. The altitude ranges from 0 to 697 metres. The climate of the region is warm and humid; the annual average temperature is approximately 15 degrees Celsius and the annual precipitation is approximately 1,900 millimetres.

Most of the natural environment in Kyotango City consists either of anthropogenically created secondary forests or agricultural lands. Most of the area's vegetation consists of secondary forests of *Pinus densiflora* (Japanese red pine) and *Quercus serrata* (konara oak). Herbaceous plant community in rice paddies cover the most flatlands located between the mountains.

2. The use and management of natural resources in the region

2.1 The use and management of natural resources in the past and present

The total area of Kyotango City is 501.84 square kilometres, of which mountains and forests cover 377.15 square kilometres (75.2 per cent of the total area) and agricultural lands cover 35.93 square kilometres (7.2 per cent of the total area).

Agricultural lands and small communities are located on the narrow flatlands along rivers. Hilly areas and mountains that surround the flatlands are covered with forests. These land uses are distributed in a complicated pattern, making a mosaic-style land use distribution.

The current use and management of natural resources are as follows:

- Rice, vegetables, and fruits are cultivated on agricultural lands.
- Forest products including timber, charcoal, and compost used to be produced in forests, but the amount of production has been significantly reduced in recent years.
- Silkworm raising to produce silk goods, cultivation of mulberry trees as food for silkworms, and cultivation of plants to produce dyes are conducted in this area, but the amount of production has been significantly reduced in the recent years.
- Fishery for human consumption is conducted in the coastal area.

2.2 Problems associated with the use and management of natural resources and its impact on biodiversity

The decreased demand for firewood and charcoal due to the increased use of fossil fuels and the decreased demand for forest-based compost due to the increased use of chemical fertilizers have significantly lowered forest use. Under such circumstances, the ecological succession has advanced in secondary forests that had been maintained for a long time, which is resulting in the deterioration of habitats and

Paddy fields and biogas plant

nurturing grounds for wild animal and plant species characteristic of secondary forests and agricultural land.

The stagnation of industries including agriculture, forestry, and fishery caused a population outflow to large cities and the aging of society. The number of people involved in the management and use of natural resources has decreased, which in turn increased the amount of abandoned fields and lowered forest management quality.

Furthermore, insufficient management increased the frequency at which agricultural lands are damaged by wild animals and further exacerbated the stagnation of agriculture in a vicious cycle.

2.3 Regional plans and other measures toward resolution of the above problems

In 2007, Kyotango City adopted the Biomass Town Vision. The vision promotes the use of biomass in an effort to resolve the crisis and the sources of the problems described above as well as other local problems.

Local goals under the Biomass Town Vision include:

- Promotion of industry based on the use of local biomass.
- Climate change mitigation.
- Conservation and restoration of the natural environment.
- Environmental education, eco-tourism, and environmental awareness-raising for the citizens.

Proposed uses of local biomass include:

- Biogas power generation and conversion of organic products from methane fermentation into fertilizer
- Conversion of the biomass into BDF (biodiesel fuel)
- Conversion of the biomass into compost
- Conversion of the biomass into biomass plastic, liquid, or resin
- Others (utilization of industrial wastes from fishery)

3. Overview of the case study

Activities presented in this section are as of March 31, 2010.

3.1 Background and history of activities

The national New Energy and Industrial Technology Development Organization (NEDO) started a microgrid experiment (Kyoto Eco Energy Project (KEEP)) in the area. Amita Corporation was commissioned by NEDO to implement a KEEP in 2003 and started to plan, operate, and manage a component of the microgrid, a biogas power generation facility, "Kyotango Recycle-based Material Production Plant" as a company facility. Such was the beginning of the relationship between Amita Corporation and this area. The operation of the biogas power generation facility started in August 2005. The facility was handed over from NEDO to Kyotango City; Amita Corporation continued to run the operation.

Amita Corporation worked on the effective utilization of liquid fertilizer, which is the by-product of the biogas power generation. At the same time, the company carried out a demonstration experiment of organic vegetable cultivation with the cooperation of local farmers in 2006 and rice paddy farming using no agricultural chemicals and chemical fertilizers in April 2007 as a part of new product development. In addition, in the end of December 2007, the company started natural grazing by releasing milk cows to the degraded forests and started "forest dairy farming" in which a forest is properly managed in a long run while producing dairy products.

3.2 Main content of the effort

The purpose of Regional Production Projects is to promote the prosperity of local communities through their involvement in the projects as well as address the relationship between people and nature in areas that face difficulties in achieving sustainability.

Main contents of the effort are as follows:

- Running and managing the Kyotango Recycle-based Material Production Plant (biogas power generation facility).
- Organic farming using liquid fertilizer produced as a by-product of the above facility and sales of agricultural crops.
- Selling forest dairy products and livestock products.

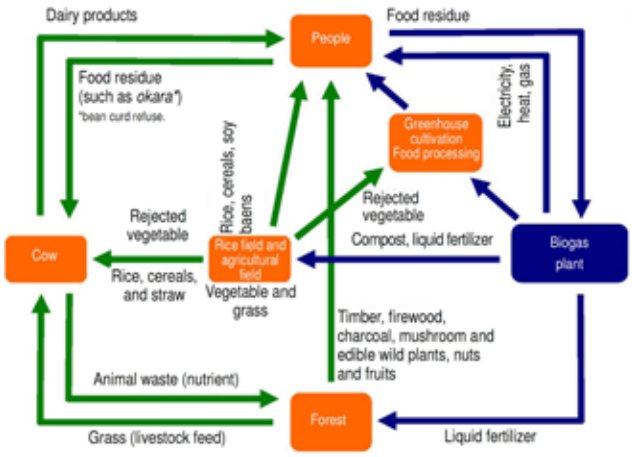

Figure 1: Conceptual diagram of material circulation in the case study area

4. The use and management of natural resources from the perspectives of the *Satoyama* Initiative

4.1 Resource use within the carrying capacity and resilience of the environment

In Kyotango City, the material circulation involving both forests and agricultural lands collapsed as the socioeconomic situation changed. At the same time, the use of natural resources in the forests and agricultural lands fell dramatically, and as a consequence, the quality of these ecosystem has been deteriorating.

In order to solve such problems, Amita Corporation aimed to establish new industries and promote sustainable use and management of natural resources. It plans to maintain traditional land use methods in harmony with a natural condition in the region and also by constructing the matter cycle using new techniques, such as the biogas power generation, the forest dairy farming, and low input farming.

With respect to the establishment of a mechanism on matter cycle, it is important to prevent production of excessive waste beyond the environmental capacity and excessive use beyond the natural resilience through biogas power generation, forest dairy farming, and low input farming. Following stock and flow management is carried out to prevent such issues.

4.2 Cyclic use of natural resources

New material flow systems have been established in the area and different land uses are now connected by the activities of biogas power generation, forest dairy farming, and low input farming as shown in a figure below. Cyclical use of natural resources, with ecosystem function and human activity in harmony, has been achieved by this material flow being executed within the range of an environmental capacity and natural resilience.

Moreover, the organic refuses that are the raw materials of the biogas power generation are collected from Kansai area, and this contributes to making proper regional matter cycle.

- The materials used for biogas power generation include the wastes generated by food industries in Kansai area. Excessive uses of the natural environment will not occur in the utilization of these materials.
- The amount of liquid fertilizer, the by-product of the biogas power generation, applied to agricultural lands is set within the range that will not cause such problems as nitrogen overload.
- Gas emission and wastewater discharge from the biogas power generation facility are properly treated to meet the environmental carrying capacity.
- Based on the knowledge and experiences of existing examples, the density of milk cow raising in the forest dairy farming is considered within the range that would not cause overgrazing, and efforts are made to restore the forest.

4.3 Contributions to local socio-economics

High-value farm and livestock products in the region, such as "Milk of the Forest" by natural pasturing and "Forest Rice" are produced without using any agricultural chemicals and fertilizers during the cultivation period and sold. Amita Corporation's business is not yet profitable. However, the accumulation and improvement of knowhow and the development of the market are advancing steadily, and it is aimed to make the business as a whole to be profitable in several years.

Amita Corporation is not a local enterprise, however, it values the harmony among nature, society, and economy in the region. As a direct contribution to the region, approximately ten local people are employed by the company (as of March, 2010). Moreover, it also works on environmental education that cooperates with a school in the region. As a result, the number of local people who understand and support the activity is now starting to increase.

This study was commissioned by the Ministry of the Environment, Japan

"Milk of the Forest"

Environmental education in a local elementary school

Reintroduction of traditional agriculture for the conservation of natural, historic, and cultural heritage in the Zushi-Onoji region, Machida City, Tokyo, Japan

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1. Regional profile

Machida City, Tokyo, Japan is located approximately 30 kilometres from central Tokyo. Machida City had been an agricultural area until the mid-twentieth century; rapid residential development started in the 1970s and today it has become a bedroom town in Tokyo. The population of Machida City grew from 61,105 people in 1958 to 405,534 people in 2005, a 6.6-fold increase due to the rapid residential development in the 1970s.

The major part of the administrative territory of Machida City is the hill area, which ranges from 27 to 363 metres in altitude. The climate of the region is warm and humid; the annual average temperature is about 14 degrees Celsius and the annual precipitation is about 1,600 millimetres.

In the northern part of Machida City, *yato* (valley-shaped landforms formed by the erosion of the hill) and traditional land uses such as secondary forests, rice paddies and other types of natural environments still remain. The plants and animals that have become rare in urban and suburban areas today can still be seen in this area. The animals and plants characteristic of the *yato* area include raptors, the umbrella species of the region (eg. Northern Goshawk), insects inhabiting forests, and plants that grow in rice paddies and canals.

The natural environment has been decreasing in surface due to the development of the region in the recent years. In addition, lack of adequate management has resulted in uncontrolled ecological succession and deterioration in the quality of the remaining natural environment. As a result, the animals and plants that typically used to be seen in the *yato* area have decreased significantly to the extent that many species are now listed as threatened species at the national level (Threatened Wildlife of Japan: Red Data Book) or Tokyo level (Important Wildlife for protection in Tokyo).

2. The use and management of natural resources in the region

2.1 The use and management of natural resources in the past and present

Traditional land uses that suit the complex landforms have generally been carried out in the northern part of Machida City. Agricultural lands and human settlements are located on the narrow flatlands along rivers. Forests are distributed on hills that surround such areas. Particularly in the *yato* area, there are traditional land uses characterized by a mixture of rice paddies that use natural spring water taken from the river source, secondary forests on slopes, farmlands, and human settlements.

In agricultural lands of the *yato* area, rice, vegetables, and fruits are produced for human consumption as well as livestock husbandry. In forests, timber, charcoal, and compost used to be produced; however, the amount of their production has been reduced significantly in recent years.

2.2 The problems associated with the use and management of natural resources and its impact on biodiversity

Landforms and land use have changed as a result of the development of the hilly areas into residential areas since the 1960s in Machida City. Forests and agricultural lands, which are important habitats and nurturing grounds for wild animals, have been significantly reduced.

Moreover, due to the increased use of cheap fossil fuels and chemical fertilizers, the advantage of being able to collect fuels and compost from the nearby forests has been lost especially in the *yato* area, where the recycle-oriented utilization of natural resources was practiced in the past. Meanwhile, the difficulty of improving agricultural efficiency due to the narrow land and slopes, which is one of the

The landscape of *yato*

***Yato* before management (left) and under management (right)**

disadvantages of the *yato* area, has become apparent. Therefore, the area is regarded as low-valued for land use, and development and abandoned management have been increasing.

2.3 Regional plans and other measures toward resolution of the above problems

One of the policies of the "Machida City Environmental Master Plan", prepared in 2002, is to conserve and restore the natural, historical, and cultural environment. The City is working on the conservation and restoration of the secondary natural environment, as it is represented in the *yato* area, through a partnership with landowners, non-profit organizations, volunteers, and other participants.

Meanwhile, the Tokyo Metropolitan Government has designated the area of Machida City where traditional land uses and agriculture of the *yato* area are still present as the "Zushi-Onoji Historical and Environmental Conservation Area" under an ordinance of Tokyo. In addition, a conservation plan concerning policies and regulations for the protection and restoration of nature to promote the conservation of the natural, historical, and cultural environment of the *yato* area has been prepared.

3. Overview of the case study

3.1 Background and history of activities

In light of the value of the natural, historical, and cultural environment of the case study area and as stated above, the Tokyo Metropolitan Government designated the relevant area as the "Zushi-Onoji Historical and Environmental Conservation Area" in 1978. This conservation area was designated with the principle of limited public entry to achieve the conservation of the natural environment through agricultural practices, and strict regulation on the use of the conservation area was implemented.

However, farmers who were affected by the national government's policy to reduce the acreage of agricultural land lost their will to continue agricultural operations on privately owned land within the conservation area. They stopped farming practices and the remaining land deteriorated due to abandonment. Moreover, in publicly owned land within the conservation area, proper management was not implemented.

Troubled by the above-mentioned circumstances, local residents organized the Machida Rekikan Kanri Kumiai (History and Environment Management Association) (hereinafter referred to as "The Association"). They proposed that local farmers who are familiar with traditional agricultural practices should be in charge of the vegetation management of publicly owned *yato* areas within the conservation area.

Based on the proposal, the Tokyo Metropolitan Government commissioned the vegetation management to the Association.

3.2 Main content of the effort

The mission of the Association is to "secure biological diversity", to "conserve *yato* landscapes in good condition", and to "implement management with a focus on the conservation of the aquatic environment and water control in the upstream area".
Main activities of the association include vegetation management (eg. mowing and raking fallen leaves), infrastructure-related work (eg. installation of signs), restoration of *yato* (restoration of abandoned *yato* areas in order to create waterside environments that provide habitats to wildlife), wildlife interventions (eg. removal of crows in order to protect the breeding and nurturing grounds of the Northern Goshawk (*Accipiter gentilis*).

4. The use and management of natural resources from the perspectives of the *Satoyama* Initiative

4.1 Resource use within the carrying capacity and resilience of the environment

The land use that combines various features including irrigated rice fields in *yato* and forests on slopes was established as a suitable land use method for the natural environment involving the topography, soil, and climate in *yato*. The sustainable management and utilization of natural resources within the range of the environmental carrying capacity and resilience of the natural environment used to be practiced in the *yato* area in the past. Thanks to such practices, a healthy natural environment that had nurtured great biodiversity has been retained. Efforts in this area aim to pass on the land use of *yato* which is adapted to such natural environment to future generations.

The Association which is commissioned by the Tokyo Metropolitan Government to manage the area's vegetation fully understands the ecosystems and ecosystem services of the area and manages the area under the three policies highlighted in table 1.

Table 1. Relationship between the management policy of the Association and the value of ecosystems and ecosystem services

Management policy	Values of relevant ecosystems and ecosystem services
Secure biological diversity	Biodiversity
Conserve *yato* landscape in good condition	Cultural service (historical and cultural environment)
Implement management with focus on the conservation of aquatic environments and upstream water control	• Supply service (nurture water resources) • Adjustment service (flood control)

The Tokyo Metropolitan Government and researchers are continuing biological surveys. They assess individual survey outcomes and examine the effectiveness of the efforts through comparative progress analysis of these outcomes. Table 2 describes an example of such impacts.

4.2 Recognizing the value and importance of local traditions and cultures

The Tokyo Metropolitan Government conducted an "Investigation of Methods to Manage *yato* in the Conservation Area" in 1995. The study compared the biota between the *yato* where rice paddies were maintained and the abandoned *yato*. It also examined traditional methods practiced by local farmers to take care of *yato*. The investigation found that in abandoned *yato*, rice paddies had changed to dry land and the environmental features became homogeneous. On the other hand, *yato* in which irrigated rice farming was continued had small environmental segments such as farm roads, irrigational canals, reservoirs, and levees between rice fields, and the combination of these segments with the surrounding forests resulted in a mosaic of different land uses that were associated with high biodiversity.

The Association produced a manual on traditional skills that were studied in the above investigation and is implementing vegetation management work in accordance with the manual. The goals of the vegetation management work included the restoration of traditional environmental segments and traditional agricultural civil engineering skills were adopted in individual projects.

As a result of the reintroduction of such traditional knowledge into present-day vegetation management work, the abandoned *yato* has been successfully restored.

Table 2. An example of positive impacts of traditional methods on the conservation of biodiversity.
Source: Report of Commissioned Survey on Precious Plant Species in the Zushi-Onoji History and Environment Conservation Area, Tama Environment Office, The Tokyo Metropolitan Government and Ryokusei Research Institute Inc. 2002.

Survey period	Overview
1986	• The "Investigation of the Flora and Fauna of the Zushi-Onoji History and Environment Conservation Area", conducted by the Bureau of Environment, the Tokyo Metropolitan Government in 1986 before the start of the *yato* management work, identified 591 species (115 families) of native plants.
1996 to 2002	• Surveys conducted from 1996 to 2002 identified 680 species (128 families) of native plants. In comparison to the 1986 survey, 89 additional plant species were recorded. • Additional species included many rare species. • The number of plant species clearly increased since the start of the *yato* management work.

Table 3. Stakeholders and role assignments of this project

Land	Stakeholder	Role
Zushi-Onoji Historical and Environmental Conservation Area (publicly owned land)	The Tokyo Metropolitan Government	Land owner; executor of conservation policies
	Machida Rekikan-Kanri-Kumiai (non-governmental organization of local farmers)	Management work (commissioned by the Tokyo Metropolitan Government)
	Liaison Committee for History and Environment Researchers (a network of experts who are involved in research on the conservation of the natural environment and the historical and cultural environment of the case study area)	Conduct biological monitoring and provide expert opinions.
	Machida City, private companies, and volunteers	Provide human and financial resources.

4.3 Natural resource management by various participating and cooperating entities

The stakeholders in this area include the Tokyo Metropolitan Government, the landowner, and the Association, the vegetation manager, as well as people from different sectors such as researchers (Liaison Committee for History and Environment Researchers) (table 3). The projects are conducted through role assignments and cooperation based on position and expertise.

4.4 Contributions to local socio-economics

Farmers who are the members of the Association feel threatened by the deteriorating natural, historical, and cultural environment of *yato*, which they have nurtured for many generations. They are certain and proud that they have inherited traditional wisdom and are capable of restoring the environment. They are translating these feelings into actions, successfully producing positive results.

This project is a rare example of the management of publicly owned land by local residents. Only a few examples of similar cases are to be found in Japan. In addition, this project has multi-dimensional significance, such as the inheritance and utilization of traditional knowledge of the region and the improvement of biodiversity through the reintroduction of human interventions for management purposes. Therefore, this project is attracting attention from the stakeholders living in the suburban area near a large city who face similar problems, and several prizes have been awarded to this project.

The local farmers have become more proud of their own occupation, which contributes to the conservation of the natural environment as well as the historical and cultural heritage, and the bond within the community has become stronger.

