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UNU-IAS Policy Report

Indicators of Resilience in Socio-ecological Production Landscapes (SEPLs)



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UNU-IAS Policy Report

Indicators of Resilience in Socio-ecological Production Landscapes (SEPLs)

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Bioversity International is a global non-profit organization of the CGIAR Consortium Research Centre that places the use and conservation of agricultural biodiversity in smallholder farming systems at the centre of its work. The Institute's mission is to investigate and promote the use and conservation of agricultural biodiversity in order to achieve better nutrition, improve smallholders' livelihoods and enhance agricultural sustainability. Research at Bioversity international focuses on: Agrobiodiversity and ecosystem services; Commodity systems and genetic resources; Conservation and availability; Forest genetic resources; Nutrition and marketing diversity. Bioversity International is also a key partner in nine CGIAR Research Programs. (<http://www.bioversityinternational.org/>)



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Foreword

The term “unprecedented” seems to permeate today’s development discourse. Unprecedented rural to urban migration rates are reshaping global landscapes; unprecedented rates of resource exploitation pose a range of intractable challenges; unprecedented changes in population dynamics and shifting dietary preferences are straining our global food production systems.

All of these unprecedented trends have raised growing concerns about the vulnerability of the systems that sustain communities around the world and humanity itself, making studies of resilience ever more important. Returning for a moment to the previous list of trends, it is important to note that 70 per cent of global food production continues to take place on small farms. Furthermore, many of these small farms are spread across landscapes that comprise a mosaic of different ecosystem types that have been shaped by the production activities of local communities. In such cases, the socio-cultural activities and traditions that have sustained these communities have far-reaching impacts on a range of factors (e.g. diet, harvest periods, land-sharing mechanisms, etc.) that shape cultivation and land management practices. Such socio-ecological production landscapes (SEPLs) provide crucial evidence for the potential of harmonious human-nature activities that can sustain biodiversity while also supporting human well-being.

The indicators of resilience in SEPLs developed jointly by Bioversity International and the United Nations University Institute of Advanced Studies (UNU-IAS) encompass a set of 20 ecological and socio-cultural factors. By taking an integrated approach to understanding the resilience of SEPLs, this set of indicators has the potential to serve as a powerful tool for both communities and decision-makers in reducing vulnerability and assessing the impacts of prevailing trends.

This policy report provides an in-depth look at the considerations that went into the development of the set of indicators and introduces the set of indicators and scoring system. The results of field-testing of the indicators from October-November 2011 in Cuba’s *Cuchillas del Toa* Biosphere Reserve are also presented along with in-depth analysis.

The effective collaboration between UNU-IAS and Bioversity International is encouraging and indicative of the potential for high quality outputs based on shared purpose. Both organizations are members of the International Partnership for the Satoyama Initiative (IPSI), the Secretariat of which is also housed at UNU-IAS, and this indicators’ work is the result of a collaborative activity endorsed by the IPSI Steering Committee. I commend these efforts towards promoting successful synergies in developing useful tools for both communities and policymakers, and hope that this policy report will generate broader interest and research into the resilience of SEPLs.

Govindan Parayil,
Director, UNU-IAS and Vice-Rector, UNU
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Finally, the authors would like to acknowledge the farm families and national scientists who shared their knowledge with the International Partnership for the Satoyama Initiative (IPSI). The IPSI Secretariat proved exemplary in providing a platform for effective collaboration among the IPSI member organizations and supporting the publication and dissemination of associated materials.

Preface: Collaboration on Indicators Research

Effective inter-organizational collaboration has characterized the research on developing and testing indicators of resilience in socio-ecological production landscapes (SEPLs). In September 2011, a preliminary set of indicators was published by Bioversity International and the United Nations University Institute of Advanced Studies (UNU-IAS) and made publicly available for comment. The indicators were field-tested for the first time from October-November 2011 in Cuba's *Cuchillas del Toa* Biosphere Reserve. By March 2012, wide dissemination of a revised set of indicators was underway, further testing was being conducted in Kenya, and additional testing planned for Bolivia and Nepal. The jointly developed indicators have filled the need for a holistic and inclusive set of indicators of resilience, and have therefore been met with broad interest across disciplines

Bioversity International and the United Nations University are both member organizations within the International Partnership for the Satoyama Initiative (IPSI), which has provided the platform for developing this collaborative research. With a broad and expanding global network of member organizations committed to promoting and supporting socio-ecological production landscapes for the benefit of biodiversity and human well-being, IPSI is well-positioned to promote synergistic collaboration among its members. One mechanism to support this process is the endorsement of "IPSI Collaborative Activities" by the Partnership's steering committee. Such activities include the active participation of two or more IPSI members towards an activity in line with the vision of the Satoyama Initiative. To promote a focused approach, IPSI Collaborative Activities are classified into five cross-cutting clusters, namely: knowledge facilitation, policy research, indicators research, capacity building and on-the-ground activities (<http://satoyama-initiative.org/en/>). The collaborative activity between Bioversity International and UNU-IAS was among the first proposals endorsed by the IPSI steering committee.

Executive Summary

The following policy report constitutes an important supplement to a set of 20 indicators for resilience in socio-ecological production landscapes (SEPLs) that was developed over the course of joint collaboration between Bioversity International and the United Nations University Institute of Advanced Studies (UNU-IAS). The indicators were disseminated widely in pamphlet form for the first time in March 2012. Subsequently, a need was identified for sharing a more in-depth overview of the considerations that went into creating this list of indicators as well as the outcomes of initial field-testing.

The report begins by defining the terminology of socio-ecological production landscapes (SEPLs), resilience, and the existing gap that this set of inclusive indicators has helped to bridge. In subsequent sections, the principles for developing the indicators are introduced and the four groupings of indicators are described in detail, namely (1) Ecosystems protection and the maintenance of biodiversity; (2) Agricultural biodiversity; (3) Knowledge, learning and innovation; (4) Social equity and infrastructure.

The latter portion of the policy report introduces the indicators themselves as well as the respective set of scores (1-5) for each indicator. A short section on the practical application of the indicators is then followed by a description of the first lessons learned from applying the indicators in Cuba's *Cuchillas del Toa* Biosphere Reserve. The field-testing took place from October-November 2011 and a supplementary annex provides a detailed indicator-by-indicator record of this process, including whether the indicators could be adequately assessed using the survey method or if further revisions to the study methodology are also required. In addition to summarizing the key lessons learned from the development and testing of the indicators, the conclusion section also provides a short overview of further progress made in testing and refining the indicators as well as next steps.

1. Introduction: The Scientific Basis for Indicators of Resilience

This report provides an in-depth look at the scientific basis for creating indicators of resilience in socio-ecological production landscapes (SEPLs), and the range of considerations that fed into their development. Following an initial description of SEPLs, a brief overview is provided about the traditional and cultural practices that shape SEPLs, and which have also fostered resilience. The first section of the report then concludes by identifying the need for inclusive indicators of resilience.

In the second section of the report, the indicators themselves are introduced following a description of the underlying principles that fed into this process. These twenty indicators of resilience in SEPLs are presented under four major overarching categories, namely ecosystems protection and the maintenance of biodiversity; agricultural biodiversity; knowledge, learning and innovation; social equity and infrastructure.

In the final section of the report, information is presented about the practical application of the indicators. Lessons learned from the October-November 2011 testing in Cuba's *Cuchillas del Toa* Biosphere Reserve are presented in detail. Additional information is provided in the report's annexes, which provide an overview of other indicator frameworks as well as detailed outcomes of the application of the indicators in Cuba and Kenya.

This policy report supplements the set of twenty indicators of resilience in SEPLs that was jointly published and disseminated in leaflet form in 2012 by Bioversity International and the United Nations University Institute of Advanced Studies¹.

1.1 Socio-ecological Production Landscapes (SEPLs)

Humans have influenced most of the Earth's ecosystems and shaped or created landscapes through activities that profoundly affect biodiversity and ecological processes. In many landscapes, people and nature have co-evolved over centuries or millennia, creating unique bio-cultural systems. Some of the historical human-nature interactions and co-evolutionary processes have been favourable to or synergistic with biodiversity conservation and still persist in landscapes in drylands, wetlands, coastal, mountain and forest environments around the world. The value of bio-cultural knowledge for the biodiversity conservation and sustainable development in these areas is often overlooked by scientists and policymakers. With the accelerating loss of biodiversity and its close association with poverty and food insecurity, there is an increasing need to broaden the global recognition of the values of these landscapes for conservation as well as human well-being.

