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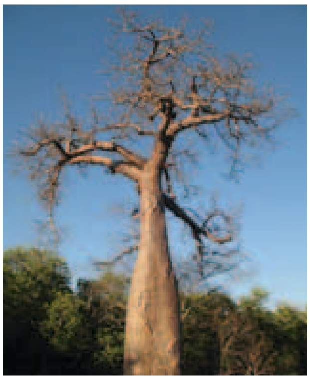

51

BIODIVERSITY AND CLIMATE CHANGE: ACHIEVING THE 2020 TARGETS

Abstracts of Posters Presented at the 14th Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice of the Convention on Biological Diversity, 10-21 May 2010, Nairobi, Kenya

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Cover Photos
(Top to bottom) Baobab, *Adansonia madagascariensis*, endemic to Madagascar (photo: Joachim Gratsfeld, Botanic Gardens Conservation International); Students investigating the intertidal area, Chumbe Island Coral Park, Zanzibar, Tanzania (photo: Chumbe Island Coral Park); Seed diversity, India (photo: Paul Bordoni, Platform for Agrobiodiversity Research, Bioversity International); Coral reef walls, Apo Island, Philippines (photo: © Greenpeace/Daniel M Ocampo)

CONTENTS

GOAL C: BIODIVERSITY CONSERVATION

GOAL D: BENEFITS FROM BIODIVERSITY

GOAL E: ENHANCING IMPLEMENTATION OF THE CBD

FOREWORD

It is increasingly evident that climate change and biodiversity loss are intricately connected. Climate change is emerging as one of the greatest threats to biodiversity, increasing pressures on genetic resources, species, populations and the continued provision of ecosystem services. Examples of such impacts can be drawn from all regions, including reductions in waterfowl populations in the Arctic to increased coral bleaching in tropical oceans.

At the same time, biodiversity conservation and sustainable use can reduce the impact and severity of climate change. There is approximately 50 times more carbon stored in the oceans and in terrestrial ecosystems as compared to the atmosphere—conserving these carbon stocks should, therefore, be an important component of climate change mitigation.

Furthermore, most healthy ecosystems have a higher natural capacity to adapt to climate change when compared to similar degraded ecosystems. Given the high projected cost for adaptation measures based on hard infrastructure and engineering, capitalizing on the natural adaptive capacity of ecosystems will be essential if the impacts of climate change, especially with regards to ecosystem productivity and water, are to be managed.

In order to benefit from the win-win opportunities associated with biodiversity–climate change synergies, it is important to fully understand the issues at all scales—from local to global. Such an understanding must be based on strong scientific evidence, which can be communicated to policy makers in order to make the case for action. This action can be catalyzed through the new strategic plan of the Convention on Biological Diversity, which will direct action beyond 2010 and will be discussed at the fourteenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-14), to be held from 10 to 21 May 2010, and the third meeting of the Ad Hoc Open-ended Working Group on Review of Implementation of the Convention (WGRI-3), to be held from 24 to 28 May 2010, in Nairobi, Kenya.

This edition of the Convention on Biological Diversity's Technical Series was prepared to accompany posters presented at SBSTTA-14. They contain a wide range of case studies and best practices illustrating how climate change adaptation and mitigation measures, and biodiversity conservation and sustainable use can be mutually supportive. It is my hope that the submissions encourage consideration of this interrelationship, and further, that they inspire action towards reducing the rate of loss of biodiversity while addressing the challenges of climate change.

I sincerely thank all of the contributors to this Technical Series for sharing their experiences, and for their enhancement of the implementation phase of the Convention.

Ahmed Djoghlaf
Executive Secretary

INTRODUCTION

In addition to the notes and information documents prepared by the Executive Secretary, it is usual practice to have a poster session during the meetings of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA). Posters presented on the margins of the meeting are accompanied by extended abstracts compiled and published in editions of the Technical Series.

The theme for the poster session at the 14th meeting of SBSTTA, in Nairobi, Kenya, from 10 to 21 May 2010, is: "Biodiversity and Climate Change: Achieving the 2020 Targets". This theme was selected to complement the discussions during SBSTTA-14 on a joint work programme between the three Rio Conventions (the Convention on Biological Diversity—CBD, the United Nation Convention to Combat Desertification—UNCCD, and the United Nations Framework Convention on Climate Change—UNFCCC).

