Multi-scale Assessments: The GEO Experience of West Asia

Adel Farid Abdel-Kader, UNEP, Bahrain
Session 6.2

The Global Environment Outlook is a comprehensive and policy-relevant assessment of the state of the global environment, undertaken by UNEP, currently every five years, to analyse environmental trends, their driving forces, current policies, and emerging issues. A GEO Yearbook is also published annually to address emerging issues and developments. The GEO reports also assess the impacts of the changing environment on people and ecosystems. As an integrated environmental assessment, the GEO report series goes beyond traditional state of the environment reports to provide answers to the following questions: What is happening to the environment and why (state, pressure)? What is the consequence for the environment and humanity (impact)? What is being done about it and how effective is it (response)? What could be alternative futures of environmentally sustainable (or unsustainable) development (scenarios)? What alternative actions could be taken?

This paper presents West Asia's experience in preparing regional inputs and integrating these inputs into the global GEO process as an example of a multi-scale assessment. The paper begins by describing the GEO process for information synthesis and review. The goals of the paper are to reflect on how the regional work in West Asia strengthens the global product and vice versa, the challenges in providing information for the global product, and the opportunities that exist for using the global product for audiences at multiple scales. It also discusses the role of ownership on the use of the findings. The paper concludes by exploring how lessons learned from the GEO West Asia experience will feed into the Arab MA sub-global assessment.

The Relevance of Local and Indigenous Knowledge for Nigerian Agriculture

Nimbe Adedipe, University of Ibadan, Nigeria; **P.A. Okuneye** and **I.A. Ayinde**, University of Agriculture, Nigeria
Session 11.1

This paper presents the results of a pilot study on agricultural practices in Nigeria commissioned by the United Nations Environment Programme (UNEP). The aim of the study was to compare indigenous knowledge about farming practices vis-à-vis modern technology in sustainable crop production. The agricultural sector plays an important role in Nigeria's economy, contributing 37 percent of the Gross Domestic Product (GDP) and employing 65 percent of the adult labor force. Over 90 percent of Nigeria's agricultural output is by small-scale (less than 5 ha), resource-poor farmers who have, for centuries, sustained the national food supply through a considerable wealth of indigenous knowledge about how to harness both natural and socio-economic factors of production. The study found that despite the introduction of agro-chemicals, many farmers continued to rely on indigenous farming practices, either on their own or in combination with modern technologies. There is therefore the emergent need for the adoption of a balance of properties approach, by a coordination rather than an integration mechanism, through a "systematic hybridization process." The study concludes that small-scale, resource-poor farmers have good reasons for sticking to their local knowledge, and that modern technologies can only be successful and sustainable if local knowledge of cultural, social, and ecological systems are taken into consideration.

Bridging Scales and Epistemologies in Swedish Nature Conservation — Some Challenges and Lessons Learned

Malin Almstedt and Marie Byström, Swedish Biodiversity Programme, Sweden
Session 9.1

Nature conservation is today much more complex than some decades ago. Conservation then was perceived by many people, also scholars in ecology, as protection of nature from human activities. We now know that human activities are part of ecosystems, and many ecosystems and species are dependent on human intervention. This is especially true in the agricultural landscape, where human intervention has interacted with nature over time and created biotopes that depend upon the usage of man. Today separation between nature and culture is not optional. Instead we need to work towards sustainable use of biological diversity and natural resources, as the Convention on Biological Diversity reaffirms.

In order to conserve and sustainably use biodiversity and biological resources, we need to better understand how human societies interact with nature. We need to know how this interaction has developed

through history to understand its present trends. The traditional knowledge that developed in the past is also valuable for the use of nature today. The human aspects are as important as the biological aspects on local, regional, and global levels. At the global level, we need more knowledge on how different societies value and use nature in order to discuss biodiversity and reach a global understanding and common ground to work from. This common ground needs to be based not only on scientific knowledge but also on a shared appreciation of the importance of human values and ethics, including our respect and affection for life and for spiritual values.

However, in our academic and professional work we often assume that informal knowledge and human values carry less weight than the formal, peer-reviewed knowledge to which we ascribe. We also tend to resist the integration of other disciplines, which are not recognised by our peers and colleagues, into our spheres of work. An important challenge today for scientists and professionals is to create space to incorporate non-scientific ways of understanding the world into our work.

There is also need for bridging current gaps between different disciplines within the current Western epistemologies, academic and non-academic, in order to enable the synthesis of knowledge in meaningful ways that respond to current socio-environmental changes and challenges both on local and on global scales. Important questions include:

What are the barriers to the creation of space within an academic or professional framework for incorporation of other ways of conceiving the world?

How can our research and policy development processes consider and integrate information and knowledge from alternative—and sometimes fundamentally different—perspectives?

How can we create platforms where people from different professions and backgrounds can meet and integrate different forms of knowledge in useful ways?

We will review processes in Sweden where efforts are made to integrate different ways of knowing. Referring to these and to the above questions, we will summarise some of the lessons learnt.

Building Bridges over Waterfalls? Experiences in Adapting the MA Conceptual Framework to Include Local World Views: The Case of the Sub-Global Assessment in Vilcanota, Peru

Alejandro Argumedo, Asociacion Kechua-Aymara ANDES, Peru

Plenary Presentation, Block 8

A conceptual framework provides the lens through which a phenomenon is viewed. The MA conceptual framework is the lens through which the health of ecosystems at various scales is being assessed at a global level. While the MA conceptual framework is being used effectively in various sub-global assessments, initial experiences with local MA assessments involving indigenous cultures indicates that the application of the MA conceptual framework in local settings will require at least some adaptations. The inclusion of local peoples' worldview, which defines their values, beliefs, attitudes, concepts, behaviors and ecosystem governance systems, must be included to ensure that responses identified in the MA assessment will meet local user needs. Unlike most MA local assessments, the Vilcanota sub-global assessment directly involves Quechua indigenous peoples in the assessment of the goods and services of their mountain ecosystem and their own well-being. Q'ueros worldview arises from their interactions with their environment --including their ability to form and manipulate concepts, to plan and predict events and communicate ideas – and such lenses are defining the focus of the assessment of ecosystem phenomena in their territories. This paper will discuss advance results of "bridging" the Q'ueros concepts into the MA conceptual framework in order to develop an adaptive tool to assess the Vilcanota sub-region.

Traditional and Modern Sciences and Technologies in India: Trading New Paradigms for Old

A.V. Balasubramanian, Centre for Indian Knowledge Systems, India

Session 11.3

The Indian subcontinent contains a fascinating range and array of knowledge systems and practices that exist side by side even today. In this presentation, I will do the following:

- Summarize the nature and characteristics of traditional Indian knowledge systems, drawing particular examples from some branches of sci-

ences and technology.
- Spell out some specific ways in which this traditional knowledge systems differ from their modern counterparts.
- Reflect on the possibilities of interlinkages and cooperation between these varying traditions as they take place today as well as in terms of future possibilities.

Present day scholarships on science from points such as sociology, epistemology, or historiography are mostly based on the assumption that western science in its modern phase is THE paradigm for a "Scientific Knowledge System." If we were to accept this criterion it is unlikely that we shall discover scientific knowledge in any other tradition since we do not find any knowledge systems identical with the modern western knowledge system anywhere. To free ourselves from this limitation we must first evolve an unbiased criterion for calling a knowledge system: "scientific." We shall initially take up one specific branch of traditional Indian knowledge system and examine it based on such an acceptable criteria to see how it measures up to being scientific.

Secondly, we look at certain specific aspects of traditional knowledge systems, which make it identifiably different from modern knowledge systems. Some aspects that will be highlighted are: approach to measurement and quantification, outlook towards experimental methods, and the nature of parameters used to build theories as well as the social organization of knowledge. The social organization of knowledge is a fascinating aspect. Knowledge in India prevails and is expressed at varied levels in diverse areas. In many areas such as medicine, arithmetic, agriculture, grammar, language, dance, music, and astrology—to name just a few—there is wide and extensive knowledge both at the level of classical texts and folk traditions. They are commonly referred to as: "Shastra" and "Lok Parampara" respectively. There is a commonality of technical terms and approaches in both the streams and they represent it as if they were two extreme ends of what is really a continuum expressing the same cosmovision. This has great possibilities in terms of revitalisation of a folk stream of knowledge, which being an oral tradition is liable to decay by employing the theories and techniques of the classical traditions. There is every reason to believe that on the ground today folk traditions are widespread in various walks of life and vibrant.

Research on traditional knowledge by scientists from the mainstream science and technology institutions is not a new phenomenon. However, a lot of this research suffers from the limitations of a mind set that essentially looks upon physical resources as well as technologies and knowledge of traditional societies as "raw material" that needs to be prospected so that one may extract what is worthwhile and useful to incorporate it into a modern western framework. This is a hangover of a colonial past, and today there is an increasing perception that such activities do not lead to revitalisation of traditional knowledge or wholesome development of the communities involved. However, in recent times there have been instances of healthy collaboration between various knowledge systems, and we shall spell out some examples and possibilities of how different systems can work hand in hand to meet specific requirement or social goals.

Incorporating Indigenous Epistemologies into the Construction of Alternative Strategies to Globalization to Promote Sustainable Regional Resource Management: The Struggle for Local Autonomy in a Multiethnic Society

David Barkin, Universidad Autonoma Metropolitana-Xochimilco, Mexico; **Carlos A Paillés Bouchez**, Centro de Soporte Ecológico Bahias de Huatulco, Mexico; **Mario Alvizouri**, Hospital Civil Miguel Silva, Mexico; **M.C. Ma de Lourdes Baron León**, Universidad Autónoma Chapingo, Mexico; **M.C. Ma Evelinda Santiago Jímenez**, Instituto Tecnologico de Puebla, Mexico
Session 4.1

In Mexico, as elsewhere in Latin America, rural communities are continually searching for new ways to improve their ability to mange ecosystems as part of their efforts to develop effective livelihood strategies to raise living standards. With a growing discussion of environmental matters and the proliferation of official programs promoting sustainable development in recent years, many communities are realizing the importance of their inherited knowledge and traditions that promote sound ecosystem management approaches. Historically, significant energies were channeled into a struggle to gain control of some land; the rallying cry of the Mexican Revolution, for example, was "Land and Liberty." The potential for raising productivity in traditional communities on the basis of inherited knowledge and local experimentation soon became apparent, as peasants found ways of doubling the productivity of maize, the basic staple crop in Mexico, during the first two decades following the period of intense land distribution. Even today, while official policy discourages dry land

maize cultivation, peasants continue to increase productivity to assure quality food for themselves and for urban consumers willing to pay premiums prices.

Our group seeks ways to support community efforts to improve and deepen their capacity for self-government and to assert their autonomy; this program is explicitly designed to support inherited epistemologies of indigenous peoples. In this context, we are working with a model of "sustainable regional resource management" that complements efforts to increase self-sufficiency and diversify productive structures, mobilizing the local resource base and strengthening traditions. By identifying objectives consistent with traditional priorities and formalizing local systems of knowledge acquisition and generation, we are better able to collaborate with producers to integrate innovations in the realm of production and marketing with collective capacities for organization and ecosystem management.

Integrating Epistemologies Through Scenarios

Elena Bennett, University of Wisconsin, United States; **Monika Zurek**, Food and Agriculture Organization of the United Nations, Italy
Session 10.1

There are many ways of knowing or gathering knowledge about social-ecological systems, including both traditional and scientific techniques. Even within these broad categories of "traditional" and "scientific," there are diverse epistemologies. Many have argued that guiding social-ecological systems can be improved by the integrated use of these bodies of knowledge. However, integrating epistemologies can be extremely difficult. Integration is hampered by differing methodologies, vocabularies, ways of assigning merit, and even worldviews. Indeed, we currently lack a conceptual framework for cross-epistemological integration.

We propose scenario development as one process for integrating different ways of knowing into a useful conceptualization. Scenarios, sets of stories about the future, can be used to integrate multiple epistemologies, including not only combining traditional or indigenous knowledge with scientific information, but also for integrating social and natural sciences, economics and ecology, quantitative and qualitative results. We will present several examples of how scenarios have been used to integrate several different ways of knowing. By going through the process of using several epistemologies in a single product, scenarios can help identify key difficulties in the integration process, which can help us to better cope with those difficulties or even help to present information so that it can be more easily integrated in the future. Because scenarios are useful at integrating many ways of knowing, their development is also useful for engaging local stakeholders and addressing local concerns in a larger context.

From Community-based Resource Management to Complex Systems: The Scale Issue and Marine Commons

Fikret Berkes, University of Manitoba, Canada
Session 4.3

Most research in the area of common property (common-pool) resources in the last two to three decades sought the simplicity of community-based resource management cases to develop theory. This was mainly because of the relative ease of observing processes of self-governance in simple cases. However, this creates a problem. Whether the findings of small-scale, community-based commons can be scaled up to generalize about regional and global commons is much debated. Even though some of the principles from community-based studies are likely relevant across scale, new and different principles may also come into play at different levels. Cross-scale institutions (such as institutions of co-management) have something in common: they provide ways to deal with complex adaptive systems. They all pertain to various aspects of complexity, such as self-organization, uncertainty, and resilience, and deal with the challenges of scale. Communities themselves can be seen as complex systems—embedded in larger complex systems. Thus, community-based resource management needs to deal with cross-scale governance and external drivers of change, as I illustrate with examples of marine commons.

The Footprints Project: Integrating Historical and Traditional Ecosystem Knowledge as "Expert Texts" to Support Multi-scalar Ecosystem Conditions Assessment

David Biggs, University of Washington, United States
Session 10.1

The Footprints Project is a proposed effort to build a geo-referenced repository of "expert texts" that may come from local expertise, archival sources, and other forms of "expert testimony" not traditionally involved in the scientific assessment of ecosystems and environmental relationships. It could function as a common interface for all kinds of "experts" to publicly log their own assessments of human and

ecology relationships and to geo-reference the extents of these assessments in a grid of 1-km resolution. Scientists, modelers and the public at-large could then read these "expert summaries" to develop more accurate "gestalt-values" relevant to scenario models of "indirect and direct drivers of ecosystem change" as described in the MA.

This presentation has two components. First, it involves presentation of a 15-minute paper with slides outlining principle concepts of the Footprints project. Then, with audience participation, it involves a discussion on these concepts with emphasis on moving towards a working local model of the project. The 300-km square study area in the Mekong Delta, site of the author's archival research, historic map overlay analysis, and local surveys will serve as a sample project area. Small-group discussions will focus on key issues and parameters involved in developing such a database on a sub-global scale. The discussion might address the following questions:

What formats should text conform to?
How might gestalt-values derived from such texts be used in modeling efforts?
How might such a program operate at a regional or global scale?
What are some ethical dimensions of such a project?

All comments from the discussion section will be summarized and added to the final paper.

Assessing Biodiversity Intactness at Multiple Scales

R. (Oonsie) Biggs and **R.J. Scholes**, Council for Scientific and Industrial Research (CSIR), South Africa
Session 4.2

Indicators are an important tool for summarizing and communicating complex and often disparate scientific data to decision-makers and the general public. Many indicators can only be applied across a limited range of spatial scales, and cannot readily be compared to indicators used at other scales. In addition, many indicators have very particular data requirements, and are unable to make use of information available in alternative forms. Developing indicators for monitoring progress towards national and global biodiversity targets has been especially challenging in these respects. We present an index for assessing biodiversity intactness (measured as the average change in population size, across all species in a particular area, relative to populations before interference by industrial society) that has meaning at all scales, can be compared within and between scales, and is flexible to the use of differing data sources. A comparison of results obtained when applying the index at scales ranging from the entire southern African region to that of a local government area in South Africa, using multiple data sources, highlights the information value provided by different scales and the location of our greatest knowledge gaps.

Holarchic Analysis of Farm Systems in the US Midwest

William Bland, University of Wisconsin-Madison, United States
Session 11.4

A framework for agroecosystem analysis can play an important role in facilitating development of the shared understandings that underlie fruitful debates surrounding agricultural practice. Such analyses and debates must inform decisions surrounding public and private investments for research and education related to agriculture and the food system, government agricultural policy, and local stakeholder influence on desired roles of agriculture in land use.

I propose a framework for a particular type of agroecosystem analysis that is directed at developing shared understandings of both the "what" and "why" of an extant system. The proposed framework looks to recent advances in ecological and complex system theory, and departs from previous frameworks most importantly in that it seeks to avoid normative assessments. The alternative begins from the view that extant systems are holarchies, and that the first step of any analysis is to understand the "why" of what is done. What is observed has a history that has importantly shaped the array of practices in use. By appreciating that a meaningful analysis must start with concerted efforts to understand the "why," the analyst acknowledges that there are reasons for what is done, and that these reasons are not necessarily captured in a cataloging of descriptors or properties.

This approach is consistent with the emergence over the last two decades of enhanced appreciation for indigenous knowledge. When the farming system is viewed as a holarchy the analyst asks, what factors are stabilizing the current approach? Then, how might evolving social and biophysical contexts challenge the present configuration and state? Appreciation of stabilizing factors and pressures for transformation then allow an appropriately humble assess-

ment of what interventions might be added to this array of factors to shape the further evolution of the system in ways deemed (by some observer and decision-making process) desirable.

A holarchic analysis applied to Wisconsin dairy farming suggests that emulating the very large farms of California and the Southwest may be a poor business and public policy choice. Such an analysis shows that the industries emerged in and are shaped by markedly different contexts, both socially and physically, and are sustained by different resource streams. Similarly, comparisons of swine production strategies reveal a rich set of contexts that must be considered collectively to understand the evolution of the industry.

The Role of Information Network Topology for Robust Local Adaptive Management

Örjan Bodin and **Jon Norberg**
Stockholm University, Sweden
Session 10.2

This paper examines the principal impact of information sharing in (social) networks of natural resource managers using a multi-agent modeling framework with computerized managers capable of experimenting, simple information processing, and decision-making. Aggregate properties of the coupled social-ecological system are analyzed in relation to different network structures. We find that the network structures have a profound effect on the systems' behavior, where networks of low to moderate link densities significantly increase the sustainability. Networks of high link densities contribute to a highly synchronized behavior of the managers, which causes occasional large-scale ecological crises between periods of stable and high production. We evaluate the findings using the framework of resilience theory, and discuss the possible implications in implementing adaptive management in a real-world setting. A proposed network structure involving a small set of experimenting managers was capable of combing high productivity with high resilience, which also conforms to theories underlying the concept of active adaptive management.

Assessment of Central Asia Mountainous Ecosystems (ACAME): Features of Multi-scale Assessment Methodology

Vladimir Bogachev, The Regional Environmental Centre for Central Asia, Kazakhstan
Session 6.2

The Central Asian sub-region is one of the MA sub-global assessments, and it is currently being developed according to the MA conceptual framework. In this paper, I describe how the assessment will take into account the natural, social, and economic conditions of the sub-region. The specific features of the CA mountainous areas are their vertical belts, transboundary sub-global MEs, considerable gradients, and lateral ("horizontal") migration of substance and energy. The mountains form cascade systems, consisting of dynamically connected and directed flows of ecosystem substance and energy. The paper will describe the scales that will be covered in the assessment, including the sub-global level, the national level, the local level, and the basin scale. The paper will also raise substantive questions about the challenges of adapting the conceptual framework to a mountainous region. For example, how do we improve the conceptual assessment framework to assess the effectiveness of responses? How do we develop the transboundary aspect of the assessment? The Central Asia mountainous ecosystems at the sub-global scale stretch across the state borders and their assessment requires coordination of methodological approaches by the experts, as well as interaction of decision-makers in the CA countries. The important task is to unify assessment methods and selection criteria the major mountain ecosystems.

Complex Responses for Complex Systems: Insights from the Southern African Millennium Ecosystem Assessment (SAfMA)

E. Bohensky, T. Lynam, and **R. Biggs**
University of Pretoria, South Africa
Session 6.4

Ecosystem services are embedded in complex, coupled systems of people and nature, known as social-ecological systems. The complexity of these systems stems from their non-linearity, discontinuities across space and time, and ability to surprise, making it difficult to design and implement effective responses when systems fail to deliver vital ecosystem services to people. This complexity also presents a challenge to assessing the effectiveness of responses. We present a model that illustrates how each ecosystem service-related problem and its set of possible response options are defined by the extent of congruence of three scopes: the scope of awareness of the problem, the scope of its impact, and the scope of the power or influence to respond. Drawing from the Southern African Millennium Ecosystem Assessment (SAfMA) experience of identifying and assessing responses, we explore the applicability of this model to several cases in southern Africa, where sev-

eral unprecedented as well as conventional types of responses are taking place with varying degrees of success. These are reviewed in light of existing theory about complex social-ecological systems and the characteristics that lead responses to succeed or fail. We conclude by highlighting insights from SAfMA that may lead to the design and implementation of more effective responses in the future.

Scales of Governance in Carbon Sinks: Global Priorities and Local Realities

Emily Boyd
University of East Anglia, United Kingdom
Session 14.1

This paper explores the arrangements of interplay in cross-scale linkages between actors engaged in carbon sinks. The Kyoto Protocol of the UN Framework Convention on Climate Change (UNFCCC) has created a strong interest in the role of forests as sinks for greenhouse gases. However, to date, mechanisms suggested to bring about such "global environmental management" have yet to show the co-benefits of global mitigation and local development. Two empirical case studies of forest carbon schemes, the Noel Kempff Mercado Climate Action Project in Bolivia and the ONF/Peugeot Land Rehabilitation Project in Brazil demonstrate diverging interests in two dimensions: vertically between actors from different arenas (global, national, and local); and horizontally between local actors, such as internal community conflicts over resource management influenced by, among other, the historical context.

The research identifies that a key problematic is the asymmetry between project design and local development priorities and the impacts of shifting property rights. Findings also indicate that incentives provided to low-income communities have been ineffective in the early stages of implementation largely due to unclear development objectives, absence of social audits in planning and design, limited participation of local stakeholder groups, and weak mechanisms to ensure information access. This paper provides suggestions for how, at different scales, institutions could better improve opportunities for multiple actor interests to be achieved from carbon schemes, such as a need for common language that reflect clear rights and responsibilities and agreement over interests, and/or tradeoffs between actors. To conclude, the paper suggests that carbon forest schemes will only succeed if cross scale institutions are explicitly addressed.

What Counts and Local Knowledge in Global Environmental Assessments and Conventions?

Peter Brosius, University of Georgia, United States
Block 5, Plenary Presentation

Two defining characteristics of the Millennium Ecosystem Assessment are (1) a concern to link scales of analysis by integrating local/indigenous knowledge into global scientific assessments and (2) creating a scientific assessment process designed to meet the needs of decision-makers. Taken together, these two characteristics present several challenges to those involved in the MA process and to those responsible for translating MA outputs into policy.

In this paper, I explore these challenges by examining how "local knowledge" is constituted in global environmental assessments and conventions. In doing so, I follow two trajectories. First, I consider the constitution of the "local" and the politics of translation. Specifically, I examine how local perspectives are elicited and presented in mediated form through social science metrics and methods. Second, I consider the constitution of "knowledge," showing how scientists interested in local/indigenous knowledge have focused overwhelmingly on environmental knowledge and ignored other domains of knowledge that are salient in the effort to link scales of analysis.

I conclude by offering an alternative approach to integrating local/indigenous knowledge into global scientific assessments that is premised on distinguishing several forms of mediation of local perspectives and that incorporates a more expansive definition of knowledge.

Integrating Indigenous Knowledge of Wildland Fire and Western Technology to Conserve Biodiversity in an Australian Desert

Neil Burrows, Western Australia Wildlife Research Centre, Australia
Session 11.2

The relatively recent exodus of Aboriginal people from parts of the Western Desert region of Australia has coincided with an alarming decline in native mammals and a contraction of some fire-sensitive plant communities. Proposed causes of these changes, in what is an otherwise pristine environment, include a changed fire regime resulting from the departure of traditional Aboriginal burning, predation by introduced carnivores, and competition with feral herbivores.

Knowledge of the fire regime during an estimated 40,000 years of Aboriginal occupation of

these lands and the involvement of Aboriginal communities in contemporary land management are important issues to be addressed if conservation lands are to be managed appropriately. As part of this process, Pintubi Aboriginal people were interviewed to obtain information about their traditional use of fire and to obtain their views on how country could be managed with fire. Of particular interest were the reasons for burning country and the temporal and spatial variation in the size and distribution of burnt patches. This valuable, but largely qualitative, oral information was supplemented with a quantitative study of fire footprints in a chronological sequence of early black and white aerial photographs and more recent satellite imagery.