This study was commissioned by the Ministry of the Environment, Japan

Town revitalization through the promotion of historical and cultural heritage in the community of Kanakura, Machino Town, Wajima City, Ishikawa Prefecture, Japan

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1. Regional profile

Wajima City, Ishikawa Prefecture, Japan, belongs to an agricultural and mountainous region far from urban areas (approximately 100 kilometres from the Ishikawa Prefectural Government Office and 300 kilometres from Tokyo).

As it faces the Sea of Japan, Wajima's history is marked by its trading port, used for exchanges with countries in Eurasia and various places in Japan. The population of Wajima City was 46,024 people in 1984. Due to the movement of population to urban areas, the population decreased to 32,518 people in 2009 (approximately a 30 per cent decrease in 25 years). The major industries of Wajima City are agriculture, forestry, fishery, lacquer ware manufacturing, and tourism.

Wajima City is located in the northern part of a peninsula. Most of the city's administrative territory is covered with hills and low-altitude mountains. The climate of the region is warm and humid; the annual average temperature is about 13 degrees Celsius and the annual precipitation is about 2,150 millimetres. Approximately 60 per cent of the city's administrative territory is covered with forested mountains, mainly forests of *Quercus serrata* and planted forests of Japanese cedar trees (*Cryptomeria japonica*) and Japanese cypress trees (*Chamaecyparis obtuse*). Rice paddies are present at river-side lowlands and basins.

There exists a significant amount of modified nature, mainly terraced rice paddies, which was developed through long-lasting human interventions in balance with the nature's capacity. It provides habitat to many precious plant species including those on the Japanese Red List of threatened species. Many water springs in the region provide habitat to a salamander endemic to Japan (*Hynobius takedai*).

2. The use and management of natural resources in the region

2.1 The use and management of natural resources in the past and present

The total area of Wajima City including the study site is 42,624 hectares, of which forested mountains cover 32,735 hectares (77 per cent) and agricultural land 4,566 hectares (11 per cent) as of 2009.

The remote Noto region ("Okunoto"), where the case study area is located, has many undulating hills and low-altitude mountains, most of which are covered with forests. Human settlements and rice paddies are located mostly on flatlands that exist along rivers and coastlines.

The current use and management of natural resources are as follows:

- In agricultural lands, rice, vegetables, and fruits are produced for human consumption and livestock is kept in grasslands.
- In forests, timber and edible mushrooms are produced.
- The recycling-based uses of resources in forests and agricultural land, such as the use of compost coming from the forest in the agricultural land, have decreased significantly.

2.2 The problems associated with the use and management of natural resources and its impact on biodiversity

The depopulation and aging of the population due to the outflow of residents to large cities have advanced in the recent years in the remote Noto region, where Wajima City is located. More and more coppice woods and rice paddies are left unattended. These areas used to provide important habitats and breeding grounds for wildlife. Natural succession of the vegetation progressed due to the lack of management and they are becoming less and less capable of accommodating a diversity of wildlife.

For instance, the human settlement at Kanakura in Wajima City, the case study area, used to be a large community of 104 households at its largest state; however, depopulation has progressed since the mid-1900s and there are only 63 households in the community today. In addition, the population is aging: more than half of the residents are aged 65 or older. Under such circumstances, the shortage of manpower for agriculture or forestry has become a serious problem in this area. The future of terraced rice fields that provide the basis of local livelihoods as well as valuable habitat and breeding grounds for animals and plants is threatened.

2.3. Regional plans and other measures toward resolution of the above problems

Ishikawa Prefecture has enacted the Ordinance for the Protection and Enhancement of the Environment of Hometown Ishikawa. More than 60 percent of Ishikawa Prefecture is covered with mountainous terrain, agricultural land or *satoyama* environments, such as secondary forests. The conservation and utilization of the *satoyama* environment is considered to be essential for environmental conservation and local revitalization. The said ordinance is relevant to the conservation of the *satoyama* environment in the Ishikawa Prefecture.

3. Overview of the case study

3.1 Background and history of activities

The settlement at Kanakura is said to have started as a landed estate of a Buddhist temple that prospered in association with the Kanakuraji Temple. Kanakura produced a large amount of rice from 1300 to 1500 and was one of the wealthiest settlements in the remote Noto region. Kanakura had a Buddhist temple and rice was produced to be offered to the Buddha. The area prospered together with the Buddhist temple.

Later, after the lord of this region burned down the entire village, people who tried to restore the settlement invited a Buddhist temple from the outside relocate to Kanakura. Because the connection between the temple and the supporting laymen was maintained, people came to Kanakura on the occasion of regular religious lectures at the temple. As a result, Kanakura was able to maintain its population through exchange with visitors even when the permanent population decreased; Kanakura re-flourished as a central community in the region.

Kanakura remained a central community throughout the 1800s and an elementary school and a post office were constructed. However, in the mid-1900s, population outflow to urban areas and the aging of the population progressed. In 1997, Kanakura Elementary School, which had been, both physically and culturally, the centre of the settlement, was closed.

Under such circumstances, local residents voluntarily set up a group in 2000 to revitalize the community. They named this group "Kanakura School" with the intention of making this a spiritual centre like Kanakura Elementary School. Kanakura School takes advantage of the "internal solidarity" of Kanakura and engages in activities that involve the entire community in order to restore the prosperity of the past by revitalizing the "exchange with the outside", which used to support the community.

Although in the beginning the activities were only conducted by volunteers, it was agreed that all households in the settlement would participate. The group is currently operating as a non-profit organization (NPO), "Yasuragi no Sato Kanakura School".

3.2 Main content of the effort

The basic policy of Kanakura School is: "all the members are teachers". The members discuss history, culture, nature, society, health, and daily life by expressing and exchanging opinions and ideas. They have the following three policies with respect to their activities:

1. Discover "peaceful community, Kanakura": Explore the origins and legends associated with the current place names. Explore the history of Shinto shrines and Buddhist temples. (Rediscover local resources.)

2. Disseminate "nostalgic hometown tastes" to other areas: Koshihikari (one of the major rice brands) harvested in Kanakura, suwari soup, kogemeshi (burnt rice). (Pass on traditional food culture.)

Shoganji Temple
(one of the Five Temples of Kanakura)

Open Café
(Inside Keiganji Temple, one of the Five Temples of Kanakura)

3. Disseminate "peaceful community, Kanakura": Introduce Kanakura's seasonally varying scenic beauty (settlement, the temple compound, etc.), wild plants, flowers, and trees. (Pass on traditional landscape.)

Main contents of the effort include conducting research on the history of the local community and its natural environment, developing walking paths, promoting local specialties, organizing events, and cooperating with universities.

4. The use and management of natural resources from the perspective of the *Satoyama* Initiative

4.1 Resource use within the carrying capacity and resilience of the environment

Resilience of the natural environment in Japan is generally robust due to its abundant rainfall and warm climate, and this also applies to Kanakura. Without human influence over natural succession, the environment in the area would become covered by homogeneous vegetation. Reduced use of natural resources in Kanakura has left unattended the rice fields and forests that were previously managed. The plant coverage and biodiversity is feared to decrease under such conditions.

Local residents and researchers are aware that the landscape around terraced rice paddies is also important for wildlife. The Satoyama Satoumi Nature School of Kanazawa University surveyed the biodiversity of the Noto Peninsula from 2006 to 2008, including Kanakura. The survey found a variety of plants in human-influenced areas, such as the terraced rice paddies, that cover the majority of the community and the managed grassland around the rice paddies.

Human activities affecting the natural environment have been taking place for generations, since the establishment of the Kanakura community, and combined with the area's original natural forces, they have created the vegetation of Kanakura. Kanakura School is preserving the ecosystem by maintaining the terraced rice paddies.

4.2 Recognizing the value and importance of local traditions and cultures

Kanakura is a community that has prospered based on rice paddy farming in terraced rice fields as well as by receiving visitors from the outside. The activities of Kanakura School are also based on this system that has sustained the community in the past and aim to revitalize the community by attracting people from large cities to secure the constant visiting population.

Kanakura School transformed the entire Kanakura community as an eco-museum named "Yasuragi no Sato" (peaceful village). Specifically, they installed information boards to explain the local history as well as signs for people who enjoy walking. They also improved the landscape in the community by planting azalea and cherry trees. Such efforts have enabled visitors to enjoy walking around the community as they savour the landscape and local history. They are also working to attract visitors by publishing a Kanakura walking map that features the Five Temples of Kanakura, legends associated with Kanakura, and suggested walking paths so that visitors can enjoy the history, culture, nature, and landscape of Kanakura.

As a result of these efforts, approximately 8,000 visitors come to Kanakura annually, whose population is only about 160 people. The visiting population is actually increasing.

4.3 Natural resource management by various participating and cooperating entities

In addition to the participation of every household in the community, Kanakura School is also working with academic institutes. This arrangement connects and stimulates the activities of Kanakura School and the research activities of Kanazawa University. The *satoyama*-stationed researcher system is operated to facilitate cooperation between Kanazawa University and the local residents. In this system, people working for *satoyama* conservation and local revitalization are assigned *satoyama*-stationed researchers or *satoyama* guest researchers/investigators to promote cooperation between the academic and public sectors.

The activities of *satoyama*-stationed researchers are based on the following three principles: (1) "information gathering" to collect requests and suggestions from local residents to utilize them in the university's research; (2) "information transmission" to utilize the research outcomes that the university has accumulated; and (3) "study session" to deepen the understanding of the principle of cooperation between the academic and public sectors centring on *satoyama*-related activities and working toward regional improvement and promotion of *satoyama* studies.

Local historians are assigned as *satoyama*-stationed researchers in Kanakura. They participate in the study, communication, and transmission of the unique history and legends of Kanakura.

4.4 Contributions to local socio-economics

The rice harvested in terraced rice paddies are air-dried in a traditional method called haza-boshi.

Visitors find the rice especially attractive because (1) the rice is harvested in terraced rice paddies, the major element of the traditional landscape of the community, (2) the taste is improved through the use of the traditional method, and (3) the rice is associated with a particular historical background; Kanakura rice was not taken as land tax around 1300 to 1500 and thus considered to be a rare type of rice that was not available to those outside Kanakura. The rice is sold as a brand of rice named "Koshihikari Kanakura-mai", which is gaining popularity and becoming well-known. Rice for *sake*-making is also produced in the terraced rice paddies. The *sake* produced using the *sake* rice is sold under the name "Jummaishu Maizokin". *Sake* and Koshihikari Kanakura-mai rice are advertised as specialty products from the terraced rice paddies of Kanakura. Sales outside Kanakura directly contributes to the preservation of the terraced rice paddies.

A café named "Ki no Koe" (voice of trees) was opened in the corridor of Keiganji Temple, one of the Five Temples that symbolize Kanakura. The café serves dumplings, pizzas, rice cakes using local vegetables, local ancient rice and others. The café helps increase the demand for locally grown agricultural crops.

This study was commissioned by the Ministry of the Environment, Japan

Case studies from Europe

BurrenLIFE – Farming for conservation in the Burren

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1. Introduction

The limestone landscape of the Burren has been moulded by ice, etched by water and modified by man. The local geology and climate were important factors in the development of a distinct form of transhumance known as 'winterage', which is synonymous with the Burren. This traditional grazing practice has been fundamental in shaping the rich natural and cultural heritage of the area and our ability to maintain what is one of Europe's important semi-natural landscapes is dependent on its continuation.

Over the last 35 years, there have been significant changes in the farming systems of the Burren as farmers and their families have responded to world markets, agricultural policies and the national economy. The stark reality is that farming in marginal areas like the Burren is neither economically viable nor attractive in this day and age. This is having a negative impact on the rural communities whose children invariably move away to find better paid employment elsewhere. Many older farmers have no descendents willing to work alongside them and imbibe the vast knowledge accrued over generations, so with each death the Burren loses yet another slice of the understanding required to manage this exceptional area. The changes are also damaging the Burren's heritage: reduced grazing levels are leading to an increase in rank vegetation and scrub[1] is spreading on to the flower-rich grasslands to the detriment of their prolific biodiversity as well as obscuring and damaging archaeology. Increasing scrub is not only reducing the available grazing land, it is also making it harder to farm in what is already a difficult and somewhat inhospitable terrain.

The BurrenLIFE Project was set up in 2004 to develop practical management techniques that would facilitate a return to more traditional grazing regimes and form the basis of a more sustainable approach to farming in the area. If this could be achieved there would be positive benefits for the environment, habitats, communities and economy of the Burren.

[1]Scrub is vegetation dominated by woody shrubs or bushes that are less than 5 metres tall. Hazel (*Corylus avellana*) is the dominant scrub species found in the Burren but other species include Blackthorn (*Prunus spinosa*) and Whitethorn (*Crataegus monogyna*)

Location of the Burren, Ireland

2. Location & Topography

The Burren is an area of low-lying (<330 metres) glaciated, limestone karst situated on the mid-western seaboard of Ireland in the Atlantic region of Europe (approx. Latitude 53° N, Longitude -09° W). The name 'Burren', derived from the Gaelic word *Boireann* meaning 'rocky place', encapsulates the stark landscape dominated by low, bare, terraced hills of carboniferous limestone and expanses of limestone pavement. First impressions suggest a barren place but this could not be further from the truth. As well as its karstic geology, the Burren is internationally renowned for its unusual and abundant flora, and boasts the highest concentration of archaeological monuments in Ireland. These stand testament to an agricultural history stretching back some 6000 years to the early Neolithic.

There is no accepted consensus as to the extent of the Burren. The northern and western boundaries are easily defined by the coastline but lack of agreement as to the southern and eastern borders means that sources vary as to its area; some suggesting it is only 350 square kilometres and others as much as 720 square kilometres. Whichever you take, the Burren is a small, geographical region, occupying at most one per cent of the area of Ireland. The Burren can be divided into two distinct geographical zones: one upland, the other lowland. The upland 'High

Burren', situated in the western part, is characterised by low hills with extensive areas of bare rock, rough grassland and hazel-dominated scrub. The 'Low Burren,' situated in the eastern part, is a flat limestone plain with an average altitude of 20 to 30 metres characterised by wetlands, limestone pavement, improved agricultural grassland on areas of glacial drift and some rough limestone grassland.

3. Socio-economic characteristics

The Burren is very much a rural area. In prehistory, most of the settlements were on the uplands but modern settlement patterns are in complete contrast, with most towns and villages on the lowlands of the northern and western coastlines or along the junction of the limestone and shale geology to the south. Traditionally, the people who lived in the Burren would have worked there too, primarily in agriculture and associated industries. However, recent times have seen a shift with numbers working in agriculture falling and those in the 'services industry', much of which centres on local tourism, increasing. Not only have the numbers working in agriculture decreased but many of those still farming, work off-farm either part or full-time and have to fit in their farm jobs into evenings or weekends.

The move away from agriculture is mirrored in the decrease in the population of the Burren. For example, the population of Ballyvaughan Rural District (c. 75 per cent of the 'High Burren' region) decreased by 27.45 per cent between 1911 and 1996, falling from 3,651 to 2,649, whilst that of the rural District Electoral Divisions almost halved from 2,423 in 1911 to 1,241 in 1996 (Burrenbeo, 2009)

4. Climate

The Burren has a temperate, oceanic climate characterised by mild, wet winters with few frosts and cool, moist summers. Between 1961 and 1990, the mean daily temperatures recorded at the meteorological station at Carron, in the centre of the Burren uplands (height 155 metres), was 8.9 degrees Celsius. July and August are the warmest months with mean daily temperatures a little above 14 degrees Celsius and January and February the coolest, with mean daily temperatures below 5 degrees Celsius. Rainfall is high, the yearly average being 1525 millimetres. The wettest months are between October and January with approximately 160 millimetres of rainfall per month (The Irish Meteorological Service, 2009).

5. Biodiversity, habitats and conservation designations

The Burren contains a range of habitats listed in Annex 1 of the European Union Habitats Directive. These include priority habitats: orchid-rich dry calcareous grasslands, limestone pavements, calcareous fens, turloughs and petrifying springs; as well as other listed habitats such as hard oligotrophic lakes, alpine and boreal heaths and *Juniper communis* growing on calcareous substrates. Because of this, approximately 30,400 hectares of the Burren are designated as Special Areas of Conservation (SACs).

The grasslands, heaths and pavements are home to the Burren's internationally renowned flora. Approximately three-quarters of Ireland's 900 native plants occur in the Burren, and many of them flower in a profusion not seen elsewhere in Britain and Ireland (Webb and Scannell, 1983). This diverse flora includes unique plant assemblages formed by the juxtaposition of arctic, alpine and northern European species with southern European and Mediterranean species, e.g. the alpine Spring Gentian (*Gentiana verna*) can be found growing alongside the arctic Mountain Avens (*Dryas octopetala*) and the Mediterranean Dense-flowered Orchid (*Neotinea maculata*).

The grasslands and heaths are highly complex, forming intimate mosaics where the plant communities grade subtly from one to another along a continuum that reflects variations in both environmental factors and management (Parr *et al*., 2009). Many of the communities are very species rich and it is not uncommon to have a dozen or more species of grass, herb and sedge in an area of less than 25 square centimetres. Thin rendzinas, most less than 5 centimetres deep, are the predominant soils on the Burren hills. Their low nutrient status combined with the free-draining nature of the karst substrate means that they are fairly inhospitable and this helps to promote plant diversity as it is difficult for any species to gain a competitive edge. It also means that these grasslands and heaths have a very low agricultural productivity. Unimproved grasslands occur-

Mountain Avens (*Dryas octopetala*) is an Arctic plant that is very common in the Burren despite the temperate climate.

ring on drumlins and in valleys are more productive due to the better water retention of the deeper, clayey, glacial till soils, but the leaching effect of the high rainfall lowers their nutrient levels so those that have survived agricultural improvement are rare relicts of once common species-rich lowland meadows. Grazing is another very important factor in maintaining the diversity and abundance of plant species and this is discussed in more detail later.

These flower-rich habitats support a large, but under-researched, variety of invertebrates including the Marsh Fritillary (*Euphydryas aurinia*), Ireland's only butterfly listed on Annex II of the Habitat's Directive, and populations of important pollinators that are in decline elsewhere e.g. Shrill Carder Bee (*Bombus sylvarum*). The large insect populations provide good supplies of food for bats including internationally important populations of the Lesser Horseshoe Bat (*Rhinolophus hipposideros*).

As with the grasslands and heaths, low nutrient status and high calcium carbonate levels are important driving factors in the aquatic habitats of the Burren. Currently, they are threatened by increased nutrients coming from both agriculture and the septic tanks that are the sole effluent systems of many rural dwellings.