Parties, other Governments and relevant United Nations bodies, inter-governmental, non-governmental, regional and international organizations, indigenous and local communities, and the private sector were invited to contribute posters and extended abstracts detailing case studies and best practices on how climate change adaptation and mitigation measures, and biodiversity conservation and sustainable use can be mutually supportive.

Each of the 58 abstracts published is presented within one of the following five sections:

A: Indirect drivers of biodiversity loss;
B: Direct drivers of biodiversity loss;
C: Biodiversity conservation;
D: Benefits from biodiversity; and
E: Enhancing implementation of the CBD.

These headings correspond to the five goals of the draft strategic plan for 2011–2020, submitted for consideration by SBSTTA-14 and the third meeting of the Working Group on the Review of Implementation (WGRI-3).

All abstracts are presented, unedited, in the form in which they were submitted. Please note that the corresponding author is identified, where applicable, by an asterix (*). An author and keyword index can be found at the back of the publication.

A

INDIRECT DRIVERS OF BIODIVERSITY LOSS

1. UNDERSTANDING THE INDIRECT DRIVERS OF BIODIVERSITY LOSS FROM A SYSTEMIC PERSPECTIVE

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Keywords: cultural/institutional/structural drivers, values of society

SETTING THE SCENE OF EMERGING ENVIRONMENTAL PROBLEMS

Notwithstanding all the efforts have been made globally towards tackling environmental challenges, the negative effects of climate change are accelerating and the rate biodiversity loss is still continuing worldwide. There are numerous assessments that show if humankind keeps following the current trend of economic growth and development, it steps out the limits of Earth and thus generating irreversible processes.

According to the global assessments, more than a third of species assessed are facing extinction and an estimated 60% of the Earth's ecosystems have been degraded in the last 50 years, with negative consequences for the ecosystems services that flow out of them (Millennium Ecosystem Assessment, 2005). Besides, in the 10 years from 1995 to 2005 atmospheric CO_2 increased by about 19 ppm; the highest average growth rate recorded for any decade since direct atmospheric CO_2 measurements began in the 1950s (IPCC, 2007). Furthermore, the Living Planet Report 2008 (WWF International, 2008) shows if current trends don't change, humanity will be demanding two planets worth of resources by the mid 2030s, while a 2009 assessment of the Global Footprint Network (Global Footprint Network Standards Committee, 2009) reveals if all people lived and consumed like Europeans we would need 2,6 planets. Moreover, in a recent article of Nature (Rockström, J. *et al* ,2009), authors argue that summing up humanity's global impact we have already transgressed safe limits in the use of biodiversity, nitrogen load and climate, at the same time we are close to safe limits with phosphorus load, ocean acidification and freshwater and land use.

SYNERGIES IN ADDRESSING CLIMATE CHANGE AND BIODIVERSITY CHALLENGES

In spite of the high priority given to climate change and biodiversity loss for several years globally in the framework of the Rio Conventions, environmental problems keep threatening the World's populations. Besides, notwithstanding that synergies are emerging between the different focused UN Conventions through establishing liaison groups and enhancing communication and cooperation, the different environment problems cannot be solved without adopting holistic approach.

As already the Brundtland Report (World Commission on Environment and Development, 1987) pointed out, the issues of environment and development are inherently interlinked. It means that in a thorough analysis the pressures, drivers and impacts will be the same in the case of all environmental problems, let they be biodiversity loss, climate change, waste or air pollution. The same drivers are behind these environmental problems, and the pressures, responses and impacts interlink the various environmental issues.

Taking this into account, recent EU ("Cibeles" priorities, 2010) and global (UNEP/CBD, 2010) post-2010 biodiversity policies have started to focus more on responses to address the drivers thus tackling environmental pressures also. However, to reveal and tackle the drivers behind environmental pressures, this trend in biodiversity policies should be enhanced and the complex nexus of cause-effect relationships, which connect climate and biodiversity changes and socio-economic trends, has to be sufficiently revealed (CEEweb, 2009).