The study focused on a remote region of the Western Desert, an area from which Aboriginal people living a traditional lifestyle had most recently departed. The earliest aerial photographs (1953) were taken as part of a military rocket development project over an area that was occupied by Aboriginal people living in a traditional manner at the time of the photography. The photography revealed a landscape mosaic of small burnt patches of vegetation at different stages of post-fire succession. This pattern was consistent with information provided by Pintubi people; that fire was used purposefully, frequently, and regularly across the landscape for many reasons but mainly to acquire food. Analysis of satellite imagery since the 1970s, and since the cessation of traditional burning practices, revealed that the fine-grained, multi-phased mosaic has been obliterated in recent times and replaced by a simpler mosaic consisting of either vast tracts of long unburnt and senescing vegetation or vast tracts of vegetation burnt by lightning-caused wildfires.

Dramatic Scenarios:
An Interactive Paper Exploring Transformative Approaches To Theatre And Research

Jane Burt and **Athina Coptoros**
Rhodes University, South Africa
Session 9.4

The village of Micebisi is one of the Southern African research sites of the Millenium Ecosystem Assessment. Part of that study has been a process of working with "scenario planning". Scenarios are plausible visions of alternative pathways to the future and the consequences of various aspects of life on earth. It is a useful, structured way to stimulate thinking and debate about future events or trends, and to explicitly state our uncertainty to these.

In the Micebisi, we have used what we call, Theatre for Transformation, as a way of engaging with scenario planning. Theatre for Transformation, draws in the techniques of Theatre of the Oppressed (Boal, 1979), Theatre for Development (Mda, Z, 1993) and Drama in Education (O' Toole, J, 1992). The process of drama allows us to view life "as if it where real". It is a creative experience that can challenge people to think beyond their current contexts by working within an imaginary space that is similar to their own situation. Augusto Boal describes theatre of this nature as "the weapon of the people". It creates the space (the stage) for people to explore and voice alternative scenarios that could transform situations of disempowerment and inequality.

In the case of Micebisi, all aspects of the project have followed an ethic of participation, from the development of the scenarios to the video recording of the process. This process will be shared with conference participants in the form of an interactive presentation (including viewing the video documentary) by some members of the project team. The focus of this presentation will be to share the techniques associated with Theatre for Transformation for exploring more sustainable futures in a way that is participatory and acknowledges everyone's knowledge (from research results to local/indigenous knowledge) as equally important and valid.

Patta Hoiri and Likanantay People: Rescuing the Knowledge of the Land

Beatriz Bustos and **Hernán Blanco**
RIDES – Recursos e Investigación para el Desarrollo Sustentable, Chile
Session 9.1

The objective of this paper is to discuss and reflect upon ways in which the Atacameños, and their traditional knowledge, is being integrated into the Millennium Assessment project in the Salar de Atacama, a 3,000-square kilometer salt lake 2,300 meters above sea level.

The origins of the Atacameños can be traced back to twelve thousand years ago, and today they are the main inhabitants in the Salar de Atacama; there are approximately 3,000 people scattered amongst 22 villages. They are acknowledged as “indigenous people” by Chilean law. Their original language, Cunsa, has disappeared. Their main economic activities are subsistence agriculture and live-

stock grazing. Among the problems they face today are water scarcity and youth migration to the cities. More recently, the Atacameños have become involved in mining and tourism activities in the area, particularly youngsters.

The Atacameños are essential actors in the Millennium Assessment project in the Salar. Their lives have ancient and deep ties with the land, which has determined their social and cultural lifestyle. Any meaningful assessment of the local environment, including conditions, trends, plausible scenarios, and interventions needs to have direct involvement and input by the Atacameños. This paper will describe the methodological approach to involving the Atacameños in the project, including its four major stages: (i) familiarizing and appreciating the Atacameños: the social profile (history, values, conflicts, leaders, channels of communication, attitudes towards development, and specific productive activities such as mining and tourism); (ii) understanding the Atacameños' epistemology to reflect on concepts such as "goods and services" provided by the Salar ecosystem and about their concept of "assessment"; (iii) identifying and discussing, together with the other non-Atacameños actors, proposals for scenarios and interventions; and (iv) dissemination and discussion activities throughout the project. The paper will include a critical analysis of recent co-operation initiatives that involve the Atacameños.

Challenges and Implications of Using ATK for Species Conservation: A Case Study of Northern Canada Wolverines (Gulo gulo)

Nathan Cardinal, Dalhousie University, Canada
Session 2.2

The word "ecology" comes from the Greek word for house, implying that the scientific pursuit of ecology is the study of one's home, or the study of the world around us. First Nations have a similar traditional concept in that they do not differentiate between "wilderness" and their Oikos. However, there is often a difference drawn between what is considered "scientific" and what is considered "traditional". Although both knowledge systems contain valuable information, scientific knowledge has predominated throughout the world. However, for many species, there is a significant lack of such scientific knowledge.

The northern Canada wolverine (Gulo gulo) is one species for little scientific information exists. It is widely acknowledged that the majority of knowledge regarding wolverines is held by aboriginal people who have lived in close proximity to the wolverine for many years, not western science. Due to their natural rarity and geographic isolationism, there have been few studies of the wolverine, and it is considered the least studies of the large carnivores. To adequately assess wolverines, and to improve the decision making regarding their status, wolverine Aboriginal Traditional Knowledge (ATK) needs to be collected. This presentation will discuss the uses of ATK in species conservation and the associated challenges and implications, using the northern Canada wolverine as an example. I also highlight the implications of using ATK knowledge, both to the species itself, as well as the aboriginals from whence the knowledge came from. By using the wolverine as a case study, it would demonstrate the large amount of information held by aboriginals, and the novel approach being used in Canada to access and use this knowledge to improve the species conservation.

Scale and Cross-scale Dynamics: Governance and Information in a Multi-level World

David W. Cash, Harvard University, United States; **W. Neil Adger**, University of Anglia, United Kingdom; **Fikret Berkes**, University of Manitoba, Canada **Po Garden** and **Louis Lebel**, Chiang Mai University, Thailand; **Per Olsson**, Stockholm University, Sweden; **Lowell Pritchard**, Emory University, United States; and **Oran Young,** University of California, United States
Session 4.3

The study and practice of ecosystem assessment and management increasingly recognize the importance of scale and cross-scale dynamics in understanding and addressing human and environmental change. For many human-environment issues, science communities, policy-makers, and managers at all levels have begun to struggle with questions such as: How can we structure assessments of large-scale environmental change to integrate with decision-making at multiple levels simultaneously? Who should participate in such activities to assure salience for decision-makers, scientific credibility, and political legitimacy for multiple audiences and different levels? How should authority and responsibility to assess and manage environmental problems be apportioned at different levels? What are the implications for data collection, standardization, and analysis when information originates, is produced, and is translated across multiple levels?

Numerous efforts to try to address these kinds of questions, including the Millennium Ecosystem As-

sessment (MA), characterize the rapidly evolving landscape of assessment and governance practice and scholarship. Recent contributions in a number of fields have addressed the institutional dimensions of scale and cross-scale dynamics as they relate to, among other topics, resilience, institutional interplay, management of commons, assessment, polycentricity, panarchy, distributed knowledge-action systems, global science and local knowledge, sustainability science, and the role of information institutions in multi-level systems. What is missing from these parallel efforts is a systematic way of thinking about and addressing the challenges involved in integrating science and policy across multiple levels.

A New Look at Urban Green Areas

Johan Colding, Royal Swedish Academy of Sciences, Sweden; **Jakob Lundberg** and **Carl Folke**, Stockholm University, Sweden
Session 10.2

The paper presents an analysis of present day land use and the potential for co-management of urban green areas in the Stockholm County, Sweden. The area has experienced a rapid population growth over the last decades. During the 1970s, 8 percent of the green areas in the Stockholm County were lost due to urban development. This loss was about 7 percent per decade during the 1980s and 1990s.

The paper examines the driving forces of population growth and subsequent urban growth for present day land use in the green areas surrounding the Stockholm National City Park (NCP). This park of 27 km^2 was legally protected in 1994, having unique cultural, recreational, and biological values. Within a radius of 20 km from the centre of the park, different categories of land use are analysed including nature reserves, allotment areas, golf courses, cemeteries, city parks, agriculture, and forestry. Using a GIS-analysis, the different proportions of land use to total green area surface are estimated. The paper identifies major user groups of land forms, their institutional settings and property rights, and identifies what local ecological knowledge and management practices user groups hold. An estimate is being made to what extent different property rights and lease arrangements have the capacity to halt loss of biologically important green areas. The paper discusses how user groups can become more closely involved in the management of green areas in the Stockholm County. It concludes that co-management designs hold the potential to strengthen biodiversity conservation and ecosystem services, necessary for societal development and for building adaptive capacity for an uncertain future.

Quality Assurance in Science for Governance: The Case of the OGMIT Project

Serafin Corral-Quintana
La Laguna University, Spain
Session 10.4

The OGMIT project, funded by the Italian government, aims at providing policy recommendations on large-scale usage of GMOs based on a wide consultation process. The GMOs topic entails multiple dimensions of analysis that cannot be amalgamated into a single scale of measurement because they pertain to different aspects and actors of the processes. Actors talk different languages, express uncertainty and concerns in different ways. Therefore, the production of quality-assured information about large-scale usage of GMOs implies covering wider perspectives other than just scientific and technical.

In the OGMIT project, a purposeful consultation process with wider sectors of the society (including risk perception and uncertainty) will be implemented to uncover perceptions and positions on large-scale application of GMOs into the Italian food system, where relevant science will be used to start a debate to explore multiple perspectives related to the usage of GMOs in Europe and, in particular, Italy. The consultation process allows the exploration of desirable scenarios for agricultural systems from the societal point of view, including the GMO-based agriculture scenario and food systems. The expected results of the OGMIT project are the production of scientifically sound and socially robust policy recommendations for GMO governance and guidelines for informing and involving civil society in the GMO debate.

Foghorns to the Future: Using Knowledge and Transdisciplinarity to Navigate the Uncharted Waters of Complex Social-ecological Systems

Georgina Cundill and **C. Fabricius**, Rhodes University, South Africa; **Neus Martí**, Autonomous University of Barcelona, Spain
Session 2.4

Complex social-ecological systems are shaped by cross-scale interactions, non-linear feedbacks, and fast and slow changing variables. Transdisciplinary approaches that combine participatory and conventional methods and which ”democratise” knowledge

to enable inputs from local, informal experts are essential tools in understanding such systems. However, researchers and practitioners often need to make trade-offs when they enter the uncharted waters of transdisciplinarity, participatory research and democratised expertise. Furthermore, there is a shortage of information and consensus on the process, methodologies, and techniques that are appropriate to investigate such complex systems.

This paper maps out some of the approaches to scale, complexity, and epistemology adopted by researchers and practitioners when investigating social-ecological systems, and discusses some of the trade-offs involved. Through examples from South Africa and Peru, we highlight the ”navigational devices” or tools available to researchers who seek to “bridge epistemologies” on the ground. We argue that a boat navigating between unknown shores may be a more appropriate metaphor than a bridge, where the start and end points are fixed and known.

A Synthesis of Data and Methods across Scales to Connect Local Policy Decisions to Regional Environmental Conditions: The Case of the Cascadia Scorecard

Chris Davis, CommEn Space, United States
Session 10.1

The availability of geospatial data has grown enormously in recent years. Remotely sensed imagery is increasingly available in multiple spectra, inter-seasonally, and in multiple resolutions. Coupled with the prevalence of various software packages that facilitate the use of these data, this is a powerful phenomenon for those concerned with the changing state of the earth's natural systems. The use of these information sources has attracted the attention of community groups and conservation organizations who perceive that these data convey credibility and accuracy in the policy arena. CommEn Space works closely and frequently with conservation groups whose efforts connect local politics to regional environmental conditions. From these efforts, some persistent questions arise repeatedly: What issues lend themselves to exploration through broad scale remote sensing and geographic analysis methodologies? How can the results be meaningful among various "readers" who aren't conversant in the data and methods used to produce the analyses? And how can phenomena, visible at the broad geographic and short temporal scales, be linked to decisions and actions carried out on a daily basis at the local scale?

This paper explores these questions through the experience of the Cascadia Scorecard. The Scorecard is an index or set of indicators that focus on seven key trends that environmental and community groups in the Pacific Northwest region of North America have committed to monitoring in an effort to gauge the sustainability of the region's growth. This paper details how the approach to two of the indicators—the rate of urban sprawl and forest fragmentation—synthesizes multiple data types across several geographic and temporal scales to produce information that is meaningful in a local decision-making context. The urban sprawl and deforestation analyses at the regional scale were augmented by studies of building-permit patterns that drove urban growth in three metropolitan centers. The result is a study that exposed the ties between local decisions carried out at the neighborhood scale and their cumulative effect at the regional scale. The paper highlights strategies that have proven relevant to utilizing geospatial analyses carried out at multiple scales in an effort to both produce meaningful science and influence decision-makers, one that could be adapted to international settings.

Bridging the Gap or Crossing a Bridge? Indigenous Knowledge and the Language of Law and Policy

Michael Davis, Australia
Session 2.1

In this paper, I explore the ways in which language is used in legal and policy discourses to refer to indigenous peoples’ knowledge of land and environment. My paper will offer a critique of this language, based on a reading of alternative and diverse discourses from anthropology, indigenous, and other perspectives. I am interested in how the language of law and policy might reflect, or otherwise, an indigenous way of articulating and conceptualising cultural knowledge. Focussing on some specific Australian legislative and policy developments in recent years on environment, land rights and native title, I want to interrogate concepts and categories (such as ”tradition”, ”Indigenous knowledge”) that are employed in these.

Within the legal and policy arena, different laws employ different concepts and categories in their endeavours to reflect or provide for indigenous epistemologies. Terms such as ”traditional knowledge” and ”cultural knowledge” are often used to reference indigenous ways of knowing. The term ”tradition” is

used as a kind of essentialised western understanding of indigenous societies. Yet the particular use of these terms in law and policy suggests that a seamless, homogenous, and unproblematic system of knowledge exists in and amongst all indigenous communities. It suggests an inability or unwillingness of the dominant legal and policy discourses to seek a more inclusive or adaptive language that can better reflect the complexity and diversity of indigenous epistemologies. By questioning the language in law and policy, I hope to draw out some possibilities for finding common ground between these western governmental and administrative epistemologies, and what we might understand as indigenous epistemologies.

Andean Knowledge Systems: Pacha Mama as Basis for Endogenous Development in the Andes

Freddy Delgado Burgoa, Compas-Latinoamerica, Bolivia
Session 10.3

The paper presents some of the features of traditional American knowledge systems: the sacred nature of Mother Earth (Pacha Mama), the cyclic notion of time, the mutual and reciprocal relationship between humans, animals, crops and nature, the living astronomy, role of festivals and rituals, and the importance of traditional leaders in land use practices, mutual aid, and ritual practices. It explores the central concept of Pacha Mama in the Andean knowledge systems: a sacred time-space that goes beyond the physical and socio-economic domains studied by conventional sciences. On this theme important studies have been made on the use and management of land in agriculture. These studies show the difference of indigenous concepts with those of conventional science. But they also indicate their complementarity in their contribution to endogenous development.

Freddy Delgado will present examples from a Bolivian university that carries out research and scientific education together with traditional leaders, using participatory and qualitative methods. These include new paradigms for science and development within the possibilities of western science. In this new perspective, a multi-methodological and transdisciplinary approach is advocated, which is called "participatory revitalising research". The experiences to document, strengthen and revitalise indigenous practices in agriculture, health, and marketing strategies will be shared. The exposure of university staff and students to rural life, the teachings of rural leaders on the cosmovisions and traditional technologies, as well as the intercultural dialogues in the universities, contribute to a synthesis between western knowledge and traditional Andean knowledge.

Emergency Response Policies and the Assessment of their Impacts in Western China

Suocheng Dong
Chinese Academy of Sciences, China
Session 4.4

This paper presents a set of emergency response policies that would enable ecosystem restoration and environmental protection in western China. The physical environment of western China determines the basic pattern of regional socio-economic differentiation, with major cities and developed areas found along rivers and suitable traffic corridors in a manner consistent with the point-axis regional differentiation law.

This paper uses an eco-economic classification of western China and a human activity analysis to evaluate policy impacts. Specifically, eco-economic regions were classified and mapped by means of GIS, a set of indicators was selected, and a model was developed of environment and socio-economic interlinkages. Four cases studies in the region were examined: arid areas (Hexi corridor area in Gansu Province), loess plateau areas (Dingxi Prefecture on Loess Plateau), typical cities characterized by heavy and chemical industries (Lanzhou), typical cities characterized by comprehensive industries (Xi'an).

The case studies allowed examination of the impacts of various economic situations, and policies and management strategies, including environmental restoration, agriculture, filling of wetlands and lakes, forest harvest, family planning, and the presence of different levels of poverty. In each case study, trade-offs among ecosystem goods and services were examined in order to provide a scientific basis for the policy-making for sustainable development. Based on this analysis, a number of emergency response policies are suggested with the aim of establishing an eco-economic development strategy that would harmonize the relationship between the ecosystems and socio-economic development in the region. These policies would involve: improved industrial and urban planning; restoration of forest and grasslands in some currently cultivated areas; watershed protec-

tion; incentives for the establishment of high-tech industry; establishment of a regional tourism policy; mechanisms for compensating upstream landowners for watershed protection; use of green GDP and green economic accounting; and changes to property rights.

Embedded Scale: Interdisciplinary and Institutional Issues

Stephen Dovers
The Australian National University, Australia
Session 14.1

This paper will discuss two related, important, but often overlooked aspects, of scale issues in sustainability. The first is that of the variation in spatial and temporal scales embedded in the theory and method of the different disciplines necessary for joint investigation, better understanding and more effective management of interdependent natural-human systems, across the natural and social sciences and the humanities. The second is that of disjunctions between scales of natural and human systems as measured and investigated by researchers, and the scales at which existing or reasonably imaginable institutional and organisational settings operate. Positive suggestions will be made on addressing these divergences. The paper draws on experiences in the ”interdisciplines” of ecological economics and environmental history and other interdisciplinary enterprises, and on detailed analysis of Australian and other resource and environmental management regimes over the past three decades.

Linking Indigenous Knowledge with Attitudes Towards Science Among Artisans in India and South Africa — A Collaborative Cross-cultural Project

Hester du Plessis, Technikon Witwatersrand, South Africa; **Gauhar Raza**, National Institute of Science, Technology and Development Studies, India
Session 4.1

In this paper, we discuss a collaborative research project between India and South Africa that involves the documentation, study, and understanding of the extent to which indigenous knowledge systems (IKS) and modern technologies are utilized in the traditional manufacturing processes of artisans in both countries. The focus of the project is on redefining the characteristics of ”knowing” (of knowledge) as not just a mere contemplative gaze, but also as a practical activity. By focusing on artisans, we place the question of knowledge in a material and practical context. We weave together indigenous knowledge systems of the production of artifacts with the artisans' understanding of science and technological processes. This allows us to develop interventions that capitalize on existing skills, practices, and social relationships rather than undermining them, which contributes to their sustainability. In our presentation, we will share the pitfalls and successes of this multidisciplinary, cross-cultural international research project with the help of a visual, interactive slide presentation.

We will begin by discussing the theoretical issues underlying knowledge production and utilization, particularly in the context of uneven development. We then turn to our research methodology, which assessed the artisans' understanding of science as well as their socio-economic circumstances. We will share the processes of developing the questionnaire, conducting the field surveys in both countries, as well as the subsequent publishing of the research findings. These experiences will be of value to other researchers embarking on cross-cultural and cross-disciplinary research projects.

Keep it Simple and Be Relevant: The First Nine Years of the Arctic Borderlands Ecological Knowledge Co-op

Joan Eamer, Environment Canada, Canada
Block 5 Plenary Presentation

This paper describes the experiences, challenges, and lessons learned of the Arctic Borderlands Ecological Knowledge Co-op. Two goals of the Borderlands Co-op are to monitor and report on ecological change and to improve communications and understanding among communities, scientists, and government resource managers. The Arctic Borderlands Ecological Knowledge Co-op operates on two scales: (1) the 250,000 km^2 range of the Porcupine Caribou Herd, which annually migrates across national and territorial borders and through parks and several land claim settlement regions in Alaska and northwestern Canada and (2) the predominantly aboriginal communities that are the main users of this herd.

Local knowledge is documented through community-run annual interviews with local experts—aboriginal hunters, trappers, fishers, and berry-pickers who have been out on the land and observing conditions over the year. The community interviewers prepare their own reports on the results and share these with other communities at an annual gathering. Results are compiled into a database and summaries

are prepared across communities and over the years. This information is examined along with status and trends information, such as temperatures, ice phenology, and animal populations, acquired from government records and science studies.

We face challenges in summarizing and interpreting results from science-based and local knowledge-based sources, and challenges in integrating knowledge that is based on traditions, experiences, observations, and measurements at varying scales.

We have found that much of the success that we have had is due to working hard at developing a program structure that helps to build trust and ownership among the varied participants. This in turn gives credibility to the results. Over the years, the program structure has evolved from an informal team to a registered non-profit society, with a 15-person board of directors. Board members include aboriginal community representatives, elders, and managers and scientists working in government and academia, in both Canada and the United States. Environment Canada has provided ongoing funding and support for the Borderlands Co-op and has fostered its development over the years.

The Borderlands Co-op has grown and evolved, responding to changing pressures on communities and ecosystems. It relies on the willingness of the people in the region to learn from one another and to innovate. The initial meeting from which the Co-op developed, established guidelines: “Go Slow; Keep it Simple; Be Relevant; Focus on the Long Term; Economize”.

Emergent Properties of Scale in Global Environmental Modeling — Are There Any?

William E. Easterling III, International Penn State Institutes of the Environment, United States
Session 14.3

This essay argues that much of the concern over issues of scale in the modeling of complex human-environment systems—of which integrated assessment models are a special case—tends to be preoccupied with bottom-up aggregation and top-down disaggregation. Deep analysis of the underlying explanation of scale is missing. One of the intriguing propositions of complex system theory is the emergence of new structures at a high level of scale that are difficult, if not impossible, to predict from constituent parts. Emergent properties are not the mysterious creation of “new material” in the system, but rather the placement of the components of the system into their logical context (scales) so that the observer/modeler can see structures arise from them for the first time. The stochastic interaction among low-level elements that gives rise to emergent properties may be part of a larger process of self-organization in hierarchical systems. Self-organization and attendant emergent properties constrain low-level elements through a network of downwardly propagating positive feedbacks. Those feedbacks not only tend to hold the system in a temporary stable state, but they also render it vulnerable to radical reorganization by rapid external forcing.

The vulnerability of the US agricultural production system to climate change is given as an example of how a self-organizing, hierarchical system paradoxically may become susceptible to large external shocks as a result of the emergence of high-level structures that seek to protect its low-level components from short-term variability. Simulations of changes in Honduran maize production in the aftermath of Hurricane Mitch using the CLUE land use model demonstrate the influence of multi-scale complexity on the resilience of land use after disturbance. Finally, it is argued that improved understanding of emergent properties of scale may give fundamental insight into the conditions of surprise.

The Role of Informal Institutions for Sustainable Landscape Management: Taboo Systems in Southern Madagascar

Thomas Elmqvist, **Maria Tengö**, **J.A. Rakotoarisoa, K. Johansson, J. Lundberg, M. Lingard**, Stockholm University, Sweden
Session 2.2

In southern Madagascar, informal institutions have historically played an important role in maintaining spiny forest ecosystems and their capacity to generate valuable services. In this paper, we argue that future sustainable landscape management must build on such informal institutions, including the local knowledge and management techniques.

Taboos related to natural resources are suggested to be integral parts of "invisible" resource management systems. We have analyzed two categories of taboo systems in southern Madagascar: (1) habitat-taboos and (2) species-specific taboos and their potential role in sustainable resource management.

Since the early 1970s, the spiny forest in southern Madagascar has declined principally due to clearing for agriculture, cattle herding, timber harvest, and charcoal production. However, numerous patches of

forest are taboo and have remained untouched for sacred reasons, even in the most intensively used areas. Our studies reveal a rich set of rules and restrictions connected with these forests. Species diversity of e.g. plants and pollinators is in general very high in these forests and contribute to generate important ecosystems services in the agricultural landscape.

The tortoise *Geochelone radiata* is endemic to the dry, spiny forest of southern Madagascar and represents an example of a species-specific taboo. Historically, the taboo has offered the tortoise population considerable protection. However, today this institution is starting to erode and populations are declining. A combination of a legal recognition of the taboo and a regulated small-scale, income-generating trade in tortoises are likely to be the most effective measures to prevent extinction.

In order to build capacity to cope with changes and buffering strong social and economic drivers, informal institutions need to be officially acknowledged and nested with institutions at regional and national levels. In addition, we also emphasize the crucial importance of maintaining adaptive capacity in local communities and providing space for continuous evolution of institutions linked to landscape management.