The Burren's woodlands have had a traumatic history. Once extensive, they were so reduced by man's activity that a 'fuel famine' was recorded in the mid nineteenth century, and a visitor in 1852 referred to hazel (*Corylus avellana*) only occurring as 'a scanty growth here and there amongst the stone walls which divide field from field' (cited in Ó Dálaigh, 1998). Since then, hazel has been expanding and it was calculated that about 14 per cent of the High Burren was covered by hazel-dominated scrub in 2003 (Parr *et al.*, 2006) with a further 5 -10 per cent seriously 'scrub-affected'. This expansion has serious implications for the future survival of both the current biodiversity and farming in the Burren uplands. While some of the mature stands of hazel represent the very rare habitat 'Atlantic hazel woodland', particularly important for its lichen and fungal communities, the continued spread of scrub species such as hazel and blackthorn (*Prunus spinosa*) will have a serious impact on the plant communities of the grasslands and heaths unless it is managed

6. Brief history of agriculture in the Burren

The agricultural history of the Burren is largely one of pastoralism, the focus being on grazing animals with tillage playing a smaller role. Palynological and archaeological studies suggest that farming first began in the Burren c. 5,800 BP (O'Connell, 1994).

The Burren Landscape is dominated by low, bare limestone hills with scattered patches of grassland, heath and hazel scrub.

Lynch (1988) found evidence of Neolithic agriculture during excavations of the Poulnabrone portal tomb dated to 5,500 BP and the frequency of wedge tombs, mound walls and farm settlements indicate that farming continued through the Neolithic period. By the early Bronze Age, the Burren uplands were already densely settled and intensively farmed (Jones, 1998). During the Iron Age there appears to have been a decline in agricultural activity which was accompanied by a resurgence in scrub (O'Connell, 1994). This may have been linked to over-intensive land use, possibly combined with a climatic downturn that led to extensive soil loss (Jones, 1998).

The resurgence in farming activity during the early Christian period was marked by an increase in tillage and greater use of lowland areas with deeper more productive soils. This revival is linked to the arrival of Christianity and the introduction of new technologies by religious communities such as the Cistercian monks. The large number of ring forts (early Christian period farmsteads) suggests the Burren was well established as an area of significant agricultural activity at this time (McCormick, 1995). Indeed, one reference from 1317 AD claims that the Burren was 'overflowing with milk and yielding luscious grass' (O'Grady, 1929).

During Medieval times the Burren lands were redistributed to English settlers. The 'Book of Survey and Distribution' (Simington, 1641) provides detailed descriptions of 35 land types within the Barony of the Burren which were further broken down according to their value and profitability. For example, arable land was divided into 7 types and 24 profit levels while pasture was divided into 12 types and 63 profit levels including 'heathy' pasture, 'rockie' pasture and 'dwarfwood' pasture. This long-recognised diversity in habitat type and related productive capacity of the Burren remains highly

relevant in determining modern-day management systems for the region.

Despite Medieval wars, disease and famine, the population of the Burren continued to increase until the mid-nineteenth century when the great famine occurred with devastating effect. Subsequently, the number of farmers declined steadily and continued to do so over the course of the twentieth century, even after much of the land was redistributed to local families. At this time the farming systems were mixed, typically including cows, store beef cattle, sheep, goats and tillage. Following Ireland's accession to the EEC in 1973, concerted efforts were made to improve farm income and many Burren farmers began to specialise in suckler-beef production. Today, the number of farmers continues to fall and most farm on a part-time basis (Dunford, 2002).

7. The tradition of winterage and its importance to the biodiversity of the Burren

Transhumance, the movement of livestock to upland areas during the summer, is common throughout Europe. However, the Burren is unusual in that it practices a 'reverse' transhumance. For centuries, livestock have been moved onto the Burren hills in late autumn to spend the winter grazing the extensive limestone grasslands, heaths and pavements known locally as 'winterages'. Nobody knows when or why this tradition began but putting cattle on the hills during the season of cold winds and driving rain seems to fly in the face of logic. It may have been in response to a lack of water in the summer when any rain rapidly passes through the thin soils and into the natural drainage systems of the karst. Or it may have been down to the fact that the limestone hills of the Burren act as a giant storage heater, releasing the warmth stored during the summer over the winter so the climate is milder than many other exposed upland areas. Whatever the reason, a system of farming developed where the cattle spend the summers on more productive lowland grasslands while the Burren uplands are left fallow or only lightly grazed. This combination of winter grazing, which allows the plants on winterages to grow, flower and set seed unhindered during the summer, and environmental conditions means that the grasslands and heaths of the Burren winterages are some of the most diverse and species-rich in Ireland. The vegetation that builds up on the winterages during the summer is essentially a standing hay crop which is a vital food source for livestock over the winter. If not grazed sufficiently, dead vegetation accumulates and suppresses light-dependent herbs whose abundance decreases over time and eventually there is a loss of species.

The traditional grazing practiced in the Burren is a form of reverse transhumance: cattle spend the winter months grazing on the hills having spent the summer on the more productive lowland pastures.

8. Recent changes in farming practice

The last 35 years have seen significant changes in the winter grazing systems. Specialised suckler-beef production has replaced the keeping of store cattle (cattle that would be sold on to be finished for the beef market), continental crosses have replaced traditional 'hardy' breeds and calving takes place two to three months earlier to tie in with the export weanling trade. All of this means that the nutritional requirements of the in-calf, suckler cows grazing the winterages in the modern system are higher than they were for previous cattle types. Unfortunately, forage on the Burren winterages does not meet these needs between January and March when the cows are in late pregnancy (Moran *et al.*, 2008). As a result, farmers began to feed silage to cows on the winterages or house them and feed them indoors for all, or part of, the winter. Housing cows for the winter is more convenient for farmers, particularly those farming part-time or of retirement age, as they are easily checked or fed at any time which is in marked contrast to the difficulties of looking after animals on the winterage with the constraints of poor access, rough terrain, scrub encroachment and long, dark nights.

These changes have not been good for the environment or habitats of the Burren. Silage[2] feeding and housing have led to a reduction in grazing levels on the winterages and, as a result, we are seeing an increase in rank grassland and scrub at the expense of the rarer plants of the Burren such as spring gentians (*Gentiana verna*) and orchids. Silage feeding also leads to point-source pollution around the

[2] Silage is a type of fodder for livestock. In the Burren, silage is prepared by cutting grass and partially fermenting it under air-tight conditions created by wrapping the bales in polythene or storing it in pits covered by polyethene.

feeders and the karst geology means there is a high risk of the nutrients in the dung being transferred to the wetland ecosystems in the Burren lowlands leading to enrichment and disruption of their sensitive ecology. It also contributes to faecal contamination of the local water supply which has implications for human health.

9. BurrenLIFE 'Farming for conservation'

The concept of 'farming for conservation' as a means of addressing the impact of on-going farm polarisation (agricultural intensification on more productive lands and marginalisation of winterages) on the natural and cultural heritage of the Burren emerged from the studies of Dunford (2002). The BurrenLIFE Project was set up following a successful application to the European Union LIFE-Nature fund, with a five-year remit to develop practical solutions to the agricultural issues that were threatening the habitats of the Burren. In doing so, it hoped to revitalise farming on the winterages and to restore the pride of the farming community by alerting them to their pivotal role in conserving the exceptional landscape and biodiversity that their ancestors helped to create, something that most farmers had lost sight of during the concerted push for increased production and agricultural intensification of the latter part of the twentieth century.
Central tenets of the project were partnership, the adoption of practical local solutions to local problems rather than the 'one size fits all' approach often associated with agri-environmental schemes, and finally, detailed monitoring of the agricultural, ecological and socio-economic implications of the management changes.

9.1 Partnership

BurrenLIFE was the first major 'farming for conservation' project in Ireland and marked the first working partnership between the National Parks and Wildlife Service, Teagasc (the Agriculture and Food Development Authority) and the Burren branch of the Irish Farmers Association. It was 75 per cent funded by the European Union LIFE-Nature fund which supports the management and conservation of Europe's most remarkable flora, fauna and habitats, and was noteworthy for its success in bringing together all the relevant stakeholders: farmers, scientists, and the conservation, agricultural and local development agencies.

9.2 Practical local solution to local problems

The research aspect focused on 20 Burren farms (LIFE Farms) that worked directly with the project to test the ability of simple ideas based on traditional management to deliver benefits for both habitats

The Marsh Fritillary is Ireland's only butterfly that is listed on Annex II of the Habitats Directive - there are several populations in the Burren.

and farmers. Many of these ideas came from the farmers themselves and were based on their knowledge of their own land, much of which is rooted in the experiences of the generations who went before. For example, the carrying capacity of land in the Burren is so variable that it was sold or leased on the basis of the number of animals it could support for a given period rather than its area. The knowledge that a particular winterage can carry thirteen cows for six months and not an animal more, is built up over generations and is not the sort of thing that an 'outsider' can predict with any accuracy.

Conservation measures based on traditional management included re-establishing stocking rates based on the natural carrying capacity of the winterage, improving livestock access by cutting paths through scrub, restoring internal walls, improving the supply of drinking water and removing scrub during the early stages of spread onto grasslands and heaths. The work was carried out by the farmers, their families or local people who had the relevant skills and experience. This has had the dual benefit of showing that conservation work can provide local employment whilst also improving the understanding and acceptance of conservation principles that may otherwise be seen as a retrograde step when viewed against the push toward increased productivity and intensification.

Other more innovative changes, such as replacement of silage with a concentrate feed that was developed to provide the suckler-cow with the additional protein, energy and minerals she required, whilst also encouraging her to graze more, have only been fully accepted by the farmers once they have seen the positive benefits. This has proved so successful that many farmers outside of the twenty 'LIFE' farms have moved from, or reduced, silage feeding and begun to use the BurrenLIFE concentrate ration instead.

9.3 Monitoring

As it was hoped that the management recommendations developed during BurrenLIFE would go on to form the basis of a new agri-environment scheme designed specifically for the Burren, it was essential to show that they did achieve what they set out to. The monitoring carried out has been diverse but the following examples give a flavour of the way in which science and economics are being used to validate the management practices.

- Early analysis of vegetation data collected to assess the impact of improved grazing levels has shown positive benefits in terms of reductions in litter (dead vegetation) levels, increased herb cover and increases in the abundance of plants characteristic of the limestone pastures.
- Monitoring the impact of grazing on hazel (*Corylus avellana*) seedlings suggests that winter grazing by cattle will not stop the spread of the hazel-dominated scrub but will help to suppress its growth and this highlights the importance of human intervention if scrub encroachment is to be managed.
- Agricultural monitoring has shown that the BurrenLIFE model of farming for conservation can have positive benefits for animal health and welfare, e.g. a reduction in the incidence of blood scours in calves.
- The development of a nutrient export model (Bartlett *et al*., 2009) suggests that switching from feeding silage to a concentrate ration reduces the risk of nutrient transfer from the winterages to the sensitive wetland habitats of the Burren lowlands as well as reducing nitrogen inputs through the reduction, or cessation of, silage production.
- Analysis of the economics of feeding silage verses the BurrenLIFE ration shows that significant savings can be made thus improving farm viability.
- A commissioned report on the 'Socio-economics of farming for conservation in the Burren'(Van Rensberg *et al*., 2009) suggests that based on "the entire direct payments and administrative costs of the BLP [BurrenLIFE] program … the rate of return on government support for these systems is no less than 235 per cent" which highlights the potentially positive economic impact of farming for conservation.

10. Getting the message out

If they are to be successful, conservation initiatives must gain the understanding, acceptance and support of the target practitioners e.g. farmers, local communities and stakeholders as well as governing bodies at local, national and international levels.

BurrenLIFE recognised that the best way to convince the Burren farmers of the benefits of farming for conservation was to demonstrate the conservation measures on working farms. This was done through regular demonstration days on LIFE farms which provided farmers and advisors with the opportunity to see and discuss issues such as grazing levels, feeding and scrub removal.

The Project set out to create better awareness and understanding of the heritage of the Burren within the local and wider community. This was done through an extensive 'heritage-education' programme which targeted: school children and teachers; local communities and the general public; researchers, scientists and conservation practitioners both home and abroad; farming advisors; policy makers and government representatives.

Another initiative that has helped to raise the profile of farming for conservation has been the facilitation of local farmers in setting up a Burren Beef and Lamb Producers' Group. Their marketing of high quality 'conservation grade' meat produced using traditional winter grazing helps to remind people how important this method of farming is in conserving the rare and abundant flora that tourists come to see. The premium paid for this produce also helps to improve the financial viability of the farms involved.

11. Into the future

The BurrenLIFE Project has the overwhelming support of both the local farming, and wider communities of the Burren. Farmers of the Burren are now proud of the place; they no longer see themselves as living in a 'landscape of shame' as they did when trying to scratch a poor living from a difficult land (O'Rourke, 2005). Undoubtedly, this change of view has its roots in what was Ireland's new-found prosperity and the decreased dependence on farming for the main source of income. However, the BurrenLIFE Project has also played a part as it has helped farmers to see the landscape of the Burren that their forebears fashioned and they maintain, as many others see it: a place to cherish and conserve. Most importantly, the BurrenLIFE approach has been able to put the farmers back at the centre of the decision making – to ask them what they would do rather than make them abide by the inflexible rules and 'calendar farming' that are central to too many agri-environment and conservation schemes.

The Project has now completed its five-year remit, so what next? Ireland's national agri-environment scheme is currently undergoing radical change and must reinvent itself in light of the requirements of Cross compliance and 'Good Agricultural and En-

vironmental Condition' under the Single Farm Payment. Funding has been set aside by the Department of Agriculture and Food for a three-year agri-environment scheme specifically tailored to the local issues, needs and desired outcomes of the Burren. The challenge is to translate the findings of the research and monitoring carried out on the LIFE farms into a scheme that will deliver the conservation and environmental requirements and reward farmers who deliver these through the maintenance of winter grazing. The farmers of the Burren and other similar high nature value areas cannot compete in terms of agricultural production in today's global market. If we want to retain the natural and cultural heritage of these areas and all the associated benefits in terms of ecosystem services, conservation of biodiversity and contribution to the well-being of both the local population and those who visit, we must recognise that these are now the main products of agriculture and the tried and tested mechanism for their delivery must be supported. Hopefully, the findings and experiences of the BurrenLIFE Project will safeguard the tradition of 'winterage' and in doing so, help to deliver future sustainability for the Burren.

Acknowledgements

We wish to thank the EU LIFE-Nature Programme, the National Parks and Wildlife Service, Teagasc, the Burren branch of the Irish Farmers' Association, the 'LIFE' farmers and their families, and all the other farmers of the Burren who have given so freely of their knowledge and time.

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The *dehesa*/*montado* landscape

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The *dehesa*/*montado* of Spain/Portugal is a cultural landscape; a savannah-like wood pasture that is the result of prolonged human action. It works as an extensive and integrated agrosilvopastoral system where agriculture, forestry and grazing are combined in a sustainable manner.

1. Study area

1.1 Geographical coverage

It covers approximately four million hectares of the southwestern part of the Iberian Peninsula, mostly located in the regions of Extremadura (1.25 million hectares), Andalucia (700,000 hectares) and Castilla y Leon in Spain, and Alentejo (800,000 hectares) and Algarve in Portugal. The core area is primarily composed by the regions of Extremadura and Alentejo. The boundary coordinates of the area are approximately 41º-37ºN and 8º-4ºW.

The largely rural environment is associated to cities at two levels: small towns located within the area, as in the case of Badajoz (140,000 inhabitants), Caceres (90,000), Plasencia (40,000), Evora (50,000), Beja (35,000), or Portalegre (25,000), and bigger peripheral cities, which have seen rapidly increasing population, such as Seville (700,000), Huelva (150,000), Salamanca (155,000), or Ciudad Real (70,000).

1.2 Socio-cultural background

Since it comprises two countries there are at least two main cultures. Portugal (GDP per capita US$23,041 in 2009) and Spain ($35,116) were merged in former times, although the two countries became completely independent from each other in 1640.

1.3 Public services available

These services can only be described in national terms due to the size of the area. Education and health services are predominantly public and a responsibility of the autonomous regions in Spain and of the national government in Portugal. Water and sanitation are a responsibility of the local governments. While water is accessible to almost all the population, that is not the case for sanitation in villages and small towns and this service is still behind, as compared to other Western European countries.

Figure 1. Aerial view of an area of dehesa.

1.4 Natural environment

The *dehesa* extends over the foothills and gentle slopes of the mountainous areas (Sistema Central, Sierra Morena), as well as over the plateaus (Extremadura) with altitudes that range from 2000 metres above sea-level to sea level.

The climate is Mediterranean, modified by the continental influence in areas far from the sea, with hot and dry summers and cold-to-mild wet winters.
Soils are very poor in nutrients and have a shallow cover, with little capacity for moisture retention, which make arable farming extremely limited and unsustainable in these areas.

1.5 Biodiversity and ecosystems

The seminatural ecosystem is a mixture of woodland and grassland. The dominant tree species is Holm Oak (*Quercus ilex* subsp. *rotundifolia*) together with Cork Oak (*Quercus suber*) and herbaceous plants adapted to survive prolongued hot summers, cold winters, and low soil fertility. Its production and regeneration has been stabilized and is very dependent upon human action.

Three vegetation layers can be identified. A scattered, xerophytic, sclerophyllous and perennial tree layer, with 20 to 100 adult trees per hectare and 10 to 50 per cent crown coverage. Its density is very dependent on the history of the site and the treatment applied to the trees. Each individual tree develops a microclimate, intercepting rain and solar radiation, reducing runoff and mitigating the drying effect of wind. This increases the biodiversity under the tree shadow.

The herbaceous layer is seasonal, very rich in species, and with a low productivity. Finally, there is an almost absent shrub layer, controlled or eliminated with tilling and grazing. Only steep areas maintain the species richness: *Pistacia lentiscus*, gum rockrose (*Cistus ladanifer*), or *Lavandula stoechas*.

Figure 2. Dehesa landscape with holm oaks.

1.6 Threats

A number of factors are causing decay in tree density, coverage and functions in the last decades. One in particular has a particular environmental character, the disease termed seca, or sudden die-off of the trees, that has its roots in the stress caused by the lengthening of the dry season and the opportunistic invasion of a fungus.

Other important factors have an anthropogenic and historical nature. In periods of severe starvation, particularly in the 1950s, trees were cut and land was put into cultivation. Later on, the crisis of the African swine fever caused a dramatic decline of the black Iberian pig livestock –not completely recovered thus far- and the disruption of the pastoral function of the *dehesa*, which ultimately led to transform it to arable land. The introduction of non-native swine breeds, with a higher productivity, to supply an increasing demand for meat led to a steep decline of the black pig livestock. Also, the partial substitution of cattle for sheep, due to changing market demands, is increasing grazing pressure in the number of units and duration. The result is a landscape that does not already hold mixed species and multiple breeds but a single dominant species, particularly cattle.

And, more importantly, the focus of the European Common Agricultural Policy on productivity and single crops, and the unawareness of the systemic operation of this agrosilvopastoral economy led to a poor access to financial resources, and to a loss of ability to perform successfully in an agricultural market dominated by competitiveness and not by sustainability.