USING THE DPSIR MODEL FOR DEVELOPING EFFECTIVE RESPONSES

In order to that biodiversity and climate policies could develop sound basis for the necessary actions, a complete understanding of the complex relationships of the various factors is needed. Considering the DPSIR (*drivers-pressures-state-impact-response*) model adopted from the European Environment Agency model (EEA, 2005) could provide a useful causal framework for formulating policy responses to environmental problems (Figure 1.).

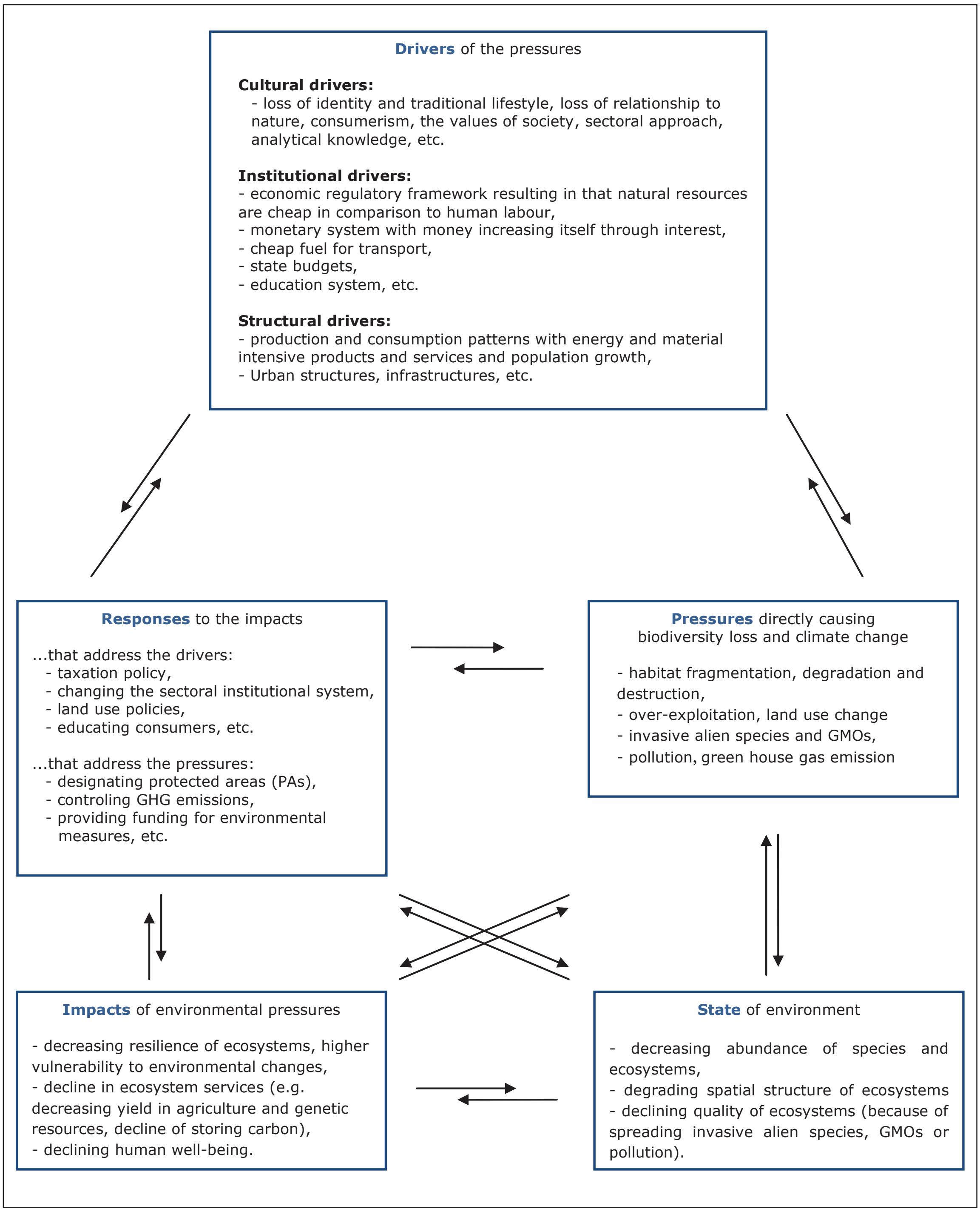

FIGURE 1: Environmental problems in the DPSIR (Driver-Pressure-State-Impact-Response) model

The model describes the interactions between society and environment. The *State* of environment is the biotic condition. *Pressures* exerted by the society change the state of environment. They include the release of substances (emissions), physical and biological agents, the use of resources and the use of space. *Drivers* are the social, demographic and economic developments in societies, which manifest themselves in the exerted pressures. *Impacts* on human and ecosystem health, as well as resource availability result from the adverse changes of the state of environment. *Responses* are the measures taken to address drivers, pressures, state or impacts by the society.