Bridging Epistemologies and Integrating Indigenous Knowledge with Scientific Knowledge for Sustainable Development: A Case Study Among Iranian Nomads

Mohammad H. Emadi
Ministry of Agriculture, Iran
Session 11.2

The geo-climatic characteristics of Iran make most of the country more suitable for pastoralism than crop cultivation. The pastoral nomads of Iran, who had been able to achieve a "sustainable balance" between their environment and their economy throughout their history, are now being held responsible for the degradation of the rangelands by the experts and state officials. The government of Iran has placed considerable resources into provision of advice and services to improve the natural resource status of Iranian rangelands, yet these efforts—characterized by the process of technology transfer and top-down centralized planning—have failed to improve the livelihood among nomads and address the ecological problem.

This paper explores and compares two different epistemologies and systems of meaning among the stakeholders: a group of nomads on the one hand, and the outsiders (officials, academics, and practitioners) on the other. The paper, which is based on findings of an Action Research project conducted by the author among nomads and officials, highlights the basic epistemological differences between the two groups, and shows that their agendas and priorities are radically different. The outcomes of action research shows that bridging these two systems of meaning through their active participation and dialogue could improve collaborative efforts to address the environmental degradation in the region. It shows how integrating different knowledges can generate a better understanding and knowledge of the current situation and avoid the implementation of undesirable and ineffective technologies.

Sustainable Development Indicators for Global Environmental Change in the Philippines: Local Communities' Meanings and Interpretations

Vicky Espaldon, Rodel Lasco, Rex Victor Cruz and **Maricel Tapia**
University of the Philippines Los Baños, Philippines
Session 2.3

Scientific method or science has been considered the major source of knowledge and understanding of natural systems. This worldview, the superiority of science as a source of wisdom, has marginalized the wealth of indigenous knowledge stored in the memory and experiences of local people. As a result, local knowledge has remained at the backseat of science, and sometimes has become in itself an object of science. Yet the power of innate understanding of nature by indigenous people is gradually being recognized as a key to understanding sustainable development paths.

This paper examines the Philippine national sustainable development indicators (SDI) system and attempts to determine whether indicators for global environmental change are part of the identified national SDIs. More specifically, this paper reports the results of the field research to develop and test a methodology of evoking the meanings and interpretations of sustainable development and environmental changes in the context of the local cultural-environmental system. In this way, this set of local meanings and interpretations can be integrated in the national SDI system. This mainstreaming of indigenous wisdom may have far reaching policy implications, particularly to policies relating to equity and social justice in natural resources allocation.

Mobilising Knowledge for Ecosystem Assessments in the Southern African Millennium Assessment (SAfMA)

Christo Fabricius, Rhodes University, South Africa; **Bob Scholes**, Council for Science and Industrial Research Environmentek, South Africa; and **Georgina Cundill,** Rhodes University, South Africa
Session 6.4

In assessments such as the southern African Millennium Assessment or SAfMA, knowledge relevant to an issue of societal importance is collected, evaluated, organised and communicated in order to support decision-making. Formal assessments are, by nature, part of the 'scientific' world view. In order to retain their credibility and power, they have to conform to the norms of evidence, logical inference and trace-ability that apply in that domain. This type of formal knowledge is the conventional source of information for ecosystem assessments. But local resource users also constantly assess the condition of their ecosystems, albeit in an informal and tacit manner. This informs their decisions about short term ecosystem utilization and enables them to make longer term predictions. In the process, a knowledge system tacitly evolves through adaptive management and inter-generational learning, and is transferred between ecosystem users. A great deal of relevant information is held in these less formal local, 'traditional' or 'indigenous' knowledge systems.

This paper suggests approaches by which formal and local knowledge can, in complementary ways, be brought to bear on ecosystem assessments. It provides examples of the appropriate and inappropriate use of local and formal knowledge respectively and suggests rules for validating them. It further indicates how the procedures usually associated with formalising local knowledge can usefully be applied to tacit knowledge within the science domain as well. Local knowledge, embedded in local cultures and belief systems, is most useful for gathering localized and fine-grained information about ecosystem and social dynamics, ecosystem management practices, local belief systems, human behaviour, historical patterns of social and ecological change, and information about fine-grained key resource areas that make a disproportionate contribution to human well-being.

The SAfMA assessment process added value to these different sources of knowledge through

- collation: making relevant information from diverse and dispersed sources available;
- evaluation: comparison, checking and applying informed judgement to competing or absent information;
- summarisation: approaches to reducing the complexity and detail of data, including indices, indicators and statistical analysis;
- synthesis: recombination of primary information to provide novel insights, through simple or complex models;
- promoting dialogue and debate between investigators with varying world views who work at different spatial scales, and amongst decision makers and the public;
- communication: translating from specialist/technical domain into a policy domain using maps, diagrams, pictures, tables and words, and its dissemination in printed and non-printed media.

Hotspots Versus Handouts: Illusions of Conservation and Development in Papua New Guinea

Colin Filer, Australian National University, Australia; **Jane Mogina**, University of Papua New Guinea, Papua New Guinea; and **Simon Foale**, Australian National University, Australia
Session 6.1

The relationship between conservation and development in Papua New Guinea (and in other parts of Melanesia) contains a rather odd mixture of illusion and reality. On the one hand, a growing number of formal organisations pursue the conservation of a high degree of biological diversity, which is apparently associated with a high degree of cultural diversity, a seemingly excessive degree of social and political fragmentation, and the customary ownership of most natural resources. On the other hand, the customary resource owners seem commonly to be obsessed with dreams of extractive development, which pose an obvious threat to the maintenance of both biological and cultural diversity, and therefore seem to wish to cut the ground from under their own feet. The conservation organisations are obliged to fund their own pursuits by demonstrating that they can make a difference to a situation in which biodiversity values are not only very high, but also seriously threatened. These are the "hotspots" to which their funding gravitates. But if they offer to purchase conservation from the customary owners of the spaces which contain these precious values, they seem to promote the "handout mentality", which motivates the dreams of extractive development, and sometimes find themselves engaged in a real competition

with developers, which they can hardly hope to win.

Yet the dreams themselves are not always realised and are seldom realised for very long. So conservation organisations often find that they are dealing with local clients who do not seem to desire the conservation of biodiversity, but cannot actually get the development which they really do seem to want. If their dreams are not realised, they do not constitute the sort of threat which would seem to warrant the spending of a hard-earned conservation dollar. But even if their dreams are realised, the extraction of specific resources for a limited period of time may still not lead to a long-term process of capital accumulation which makes a lasting impression on the landscape.

In some cases, it can even be argued that local custom and practice is responsible for the production and reproduction of both biological and cultural diversity, even in the face of extractive industry, because it not only helped to create the environment which is being plundered, but will also help to reconstitute that environment after the plunderers have moved on to fresh pastures. But it seems that this feature of local custom and practice is not accompanied by a form of consciousness or "local knowledge" which is amenable to dialogue or partnership with the conservation organisations which would prefer to prevent the process of extraction or dampen local enthusiasm for it. If anything, conservation organisations are liable to construe the "handout mentality" as evidence that local subsistence practices are themselves potential threats to the maintenance of biodiversity values under circumstances of rapid population growth and the decline of traditional institutions.

Such general statements must and do admit of many exceptions, because the reproduction of cultural diversity and social fragmentation on a large scale entails a continual divergence between the real or imaginary 'roads' pursued by different local groups or communities under different local circumstances. The question we propose to address in this paper is the extent to which the general rule and the local exceptions to the rule vary between those groups or communities whose forests are the real or imaginary targets of the large-scale logging industry and those groups or communities whose coral reefs are the real or imaginary targets of the large-scale fishing industry, and how this variation then shapes the contest or dialogue between the hotspot mentality and the handout mentality.

The Scale and Epistemology of Coral Bleaching in Papua New Guinea

Simon Foale
Australian National University, Australia
Session 6.1

Coral bleaching events around the world appear to be increasing in frequency and severity, with the 2002 bleaching events reportedly causing greater coral mortality than those in 1998. The primary driver is global (i.e., excessive CO^2 production in industrial countries), while the impact is local and highly variable. Ecological, and consequent socio-economic impacts of coral bleaching may not be measurable in relatively lightly bleached areas, such as Milne Bay, Papua New Guinea, for perhaps 10 or more years, though medium- to long-term (10–50 years) impacts are likely to be dramatic.

Recent work indicates that certain species may acquire cross-protection if they are exposed to sub-lethal levels of "solar" bleaching prior to exposure to the Sea Surface Temperature (SST) anomalies that induce "temperature" bleaching. However such cross-protection has only been demonstrated for one species of coral and its one species of symbiotic zooxanthellae algae. There may be a level of general recovery in the long term (> 50 years), due to differential survival and expansion of more resistant species, but a significant proportion of the world's reefs are unlikely to ever again closely resemble pre-1980s community structure.

This issue illustrates the importance of considerations of scale, both in space and time, perhaps better than any other. Assessment of bleaching via remote sensing also presents scale-related challenges because of insufficient spatial-resolving power on any of the current generation of available space-borne sensors for accurate detection of bleached colonies.

Coral bleaching also raises significant epistemological issues. It is a new phenomenon, and as such there is typically no suitable explanatory framework within indigenous marine cosmologies in coastal Melanesia. How do Pacific Islanders explain coral bleaching? How does the small amount of scientific information that filters out to them become incorporated into local understandings? On Malie Island in the Lihir group in Papua New Guinea, bleaching has been blamed on submarine tailings from the nearby gold mine. The same conclusion was also reached on Tanga Island, which is much further away. Most Pacific Islands folk taxonomies have relatively few categories for corals, and understandings of coral biology and ecology are very different from those of

biologists. Given the incomplete nature of scientific knowledge of coral bleaching, this area holds many challenges, both for the use of indigenous knowledge in ecosystem assessments and for marine resource management programs in general.

Digital Earth Technologies as Community Decision-Support Framework for Enhancing Human Welfare and Environmental Resources in the Qinghai-Tibet Plateau

Timothy Foresman, International Center for Remote Sensing Education, United States
Session 9.3

The challenges associated with seeking sustainable development, along with the explicit goals of enhancing human welfare and conserving environmental resources to ensure adequate ecological service, cannot be deferred to governments alone to address. Experience has demonstrated that only through comprehensive and community-based grassroots efforts, in partnership with government agencies, can achievements be made towards sustainability objectives. Type II partnerships, as championed by UN Secretary-General Kofi Annan, have been identified as the optimal approach to community cooperation and collaborative efforts for improving lives and the environment. The information underpinnings and the tools for assessment and planning for collaborative efforts have been rapidly advancing and are now more easily available in remote regions.

Under various Asian (both China and Japan) Digital Earth initiatives an experience base has developed related to methods of encouraging local communities to use advanced spatial technologies and models for assessment, education, and environmental remediation. Based on these experiences, a proposed initiative for environmental conservation and social improvements has been communicated and accepted by members of various Chinese government agencies, Chinese universities, and international NGOs. A center of excellence is being created to foster a series of community-based meetings in Xining, China as a comprehensive set of environmental and social assessments are conducted in cooperation with teams of Chinese and international scientists. This effort is being aligned with the integrated assessment methodology of the Millennium Ecosystem Assessment. Sets of signed agreements and a conceptual design have been completed for the 2004 initial workshops and field exercises.

Building the Digital Asia Network for Emerging Crises

Hiromichi Fukui, Keio University, Japan
Session 9.3

As we can see in global warming and SARS, the various risks we face at both local and global scale are all interrelated to each other, and also tend to suddenly emerge at a very local level. These risks also tend to spread exponentially, causing spatial and temporal chain reaction. This type of risk is generally called Emerging Crises.

Conventional science has only been able to deal with parts of these problems. The approach taken by conventional science will not be adequate for dealing with the Emerging Crises of the 21st Century. More precisely, we have reached a stage where a new approach needs to be invented to deal with these emerging crises, whereby the problems are identified in real time as the risk emerges, then several researchers collaborate in analyzing the problem, applying knowledge from various areas of sciences, and putting the problem in perspective, and eventually merging and cross-referencing the results of the various analyses to reach a solution.

In order to deal with environmental issues from global scale to regional and local levels, a correct grasp of the history and the current status of the earth are essential, and we must share a common recognition of the issues. The first step to build a sustainable society is to monitor, identify, and store the data of phenomena on the earth, then process and interpret the raw data, turn them into understandable information to display, publish and distribute. Therefore we need “the Digital Earth” (DE) that is a virtual representation of our planet on the Internet. The DE enables a person to explore and interact with the vast amounts of natural and cultural information gathered about the earth. Much of this information refers to some specific location on the earth, therefore it is referred to as geospatial information which is mainly provided by RS and GIS. The DE 3-D geo-browser provides a tangible and visible reference for average citizens to utilize and understand the global spatial data infrastructure.

Specific DE activities in our interest are intended to move sub-DE project that is Digital Asia in the present. The concept of Digital Asia Network (DAN) is an initiative to provide people and communities with easy access to geo-spatial information over the Internet by establishing a scheme to integrate and share the GIS and RS data among all the countries of

Asia by using web-based GIS.

Our goal is to be able to visualize various types and levels of information, ranging from global to local seamlessly and to present the whole picture of the problems we are facing at a global scale, and to form "knowledge about ourselves as global citizen" based on a common understanding. Through development of assembly microchips with Internet accessibility, future society will realize a ubiquitous environment where all objects and people in the real world exist within provision of some sort of computer system. An overview of the scope and breadth of this innovative initiative and strategic planning for the implementation of DE and DAN are also discussed.

Evolving Institutional Mechanisms to Facilitate Bridging Scales and Epistemologies — An Indian Case Study

Madhav Gadgil, **Yogesh Gokhale**, and **K.P. Achar**, Indian Institute of Science, India; **Anil Gupta** and **Riya Sinha**, National Innovation Foundation, India
Session 2.4

India is a land rich in diversity of life and related knowledge, a heritage that is being rapidly eroded today. A significant response to this challenge has been the recent enactment of the Biological Diversity Act. This has prompted the development of two often conflicting international agreements, namely, the Trade Related Intellectual Property Rights provisions (TRIPS) of GATT and the Convention on Biological Diversity (CBD). There is as yet no proper resolution at the international level of how the provisions of CBD and TRIPs will be implemented.

This paper describes efforts in India to act on these two important provisions of the CBD. The Biological Diversity Act has a National Biodiversity Authority, State Biodiversity Boards, and, at village council level, Biodiversity Management Committees (BMCs). The documentation of biodiversity and related knowledge will be undertaken by BMCs for their respective jurisdiction. Biodiversity Information System (BIS) has been proposed to manage the information collected from documentation efforts such as the People's Biodiversity Registers (PBRs) and to link other national- to local-level databases related to biodiversity (e.g., flora, fauna) hosted by various organizations in India. BIS and all the databases will have public and confidential domains based on the nature of the information. The documentation in PBRs will also have public and confidential domains as per the consent of the information provider. The confidential information will be documented by National Innovation Foundation (NIF), an organization recognized by the government of India by having Prior Informed Consent regarding safeguarding, value adding, and benefit sharing of information with the informant. This confidential information will be called a "People's Knowledge Database" (PKD). The synoptic information of confidential knowledge will be available in public domain databases. NIF will release a National Register with public and confidential domains. Synoptic information from PKD will be part of the confidential database of the National Register after scrutiny. NIF will have authority to communicate with scientific and technical institutions to use information in the National Register for research and development for product development. Other public domain information will be managed by respective State Biodiversity Boards.

This kind of mechanism will allow legitimate access to knowledge of local people which requires validation. Society at large will benefit due to the new use in sectors such as health care, etc. Local people will have an opportunity to link with larger processes from village to global scales.

Multi-scale Integrated Analysis of Sustainability: A Methodological Tool to Improve the Quality of Narratives

Mario Giampietro, Istituto Nazionale di Ricerca per gli Alimenti e la Nutrizione (INRAN), Italy
Session 10.4

The goal of this paper is to introduce an innovative methodology—Multi-Scale Integrated Analysis (MSIA)—that was developed for dealing with the new challenges implied by multi-criteria analysis of sustainability:

- Dealing with non-equivalent perceptions and representations of the reality resulting from the adoption of different criteria of observation and different scales. An integrated assessment of sustainability requires, in fact, a multi-dimensional and multi-scale analysis. This translates into the need of handling technical incommensurability.
- Dealing with the unavoidable existence of legitimate, but contrasting, perspectives found among social actors about what should be considered an improvement or a worsening. When comparing human values it is not possible to define, in substantive terms, "the best course of action". This translates into

the need of handling social incommensurability.
- Dealing with a heavy level of uncertainty and genuine ignorance when using science for governance. It is not possible to generate accurate and relevant scenarios when forecasting the future of adaptive systems evolving across scales.

The paper is divided in three parts. Part 1 introduces, from a theoretical point of view, the epistemological challenges implied by multi-dimensional, multi-scale analyses of sustainability. The peculiar characteristics of MSIA approach are contrasted with those of conventional tools developed within the reductionistic paradigm. Part 2 uses a simple example of application to illustrate the basic rationale of the MSIA approach and the type of results that it can provide. Finally, Part 3 introduces three key concepts derived from Complexity Theory, which are the building blocks of MSIA. These include, a) Multi-Scale Mosaic Effect across levels and dimensions (look for a redundancy of external referents to back-up your assessment); b) Impredicative Loop Analysis (how to analyze autocatalytic loops across scales); and c) Useful Narratives for Surfing Complex Time (models are good for simple systems, complex systems require a narrative).

Coping with Uncertainty and Surprises Across Scales: Stakeholder Involvement to Identify Slow Structuring Variables for Socio-ecological Resilience of Kristianstad Water Kingdom

Line Gordon, **Örjan Bodin**, **Jon Norberg**, and **Carl Folke**, Stockholm University, Sweden
Session 10.2

A large network of steward associations is today involved in the management of ecosystem services in the Kristanstad Water Kingdom, Sweden. This is a dynamic semi-urban area of great ecological value. The local network has during the last 30 years built up a hitherto successful strategy to cope with the environmental challenges in the area, with a focus on wetland restoration. Even though the network of steward associations is locally well connected, there seems to be weak ties to key stakeholders and agents in the surrounding watershed.

The aim of this assessment is to identify the slowly changing variables at regional and watershed scales that can trigger potential surprises and threshold effects at the local scale of the Kristianstad Water Kingdom. We are working on a simple, but illustrative, biophysical model that can form the basis of a learning tool/forum of discussion for stakeholders at different scales in the area.

Three structuring variables seems of importance at the watershed level: (1) a changed variability in water flows (caused primarily by land cover alterations upstream, straightening of the Helgeå river upstream, and potential climatic changes), (2) an increase in humic content in water flowing through the system (caused primarily by logging/deforestation upstream), and (3) growth of bushy vegetation in the wetland areas (a local process caused by e.g. changed grazing pressures). In a regional context, the new European Water Framework Directive imposes institutional challenges and the urbanisation of the region alter existing worldviews and therefore impose new management practices.

Extensive ecological knowledge exists among the local managers in the region. We will identify key informants (both local users and scientists) and hold workshops in order to develop the first versions of the model. The building of a common conceptual ground for the biophysical model will thus be a method of integrating local and scientific knowledge.

By using the model, we hope to strengthen the existing steward association networks as well as involving new members outside the Water Kingdom area, but within the watershed. It will also be used to identify possible regional scenarios and can be a tool used in the synthesis of different sub-global assessments in the Millennium Ecosystem Assessment.

Multi-scale Integrated Analysis of Farming Systems in the Lao PDR

Clemens M. Grünbühel and **Heinz Schandl**
University of Klagenfurt, Austria
Session 11.4

The entire region of Southeast Asia is currently experiencing rapid socio-economic transition. Change occurs at various levels of the economy as well as in social structure. Lao society is gradually becoming a vital element of the trade and transport networks in the larger region (ASEAN integration and Mekong countries). National policy aims at promoting poverty eradication and increases in national income. Not only does such a development put pressure on the environment but the social system is also faced with a series of constraints regarding land availability, energy sources, and labour force distribution. These constraints work at several different levels of scale, i.e., the national economy, the village society, and the individual household level. The pa-

per analyses the constraint variables on the various levels and describes inter-linkages among them.

We analyze certain characteristics of the social system and its natural relations regarding its metabolic exchange with ecosystems (and other social systems) and its way of managing time and land resources. More specifically, we investigate returns upon investment of labour and land on multiple scales within an integrated assessment framework. Since the Lao economy is largely based on agriculture (dominant parts of it in subsistence farming), we identify six distinct farming system types according to the production system and to geomorphologic conditions. Within these types, the constraints for gaining sufficient household income are explored.
The basis of the typology of farming systems stems from in-depth research of macroeconomic and on-site data conducted in Laos during 2000 to 2002. The typology serves to link the macroeconomic analysis to the village level. It allows aggregation of the individual categories according to the number of cases evident in the society. They are then compared to standard national indicators from official databases. Doing this, we are in a position to assess whether the national statistics or the modelled data more adequately describe the processes observable in the Laotian society. In the case of developing economies, economic databases are often insufficient. This calls for innovative methods that make estimates for the national level possible and support cross-checking with official sources.

Using such a framework, we are able to show that, e.g., rotational cycles in shifting cultivation systems do not affect land area consumption as well as describing effects of farming systems intensification on the income structure of individual households in rural areas. As a result, we are able to observe important patterns and processes in the agricultural development of Lao PDR on different levels of scale. These are put forward for discussion and evaluation of existing policy strategies and instruments currently in use.

Digital Earth: Bridging the Scales from Global to Local for Sustainable Development

GUO Huadong and **Wang Changlin**, Chinese Academy of Sciences, China
Session 9.3

Digital Earth is a virtual representation of the planet, an information system with tremendous amount of multi-resolution and multi-scale data as shown in multiple dimensions. By acquiring the large amount of data of the earth, and utilizing the techniques of computer, image and graphic processing, network, virtual reality, and so on to study the real earth and its relevant phenomena in a digital way, the Digital Earth provides us a brand-new view to see our world.

Sustainable development is a major issue to be addressed in the goals and activities of the International Society on Digital Earth, which will be established very soon. The Digital Earth activities, to date, have already focused on sustainable development in the past three International Symposiums on Digital Earth, especially the third one addressing Information Resources on Global Sustainability. Regarding our views of the earth from global to local scales, earth observation technology plays a key role in building the Digital Earth, providing a huge amount of spatial information data at various resolutions and scales about our earth for sustainable development. Based on spatial information data, we have built a Digital Earth prototype system, which bridges the scales from global to local and demonstrates its applications in crop growth monitoring, disaster, digital archaeology, environment management, and digital city, etc. The development of Digital Earth will significantly contribute to global sustainable development and will better bridge the scales from global to local for assessment of environment and other related subjects.

Collaborative Learning, Organizational Innovation, and Adaptive Co-management of Wetland Ecosystem Services in Sweden

Thomas Hahn, **Per Olsson**, **Kristin Johansson**, **Andreas Duit**, and **Carl Folke**
Stockholm University, Sweden
Session 10.2

The literature on ecosystem management and assessment is increasingly focusing on the social capacity to enhance ecological resilience and the services it sustains. Organizational flexibility and participatory approaches to learning that are needed to respond adequately to environmental change have been highlighted but not critically assessed. In this article, we describe/analyze a case where a small group of organizational entrepreneurs have achieved a platform as an informal municipality administration (Ecological Museum in Kristianstad Water Kingdom, EMKWK) and collaborate with stakeholders at all organizational levels to manage the capacity of wetlands to produce essential ecosystem services around the city of Kristianstad, southern Sweden.

EMKWK creates arenas for solving conflicts, creating meaning, and sharing information among stakeholders in relation to specific problems arising in the area. It is a dynamic system where ad hoc organizations are formed for each problem arising, involving stakeholders that are nested across scales in society. These arenas also make it possible for different knowledge systems, such as local ecological knowledge and scientific knowledge, to be combined. With a clear holistic view and ecosystem approach, EMKWK has established an informal network, anticipated and forestalled several conflict, and identified win-win-situations through collaborative learning and confidence building in an adaptive co-management process. Not only do these collaborative learning processes help monitor, interpret, and respond to signals of ecosystem change, but also build capacity and trust to deal with change in a fashion that sustains the well-being of coupled social-ecological systems.

Linking Archival and Remote- sensed Data for Long-term Environmental Monitoring

Hamisai Hamandawana, **Raban Chanda**, and **Frank Eckardt,** University of Botswana, Botswana
Session 2.3

The broad objective of this presentation is to illustrate how archival/historical and remote-sensed data can be used to complement each other for long-term environmental monitoring. One of the major constraints confronting scientific investigation in the area of long-term environmental monitoring is lack of data at the required temporal and spatial scales. While remote-sensed data have provided dependable change detection databases since 1972, long-term changes such as those associated with typical climate scenarios often require longer time-series data. The non-availability of data in readily accessible/usable formats for periods predating the conventional satellite data traditionally accessible to the public has, for a long time, restricted the scope of environmental studies to synoptic overviews covering short-time scales. As a result, our understanding of different ecosystem processes has been informed by thin data incapable of yielding plausible explanations.