1.7 Local economies

The *dehesa* historically (at least during the Middle Ages) exhibits a successful integration of a rural-based economy with nature conservation and biodiversity preservation. Yet multifaceted, the *dehesa* essentially aims at extensive livestock production, so that other activities turn out to be subsidiary or complementary. Pastoral husbandry is based both in browsing and grazing. Animals forage by themselves natural pastures and low vegetation, completing shrub control, or feed on leaves, soft shoots, and fruits (oak acorn) such. Thus, shortage of fresh fodder is supplemented with browsing and grazing immature cereal crops. Every two to five years cropping is carried out to both provide for forage and control shrub species invading the herbaceous layer. Yield is in the range of 1200 to 1800 kilograms per hectare per year, depending on tree coverage.

Silviculture is based on the production of firewood, cork harvesting and the utilization of oak acorn for swine foraging, with yields of 200-400 kilograms per hectare per year, a process that runs from October until January and known as montanera. Branch pruning occurs every 10-20 years, and debarking happens every 9-12 years.

Hunting evolved from a deep-rooted complementary resource into a key economic activity detached

Figure 3. Swine foraging oak acorn in a dehesa.

from food provision since the 1960s, and associated to nature-based leisure. The principal species hunted are red deer (*Cervus elaphus hispanicus*), wild boar (*Sus scrofa*), wild rabbit (*Oryctolagus cuniculus*), or red legged partridge (*Alectoris rufa*).

1.8 Main stakeholders

Several levels of administration (European, national, regional and local) develop sectoral policies, particularly agriculture, forestry, environmental protection, and spatial planning, with an effect on local individual and social stakeholders.

Social actors such as rural development groups, who manage financial resources –structural or cohesion funds-, from the EU Commission, or environmental non-governmental organizations seeking more environmental protection play a key role in promoting developments compatible with the values of the *dehesa* or in supporting natural resource conservation.

Industrial activities based on local natural resources, such as dairy and meat industries, cork transformation, or tourism industry act as interpreters of the needs, demands, and transformations in their markets and the relationships with the landscape.

Individual stakeholders to be taken into account include private landowners, particularly holders of latifundia, landless peasants, and hunters.

2. Land utilization and natural resource management

2.1 Ecosystem services and carrying capacity

The landscape contributes to maintain the genetic variety of livestock raising traditional cattle breeds (avileña-negra iberica, retinta, Spanish fighting bull), sheep breeds (merino), black Iberian pig, traditional varieties of agricultural species, and pasture species selected by grazing over centuries.

It supports a high biological diversity and is the habitat of endangered or protected species such as the Iberian lynx (*Lynx pardinus*), a mammal formerly inhabiting the whole *dehesa* area and nowadays reduced to much smaller sites, the Iberian imperial eagle (*Aquila adalberti*), the cinereous vulture (*Aegypius monachus*), or the black stork (*Ciconia nigra*). The rise of the economic value of hunting led to the enclosure of the private plots, increasing the fragmentation of the territory, while the growth of the stock of various hunting species is increasing the pressure on the vegetation and the transmission of diseases to livestock.

The structure of the woodland, with many discontinuities, contributes to prevent wildfires and to avoid the erosion process by reducing runoff. Farming helps to fix population in rural areas, which do not have an alternative industrial activity, to mitigate urban growth and organize large unpopulated areas with small villages.

2.2 Integration of traditional ecological knowledge

The *dehesa* is the result of a continued process of adaptation of human populations to a harsh environment and the transformation of the natural ecosystem while keeping its basic components, functions and relationships. The species and breeds introduced make an optimal use of the multiple resources available in each layer throughout the year. Both extensification and transhumance had the purpose of diminishing the livestock load in the dry season, in the second case by displacing herds to northern pastures, and in the first by reducing the number of heads per area. A particular case is the *dehesa* boyal (oxen *dehesa*), a collective property owned by the village for the exclusive foraging of working animals (cattle, horses or mules).

The sustainability and efficiency of the agrosilvopastoral system has been demonstrated by its ecological stability for centuries.

2.3 Optimization of ecosystem services

The poor content of organic matter and nutrients of soil, particularly in certain areas, is sometimes modified by enclosing sheep herds and promoting intensive grazing. This grazing livestock will deposit their droppings over a smaller area. The induced fertilization produces a local improvement in plant biodiversity, with 90 per cent coverage of *Poa bulbosa* and species of the genus *Trifolium* (clover), and quality of the pasture, a landscape unit usually termed majadal. This unit is clearly distinctive for its higher production, earlier growth and later withering. The majadal remains fallow in summer to allow for the species regeneration.

Cinque Terre National Park: Where farmland meets the sea

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1. Study area description

1.1 Main geographical features

Cinque Terre National Park covers an area of about 3,800 hectares in the Province of La Spezia, Liguria Region (figure 1). It extends for 20 kilometres in length along the coast and it borders with the Liguria and Tuscany regions. It is located on the north-western coast of Italy between the Promontory of Mesco to the west and Persico Point to the east.

It includes the entire municipalities of Riomaggiore, Vernazza and Monterosso al Mare and some areas of La Spezia and Levanto. The name "Cinque Terre" (i.e. "five lands") derives from the three villages and their hamlets, Manarola and Corniglia.

It is a typical Mediterranean area modified by man during centuries to produce a unique landscape characterised by steep hillsides that drop down to the sea and are marked by a geometry of terraces held up by dry stone walls cultivated with vineyards (figure 2). The landscape has been recognized by UNESCO as a world heritage site.

1.2 Socio-cultural features

About 4200 persons live in the area. Archaeological discoveries, descriptions, place-names and cartography allude to Roman origins for the first settlements of the Cinque Terre (like the Tabula Peutingeriana and l'Itinerarium Ravennate). What is certain is that from early medieval times to the end of this century, wine growing represented the most common type of agricultural production and the only one to be widely commercialised.

Figure 1. Location of the study area

1.3 Natural environment: topography, altitude, climate, vegetation, and soil

The Cinque Terre National Park is a natural oasis of uncontaminated environment. The landscape is made up of rocks from different origins and periods and is characterised by a peculiar gradients and absence of flat stretches. The coast, high and jagged, is linear and hardly has any inlets or promontories. The sea is pleasant and carved by evocative caves.

The territory is formed by very steep slopes, etched with streams of moderate seasonal flow, running sub-orthogonal to the coastline and descending steeply from the watershed ridge of Val di Vara, which rises 600 to 800 metres on average, sometimes at less than one kilometre from the sea (figure 3).

The few sandy and stony beaches are the result of detritus carried by water, landslides or the accumulation of material left by man.

The mountain chain shelters the coastline from northern winds, while hot and damp currents from the sea hit the mountainous buttresses with consequent condensation of water vapour that is transformed into fog on the hill tops and frequent rainfalls at high quotas. The climate is Mediterranean with dry summer seasons and particularly mild winters. Orographical complexity has led to a variety of microclimates consequently with a diversification of vegetation. Ilex woods have partly been substituted with cultivated land or with other arboreal species like cluster pine, cork oak and chestnut.

In the coastal environments, sea fennel and daucus gingidium are found near capers, which were hitherto actively cultivated. In rocky environments, beside sea groundsel, there are two-coloured groundsel, rue and other varieties; in wider cracks of the rocks there are arboreal euphorbia and numerous species typical of the Mediterranean maquis.

Throughout the territory, one can find smaller bushes like rosemary, thyme, helichrysum and lavender. Arboreal and mixed macquis formed by lentisk, myrtle, terebinth, broom, strawberry-tree, mock privet and juniper create a dense and intricate wood of creepers such as smilax, madder, fragrant virgin's bower, asparagus, and honeysuckle.

The Cinque Terre National Park is naturally a pleasant habitat for various species of fauna, which find

Figure 2. The characteristic terraces of Cinque Terre area

ideal conditions here for daily life and reproduction. Avifauna species include the Herring Gull, Peregrine and Raven. Mammals include the dormouse, weasel, mole, beech-marten, badger, fox and wild boar. In wooded areas it is easy to admire the wall-climbing lizard, green lizard and some snakes like the coluber and viper; near streams there are frogs and splendidly coloured salamanders.

A colossal undertaking gave way to a unique and unrepeatable landscape. The human activities are noteworthy today due to changes in socio-economic equilibrium that have led to progressive abandonment of traditional cultivation.

From a geological point of view, the Cinque Terre presents characteristics of considerable interest, in fact in the area there are rocks of different origin and age surface, placed in a complex manner.

1.4 Biodiversity and ecosystems

The environment of the Cinque Terre has been profoundly modified by man over time through the moulding of the slopes for the cultivation of grape vines, citrus fruit and olive trees, yet thanks to the climatic conditions, the orographic characteristics and the distinctive geological constitution of the area can be identified within a variety of environments (figure 4).

The fires that frequently develop in the area, above all in the summer months, are one of the strongly influential elements on the ecological dynamics of the area and the consequent nature of the vegetable landscape.

The vegetation is Mediterranean, even if in the analysis of the corologic spectrum the presence of eurasian and cosmopolitan species emerge: depending on the classification in the high plains there are species of horizons belonging to the basal or piedmont plains which develops at 900 metres above sea level. It concerns the following three horizons:

1. the coastal halophytics
2. the evergreen mediterranean sclerofilles
3. the broad leaved thermophiles

In the first horizon in which there are plants that can tolerate high quantities of salts, it is possible to recognise the formations of marine rocks, characterised by the presence amongst the other species of *Chritmum maritimun, Daucus gingidium, Catapodium marinum*.

The Ligurian landscape favours the Euphorbia formation, in fact the *Euforbia arborea* is a typical shrub found in the area, it settles on stony ground and debris or in abandoned areas characterised by rocky and well drained terrain. The *Asparagus acutifolius* and *Asplenium onopteris* are also part of this formation, together with other species found in the holm-oak groves. Close to the calcareous outcrops this formation differentiates itself by the presence of *Ampelodesmos mauritanica*.

The second horizon of noteworthy interest contains the most typical aspects of the coastal landscape of the Cinque Terre. This vegetation horizon is characterized by the Mediterranean bush, dominated by the holm-oak (*Quercus ilex*), (*Pinus pinaster, Pinus halepensis*) pine and cork-oak woods (*Quercus suber*), while the garrigues (low, degraded scrubland) is associated to superficial soils and rocky outcrops. The main species of the garrigues to note are *Helichrisum italicum*, *Thymus vulgaris*, *Euphorbia spinosa* subs. *Ligustica, Genista salzamnii, Santolina ligustica* (typical of the ophiolite outcrops).

In the bush there are different types of shrubs (*Pistacia lentiscus, Arbutus unedo, Myrtus communis, Cistus salvifolius, Erica arborea, Rhamnus alaternus*) and trees such as *Quercus ilex, Pinus pinaster, Pinus halepensis,* and *Pinus pinea*.

In the broad leaved thermophile horizon there are the chestnut woods mostly at a height of 450 meters, oak woods and mixed forests. The most representative species of this horizon are *Castanea sativa, Quercus cerris, Ostrya carpinifolia* and *Quercus pubescens.*

1.5 Local economies

The larger part of the inhabitants derives its income from tourism activities; many of them are commuters towards La Spezia or Genoa.

Agriculture still has an important role in the local economy, especially for the production of the Cinque Terre Bianco DOC and Sciacchetrà DOC wines (figure 5).

1.6 Main stakeholders and agencies involved in the management of the area

The management of the protected terraced area is entrusted to the Ente Parco Nazionale delle Cinque Terre (a national public body), according to the Italian law on protected areas (number 394, year 1991). It acts in agreement with the different administrative bodies: the regional level, the provincial level and the municipal level.

Several environmental and social associations are involved in work experiences, educational training in the field to learn how to build dry stone walls, etc.

The National Park also has a strong network of relationship with research groups from all over the world and a continuous exchange of experience with other UNESCO sites, especially "cultural landscape", thanks to specific twinning programmes.

2. Land use and natural resource management

2.1 Evaluation of impacts of resource utilization and management schemes on biodiversity

The institution of the National Park had a positive effect on the conservation of the terraced system and on the species that live in this Mediterranean region, especially with respect to avoiding fire events, thanks to the recent presence of men on the field and a good monitoring action.

The area could be threatened by long and short-term risks:

• the hydrogeological risk, caused not only by the extreme steepness of the coastal slopes, but also by the instability of the dry structures that support the slopes, due to the abandonment of the traditional agricultural activities as a result of the small financial return for entrepreneurial activity, at least until recent times.

• The unexpected dimensions of the growth in tourism in the last few years, which, in addition to compromising the equilibrium of the delicate eco-system through their impact, risk transforming the cultural identity of the community, resulting in the loss of sense of place and tradition which have become part of a collective heritage at an international level.

2.2 Landscape management and biodiversity conservation

The agro-ecosystems of the Cinque Terre National Park play an essential role in biodiversity conservation. In the past, the native grapevine of this area suffered from the attack of the Phylloxera (*Daktulosphaira vitifoliae*) that spread in Europe in the second half of eighteenth century and in Cinque Terre area around the 1920s. Among the threatened grapevine there were the Razzese or Rossese, the Picabon, and the Brusapagià.

With the objective of rescuing these grapevines, which had almost completely disappeared, a joint project between the National Park and the Italian

Figure 3. High resolution remote sensing data to monitor the status of the Cinque Terre area

Figure 4. Human settlements, vineyard terraces, Mediterranean maquis and coastline in Cinque Terre

Council of Researchers was started in 2005. The following year (2006) another project, with similar objectives was funded by the Italian Ministry of Agriculture. Thanks to these activities and to the conservation of traditional landscape management, more than 1,200 grapevines belonging to endangered cultivars are now growing on the terraces of Volastra and Manarola.

The rich mosaic of Mediterranean vegetation and cultivated areas, typical for the protected area, is an example of the deep relationships between natural area and human shaped landscape.

2.3 Application of Traditional Ecological Knowledge (TEK) and practices and their integration with modern scientific knowledge

Traditional knowledge was fundamental for building a landscape that is the result of a collective project undertaken by the local community during centuries. The impossibility of introducing mechanical machines in the area, other than through the little monorail that brings the boxes full of grapes during harvest time, contributed to preserving the TEK. The older generation is the one who knows how to build the dry stone walls and their knowledge has to be transmitted to future generations. In fact, the dry-stone walls were built exclusively from rocks carefully positioned one on top of the other and filled with crushed stone and earth, without using any cohesive material. The good quality of the stones and above all the masterly art of positioning the rocks guarantee against frequent collapses.

Today modern scientific knowledge completes the traditional one to manage the landscape using geographic information systems (GIS) and to try to reintroduce indigenous wine seeds such as Rossese, Piccabon, Bruciapagliaio and Frappelào, for which the Cinque Terre has been known since the Middle Ages.

2.4 Maintenance of TEK

Today the terraces and the dry stone walls are still built by the hands of the farmers. The way in which the wine is produced is still traditional.

The adoption of several educational programmes should ensure the transmission of TEK to the next generations. Some of the technologies used in the area have been introduced from other sites. The use of monorail, for instance, was introduced in the area at the beginning of the 1980s after a visit of some local farmers in the Alps region.

All the transformations in the land use are planned and ruled by specific planning instruments (such as the Plan of the Park or the Rural Development Plan) and national and regional laws.

The Cinque Terre landscape is characterized by the terraces that form a territorial belt extending almost continuously from the promontory of Mesco to Punta Persico, sometimes starting at sea level or just above the rocky inaccessible walls up to 350-400 metres, with peak points that exceed 500 metres or more taking into consideration that the highest points have been abandoned for some time and covered by pine forests. It is assumed that the work of terracing began between the twelfth and thirteenth centuries.

There are three different types of walls that can be identified:

- dry stone walls (two types, the first is levelled with the plane of use and the second is above the plane of use for protection, water channelling and walking)
- walls stone-bound by lime mortar, allowing the building of higher walls (used for more precious cultivation such as lemon orchards)
- grassy edges (slightly sloping clay terrain with little stone material)

Dry stone walls vary in height depending on the steepness of the slopes while their length depends on the morphology of the slopes and the fragmentation of the territory. Walls with raised tops with respect

Figure 5. Grape harvest using the little monorail

to the cultivation plane are found above all in the eastern area of the Cinque Terre, which is largely exposed to winds and where it is necessary to remove excessive amounts of stone from the terrain.

Walls with stones bound by mortar are found mainly in the area of Monterosso and Vernazza, in terrain where there is cultivation of citrus fruits and greater availability of water. In this case, also due to the more favourable morphology of the slopes with respect to other areas, the walls reach greater heights and also mark property boundaries.

Grassy edges are found in clay terrain with slopes that are not very elevated and where there is a scarcity of stones, as in several areas in the municipalities of Monterosso and Vernazza, belonging to the catchment basin of the Val di Vara.

The traditional, low pergolas played an important role in determining the perception of the landscape of the terraces cultivated for wine, above all in past years. They characterise the slopes giving them an almost natural aspect and are different from the method of cultivation in rows, which is easier and requires less physical stress for those who cultivate them. The use of the pergolas makes the soil of the terraces visible and changes the aesthetic aspect of the landscape. It is characteristic of several areas of the Park, above all in the eastern areas, where the pergolas are protected from the wind by dried heather branches. It is still possible to see the use of this technique in many terraced areas.

The decision-making process aims to involve all the different stakeholders, especially the private farmers and the member of the cooperatives. The political system is based on having the agreements of all public bodies involved in the management of landscape.

The Plan of the Cinque Terre National Park has introduced some specific regulations to protect the site. For example, a specific article provides for landscape and environmental recovering projects and for sustainable tourism. The article states: "in order to achieve the aims of the Park, the enslavement of urban interventions in the Cinque Terre National Park area is subject to effective farm production in plots of lands and the maintenance of the cultivated terraces of the dry-stone walls, of the path system which connects the fields and of extraordinary interventions which do not concern the insertion of a new hygienic service in the buildings."

It is also possible for private and public persons (in this case the national park) to enter into an agreement in order to let a specific entity maintain the land, restore it and benefit from its use for a period of twenty years. At the end the parties can decide to continue or not. This gives an added value to the landscape that can be conserved and restored.

People can sell their products (grapes, lemon, basil etc.) to the cooperatives that engage in the production of wine, lemon marmalade, pesto, and sauces. Organic products are worth more than the traditional ones.

Several specific activities which contribute to the improvement of human-well are performed in the area, such as ecotourism, valorisation of local products and the application of new technologies and possibilities even in a difficult area.

3. Conclusion

The Cinque Terre area represents an example of the equilibrium between human activities, sustainable use of natural resources and landscape and nature conservation. However the fragility of this kind of territory requires human intervention, and the abandonment of agricultural activities on the terraces has quickly led to the disappearance of this valuable landscape, recognized by UNESCO as a World Heritage Site. The successful work conducted by the Cinque Terre National Park to promote agricultural use of the territory demonstrates that even in highly vulnerable territories it is possible to achieve the conservation of the landscape and of nature in a sustainable way.