The studies of interactions between humans and their environments have received increasing attention in a number of scientific fields, contributing to the conceptualization of these landscapes as complex *social-ecological* systems (SES) of coupled human and natural systems (Redman et al. 2004; Folke et al. 2010). The term *socio-ecological production landscapes* (SEPLs) was coined to refer to mosaic production landscapes that have been shaped through long-term harmonious interactions between humans and nature in a manner that fosters well-being while maintaining biodiversity and

¹ http://satoyama-initiative.org/wp-content/uploads/2011/09/Indicator_SEPLs_EN.pdf

ecosystem services (Gu and Subramanian 2012)². The unique traits that arise from the biological, physical, and social interactions among the various components comprising SEPLs are manifested in traditional ecological knowledge and customary sustainable use of biodiversity. In many cases, the maintenance of unique cosmologies and cultures anchored within bio-cultural knowledge systems is essential for the conservation of biodiversity and the continuous flow of ecosystem services.

Since 2011, collaborative work has been underway to develop indicators of resilience in SEPLs and to further refine these through field testing³. Considering the existence of SEPLs in diverse locations around the world and their importance as living examples of sustainable use, the development of this holistic framework of indicators can contribute to building a clearer understanding of how SEPLs are sustaining human well-being and biodiversity in a rapidly changing world.

1.2 Resilience of SEPLs

The seminal paper on ecological systems by Holling (1973) not only defined the clear differences between stability and resilience, but provided convincing examples of situations in which a system can be unstable, but resilient. The increasing number of environmental and societal crises of recent years has certainly caused widespread instability and shocks to many of the ecosystems around the world, but resilient systems have the capacity “to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks” (Walker et al. 2004).

The mosaic features of SEPLs have been shaped over generations by a strongly interlinked set of traditional practices and production activities that have been adapted and transformed to maintain and improve the community’s well-being while absorbing shocks to the system. Consequently, the harmonious human-nature interactions that have formed SEPLs around the world have generated areas characterized by higher levels of resilience. Nevertheless, landscape resilience in the face of past crises is no guarantee that SEPLs will have the same capacity to absorb and adapt to the pressures associated with climate change, globalization, and unprecedented rates of rural to urban migration.

A resilience approach (Holling 1973; Gunderson and Holling 2002) is therefore useful when considering the potential to maintain, revitalize and rebuild such landscapes and seascapes. Fundamental changes to SEPLs have the potential to unbalance customary sustainable use processes, leading to decreased resilience and increased vulnerability. To avoid such negative trends, it is therefore crucially important not only to obtain a clearer understanding of the “components” of resilience, but also to empower local communities and provide them with the tools to understand their resilience. Such a framework would provide a strong foundation upon which to recognize negative trends and potential opportunities for further strengthening resilience.

² While the origins of the term “SEPLs” are largely derived from an inclusive view of both mosaic landscapes *and* seascapes (Duraiappah et al. 2010), the term has recently been updated to explicitly encompass “socio-ecological production landscapes and seascapes”, or SEPLS (IPSI 2012). While the collaborative work between Bioversity International and UNU-IAS on indicators of resilience in SEPLs was initiated prior to this update, and field-testing has so far focused on terrestrial landscapes, the underlying principles and conclusions of this work may also be highly applicable to seascapes. Further field-testing would help to clarify such points.

³ http://satoyama-initiative.org/wp-content/uploads/2011/09/Indicator_SEPLs_EN.pdf

1.3 The Need for Inclusive Indicators

In SEPLs, ecosystems and social systems are dynamic and inextricably linked; there are virtually no ecosystems that are not shaped by people and no people without the need for ecosystems and the services they provide. One increasingly relevant scientific approach to deal with analysis of such interwoven systems of humans and nature is through the concept of resilience. The resilience of these systems depends as much on the links between human and ecological components, in which humans adapt to the environment and change the environment in the process, as it does on ecological characteristics (biodiversity, habitat, ecosystem services) and social ones (institutions, networks, education) (van Oudenhoven et al. 2010a).

Although the resilience approach applied to SES provides a conceptual foundation for sustainable development, one area in which the resilience theory is critically underdeveloped is in metrics. As Cumming et al. (2005) state, resilience is difficult to operationalize because of its abstract and multi-dimensional nature. Alternative approaches to measure impacts of resilience, in lieu of resilience itself, have been proposed and they span from context-dependent surrogates of resilience for each SES (e.g., Bennett et al. 2005, Carpenter et al. 2006), to more conceptual models of SES, such as the Resilience Assessment Workbook developed by the Resilience Alliance (Resilience Alliance 2010) which is based on answering the question “the resilience of what to what”, first proposed by Carpenter et al. (2001). In the case of context-dependent surrogates of resilience, instead of estimating resilience directly, the alternative is to monitor attributes of the systems that are related to the resilience of the system and are measurable. These measurable attributes can be used to select resilience surrogates.

The resilience assessment framework starts by using strategic questions and activities to construct a conceptual model of a social-ecological system that represents a place of interest, along with its associated resources, stakeholders, institutions, and issues. Building on the conceptual model, the assessment guides the identification of potential thresholds that represent a breakpoint between two alternative system states and helps reveal what is contributing to or eroding system resilience. A resilience assessment can thus provide insight into developing strategies for buffering or coping with both known and unexpected change.

To measure resilience in SEPLs, which encompass all complexities a social ecological system can possibly have, developing indicators is a more useful approach to assessing resilience than trying to measure resilience itself. Because of the dynamic nature and the complexity of interrelations between the elements of SEPLs, the indicators, jointly developed by Bioversity International and UNU-IAS, are designed to capture the different aspects that are entailed and essential for sustaining a resilient landscape (e.g. cultural, social, ecological and agricultural). These indicators are based on case studies that describe communities’ strategies to cope with and adapt to change, they are meant to help measure a community’s capacity to build resilience and harness ecosystems services through innovation, adaptation, and the sustainable use of biodiversity. They are not conceived as defined set of measurements but rather as a guide to understanding and strengthening SEPLs resilience.

2. Principles for Developing an Inclusive Set of Indicators

To improve our understanding of the social and cultural dimensions of biodiversity conservation and to support the beneficial links between local communities and ecosystems they inhabit, a set of indicators has been identified based on the work by Mijatovic et al. (2012) and van Oudenhoven et al. (2010a,b) (Annex 1). They serve as an analytical tool to understand and 'measure' resilience, which largely depends on biodiversity at different scales (from landscape to genetic levels). The urgency to focus on resilience, or the ability to retain structure and function after disturbances and adapt to change, comes out of the notion of SEPLs as dynamic (rather than static) evolving systems.

The main way in which the resilience indicators differ from conventional indicators of ecosystem health (species richness, nutrient and water recycling, soil productivity, etc.) is that those fail to capture its social dimensions and do not provide historical view of the landscape. Moreover, "they tend to overlook systems of traditional ecological knowledge which are practical, attuned to local ecology and embody a complex of (socio-cultural) interactions pertinent to ecosystem functioning and resilience" according to van Oudenhoven et al. (2010a). The resilience indicators presented in this paper are firstly designed for communities to use for developing projects supporting the conservation and other benefits derived from their management of biodiversity within their traditional production systems. They are also intended for scientists, conservation and development agencies to identify critical areas for support of community-based management and adaptation to increase the resilience and welfare benefits in key bio-cultural landscapes. The indicators also intend to facilitate communication between local communities and 'outsiders' by providing a common framework for assessing resilience and exchanging information across SEPLs.

The conservation of agricultural biodiversity (ABD) provides a stream of benefits that contribute to livelihoods (whether concrete, in the form of monetary and ecological benefits, or perceived, in the form of cultural or spiritual benefits). Communities living in SEPLs use the indicator framework to measure various aspects of the landscape they inhabit which helps translate the direct (increased well-being, nutrition, etc.) or indirect benefits (potential resilience of system in the face of climate change, etc.) of ABD conservation and, therefore, the increased perceived value of conserving biodiversity. Researchers and project developers use the indicators to develop and improve programmes which increase the potential benefits of conservation of ABD.

Based on the above review, the following principles for defining and selecting indicators for conservation and livelihoods at a landscape scale have been identified:

- Indicators should be easy to understand and use by local land users.
- Processes should involve participation of implementers as well as local communities (but should also reflect existing plans and commitments).
- Agreed objectives for those outcomes that occur at the bio-cultural landscape scale should be clearly defined.