TACKLING INDIRECT DRIVERS BEHIND ENVIRONMENTAL CHALLENGES

The pyramid of drivers (the socio-economic root causes behind environmental pressures) organises the drivers in three different layers (Figure 2.).

Structural drivers are difficult to change, and comprise the production and consumption patterns, the urban and spatial structures, the infrastructures, etc. They directly lead to environmental pressures, and they also mean a structural obstacle to achieving changes in the other drivers (e.g. the infrastructure of gas pipe lines and equipment make it more difficult to switch to decentralised, alternative energy source use because of the large transition costs). Institutional drivers include *inter alia* the legislative and economic regulatory framework, and indirectly determine the structural drivers. Cultural drivers are the most deeply lying causes, and include the approach and values of society, the knowledge they possess, etc.

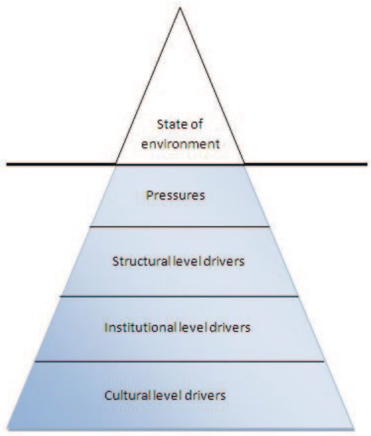

FIGURE 2: Cultural, Institutional and Structural Drivers

From holistic point of view, measures for tackling the drivers have to be developed and implemented since, without addressing their root causes; pressures keep regenerating notwithstanding all efforts to eliminate them. Moreover, it is crucial to tackle these drivers of environmental pressures in order to avoid shifting pressure from one attribute of the environment (abundance of natural resources, spatial structure and quality of the environment) to the other. Therefore, without adopting a holistic approach and working out holistic solutions for drivers, pressures cannot be influenced substantially.

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2. BIODIVERSITY AND CLIMATE CHANGE
Ethical Foundations for German National Strategies and Suggestions for their Communication

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Keywords: conservation concepts, climate change, ethics, communication, good change

INTRODUCTION

Germany has adopted a National Biodiversity Strategy (NBS) as well as a Strategy for Climate Change Adaptation (DAS), both embedded in the National Strategy for Sustainable Development. An ongoing study for the Federal Agency of Nature Conservation examines and elaborates the ethical foundations on which those strategies are to be based. The first part identifies ethical arguments underlying NBS and DAS and explains them to a general audience. An analysis of strengths and weaknesses of different arguments leads to recommendations for a successful communication of the strategies. The second part looks at the linkages between nature conservation, protection of biodiversity, mitigation of and adaption to climate change with regard to environmental ethics as well as to the goals and practices of nature conservation. This kind of ethical groundwork is one of the necessary prerequisites for successfully communicating and achieving the 2020 goals.

GOOD ARGUMENTS FOR CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY

By ratifying the Convention on Biological Diversity (CBD) in 1993 and the UN Framework Convention on Climate Change (UNFCCC) in 1994 Germany has dedicated itself to the conservation of biodiversity, to the sustainable use of its components and to the fair and equitable sharing of the benefits arising out of its utilisation as well as to the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. What reasons can be named for such a commitment? Why should a nation save, use and share biological diversity? From an ethical perspective, there exist three kinds of possible answers (Eser 2009):

"Because it is in our own best interest"

For large parts NBS and DAS do follow these lines of argument: Biological diversity is useful with regard to its ecological, economic and socio-cultural functions. We need it for our physical survival as well as for our emotional and cultural well-being. Therefore, prudence tells us to save it. The conservation of biodiversity would then be a matter of utility, not of morality.