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Challenges in collective action for natural resource management:
A study of common property regimes in the municipality of Guitiriz (northwest of Spain)

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1. Introduction

Traditional agricultural landscapes of Japan, known as *satoyama* landscapes, consists of a mixture of forests, ploughed fields, grasslands and villages (Kobori and Primack, 2003). As Sauer (1925) pointed out, the work of mankind is expressed through landscape. Being so, it should not be surprising that these types of landscapes have common characteristics in terms of their management by local communities, due to similarities and difficulties of agricultural activity. There are several definitions of *satoyama*. According to Kobori and Primack (2003), the oldest definition is forest managed by local agricultural communities. This definition relies on the importance that young and fallen leaves produced in these forests could have as fertilizer to the wet rice paddy fields, and brings to mind the role that forests have had in traditional agroforestry systems. The traditional agroforestry system of Galicia, a region in the Northwest of Spain, is not much different: many authors have showed how common lands[1] were used to support agricultural production in the cultivated lowlands (Fernández Leiceaga *et al*., 2006; Calvo-Iglesias, Crecente-Maseda and Fra-Paleo, 2006; Bohuier, 1979).

In the last few decades, however, agrarian systems in general have suffered a wide range of changes. Common lands, in particular, have progressively lost their supportive function of agriculture. Many of the causes of this loss of function are as common for *satoyama* landscapes in Japan as for common lands in Galicia, like the impact of energy revolution, the introduction of inorganic fertilizers and the ageing of rural populations (Fernández Leiceaga *et al*., 2006; Fukamachi, Oku and Nakashizuka, 2001). Such developments and changes in land-use practices have caused a dramatic decline of these landscapes and the associated wild species (Kobori and Primack, 2003). In this work, we outline the main characteristics of common land in a municipality of Galicia (Guitiriz), how its role in the agroforestry system has evolved, its effects on landscape, and what perspectives exist for the future.

[1]From the legal point of view, the definition of common land remains a complex task. However we could define common land as piece of land in private ownership, where people, known as commoners, have certain traditional rights to use it in specified ways, such as for grazing for their livestock or for gathering firewood.

2. Overview of the study area

The municipality of Guitiriz is part of the region of Galicia, in the northwest of Spain. It is located between 7º41' and 7º57' west and 43º5' and 43º 20' north, covering a total area of 294 square kilometres (figure 1). The terrain is formed by gentle, rolling slopes and the altitude ranges between 400 and 800 metres above sea level. The climate is typically oceanic, with usually moderate temperatures (the monthly average temperature ranges between 5 and 17 degrees Celsius) and abundant and evenly distributed rainfall (annual average of 1000 millimetres), although there is always the possibility of a short drought period in the months of July or August. As a consequence, the natural ecosystems would be dominated by formations of deciduous hardwood trees, mainly of the Fagaceae family, usual in the European Atlantic coast. Strong human pressure, though, has historically prevented these formations to represent anything but a marginal land cover in terms of total area occupied, much to the favour of agricultural land or man-made afforestations with *Pinus pinaster*, *Pinus radiata* and, more recently, *Eucalyptus globulus*. Total forest area has dramatically increased in the last fifty years and currently accounts for 36 per cent of the municipal area (Corbelle and Crecente, 2008a).

The evolution of the population has been characterized by a steady decrease for more than fifty years, from about 11,500 inhabitants in the middle of the twentieth century to 5,974 in 2007 (INE, 2009a). Population density, at 20 inhabitants per square kilometres, is much lower than the Spanish and Galician averages (87 and 94 nhabitants per square kilometres, respectively): this is the result of a long tradition of migration in search of better employment opportunities, and as a consequence the remaining population shows a large proportion of elderly people (31 per cent is older than 65). High population dispersion, with more than 310 different settlements, is another important aspect that can explain the complexity of the Galician landscape. Agriculture has traditionally been the main source of employment, and even in the present it still occupies more than one third of the working population. Most of these jobs are generated in small familiar farms that

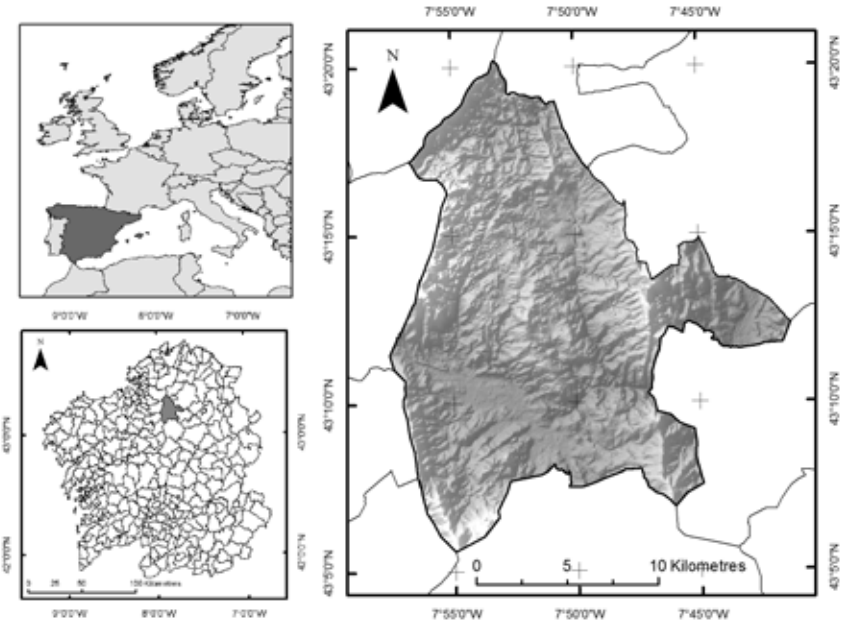

Figure 1. Geographic location of the study area: Guitiriz (Galicia, Spain)

make use almost exclusively of family labour. In correspondence with the tendencies already mentioned for the total population, the number of farms descended from 2009 in 1962 to 1259 in 1999 (INE, 2009b). The closure of farms is normally associated with a lack of economic viability, lack of succession, or both (Sineiro *et al*., 2004). The lack of economic viability is usually coupled to the small dimension and high fragmentation of farms: the average farm area is 15 hectares, typically divided into many different land parcels.

3. The use of land in the traditional agricultural system

The agroforestry system present in the area until the second half of the twentieth century was characteristic of most of the region and is well-documented in the literature (Bouhier, 1979). The system was centred on the existence of contiguous arable fields ("agras") belonging to different owners, with no internal physical separation between them, but jointly delimited with small stone walls from the rest of the territory. Each human settlement had usually two or three of these "agras" at its disposal, distributed so that each family had at least one plot in each one: cultivation in the "agras" consisted in a two-year rotation in which wheat, potatoes (sometimes corn), and turnips were planted in succession. All the plots in the same agra were planted with the same crop at a given time, so the system ensured not only that the village obtained one potato and wheat harvest each year, but that each family also got a share of each. Animal husbandry, a rather marginal activity at the time, at least in terms of the land devoted to it and the share of the total family income that generated, was mainly supported by the existence of small parcels devoted to pastures around the agras. In addition, some other small parcels, particularly those located closer to houses, were used to grow vegetables.

One striking feature of the agroforestry system described above was the fact that only a small fraction of the territory was devoted to agricultural production, while a large part of it (up to 50 per cent, Corbelle and Crecente, 2008a) was left to be occupied by shrubs and woody vegetation. This contrasted with the situation in other areas of the Atlantic coast of Europe, where the proportion of land devoted to arable land and pastures was generally higher. The secret, well guarded from the occasional observer, lay in that most of that vegetation was actually forming part of the system, and a very important part indeed: those lands were occasionally ploughed to produce a cereal harvest, then seeded with shrubs of the Leguminosae family (*Ulex* spp). Shrubs would then provide extensive pastures during the first years and organic biomass to fertilize arable lands from there on to the next plough, maybe ten years later. Extensively used shrublands were thus an essential part of the agroforestry system, ensuring that the productivity of the arable lowlands remained at acceptable levels.

In most cases, shrublands were assembled in a form of common property which made it possible for all villagers to enjoy the right to make use of it: shrublands could either not be associated to any particular subdivision of the common land, or in some other cases a more formal assignment of common land was made to each family in the village. The advent of inorganic fertilizers and mechanization that took place from the decade of 1960 greatly transformed the role of most of those common lands in the agricultural system.

Nevertheless, these changes had probably begun considerably before the generalization of inorganic fertilizers and other innovations. In the eighteenth century, the use of common land was intensified. As

Figure 2. An example of the typical landscape corresponding to the traditional agricultural system: the light-grey parcels to the left form three "agras". The Northern and Southern agras (the lightest shades of grey) were apparently planted with wheat and have already been harvested, while the central ones are still planted with potatoes or corn.

early as 1860 afforestation activities started to take place in Galicia, predominantly oriented to timber production. The economic and social changes that took place in this period would be the origin of the communal property breakdown: although traditional practices would continue until well in the middle of the twentieth century, the seeds of broader individualization processes had been sown. The crisis of communal property would be intensified due to the confiscation processes initiated by the State in 1855 (Balboa López, 1990). Thus, the process of communal property individualization would be aggravated due to: 1) the growing distrust with respect to insecurity in the legal status of common property (until the 60s of the twenty century, this kind of property was not legally recognized), 2) the need to increase yields due to population growth, and 3) the tendency of State forest officials to manage land using criteria completely alien to the local agricultural system (Fernández Leiceaga *et al*., 2006).

From the decade of 1940 onwards, the forestry policy of the dictatorship was aimed at turning Galicia into the biggest regional producer of timber in Spain, with afforestation projects having their heyday in the period 1952-1961[2] (Rico Boquete, 1995). The State appropriation of common lands to carry out afforestation led to intense conflict with local communities, which in the end paved the way for the definitive devolution of common land to their legitimate owners. The Forestry Act of 1957 became a milestone by recognizing the existence of common lands for the first time. The Act of 1968 would recognize that the property of these lands actually corresponded to the neighbourhood communities, and set the basis for the 1980 Act which established the process to classify the area of common land.

The area of common land in the municipality of Guitiriz, according to the official cadastre, is 8344 hectares, which accounts for 23 per cent of the municipal area (this is around of the Galician average, 22 per cent). Common land thus has great territorial importance in the region. The current use of this land is mixed, as it comprises pine afforestations, shrublands, pastures, and others (figure 3).

In the municipality there are currently 14 Association of Common Land Owners (ACLO) to which are associated a total of approximately 1,670 members. The largest ACLO is the community of San Xoán de Lagostelle, with almost 1,100 ha and 600 members. As we can see in the figure 4, the correlation between ACLO area and the size of its membership is very weak.

4. Existing planning activities

Land fragmentation and low agricultural area per farm caused the costs of agricultural activity (in Galicia and in Guitiriz in particular) to escalate up to levels that hamper the economic viability of farms. Therefore, planning activities have been largely aimed at optimizing the efficiency of land-based economic activities that could promote sustainable development in rural areas (Ónega-López, Puppim-Oliveira and Crecente-Maseda, in press). Although some of these planning activities, such as land consolidation plans for arable lands, have been somewhat effective in avoiding land abandonment and its consequences (Corbelle and Crecente, 2008b), one of the major causes of inefficiency of Galician farms, the low average of agricultural area per farm, has yet to be addressed. This is due to the fact that land consolidation does not increase the agricultural area of

[2]Afforestation continued afterwards, but not with the same intensity.

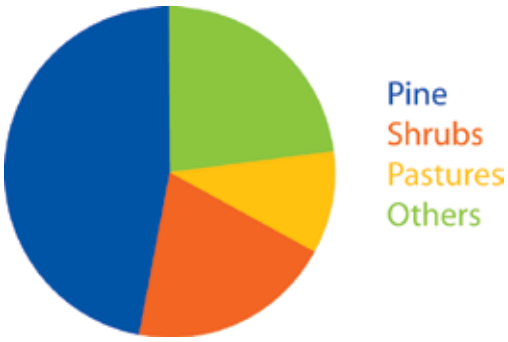

Figure 3. Main land uses of common lands in Guitiriz

farms, but only aggregates plots of the same owner.

Planning activities in relation to common lands have taken this problem into account. The «Improvements in Private Common Land Program» (1984-1991), later called «Improvement and Management of uncultivated and underused land Program» (1991-1997), and finally replaced by the Conservation Measures of the Landscape and Prevention of Erosion on Forest Grazing Systems (from 1997 to the present)[3], seek to achieve the economic (increased available land for farming), social (greater social cohesion around the importance that common land may have for the village), and environmental (reduction in the number of wildfires, landscape conservation, conservation of ecological balance) benefits that communal management of pastures in common lands can produce. Two ACLO of Guitiriz still continue with the program. However, most communities are usually more devoted to wood production than to agricultural practices (only 23.5 per cent of the total area is devoted to pastures in Guitiriz, while in other neighbouring localities, as Sarria, this accounts for 60 per cent of the common land). Although the primary reason that communities have to subscribe to this program remains advice from administration staff, there are increasingly more communities that seek opportunities in the program to improve the environmental and landscape management of their lands (García Arias, 2003).

[3]Note how these plans have evolved from having more economic purposes to more environmental objectives.

5. Participation of stakeholders

All Associations of Common Land Owners (ACLO) are legally required to designate a governing board formed by a president, secretary, treasurer and appointed members. Any neighbour having his/her usual residence in the parish where the common land is located is automatically considered, *ipso iure*, a member of the ACLO. Stakeholders are entitled to participate in democratic assemblies where decisions are made collectively. The number of meetings per year is established in the ACLO statutes (in the case of Guitiriz, there are communities with one annual meeting and others with more that four per year). During the establishment of the ACLO, it is decided who will use the land resources, what uses are permitted, the area of these uses, etc. In addition, the community decides on the destination of generated incomes. Whenever a ACLO is not constituted, or it is not active, the management of the common land may be carried out by the Administration. In many cases, ACLO constitution took place after the Administration took charge for some time. Also, it is rather common that the governing board of the ACLO decides to manage these lands jointly with the Administration through an agreement between both parts. In the case of Guitiriz, almost 60 per cent of the common lands are managed jointly with the regional Administration (Xunta de Galicia), in which case the area is almost entirely afforested with pines.

Regarding the social profile of ACLO members, a large proportion of them are retired or no longer engaged in professional agricultural activities. This explains why common land management has been almost completely decoupled from farming activities. On the other hand, several decisions that are put to

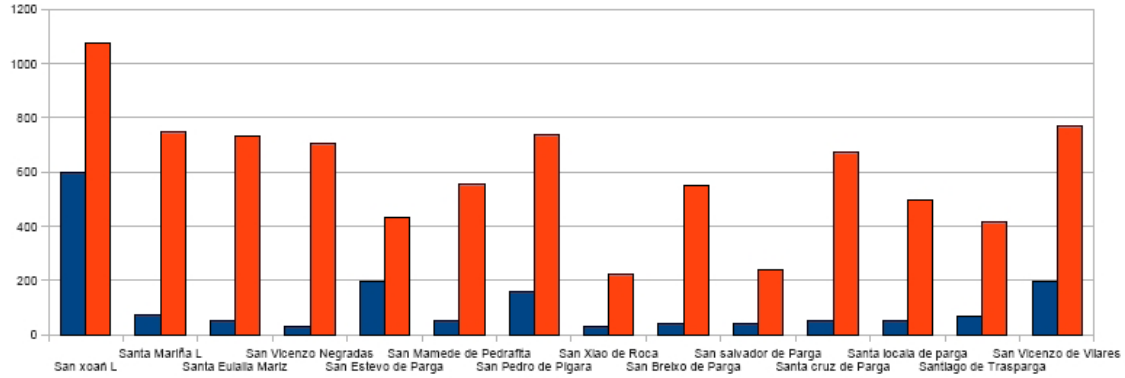

Figure 4. Area managed by Associations of Common Land Owners (ACLO) in Guitiriz (red) and number of associated members (blue).

the vote in the assemblies come from technical staff of the regional Administration, which manages, on behalf of the community, subvention application procedures, firewalls executions, etc. In the best of cases, these proposals are forwarded by the governing board to the ACLO members. Usually, members of the community are not aware of how the common property is in effect being managed by the administration.

6. Contribution of these practices to well-being

Benefits of common property can be classified intro three closely-related categories: economic, social and environmental benefits. Economic benefits, such as financial income, are currently generated mainly from wood sales, land renting for quarries and wind farms. These financial income sources may have two destinations: they may be used to fund improvements of local infrastructure, or they may be shared (in whole or in part) amongst the community members. In Guitiriz, only four ACLO share the financial income, while the other 10 devote it entirely to the improvement of local infrastructures.

However, if the concept of economic benefit is expanded, we note that common lands do not only generate a benefit from production, but also recreational and environmental benefits. Fernández Leiceaga *et al*., (2006) carried out an estimate of these economic benefits in common lands of the province of Lugo in 1997, which is shown in table 1.

Social benefits are, however, harder to measure. It could be argued that community management of environmental resources enhances active democratic processes, or forms of collective action, by improving social capital. This improvement of social capital could also, as pointed out by authors such as Mukhija (2005), reduce transaction costs. Thus, communities with collective management of resources should "work" better on a wide range of economic, social and environmental issues. Yet this argument has not been demonstrated for the municipality of Guitiriz, where meeting attendance is considerably higher than in other municipalities. This is because participation in the collective management of common lands is not directly made by the owners but, as indicated above, only by a team of technicians, which are not usually trained to deal with the complexity of collective property. High attendance at meetings therefore does not imply a high degree of interest in participating in collective management.

Table 1. Economic estimate of benefits generated by common land in the province.
Source: Fernández Leiceaga et al. (2006)

Origin of benefits		**Economic estimate (Euros/hectare)**
Production	Wood	106
	Pastures	9
	Fruits and mushrooms	1
	Hunting	1
Recreational-leisure		24
Environmental (carbon fixation)		70
Total		211

On the other hand, the management of these resources is no longer a social dilemma for the communities. Ostrom (1998) points out that solutions to social dilemmas[4] in resource management depend heavily on the creation of reciprocity rules. The lack of these rules in most ACLO shows that they are not dealing with a real social dilemma . ACLO has evolved from a common ownership with individual use (many users with the same interest) to a common property of collective use, with fewer users but with divergent interests. Although ACLO in Guitiriz have shown they can be profitable, this has not helped to create a true communal management, because as Pagdee, Kim and Daugherty (2006) pointed out, resource value and even common property dependency have no association with a successfully common management. Social success (and therefore economic and environmental success) of community management depends, as noted by Ostrom (1990), more on the future expectations of individuals, based on the institutional security, that they and their children will enjoy it. This is perhaps the greatest challenge the ACLO of Guitiriz faces, where most members are retired and elderly and do not see intergenerational transfers.