- Different people will have different views on desirable landscape outcomes and the process for deciding on desired outcomes has to be based upon negotiations between all concerned parties.
- No single landscape configuration will maximize the benefits to all stakeholder groups and the best that can be achieved is to maximize gains and minimize losses.
- People's perceptions and needs will change over time and the outcomes sought will need to be periodically revised and adjusted.
- Indicators should be expressed on Likert (1–5) scales. This provides a simple way of capturing people's impressions and ideas in a quantitative way.
- Participatory processes should also be extended to the way in which indicators are measured and defined.
- Set of holistic indicators to capture all the benefits related to the conservation and sustainable use of ABD in SEPLs.

3. What do the Indicators Measure?

The indicators measure elements of SEPLs resilience that are, almost by definition, strongly interrelated. The practices and institutions that they describe can be grouped into four areas: (1) Ecosystems protection and the maintenance of biodiversity; (2) Agricultural biodiversity; (3) Knowledge, learning and innovation; (4) Social equity and infrastructure. In the following section, each of these areas is discussed in greater detail.

3.1 Ecosystem protection and the maintenance of biodiversity. The health of a landscape and the ecosystems it supports is reflected in part in the diversity of species and their interactions; it also forms the physical, cultural, and often, spiritual bases of a community's well-being. Biodiversity contributes to community and landscape resilience by providing ecosystem services, which are sustained (or degraded) by the practices and institutions that regulate the use of natural resources. In the context of climate change, for example, the protection and restoration of watersheds and forest and coastal ecosystems in SEPLs helps regulate hydrology and microclimate, thereby providing a buffer against extreme weather events, floods and droughts. The four indicators falling under this category along with their respective scores are described in detail in Table 1.

Table 1: Indicators on Ecosystems Protection and the Maintenance of Biodiversity

What to assess?	Scores
<p>Heterogeneity and multi-functionality of the landscape</p> <p>Do land management practices maintain a heterogeneous landscape mosaic composed of different land-use types and ecosystem patches e.g. forest patches, home gardens, cultivated fields and orchards?</p>	<p>(5) Heterogeneous landscape consists of diverse land-use types and well-connected ecosystem patches.</p> <p>(4) Landscape mosaic consists of several land-use types and some ecosystem patches.</p> <p>(3) Landscape consists of several land-use types and fragmented ecosystem patches.</p> <p>(2) Landscape consists of two or three land-use types and few ecosystem patches.</p> <p>(1) No heterogeneity, i.e. one type of land-use predominates in the landscape.</p>
<p>Areas protected for their ecological and cultural importance</p> <p>How many landscape components that maintain ecosystem functions and services are protected? Protection may be formal or informal and include traditional forms of protection such as sacred groves.</p>	<p>(5) Protected and low-use areas cover key resources and are well-connected with ecological corridors.</p> <p>(4) Protected and low-use areas cover key resources in the landscape.</p> <p>(3) Protected and low-use areas small.</p> <p>(2) Protected and low-use areas very small.</p> <p>(1) Landscape intensively used, leading to resource depletion and accelerating loss of biodiversity.</p>

What to assess?	Scores
<p>Ecological links between landscape components for sustainable production</p> <p>Are ecological links between different landscape components maintained and harnessed for sustainable production e.g. ecosystem patches kept for pollinators, pest control, nutrient cycling, groundwater recharge and soil erosion control?</p>	<p>(5) Beneficial links between landscape components are maintained and harnessed.</p> <p>(4) Some beneficial links between landscape components are maintained.</p> <p>(3) Production systems partly depend on external inputs.</p> <p>(2) Production systems largely depend on external inputs.</p> <p>(1) Production systems heavily depend on external resources (e.g. high pesticide use).</p>
<p>Rate of recovery from extreme environmental and climate change-related stresses and shocks</p> <p>Does the landscape have the capacity to cope with and recover from extreme environmental and climate change-related stresses and shocks e.g. pests and diseases, extreme weather events, floods and droughts?</p>	<p>(5) No significant damage to landscape functioning.</p> <p>(4) High rate of recovery.</p> <p>(3) Medium rate of recovery.</p> <p>(2) Low rate of recovery.</p> <p>(1) Irreversible damage to landscape functioning.</p>

3.2 Agricultural biodiversity (ABD) forms the nexus between the health of an ecosystem and that of a community. It includes species used for food, fodder, fibre, fuel, and the large number of non-harvested species in the wider landscape directly used by or benefiting communities through the services they provide such as pollinators, soil biota and regulators of pests and diseases. Agricultural biodiversity provides material for experimentation, innovation and adaptation. The genetic diversity found in local crop varieties and animal breeds, expressed in important traits such as drought and saline tolerance, and resistance to pests and diseases, helps them adapt to various soil and climate conditions. The loss in diversity of these traits decreases options for risk management and adaptation. Revival of local food systems and landscape diversification, on the other hand, encourages the maintenance of agricultural biodiversity, and contributes to food security and self-sufficiency. Table 2 provides details about the scoring system for the two indicators that were developed under the agricultural biodiversity category.

Table 2: Indicators on Agricultural Biodiversity

What to assess?	Scores
<p>Maintenance, documentation and conservation of agricultural biodiversity in a community</p> <p>Are local crops, varieties and animal breeds used in a community?</p> <p>Is agricultural biodiversity documented and conserved in community classification systems and community seed banks?</p>	<p>(5) Local crops, varieties and breeds (#) widely used, documented and conserved.</p> <p>(4) Local crops, varieties and breeds are used by some community members; documentation and conservation practices are weak.</p> <p>(3) Local crops, varieties and breeds are used by few community members; documentation and conservation practices do not exist.</p> <p>(2) Local crops, varieties and breeds are rare and used only by very few community members; documentation and conservation practices do not exist.</p> <p>(1) Local crops, varieties and breeds no longer found.</p>
<p>Diversity of local food system</p> <p>Do communities use a diversity of traditional and locally-produced foods, e.g. cereals, vegetables, fruits, nuts, wild plants, mushrooms, berries, fish and animals?</p>	<p>(5) Locally-sourced foods abundant and widely used.</p> <p>(4) Locally-sourced foods available and used by some community members.</p> <p>(3) Locally-sourced foods available and occasionally used.</p> <p>(2) Variable availability and use of locally-sourced foods.</p> <p>(1) Scarcity of locally-sourced foods.</p>

3.3 Knowledge, learning and innovation are the means of building resilience. Communities strengthen resilience by experimenting, innovating, and learning within and between different knowledge systems, cultures, and age groups. Adaptation strategies may be novel or old, but generally build on bio-cultural or traditional knowledge. This knowledge is specific to the locations and cultures of given social-ecological interactions. It is embodied in resource use customs, agricultural traditions, local languages, cultural values, and social institutions. Many communities are losing their knowledge of local resources, biodiversity and the historical events that have shaped the landscape. The maintenance of this knowledge increasingly depends on the ability of elders, parents and the younger generations in a community to document and share it. The role of young people in valuing traditional knowledge and assimilating it with the new knowledge acquired in urban centres and schools is crucial, but often underestimated. Under the knowledge, learning and innovation category, Table 3 defines eight indicators along with short descriptions and a set of scores.