One way to improve our understanding of ecosystem processes is by cross-linking different forms of data at different temporal scales. Unfortunately, however, most research work has tended to marginalize the utility of the latter in environmental monitoring. While the accuracy of data from these records is often source-specific, varying from place to place depending on circumstances under which the same data were created, carefully conducted searches can yield useful information that can be effectively used to extend the temporal coverage of projects depending on time series data. Based on an ongoing project on environmental monitoring in the Okavango Delta, which has created a database covering 80 years between 1921 and 2001, the specific objectives of this paper are to: (a) outline how modern remote sensed data (Corona and Landsat) can be complemented by historical in-situ observations (Travelers' records and maps) to extend temporal coverage into the historical past; (b) illustrate that different forms of post-conflict intelligence data (Corona) can be constructively exploited for the furtherance of scientific understanding; (c) provide some useful pointers on the type/s of data potentially recoverable from archival records; and (d) provide a framework for a networking arrangement to facilitate the sharing of data at regional and international levels by converting data into electronically transmittable formats.

No Tree, No Bee — No Honey, No Money: Challenges and Constraints of Combining Traditional and Modern Approaches of Ecosystem and Land Use Management in Honey-harvesting Societies in the Highland Forest Areas in South West Ethiopia

Ingrid Hartmann, Humboldt University, Germany
Session 4.1

During the past decennia, Ethiopian forests have decreased from 40 percent of the country's area to a mere 3 percent—with the adverse effects on nutrition and water supply. While people generally agree upon the need for forest protection and conservation, the rigidity of the policy instruments and a certain double, moral standard in implementing these policies have created high tensions among different forest users, accompanied by severe political and ethnical clashes. These tensions can partly be interpreted as clashes between modern and traditional systems of law, technology, and knowledge.

In this paper, these tensions are explored through a case study of honey production and forest use in Ethiopia. Honey is one of the most important products within the Ethiopian economy, and honey-harvesting societies in the South Western forests of Ethiopia mainly depend on the forest flora for their living. The traditional forest use system of honey-harvesting societies is originally a holistic and synergistic one, one that relies on traditional management

practices as well as socio-cultural institutions such as inheritance and religious beliefs in maintaining the forest base. This traditional system is threatened due to the establishment of large-scale plantations in the area, as well as changes in religious beliefs on the one hand. However, this is constrained by a lack of reproductive technologies and a labour distribution that are based on a severe repression of certain groups on the other hand. Specific options for improving forest management and contributing to social justice by integrating traditional knowledge and practices will be discussed in the presentation—such as traditional indicators of soil fertility decline and local systems of labor organization with modern and global systems. As part of the presentation, a video that explores traditional practices and methods of land and forest use—honey harvesting, hunting (men's job), kojo (product of Ensete, false banana) producing and processing and honey-wine (Tej) production (women's job) —will be shown.

Towards Co-evolution of Knowledges and Sciences: Bridging Local and Global Systems - Integration or Co-evolution?

Bertus Haverkort, COMPAS, Netherlands;
Stephan Rist, University of Berne, Switzerland
Session 10.3

This paper presents experiences with and visions on the relationships between different forms of knowledge and sciences. The position is taken that, on a global level, there are numerous cultures, each having its own ways to deal with knowledge. This includes shared assumptions and beliefs about the real world; ways of learning, teaching and experimenting; ways to share information; concepts and general principles and their application in technologies, as well as social and spiritual activities. Integrating these ways of knowing does not simply imply adding the best parts of each system; we argue that sustainable integration can only be achieved if the particularities of the forms of knowledge involved, with its political, methodological, and epistemological dimensions, are addressed.

In all cultures and ways of knowing, attention is given to the question WHY things happen as well as to HOW things happen. But the emphasis and importance attached to these two dimensions may vary greatly. Western science places more emphasis on the "how" questions, leaving the question on why things happen largely unanswered. Many of the so called "local" ways of knowing focus more on the question "why" things happen.

The question how these different ways of knowing can be bridged is addressed by looking at a typology of intercultural relationships, which also influences the relationships between knowledges. The political character of the relationships between and the cultural dimensions of knowledges are considered. Depending on its historic context, the relative power of each way of knowing differs: domination, suppression, integration, or isolation occur. The investments in knowledge development as well as the ways to articulate and modify knowledge have differed. Looking at knowledge from an indigenous perspective suggests the inclusion of a wider historical, social, economic, cultural, and policy contexts. This requires mechanisms to deal with cultural protocols, values, and behaviours. For example, local notions of space, time, territory, numbers, sacred, rituals, visions, seniority, duality, and morality need to be accepted and to be given space. Knowledge from a global or western perspective is observed to have a dominant position in the world today, to have a bias towards rationality, and to give a secondary position to more intuitive and spiritual ways of acquiring knowledge.

In order to establish a relationship between different ways of knowing and sciences that benefits all parties involved, the agenda of activities to bridge western and "local" ways of knowing requires careful planning. Local knowledge should be enhanced by recovering its own mechanisms for knowledge production and reproduction. This includes ways of learning, mobilisation of resources, revitalisation, transformation, and co-evolution. Western knowledge should become much more modest, recognising its own methodological and epistemological deficiencies (for example, its dualistic and materialist view) and free itself from its use by ideological or economically powerful actors. To overcome these deficiencies, a trans-disciplinary approach to research and development, which aims at the including the material, social, and spiritual assumptions and concepts, can be enhanced. This is an argument for joining the insights of different ways of knowing, as different forms of knowledge combined have a closer relation to the multidimensional reality than just one. Joint learning is one of the key concepts in the search for common space and integration of different forms of knowledge.

Endogenous development, or "development form within" can be a key entry point: it starts with local activities aiming at the mobilisation of local actors and optimal use of locally available physical, social, and spiritual resources.

The paper argues in favour of co-evolution of knowledges and sciences through intercultural and interscientific dialogues that includes at least four steps:

1. Making an assessment of the current balance between sources of knowledge (such as the focus on HOW and the WHY) for each way of knowing;
2. Making an assessment of relative strength and weakness, based on epistemological self-reflection of each way of knowing, and suggesting strategies for overcoming them (recovery, transformation, mobilisation and revitalisation), and sharing the outcome with others;
3. Identifying opportunities for co-evolution between knowledge systems, taking into account the sources of knowledge, its processing, transformation, and communication based on mutual learning and exchange;
4. Create room for inter-epistemological cooperation and development based on a transdisciplinary understanding of science.

Papers of regional partners of the Compas programme elaborate the positions taken in this paper and provide information from Latin America, Europe, Africa, and India.

Multi-scale Object-specific Analysis (MOSA): An Integration of Ecological Theory, Remote Sensing, and Spatial Modeling

Geoffrey J. Hay, University of Montreal, Canada
Session 4.2

Landscapes are complex systems composed of multi-scale hierarchically organized entities that interact within unique spatial and temporal scales. These interactions result in scale-dependent spatial patterns that visually change, depending upon their scale of observation. Remote sensing platforms represent the primary data source from which such landscape patterns can be observed and assessed, but suffer from the modifiable areal unit problem (MAUP). The clearest way out of MAUP is by using objects, as objects constitute a non-arbitrary representation of space. Consequently, their aggregation and scaling contains implicit ecological meaning. Therefore, to appropriately monitor, model, and manage our interaction within landscapes, we require a multi-scale approach that judiciously integrates ecological theory, remote sensing data, spatial modeling, and computer vision capabilities for the automatic delineation, hierarchical linking, evaluation, and visualization of dominant landscape objects through scale. Furthermore, this approach should be guided by the intrinsic scale of the varying sized, shaped, and spatially distributed image-objects that compose a remote sensing scene.

To achieve this, we present Multiscale Object-Specific Analysis (MOSA) as a novel approach for automatically delineating and linking multi-scale landscape structures from a high-resolution remote sensing image. MOSA is composed of three primary components: Object-Specific Analysis (OSA), Object-Specific Upscaling (OSU) and Marker Controlled Watershed Segmentation (MCS). OSA is a multi-scale approach that automatically defines unique spatial measures specific to the individual image-objects composing a remote sensing scene. These object-specific measures are then used in a weighting function to automatically upscale (OSU) an image to a coarser resolution by taking into account the spatial influence of the image-objects composing the scene at the finer resolution. Because image-objects, rather than arbitrary pixels, are the basis for upscaling, the effects of the modifiable areal unit problem (MAUP) are also reduced. MCS is then applied to the newly upscaled data to automatically segment them into topologically discrete image-objects that strongly correspond to visually defined image-objects. The elegance of utilizing MCS as a feature detector is that it requires inputs that are automatically and explicitly met by the OSA/OSU outputs. Statistics are then used to describe the spatial characteristics of these multiscale landscape structures, and 3-D tools have been developed to visualize and describe their multi-dimensional morphology. Analysis is performed on an IKONOS-2 image (acquired August, 2001) that represents a highly fragmented agro-forested landscape in the Haut St-Laurent region of southwestern Québec, Canada

Changing Features of the Climate and Glaciers in China's Monsoonal Temperate-glacier Region

HE Yuanqing, Chinese Academy of Sciences, China; **Yongyuan Yin**, University of British Columbia, Canada; **Zhang Dian**, Hong Kong University, China
Session 2.5

Climatic data, ice core records, the tree ring index and recorded glacier variations have been used to reconstruct a history of climatic and glacial changes in the monsoonal temperate-glacier region of southwestern China during the last 400 years.

The region's temperature has increased in a fluc-

tuating manner during the 20th century, after two cold stages of the Little Ice Age (17th–19th centuries), with a corresponding retreat of most of the glaciers, against a background of global warming. Retreat rates accelerated after the 1980s. The few advancing glaciers that did exist have started to retreat in recent years. The amount, trend, and amplitude of variation of precipitation have differed in different parts of the region.

This paper describes the changes in monsoon patterns for the region. For example, the Dasuopu ice core, from the western part of the region, shows a decreasing trend in precipitation, the converse of the trend in temperature. In the eastern part of the region, however, a rising trend of rainfall has accompanied increasing temperatures as a result of the variable atmospheric circulations from different sources. The southwest and southeast monsoons are also described. Although it is clear that both temperature and precipitation affect the glaciers, further work is needed to confirm which is the major factor influencing present glacier change.

Cosmovisions and Environmental Governance: The Case of *In Situ* Biodiversity Conservation

Jorge Ishizawa, PRATEC, Peru
Session 9.1

It is increasingly recognised that the understanding valuable for sustainable use and regeneration of natural systems resides in practices of societies rooted in local cultures and ecosystems. Yet, this local knowledge remains often undervalued, if not downright invisible.

The case of *in situ* conservation of the diversity of native plants and their wild relatives in the central Andes is particularly interesting, since substantive knowledge is evident in the practices of the Andean peasant nurturers of agrobiodiversity who are real long-time experts in domestication of plants and animals. In contrast, scientific interest in *in situ* conservation is fairly recent. However, most of the projects now being implemented for *in situ* conservation of agrobiodiversity adopt a techno-scientific approach, that is, proceed with the implicit assumption that science and technology are privileged forms of knowing what to do and how to do things, and that different ways of knowing can be subsumed and eventually assimilated within the format of scientific and technical knowledge. That vernacular knowledge can be subsumed in scientific knowledge is a major assumption that is not corroborated in practice.

We contend that if instead we endeavour in searching for “passerelles” between scientists and holders of vernacular wisdom we may find that the domain of scientific knowledge is extremely restricted and that the domains of scientific knowledge and vernacular wisdom do not overlap in general. In effect, scientific knowledge is for the most part constructed within a very confining framework, that of an explanatory mechanism within a field defined by a strict consensual definition of what constitutes a scientific "fact." The fact that this definition is carried out by "experts," and strictly human ones, has, at least, two consequences: (1) laymen are kept out of it and thus popular (vernacular) knowledge is excluded and (2) the definition leaves out all spiritual (or non-material) connotations: it secularizes knowledge. The first consequence derives in the need for "translations" of scientific knowledge into popular language if science is to fulfill its mandate for pertinence. The second, in our view, precludes any deep understanding of issues of environmental governance which have profound spiritual roots.

Our proposal is to explicitly consider the cosmovision implicit in science and the cosmovision involved in vernacular knowledge pertaining to environmental governance as equivalent and as valid, alternative modes of approaching the issues involved. We contend that only with this explicit understanding passerelles can be built between scientists, policy-makers, and the public, irrespective of the culture they embody.

Conflict Between Resource Users and Conservation in Southern Africa: Exploring Local Access with Community-integrated Geographic Information Systems

Jennifer L. Jones, University of Pretoria, South Africa and **Albert van Jaarsveld**, Stellenbosh University, South Africa
Session 2.3

The tearing down of fences to broaden conservation areas, and in some cases create new transfrontier parks, has been praised as a laudable goal throughout southern Africa. Rather than conservation, some projects have led to conflict where fences are not torn down by conservation agencies but instead by neighboring communities opposed to conservation efforts. This presentation highlights the community of Mbangweni, located between Ndumu Game Reserve, Tembe Elephant Park, and Mozambique in northern KwaZulu-Natal, South Africa, which is presently experiencing considerable conflict. Beyond physical park access for resource utilization, the con-

flict is part of a larger scenario, resulting from historical forced removals and subsequent settlement patterns, ongoing land claim disputes, a poor natural resource base for subsistence livelihoods, and endogenous and exogenous political and ecological factors of tribal and civil government. Furthermore, the communal land has been identified as a critical component for development of a proposed transfrontier Peace Park, forcing the actors into hostile negotiations for land rights and possible relocation.

Using a Community-Integrated Geographic Information System (CiGIS), which augments conventional GIS with local knowledge, fundamental paradigms affecting the conflicts over land ownership and resource access and utilization are explored. Original data collection includes geo-referenced survey questionnaires, in-depth interviews, and participatory aerial photo interpretation from the Mbangweni community, as well as from other communities bordering the conservation areas. Subsequent social differentiation of knowledge, resulting from multiple realities due to gender, age, education, etc., within and between the communities is analyzed using qualitative, quantitative, and spatial methods, with particular focus on the social forces affecting land use, land cover change, and settlement patterns.

Results indicate that while the land within the communal area is fairly resource poor, land identity amongst residents remains strong, and traversing access through the area to Mozambique is highly important. The community's location in a corridor between the two reserves and Mozambique has resulted in economic and social patterns that are directly tied to their proximity to international border. In addition to the provision of economic opportunity, any future land negotiations or potential resettlement schemes for the proposed transfrontier park must also consider strategies to mitigate for the disruption of social linkages, potentially leading to conflict between the community and conservation agencies.

Local Ecological Knowledge in Natural Resource Management

Laxman Joshi, World Agroforestry Centre (ICRAF), Indonesia and University of Wales, Untied Kingdom; **Luis Arévalo**, **Nelly Luque**, and **Julio Alegre**, World Agroforestry Centre (ICRAF), Indonesia; and **Fergus Sinclair,** University of Wales, Untied Kingdom
Session 11.1

Rural people's livelihoods depend on their knowledge to manage available natural resources. Their knowledge continues to evolve under changing circumstances, based on personal experience and observations and acquired from secondary sources. In contrast to the populist view of cultural embeddedness of local knowledge, we assert that farmers' knowledge that has developed and been used in their decision making has ecological rationality in most cases and can be differentiated from cultural and supernatural aspects. While local insights may be comparable with scientific understanding in some respects, it may also differ in its scope and structure.

Using case studies from Indonesia and Peru we illustrate the nature and scope of local ecological knowledge. In the Indonesia case, we investigated farmers' knowledge about soil erosion and associated natural processes both at a plot and landscape levels. While plot level knowledge was rich and diverse, landscape level knowledge was rather generic and was associated with implementation constraints on an individual basis. In Peru, we appraised local ecological knowledge about soils and other aspects of farming systems among the Shipibo communities with relatively new and general but evolving knowledge system. With these examples and other references, we discuss the nature and scope, limitations and usefulness of local knowledge in natural resource management. We advocate research and development based on local knowledge and innovations that are complemented with appropriate scientific investigation.

Forest Ecosystem Assessment in Western China

JU Hongbo, Chinese Academy of Forestry, China
Session 4.4

This paper reports on efforts to conduct an assessment of forest ecosystems in western China. The assessment studies the historical conditions of forest ecosystems, assesses ecological pressures on these system, and provides support to decision-makers faced with creating a sustainable development strategy for western China. The paper uses data from several sources in its assessment, including land use and remote sensing data. It describes the forest ecosystems in China and presents indicators of condition and pressures. It also analyzes the dynamic changes that are occurring within forest ecosystems in western China. Policies for ensuring sustainable development of the region are discussed.

Validation of Traditional Meteorological Principles in Saurashtra, India

Parshotambhai Ranchhodbhai Kanani, **D.D. Malavia** and **Vijaykumar J. Savaliya**, Gujarat Agricultural University, India
Session 11.2

Saurashtra, located in the western part of Gujarat state is predominantly a dryland farming area. Since the early 1970s, it has been identified as a drought prone area. The farmers of this region give a lot of weight to the prediction of the onset of monsoon, since the choice of cropping pattern depends on it. Early showers would enable a farmer to go for long duration crops such as ground-nut (spreading type) and cotton.

Considerable progress has been made by Indian satellite technology, but the Department of Meteorology is not very helpful to farmers who are making choices related to cropping pattern. This is because the Department of Meteorology makes long-range predictions only for the nation as a whole. In the case of specific regions, the predictions are short range in nature, i.e., for a period of three days only. As a result farmers in dryland regions of India rely mainly on indigenous meteorological beliefs and knowledge to make predictions regarding the monsoon. The traditional meteorologists use methods and principles evolved by eminent astronomers and astrologers such as Varahmihir (700–800 A.D.), Bhadri (1000–1200 A. D.), Poet Ghagh (1200–1300 A. D.), and Unnad Joshi (1350–1400 A. D.). Many of the principles are embedded in cultural and religious books or have been passed on from generation to generation by word of mouth.

In this paper, we present our experience of participatory meteorological assessment and prediction with farmers of Saurashtra. We describe the methods used to predict the monsoon and discuss the establishment of an informal network of local experts and formal scientists that provides voluntary service to the people of Saurashtra by making predictions on the basis of collective assessment. We discuss the benefits of such a network, including validating indigenous beliefs, restoring confidence in traditional knowledge held in the region, and pooling knowledge across the different stakeholders. We believe that such a network can serve as a model for other dryland areas which rely on traditional experts for prediction of monsoon.

Multi-scale Scenario Development: From European to Local in the Mediterranean Region

Kasper Kok
University of Wageningen, Netherlands
Session 14.3

Desertification in the Northern Mediterranean region is largely a society-driven problem, which can be effectively managed only through a thorough understanding of the principal ecological, socio-cultural, and economic drivers. This Integrated Assessment approach also calls for a much more active role of decision-makers and other local stakeholders. MedAction, an EC-financed project, was an endeavour to define policies to combat desertification in the Mediterranean region using participatory methods. Involvement of local stakeholders was crucial, during problem definition phase as well as during presentation and validation of results.

Within the framework of MedAction, scenarios were developed at the European level, the Mediterranean level, and for four Target Areas throughout the Mediterranean region. The methodology that was followed closely resembles the basic concepts used with the Millennium Ecosystem Assessment. Focus was on the development of qualitative scenarios in the form of narrative storylines that were later coupled with DDSs at the local level. European scenarios were derived by adapting a set of existing European scenarios. Those scenarios were subsequently downscaled to fit the specific issues in the Mediterranean region. These scenarios were used as a starting point during a number of stakeholder workshops in the various Target Areas. Stakeholders included local decision-makers, but also citizens, free-thinkers, students, and journalists. A number of different approaches were followed during local scenario construction. A predominantly top-down approach using the Mediterranean scenarios as wind tunnels resulted in sets of local scenarios that facilitate upscaling to the Mediterranean level, but that are largely governed by the input given. A predominantly bottom-up approach aiming at constructing desirable futures from the local perspective, resulted in more independent and sometimes richer storylines, which sometimes lacked the Mediterranean scale vision.

The combination of three levels of organization, including the perception of stakeholders at local level, is an extremely powerful source of information in the understanding of complex systems, particularly when results are linked with local and regional models to quantify these qualitative scenarios.

Identifying the Contribution of Indigenous Knowledge in Bioprospecting for Effective Conservation Strategy

Pushpam Kumar, Institute of Economic Growth, India; **Nori Tarui,** University of Minnesota, United States
Session 11.1

This paper attempts to examine the contribution of indigenous and traditional knowledge in the process of bioprospecting, and proposes a model to analyze how such knowledge influences the benefits of bioprospecting. Empirical evidence suggests that (i) out of the two widely debated but dissenting hypotheses on the benefits of bioprospecting, one estimating higher values is supported and (ii) if the bioprospecting search is based on ethno botanical information available from local people, then the value of bioprospecting benefits will be higher than those predicted by the two hypotheses. It is crucial for bioprospecting firms to design a scheme where the information as well as access to the resources can be effectively shared between the firms and the local people in the bioprospecting site.

Integrating Ethnobiology into Forest Conservation Assessments: Lessons Learned in Cameroon

Sarah Adams Laird, United States
Session 11.1

Mt. Cameroon is one of the most biologically diverse sites in Africa, considered to be a biodiversity ”hot spot” and Pleistocene refugia. As such, it has received significant attention from researchers and conservation groups in recent years. This has included a number of relatively rapid assessments of local peoples' use of forests as well as more in-depth ethnobiological studies in pockets around the mountain. In the latter case, a range of ethnobiological methods were employed, including qualitative and quantitative techniques, each yielding different types of data, and revealing different aspects of local people's relationship with the forest. In order to understand local cultural values and integrate them into an assessment relatively localized and in-depth research is required. However, conservation of forests and assessment of ecosystem health involve addressing a broad and complex range of biological, political, social, economic, and cultural forces within and outside communities.

This paper will discuss the strengths and limitations of a range of ethnobiological methods employed over a five year period around Mt. Cameroon to assess local groups' relationship with their environment and the challenge of integrating policy, market, and traditional ethnobiological field research. In particular, it will provide lessons learned from efforts to tackle the tension between the need for local-level specificity and that for more generalized conclusions resulting from study of cross-scale interactions

The Politics of Scale in the Assessment and Management of Environmental Change

Louis Lebel, Chiang Mai University, Thailand
Session 4.3

This paper argues that the choice of scales in assessment and management of environmental change is often determined by politics as much as the characteristics of the ecosystem or natural resource under consideration. By politics I mean that different interests group intentionally use rhetorical arguments about scale to serve their own interests, and that ultimately the choice of scale for analysis and upon which decisions are made is a reflection of the strength of their interests in the resource in question and relative power. Moreover, which ever levels and scales are eventually adopted, these choices often work to reinforce the initial decisions, further privileging the interests of favored resource users over others. Scale “choice”, is not always explicit, but maybe embedded in the structures and processes of society, that make activities and differences at certain levels visible or not. Thus, the central administration of a bureaucracy sees society and the landscape from a particular “high” vantage point with limited resolution to see differences among sectors, livelihoods and places. Policies, management systems and the science of assessment used to support them, are assumed to seamlessly scale up or down. Ecologists will typically argue that there are “real” scales in nature and that if only we could get the institutional arrangements to match them, that is, fit, our problems of analysis and management would be over. On the other hand, political geographers are quick to point out how scales are social constructions. A secondary aim of this paper is to show that neither of these views taken at their extremes is correct. Relevant scales are jointly produced by interactions between social and ecological systems over time.

A Combined Index of Native and Non-native Plant Diversity to Assess Cross-scale Environmental Change

Mai-he Li, Swiss Federal Institute for Forest, Snow and Landscape Research, Switzerland
Session 4.2

Survival, growth, and development of plants in a spatial scale require suitable environmental conditions that are continuously modified by environmental change, including human activities. The present species diversity, including its composition (e.g., richness) and competition (e.g., abundance), reflects historical as well as environmental factors. Hence, measures of diversity are regarded as indicators of the well-being of ecological systems. Values of diversity are associated with plot size due to the diversity patterns in space, and with ecological zone because of the latitudinal and altitudinal patterns related to the ecological conditions. For example, these associations may occur in the following four combinations:

- Different plot sizes within an ecological zone;
- Different plot sizes across ecological zones;
- The same plot size across ecological zones, and
- The same plot size within an ecological zone.