7. Conclusions

In this work we have tried to explain how the Japanese concept of *satoyama* can be applied to and has evolved over time in the Galician municipality of Guitiriz. So we have seen how ACLO has evolved from a common ownership with individual use to a common property of collective use. In the case of Guitiriz we note how the concept of common land lost much of its old meaning (due to historical, social and economic reasons), while the concept of common forests seems to be the best expression to depict the current situation of this kind of property. This is so because today we cannot speak of an agroforestry system, where common lands (pastures, forests, shrublands) are in symbiosis with pri-

[4]A large number of situations in which individuals make independent choices in an interdependent situation (Dawes, 1975 and Dawes, 1980).

vate arable lands. Instead, it is a system in transition, where traditional agricultural practices have been heavily modified by fertilizers and mechanization, and where shrublands are no longer the energetic support of the system. On the other hand, common forests have proved to be one of the best alternatives to avoid abandonment of common lands, since they require a less intensive use and are thus less demanding in terms of work (Corbelle and Crecente, 2008b). As seen before, community property in Galicia has faced several historical setbacks and is a kind of property that is still under dispute. The strengthening of this kind of ownership will require probable changes in the legislation, because the future of ACLO can never be sure as long as central governments are reluctant to transfer management authority to local communities (Pagdee, Kim and Daugherty, 2006). Although some planning activities aimed to reinforce community management of the common property, they have not had the expected results in this municipality. However, Guitiriz is an example of how it is possible to prevent common land abandonment thought the constitutions of ACLO. A better engagement of stakeholders in common resources management still remains a difficult task. Societies are becoming more fragmented, and agreement is difficult to achieve among individuals who are not symmetric in assets and payoffs (Ostrom, 1998). As Healey (1998) points out, social networks formation and capital building remains a challenge that planning initiatives have to overcome. New planning proposals will in the future perhaps become more associated with new uses, such as recreation, leisure activities and energy production, and if community management of the natural resources is the goal, institutional capacity-building for communities will be required.

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Landscape management in Germany

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1. Introduction

The original natural vegetation of southern Germany consisted chiefly of deciduous broadleaf forest composed mainly of European Beech (*Fagus sylvatica*). However, most woodlands have been converted into farmlands for many centuries. On average, woodlands cover one third of Germany with a higher percentage in mountainous areas whereas woodland cover can be very low in highly productive landscapes. Therefore, arable land, meadows and pastures make up a large percentage of the land. The rural landscape in southern Germany is said not to have changed since medieval times.

However, the rural landscape is influenced deeply by agricultural and environmental policy. The initial purpose of Common Agricultural Policy (CAP), which was implemented in the 1960s by the European Union, was the stability of farmers' income and self-sufficiency in food. After the policy was established, the agricultural sector of several European Union countries faced severe difficulties because of excessive competition and production. Among them, Germany was quick to shift into more environmentally-conscious rural development policy by making a fundamental revision in their rural developmental law in 1976. The European Union also shifted the focus of CAP onto the preservation of rural environments and assistance for sustainable production. Moreover, the European Union developed its environmental policy by establishing a council directive on the conservation of wild birds in 1976, a council directive on the conservation of natural habitats and of wild fauna and flora in 1992, and the Natura 2000 Network in 2004, which comprises both the Bird and Habitats directives.

2. Diversification of agricultural management

The cultural landscape has been almost unchanged, but the farmers who manage the landscape had to overcome major disturbances and troubles with their farm operation. They adopted several strategies to improve their situation. Many of the former farmers who reside in rural areas have become corporate employees or factory workers. It allowed those who continued to be farmers to lease more land and to operate larger farms.

Two dairy farms were interviewed: farm 1, a goat farm (goat cheese production and sales), and farm 2, a cow breeder (direct restaurant management).

Common German rural landscape

Farm 1 comprises 170 hectares of total managed area, of which 100 hectares is pasture and 70 hectares is farmland, and 29 hectares is self-owned property. Farm 2 consists of 170 hectares of total managed area, of which 140 hectares is pasture and 30 hectares is farmland, and 35 hectares is self-owned property. The major impact of rural development policies was contributing to the reduction of farm managers and increasing farming area.

The number of farmers decreased, and even those who continue to operate farms have difficulty in turning a profit from farm products alone; therefore they attempt to diversify their management by, for instance, selling value-added processed products or partnering with tourism. In the case of the goat farm interviewed, they switched from cows to goats and started producing and processing goat milk into cheese. They acquired advanced manufacturing technology, which enabled them to earn an award from the Agriculture and Forestry Minister, and have been promoting their sales activity to supermarkets and coops for two generations.

In the other farm, the direct management restaurant owners generate the major part of their income from cow breeding, but they have a restaurant business which has become a major tourism spot with people coming in sightseeing buses. The restaurant is mainly run by their daughter and son-in-law, and the parents manage the farm and provide meat, sausage, ham, cheese, butter, bread, cakes, vegetable and fruits to the restaurant. It is literally direct delivery from producing area, and the beef is also produced within the farm to be served fresh to the restaurant customers. Not only is this restaurant located in the center of pasture, it also serves as a touring farm.

Moreover, governmental subsidies and technical support were granted for recycling and bio-gas generation to this farm about 15 years ago. Since then,

cow dirt, a byproduct of breeding, is converted into bio-gas and liquid fertilizer which is applied to the grass as high quality manure. The bio-gas, on the other hand, is used for electric generation for lighting, refrigeration, and heating. There is no odour which often is associated with breeding farms. In winter when there is snow accumulation, the cows are kept in the cattle shed. During that time, the cow dirt can be collected in concentration and recycled; therefore the electricity becomes almost entirely self-sufficient.

3. Natura 2000 and forest management

The state forest, which spreads behind the meadow, is managed by the timber industry and other forestry business. The timber market in Germany has been dominated by conifers such as fir, but broadleaf trees have come back to the market recently. Spessart State Forest is an upland region of deciduous forest dominated by European beech (*Fagus sylvatica*) and Sessile oak (*Quercus petraea*) lying at the altitude of about 500 meters about 60 kilometers east of Frankfurt. Beech naturally regenerates profusely, but historically, oak acorns have been seeded in the beech forest for harvesting of oak timbers. This beech forest has the highest biodiversity in central Europe, and is actively protected by overlapping designations as a natural park and Natura2000 site that has the ecosystem with the highest natural ranking by Natura 2000, the European Union's common nature conservation policy.

Natura 2000 is a comprehensive nature conservation policy that aims to develop ecosystem networks within the European Union. It was developed by integrating the Council Directive on the conservation of wild birds in 1976 (the Bird Directive) and the Council directive on the conservation of natural habitats and of wild fauna and flora in 1992 (the Habitats Directive). The Habitats Directive was originally intended to complement the former Bird Directive, so Natura 2000 was created to preserve local areas rather than focus on species, which was the purpose of former orders. The local state forestry office has to preserve dead trees in a part of the beech forest. The dead trees in the biotopes were purposely left in the forest to preserve habitats for insects, terrestrial snails (such as snails and slugs), and fungi, which accommodate many species of woodpeckers and bats.

4. Activities of landscape management office: Bayern State Ministry of Environment

In order to ascertain the activities of the Landscape Management Office, the authors conducted an interview with Landscape Development Unit 52 of Section 5, which oversees nature protection, landscape management, and ecology in Bayern State Ministry of Environment. The conservation object of this Unit is mainly rural landscapes. The key to the landscape management is a continuous effort to create harmony between landscape elements by thorough discussion with stakeholders including area people and non-governmental organizations, according to the officer.

Germany is so developed that development projects, such as highway construction, large scale supermarkets and factories, frequently take place even in rural areas. The changing society brings expansion of development to rural areas. For example, in Hessen, important rural landscape essences would be meadows for grazing goats and the forests behind them. The forest has a historical reason for its exis-

Table 1. Reconciliation between Agricultural Policy (CAP) and Environmental Policy (Natura 2000) in the European Union. Adapted from Ecosystem Conservation Society - Japan (2004)

Year	Main Items
1958	The European Commission was established with six countries: France, West Germany, Italy, Holland, Luxembourg and Liechtenstein ; the Common Agricultural Policy (CAP) was born; the Stability of Farmers' Income and Self-sufficiency in Food
1967	European Union First Environmental Directives (Hazardous Substances)
1976	West Germany: Revised Land Consolidation Act. Obligations to nature conservation and landscape conservation
1979	European Union Council: Birds Directive
1992	European Union Council: Habitats Directive CAP: Agricultural policy reform through the introduction of direct payments
1993	European Union established with 15 countries participating based on the Maastricht Consensus in 1991
1999	CAP: Agri-environmental measures of the rural development Regulation 1257/99
2001	European Union Council: Biodiversity Action Plan for Agriculture
2004	Natura 2000 Network comprehended both Birds Directive and Habitats Directive

Beech and oak forest in Spessart

tence. It has been inevitably managed as a forest because of geological reasons as well as historical and economic reasons. On the periphery of the forest there is a wetland which provides habitat for beavers. On the well-drained slopes of forest, vineyards were installed to produce wine. Hikers who enjoy such landscapes from nearby cities are also one of the essences comprising the landscape.

In such cases, the "landscape development" officers make an effort to reach a harmony by coordinating discussions. The stakeholders are comprised of not only each level of area representatives, but actually all the people in the area. If there is a problem regarding the rural development, it is important to start the discussion as early as possible. The key task is to balance and harmonize all the rural landscape elements. In Germany, a concept which structurally views area's natural resources and social economic level and elements called "Raumordnung"(setting land and space in order), is prevailing and it contributes to the broad environmental protection.

5. Summary: Landscape management in Germany

Agriculture in West Germany in the 1980s was in a difficult situation within the European Commission's common agricultural market. In order to improve the situation, Germany transformed its agricultural policy based on a fundamental revision of rural development law in 1976, to achieve "infrastructural development and improvement of rural areas". German agricultural policy is no longer viewing agriculture as mere producer, but extending its role as "manager of rural environments" (Ishii, 2007:199).

The European Union is striving to develop its environmental policy to protect biodiversity by shifting its target from preserving species to areas as a whole, and make a network of diverse ecosystem areas (table 1). Natura2000 emphasizes the importance of rural landscape and biodiversity.

For instance, people who live in rural areas but no longer practice agriculture still have the opportunity to make a statement about rural environmental management as a member of a rural community. This attitude could be stemming from the traditional community perspective that the people who live on the land "must protect their own land". People's high level of environmental conscience enables the high cost of direct payment toward farm businesses.

This study was commissioned by the Ministry of the Environment, Japan

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Case studies from Oceania

Living by utilizing various modified natural resources in the Solomon Islands

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1. Introduction

In addition to subsistence activities such as farming, fishing and gathering food from forests, in recent years the residents of the Solomon Islands have been making their livelihoods by obtaining cash through activities such as selling marine resources and crops and working for logging companies. This article explains the details of the use of various natural resources (both land and sea-based) and ingenious ideas for conserving the environment. Then, based on this information, the features of *Satoyama*-like landscapes in the Solomon Islands, and the direction that should be taken in order to achieve sustainable human-nature relationships are discussed.

The Solomon Islands consist of six relatively large islands and more than 900 small islands. The population consists of approximately 410,000 inhabitants (from the 1999 census), of which 90 per cent are ethnically Melanesians and the remainder Micronesians, Polynesians, etc. In total, 88 per cent of the land is customary land belonging to clans. Furthermore, about 80 per cent is forested (FAO 2007).

Information gathering was carried out mainly in the form of interviews in a village named Olive on New Georgia Island of the Western Province from 30 October to 6 November 2009. (The researchers stayed in the village for three days, from 1 to 3 November.) In addition, further information was collected from members of the Western Province parliament, Forestry Ministry officials (at the provincial office), and non-governmental organization personnel who work locally in the conservation and social development sectors.

The residents use the land on New Georgia Island (main island) and on barrier islands located off the coast of the mainland. They believe that vegetation and soil in each type of island are different.

2. Landscapes and various uses of land and sea resources

The following is a summary of land and natural resource use on the mainland, the barrier islands and in the sea.

2.1 Main island

2.1.1 Vegetation in the settlement

The most useful plants in the settlement are either domesticated or semi-domesticated, and are used for food, luxuries, tool materials, ornamental materials, shading materials, etc. The most abundant plants are betel nuts (*Areca catechu*), coconuts (*Cocos nucifera*), a domesticated species of *Barringtonia edulis* which yields edible nuts, and sago palms (*Metroxylon* spp.) which are used as material for roofs and walls.

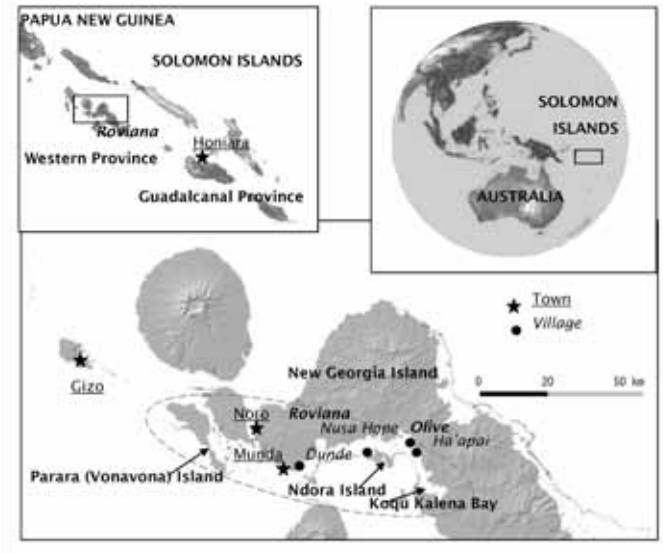

Figure 1. Research area

2.1.2 Horticultural gardens

For the residents of the area, shifting cultivation is the main mode of subsistence. There is no particular season for preparation of horticultural gardens, because both temperature and rainfall vary little throughout the year. Main crops are sweet potatoes and cassavas. Other than potatoes, vegetables such as aibika (*Hibiscus manihot*), ornamental/ritual plants such as *Cordilyne terminalis*, and plants such as *Coleus*, which deter pest animals, are grown.

In the main island, cultivation periods last from two to three years, and fallow periods are about 30 years. As each plot of land is used as a cultivation field, in turn cultivation fields, forests with various fallow periods, and other vegetation types spread like a mosaic from the settlement towards the inland area.

2.1.3 Modified forests (Nobo)

Modified forests which have been abandoned after shifting cultivation are called *Nobo*, where the residents gather medicinal plants, such as *Mikania cordata* and milkwood pines (*Alstonia scholaris*), trees for building house, such as *Commersonia bartramia*, or materials to secure rafters and roofs such as rattan (*Calamus* spp.).

2.1.4 Ancestors' modified forests/sacred areas

In order to differentiate from *Nobo*, which are more than several decades-old (sometimes more than one hundred year-old), modified forests are called *Emata*, and were deforested and then abandoned before the current residents were born. Some gigantic trees such as *Canarium*, from which the residents harvest edible fruits and resin for wax, are the indicator for the residents to know whether the forests were once modified by humans. Many of those forest areas that the ancestors used to inhabit or for rituals are now "shrines (*Hope*)," where entry and felling are often prohibited.

2.1.5 Primary forest (Muge)

Primary forests are called *Muge*, where trees (*Gmelina moluccana*) are sometimes collected for canoe-making. These trees are ideal for material for canoes because the trunks are light, grow straight, and have high water repellency. This makes it hard to find these trees and there are rules as to how to utilize them, which will be explained later. Also, these forests are often used for wild boar hunting.

Among the vast forests that the residents classify as *Muge*, some evidence of modification by humans can be found (Bayliss-Smith *et al.* 2003). Therefore, *Muge* are not totally unmodified, but partially contain human-modified parts where the ancestors once lived, and also they include forests in which the current residents have intervened.

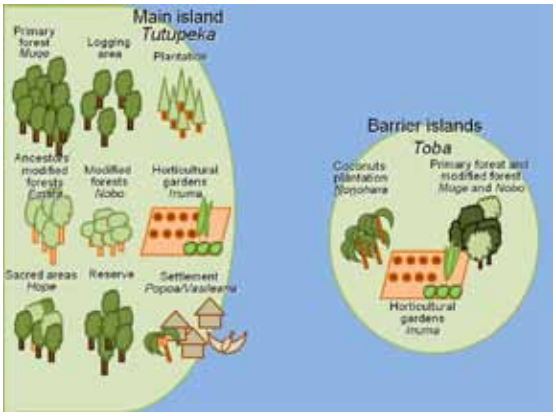

Figure 2. Classification of land use in Olive village

2.1.6 Reserves

There are two forests called "*reserves*" near Olive. They are nature reserves established by local leaders in the 1970s when the current settlement was built. Although logging by foreign companies and agricultural cultivation are both prohibited there, the residents are allowed to cut down trees for their own survival and to take non-wooden materials such as *Parinari glaberrima*, the fruits of which are used as adhesives to fill holes in canoes. Vegetation in *reserves* is different from both unmodified and modified forests described above, as the residents have been utilizing useful trees continuously.

2.2. Barrier islands

The barrier islands' soil and vegetation are different from the main island's. While the main island's agricultural fields are managed through a shifting cultivation system with a short cultivating period and a long fallow period, the barrier islands' fields are cultivated almost all the time. According to Furusawa and Ohtsuka (2009), the average period of continuous cultivation is 29 years on the average, and the fallow period is nine years.

As the barrier islands' agricultural productivity is much higher than the main island's, the barrier islands are intended to be used differently from the main island so that the residents can still successfully retain their subsistence economy, even when a new development such as growing a cash crop on the main island fails and they cannot earn enough cash.

2.3. Sea

In the following description, only lagoons, shallow sea, mangroves and marine protected area are discussed.

Sacred forest. "Tabu" ("taboo" in Pidgin) is painted on trees to inform logging companies that the area is sacred.

2.3.1 Lagoons and shallow seas

Lagoons consist of coral reefs (*Sagauru*), seagrass beds (*Kulikuliana*), sand bank (*Onone*), and silt/sand (*Nelaka*) and the residents make use of each area to earn a living (Aswani and Lauer 2006). For example, deep water in a coral reef is a place for fishing, and shallow water is for catching smaller fish to be used as bait. Also, nassa mud snails (*Nassarius* spp.) are gathered in the sandy ground areas.

2.3.2 Mangroves

Mangroves, locally known as *Petupetuana* and growing where land and sea meet, provide hunting grounds for shellfish and crabs, which are not only for the residents' own consumption but also used to exchange for cash. The residents care about the mangrove. For example, an informant reported that a group of villagers once protested and forced a logging company's operation to halt when an inflow of red soil contributed to a decrease in population of shellfish and crabs.

2.3.3 Marine Protected Area (MPA)

Local non-governmental organizations and overseas researchers planned to set up a Marine Protected Area (MPA) at a coral reef area in a lagoon (Aswani and Lauer 2006). As well as being a place for the residents to catch small fish, the reef is a spawning ground and a habitat for juvenile fish. Therefore, it is a very important area for protecting the fish population. The fishing ban should not seriously affect the residents' lives, but it should have a significant but positive effect on the fish. In exchange for setting up the MPA, the non-governmental organization built a medical clinic for the residents as a part of development aid. According to a follow-up research, marine ecologists reported that the ecosystem had improved (Aswani *et al.* 2007).