"Because we love, value or esteem biological diversity"

A second option is to regard biodiversity as part of a good life. To contribute to the conservation of biodiversity would then be a matter of virtue. Unlike the appeal to self-interest, which dominates the official strategic papers, this kind of argument rather fits the moral intuitions of conservation activists. However, arguments related to virtues are necessarily more subjective. Their subject-matter is not a set of binding rules, but personal attitudes towards nature which do—or do not—lead to certain actions.

"Because it is our moral duty"

Finally it can be argued that sustainable use and fair sharing are a matter of justice: a moral obligation towards future generations as well as towards the people already living today. Arguments of this normative type are more binding than arguments grounded in the realm of virtue ethics. Theories of justice seek to develop norms and rules applicable to all people, regardless of their attitudes and preferences.

Different Arguments are Compatible!

There is not a single comprehensive argumentation for the conservation and sustainable use of biodiversity. Rather, each type of argument listed above has its specific rights as well as specific limitations. The strengths and weaknesses of different arguments refer to philosophical and conceptual aspects as well as to impacts on successful communication. These will be elaborated in detail in the course of the ongoing study.

INTEGRATION OF STRATEGIES BY A NORMATIVE CONCEPT OF 'GOOD CHANGE'

The linkage of the National Biodiversity Strategy (NBS) and the Strategy for Climate Change Adaptation (DAS) is one of the necessary steps for maintaining and conveying biodiversity as well as for sustainable development. It will contribute to a realistic and feasible integration of climate change adaptation and nature conservation. This calls for comprehensive and reliable concepts—namely a concept of 'good change'.

Change as Challenge

The general problem of conservation and its policies is: why should we sustain or even restore a certain state of nature if it is constantly changing anyway? This applies even more under the conditions of climate change. The last decades have spawned an increase in concepts of a more dynamic outline of biodiversity protection on all levels, from populations to ecosystems. The shift from pattern to process, however, has not made very clear, whether processes themselves have become the new protection goals. It seems that often processes are understood mainly as means for maintaining those habitats and inhabitants, which require ecological dynamics. In the latter sense, process is understood instrumentally. But in many cases, natural processes are conceived of ethically as goals in themselves with intrinsic value, hence becoming more important than e.g. specific species protection goals. This tension remains unresolved.

Natural and Anthropogenic Change

Even a dynamic approach of protecting natural processes—as opposed to certain states with a fixed set of biodiversity elements—distinguishes between anthropogenic and natural change. This happens on both the empirical and the valuation level. In the first instance the difficult scientific question arises whether a certain change or a whole cluster of changes within ecosystems is caused naturally or by human action. On the normative level the question remains to justify why exactly natural changes should generally be considered good whereas anthropogenic changes are less preferable. This has already been challenged by including cultivated plants and livestock within biodiversity as well as by approaches from sustainable development. Nevertheless, telling apart natural and anthropogenic change still remains to be one of the conceptual foundations of conservation. In the face of climate change the separation between natural and human-driven change becomes even more blurred. Therefore the challenge of adequately describing and valuing transformations in and of nature intensifies.

Good Change

In response to this situation, a new conceptual approach of environmental ethics will be developed to identify desirable changes. On a practical level, this also includes formulating necessary goals and measures for conservation. Thus, the policy targets of present (sometimes naïve) conservationism have to be revised not least with regard to the concept of biodiversity framed by the CBD (cf. Potthast 2007). At the same time existing tendencies of uncritically welcoming all change will have to be put into question. This includes the role of 'naturalness' as the main or only focal point for the derivation of values. Most notably, the targets need to be expanded with regard to human-nature interaction for sustainable development. On the other hand, processes as goals need at least some indication of the pathways and trajectories to be taken, notwithstanding that no fixed goals might be targeted. This would be in accord with some classical safeguard approaches protecting large areas as well as networks and corridors of habitats. But nevertheless, the increasing speed and magnitude of natural and anthropogenic change will convey the need to establish new goods and goals beyond "to keep every cog and wheel (a)s the first precaution of intelligent tinkering", as Aldo Leopold (1970: 190) has once put it.