A simple comparison of diversity values under the first, second, and third combination may result in false interpretation of ecosystem well-being. On the other hand, all biodiversity indices have not considered biological invasions that lead directly to an increase of the species number and replacement of some existing species through competition and thereby affect the character and functioning of ecosystems .

To compare the ecosystem change based on cross-scale biodiversity, we developed a method to calculate a relative biodiversity value, which is calculated using a 3-dimensional model based on a logistic equation. The two variables consist of the ratio between the present Shannon index and the theoretically maximal Shannon index and the proportions of native plants in richness, as well as in cover or number of individuals. These two variables are therefore scale-independent. It is thereby possible to carry out a cross-scale comparison using biodiversity measures to assess the vegetation change and to estimate the effects of environmental modifications including the past human impacts on the cross-scale changes in vegetation. The rationales behind this methodical development are (i) that direct and indirect anthropogenic changes in climate, rates of habitat disturbance, nutrient loading rates, and other environmental constraints will have a major impact on successional dynamics and the maintenance of biodiversity; (ii) that species composition is more important than species or functional-group richness in affecting a range of ecosystem properties; and (iii) that the distribution of species abundance of non-native plants is a more sensitive measure of environmental disturbance than species richness alone. This method can be used to evaluate and compare cross-scale data for a better understanding of the responses of vegetation and ecosystems to global change including human activities.

Integrated Ecosystem Assessment of Western China

LIU Jiyuan, Chinese Academy of Sciences, China
Session 4.4

In 1999, the Chinese government decided to implement western development strategy by way of a series of measures such as increased financial resources to construction, financial transfer of tax revenues, more monetary input, preferential taxation, preferential land use, a mineral policy, widening of foreign development investment (FDI), and relaxation of FDI utilization limitations with a view to supporting the western development. Since 2000, it also gives more financial support from tax revenues to the minority areas. Western development of China is a significant decision for the 21st century made by China government. However, the western development of China is faced with many challenges. For instance, China entering into the World Trade Organization might lead to many uncertain incidents in the western region; the conflict of supply with demand of water resources is outstanding; the ecological environment is still deteriorating; the industrial structure is still irrational; and the infrastructure in the western region is much more backward than the one in the eastern region. This workshop is to bring scientists together to discuss possible solutions for the challenges. The themes include: (1) adaptations of the MA conceptual framework and assessment approaches, (2) ecosystem condition of western China, (3) ecosystem scenarios of western China, (4) trade-offs among ecosystem services, (5) human well-being and ecosystem services, and (6) response options.

Addressing the Issue of Scales through a Strategic Multi-scalar Approach for an Inventory and Assessment of Wetland Ecosystems-
A Pilot Study in the Mekong River Basin.

Alvin Lopez, IUCN - The World Conservation Union, Cambodia; **Max Finlayson**, National Centre for Tropical Wetland Research, Australia
Session 6.2

Human well-being and progress towards sustainable development are dependent upon improved management of the earth's ecosystems. Wetland ecosystems are currently under great threat despite the numerous goods and services they provide. The inventory and assessment framework proposed for the Mekong River Basin provides an effective tool for collecting information for managing natural resources derived from or dependent on wetlands, and for meeting national obligations under international agreements. The mechanism uses a multi-scalar approach to collect information and takes advantage of new technologies for data collection, storage, and dissemination. This multi-scalar approach has been developed in response to existing needs to obtain information at different levels and detail, and also serves to demonstrate the linkages between scales.

The proposed framework attempts to bridge scientific and local epistemologies through its data collection and assessment protocols. It builds on past inventory and assessment protocols that have been successfully developed for use elsewhere in the world. It is also based on the Asian Wetland Inventory framework; the recommendations made in a global review of wetland inventory and support the provisions used in the Ramsar Convention framework for wetland inventory and assessment. This paper provides a brief overview of the trends in wetland ecosystems, briefly discusses the development of global wetland inventory and assessment initiatives and elaborates on the multi-scalar approach taken in the proposed inventory and assessment framework for the Mekong River Basin. It further promotes the relevance of this strategic multi-scalar assessment approach to the framework for assessment proposed under the MA and the suitability of the proposed framework at the sub-global assessments and global wetland inventory and assessment as a whole.

The Tibetan Sacred Lands, Where the Nature and Culture Meet

Lu Zhi, Conservation International, China
Session 14.4

The Mountains of Southwest China Hotspot, an area of nearly one tenth of China's terrestrial land (about million km2) covers the eastern Tibet Autonomous Region, northwestern Yunnan, western Sichuan, southeast tip of Qinghai and southern tip of Gansu – the greater Hengduan Mountains. The hotspot retains the richest biodiversity among temperate forests of the world. During the summer months, the Tibetan Plateau acts as a barrier to the monsoon and traps clouds and moisture, giving the alpine flora a lushness found nowhere else − an extraordinary 230 rhododendron species are found here, half of which are endemic to the region. The diverse vegetation provides habitat to many endangered and endemic wildlife species, including the giant panda, the red panda, the golden monkey, the snow leopard and the takin.

The hotspot is as rich in culture as it is in biodiversity. Within the hotspot, nearly eighty percent of the land is inhabited by Kampa Tibetans who are have the strong belief in Tibetan Buddhism, who hold unique cultural values and perceptions towards life and the natural world. In Ganzi Prefecture, western Sichuan, it is estimated that there are over two thousand sacred natural sites designated by each village and monastery. These sites have provided a refuge to the wildlife and its habitat. Some sacred mountains survived through large-scale commercial logging in last century and retained old-growth forests. In Ganzi Prefecture of Sichuan and eastern Tibet, the places where wildlife could be viewed are usually protected in the sacred sites of local villages and monasteries. Such a practice has accumulated a rich repository of indigenous knowledge on land use and resource management that is still functional in many places in spite of severe influence from outside. This non-materialized value system presents a unique opportunity to biodiversity conservation in this hotspot and is especially important in promoting sustainable development and livelihoods, not only to Tibetans communities but also to the rest of the Chinese society.

This cultural tradition is now facing greater challenges brought about by rapid social and economic development. Building roads through remote areas

has caused habitat destruction and has brought in mass tourism, which further disturbs the habitat and stimulates wildlife consumption. Tourists from outside the area also have a gradual but profound influence on the Tibetan culture. In Tibetan communities, the use of tiger and leopard skins for clothing and the unsustainable harvest of wildlife for commercial trade are increasing. Killing of life, especially in an unsustainable fashion, is in direct opposition to Buddhist teaching and Tibetan cultural value. In Diqing Prefecture, northwestern Yunnan, schools do not teach Tibetan language so the younger generation does not read and write in Tibetan, which also presents an obvious obstacle for reviving the Tibetan cultural value on scared land.

Since late 2002, CI China has initiated the idea of developing a program that supports the sacred land protection and revival of Tibetan cultural values toward nature. So far, preliminary surveys have taken place in this area to understand the situation, build partnership, mobilize the interest, and above all, to detect the feasibility. The goal of this project is to promote the Tibetan sacred land system that integrates community-based land management and protection mechanism and traditional cultural value with an implication of sustainable lifestyle.

The Practice of Wetland Ecosystem Services' Exploitation and Utilization in the Downstream Mekong Delta and Shortcomings in Regional Wetland Exploitation and Management Policies

MAI TRONG Thong and **Vu Phuong Manh**
Vietnamese Academy of Science and Technology, Vietnam
Session 6.1

The presentation analyzes the current issues surrounding ecosystem exploitation and development in the Downstream Mekong Delta. The shift from a centrally planned economy to a socialism-oriented market economy has brought new challenges for the region. Local inhabitants, in search of economic profit, have randomly and illegally extracted forest resources, destroying tens thousand hectares of forests and hundreds thousand hectares of rice fields for the purpose of aquatic cultivation. Natural hazards and environmental vulnerabilities, such as floods, inundations, coastal flow-off and landslides, have occurred more frequently and often at increasing scale and intensity. At the same time, management policies are poorly coordinated, and authorities have neither the knowledge nor the appropriate methods for intervening in ecosystem degradation. Management policies are generally ineffective and do not consider the social or economic realities of the local inhabitants. Studying the impacts of ecosystem exploitation and utilization in the Downstream Mekong Delta in Vietnam is of importance in order to help local authorities amend and supplement current policies and measures for ecosystem conservation and sustainable development in the region.

Biogeographic Gradients and Local Management of Biological Resources in Morocco: A View from the Marketplace

Gary J. Martin, The Global Diversity Foundation, Morocco; **Rajindra Puri**, University of Kent, United Kingdom; **Mohamed Ghamizi**, **Mouley Ahmed Elaoui Elfels**, **Abdelaziz Abbad**, **Mohamed Alifriqui**, **Ahmed Ouhammou**, and **Mohamed Znari**, Natural History Museum of Marrakech, Morocco; **Fabrice Cuzin**
Session 6.3

From north to south, Morocco presents an intricate mosaic of biogeographic zones, each managed in distinct ways by local people. Much of this gradient is included in the Mediterranean hotspot of biocultural diversity, which in Morocco comprises a relatively arid area that stretches from the Mediterranean coast to the northern edges of the Sahara Desert. Drawing on the French tradition of plant ecology, researchers have characterised these zones according to elevation, precipitation levels, temperature variation, flora, fauna and human impact. Anthropologists have documented the rich cultural diversity and history of the region, which derives in part from a centuries old interaction between the indigenous Imazighen population, and diverse groups of Arabic and Jewish peoples who began arriving in the seventh century AD.

Since March 2003, the Global Diversity Foundation has been working with a team of researchers and students from the Université Cadi Ayyad in Marrakech and the University of Kent at Canterbury to characterise wildlife trade in central Morocco. Our results provide a unique perspective on gradient analyses in ethnobiology from the vantage point of the marketplace. In order to assess the cultural, biological, and economic sustainability of wildlife trade, we are collecting data on the variety and quantity of species traded, as well as on their origins, conservation status, and the chains of commercialisation that bring them from the rural hinterland to urban areas.

Our research supports the efforts of local institutions, including the Moroccan Department of Water and Forests, to identify wildlife products that are overharvested as well as those that are potentially sustainable and could be further promoted to enhance local livelihoods.

With support from the National Geographic Conservation Trust, we have made over 1,500 collections of animals and plants that are sold in rural and urban marketplaces of southcentral Morocco, and we have interviewed 123 wildlife vendors about their knowledge and practice. This initial survey—which is to be extended to southeastern and southwestern Morocco in coming years—reveals the relative contribution of various bioclimatic zones to the commercialisation of biodiversity. Excluding the large number of imported species (particularly aromatic herbs, resins, and spices from the Middle East and Asia), we find a majority of animals and plants that are captured, gathered, or harvested by people of Imazighen or mixed Arabic-Imazighen origin in six subregions: Atlantic coast, Atlas mountains, arid high plains, sub-Atlas piedmont, oases, and Sahara desert. Particular insight is drawn from our analysis of animal-plant mixtures that are used in a variety of ways, including as fumigants, medicines, spices, and talismans.

Fisheries Management and Information — A Mekong Perspective

Niklas S. Mattson and **Thomas Augustinus**, Mekong River Commission, Lao PDR; **Anders Poulsen**, Mekong River Commission, Lao PDR and Aquatic Biodiversity Studies of the Fourth Fisheries Project, Bangladesh; **Wolf D. Hartmann**, Mekong River Commission, Lao PDR
Session 6.1

Conventional fisheries management has tended to emphasise predictions of the behaviour of fisheries resource systems in order to modify management according to relatively short-term objectives, usually with the stated goal of optimizing specific outputs. Management relies on complex models with large-scale averages as inputs to predict the status of fish stocks. Associated top-down management interventions have poor support among fishers.

Recent fisheries management discourse include increased awareness that fisheries are complex socio-ecological systems and that management cannot expect to optimise the system, e.g., toward Maximum Sustainable Yield. Further, increasing emphasis is put on the process by which information for management and policy is generated.

The Mekong River supports the possibly largest inland fishery in the world, with a total annual catch of more than two million tonnes. The fishery differs from large-scale marine fisheries in that it mainly consists of small-scale, diffuse fishing operations. However, the approach to management is by and large conventional and top-down. It is argued that a common cognitive basis for fisheries management, which is seen as legitimate by all stake holders, needs to be developed. Local knowledge contributed by fishers through co-management can be used to highlight slower, more predictable variables, including information on habitats and other basic biological and physical processes. Such information is essential for local management, but should also be used in larger-scale assessment of the fisheries resources. The challenge will be to establish a process whereby information from different sources, across scales and sectors, can be integrated into management models to form legitimate interventions.

The Importance of Scale in Determining the Human Population Distributions in the Marshall Islands

Will McClatchey and **K. W. Bridges** - University of Hawaii, United States
Session 6.3

Traditional environmental knowledge has been employed by ancient people in the selection of habitation sites in the landscape. In simple terrestrial systems such as Pacific atolls, the apparent patterns of these kinds of decisions may provide insights into the logic that was employed. Based upon ecological analyses at Ailinginae Atoll, Kapingamarangi Atoll and human demographic data from the Republic of Marshall Islands, we have studied two scales of evidence that address the same issue: sustainable human population survival in the Marshall Islands. The scales that were explored are: selection of an islet on which to live at a particular atoll, and distribution of human population levels across a group of islands. We conclude that different factors are impacting the decisions at different scales. Small island effects seem to explain the selection of islets within an atoll while terrestrial land area explains the distribution of the population across the Marshall Islands.

Intellectual Skepticism, Operational Optimism: Overcoming Barriers to Integrating Local Ecological Knowledge in a Multi-scale Assessment in the Tsimshian Territory

Charles R. Menzies
University of British Columbia, Canada
Session 2.2

In this paper we discuss our research and community-based experiences of overcoming barriers to integrating local ecological knowledge in large-scale scientific assessments. In particular, we identify operational solutions that we developed during the life of the two projects. Ultimately, we argue that science (as a social institution) has to learn how to accommodate itself to local knowledge. While we do not promise the final answer, we do suggest that our experiences are part of the answer to effecting such a change.

The theoretical barriers to integrating local ecological knowledge within global scientific assessments extend beyond simple matters of scale. The root barrier stems from epistemological differences that render the simple integration of the knowledge and wisdom of local resource users difficult to translate into abstract lines on maps or numbers in tables. A more pressing and problematic barrier stems from the institutional privileging of "science" over "folk", "local", or "traditional" knowledge. Combined with the lack of regard for research methods that attempt to learn from, rather than mine or dredge out ecological knowledge from local communities, these barriers to integration often reduce the integration of local knowledge to the status of an afterthought or a token addition late in the process. Yet we persist in trying, if for no other reason than our experience as members of resource dependent communities and anthropological researchers reveal the value of local knowledge in understanding the way ecosystems work.

This paper draws upon two community-based research projects being conducted within the territories of the Tsimshian First Nations of north coastal British Columbia (Forests for the Future: Integrating Local Ecological Knowledge with Natural Resource Management www.ecoknow.ca; Cultural and Social Spatial Analysis, supported by the BC Coast Information Team www.citbc.org). While these projects differ in terms of their methodology (the first is primarily interview based and the second involves mapping social and cultural values) taken together they offer important commentary on how to overcome the barriers to integrating local ecological knowledge within global assessments.

A Multidisciplinary Multi-scale Framework for Assessing Vulnerability to Global Change

Marc Metzger and **Rik Leemans**, Wageningen University, Netherlands; **Dagmar Schröter**, Potsdam Institute for Climate Impact Research, Germany
Session 6.2

Terrestrial ecosystems provide a number of vital services for people and society, e.g., biodiversity, food, fibre, water resources, carbon sequestration, and recreation. The future capability of ecosystems to provide these services is determined by changes in socio-economic characteristics, land use, biodiversity, atmospheric composition, and climate. Most published impact assessments do not address the vulnerability of ecosystems and ecosystem services under such environmental change. They cannot answer important multidisciplinary questions such as: Which are the main regions or sectors that are vulnerable to global change? How do the vulnerabilities of two regions compare? Which scenario is the least harmful for a sector?

This paper describes how the project ATEAM (Advanced Terrestrial Ecosystem Analysis and Modelling) uses a new approach to ecosystem assessment. Within ATEAM a full suite of ecosystem models, covering biodiversity, agriculture, forestry, hydrology, and carbon sequestration are fed with the same input data and are run with the same consistent SRES-based scenarios. Each model gives insights into specific ecosystems, as in traditional impact assessments. Moreover, by integrating the results in a Vulnerability Assessment, multidisciplinary questions, such as those listed above, can be answered as well. A statistically derived European environmental stratification forms a key element of the Vulnerability Assessment. By linking it to a global biome classification, comparisons can be made using data from different assessments and scales. The paper presents the first results of ATEAM's Vulnerability Assessment, and illustrates how ATEAM's multidisciplinary multi-scale vulnerability framework can be used at different scales.

Interfacing Two Knowledge Systems: Local Knowledge and Science in Africa

David Millar, Centre for Cosmovision and Indigenous Knowledge, Ghana
Session 10.3

In this article, with reference to Ghana and Zimbabwe, I explore the traditional African worldview, life world, belief systems, and ways of thinking and

reasoning. This discourse captures the rich combination of spirituality, materiality, and the social in a concept referred to here as Cosmovision. Nowadays, this worldview co-exists with western worldviews and systems of thinking, in various shades and combinations of both, as several parallels within the same continuum.

In the article, I try to illustrate that in the traditional African knowledge systems often a hierarchy exists between divine beings, spiritual beings, ancestors, and natural forces, such as climate, disease, floods, soil, vegetation, and animals. The worldview suggests a cyclical notion of time, and gives rise to several rituals in which the elders and spiritual leaders play a prominent role. From the examples of Ghana and Zimbabwe, it becomes clear that in the traditional worldview land, water, animals and plants are not just a production factor with economic significance. They have their place within the sacred nature.

The role of colonialism in subordination of the African science and knowledge system in general is discussed. The article argues that the Transfer-of-Technology model assumed even after independence still subjugated the African knowledge system and continues to do so. This not withstanding, the African knowledge system persists albeit marginally and has sustained many lives this far.

The article ends with a series of conclusions that highlight the reawakening of interest in the African knowledge system. This new interest is due in part to the persistence of elements of the African knowledge systems despite the numerous interruptions by interventionists. The failure of interventions from the western world to provide the envisaged benefits has gone to buttress the need for an alternative to the dominant paradigm approach. With these concluding remarks the article then makes a recommendation for an endogenous development process that focuses on a blend between the two knowledge systems within the concept of endogenous development.

Regionalizing Scientific Assessments to Strengthen Global Civil Society

Clark Miller, University of Wisconsin-Madison, United States
Session 14.2

When designing scientific assessments, attention is usually paid to establishing strong information flows from scientists to decision-makers. For global environmental assessments, targeted "users" are those whose decisions affect the management of earth systems. In this framework, regional components of global assessments bridge scales by informing local decision-makers of global knowledge and global decision-makers of local knowledge. In this paper, I offer an alternative model in which scientific assessments contribute not only to decisions about managing natural resources but also to the structure of global politics. The object of concern is not only the management of the planetary environment but also the governance of the world polity. I argue, in short, scientific assessments function as experiments in global democracy as well as sources of policy-relevant scientific information. This model derives from two extensive literatures: (1) historical research indicating that science has played an important role in building civil society in many democracies and (2) comparative research indicating that different cultures reason about and manage risk quite differently from one another, even among the advanced, industrial democracies of the West. In this model, regional assessments offer an opportunity to open up global decision-making to a wider array of voices and to bring alternative approaches to environmental management into explicit dialogue with one another. I argue that this model has important implications for how assessments should approach regionalization, and offers a number of potential advantages, including strengthening the legitimacy of international scientific assessments, building social capacity to address global environmental change, attuning global and local environmental management, helping countries learn to reason together about global environmental risks, and strengthening global civil society.

Traditional Management of Food Production and Implications for National Food Security and Self-Sufficiency in Papua New Guinea

Jane Mogina, University of Papua New Guinea, Papua New Guinea; **R. Michael Bourke**, Australian National University, Australia
Session 2.4

Traditional knowledge is fundamental for food production in Papua New Guinea (PNG). Domestically produced food is valued at about US$430 million and most is produced at the household level. Locally grown staple food contributes substantially to the national economy. In the rural areas, people have access to land, which they cultivate for household consumption. Food production is managed at the household level by utilising different crops species and numerous cultivars. In addition, different landforms are cultivated to accommodate the varying

nutrient and water requirements of the crops. Food is grown for a social purpose through exchanges and other mechanisms as well as the nutritional benefit.

Population pressure in rural communities, particularly on small islands, has a significant impact on the strategies employed to produce food. As arable land becomes limited, villagers change their food production practices. These changes include increased intensity of land use and change in the crops and cultivars grown. Villagers intensify land use by adoption of more productive species, such as cassava and sweet potato, and more productive cultivars, for example, triploid bananas. The older staples such as taro and yam continue to be grown because of their social roles in society. In this presentation, we give an overview of how people achieve food security in different agroecological zones, and how land use is being intensified in response to land shortages.

Gradients of Ethnicity from Aboriginal to Modernized and their Effects on Biodiversity in Papua New Guinea

Jane Mogina, University of Papua New Guinea, Papua New Guinea
Session 6.3

Ethnobotanical knowledge in subsistence societies changes, as the people in these societies become more integrated into a broader regional and global society and culture. Results from a Papua New Guinea study designed to contrast two subsistence villages differing in their level of modernisation indicate that different use categories of plants are embedded and distributed differently in the society and thus each category of use reveals varied responses to outside influences. In subsistence communities relying upon oral and practical transmission of knowledge, it may be expected that knowledge will maintain a pragmatic balance between what is essential for sustenance and that which adds status, explanation and justification – including ritual and esoteric knowledge. Basic knowledge for sustenance, including shelter, food and medicine was widely distributed across clans, villages and regions. Such knowledge is robust while in use, but liable to replacement if alternatives become adopted. Novel materials, crops and modern medicines all have the potential to replace traditional materials, practices and ritual but leave much social structure intact. The impact of such change is an accelerated loss of knowledge of biodiversity, particularly, crop diversity, not so much because of loss of biodiversity, but because of the loss of traditional structures and institutions which maintained and transmitted the knowledge.

Bridging Epistemologies: Lessons from the MA Sub-global Assessments

Jane Mogina, University of Papua New Guinea, Papua New Guinea
Block 3 Plenary Presentation

Fundamental to the MA conceptual framework is the engagement of ecosystems users in the assessment process. Users and their worldviews and knowledge systems vary. In this presentation I attempt to explain what knowledge is in different contexts, the cultural role it performs, as well as how it is generated, transmitted, maintained and utilised in adaptation to change in various communities within Sub-global Assessments. In addition I attempt to answer the question "Do the realities of doing local ecosystem assessments meet MA's intentions of Bridging Epistemologies?"

Bridging is understood to be an issue of communication among differing worldviews of ecosystems as well as across scales, as scale of analysis inherently influences knowledge. Thus, particular attention is paid to the various processes that enhance or inhibit the communication process between the different worldviews. While scale issues present the most complex challenges in our attempts to bridge different knowledge systems, they also provide opportunities for innovative ways of conceptualising local knowledge.

Indigenous Knowledge and Ecosystem Assessment in Costa Rica

Seferino Morales, Victor Chale, and **Esther Camac**, Association IXACAVAA for Indigenious Development and Information, Costa Rica
Session 9.1

Indigenous knowledge has developed over many years of observation, experimentation, and day-to-day use of environmental resources. This knowledge has in large part been transmitted orally and by diverse methods such as histories, myths, songs, and dances. Indigenous knowledge is also local, in that it is generated in a very particular place with its own character, identity, and socio-economic circumstances. This paper describes the efforts to include this knowledge in the ecosystem assessment of the indigenous territories of Cabecares de Chir-

ripo. The paper describes the environmental and cultural threats to the region, including industrialization and large-scale agricultural production, and the changing system of values about humans' relation to the environment. It describes the way the indigenous population perceives their word, and their relationship to space and time. We describe how to revitalize and to deepen this knowledge, and suggest that an alternative approach to managing ecosystems that is based on our ancestral knowledge and our values of balance between human beings and nature may provide the answer to environmental problems in the region.

Social-multicriteria Evaluation (SMCE): Methodological Foundations and Operational Consequences

Giuseppe Munda, Universitat Autonoma de Barcelona, Spain
Session 10.4

In order to address contemporary issues, economics and decision sciences need to expand their empirical relevance by introducing more and more realistic (thus more complex) assumptions in their models. One of the most interesting research directions in the field of public economics is the attempt to introduce political constraints, interest groups, and collusion effects explicitly (Laffont, 2000). The main argument developed here is the proposal of the concept of "Social Multi-criteria Evaluation" (SMCE) as a possible useful framework for the application of social choice to the difficult policy problems of our Millennium, where, as stated by Funtowicz and Ravetz, "Facts are uncertain, values in dispute, stakes high, and decisions urgent". This paper starts from the following main questions: (1) Why "Social" Multi-criteria Evaluation? and (2) How should such an approach be developed? The foundations of SMCE are set up by referring to concepts from complex system theory and philosophy, such as reflexive complexity, post-normal science, and incommensurability. To give some operational guidelines on the application of SMCE basic questions to be answered are: (1) How is it possible to deal with technical incommensurability? and 2) How can we deal with the issue of social incommensurability? To answer these questions, using theoretical considerations and lessons learned from real-world case studies, is the main objective of the present article.