Table 3: Indicators on Knowledge, Learning and Innovation

What to assess?	Scores
<p>Innovation in agricultural biodiversity management for improved resilience and sustainability</p> <p>Do community members improve, develop and adopt new agricultural biodiversity management practices to adapt to changing conditions, e.g. climate change, population pressure, resource degradation?</p> <p>Examples of innovative practices are the adoption of water conservation measures (drip irrigation), diversification of farming systems and switch to drought- or saline-tolerant crops/ varieties.</p>	<p>(5) Community members are receptive to change and adjust their practices through local innovation.</p> <p>(4) Community members are receptive to change; local innovation takes place but can be strengthened.</p> <p>(3) Community members are receptive to change but the rate of innovation is low.</p> <p>(2) Community members are moderately receptive to change, no innovation.</p> <p>(1) Community members are not receptive to change, no innovation.</p>
<p>Access and exchange of agricultural biodiversity</p> <p>Are individuals within and between communities connected through institutions and networks for the exchange of agricultural biodiversity, e.g. seed exchange networks, local markets and animal and seed fairs?</p>	<p>(5) Multiple systems of exchange regularly operating within and between communities across different cultures and landscapes.</p> <p>(4) Exchange within and across communities takes place but can be strengthened.</p> <p>(3) Exchange takes place occasionally.</p> <p>(2) Exchange takes place rarely.</p> <p>(1) Systems of exchange do not exist.</p>
<p>Transmission of traditional knowledge from elders, parents and peers to the young people in a community</p> <p>Is the knowledge of key concepts and practices about land, water, biological resources and cosmology transmitted between different age groups?</p>	<p>(5) Key concepts and practices known to all community members, including youth.</p> <p>(4) Key concepts and practices known to community members, but not to those considered youth.</p> <p>(3) Key concepts and practices known only to adults and elders.</p> <p>(2) Key concepts and practices known only to elders.</p> <p>(1) Traditional knowledge lost.</p>

What to assess?	Scores
<p>Cultural traditions related to biodiversity</p> <p>Are cultural traditions related to biodiversity maintenance and use continued by young people, e.g. festivals, rituals, songs, etc.?</p>	<p>(5) Cultural traditions practiced by all community members including youth.</p> <p>(4) Cultural traditions practiced by community members, but not by those considered youth.</p> <p>(3) Cultural traditions practiced only by adults and elders.</p> <p>(2) Cultural traditions practiced only by elders.</p> <p>(1) Not practiced.</p>
<p>Number of generations interacting with the landscape</p> <p>How many generations interact with the landscape for subsistence and income?</p>	<p>(5) Three or more generations interact with the landscape.</p> <p>(4) Two or three generations interact with the landscape.</p> <p>(3) Two generations interact with the landscape.</p> <p>(2) One or two generations interact with the landscape.</p> <p>(1) One generation interacts with the landscape.</p>
<p>Practices of documentation and exchange of local knowledge</p> <p>Are community-based institutions and systems for documentation, exchange and acquisition of externally-sourced knowledge in place? E.g. existence of traditional knowledge registers, resource classification systems, and community biodiversity registers, farmer field schools.</p>	<p>(5) Institutions and systems for knowledge documentation and exchange are present and well-functioning.</p> <p>(4) Institutions and systems for knowledge documentation and exchange present but can be strengthened.</p> <p>(3) Some knowledge documentations and exchange taking place but need to be strengthened.</p> <p>(2) Only a small fraction of knowledge documented.</p> <p>(1) Documentation of knowledge does not take place.</p>
<p>Use of local terminology or indigenous languages</p> <p>Do community members use local terminology related to land and (the use of) biodiversity, and, if applicable, do they speak the local dialect or language?</p>	<p>(5) Local terminology (and local dialect or language) widely used in the community.</p> <p>(4) Local terminology used by the majority of community members.</p> <p>(3) Local terminology used by a part of the community.</p> <p>(2) Local terminology used by a small part of the community.</p> <p>(1) Local terminology not used.</p>

What to assess?	Scores
<p>Women's knowledge about biodiversity and its use</p> <p>Are women's knowledge, experiences and skills recognized as central to practices that strengthen resilience?</p>	<p>(5) Women's knowledge, experiences and skills recognized, respected and used.</p> <p>(4) Women's knowledge, experiences and skills mostly recognized and respected and used.</p> <p>(3) Women's knowledge, experiences and skills partially recognized, respected and used.</p> <p>(2) Women's knowledge, experiences and skills receive little recognition.</p> <p>(1) Women's knowledge, experiences and skills not recognized.</p>

3.4 Social equity and infrastructure are key features of SEPL resilience. Gender inequality, social exclusion and marginalization can hinder the ability of women, indigenous and other groups to strengthen resilience. Women hold specific knowledge and skills related to biodiversity, and thus their role in adaptation is essential. For indigenous communities, resilience is intrinsically linked with their efforts to protect traditional ways of subsistence and cultural heritage. The ability to access ancestral lands and engage in traditional land use and agricultural practices are important conditions for communities to maintain biodiversity and associated traditional knowledge. Resilience is also dependent on the availability of efficient and functioning social infrastructure, such as communication, health and education and markets to meet various needs and aspirations of the communities. The final category of social equity and infrastructure includes six distinct indicators, each of which can be scored from one to five as shown in Table 4.

Table 4: Indicators on Social Equity and Infrastructure

What to assess?	Scores
<p>Local resource governance</p> <p>Are land, water and other resources effectively managed by community-based institutions? I.e. existence of traditional institutions (customary laws) and non-traditional local initiatives (governmental and non-governmental) for the sustainable use of resources.</p>	<p>(5) Institutions in place and resources effectively managed.</p> <p>(4) Institutions in place and some resources effectively managed.</p> <p>(3) Institutions in place but need to be strengthened.</p> <p>(2) Institutions not effective.</p> <p>(1) Institutions not present.</p>

What to assess?	Scores
<p>Autonomy in relation to land and resource management</p> <p>Does the community have autonomous access to indigenous lands, territories, natural resources, and sacred and ceremonial sites, e.g. clarity of tenure rights?</p> <p>Is that autonomy recognized by outside groups and institutions, e.g. governments and development agencies?</p>	<p>(5) Community has access to its traditional lands and resources and autonomy in their management.</p> <p>(4) Community has access to its traditional lands and resources and partial autonomy in their management, but its autonomy needs to be strengthened and recognized by outside groups.</p> <p>(3) Community has limited access to its traditional lands and resources and limited decision power over their management.</p> <p>(2) Community has limited access to its traditional lands and resources and no decision power over their management.</p> <p>(1) Community has neither access to nor decision power over traditional lands and resources.</p>
<p>Gender</p> <p>Are women involved in decision-making and communication with outsiders?</p> <p>Do women have access to resources, education, information and opportunities for innovation?</p>	<p>(5) Women are involved in decision-making and communication with outsiders, and have the same access to resources and opportunities as men.</p> <p>(4) Women are involved in decision-making and communication with outsiders, and have access to resources and opportunities, but less so than men.</p> <p>(3) Women are partially or occasionally involved in decision-making and have limited access to resources and opportunities.</p> <p>(2) Women are rarely involved in decision-making and have limited access to resources and opportunities.</p> <p>(1) Women are not involved in decision-making and have no access to resources and opportunities.</p>
<p>Social infrastructure</p> <p>Is social infrastructure, including roads, schools, telecommunications, markets, energy, and electricity in place?</p>	<p>(5) Social infrastructure exists and meets all community needs.</p> <p>(4) Basic social infrastructure exists.</p> <p>(3) Not all necessary infrastructure exists or functions satisfactorily.</p> <p>(2) Some major social infrastructure is missing and opportunities for its improvement are limited.</p> <p>(1) No infrastructure in place.</p>

What to assess?	Scores
<p>Health care</p> <p>Do community members have access to health care?</p> <p>Are traditional healing methods and modern medicine present?</p>	<p>(5) Health care accessible for all community members and functions to the satisfaction of the community.</p> <p>(4) Basic health care accessible.</p> <p>(3) Health care facilities exist but do not function satisfactorily or not easily accessible.</p> <p>(2) Health care facilities not satisfactory and not easily accessible.</p> <p>(1) Health care not accessible.</p>
<p>Health risk</p> <p>Is there a health risk from epidemics, water contamination, air pollution or other threats, e.g. malnutrition?</p>	<p>(5) Low risk.</p> <p>(4) Average risk.</p> <p>(3) Moderate risk.</p> <p>(2) High risk.</p> <p>(1) Very high risk.</p>

4. Applying the Indicators

The indicators, presented in tables 1 to 4, are developed to guide the assessment of resilience in a community. The assessment entails assigning a score and a trend to each indicator by answering the questions listed in the tables' first column. A qualitative or quantitative score can be assigned to all indicators using a 5-point scale given in the tables' second column. To collect information about changes in trends, the following categories can be used for each indicator separately:

↑	Steep upward trend
↗	Slow/some increase
→	No change
↘	Slow/some decrease
↓	Steep downward trend

The way the indicators are used will differ depending on the user. Communities may seek to monitor the impact of external development, agricultural or conservation interventions on traditional livelihoods; for practitioners and scientists they can help elucidate whether and how the day-to-day interactions between people and the landscape contribute to landscape resilience. Most importantly however, the indicators intend to provide a common language between 'traditional', 'governmental' and 'scientific' communities which values, rather than obscures the complexity of human environment interactions.