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3. WOMEN'S KNOWLEDGE AND PRACTICES ON BIODIVERSITY MANAGEMENT IN THE HIMALAYAS

Contributions to Climate Change Adaptation

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Keywords: gender, traditional knowledge, natural resources management, adaptation

INTRODUCTION

Himalayan mountain communities are repositories of traditional knowledge related to the biodiversity which is vital to their own survival and to the survival of mountain ecosystems. Furthermore, mountain communities contribute to ecosystem maintenance through their rich culture, religious and spiritual beliefs, which incorporate a knowledge that has evolved over generations (Wagle et al. 2006). Farmers have contributed immensely to the region's agro-biodiversity by developing diverse cultivars and varieties of crops over countless years of experimentation. These communities are the keepers of information on biological resources, varieties of food crops, livestock, and plant species (Byers and Sainju 1994).

In the Himalayas, women are the backbone of the mountain economy and their role in enhancing, maintaining, and sustaining biodiversity resources, particularly in the agriculture and forestry sectors, has been crucial. They are active participants in household and subsistence agricultural activities (ICIMOD 1997) and invest most of their productive lives in the land-based production process. As primary users and managers of subsistence resources, they have tremendous knowledge on the medicinal and nutritional value of diverse plant species (Byers and Sainju 1994).

Biodiversity conservation and management entails the sustainable use of biological resources which are often gendered: studies have shown that men and women differ in their preferences for the utilization of biological resources and in their conservation practices. Studies have also shown that the type of knowledge retained by men and women on biodiversity differs and varies according to their age, ethnicity and geographical location (UNDP/FAO, 2001; Ghimire et al. 2004; Yaofeng et al. 2009). Women and men perform different tasks and activities, and hence have different preferences, knowledge and skills (UNDP/FAO, 2001). Women usually have a greater store of knowledge on how biological resources can be used in the household whereas men's knowledge is more often related to how these resources can be used to earn an income.

The vast repository of traditional knowledge in the Himalayas has not been well-documented. This knowledge, gathered over generations, can be critical in helping the people of the Himalayas to adapt to the changes now being inflicted by both climate change and other socio-economic changes.

ADAPTATION TO CLIMATE CHANGE-WHEN GENDER MAKES A DIFFERENCE

Climate change may adversely affect the biodiversity of the Himalayas, and in doing so, it may endanger the livelihoods of mountain people. In facing this challenge, the rich knowledge that Himalayan women have for maximizing the use of natural resources found in mountain ecosystem and the varied skills they possess in appropriate mountain farming practices can help their communities to adapt.

Traditional Himalayan mountain communities have sound practices of seed processing and seed preservation. Studies show that 80–90 percent of the seed requirements for farm-household crops are met through a traditional seed management and exchange systems where the role of women is very significant. Women manage a large diversity of seeds by participating in all aspects of farming and are active in exchanging seeds within the community and between different communities and villages. They are the custodians of traditional knowledge related to seeds, and as such they help to maintain a diverse gene pool and contribute to the *in-situ* conservation of bio-resources (Shrestha 1998).

FIGURE 1. A woman selling fruits and vegetables in the market, Garo Hills, North East India

In mountain societies, medicinal plants provide pharmaceuticals for the primary health care needs of the community and also provide an important source of cash income. Men and women are responsible for different species of medicinal plants. Women are involved with those medicinal plants species which are relevant for maternal health care and which are used for common and minor illnesses (Rijal 2008). In Bhutan, 45 percent of the women collect medicinal plants. In Nepal, women are the ones who collect herbs and wild vegetables. In the Gabral Valley, (Swat district, Pakistan) 90 per cent of the medicinal herbs are collected by women and children (Hamayun et al. 2005).

Another serious change impacting Himalayan communities is the emigration of large numbers of men folk which has let to mountain farming becoming largely feminised. The knowledge and special skills that women have in agriculture and natural resources management will be critical to preserving and regenerating mountain biodiversity and in adapting to both social change and climate change.

ICIMOD is presently engaged in the following:

- Collecting and disseminating information on the impacts of climate change in the Himalayas.
- Conducting research on traditional knowledge and local adaptation strategies that give visibility to women's roles and capacities
- Building capacities to better understand gender issues related to biodiversity conservation
- Promoting new livelihood options that make the best use of alternative energy sources and enhance mountain people's resilience by reducing the pressure on mountain natural resources
- Advocating at the global, and regional level for the empowerment of women and for gender mainstreaming as an adaptation strategy to deal with both social change and climate change.