The Southern African Millennium Ecosystem Assessment (SAfMA) Process

Constancia Musvoto, University of Zimbabwe, Zimbabwe; **Albert S. Van Jaarsveld** and **Belinda Reyers**, Stellenbosch University, South Africa; **Marcus Lee**, WorldFish Center, Malaysia; **Sem Shikongo**, Ministry of Environment and Tourism, Namibia; and **Michael Mutale**, Zambia
Session 6.4

The Southern African Millennium Assessment (SAfMA) is one of the sub-global assessments of the Millennium Ecosystem Assessment. SAfMA was undertaken at three scales in a fully nested design. Each scale was assessed by one or more assessment teams and aimed to address needs of different sets of users. The regional scale assessment, covering all the land in Africa south of the equator addressed the needs of the Southern African Development Community (SADC). Nested within the regional assessment, were basin-scale assessments that covered two of the major drainage basins (the Zambezi and Gariep). These assessments targeted at the needs of governments and other agencies from the southern African countries spanning the basins. Nested within the basins were several "community-based" studies, which were typically at the scale of a village, city, or even a broader eco-region. These incorporated conventional scientific data as well as informal local knowledge. These "local assessments" catered directly to the interests of local authorities and communities. Each assessment comprised a team of researchers, and SAfMA had a total of five assessment teams based at different institutions in the region. The assessment teams were interdisciplinary and were made up of scientists based in Lesotho, South Africa, Malawi, Mozambique, and Zimbabwe. The teams met regularly in order to ensure integration across scales and between assessments.

SAfMA engaged with different stakeholders at the different levels and addressed their needs in a variety of ways; these ranged from the appointment of advisory and users groups who were involved in intensive workshops to resolve issues of mutual concern. The two-tier SAfMA governance system comprising the Advisory Committee (AC), representing regional stakeholders, and the Technical Committee (TC), made up of the leaders and team members of the five assessments, ensured continuous dialogue between stakeholders and scientists carrying out the assessment.

Some of the major lessons learnt during the assessment process include:

- The importance of allocating sufficient resources and time for user engagement during sub-global assessments. Our experience was that user engagement becomes more intensive and costly the more localised the user groups were.
- It is also important that a multi-scale assessment should include at least one level between global and local assessments. The closer the scale of this additional selected level can be matched with administrative boundaries and data availability the better.
- The importance of an independent advisory committee to advise the technical team and to resolve issues that emerge from a multi-team and multi-disciplinary assessment was also repeatedly underscored in this study.
- That fully nested integrated studies require careful planning and integration from the beginning and should not rely on integration after all assessments are complete.

Assessment and Empowerment

Manoj Nadkarni, CERNA, France; **Malavika Chauhan**, Jawaharlal Nehru University, India
Session 2.1

Indigenous knowledge around the world is based on prevailing cultures, worldviews, and paradigms. Initially assessments involved simple collection and inventory with little attention paid to the environment or to interrelationships between different components of the system. Especially when undertaken in areas where access was difficult such assessments more often than not resulted in loss and damage to the local environment, as well as changes in local customs and socio-economic structure. Over time, however, assessment techniques have evolved to the point where a great deal of importance is paid to treating indigenous cultures sensitively and to controlling ecological damage. This sensitivity often arises from a fear that knowledge may be lost if the locally prevailing worldview is disturbed in any way, and this factor unfortunately, in many cases, supersedes any other interest in the cultures concerned.

This paper, by making overt the biases inherent in assessments, shows that impacts on the local community—ranging from the loss of local customs, rituals and practices to the loss of local knowledge—cannot be avoided if principles of democracy, equity, and non-sexist development are to be adhered to. It will examine recent studies involving women in biodiversity conservation, since the view of women as keepers of the local environment and ecology is common in present community development thinking. Although this thinking has good intentions, it may assign a value to women's labor that is restrictive in terms of gender roles and direct women into activities that enforce gender discrimination.

Social Networks for Ecosystem Management: A Case Study of Kristianstads Vattenrike, Sweden

Per Olsson, **Lisen Schultz, Carl Folke,** and **Thomas Hahn,** Stockholm University, Sweden
Session 4.3

Since change and uncertainty are inherent characteristics of social-ecological systems, ecosystem management needs to be a flexible, learning-based, and information-intensive process. Social structures are needed to facilitate information flow in order to create feedback loops at different scales in society that match the scales of ecosystem processes and dynamics. This study investigates the role of organizational networks to create such feedback loops, including monitoring and interpreting signals of ecosystem change, sharing information, and adjusting management practices and associated institutional and organizational structures accordingly. Since members of such networks often come from different backgrounds (for example, local resource users, researchers, and managers) they have access to different sources of information. In this way, different knowledge systems can be combined in the management of ecosystem services and social networks can be the mechanisms through which knowledge becomes practice.

We identify a diversity of networks involved in the management of a range of different ecosystem services in the lower parts of the Helge River basin, southern Sweden, an area which is part of the Swedish Sub-global Millennium Ecosystem Assessment. We investigate the mechanisms that sustain these networks and information flows. We analyze whether or not the ecological knowledge and associated management practices among members of these networks have the potential to maintain the capacity of ecosystems to sustain a flow of critical ecosystem services. Furthermore, we analyze the role of stewards for monitoring and interpreting signals of ecosystem change, sharing information, and improving management practices and associated institutional and organ-

izational structures. We show that social networks play an important role in adaptive co-management of ecosystems by facilitating information flow, learning processes, and adaptation to ecosystem change. Further, organizational networks can promote social learning, combine different knowledge systems, and increase the capacity to manage dynamic social-ecological systems, including uncertainty and change.

Ecosystem Services and Human Well–being: A Participatory Approach to Research in Sistelo

Elvira Pereira, Technical University of Lisbon, Portugal; and **Cibele Queirós**, University of Lisbon, Portugal
Session 14.2

The participation of the community in the diagnosis of well-being and life conditions is nowadays accepted as essential, as it captures aspects that conventional analyses tend to ignore. Well-being is multidimensional, dynamic, complex and specific in character. In addition, well-being is linked to an interlocking set of factors which reinforce each other and that are difficult to understand by outsiders. This demands a local diagnosis and makes it necessary to listen to the communities being studied. In-depth local research is important to understand the processes that affect human wellbeing as well as to understand the behaviours of the community. However, policy makers have traditionally supported their decisions with technical and "scientific" knowledge, disregarding people's perceptions, priorities, needs and knowledge. Today, there is in fact recognition of the value of traditional knowledge, and although the "scientific" knowledge is important, it should be complemented with information directly provided by the community, using participatory methods.

This paper presents the initial results of a participatory approach to research on human well-being in Portugal. The research is being conducted at Sistelo, Arcos de Valdevez, Portugal, within the framework of Portugal's MA Sub Global Assessment. The first stage of this study ran from November 2003 to March 2004. Its main goals were: (1) to define and characterize human well-being as perceived by the community in Sistelo; and, (2) to assess the community perception about the links between ecosystem services and community well-being. A range of tools from Participatory Rural Appraisal and Rapid Rural Appraisal and other field methods were employed, such as direct observation, familiarization and participation in activities, semi-structured interviews, well-being ranking, scoring, trend lines, and problem ranking. The utility of this approach is that it will allow us to bridge different kinds of knowledge, fill in information gaps, and improve global and local knowledge to better inform decisions taken by different stakeholders, including the community.

Integration of Scientific and Traditional Knowledge in the Protection of Sacred Sites in the Russian Arctic

Tatyana Petrova, Ministry for Natural Resources of the Russian Federation, Russian Federation; **Tamara Semenova,** Russian Association of Indigenous Peoples of the North (RAIPON), Russian Federation
Session 2.2

There is a lack of scientific information about the biodiversity of marginal and remote Arctic ecosystems. Yet in the Russian Arctic, the share of protected natural areas is relatively high (6-10%) compared to the rest of Russia (2%). But the protection of these vast territories cannot be secured adequately. In this paper, we describe the importance of indigenous and local beliefs and knowledge through the lens of sacred sites. Sacred sites accumulate the local knowledge and cultural values of the Russia Northern communities. In addition, sacred sites are often located within important natural areas with significance for biodiversity conservation. The protection of the sacred sites by indigenous peoples can make a substantial contribution to biodiversity protection in the Russian Arctic. Sacred sites also provide an opportunity to establish environmental and social monitoring by the local community. We also stress importance of the ecosystem management of the sacred sites that could be a vital component of the indigenous community sustainable development.

The Syndromes Approach to Scaling — Describing Global Change on an Intermediate Functional Scale

Gerhard Petschel-Held, Potsdam Institute for Climate Impact Research, Germany
Session 14.3

A dynamic description of global change on an intermediate functional scale on the basis of approximately independent sub-models is elaborated. Sixteen of these sub-models are primarily identified as Hazardous Functional Patterns (HFPs) generating non-sustainable trajectories (Syndromes) of the civilization/nature system. After an "idealistic deduc-

tion" of the main concepts, an iterative procedure—formally based on Qualitative Differential Equations—is now introduced that allows the systematic generalization of case study-based knowledge to obtain consistent HFPs on a coarser functional scale. The method is illustrated with the Sahel HFP.

Hierarchies and Panarchies: Scale (Mis)matches in Ecosystem and Political Processes

Lowell Pritchard, Emory University, United States
Session 4.3

The set of issues raised by hierarchy theory both complexifies and clarifies problems of environmental and social change. The question of scale applies to our observation regime or frame of reference and to the models we build and describes the processes we observe, but it applies most fundamentally to the actual processes themselves, as they occur in space and time. This allows the researcher to probe deeper—to think about why scale breaks in natural and social hierarchies exist, and what the linkages are between scales of processes. The implication is that processes that operate on similar scales, either spatially or temporally, are more likely to have important interactions, and that there may be a fit (or lack of fit) between the dynamics of managed ecosystems and the scales of management. The literature on co-management implies that hierarchies of ecosystem processes necessitate hierarchies of management institutions.

While nested, harmonious systems are the "ideal" prescription for ecological management, with each organizational level corresponding to the scale of important emergent ecological properties, in the real world there are whole levels missing, particularly for meso-level institutions. Salient research would take seriously the historical reasons for such a lack, and recognize that institutional interplay may explain the gaps.

Effective ecological management calls for the ability to monitor local resource use and conditions, to understand and respond to meso-scale processes (fire, floods, soil erosion, etc.) and to respond to global-scale changes that may be occurring over long-time scales. Clearly, no single management system would be able to do this. Bureaucratic, legislative, enforcement, and taxation authority is vested chiefly in the nation-state—precisely the scale of least importance for interacting with natural systems. Given the allelopathic nature of national-level institutions, the capacity at the local level for creating formal management systems is increasingly endangered; and the capacity at international levels under constant threat.

For this reason, the literature on self-organization and spontaneous institutional change and formation (and the attendant opportunities and constraints) is valuable for understanding ecological management. But many scalar properties of social and political systems are not easily (or necessarily) amenable to generalization. To make inferences about what levels of social organizations are most or least vulnerable to capture by special interests, hold the highest degree of legitimacy for regulated actors, or offer the promise of novel or innovative answers to ecological problems, is impossible without delving deeply into cases and their histories.

When multiple hierarchies overlap and change over time, as they do in a panarchy, there can be significant interactions when the scales do not match. This is true both for social systems interacting with natural systems at inappropriate scales and for social systems in their coordination with each other. For example, successes in adaptive management in developed world settings may derive as much from the comprehensiveness of managing large, contiguous areas, and from the administrative capacity of the bureaucracies overseeing them, as from the approach itself. International environmental and development NGOs are an example of a particular theoretical conundrum in scalar terms because of the way they juxtapose global value systems with very local management systems, and do so in a direct way, often without mediation by national-level institutions.

Where management systems interact across levels of organization, the varied local forms that are (supposedly) adapted to heterogeneous local conditions may restrain the level of possible cooperation. Again, the very strengths of localities and centralized authorities are, in general, in opposition to each other. A variety of locally-adapted systems in institutionally heterogeneous developing countries creates administrative nightmares for centralized bureaucracies, where one expects the values of standardization and generalization to be pre-eminent.

And finally, where there are multiple hierarchies that touch on ecological management, not all have ecological management as their mandate. Some bureaucracies will touch ecological systems only peripherally, and only at some scales. Ecological problem solving becomes a struggle to focus attention on a particular problem, to create an epistemic community to meet the exigencies of a particular crisis.

Linking Traditional and Scientific Knowledge Systems on Climate Prediction and Utilization

Rengalakshmi Raj, M.S. Swaminathan Research Foundation, India

Session 11.2

Traditionally, farmers have used traditional knowledge to understand weather and climate patterns in order to make decisions about crop and irrigation cycles. This knowledge has been gained through many decades of experience, and has been passed on from previous generations. The knowledge is adapted to local conditions and needs. However, increasing variability in climate has reduced farmers' confidence in traditional knowledge and has led them to seek out scientific weather forecasts. These scientific forecasts are formulated at a much larger scale, diverging with local needs.

This paper discusses a project initiated by the M.S.Swaminathan Research Foundation that focuses on integrating scientific and local knowledge on climate by developing localized climate and weather systems at the village level. The project strives to bridge two different knowledge systems by following a multi-stakeholder participatory approach. The project includes information sharing and training programs designed to build the capacities of women and men farmers in the use of forecast information. The selected villages have computer-based "Village Knowledge Centers," in which a central "hub" receives the more general scientific information and adds value to it by converting it to local specific information. The local farmers manage the Village Knowledge Centers; access is ensured to all irrespective of caste, class, gender, and age. The paper shows how linkages were made between the farming communities and government agencies, and chronicles the needs, constraints, and opportunities of this type of approach to bridging different forms of knowledge across scales.

Multi-scale Integrated Analysis of Societal Metabolism: Learning from Trajectories of Development and Building Robust Scenarios

Jesus Ramos-Martin, Istituto Nazionale di Ricerca per gli Alimenti e la Nutrizione (INRAN), Italy

Session 11.4

The paper presents two applications of Multi-scale Integrated Analysis of Societal Metabolism. The first is related to the recent economic history of Ecuador and Spain, and is therefore an application to learn from past trajectories of development. Understanding the relationship between the Gross Domestic Product (GDP) and the throughput of matter and energy over time in modern societies is crucial for understanding the biophysical and economical constraints implied by the parallel evolution of the different hierarchical levels of an economy as seen as a nested hierarchical system. It is also crucial for contrasting the behaviour of economic systems in terms of raising the material standard of living of their populations and in terms of the associated environmental impact; that is, for checking the congruence of the development scenarios. The second application, on the other hand, uses MSIASM for scenarios analysis. The goal of this example is to illustrate the mechanism through which MSIASM can perform a quality check on future scenarios of economic development, helping us to build robust scenarios. To do that, MSIASM is applied to check a set of hypotheses of economic development for Vietnam in the year 2010. Since MSIASM approach handles simultaneously both economic and biophysical characteristics, when characterizing a given scenario these characteristics must result congruent with each other in the non-equivalent representations across levels. In this way, it becomes easy to detect those scenarios in which the expected economic performance (= the set of economic characteristics associated to a given goal of development) is not consistent with the possibility of establishing the relative biophysical characteristics.

Application of the "Public Domain" to Indigenous Knowledge and Western Scientific Knowledge

Margaret Raven, United Nations University, Japan

Session 14.5

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An examination of the "public domain" and "public-private" dichotomies as it relates to indigenous traditional knowledge and cultural expressions, biodiversity conservation and genetic resources can help to highlight some of the broader issues surrounding the debate over the divide between indigenous knowledge and western science. The focus of this paper is an exploration of "public domain" and "public-private" dichotomies as a way to understand both conflicts between indigenous and western science knowledge systems and conflicts that indigenous peoples experience when attempting to both share and restrict access to indigenous traditional knowledge and cultural expressions.

Indigenous traditional knowledge and cultural expressions is considered a valuable product. Its use being visible in the cultural industries, scientific re-

search, pharmaceutical ventures, and biodiversity conservation. In western theoretical concepts of knowledge and property, indigenous traditional knowledge has been classified as ”public domain” knowledge. Indigenous peoples experience tension over the use and sharing of our knowledge, and thus difficulties with western intellectual property regimes and the notion of the ”public domain”. Indigenous peoples sit in a precarious position—the need to protect and conserve our knowledge as a cultural expression—and for some the desire to share knowledge of ecological and medical importance. One element of this accepts the notion of intellectual property rights and hence the enclosure of the ”public domain”, the other element of this rejects the notion of intellectual property rights and hence advocates for the expansion of the ”public domain”. Thus, disputes over the use of knowledge and information, including indigenous traditional knowledge and cultural expressions, arise because of different understandings of what knowledge is and how it should be used, and over what constitutes ”public domain” knowledge.

This presentation/workshop explores the boundaries and contours of the ”public domain” as it relates to indigenous traditional knowledge, biodiversity conservation, and genetic resources. It does this in three steps. Firstly, by looking at some of the working definitions of the ”public domain” used by international organizations such as the World Intellectual Property Organization (WIPO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the United Nations Convention on Biological Diversity (CBD). Secondly, outlining some of the critiques of these definitions put forward by indigenous peoples. And, thirdly, through the use of cultural theory, the notion of the ”public domain” and knowledge boundary conflicts are explored as public-private dichotomies in order to outline alternative ways of viewing conflicts over knowledge.

Throughout the presentation/workshop, I argue that a re-definition of the ”public domain” that respects and reflects indigenous traditional knowledge sharing and management regimes is required. Such a re-definition may alleviate conflicts over the use of indigenous traditional knowledge and cultural expressions by cultural industries, western scientific researchers, pharmaceutical companies, and biodiversity conservation organizations.

Bridging Scales and Epistemologies in the Millennium Ecosystem Assessment

Walter Reid, Millennium Ecosystem Assessment, Malaysia

Block 1 Plenary Presentation

In response to lessons from previous international assessments and in recognition of unique features of an ecosystem assessment that are unlike previous global assessments of climate and ozone, the Millennium Ecosystem Assessment was designed as a multi-scale assessment and has established mechanisms to incorporate information and knowledge from non-peer-reviewed sources including local and traditional knowledge. This paper describes the basic multi-scale and multi-epistemology features of the MA and the rationale for those features, but focuses on the challenges being encountered in their implementation and begins to identify lessons that could be applied in future assessments. In particular, the paper explores: (i) the definition of scale within the MA, noting that the distinguishing features of the different scales of the MA appear now to involve principally the scale of authority of the users of the assessment rather than the scale of analysis; (ii) mechanisms to overcome barriers to effective cross-scale interactions among assessments; (iii) the fundamental challenge of undertaking an assessment that is viewed as credible, legitimate, and salient in different epistemological contexts; and (iv) the tensions—as well as complementarities—that exists between “getting it right” (as through the creation of a multi-scale, multi-epistemology, multi-sectoral assessment) and “making it relevant” (as, for example, to traditional single-scale, single-epistemology, single-sector users).

From Epistemic Monoculture to Cooperation between Epistemic Communities – Development Research and Sustainability

Stephan Rist, **Urs Wiesmann**, and **Anne Zimmermann,** University of Berne Switzerland

Session 2.1

Sustainability-oriented development research aims to contribute to reshaping current relations between ecology, society, and economy as part of a social learning process. This requires that the role of science be redefined as part of a societal form of knowledge production. This process is based on an integration of scientific and other forms of knowledge, especially so-called ”local knowledge”. Differ-

ent forms of knowledge are rooted in different epistemologies. It is therefore necessary to define a strategy for creating a common ground and space for cooperation between different epistemic communities. The first step of such a strategy consists in recognizing that there is no objective relationship between science and local knowledge. Science either (1) ignores local knowledge, (2) uses it where information conforms with its own epistemological criteria, (3) has a paternalistic attitude towards it, or (4) engages in an intercultural relationship with the ”owners” of local knowledge systems. In order to achieve cooperation between different epistemic communities, it is necessary to re-contextualise the process of knowledge creation within the framework of concrete societal values.

This leads to a second step consisting in assimilating the consequences of a shift from a science-based to a societal model of knowledge production. This implies the need to recognize that social learning processes can only take place if knowledge of how natural or social processes are happening is combined with knowledge of the reason why and for what purpose they take place. If the latter is lacking, knowledge about how things happen remains meaningless, as it does not take into account the value system(s) within which the processes are embedded.

The third step consists in epistemological self-reflection by the epistemic communities involved, in order to identify similarities and contradictions between their knowledge systems: many local knowledge systems apply a phenomenological approach to explain why and for what purpose natural, social, and cultural phenomena take place. By assuming that nature, human beings, and spiritual entities form a living organism, phenomena are contextualised within the perspective of a meaningful universe assuming that mind is linked to matter. Such systems constitute solid ground for defining action guided by ethical values. By contrast, science usually focuses more on how processes and elements interact, in order to explain the mechanisms of processes and phenomena. Ethical aspects are relegated to the subjective sphere of life, which is defined as not pertaining to scientific knowledge assuming that mind and matter are not directly linked (dualistic worldview). This leads to decontextualised description of phenomena.

The fourth step consists in creating space for constructing common epistemological ground beyond preconceived epistemological positions. We argue that two trends should be interrelated more systematically. One relates to the fact that science is becoming increasingly interested in analyzing why the world is such as it describes it. “What for” questions are thus becoming more important. On the other hand, science observes that local knowledge is being used and reproduced by its owners in an increasingly reflective and less imitative manner. By bringing together these two trends, those involved can submit the presuppositions of the epistemic community of science to critical revision and help create and strengthen epistemic communities within the actor categories of local knowledge holders, enabling them to engage more as peers in a dialogue and cooperation with scientific epistemic communities. Against this background, we argue that the main difference between science- and local knowledge-based epistemic communities are representing worldviews with different starting points within a mind-matter continuum. Concrete examples of the heuristic, technical, and practical potentials of intercultural cooperation will be explored based on examples from geosophy, alternative medicine, agriculture, ecology, physics and analytical philosophy.

Steps towards a Post-materialist Science: Lessons Learned from Endogenous Development in Europe

Stephan Rist, University of Berne, Switzerland
Session 11.3

Sustainability-oriented development research aims to contribute to reshaping current relations between ecology, society, and economy as part of a social learning process. This requires that the role of science be redefined as part of a societal form of knowledge production. This means to integrate science and so-called ”local knowledge”. Local forms of knowledge cover a wide range of issues related to organic and biodynamic agriculture, complementary medicine, solidarity-based economy, and currency systems. Science and scientists are playing an important role in these movements. But by bringing science into a process of social change, science becomes transformed from a disciplinary towards a transdisciplinarity framework of orientation.

A major feature of this transformation is represented by openness towards the revision of materialist theory of cognition. There is a growing strain of research done in the context of alternative movements, which directly and indirectly show that excluding ”a priory” a mind-matter relationship is not more then one option among others. Analysing examples from organic agriculture, complementary medicine, alternative economics, biology, physics, and philosophy are allowing to devise a new under-

standing of the role and content of science in society. It can be labelled as an emerging post-materialist science; main features in regard to its epistemology, methodology, and integration into processes of social change will be discussed.

Bridging Scales: Lessons from the MA Sub-global Assessments

Jeffrey Romm, University of California at Berkeley, United States
Block 13 Plenary Presentation

The human organization of environmental services – and the ecological generation of these services – necessarily operate at different scales of system, and their needs and opportunities for self-stabilization often conflict with one another. This paper addresses causes and consequences of disparity in scale between human and ecological processes, and the forms of relationship between differently-scaled human and ecological systems, that may increase complementarity between them. Of particular interest are relationships through which mutually stabilizing interactions are likely to occur despite very different sources and vulnerabilities to threat.

Scale, Knowledge, and Space: Spatial Organization of Environmental Knowledge in Northern Thailand

Robin Roth, Clark University, United States
Session 14.1

Managing forests for their satisfactory provision of multiple goods and services to both the global and local commons requires effective cross-scale cooperation between local management institutions and state management institutions. Integrating distinct knowledges produced and employed at the two scales of management has proven very challenging. This paper illuminates how a better understanding of the spatial expression of knowledge operating at distinct scales can help lead to a more fruitful integration of local knowledge and practice with state knowledge and practice. After a critical review of the literature pertaining to environmental knowledge, this paper examines the links between the production of knowledge and the production of space within resource management institutions. It then explores the linkages between scale, knowledge, and space using a case in Chiang Mai Province, Thailand, where government foresters are meeting resistance in their attempts to establish a National Park and pilot a model for sustainable land use. The paper identifies moments of convergence, compatibility, and conflict between local and state management institutions and argues that scholars and practitioners need to examine epistemological differences, along with their spatial expression, in order to create a preferable organization within which environmental goods and services for both the global commons and the local population can be met.