5. First Lessons from Application of Indicators in Cuba (Cuchillas del Toa Biosphere Reserve)

5.1 Introduction

The indicators to measure the resilience of socio-ecological production landscapes were tested in the Biosphere Reserve of “Cuchillas del Toa” (RBCT) from 25 October – 1 November 2011. The indicators had previously been analysed and adjusted, and a few questionnaires were elaborated in order to obtain the necessary information through focus groups discussions. The study was conducted in four communities in the region known as “Las Miniciones”, “Rincones”, “Vega Grande” and “Rancho de Yagua”.

Cuchillas del Toa Biosphere Reserve is an important reservoir of genetic material of many fruit and horticultural species and varieties that are currently under threat within the larger, more intensive agriculture systems elsewhere in Cuba. This reserve has been chosen for testing the indicators of resilience as it contains a large area of agricultural landscapes, a large number of farm families, and covers the full range of agro-ecosystems found in Cuba. The communities living in the buffer and transition zones of the Reserve practice traditional *conuco* and home garden cultivation in close association with natural landscapes that maintain major components of the total biodiversity.



Figure 1: Location of Cuchillas del Toa Biosphere Reserve

This Biosphere Reserve (RBCT) was established by UNESCO in 1987. Its core area, the National Park “*Alejandro de Humboldt*” was registered as World Heritage Site in 2001 and today is the most complex park within the National System of Protected Areas of the country. Complex geology and varied topography have given rise to a diversity of ecosystems and species unmatched in the insular Caribbean and created one of the most biologically diverse tropical island sites on earth. The site has the highest plant diversity including endemism of the Cuban archipelago and the insular Caribbean. Endemism of vertebrates and invertebrates is also very high. The RBCT is located in eastern Cuba, in the mountains of *Nipe-Sagua-Baracoa*, with heights reaching 1,000 m. It has a total area of about 208,000 ha. The reserve provides the highest levels of endemism of the island and of the Caribbean islands, as well as most of the country’s river systems.

Agricultural biodiversity managed by farmers settled in the Reserve is an invaluable resource for the country’s genetic resources, while, at the same time, representing a component that confers great value to the rich landscape where agriculture is practised.

5.2 Description of the Farmers Surveyed

The survey was conducted with a focus group of 12 people coming from the 4 communities. The focus group included five land owners (four men and one woman), two women with no land property and five children and adolescents.

5.3 Summary of Survey Results

The survey was conducted by INIFAT (Instituto de Investigaciones Fundamentales en Agricultura Tropical “*Alejandro de Humboldt*”) technical staff. This pilot study, aimed at testing the effectiveness of the indicators in assessing resilience in SEPLs, helped identify, in a participatory manner, gaps in knowledge and areas of intervention to improve the resilience of the studied communities in *Cuchillas del Toa* Biosphere Reserve. Based on the consultation with farmers and their perception of what was most important to secure resilience of their landscape, the following two indicators, out of the twenty proposed, were not assessed: Areas protected for their ecological and cultural importance and Cultural traditions related to biodiversity. A detailed indicator-by-indicator description of the findings of this pilot study is provided in Annex 2. While some of the resilience strategies are in place in these communities, lack of basic social infrastructures, inadequate access to information and impossibility to exchange experiences were identified as important areas of intervention to increase resilience of the communities and favour the permanence of the community members, especially youths, in those areas.

During this exercise INIFAT staff also suggested fine tuning of the text of some of the indicators’ scores in order to make them more significant and understandable to the community members. Although the indicators are defined and measured in terms easily perceived and used by local communities, the results of this survey also highlight that the level of understanding of the landscape elements between members of a community or between different communities may vary enormously and depend on the existence and the duration of collaborative initiatives between communities and local scientists.

6. Conclusion

Accelerating global trends, including a growing population and shifts in dietary preferences, have placed tremendous strain on many of the world's landscapes and seascapes. Statistics of advancing desertification, disappearing fish stocks and falling water tables are just a few of the indicators highlighting the unsustainability of current food production activities and the exploitation of natural resources.

While such statistics can be entered into models and plotted on graphs, an often-overlooked aspect of food production is the set of traditions and the culture that in many cases has developed in conjunction with such activities. Indeed, many landscapes and seascapes around the world have been shaped over generations by sustainable use of natural resources based on wise stewardship of the surrounding ecosystems in a manner that both sustains biodiversity and promotes human well-being. Socio-cultural activities and traditions are a crucial element of such landscapes and impact everything from local diets and cultivation timetables to harvesting methods and allocation of local resources.

The long-term health of such socio-ecological production landscapes (SEPLs) therefore depends not only on the health of the mosaic of different ecosystem types, but also on the socio-cultural aspects that have sustained the communities managing these SEPLs. At the same time, this duality also provides an additional source of resilience to SEPLs.

An integrated approach is therefore crucial to understanding the vulnerability and resilience of SEPLs – focusing not just on the mechanics of a healthy ecosystem, but also on the range of socio-cultural factors that sustain communities. The set of 20 indicators of resilience in SEPLs contained within this policy report serves to fill an existing gap by focusing on the range of factors spanning both the ecological and socio-cultural spheres. They therefore provide a simple, but powerful tool for communities and policymakers to understand the resilience of SEPLs, identify potential negative trends, and, as appropriate, make decisions to further reduce vulnerability.

As the mantra goes, a model is only as good as the data used to create it, and while careful consideration led to the creation of the set of 20 indicators of resilience in SEPLs, field-testing was a crucial next step towards verifying their usefulness and towards making them more rigorous and representative of resilience in SEPLs.

The field-testing in Cuba's *Cuchillas del Toa* Biosphere Reserve from October-November 2011 provided insight into the applicability of the indicators and helped to identify areas in which changes would be appropriate. During the preparation of this policy report, additional field-testing has been conducted in Kenya, Bolivia and Nepal, leading to a growing body of knowledge about the challenges and potential for widespread application by and for communities. This policy report is meant to highlight the initial development and first field-testing of the indicators, but does not contain the results of further testing. Revisions to the set of indicators can, however, be found online⁴ and efforts are underway to share further outcomes of field-testing and to prepare a manual describing lessons learned from application of the indicators and recommendations for how they can be most effectively used in additional locations. In addition, while initial field-testing of the indicators has thus far been focused on landscapes, future testing within a seascape setting could help to further enhance and expand the applicability of the indicators.

⁴ http://satoyama-initiative.org/wp-content/uploads/2011/09/Indicator_SEPLs_EN.pdf

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Annex 1: Existing Indicator Frameworks Reviewed during Development of Indicators of Resilience in SEPLs

Type of Indicator Framework, and specific information	Location Used	Source
<p>Sustainable livelihood:</p> <ul style="list-style-type: none"> • Creation of working days • Poverty reduction • Well-being and capabilities • Livelihood adaptation, vulnerability, resilience • Natural resource sustainability 	N/A	"Sustainable Rural livelihoods: A Framework for analysis" (Scoones, 1998)
Indicators of well-being	India	"Poverty debate in India: a minority view" (Jodha, 1988) in "Poverty and livelihoods: whose reality counts?" (Chambers, 1995)
<p>Agrobiodiversity conservation: Important factors for agrobiodiversity loss</p>	India	"The Role of Cultural Values in Agrobiodiversity Conservation: A Case Study from Uttarakhand, Himalaya" (Nautiyal et al., 2008)
<p>Agrobiodiversity Hotspots: Indicators for identifying National Agro-biodiversity Heritage/Hotspot Sites (NAHS) (p.1133)</p>	India	"Criteria for identification and assessment of agro-biodiversity heritage sites: Evolving sustainable agriculture" (Singh and Varaprasad, 2008)
<p>Agrobiodiversity conservation: "The degree of dependency of farmers' on their agrobiodiversity is a crucial indicator to express the likelihood of farmers maintaining the biodiversity-friendly land use."</p>	Indonesia, Thailand	"Rapid Agrobiodiversity Appraisal (RABA) in the Context of Environmental Service Rewards" (Kuncoro et al., 2006)
<p>Agrobiodiversity and transmission of local knowledge</p>	Lao PDR	"Agrobiodiversity and Local Knowledge Issues In Luang Prabang and Xieng Khouang Provinces" (Jatiket and Samsamay, 2007)
<p>Indicator-based evaluation of system sustainability</p>	Latin America	"Ten years of sustainability evaluation using the MESMIS framework: Lessons learned from its application in 28 Latin American case studies" (Speelman et al., 2007)