3. Traditional rules for conservation

The residents participate in managing the reserves and MPAs described above. However, they observe traditional rules for conservation as well.

One example of such rules concerns the use of a scarce tree, the white beech (*Gmelina moluccana*). When a person knows that a new canoe will need to be made in future, he has to find a young white beech and make a mark on it to inform the other residents of its future use. Then, when it is time for canoe-making, he has to ask for the customary chief's permission.

There is also a rule for gathering sago palm leaves which are an essential material for roofs and walls of traditional houses. As it takes a very long time for a sago palm to re-grow once the trunk is cut down, the rule says that the trunk should be untouched and only leaves can be cut off. It also says that they should leave four leaves untouched because the tree would die if all the leaves were cut off.

4. Conclusion

The landscape of subsistence villages in the Solomon Islands is made up of settlements along the coastlines surrounded by what resembles a mosaic of various human-modified forests on the land. The marine environment is comprised of shallow lagoons and barrier islands farther offshore. Compared to *satoyama* in Japan, there are relatively less modifications by humans. Also, agricultural fields are not kept tidied on a permanent basis. After a forest is transformed into a crop field, the field turns back into a forest again in time. Therefore, each forest is unique and made up of many diverse species. As each forest has different flora and fauna, the residents use each for a different purpose.

In recent years, with the influence of the market economy, commercial logging has been carried out widely, and industrial forestation is being performed where such logging has been implemented. At the sea, there is an increase in scale of marine product gathering for cash, which is seriously affecting the marine ecosystem. The continuity of such a trend could destroy the residents' livelihood, triggering a

A woman collecting nassa mud snails

decrease in the number and variety of species.

Generally, Pacific Islands governments are not very keen on projects aimed at the conservation of nature, partly because the government revenues depend largely on the utilization of natural resources such as lumber and fishing. Furthermore, even if a government tries to take action on conservation, it is difficult to achieve a successful outcome because most of the territories consist of customary lands in which protected areas cannot be set up without the residents' consent.

The residents in the Solomon Islands, whose livelihoods have been heavily reliant on farming and fishing, have no choice but to continue making a living out of natural resources.

Even for the sake of conserving natural resources in the Solomon Islands, it is virtually impossible to persuade people to leave unmodified forests untouched or to protect all coral reefs. Even if such ideas were accepted, it is unlikely that the agreements would become permanent. Therefore, for the residents' lives and traditional culture, also for the variety of local species, it is important to stop large-scale changes such as deforestation and industrial reforestation, and also to provide support for the use of *reserves* and modified forests.

This study was commissioned by the Ministry of the Environment, Japan.

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Nature-friendly agriculture in the State of Queensland, Australia

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1. Introduction

Australia has a highly advanced agricultural sector and has largely depended economically on the export of agricultural products, despite receiving small amounts of rainfall over most of its territory. This is mainly due to large-scale farm management and mechanized farming practices. Since such agricultural systems have gradually caused environmental degradation through soil erosion, increases in salinity, and water pollution from agricultural chemicals, the central and state governments, non-governmental organizations and farmers have begun cooperating on the development of nature-friendly agricultural systems.

Australia's nature-friendly agriculture does not depend largely on so-called traditional knowledge for the management of land and wildlife but agrees with the *Satoyama* Initiative (SI) with respect to the basic idea of harmonization between development of human activities, especially agriculture, and conservation of biodiversity. It is of relevance to the SI that advanced agricultural systems in developed countries, including Australia, can be more nature-friendly, decrease their environmental impact and conserve biodiversity. Keeping these notions in mind, this field survey aimed to investigate innovative farming systems in the State of Queensland, where agriculture has been a major industry and the natural environment has been well conserved.

The State of Queensland, located in the northeastern part of Australia, is one of most biologically diverse regions of Australia and has a population of approximately 4.4 million (Australian Bureau of Statistics, 2009). In the Far North Queensland area, approximately 900,000 hectares of the forest known as the "world's oldest rainforest in existence since the age of the continent of Gondwanaland" was designated a "Wet Tropics World Heritage Area" (WTWHA) in 1988.

However, the agriculture and forestry that began there in the latter half of the nineteenth century have fragmented the rainforest and hindered its biological diversity. Moreover, chemical substances and soil particles from agricultural run-off have caused (and are causing) problems such as damage to the coral reef in the coastal areas. In such an environment, the Wet Tropics Management Authority (WTMA), Far North Queensland Natural Resource Management Limited (FNQ NRM Ltd) and Rainforest Cooperative Research Center (Rainforest CRC) have taken measures to coexist with the bountiful natural resources.

Figure 1. Map of the Wet Tropics World Heritage Area and the research sites. The upper and lower marker indicate, respectively, the location of case study 1 and case study 2.

The main industries in Queensland are agriculture (sugar cane, tropical fruits, and cotton), cattle ranching, and tourism. This case study reviews how agricultural measures adopted by the farmers in the vicinity of the WTWHA are high in sustainability.

The study focused on the tropical fruit-producing farmers of the Tully region and the sugar cane farmers of the Ingham region and was conducted between 19 and 29 November 2009 by Ryutaro Ohtsuka (Japan Wildlife Research Center) and Masatoshi Sasaoka (Japan Wildlife Research Center), with the assistance of Stefan Ottomanski (Nagao Natural Environment Foundation).

2. Case study 1: Nature–friendly fruit farms

2.1 Overview of the fruit farm

This farm is located in a forest approximately 140 kilometres south of Cairns in the Mission Beach area of the northern part of Queensland, an area where the low lying tropical forest is still intact. The area

Box 1. Southern Cassowary (*Casuarius casuarius johnsonii*)

There are three subspecies of cassowary (all species classified in the same species of cassowary, *Casuarius*), and the one found in Australia is the *Casuarius casuarius johnsonii*. This subspecies is currently found in Australia only in three forested areas of wet tropics in the Iron Range of Cape York in the northernmost part of Queensland (Australian Rainforest Foundation 2009: 7). It is estimated that there are approximately 1500 individual specimens remaining in existence in the wild (FNQ NRM Ltd and Rainforest CRC 2004: 43).
The cassowary plays an important role as a distributor of seeds of various constituent plants in tropical rainforests. Cassowary is one of the indispensable constituent elements in sustaining the diversity of the plant population in wet tropics. However, the number of cassowaries are currently in decline as a result of the destruction of rainforests due to agricultural work, expansion of residential areas, destruction and isolation of their habitats, road kill (i.e. killed by passing road traffic), as well as competition with wild boars for food resources and breeding grounds (Community for Coastal and Cassowary Conservation, http://www.cassowaryconservation.asn.au/Newcassowaries.htm).

Southern Cassowary

is considered iconic of Queensland's natural heritage and important to the preservation of the endangered and protected Southern Cassowary (*Casuarius casuarius jhonsonii*) (see Box 1).

Mr. Peter Salleras and his wife Alison purchased a 220-acre (89 hectare) property in the Feluga area adjoining the Mission Beach area in 1983 and began to farm various tropical fruits, mainly jack fruits, durians, and rambutan, and distributed and sold these agricultural products to restaurants, resorts, and supermarkets in the neighboring cities.

Peter Salleras is also the Chairman of the Community for Coastal and Cassowary Conservation (C4), which conducts environmental protection activities, including investigative research on the Southern Cassowary, regeneration and protection of its natural habitat, and a refuge for cassowaries who were the victims of accidents.

2.2 Protection of the forests within the fruit farms

Approximately two thirds of the 89-hectare property have not been exploited so as to partly connect to the tropical rainforest in the Wet Tropics World Heritage Area.

According to Peter Salleras, retaining the tropical rainforest within the fruit farm can, in addition to protecting the fruits from strong winds, protect them from extremely high temperatures and sustain a microclimate suited to the cultivation of the fruits. Such an effort also benefits fruit farm management through the conservation of biodiversity.

Of the animals inhabiting these forests, sugar glider (*Petaurus breviceps*), the pythons (*Morelia* spp.), and bandicoots (small animals belonging to the family Peroryctidae) play significant roles. The sugar glider consumes beetles, such as the Christmas beetles (*Anoplognathus* spp.), that are harmful to the fruits. The pythons eat rats that cause enormous damages to the fruit crops and taro. Two species of bandicoot, the northern brown bandicoot (*Isoodon macrourus*) and the long-nosed bandicoot (*Parameles nasuta*), eat grubs of the native beetles such as cane beetle (*Dermolepida albohirtum*); the grubs of cane beetles are the major pest for many crops since they eat roots of many tree crops as well as those of sugar cane.

In addition to contributing to effective pest control, many insects inhabiting the nearby forest help with the pollination of fruit trees.

2.3 Extermination of wild boars to protect the cassowaries

In the eastern and northern regions of Australia, non-native species of wild boars have a devastating effect on agricultural crops and are very disruptive to natural ecosystems.

Even in the fruit farms of the Mission Beach area, wild boars are considered to be the most harmful pest because they eat the seedlings of the fruit trees and dig up the cultivated ground.

The wild boar is also directly responsible for the decline in the number of Southern Cassowaries. For instance, as wild boars eat many of the same fruits, small animals and mushrooms that Southern Cassowaries eat, the two species are in close competition. Moreover, wild boars destroy the nests of Southern Cassowaries and eat their eggs.

Therefore, the extermination of wild boars not only serves to protect crops, but also contributes to maintaining a good environment for Southern Cassowaries.

The forest remaining alongside the fruit farm

A cage trap to capture the wild boar

Wild boars were previously killed by hunting dogs. Unexpectedly, however, these dogs eventually attacked cassowaries to death. For this reason, Peter Salleras and the members of the C4 group made efforts to develop traps that capture only wild boars. One type of trap is a cage trap that capitalizes on the wild boar's behaviour of raising its snout when searching for food. The traps' door falls down when the boar touches the bar, which is connected with the door, with its snout while it looks for bait (for instance, bananas) placed in the central part.

3. Case study 2: Nature–friendly sugar cane farm

3.1. Overview of the farm

The Herbert River Catchment contains extensive sugar cane plantations, cattle ranches, and tropical fruit farms mainly specializing in mango, lychee and banana.

Mr. Mario Porta manages approximately 1,000 hectares of sugar cane plantation and 1,000 hectares of cattle grazing land. He produces approximately 110,000 tons of sugar cane annually and is one of the largest operators in the area.

3.2. Cultivated land management to prevent soil erosion and water contamination

Since the mid 1990s, Mario Porta has been conducting the following nature-friendly farming practices with the support from a local non-governmental organization, Terrain Natural Resource Management-Herbert Team and the Bureau of Sugar Experiment Stations (BSES), which is an experimental agency funded by sugar cane producers to conduct research to increase sugar cane production

Mario Porta uses a laser measurement device, i.e. advanced levelling technology, to precisely measure the height of the ground in the sugar cane fields to make the ground flat.

In addition, he pays great attention to drainage ditches. Until recently, to expand the area of his sugar cane fields, he made the drainage ditches as narrow as possible. However, this resulted in severe soil erosion in the vicinity of the drainage ditches. To combat this, he made the ditches five metres wide and shallow, and planted grass in them. This has reduced the speed of run-off from the sugar cane fields when it rains and prevented soil erosion and outflow of nutrients. All this has resulted in the retention of soil fertility and savings in the amount of added fertilizer and costs.

Also, when preparing the cultivated land described above, he created large-scale artificial lagoons in the middle of his large-scale sugar cane plantation where run-off is collected. The accumulated residues in the lagoon and wet areas can be recycled later to the fields, which results in enabling the retention of soil fertility. In addition, the artificial lagoons help trap the run-off silt and soil nutrients in the lagoon and wet areas. It is considered that such artificial lagoons contribute to the retention of the quality in the river and coastal environments because the quality of water flowing into the rivers improves dramatically.

Furthermore, he also planted a variety of soil-retaining scrub species such as *Nauclea orientalis* and *Eucalyptus platyphylla* in the ponds and wet areas. He has 12 arterial lagoons and wet areas in his plantation; six of these have already had this scrub species planted on site, thereby forming a green corridor.

It has been pointed out that the creation of the lagoons and wet areas as well as the green corridors could form breeding grounds for endangered species, such as false water rat (*Xeromys myoide*s) and Grass Owl (*Tyto capensis*) as well as various waterfowl and migratory species (Smith 2008). Mario Porta reports that he has seen a markedly greater number of birds and water animals than before.

He reports that the introduction of such environmentally-friendly agriculture practices has cost him a total of 250,000 Australian dollars, some of which was refunded through a grant from the Australian

Wide drainage ditches in the field

Government Envirofund. Nonetheless, eventually such efforts bore fruit; he was able to gain some of his investment back as additional lowland is now available for use, soil degradation has decreased, and the costs incurred for fertilizers have been much reduced (fertilizer costs were reduced by 65,000 Australian dollars in 2006).

4. Conclusions

Few ecological studies examine how nature-friendly agricultural practices, such as those highlighted above, have affected the biodiversity in any given area. It is critical to perform scientific environmental evaluations to clarify the impact of such efforts on the biodiversity of a region.

In light of this study, it should be noted that there is the Reef Rescue Fund that aims to protect the coral in the Great Barrier Reef, which the farmers could avail of as a means to engage in nature-friendly agriculture. This Australian government fund supports effective soil management practices to suppress the run-off of nutrients, agricultural chemicals and red silt from agricultural land. In addition to this fund, there is great enthusiasm for the introduction of an eco-accreditation system to distinguish nature-friendly agriculture produce from non-nature friendly agricultural produce, as a market-based mechanism to encourage eco-friendly production, as well as for tax incentives for eco-friendly farming.

This study was commissioned by the Ministry of the Environment, Japan

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Table 1. Measures of Nature-Friendly Agriculture

Protective Techniques Introduced	Sought-After Effects
• Leveling of cultivated land	• Prevention of soil erosion and nutrient run-off • Reduced expenditure on fertilizers for the fields • Protection of the coral in the coastal areas downstream, etc.
• Creation of wide shallow drainage ditches • Plant grass in the drainage ditches	
• Creation of artificial lagoons and ponds	• Reductions in the cost of maintenance and investment in the region • Protection of the coral in the coastal areas downstream, etc
• Joining up of the green corridor around the lagoons and wet areas by the planting of scrub	• Contribute to biodiversity in the region • Improvement of the visual aspect of the agricultural scene

Synthesis of the case studies

Overview of features of socio-ecological production landscapes

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The following overview of features of socio-ecological production landscapes is based on the case studies presented in the second part of this document. The section highlights the various physical structures, management techniques and governance systems that characterize these landscapes. In addition, it presents an overview of the benefits they provide for biodiversity, the threats they currently face, and ways to address these threats.

1. Features of socio-ecological production landscapes

1.1 Physical structures

Human activities such as agriculture, forestry and fishing have a significant influence in shaping socio-ecological production landscapes. Although the size of the landscapes can vary from a few to hundreds of hectares, many of the case studies presented here feature mosaic patterned, complex and multipurpose land uses.

1.1.1 Mosaic patterned land use

In most parts of Asia, vegetable plots, crop fields, fish ponds, rice fields, pasturelands or forests can often be found at various distances from settlements. As a result, these landscapes often show patches of varied land use corresponding to their distance from settlements, topography and other features. Such a spatial pattern consisting of various patches of land use is often referred to as a "mosaic" pattern, and is featured in several of the case studies presented here. In Tanzania, the *ntambo* land use system uses different topographies for different purposes — forest and shrubs in ridges and slopes above settlements, homegardens in and around settlements, coffee gardens immediately below settlements, followed by crop fields on steep slopes for maize and other crops. In Kitui, Kenya, a diverse mosaic landscape with gardens, crops fields, forest groves, pastures, forest floodplains and water harvesting sites maximizes biodiversity and minimizes food security risks. In the *satoyama* of Machida, Tokyo, rice fields are located in valleys along rivers, and crop fields and settlements are located on the terraces and secondary woodlands of surrounding hills. Mosaic patterned land use can also be observed in the Solomon Islands, Argentina, and in the landscape surrounding unique irrigation networks consisting of man-made lakes and ponds, traditionally known as 'tanks', in Sri Lanka.

1.1.2 Complex and multipurpose land use

Homegarden agroforestry systems consisting of complex and multipurpose land use structured by multi-layered vegetation, which provide staple food, fruits, vegetables, spices, and fuel, with livestock raising near dwelling places, are common throughout the tropics and sub-tropics, as seen in Sri Lanka, Bangladesh, India and Tanzania. In Spain and Portugal, agrosilvopastoral systems consisting of a combination of agriculture, forestry and grazing are practised in areas where arable farming is extremely limited due to soil low in nutrients with little capacity for moisture retention, forming landscapes called *dehesa* or *montado*. Finally in Louisiana, multipurpose land use is seen in the integration of crawfish farming with rice cultivation.

1.1.3 Other structures

It should be noted that not all the landscapes presented here show mosaic features or complex, multilayered land uses. For instance, the landscape of the Maasai people in Kenya does not show these features. However, the land and natural resources are being managed so as to provide food and a set of ecosystem services for local communities, which also is a characteristic of socio-ecological production landscape.

While most of the features introduced in the case studies have been produced as a consequence of long-term interaction between humans and nature based on traditional ecological knowledge, cases with recent human intervention have also been taken into consideration, such as the Australian case study, where forests in fruits farms are deliberately preserved so as to provide a connection with tropical rainforests in the adjacent world heritage area.

1.2 Management techniques

In adapting to natural environments and in overcoming natural difficulties, such as steep terrain and infertile soil unsuitable for cultivation, humans have developed various techniques or systems of utilization and management of land and natural resources to avoid environmental degradation while optimizing land utilization.

1.2.1 Rotational systems

Management based on a rotational system is widely seen in many of the socio-ecological production landscapes. For instance, in the Solomon Islands, af-

ter a forest is cleared, crop cultivation lasts for two to three years, after which the land is allowed to enter a fallow period of about 30 years. During the resting period, the secondary forest that succeeds the cultivated field provides various products such as medicinal plants and rattan, before being used again for cultivation.

Before the second half of the twentieth century, an agricultural system in Galicia (Spain) was based on arable fields called *agras*. *Agras* were successively planted with wheat, potatoes, turnips and sometimes corn on a two-year rotation basis. Each family held at least one plot in each *agras;* the system thus ensured yearly harvests of potatoes and wheat for the village and a share for each family.

In the highlands of Tanzania, a unique indigenous *ngolo* (pits surrounded by four ridges) cultivation system is practised on steep slopes to plant maize, beans and wheat on a rotational basis. During the rainy season, these pits act as reservoirs preventing the destructive effects of surface runoff in the steep cultivated slopes.