Overcoming Asymmetrical Power Relations: The Challenges for Epistemological Integration

Marie Roué, Director of Research, Centre National de la Recherche Scientifique/Muséum National d'Histoire Naturelle, France
Block 3 Plenary Presentation

During the last 15 years, the value of indigenous and local knowledge for biodiversity conservation and impact assessment has gained increasing recognition in international conventions and fora. However, as asymmetrical relations of power characterize these arenas, can indigenous peoples make themselves heard?

When indigenous peoples are present in international arenas, they are constrained not only to speak in languages that are not their own, but also to adopt coded ways to talk about themselves that have been forged to a large extent by others. What limits and constraints are imposed by this obligatory adoption of representations that are at odds with one's own? Is it better to fulfill oneself the mediator role between your culture and the outside world? Or to let others, NGOs in particular, manage this difficult 'translation'? We fear that a proliferation of half-hearted references to traditional knowledge by western bureaucracies might constitute a major threat to its continuing vitality and transmission.
Our second point will turn towards the epistemology of science. Already within western science, rival theories resist comparison because they are incommensurable and convey different conceptual schemes that can only be understood from within. Yet here we are attempting the even more ambitious project of coupling western science with other systems of knowledge. Using both philosophy of science (Kuhn and Quine) and anthropology, we propose a first exploration of the barriers and potential for communication between different knowledge systems.

Turning to a specific case study, we consider an

attempt by the Cree First Nations of James Bay (Canada) to transmit their ecological knowledge in the context of an environmental impact assessment of hydroelectric dams on their territory. Given the exactitude and amplitude of Cree knowledge, as well as its holistic and interdisciplinary nature, we discuss the conditions that allow its expression, presentation and successful application in this 'foreign' context. To conclude on a positive note, we consider whether a new path may be emerging based upon novel concepts such as 'technical democracy', 'hybrid fora' and 'dialogic processes'. Conflicts between citizens, experts and politicians over the last twenty years have laid the groundwork for a new epistemology based upon a more democratic relationship between sets of knowledge. Conflicts over GMOs or the underground storage of atomic waste have transformed the relationship between scientific and profane experts. Rather than once more engaging in a demagogical process of environmental education for the masses by « those who know », these actors have elaborated together new questions, which are at once scientific, technical and societal. Perhaps these new fora offer a ray-of-hope for a mutually productive dialogue between western science and other knowledge systems.

Tibetan Ethnobotany and Gradient Analyses: Menri (Medicine Mountains), Eastern Himalayas

Jan Salick, Missouri Botanical Gardens, United States; **Danica Anderson**, **Jessica Woo**, **Ruth Sherman**, **Norbu Cili**, **Ana Dorje**, **and Sonam Dorje**

Session 6.3

Menri or Medicine Mountains of the Eastern Himalayas (transliterated as Meili Snow Mountains, NW Yunnan, China) is the traditional source of many Tibetan medicinal plants, with many local Tibetan medicine practitioners. Within these mountains, Kawa Karpo, the second most sacred mountain in Tibet, is the site of this study. We ran two transects from the upper Mekong River (2000m) up the mountain, to the upper vegetational reaches (5000m); one transect had northern aspect and one southern. Every 200m along the transects, we sampled trees >10cm dbh in 5 random100m2 quadrats and all vegetation in 3 1m2 quadrats within each larger quadrat. Results demonstrate that elevation is the predominant vegetation and ethnobotany variable, with aspect and slope secondarily affecting plant species and distributions. Useful plants follow overall patterns of biodiversity as previously shown on Mt. Kinabalu, Borneo, although specific plants are associated with specific vegetation zones. Notably, highest richness (S) and biodiversity (H) are found in alpine meadows with secondary peaks in lower elevation dry scrub, while some mid-elevational areas with higher tree diversity and richness have lowest overall species diversity and richness (possibly due to shade and acidity). Tibetan doctors co-authoring this paper stress the importance of all habitats for Tibetan medicinal, cultural, and economic stability. Joining our epistemologies, we conclude that biodiversity conservation is crucially linked to sustainable use of natural resources used by local Tibetans.

Global Responsibility and Local Knowledge Systems

Datu Victorino L. Saway, Talaandig School of Living Traditions, Philippines

Session 2.1

Local communities are equipped with knowledge systems that have enabled them to survive for generations, as well as form the foundation for the social, economic, political, and spiritual conditions of their cultures and identity as peoples. This paper will discuss framework of local knowledge and the concept of global responsibility according to the cultural perspectives of the local Talaandig people of Bukidnon, Mindanao Island, Philippines. In the Talaandig community, knowledge is explained through the framework and structures of the earth, the human body, the family, the community or tribe. These structures are called "Agpangan". Knowledge defined through the Agpangan can be expanded horizontally or vertically from a simple to a complex idea or situation. I present the idea that local communities bear the responsibility to explain the significance of their unique cultures in a similar manner to which global science explained itself to the common mind. I argue that the link between local knowledge and global science is common sense, and show how common sense enables the Talaandig community to account its responsibility to the family, the community, and the world. Common sense can in the same way serve as the link between local knowledge and global science.

Ecosystem Management by Local Steward Associations – A Case Study from "Kristianstads Vattenrike," the Swedish MA

Lisen Schultz, **Per Olsson**, **Åse Johannessen**, and **Carl Folke**, Stockholm University, Sweden
Session 10.2

Recent research indicates that involvement of a diversity of stakeholders in ecosystem management may be beneficial in many respects. Management plans that involve local resource users and stewards create stronger incentives for ecosystem management in the community. In addition, local ecological knowledge in steward associations can provide unique information about local conditions and ecosystem dynamics.

In this study, which is part of the Swedish subglobal Millennium Ecosystem Assessment, we have carried out a social inventory of local steward associations in the lower parts of the Helge River basin, southern Sweden. Instead of making inventories of biodiversity and key habitats, we assess ecosystem services and existing management systems behind these services. We identify steward associations in the landscape, key individuals in these associations, their ecological knowledge and their management practices. We analyze the potential contribution of the associations to adaptive co-management in the area.

The assessment reveals a rich diversity of steward associations that manage a range of ecosystem components. It also reveals local ecological knowledge among the members of these steward associations considering species and their biology, ecological processes and functions, and how ecosystems are linked across scales. For example, farmers contribute to bird habitats and other wetland services by letting cows graze by the river shore, forest owners apply management practices that support the ecological functions of the forest, hunting and fishing associations improve habitats for fish and game, and village associations maintain management practices that enhance biodiversity. Furthermore, the Bird society of NE Scania, the local branch of the Swedish Society for Nature Conservation and The World Wildlife Fund contribute by engaging people in the landscape in monitoring, management and conservation of ecosystems and their services. A municipality organization, the Ecomuseum Kristianstads Vattenrike (EKV), coordinates many of these efforts in a shared vision. This coordinating team provides an ecosystem approach, builds on local knowledge and engagement and links efforts to higher scales.

Designing ecosystem management based on social-ecological inventories has the potential of improving the management system. Local steward associations could provide long-term, close monitoring of ecosystem changes, local ecological knowledge, and improved links across scales, especially to landowners and other local inhabitants. They are therefore important in adaptive co-management systems. It is concluded that a coordinating team like the EKV can facilitate such processes.

Implications of Conducting Local-level, Participatory Ecosystem Assessment and Management in Nation with a History of Centralized Decision-making

Cristiana Simão Seixas, Brazil
Session 14.1

Natural resources and ecosystem management is often a product of institutional interactions across different political scales. The need to bring together local ecological knowledge and scientific knowledge for resource and ecosystem management has been well stressed in the past decade, especially after Rio '92 conference. As a result, the discourse of participatory management has been incorporated in several government policy agendas. In many cases, however, particularly in centralized political system, higher-level government organizations propose ways of combining local and scientific knowledge based on theoretical models extracted from scientific literature or based on experiences of successful case studies elsewhere, without taking into account socio-cultural differences among localities. Hence, in nations with a history of centralized decision-making, several problems arise in trying to implement local-level, participatory research and management. For example, to what extent are policy-makers prepared to accept local knowledge as a credible knowledge system that may complement scientific knowledge? To what extent are local resource users (used to paternalistic, top-down decision-making) prepared to engage participatory research and management? To what extent are fieldworkers (government and NGO staff, including science-trained researchers) trained to mediate the flow of knowledge between bureaucrats and resource users or to accept different understanding of ecosystem dynamics? There is a huge gap between theory and praxis in conducting participatory research and management in the field and in combining local and scientific knowledge across political scales for ecosystem assessment.

The aim of this paper is to identify some of the

driving forces that enable or impede local level ecosystem assessment in a nation with a history of centralized decision-making, such as Brazil. For this purpose, I analyze three case studies of participatory fisheries management, based on government—or NGO-driven initiatives in different regions of Brazil (a northeast reservoir co-management fisheries, the Lagoa dos Patos Forum, and the Arraial do Cabo Marine Extractive Reserves—examples extracted from the literature) and a Brazilian initiative of conducting local-level ecosystem assessment (the Ibiraquera Lagoon project—in which I am involved). In particular, I intend to answer some of the following questions: What are some of the barriers faced by users in engaging a local-level ecosystem assessment (participatory research) and participatory management as proposed by the MA? What are some of the major problems fieldworkers (government or NGO agents) face in trying to implement participatory research and management where there is no tradition of such an approach? What role has nested institutions played in combining local and scientific knowledge to improve policy at a higher scale? How does higher-level institutional rigidity or flexibility impede or enable knowledge flow (both local and scientific) across scale? How have these and other experiences contributed for creating new arenas for cross-scale institutional management, and for networking experiences and capacity-building nationwide?

The Role of Knowledge in Sustainable Development

Ismail Serageldin, Biblioteca Alexandrina, Egypt
Block 1 Plenary Presentation

Sustainable development is about giving to future generations as many opportunities if not more than we have had ourselves. Striking the right balance between use of resources and their depletion, co-existence with the rich and diversified range of organisms with which we share the planet, and dealing with the pollution effects of the unavoidable economic activities undertaken by humans, all require the gaining of knowledge about nature and her processes and the delicate web that links our ecosystems and ourselves. This knowledge makes it imperative that the best science be deployed to address the challenges of the global environment as much as the local issues that impact so directly on people's lives. The scaling up of the local to the global requires special knowledge and understanding.

At the start of the 21st century, three forces give grounds for cautious optimism that some of the negative trends of the late 20th century can be reversed, namely:

Knowledge and the scientific community: Better understanding of the mechanisms and true importance of long-term issues such as climate change, and the interlinked nature of environmental processes. The MA is a prime example of this area of achievement.

Knowledge and the productive sectors: The shift towards the knowledge-based economy which is invariably much less resource intensive, and the gradual introduction of biologically-based processes which are more efficient and less polluting than the basically mechanical and chemical processes that dominated the second half of 20th century production.

Knowledge and the public at large: A public awareness about environmental issues and the desirability of adopting sustainable development paths based on knowledge provided by the scientific and environmental movement creates a climate within which difficult political decisions can be made.

Self-organizing Maps for Integrating Environmental Data across Multiple Scales

Subana Shanmuganathan, **Philip Sallis**, and **John Buckeridge**, Auckland University of Technology (AUT), New Zealand
Session 2.3

In this paper, we elaborate upon a self-organizing map (SOM) application for integrated analysis of local and global data at different scales. The examples illustrate how SOM methods could be used to analyze the correlations within data sets from different sources with inconsistent labeling and limited prior knowledge. Since the 1980s, many researchers have recognized and emphasized interdisciplinary methods for ecosystem modeling. In this paper, we describe how researchers are using intelligent systems based on animal (including human) brain and nervous system structure and functioning to develop approaches and methods to analyze data across multiple scales. Of these intelligent systems, the use of artificial neural networks (ANNs) is seen to produce considerable success. The success of SOM (a connectionist model of ANNs) methods to analyze large amounts of disparate monitoring data sets across different scales is seen as quite significant in modeling complex ecosystems.

We argue that SOMs provide an excellent tool for the visualization of multidimensional data sets and the discovery of correlations within the variables analyzed in the form of patterns and structures. SOMs are two-layered feed forward ANNs with unsupervised algorithmic learning, capable of projecting multidimensional data sets onto low-dimensional displays by a topology preserving mechanism. In many other disciplines, such as industrial engineering and finance, multidimensional, disparate data sets are successfully analyzed using SOMs. For example, the use of SOMs in financial data analysis has enabled analysts to gain useful knowledge on global economic markets. Here, we show how SOM methods could be used to analyze local and global environmental data—as well as the two simultaneously—to help us understand the links and correlations across scales. Data from New Zealand and global summaries are used for this purpose.

Bridging Gaps Between Farmers' and Scientists' Soil Classification: Revisiting the Methodology Used in Documentation and Analysis of Farmers' Knowledge

Pratap Shrestha, Local Initiatives for Biodiversity, Research and Development (LI-BIRD), Nepal; **Fergus L. Sinclair** and **Morag McDonald**, University of Wales, United Kingdom
Session 11.1

Several studies on farmers' local knowledge about soil classification and soil properties have been done across the globe in the past, in which attempts have also been made to correlate such knowledge with scientists' findings of soil classification and soil properties. In a majority of the cases, a great variation in farmers' soil classes has been reported not only between two regions of a country but also between the farmers of the same locality or village. The reason for such variation appears to be largely due to the continuous nature of soil medium as opposed to discrete categories of other farm resources. On the other hand, a good regularity has been found in farmers' explanation or description of soil properties across locations suggesting that, despite difference in terminology used for soil classification, farmers have a good knowledge about the soil properties of different soil classes. However, scientists rarely use such knowledge to establish the scientific basis of farmers' soil classification. As a result, a large variation in farmers' terminologies for different soil classes has always posed a problem for scientist to correlate such local soil classes with scientific soil classification and to establish a common ground and medium for communication between farmers and scientists. The experience of a recent study in the Middle Hills of Nepal shows that, with the use of an objectively structured framework, a more systematic farmers' soil classification can be obtained that not only confirms with the scientific soil classification but also generates a common farmers' soil classification across locations as well as between farmers. It is important to understand a broader context of local terminology about soils, beyond identification of the labels used for different types, in order to learn about local soil classification and discern regularities across locations as well as local particularities. Getting the methodology is, therefore, important in order to bridge gaps between farmers' and scientists' soil classification and facilitate integration of local knowledge into global scientific assessment.

Knowledges and Legal Reform in the Sahel: Linking Traditional and Modern Natural Resource Management Legal Regimes Horizontally and Vertically Through Use of ICTs

Lars. T. Soeftestad, Supras Consult, Norway; **Hans-Werner Wabnitz,** The World Bank, United States
Session 10.1

The paper describes a research-cum-action Initiative in Mauritania, Technology Fosters Tradition (TFT; www.cbnrm.net/webhosting/tft/), a radically new approach aimed at sustainable management of the Sahelian environment through empowering local people to transform the present exploitation of natural resources.

The Sahelian region can be characterized as follows: (i) rapid degradation of the flora and fauna, (ii) the public sector is unsympathetic to effective environmental protection, (iii) legal systems are dysfunctional, and (iv) there are increased levels of conflict between ethnic groups and between pastoralists and farmers.

The Initiative takes the following as points of departure: (i) the economic and cultural survival of people in the Sahel depends upon protecting the environment, (ii) local people know the traditionally recognized land use patterns, (iii) some behavior needs to be changed in light of recent environmental degradation, (iv) traditional management has been corrupted by government intervention, and (v) changes in culturally embedded behavior will be

achieved only voluntarily.

TFT's approach to addressing and resolving these problems lies in identifying and addressing the needs of the local people. The Initiative starts with assessing local practices, tracing and fixing them on maps, and screening for environmental effects. Required changes in use patterns will be negotiated until a consensus agreeable to all parties is reached.

These negotiated behavioral rules will be consolidated in regulations which are: (i) formulated by local people, (ii) written in local dialects, (iii) clear, short, and succinct, stating purpose and policy; (iv) simultaneously drafted in the official languages of the country, revised and edited in an itinerant process with the input of experts, and (v) conform to the objectives of international environmental conventions. The texts will be archived in the Official Gazette and on the Internet and also affixed on GIS-centered geographic maps. The process constitutes a legal reform that gives priority to customary law over transplanted law, thus establishing the basis for a convergence between the actual behavior of the population and the laws and regulations intended to govern such behavior.

Several, partly new approaches and tools will be used. They include: (i) specific biotopes will be governed by specific regulations, (ii) GIS and the Internet will be used to record laws and constitute the foundation for a modern land-registry with traditional use-right descriptions, and (iii) community-driven and co-management policies at the communal level.

Located at the intersection of several legal regimes, including French civil law, Islamic law, and traditional customary rules, the Initiative aims to systematize and integrate these legal regimes on the local, national, and international levels. This will be facilitated through extensive use of modern Information and Communication Technologies (ICTs). The epistemological aspects of aligning different bodies of legal knowledge, across a spectrum of cultures and ethnic groups as located on different societal levels by means of traditional and modern ICTs, is a case of trial and errors, which will provide useful insights and lessons for the future of similar progressive legal reform efforts elsewhere in the Sahel and beyond.

The partners are: GLIN - The Global Legal Information Network (www.loc.gov/law/glin/), GTZ (www.gtz.de), NASA (www.nasa.gov), and the World Bank (www.worldbank.org).

Local Knowledge, A Viable Way of Life: A Case Study Based on Experience from the Sinai Peninsula, Egypt

Mohamed Tawfic and **Manal Hefny,** Suez Canal University, Egypt
Session 2.4

The Sinai Peninsula, located between the Nile Valley in Africa and West Asia, is one of the main heritage sites of mankind, embracing a unique collection of sacred shrines and ecologically valued landmarks. The Sinai is extremely ecologically diverse as a result of its location as a land bridge connecting Africa and Asia. It encompasses arid, coastal, mountainous, wetland, and agricultural ecosystems, each with its own characteristics, including different sets of ecosystem goods and services. Because of its history rather than its capability, Sinai is principally inhabited by Bedouins. Most of the Bedouins migrated to the Sinai from Najd and Hejaz in the Arabian Peninsula soon after the Arab conquest of Egypt, although some are thought to have originated from Europe and brought to the region by the monks of St. Katherine monastery, located in south Sinai.

Sinai Bedouins are a special sect of the Egyptian community with a very distinct culture. Their local knowledge is an integral part of their existence and livelihood. Such knowledge systems are cumulative and represent generations of experience, careful observations, and trial and errors experiments. The development of local knowledge systems covering all aspects of life, including management of the natural environment, has been a matter of survival to the peoples who generated these systems. All members of the Bedouin community have traditional knowledge: elders, women, men, and children. The quality and quantity of local knowledge possessed by individuals varies as a result of such factors as age, education, gender, daily experience, outside influences, roles, and intellectual capability.

Local knowledge is increasingly recognized as one of the major powers influencing ecosystem management and Sinai is no exception. In Sinai, local knowledge played a vital supportive role in Bedouins' lives, particularly with regards to management of agrodiversity, water and drought management, folklore medicine, and crop production.

The importance of local knowledge is particularly apparent during the times of crisis that the Bedouins have experienced, such as war and political conflict. The present paper sheds some light on the roles of local knowledge among these people.

Cross-scale Assessment of Biodiversity: Opportunities and Limitations of the Natural Capital Index (NCI) Framework

Antoni Tekelenburg and **D. van Vuuren**, National Institute of Public Health and the Environment, Netherlands; **Rik Leemans**, Wageningen University, Netherlands; **Ben ten Brink**, Netherlands Environmental Assessment Agency (RIVM), Netherlands
Session 6.2

Biodiversity depletion is a local process and species extinction rates depend on the size of area under study, but it is certainly taking place worldwide. Underlying causes of biodiversity loss are a mix of global, regional, and local pressures, such as climate change, pollution and land use change. Although many efforts have been undertaken to assess the condition and trends of species biodiversity by focussing on one specific geographical level, less attention has been given to the integration of biodiversity assessments simultaneously carried out at different scales. Without the knowledge of cross-scale interactions between causes and consequences, biodiversity loss is difficult to understand. The expectation is that complementary information between scales may increase knowledge and improve decision-making processes.

Neither a major experience nor an international-accepted methodology of integral biodiversity assessments that focuses on links between scales, could be found in literature. However, from recent modelling and indicator development, lessons can be learned; being the basis of experimental learning by doing. The Natural Capital Index (NCI) framework was taken up for this purpose. It was developed by the Dutch National Institute for Public Health and the Environment (RIVM), with the aim to support the SBSTTA-CBD panel on biodiversity indicator development. The NCI has been carried out so far at three levels of space: globally in the *Global Environmental Outlook 3*, regionally in Europe, and nationally in the Netherlands. The systematisation of the experience, which consists of a participatory methodology for looking back into what happened, offers the route to answering the question—wheter the conceptual framework of the NCI is able to integrate effectively the results of biodiversity assessments at different geographical, temporal, and institutional scales. Integration is here referred to linkages of pressures variables and impact measures between scales as well as stakeholder involvement in learning processes.

In this paper, special attention is given to limitations and opportunities of the NCI methodology, possible pitfalls for general cross-scale biodiversity assessment, and suggestions for methodology. We will start with making our choice for concepts of biodiversity change explicit. Then, the NCI is explained briefly. Results of assessments at three levels of space are presented and followed by an evaluation of the NCI framework focussing on integration between scales. Fundamental topics for cross-scale analysis were extracted from literature. Finally, conclusions are drawn for short-term application in global assessment of the Millennium Ecosystem Assessment and for long-term application under the UNEP-CBD umbrella.

Mapping of Management Practices to Address Local Ecological Knowledge — Cross-scale Learning from Cases in Sweden and Tanzania

Maria Tengö, Stockholm University, Sweden; **Kristina Belfrage**, Swedish University of Agricultural Sciences, Sweden
Session 2.4

In the Millennium Ecosystem Assessment, it is acknowledged that human well-being is dependent on the capacity of ecosystem to provide services. In this paper, we apply the hypothesis that management practices based on local ecological knowledge and understanding (LEK, sensu Olsson and Folke, 2001) can enhance the capacity of local ecosystem to serve human needs.

Local knowledge is often practical, tacit, and, thus, difficult to address directly. We present mapping of management practices as an approach to address and incorporate LEK in assessments and management plans for ecosystems. The starting point was a study of practices for agroecosystem management among smallholder farmers in northern Tanzania. The result was shared with local farmers in east-central Sweden, who found many similarities in their way of management, in spite of different socio-economic and biophysical conditions. This led to a comparative parallel study in Sweden, a cross-scale analysis of local practices for managing ecosystem services.

In the Mbulu Highlands of northern Tanzania, farming is constrained by hilly topography, relatively poor soils, and unpredictable rainfall. Semi-structured interviews and participatory mapping techniques were used for mapping practices applied to deal with these constraints. In Roslagen in east-central Sweden, the short cropping season, comparatively poor and stony soils, and local dry spells in

early spring set the conditions for farming. As one of the authors is a part-time farmer active in that rural community, participatory observation and interviews were the principal methods applied in this case.

Several principles for management were found in both cases:

- Practices that take advantage of and work in line with ecosystem functions such as pollination and pest control;
- Adjusting management according to dynamic qualitative indicators. For example, sowing or harvesting starts when indicator plant species reach certain maturity stages, capturing information on soil temperature, local microclimate, and day length; and
- Spreading risk as a greater imperative than maximization of production. Risk spreading, e.g., through crop diversity and multiple sowing dates, enhances the capacity of the ecosystem to perform services also during periods of stress, such as drought and pest outbreaks.

In addition, we found that networks and institutions for flexibility and risk sharing are important components in both systems. Also, many management practices are connected to norms and values of the local farmers, such as respect for certain species, which is not explicitly connected to production success.

In conclusion, this study shows that management practices can reflect the richness of LEK and the ecosystem services that are managed. In addition, it seems that a mapping of practices have a high communicative value, and thus can be a useful tool to detect and respect local knowledge in assessments and management, such as adaptive co-management regimes. The study also shows that it is crucial to include the wider institutional setting that LEK is embedded in. Finally, LEK is developed to cope with an environment that is dynamic and will continue to be so; the dynamic nature of LEK must not be forgotten when mapping practices.