Type of Indicator Framework, and specific information	Location Used	Source
Conservation and livelihood indicators to assess performance of attributes at the landscape-level	Morocco, Central African Republic, Tanzania	"Assessing environment and development outcomes in conservation landscapes" (Sayer et al., 2007)
Ecological indicators: <ul style="list-style-type: none"> • Flow of information as indicator of potential for adoption and flow of materials for current adoption • Erosion and productivity indicators • Soil productivity indicators (crop productivity, soil characteristics, management requirement, species of weeds, diseases, and pests and termites) 	Nepal	"Renewable Natural Resources Management for Mountain Communities" (Stocking et al., 2005)
Performance of sustainable livelihood and environmental management for building resilience to climate change , particularly causing drought <ul style="list-style-type: none"> • Land degradation (slowed or reversed); • Condition of the vegetation cover (stabilized or improved); • Soil and/or crop productivity (stabilized or increased); • Water supply (stabilized or increased); • Average income levels (stabilized or increased); • Food stores (stabilized or increased); • Migration (slowed, stabilized, or reversed). 	Sudan	"Sustainable livelihood approach for assessing community resilience to climate change: case studies from Sudan" (Elasha et al., 2005) <p>*generic indicators used as a base for discussion and revision by community</p> <p>**see document pg. 15 for general SL indicators for assessing capital assets</p>
Rural livelihood sustainability	Uganda, South Africa	"Formulating Indicators for Rural Livelihoods: Lessons from Uganda and South Africa." (Howlett et al., s. d.)

Annex 2: Detailed Results from Application of Indicators in Cuba (Cuchillas del Toa Biosphere Reserve)

1: Ecosystems Protection and Maintenance of Biodiversity

Heterogeneity and multifunctionality of the landscape

Score 4 ↗

To understand the heterogeneity and the multifunctional landscapes, drawings of two representative farms of the visited area were made.

Description of Diego Arcalla's farm, Community (Munitions)

The farm has a total area which exceeds 10 ha, including natural vegetation which constitutes the largest percentage. The farmer does not manage the areas with natural vegetation.

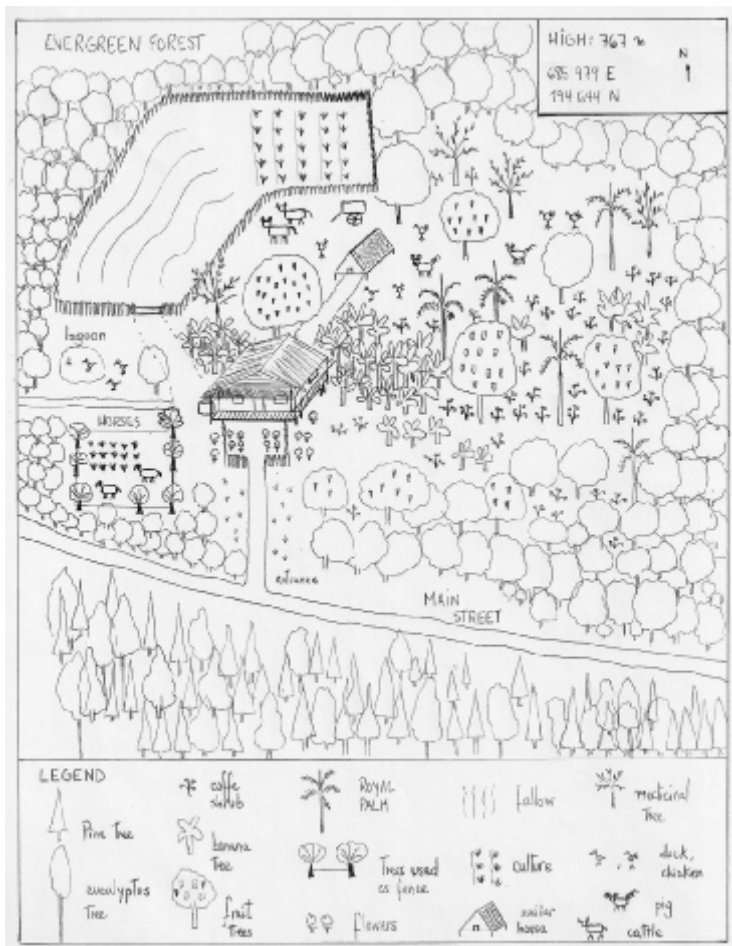


Figure 2: Schematic drawing of Diego Arcalla's farm, Las Municiones community

Cultivated plants are located in the four cardinal points with respect to the house. In a rear position compared to the consumption area there is semi-natural vegetation, forests as well as plant successions between 0-20 years of age, and young forests between 20-80 years.

The main groups of plants identified were: wild and cultivated plants, including banana (*Musa* spp.) and coffee (*Coffea* spp.), and different fruit species such as the sapote (*Pouteria sapote*), ornamentals such as roses (*Rosa* spp.) and croton (*Codiaeum variegatum*) and medicinal herbs such as basil (*Ocimum* spp.).

The most important uses of the flora are for animal feed, royal palm (*Roystonea regia*), and medicinal (*Allophylus cominia*). Also notable is the use of timber, for example in the case of incense (*Protium fragrans*) and the use as fuel wood in *Cupania* sp.

Wildlife fauna is represented by a significant presence of birds. The fauna is represented by domestic animals used for food like hens, ducks, turkeys, pigs and pet animals, dogs and cats.

Climate variables measured at the time of evaluation

- Season: Autumn
- Relative humidity: 68.4%
- Wind speed: 2.5 m / s
- Temperature: 27.5 ° C
- Measuring Time: 12:00 p.m.

Description of Victor Savon's farm (Community Corners)

The farm covers an area of 10.7 ha and also includes a small percentage of natural vegetation. In some areas reforestation with precious wood forest species such as hibiscus (*Talipariti elatus*) and cedar (*Cedrela odorata*) is being implemented. This activity is paid by the National Forest Development Fund (FONADEF).