1.2.2 Transhumance system

In the Burren hills, Ireland, a 'reverse' transhumance system, where livestock are moved to the Burren hills in late autumn to spend the winter grazing in the upland grasslands, has been practised for a long time. In the summers, cattle are moved to the more productive lowland grasslands, while the Burren uplands are left fallow or lightly grazed. Although the clear reason for this "reverse" transhumance is unknown, winter grazing in the uplands itself is one of the reasons for the high biodiversity in this area, because it removes accumulated dead vegetation which would otherwise diminish the habitat for less competitive light-dependant herbs, and allows the plants on the uplands to grow, flower and set seed unhindered during the summers.

1.2.3 Resource circulation system

All over the world, forest leaf litter and plant debris produced by agricultural land and livestock manure are used in fields as compost.

In Kyoto, Japan, new technologies based on biomass power generation and forest dairy farming have been undertaken by a private company and the local government in collaboration with farmers, to integrate various land uses which have been disrupted due to changes in socio-economic conditions. Similarly, in the case of Germany, biogas generation from cow manure is operated to provide electricity for lighting, refrigeration and heating in the farmer-owned restaurant which uses local farm products. These are examples of holistic management systems based on the concept of resource circulation aimed at restoring devastated natural environments and promoting new industries in rural areas.

1.3 Social systems

Land and natural resources in socio-ecological production landscapes are often managed by a single family, extended family unit, or co-managed by a village community, depending on the socio-cultural background of the area. For example, homegardens in the tropics and sub-tropics are usually managed by a single family unit, although management is sometimes shared among the residents of the same village who do not have access to resources such as fuelwood. The case study from Galicia (Spain), highlights the use of Associations of Common Land Owners (ACLO) to collectively manage land resources, particularly with respect to forested landscapes.

With the weakening of traditional community systems centred on farmers, non-governmental organizations/non-profit organizations, in collaboration with researchers and private enterprises, often take up the leadership of the management of the revitalization of socio-ecological production landscapes. For example, in Kanakura, Ishikawa Prefecture, Japan, a local non-profit organization collaborates with landowners, a university, the local government and a private enterprise to attract visitors and to revitalize the socio-economy through the promotion of local products. In the example from Cambodia, a traditional village community is involved in homegardens, rice cultivation and other agricultural activities. With the help of international non-governmental organizations, villagers have been applying sustainable methods of composting readily available crop residue, animal manure and water hyacinth into natural fertilizer.

There are cases where traditional social systems coexist with modern technologies in the management and utilization of land and natural resources. For instance, in the Oaxaca State of Mexico, a traditional local governance system called *Usos y Costumbres* (Uses and Customs), which is rooted in indigenous systems of community service that give particular importance to village elders, open assemblies and consensus, has been successfully incorporated into modern community-forestry enterprises.

In countries with large scale monoculture farming and the use of modern technology, such as pesticides, there are innovative individual farmers who have started nature-friendly agriculture, as exemplified in the case studies from the United States and Australia. Also, as illustrated in the previously-men-

tioned case study from Kyoto, Japan, private companies can undertake projects to sustainably manage land and natural resources and generate profits by adding value to their products through practices such as forest dairy farming.

In some cases, social systems that govern the management and utilization of land and natural resources are deeply rooted and influenced by traditional beliefs in the area. For instance, in the Potato Park in Cusco, Peru, decision-making is based on Andean beliefs, guided by the principles of *ayni* (reciprocity), that all elements of nature, including human beings, give and receive, thus contributing to the common good and harmony of the world. This principle can be seen in seed exchanges among the communities and in the distribution of agricultural work.

2. Benefits of socio-ecological production landscapes

2.1 Biodiversity

Most case studies mention the importance of biodiversity in the study areas in the broader context, such as diverse habitats leading to higher biodiversity. Most studies also report that a relatively healthier system with higher biodiversity is maintained in homegardens as compared to other agricultural systems. Appropriate human interventions, such as periodic tree cutting seen in Japan and grazing management systems seen in Spain, Portugal and Ireland, contribute to nurturing the unique biodiversity of woodlands and grasslands. For example, three-quarters of Ireland's 900 native plants are found in the Burren, forming flower-rich habitats that support a large variety of invertebrates, including the Marsh Fritillary, Ireland's only butterfly listed in Annex II of the Habitats Directive.

2.2 Ecosystem services

2.2.1 Provisioning services

One of the main ecosystem services of socio-ecological production landscapes is the supply of food, fuel, and medicinal plants. These products are a vital source of food and income, especially during difficult economic times, and help contribute to the improvement of livelihoods in developing countries. Kandyan homegards in Sri Lanka, for instance, harbour a rich array of cultivated plants, including grains, vegtables, fruits, spices, medicinal plants, timber trees, and livestock. In Kyotango City, Japan, a company recycles local biomass from various sources to generate fuel.

2.2.2 Regulating services

Regulating services include maintaining soil fertility, as illustrated in Kampong Cham, Cambodia, where organic fertilizers produced within the community are used; preventing soil erosion, as seen in the *Ngolo* system of cultivation in Tanzania; improving water quality and carbon sequestration, as exemplified by the homegardens of Wayanad, India, and regulating microclimate, as seen in homegardens of the dry climate areas of Bangladesh.

2.2.3 Cultural services

The outstanding scenery of the landscape, which is located in the unique and sometimes vulnerable environment, can be utilized through tourism. In the northwestern coast of Italy, the unique landscapes of Cinque Terre National Park, characterised by steep hillsides that drop down to the sea and marked by the geometry of terraces held up by dry stone walls and vineyards, provide opportunities for tourism activities from which many inhabitants derive their income. Other cultural services include the sense of pride of place or way of life. For example, in Peru, the Quechua communities have developed a sense of pride in their traditional way of life, which is reflected in the creation of a restaurant featuring traditional cuisine and a handicraft centre.

2.3 Human well-being and economic benefits

In many studies, securing stable access to natural resources such as food, fuels, and fertilizers has been described. Kandyan homegardens reportedly provide 30-50 per cent of household income. Integrated farming systems in Louisiana not only contribute to healthier ecosystems due to decreased use of pesticides for crawfish farming and birds feeding on crawfish, but they also increase economic viability by providing two sources of income.

Value added food products can create opportunities to earn income and improve livelihoods by informing consumers of the production of goods using traditional and/or environmentally sustainable methods. In addition, prevention of natural disasters and improvement in health conditions have also been mentioned in the reports. Understanding the linkages between natural resource management and utilization, ecosystem services and biodiversity, and their contribution to human well-being in socio-ecological production landscapes is important for strengthening, maintaining and rebuilding a positive nature-human relationship.

3. Challenges and ways to overcome them

3.1 Challenges

Most challenges encountered in the case studies include direct and indirect factors of biodiversity loss and ecosystem degradation. Direct factors which are causing or have already caused biodiversity loss and

ecosystem degradation include land conversion for urban development and cultivation and unsustainable logging and plantations. In addition, change from multiple-cropping to sole-cropping systems and the introduction of new crop species, including high yield species, have been reported to cause loss of species and genetic diversity of cultivated plants. Other factors include inappropriate cultivation or management methods, such as the excessive use of agricultural chemicals, disease and pest outbreaks, and decreasing and ageing populations in rural areas, which, coupled with other factors, have resulted in the abandonment of farmland, forest, and grassland, leading to changes in vegetation. Indirect factors include the loss of traditional knowledge, weakening of traditional social systems, and farmers' economic difficulties.

In addition to these, regional and/or national policies are also affecting some of these landscapes. For example, agricultural and forestry policies to promote large-scale monoculture or forest plantation may affect crop diversity directly, and in some cases, reduce the economic benefits of small-scale farmers, particularly in environmentally-disadvantaged areas. Lack of awareness is also an important factor for these changes. Some reports suggested that environmental change caused by climate change is of increasing concern. For example, in Peru, where cultivation of various crop varieties depends greatly on altitude, potato cultivation has been reportedly moving upward in recent years due to global warming, sparking concerns of possible genetic erosion and disease outbreak.

3.2 Some experienced and proposed means to overcome the challenges

Since most documented challenges are related to the economy, many case studies suggest improving the economic situation by adding value to products produced using traditional or environmentally sustainable methods, diversifying livelihoods, finding new uses for once utilized land and natural resources, such as recreation and leisure activities, and energy production. To overcome the loss of traditional ecological knowledge, several reports suggested recording traditional management methods of natural resources and building of databases to store traditional ecological knowledge, especially on the uses of medicinal plants. In addition, building sustainable social systems for effective utilization and management of natural resources was highlighted. While farmers' associations seem to be effective, especially in cooperative marketing and traditional management, partnerships between multiple stakeholders such as farmers, local government, scientists or research institutes, and non-governmental organizations are also suggested as important and effective. Finally, raising awareness and capacity-building are also essential to overcome these challenges.

Annex

PARIS DECLARATION ON THE "SATOYAMA INITIATIVE"

1. The Global Workshop on the *Satoyama* Initiative was held at the Headquarters of the United Nations Educational, Scientific and Cultural Organization (UNESCO) in Paris from 29 to 30 January 2010. It was organized by the Ministry of the Environment of Japan (MOE-J) and the United Nations University-Institute of Advanced Studies (UNU-IAS), and co-organized by UNESCO, the United Nations Environment Programme (UNEP), and the Secretariat of the Convention on Biological Diversity (SCBD). The Global Workshop built on the two preparatory workshops held in Asia, the first in Tokyo on 25 July 2009, and the second in Penang, Malaysia, on 1-2 October 2009 (see reports at www.satoyama-initiative.org).

2. The objectives of the Global Workshop were to discuss the *Satoyama* Initiative's concept and define the elements of activities to be included in the Initiative. Participants in the workshop included members of the Bureau of the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) and the Bureau of the CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), and biodiversity and community development experts from intergovernmental and governmental agencies, academic institutions, and non-governmental organizations, in particular those working very closely with indigenous and local communities. The meeting was open to the public and co-chaired by Prof. Kazuhiko Takeuchi, Vice Rector, UNU, Dr. Spencer L. Thomas, Chair of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), CBD, Ms. Somaly Chan, Director, International Convention and Biodiversity, Department of the Ministry of Environment, Cambodia, and Prof. James H. Seyani, Director General, National Herbarium and Botanic Gardens of Malawi.

3. Participants of the Global Workshop welcomed with appreciation the efforts of the Government of Japan and UNU-IAS in developing and putting forward the *Satoyama* Initiative. Opportunities for the participation of Parties, other governments and relevant organizations in this initiative were noted. The Government of Japan and UNU-IAS have developed and maintained an internet-based portal site for the *Satoyama* Initiative. They have conducted more than 20 case studies based on literature review and through local stakeholder workshops held in Malawi, Cambodia, Mexico, Peru and other countries during 2009.

4. The primary outcomes of the Global Workshop were the Co-Chair's Summary and this Paris Declaration, which broadly reflect the discussions among participants, and not necessarily the opinion of their respective countries or organizations. The annex to this declaration contains a description of the *Satoyama* Initiative, its objectives, headline activities and mechanisms for its operationalization. Participants at the Global Workshop requested the Co-Chairs to jointly submit this Declaration to the Fourteenth Meeting of the SBSTTA, to be held in Nairobi from 10 to 21 May 2010, and the Tenth Meeting of the Conference of the Parties to the Convention on Biological Diversity, to be held in Aichi- Nagoya, Japan, from 18 to 29 October 2010.

Annex

THE "SATOYAMA INITIATIVE"
FOR THE BENEFIT OF BIODIVERSITY AND HUMAN WELL-BEING

1. "Socio-ecological production landscapes"[1] are dynamic mosaics of habitats and land uses that have been shaped over the years by the interactions between people and nature in ways that maintain biodiversity and provide humans with goods and services needed for their well-being. These landscapes have proven sustainable over centuries and are considered living examples of cultural heritage. A number of studies indicate that management of these landscapes is compatible with the Ecosystem Approach and the Addis Ababa Principles and Guidelines on the Sustainable Use of Biological Diversity[2] and could be a tool for implementing the post-2010 Target of the CBD. In these landscapes, natural resources are used in a cyclical manner within the carrying capacity and resilience of ecosystems; the value and importance of local traditions and cultures are recognized; and the management of natural resources involves various participating and cooperating entities and contributes to local socio-economies. These landscape management practices are conducive to maintaining an optimal balance of food production, livelihood improvement and ecosystem conservation.

2. Socio-ecological production landscapes are found in many regions of the world under various names such as muyong, uma and payoh in the Philippines, mauel in Korea, dehesa in Spain, terroirs in France and other Medi-

[1] Socio-ecological production landscapes are certain kinds of biocultural landscapes. In the context of this declaration, they include seascapes.

[2] Annex II of decision VII/12 of the Conference of the Parties to the Convention on Biological Diversity.

terranean countries, chitemene in Malawi and Zambia and *satoyama* in Japan. Some of these areas are formally recognized as protected landscapes/seascapes under the IUCN protected area category V, World Cultural Heritage sites, Biosphere Reserves, Globally Important Agricultural Heritage Systems, and/or Indigenous and Community Conserved Areas. They all have in common the wise and sustainable use of biological resources in accordance with traditional and, in some cases, modern cultural practices.

Benefits

3. Information presented in the workshop and from case-studies in the literature indicates that when they are managed effectively, socio-ecological production landscapes provide a wide range of provisioning, regulating, cultural and supporting services, and thus contribute to livelihood and human well-being of local communities, and the achievement of the Millennium Development Goals (MDGs) and relevant national development policies. They also provide members of local communities a sense of their roots and identity. In addition, they can contribute to the mitigation of and adaptation to climate change, inter alia, by conserving and enhancing carbon sinks and reservoirs, reducing greenhouse gas emissions, and increasing resilience to adapt to the negative effects of climate change at the landscape or territorial scale. These socio-ecological production landscapes can make an important contribution to the implementation of the Convention on Biological Diversity. They can also play an important role in achieving connectivity/corridor conservation across wider landscapes by making linkages between other protected areas.

Issues

4. Some socio-ecological production landscapes have been abandoned as a result of rural depopulation and ageing populations, while others are increasingly threatened in many parts of the world due to various pressures such as unplanned urbanization, industrialization and increase in population/resource demand. The loss or degradation of these landscapes leads inevitably to a decline in the various ecosystem services that they provide, with serious consequences for the local and broader communities that rely on them. In some cases, socio-ecological production provide for the livelihood of local communities and could thus be abandoned as people move to urban areas in search of employment and better living conditions. There is therefore a need for a range of options to support indigenous and local communities in continuing to maintain these landscapes, as they have done for generations.

The Initiative

Overall description and objectives

5. Measures are urgently needed to support and, where necessary, revitalize or rebuild socio-ecological production landscapes including through broader global recognition of their value and by addressing the issues identified above. The *Satoyama* Initiative has been developed to respond to these needs. Its overall objective is to promote and support socio-ecological production landscapes to maintain their contribution to human well-being and the three objectives of the Convention on Biological Diversity.

6. The *Satoyama* Initiative recognizes the importance of other ongoing initiatives dealing with socio-ecological production landscapes and seeks to provide a platform for cooperation and support.

7. The Initiative can also be considered as a tool, consistent with the Ecosystem Approach, for the implementation of the proposed post-2010 Strategic Plan of the Convention , in particular the 2020 targets relating to the sustainable management of all areas under agriculture, aquaculture and forestry; the reduction below critical ecosystem loads of pollution from excess nutrients (nitrogen and phosphorus) and other sources; the management of the multiple pressures on vulnerable ecosystems impacted by climate change and ocean acidification; the improvement of the status of crop and livestock genetic diversity in agricultural ecosystems and of wild relatives; the raising of awareness of the role of biodiversity; the safeguarding or restoration of terrestrial, freshwater and marine ecosystems that provide critical services, and contribute to local livelihoods; the guarantee for all of adequate and equitable access to essential ecosystem services; the protection of traditional knowledge, innovations and practices, as well as the rights of indigenous and local communities; and the increase of capacity (human resources and financing) for implementing the Convention.

Specific goals/activities

8. The *Satoyama* Initiative aims to

> (a) Enhance understanding and raise awareness of the importance of socio-ecological production landscapes for livelihoods and the three objectives of the Convention. This goal will be met by
>
> > (i) Collecting, analyzing, synthesizing and comparing case-studies, and distilling lessons learned for dissem ination through a searchable online database and other means, and for use in capacity-building activities;

(ii) Undertaking research on ways and means to (i) promote wisdom, knowledge and practice which enables us to enjoy a stable supply of diverse ecosystem services,

(ii) build bridges for inter-cultural communication between traditional ecological knowledge systems and modern science; (iii) explore a "New Commons" or new forms of co-management while respecting traditional communal land tenure where necessary, (iv) revitalize and innovate socio-ecological production landscapes; and (v) integrate results in policy and decision-making processes;

(iii) Developing measurable indicators of resilience associated with linkages between human well-being and the socio-ecological production landscape mosaic, including linkages between wild and anthropogenic components of landscape and ecosystems; and applying these indicators to contribute to the implementation of the Ecosystem Approach; and

(iv) Increasing awareness by promoting education, information dissemination, and document production about these landscapes.

(b) Support and expand, where appropriate and as part of the implementation of the post-2010 Strategic Plan, socio-ecological production landscapes, building on activities in subparagraph (a) above. This goal will be achieved by:

(i) Enhancing capacities for maintaining, rebuilding and revitalizing socio-ecological production landscapes, including through regional capacity-building workshops and support for on-the-ground projects and activities;

(ii) Collaborating with and/or strengthening synergies with local community organizations, national governments, donor agencies, and NGOs, other UN agencies and organizations dealing with socio-ecological production landscapes in the implementation of their respective activities related to the Initiative,

(c) Collaborate with other initiatives and programmes which are operating in this area such as inter alia GIAHS and those of IUCN and UNESCO.

Supporting mechanisms

9. An International Partnership will be established and strengthened, with links to national/sub-national and regional partnerships, to carry out the activities identified by the *Satoyama* Initiative. The International Partnership will be open to all organizations dealing with socio-ecological production landscapes to foster synergies in the implementation of their respective activities, as well as others planned under the Initiative.

10. In order to facilitate the activities proposed for the *Satoyama* Initiative, it is important to:

(a) Identify and develop potential windows and mechanisms to finance, including through innovative financing mechanisms such as the payment for ecosystem services, the implementation of the Initiative and support the International Partnership-related projects and activities,

(b) Mobilize the financial resources needed for implementing the Initiative, including support for the International Partnership for the *Satoyama* Initiative,

(c) Facilitate consultations among partner organizations, including on the processes of the proposed General Meetings for the International Partnership for the *Satoyama* Initiative, in order to facilitate cooperation and create concrete collaborative programmes and activities among partner organizations, including regional collaboration/cooperation, with a view to generating synergies in the programme implementation by such partner organizations, and

(d) Report on relevant achievements to the CBD SBSTTA and Conference of the Parties in accordance with the items on their respective agendas and the multi-year programme of work for the Conference of the Parties, and as part of the review of the Millennium Development Goals in 2015.