The Challenge of Integration: Insights from Integrated Natural Resource Management Research by the Alternatives to Slash-and-Burn Programme

Thomas Tomich, World Agroforestry Centre (ICRAF), Kenya; **Julio Alegre**, ICRAF Amazonia, Peru; **Veronika Areskoug**, ICRAF SE Asia, Thailand; **Andrea Cattaneo**, US Department of Agriculture, United States; **Jonathan Cornelius**, ICRAF Amazonia, Peru; **Polly Ericksen**, Earth Institute of Columbia University, United States; **Laxman Joshi,** ICRAF SE Asia, Indonesia; **Joyce Kasyoki**, ICRAF/ASB, Kenya; **Christopher Legg**, International Institute for Tropical Agriculture (IITA), Nigeria; **Marilia Locatelli**, Embrapa, Brazil; **Daniel Murdiyarso**, Center for International Forestry Research (CIFOR), Indonesia; **Cheryl Palm,** Earth Institute at Columbia University, United States; **Roberto Porro**, CIAT/ICRAF Amazonia, Brazil; **Angel Salazar-Vega**, Instituto de Investigaciones de la Amazonia Peruana (IIAP), Peru; **Dagmar Timmer**, ICRAF/ASB, Kenya; Meine van Noordwijk, ICRAF SE Asia Regional Programme, Indonesia; **Sandra Velarde,** ICRAF/ASB, Kenya; **Stephan Weise**, IITA Humid Forest Centre, Cameroon
Session 6.2

The Alternatives to Slash-and-Burn Programme has focused on relating its local ”benchmark” sites to a much larger geographic scale, encompassing the tropical humid forest biome. In addition, in understanding policies and trade-offs, it has similarly scaled local findings up to the global level, showing that a local and regional research and policy program can have relevance and impact at the global scale. To date, ASB has concentrated on producing these scientific outputs, but has devoted much less attention to understanding and documenting the processes and institutional innovations that have made this possible. This paper will present the efforts of ASB, in collaboration with the “Sustainability Science” group based at Harvard University’s Kennedy School of Government, to understanding the scope and limits of a complex international consortium to integrate information across disciplines, institutions, scales, and knowledge systems.

The Ok Tedi Project: Assessing an Assessment

Patricia K. Townsend, University at Buffalo, United States; **William H. Townsend**, US Army Corps of Engineers, United States
Session 14.2

During the feasibility and construction phase of the Ok Tedi mine in Papua New Guinea at the beginning of the 1980s, an extensive program of environmental, social, and cultural impact studies was undertaken. The open pit copper-gold mine began production in 1984 under the ownership of a multi-national consortium of companies and the Papua New Guinea

government. At the end of 2001, the last of the three original companies involved pulled out, acknowledging that the project was an environmental (and public relations) disaster. Neither the planned tailings dam nor stable dumps for retaining waste rock were built, resulting in the disposal of all mine wastes into the Ok Tedi (Alice), a tributary of the Fly River. The mine continues to operate at full capacity, producing more than 600,000 tonnes of copper concentrate per year.

In this paper, we examine the impact assessments that scientists produced in the early 1980s. We evaluate these assessments in terms of questions of (1) spatial scale, (2) time scale, (3) the inclusion/exclusion of local perspectives on the environment, and (4) other significant omissions. We ask whether better information would have produced better decisions by the companies, government, and local communities about whether and how to proceed with development of the mine. Or, on the contrary, did decision-makers choose to ignore or exclude scientific information that was already in hand and discourage the collection of data that might challenge decisions that had already been made from differing value systems?

When the Local Meets the Global: Dynamics of Indigenous Knowledge Interaction with Global Issues

Walter E.A. van Beek
Utrecht University, Netherlands
Session 11.3

Indigenous knowledge, usually referred to as IKS, bears some general characteristics: it is local, practical, detailed, and usually small scale. On the other hand it is woven into the fabric of social life, with often implicit and explicit religious connotations; in short, it tends towards holism. Finally indigenous knowledge is *agrapha*, non-written, which implies its own dynamics, its own patterns of change and a general lack of orthodoxy. One result from these characteristics is domain specificity in indigenous knowledge, a reason why the term "system" is debatable. The connotation as system seems to be an academic question, but it is not. The system characteristics of indigenous knowledge, often constructed from the holistic perspective, imply coherence, internal relations and mechanisms for homeostasis. In this paper these notions will be looked at within particular African cases, in order to assess the internal properties of the indigenous knowledge system. The arena to view these properties is formed by the encounter of indigenous knowledge with cosmopolitan exogenous knowledge, and especially with claims for international rights, ownership and eventually profit. The results of this encounter can be encapsulated in the term "granulation of knowledge" and highlight the characteristics of indigenous knowledge and the main western approach to knowledge and knowledge systems.

Diagnostic Use, Consciousness, and the Availability of Timber Use in South East Mexico

Carmen Vergara-Tenorio and **Silvia Del Amo Rodriguez**, Programa de Accion Forestal Tropical A.C. Centro de Investigacion Tropical, Mexico
Session 4.1

Timber use problem has been poorly studied in Mexico. Current works do not satisfy information needs about access, transport, and household organization for timber use. Then, this study answers to these and other questions. The main objective was to motivate community reflection about the use of timber as a primary source of energy, the difficulties of using timber, and the importance of wood for future and daily life activities. Then, we wanted to improve timber use more efficiently.

The whole process took five years and it is an example of applying a holistic, integral, and participative methodology. Acknowledgement of the problem and solutions about timber was achieved using female participation and by taking into account ecological and socioeconomic aspects for the conservation and use of tropical resources. The study comprises the following stages:

- A preliminary diagnostic carried out through collective exercises with community groups. We identified each local population's general timber supply, different timber uses, and issues about wood.
- Identification of three representative ecosystems regions with variable consumption of wood in the states of Campeche, Chiapas, and Veracruz.
- Sensibility workshops with communities to know about household daily consumption of timber. We also built the first models of rustic stoves. We collected biological, anthropological, and social information, such as species preferred and women's activities around timber.
- Quantitative studies about consumption and availability of timber in the three states of the study. We characterize the domestic, commer-

cial, and industrial use of timber in eight communities, through 388 surveys and a forest inventory with more than 10,000 data of trees.
- Data return to communities. We went back to the towns and informed participants about the results. There were five workshops with 151 participants.
- Collective agreements facilitated the successful reduction in timber consumption and its social acceptance. As a result, communities built 151 rustic stoves according to previously designed models that were culturally accepted.

We and the communities learned many lessons. The most important was the active participation of local populations and the need for making its own the new ways of using timber and rustic stoves. Finally, one of the most important contributions of the study was the systematization of the results. We created a database called SICOREL, where all the information can be consulted easily.

A Review of Biodiversity Assessment Approaches: Tools for Integrating Global and Local Values

Sonja Vermeulen, International Institute for Environment and Development, United Kingdom
Session 14.2

Biodiversity assessment approaches reflect underlying biodiversity values. At their best, biodiversity assessments can deliver the sort of information that helps different interest groups to communicate and negotiate shared and divergent biodiversity values. This paper reviews a range of the assessment approaches used by governments, international organisations, local communities, the private sector, natural scientists, and social scientists in terms of their inclusion of multiple biodiversity values, as well as the tools that they use for acknowledging and integrating these different values.

Effects of Regional-scale Conservation Planning at the Local Level: Chachi (Cayapa) and Afro-Ecuadorian Communities' Utilization of the Endangered Coastal Forests of the Ecuadorian Chocó and their Understanding of Sustainable Development and Biodiversity Conservation

Nathalie Walker, University of Oxford, United Kingdom
Session 14.1

Conservation planning by international conservation organizations is targeting large areas (designated hotspots or ecoregions) of high biodiversity and at great threat that cross political boundaries and share environmental and biological characteristics. The large-scale approach to biodiversity conservation has been recognized as necessary in order to ensure that large-scale ecological processes and viable populations of species are preserved and to conserve areas large enough to withstand disturbance and environmental change.

The Chocó biogeographic region, which encompasses the moist and humid forests of northwestern Ecuador and western Columbia, is recognized as being of very high priority for conservation because of its extremely high level of biodiversity and the many plant and animal species that are endemic to the region. The coastal forests of Ecuador are amongst the most threatened in South America with less than 10 percent of the original forest remaining intact. The lowland forests of the Ecuadorian Chocó are inhabited by indigenous Chachi (Cayapa) and Afro-Ecuadorian and mestizo communities. The Chachi and Afro-Ecuadorian communities have been present for a number of centuries, the Chachi having migrated from the Andes and the Afro-Ecuadorians from Colombia. The mestizo communities have colonized the area since the 1970s and large-scale deforestation in the region has occurred in only the last forty years. The high level of deforestation has led to a number of different conservation and sustainable development projects being implemented in the region including land purchase for reserve creation, ecotourism, and sustainable forestry schemes. Initiatives to combine the conservation efforts of NGOs and Ecuadorian governmental institutions have been developed. Plans for the region aim to co-ordinate groups involved in conservation at the regional and local level, to ensure that development activities are integrated with conservation efforts, and to educate local communities about the importance of conservation to the future of the region. The effects of a regional strategy for the management of ecosystems and natural resources are considered at the local level through the study of different communities' vision and utilization of the forest. The communities' views about conservation and sustainable development are explored, as well as the ways in which the regional strategy addresses their needs and the implications for the success of the strategy.

Agro-urban Ecosystem Health Analysis in Kathmandu, Nepal: A Multi-scale, Multi-perspective Synthesis

David Waltner-Toews
University of Guelph, Canada
Session 11.4

This case study illustrates the links between problem structuring, multiple epistemologies across nested scales, assessment, and remediation. Cystic echinococcosis is a parasitic disease of people associated with a gastro-intestinal tapeworm of dogs. Since it usually cycles between canids and other vertebrates, the parasite is linked to food safety through slaughtering techniques, which in turn are related to changes in the characteristics of the agro-urban ecosystem. These in turn cannot be dealt with without addressing the socio-economic and cultural aspects of the system, that is, the eco-social narratives which people (including scientists) use to structure their daily lives. A ten-year series of research projects in Nepal and a review of the global attempts to control this disease, demonstrated that conventional science could provide explanations but had a mixed record at achieving solutions. Effective solutions were arrived at only after local stakeholders and governance structures were engaged in the definition of the problem structuring. Assessment (placing values on scientific measurements) and remediation (acting on those values) require both citizen engagement and a nested, complex, systemic, epistemic stance. These are synthesized through the creation of culturally acceptable narratives.

The Ecological Impact of Environmental Policy in Great Western Development: A Case Study of Returning Farmland to Forest and Grassland

WANG Qiao and **PEI Xiaofei**, State Environmental Protection Administration, China
Session 4.4

The western part of China is the source of many rivers like Yangtze River and serves a significant resource base, strategic reserve, and ecological shield for the whole country. Due to natural, social-economic, and historical causes, the ecological condition and environmental quality is seriously degraded in the western part of China. Above 80 percent of the country's soil erosion is located there, as is most of the desertification and degenerated grasslands. Carrying out the strategy of developing the western region is an important component of China's modernization drive, and ecological construction and environmental protection is one of six priority tasks. In 1998, a project aimed to protect natural forest and return farmland to vegetation was implemented and resulted in the recovery of vegetation and curbed the trend of soil erosion. In this paper, we analyze the policies that return farmland to forest and grassland, their implementation, and their ecological impact. Policy recommendations are brought forward in order to solve the problems caused by implementation of the policy.

An Epistemic Approach Applied for Integrated Water Quantity and Quality Problems: A Case Study of Berlin

Volker Wenzel, Potsdam Institute for Climate Impact Research, Germany
Session 6.2

In this paper, we explore how to move away from monolithic models of integrated systems analysis towards an approach that is open and question oriented. Methods such as systems analysis, mathematical modeling, and computer-aided simulation are powerful tools that can greatly contribute to our understanding of complex processes combining both ecological and socioeconomic aspects. This approach follows a diamond-shaped, epistemic structure that leads from clear problems to clear solutions. However, between these two points we have to do extensive work of selection and accumulation of what is needed for solution, followed by an intensive, purposeful aggregation, structuring, and organization of the accumulated material and information. Single steps of this work will be translated into such categories such as scenarios, drivers of change, human activities of control, stakeholders' interests and participation, subjective and objective criteria, and evaluation.

The approach is then applied and demonstrated for the case study of Berlin, which is dedicated to integrated water quality and quantity research. We begin by describing the pressures on the Berlin water system—ranging from new economic conditions under globalization to the effects of climate change. We then turn to set up the model to be used for impact analyses. This integrated model is a combination of approved special purpose models such as climate change, sealing and runoff models, hydraulic and long-range water management models, as well as water quality and aquatic ecosystem models. The single indicators delivered by those models are then

combined to few relevant index variables and evaluation criteria, integrating ecological, economic, social, and normative aspects. We also show how different interest groups and stakeholders can help to develop alternative strategies for water management, including rain water management, additional water purification efforts, and biotope protection measures, among others.

Considering Interactions between Processes that Operate at Different Scales

Thomas Wilbanks, Oak Ridge National Laboratory, United States
Session 14.3

It is clear that many phenomena that contribute to global and regional ecosystems, positively or negatively, are the result of processes that operate at a local level. Examples include microscale human land use, economic production, and resource consumption decisions, including adaptations to many kinds of environmental variation, reflecting local decisions by individual farmers and government leaders in small settlements. But it is also clear that local-scale processes are affected by processes that operate at much larger scales, from regional environmental pollution to national access, to financial resources, to economic globalization and global technological change. On the one hand, initiatives at a global or national scale can constrain or overshadow local adaptive capacity and knowledge bases about sustainability. On the other hand, local capacities to act sustainably are greater if they are enabled by facilitative actions at a larger scale. As the importance of action at global and national scales to address certain environmental challenges becomes more urgent, while it is increasingly clear that local responses to environmental challenges are often the most effective, improving our understanding of relationships between processes at the different scales is a very high priority.

How Scale Matters: Some Concepts and Findings

Thomas Wilbanks, Oak Ridge National Laboratory, United States
Block 13, Plenary Presentation

This paper will briefly summarize some theoretical concepts related to how scale matters in conducting large integrative nature-society assessments, including conceptual reasons why such assessments should give attention to multiple scales; suggest several issues that need further research attention, including the development of general hypotheses about how scale matters; and consider cross-scale interactions as an important part of the challenge, including basic dimensions of such interactions.

Local and Indigenous Ecological Knowledge as an Emergent Property of a Complex System: A Case Study in the Solomon Islands

Ellen Woodley, Liana Environmental Consulting, Canada
Session 6.1

Despite unprecedented interest in local and indigenous ecological knowledge (IEK) over the last 20 years, there is still a lack of awareness of the implicit complexity in IEK and the epistemological barriers to its effective use for ecosystem management. Development professionals and project participants often minimize the importance of social structures and biophysical features of the ecosystem that support the system of knowledge and how the process of change impacts that system. For researchers and development practitioners, both local and nonlocal, to have access to and to understand situated, embedded knowledge that is undergoing change and adaptation, a new conceptual approach is required.

This paper describes research that attempts to expand and refine the understanding of indigenous ecological knowledge as dynamic and place-based in order to better inform contemporary resource management strategies. This research positions local ecological knowledge as an emergent property of a complex of context, practice, and belief (CPB). The CPB complex represents the conditions that structure knowing. In this approach, knowledge is understood as process, or ”how” people know, not ”what” they know. IEK is, therefore, emergent from and a representation of complexity. The approach diverges from the widely applied development practice of participatory consultation designed to extract knowledge, and instead examines local epistemology and the process of change to understand the basis of human-ecosystem interaction. The paper describes the CPB complex in the communities of Uzamba and Valapata in the Solomon Islands, and shows that understanding how people are engaged within their surroundings, instead of documenting knowledge that can be articulated, can assist in bridging differences in worldviews.

Framework for the Assessment and Management of Natural Capital in Qinghai-Tibet Plateau

YAN, Wanglin, Keio University, Japan
Session 9.3

China has made a great step towards an "all-out, somewhat abundant society" by setting forth the Great Western Development Strategy at the end of the 20th century. This is a chance for development that has been eagerly awaited by people in the western regions. It is also a challenge that this region has never before experienced. While western China, owing to its long history, diverse cultures, and rich resources, has a high potential for development, the poor social infrastructure and remote conditions present obstacles for modern industrialization. Furthermore, unsustainable agricultural practices have seriously degraded the land and brought the natural ecosystems and living environment to a critical state. These changes have been further accelerated by the recent global climatic changes.

The concept of Natural Capital and the mechanism for exchanging ecosystem services in market emerged in the 1990s, and has provided a new approach for balancing environment conservation and human well-being in development. The purpose of our research project is to apply this concept and the framework of ecosystem assessment recommended by the Millennium Ecosystem Assessment to the Qinghai-Tibet Plateau to assess and manage the ecosystem services in the highland, and make social development plans.

We chose the Qinghai-Tibet Plateau as our study area for the a few reasons reasons. First, the Qinghai-Tibet Plateau is the headwaters of three major Asian rivers: the Yangtze River, the Yellow River, and the Mekong River. The region has abundant water and mineral resources, unique biodiversity, scenic highland landscapes, and historic Tibetan Buddhist culture. Many of the natural and cultural characteristics of the Plateau are irreplaceable for Asia and for the world. Second, with the support of China's government and local governmental sectors, we have established various international exchange and assistance activities with the government of Qinghai Province. These activities provide an international network that will enable findings from this case study to be of benefit in other regions and nations and also provide mechanisms by which the findings can lead directly to implementation by local communities. Third, the environmental attributes of the plateau, because of its geographic location, are at risk of being ignored when priority is given to economic development, despite the irreplaceable nature of both the ecological systems and social resources. More effective governance of this natural capital, using an interdisciplinary approach to policy-setting, will make it possible to identify sustainable development strategies that harmonize economic development with environment conservation and cultural renewal in the highland. We believe that our work will produce benefits not only for Qinghai Plateau and China but also to East Asia and the world.

The Epistemological Concept of Nature Conservation and Human Activities as Seen from the Dongba Religion of Naxi People of Southwest China

YANG Fuquan, Yunnan Academy of Social Sciences of China, China
Sessions 4.5 and 6.5

This paper focuses on Naxi epistemological concept that is the base of the relations between Dongba religion and the traditional conservancy practices of the environment among Naxi Ethnic Group. It analyzes the basic spirit of Dongba culture based on my own personal experiences and anthropological fieldwork in the areas of the Naxi people. The author wants to express from this case study that the indigenous knowledge that has been handed down from generation to generation is very important for the sustainable conservation of the environment and the social harmony and stability of a community. It should not be ignored by present sciences and scientists; modern science and scientists should try to build a bridge between the sciences and indigenous knowledge of ethnic minority people.

The synopsis of the paper is as follows:

- The concepts of Dongba religion about Nature and Man and their relationship
- The practice of environmental knowledge for conservancy of environment in Naxi communities, transmitted by the Dongba Religion;
- The relation of Dongba religion and the customary laws and local regulations of communities;
- The epistemology of Naxi people in interface with modern scientific society as seen from the Naxi communities; and
- In conclusion, the relationship between the epistemological concept and indigenous knowledge and sciences seen from the case study of this paper.

Designing Evaluation Tools to Identify the Implications of Climate Change and Economic Development for Sustainability in Lijiang and Yulong Mountain Region, China

Yongyuan Yin, University of British Columbia, Canada
Session 2.5

Research on developing well designed evaluation tools will provide the information and understanding necessary for identifying more effective adaptation options and better management plans for ensuring regional sustainability. This paper presents an integrated approach that integrates climate change vulnerability identification, adaptation option evaluation, and multi-stakeholder participation. The integrated approach will be applied in Lijiang and Yulong Mountain region of China for identifying desirable resource management plans to reduce climate change vulnerabilities. Different computer- and non-model-based methods will be adopted to form the integrated approach. The research starts with the identification of vulnerabilities of ecosystems and economic sectors to climate change. This is followed by survey and interviews that allow stakeholders to participate in a multi-criteria evaluation of adaptation options. The analytic hierarchy process (AHP), an MCDM technique, will be employed as an adaptation-evaluation tool to rank desirability of resource management plans. The paper will provide some articulation on how the integrated approach can provide an effective means for the synthetic evaluation of the general desirability levels of a set of resource management plans through a multi-criteria and multi-stakeholder decision-making process. Thus, the study contributes to the science of ecosystem assessment.

Spatial Allocation of Agricultural Production Using a Generalized Cross-entropy Approach

Liangzhi You and **Stanley Wood**, International Food Policy Research Institute, United States
Session 4.2

One of the major analytical weaknesses of regional and global agricultural studies is the inability to objectively re-aggregate production statistics into any other geography (e.g., agro-ecological zones or watersheds) than geopolitical boundaries. Using a generalized, cross-entropy approach, this paper proposes a spatial allocation model to make plausible allocations of crop production into individual pixels, through judicious interpretation of all accessible evidence. The information from various sources includes, but is not limited to, production statistics, farming systems, satellite image, crop biophysical suitability, crop price, local market access, and prior knowledge. An example is presented applying the spatial allocation model to simultaneously allocate eight major crops using state-level statistics in Brazil, and comparing the allocated result with actual municipio-level statistics. The results from the model are also compared with those using other simplified allocation methods to evaluate the performance of the proposed spatial allocation model. This paper demonstrates that the cross-entropy method is flexible enough to be able to include quite a wide range of constraints, and yet powerful enough to provide a reasonably accurate estimation. It also shows new technologies such as remote sensing and image processing can provide useful tools to address the heterogeneity in agriculture production, infrastructure, and natural resources.

Species Richness by Elevation Gradients in Mountain Areas and the Associated Impacts of Climate Change

YU Hua, Nanjing University, China
Session 2.5

Mountain environments will be particularly susceptible to the effects of climate change. Estimates of vegetation responses at high altitudes have been made by modeling the potential distribution patterns in accordance to predicted changes in temperature regimes and precipitation. These models are based on present vegetation communities, thus, the study of vegetation zones by elevation gradients is important to further this field of research. The distribution of species richness of seed plants by elevation in Hubei Province, P.R. China, was studied and it was demonstrated that the relationship between species richness and elevation was not linear, but had a hump-shaped distribution. Factors influencing the species richness along elevation gradients are temperature, atmospheric humidity, soil, nutrient availability, and anthropogenic effects. This study also acts as a baseline from which to gauge the degree of change that may occur in Hubei. The complexity of high elevation ecosystems creates uncertainty in making predictions that apply to all scenarios and locations, which is reflected in the results of recent studies on vegetation responses to climate change.

Ecological Modeling on Sub-global Scale

YUE Tian Xiang, Chinese Academy of Sciences, China
Session 4.4

The basic focus is to assess conditions and trends of ecosystems and their services, driving forces of the changes, and the consequences of ecosystem change for human well-being. Indicators are quantitative measures of ecosystems and their services, drivers, the impacts of changes in those services on human well-being, or response options. Any indicators are inevitably the product of a model of the system whose state attempted to be indicated. For calculating the indicators and their interrelations, a modelbase management system is developed. The modelbase will consist of the most appropriate models selected from all models that have been published in various publications. The general functions of the modelbase management system include: (1) allowing for the creation of decision models from existing modules, (2) providing a mechanism for the linking of multiple models to allow for sequential processing and data exchange, (3) allowing the user to modify models to reflect specific preferences, (4) storing solver algorithms for easy access, (5) providing a catalog and organizational schema of stored models, and (6) allowing for management of the modelbase with functions similar those in a data management system, such as query, retrieval, storage, delete, and add.

The fundamental purpose of the sub-global component of the MA is to illuminate ecosystem issues at a range of geographical scales from regional to local and to determine critical cross-scale interactions. For performing the multi-scale assessment, a grid-generation model for multi-scale information fusion is constructed. Because the grid generation model has a very high requirement for computing capacity of computers, and under the present situation it is difficult for a single computer to perform calculations related to the Integrated Ecosystem Assessment for Western Development of China, the grid computing method is introduced into operating the models. As applications of the approaches presented in this paper, the relationship of biodiversity and ecosystems on various scales and the linkage between ecosystem services and human well-being are modeled.

The Sustainable Development of Tourism in Lijiang

ZHANG Hong, Yunnan University of Finance and Economics, China
Session 2.5

Lijiang is a famous tourism destination in China. In recent years, the tourist industry in Lijiang has developed rapidly and has brought improvements to the quality of life of the local residents. However, the scale of tourism has also resulted in environmental degradation, such as the retreat of the iceberg of Yulong Snow Mountain. This paper analyzes the problems of tourism development in Lijiang. The author suggests that Lijiang's tourism is not sustainable under current conditions and that there is the danger that the natural environment will be destroyed. Lijiang has to change its present tourism development strategy to one that will be more sustainable over the long term. This paper provides policy suggestions for an alternative development path for Lijiang.