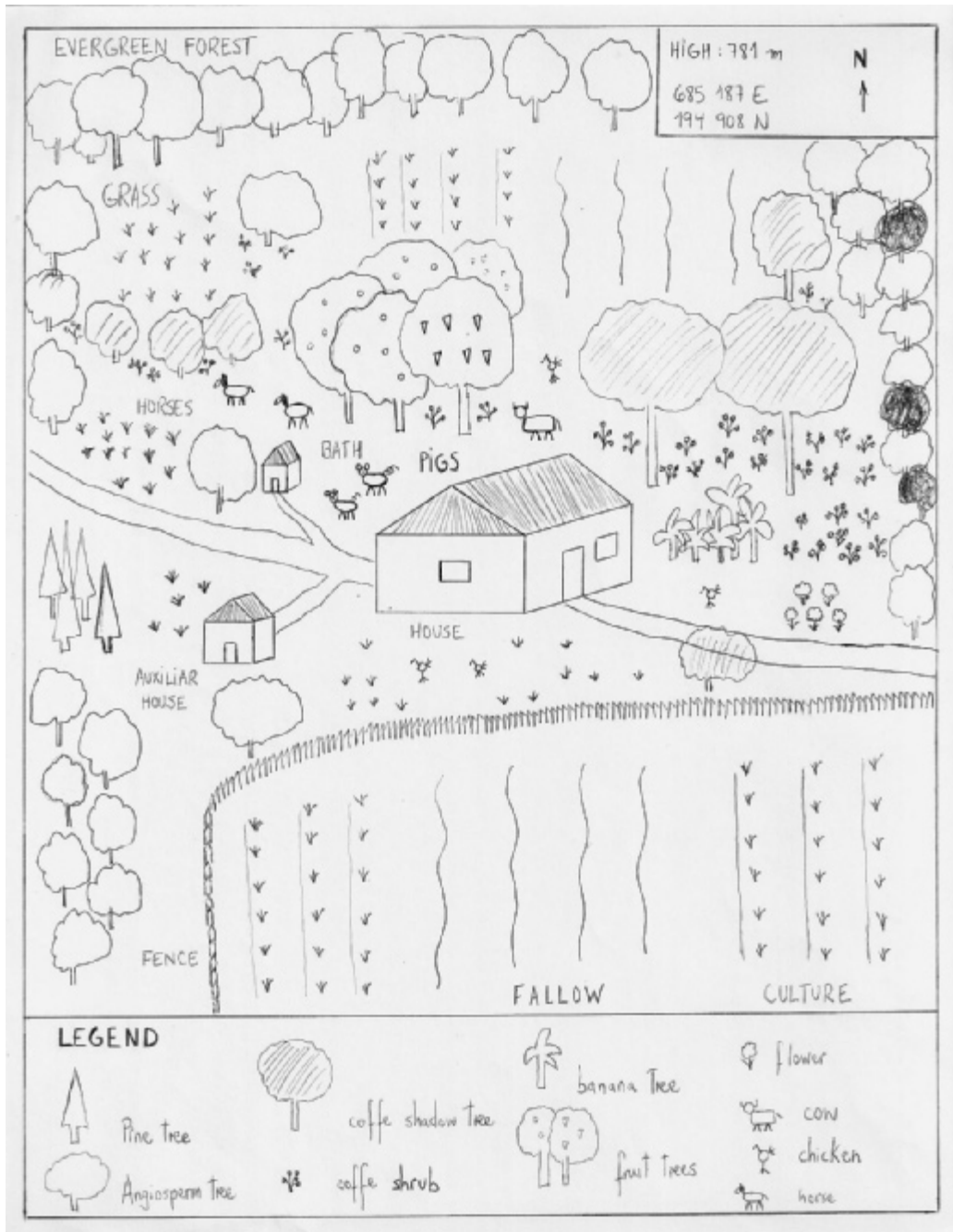


Figure 3: Schematic drawing of Victor Savon' farm, Rincones community

Cultivated plants are distributed in the four cardinal points with respect to the housing. Natural vegetation is in the farm area, such as the mesophilic submontane evergreen forest, pasture with pockets of crops and secondary vegetation (bush, grasslands and other) aged between 0 and 80.

Major plant groups are: banana (*Musa* spp.), Coffee (*Coffea* spp.), grains, roots and tubers and vegetables. Also ornamental plants such as roses (*Rosa* spp.) and Madagascar periwinkle (*Catharantus roseus*), and permanent fruit such as citrus (*Citrus* spp), sapote (*Pouteria sapote*), guava (*Psidium guajava*) and mango (*Mangifera indica*). Among the medicinal species some are cultivated and others are wild.

The main uses of the biota were: food, medicinal, ornamental, timber, honey and others. Among the plants cultivated for medicinal purposes cinnamon (*Cinnamomum chinense*), basil (*Ocimum* spp.), sage (*Pluchea odorata*) stand out. The trees used as wood (precious, hard and soft) are represented by species such as hibiscus (*Talipariti elatus*) ocuje (*Callophyllum utile*), cedar (*Cederla odorata*), *Cinamomum cubense* and others.

Wildlife is represented by birds and Lepidoptera both with butterflies and moths. The domestic fauna is diverse and dominated by chickens, pigs and sheep, pet animals dogs and cats are also present so as work animals like horses and cattle.

Climate variables measured at the time of evaluation:

- Season: Autumn
- Relative humidity: 68.7%
- Wind speed: 3.3 m / s
- Temperature: 28.1 ° C
- Measuring Time: 12:17 p.m.

Ecological links between landscape components for sustainable production

Score 4 ↗

Farmers do not have a clear perception of the ecosystem services and functions but undertake agro-ecological management practices that contribute to sustainable production in these systems. They conserve and protect wild flora because it is preferred by bees which are then fundamental for the pollination of crops. Farmers take advantage of crop residues and animal excreta to produce compost and vermicompost, they collect rainwater to conserve groundwater and use it to irrigate crops and for domestic use. They use traditional methods to prevent soil erosion like ditches and fences against the slope.

Rate of recovery from extreme environmental and climate change-related stresses and shocks

Score 4 ↑

Cuba is equipped, through the civil defense, with an early warning system that keeps the population informed before any extreme weather event. This, coupled with the educational level of the Cuban farmer, makes them well prepared to face hurricanes and provides them with high resilience. After natural disasters occur farmers utilize fallen

timber from forests, exchange traditional seed cultivars among neighbours and quickly re-plant short-cycle crops. The production affected by these phenomena is used as animal feed to make compost.

Given the high incidence of pests and diseases chemicals are used sparingly and other agro-ecological techniques are applied (application of earth at the whorl of the corn to control moths).

Considerations:

We evaluated three of the proposed indicators; the indicator on protected areas for their ecological and cultural importance was assessed only partially as only three caves considered sacred by the farmers of the sites were identified, the recognition of these caves is informal but has allowed maintaining the sources of water which are found in them.

From the perception of farmers the most important indicators are: Heterogeneity and multifunctionality of the landscape and rate of recovery from extreme Environmental and climate change-related stresses and shocks. It is important to distinguish the knowledge possessed by farmers on how to deal with extreme weather events and the resilience to them from their ability to cope with the incidence of pests and diseases, which could be improved through capacity building, especially in the use of traditional cultivars that show better adaptation to changing climatic conditions of the areas.

Identified gaps:

- ✓ Lack of awareness of services provided by the ecosystem.
- ✓ Insufficient support from farmers' associations for the recovery of agricultural systems against natural disasters.

2. Social Equity and Infrastructure

Local resource governance

Score 4 →

The land, water and other resources are primarily managed by local communities according to the organizational structure of farmers in Cuba. These are grouped mainly within the National Association of Small Farmers (ANAP), a non-governmental organization, in two forms, Credit and Service Cooperatives (CCSF) and Agricultural Production Cooperatives (CPA). The farmers interviewed belonged to three CCS. These organizations are responsible for managing resources in a participatory manner. However, problems were identified in relation to resource allocation and payment for production. This situation can affect the retention of farmers in the area because they could lose the economic incentive besides insuring their production.

Autonomy in relation to land and resource management

Score 4 ↑

Despite these communities being in protected areas, farmers have autonomy over the resources they manage, both agricultural and natural. They have free access to the areas and can use available resources in a sustainable manner. These farmers are seen as guardians of natural diversity. However invasive actions such as deforestation must be authorized by the Ministry of Science Technology and Environment and the Ministry of Agriculture.

Farmers are recognized by external organizations, which take into account their voice when making decisions that may affect the landscape around them as well as for the allocation of resources which may improve their living conditions.

Gender

Score 4 ↗

Among the farmers interviewed three of them were women, one of them owes the farm with full autonomy to decide on resources management. The other two respondents are involved in decision-making even though they have clearly defined roles within the farm, because they deal primarily with the care of pets, ornamental plants, medicinal and condimental species.

Women have the same access as men to education, health and resources as well as the ability to innovate and adopt new technologies, for example the landlady produces sunflower oil in an artisanal fashion from the crop she grows in her farm. According to her words: "by trying you go far". In addition, the lady farmer coordinates the circle of interest on forestry for community children.

Social infrastructure:

Score 3 ↗

Despite the existence in Cuba of a free and compulsory education system up to grade 9, in the communities visited there are difficulties with access to schools because they are far away, particularly with regard to the middle school (7th to 9th grade), located between 1 to 7 km from the houses.

The water is obtained from natural sources (streams and springs) as well as energy for food processing (wood from vegetation in the surroundings). They have no electricity, only one community has a power plant that provides service for four hours a day. The distance to the nearest road ranges between 1 to 12 km.

There are common areas widely used as video rooms, equipped with TV and DVD that serve as gathering places, library with books for children and international literature, but lacking material of popular interest which is highly demanded by farmers.

Health care

Score 4 ↗

Medical care in Cuba is free and is run by general practitioners within communities, clinics within village and hospitals in the cities. In the visited communities family doctors are there but are remote and of difficult access (7-10 km) polyclinics (12-30 km) and hospitals (40 km).

Health risk

Score 4 ↗

Although there are external sources of pollution such as mining, farmers do not receive any source of environmental pollution, they consider water and soil quality to be good and they do not recognize any other form of environmental risk.

Farmers are unaware of the effects to the environment of harmful practices they use such as “slash and burn”. Sometimes they apply chemicals without considering the environmental impact because it is not recognized as a risk.

Considerations:

This group of indicators is useful to assess the resilience of ecosystems as they describe the living conditions of communities and their status largely influences the permanence of these communities at the sites. We evaluated all the indicators and the way the questions were designed allowed receiving clear answers, except for the Health Risk indicator for which we will have to identify and propose new questions that help farmers recognize the health risks.

From the perception of farmers the most important indicators are: Autonomy in relation to land and resource management, health care and social infrastructure.

The information obtained allows the recognition of the main causes that could lead to the abandonment of rural areas and serves as a tool for decision-making by local governments and other decision-makers.

Identified gaps:

- ✓ Inadequate access to information on environmentally sound agricultural practices, new varieties and technologies, management of agricultural and natural resources.
- ✓ Lack of knowledge about possible sources of internal and external contamination.
- ✓ Lack of opportunities for the exchange of experience between farmers from different communities.
- ✓ Poor management of cooperative marketing of agricultural products.

3. Agricultural Biodiversity

Maintenance, documentation and conservation of agricultural biodiversity in a community

Score 4 →

Farmers produce nearly all the food they need for their support from local crops and domestic animals that they keep and maintain, except for some products like rice, sugar and oil which they get from subsidized stores or private shops. Some farmers have started planting rice, sugarcane and sunflower (for vegetable oil extraction in local small industries) in order to bridge the shortfall of such products and save some money. Even though there are community seed banks in the eastern region of the island, there are two 'conservation/custodian farmers' in the village who provide neighbours with seeds, especially in case of natural disasters. Although communities lack community registers that provide information on the knowledge associated with local diversity, farmers/farmer communities have organized activities to enhance maintenance and exchange local knowledge between and among communities in the region.

Diversity of local food systems

Score 5 ↑

A rich diversity of useful species, both of cultivated, wild plants and domestic animals, is extremely important in traditional agricultural systems. Farmers manage and preserve this diversity according to their needs, and based on the different uses of the diversity. The most important diversity from the farmers' perspective lies in fruit trees, vegetables, grains, roots and tubers, seasoning and medicinal plants. Farmers use approximately 50 species, 80 per cent of which come from traditional cultivars.

Considerations:

Local variability has traditionally been used in these agricultural systems, mainly due to the location of the farms in remote areas far from cities, which has forced farmers and their families to find alternatives for their food sources.

Identified gaps:

- ✓ Lack of community seed banks in the pilot sites
- ✓ Lack of methodologies to classify agricultural biodiversity

4. Knowledge, Learning and Innovation

Innovation in agricultural biodiversity management for improved resilience and sustainability

Score 4 ↑

The farmers surveyed are fully receptive to change and see the need to use their farms as a centre for experimentation and introduce new cultivars and technologies in order to ensure the subsistence and the production of economic benefits to the family. The survey showed that farms are diversified in their production, in terms of traditional and commercial varieties (the latter to a lesser extent), this diversification ensures production against climatic events. Traditional cultivars, such as *ají cachuchón* (chili) and *frejol Camagüey* (bean), coexist with commercial varieties, such as *Pimiento verano 1* (pepper) varieties and 'Velasco' beans, in fields where agriculture is rain-fed. Besides farmers also plant Nim trees with the purpose of both using it as a bio-insecticide and to provide shade to other crops; farmers, also apply organic fertilizers such as some strains of *Rhizobium* to ensure nitrogen fertilization and they use inert materials for storing grains (e.g. sand, ash). It should be noted that farmers always try to apply sustainable practices which are in harmony with the environment.

Access and exchange of agricultural biodiversity

Score 5 ↗

Seed supply and exchange networks in the communities of the region are identified, as well as nodal farmers who recognize the importance of these networks the dynamics of these informal systems, and therefore put special effort in the preservation of diversity they manage (this positive attitude of famers results from previous projects executed in the eastern region in the past). The capacity of the informal seed system in conserving and maintaining crop genetic resources over time relies in the exchange of seeds between and among communities. The informal seed system also contributes to improving relations between farmers, communities and institutions and improving institutional capacities at local and national level. Seed and diversity fairs (which are held two times per month), have had positive effects on farmers who could sell their seeds and agricultural products, exchange experiences, increase the variability of their crops, and they are provided with containers to store seeds and working tools to be used in their farms. It should be noted that local governments and the formal sector were very receptive and they showed interest in continuing these activities as a way to encourage contribution to the sustainability of rural areas and sustainable food production for urban areas.

Transmission of traditional knowledge from elders, parents and peers to the young people in a community

Score 5 ↗

The knowledge on use, management and conservation of diversity needs to be transmitted to younger generations the same way our ancestors have been transmitting it for years. Older generations transmit their knowledge to younger people in their free time, when they cooperate with the agricultural work of the farm, at the same time rural schools include technical skills related to agriculture, starting from primary and secondary schools: for example a course on 'The world we live' is taught to younger generations; or courses on management of nurseries, and protection of biodiversity are taught by environmental education specialists. School gardens for primary schools are created so that young children can familiarize themselves with agricultural practices, learn to look after the crops and to recognize and respect the work their parents carry out in their farms.

Cultural traditions related to biodiversity

The information collected to respond to this indicator was not sufficient; a new survey should be designed in order to be able get the required information. Therefore no score was given. While it is true that more and more young people learn traditional knowledge about how to manage crop diversity at early stages, communities lack programmes of cultural activities (festivals, songs) that are appealing to young generations, to be used as additional tools to consolidate this knowledge.

Number of generations interacting with the landscape

Score 4 ↗

Among the five families visited, three included three generations interacting with the landscape; one included two generations and in the fifth one the owner was the only person taking care of all the farm activities. In general the young generations showed interest and motivation in remaining in the fields.

Practices of documentation and exchange of local knowledge

Score 3 ↗

There is evidence that communities are carriers of a vast traditional knowledge regarding the practices and traditions of use of local crop variability, however, this indigenous knowledge is not properly compiled and documented. In general, it remains as individual patrimony. Although the projects carried out in the past in this area extracted and compiled much of this information, the communities still lack of study material basis to safeguard the wealth of this indigenous knowledge that characterizes these communities.

There are no field schools for farmers; and although ANAP offices are used, and have been in the past, for training, farmers claim that most of the training they have received so far, comes from the workshops organized by the INIFAT-Environmental Services Unit, Guantanamo (USA) research team.

Use of local terminology or indigenous languages

Score 4 ↗

In Cuba each region is identified by the different uses of language: over generations people from the eastern Cuba have created terms that are still used today, for example: *sao* for weed, *foguiao* for grown (commonly used), *bomba* for a home-made vinegar and *sambumbia* for pickle peppers. These terms can have different meanings in other localities. Furthermore, these terms are used outside the mountainous regions where these communities live, and they are also used by inhabitants of more urbanized areas, of the same province.

Women's knowledge about biodiversity and its use

Score 4 ↑

Women's role in the conservation of agricultural diversity has been stimulated, recognized as prominent and enhanced at national and local levels, by the joint actions implemented in rural communities in the eastern region for over five years by INIFAT and USA. Female owners have been selected for such studies, and traditional cultivars have been registered in the Register of Commercial Varieties of Cuba under the name of the women who bred important crop variability, which was critical for the recovery of their productive systems under biotic stresses or after natural disasters. These women are socially accepted and recognized by all community members; Positive contributions in terms of decision and ideas are accepted by the community regardless of the gender of the farmers that generated them.

Considerations:

In general it was found that farmers are receptive to changes, by introducing innovations in their farming systems as well as cultivars and technologies which contribute to improving yield and protecting biotic and abiotic stresses. The projects carried out in the past in these communities resulted in a gain in experience in matters related to the production and exchange of seeds and in the organization of fairs that produce economic benefits.

In the indicator "**Transmission of traditional knowledge from elders, parents and peers to the young people in a community**" the score does not admit any flexibility, according to what it is supposed to be measuring, for example we felt we had to score as 5, even though this indicator is likely to be improved in the communities, but the score 4 did not include young people.

For the indicator on "**Practices of documentation and exchange of local knowledge**" the score should be enriched, since it only includes documentation and exchange of knowledge and does not address other aspects that should be measured, such as the acquisition of knowledge from external sources.

Although there are no dialects in Cuba, the indicator “**Use of local terminology or indigenous languages**” is very useful because it enhances the exchange of information between farmers and experts from different institutions. The way the collection of information is organized does not allow having the same people carrying out the data collection, therefore sharing a common language facilitates the understanding of the information provided by farmers.

Identified gaps:

- Need to encourage cultural activities (festivals, competitions) linking traditional knowledge to diversity.
- Lack of Community Registries for diversity methods for the collection of information.
- Insufficient spaces to share knowledge and experiences between farmers and insufficient support from local organizations to respond to the needs of communities.

Notes

Notes

UNU-IAS Policy Report

Indicators of Resilience in Socio-ecological Production Landscapes (SEPLs)

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