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4. CHUMBE ISLAND CORAL PARK EDUCATION PROGRAMME
Communicating Biodiversity and Climate Change

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Keywords: marine protected area, Environmental Education (EE), Education for Sustainable Development (ESD), eco-tourism, community involvement

INTRODUCTION

There is an urgent need to increase public awareness about the need for sustainable management of precious ecosystems such as coral reefs, mangroves, seagrass meadows and the entire seascape. Chumbe's environmental education programme provides an excellent opportunity for hands-on learning for both students and teachers from Zanzibar and other parts of the world.

The education programme of Chumbe Island Coral Park (CHICOP), in Tanzania has since 1994 offered one day school excursions to Chumbe Island to more than 4000 students and 800 teachers. The excursions offer environmental education for schoolchildren, and at the same time give teachers ideas for how to conduct field-based activities related to marine biology, forest ecology, environmental issues such as biodiversity and climate change. School education in Zanzibar, as elsewhere in the region, is based on rote-learning of an extremely academic syllabus having little relationship with the surrounding world. Though Zanzibar is a coral island, coral reef ecology is insufficiently covered in school syllabi. Extra-curricular activities, such as field excursions are rarely organised and very few children have a chance to visit reefs and coral-rag forests. This is also partly due to the fact that children (particularly girls) rarely learn how to swim. For more than a decade, the Chumbe Environmental Education Program is the only regular and large-scale program in Tanzania that fills this gap in school curricula and provides educational experiences and information for local schools on marine ecology and environmental issues.

CHUMBE ISLAND EXCURSION

Guided by park rangers on the coral reef and along nature trails created in the coral rag forest, the participating children have benefited greatly from the insight they gained from lectures and practical experience in marine biology, forest ecology and environmental protection discussing climate change and biodiversity issues. Most of the school trips have been conducted during spring tides to give the students and teachers an opportunity to visit the "intertidal trails" and learn more about the reef and its inhabitants by walking on foot on the exposed and dry littoral zone at low tide. Once the tide comes in, the students have also been given the chance to snorkel on the reef and be guided by the trained education rangers to see the diversity of coral, fish and other marine life on the Chumbe reef (figure 1 showing snorkelling preparation). An important part of the excursions has also involved an introductory talk about the coral reef ecosystem and threats to this precious ecosystem.

TEACHERS'S FEEDBACK

Teachers Evaluation workshops are held with the aim of evaluating the excursions and investigating the linkages between the Chumbe Environmental Education Programme and the current biology, geography and civics curricula. Interestingly, during the workshops the teachers found that there were more links between the school curriculum and the Chumbe programme than they had previously thought. Thanks to feed-back from teachers each trip to the island now includes a "pre-visit" to all schools where at least one member from the CHICOP team comes to the school to give a briefing about the trip, to show the students and the teachers the snorkelling equipment, the life jackets, and an introduction to the Environment etc.

In addition to island excursions, CHICOP has also conducted outreach work within schools, which has proven to be extremely successful. Not only have schools fully participated in the field excursions but have also shown great enthusiasm to undertake more field based, hands-on, extra curricula learning in the ordinary school environment. Some of the topics for many environmental clubs are waste management, biodiversity loss and climate change mitigation projects such as tree and mangrove planting activities.

FIGURE 1: Secondary students learning to snorkel, Chumbe Island Coral Park

ENVIRONMENTAL EDUCATION FOR THE COMMUNITY

Along with the Education Programme for schools, CHICOP has been actively involved in other projects to increase public awareness about the need for sustainable management of precious marine and coastal resources. Since CHICOP was created in late 1992, five former fishers from adjacent villages have been employed as park rangers and trained in marine park management and monitoring techniques for the reef and the forest. The majority of the Chumbe staff comes from local communities on Zanzibar and they all receive training on basic marine and coastal ecology, eco-technologies such as rainwater harvesting, and sustainable waste management practices such as composting, recycling and the importance of sending hazardous waste such as batteries to the municipality to dispose of it properly.

CHICOP is also building a reputation for having great knowledge in marine environment and in recent years Chumbe has been involved in training of Local Government Officials, groups of fishermen from all over Zanzibar, local NGO's and other groups interested in marine and coastal environment and education. When the consequences of climate change is getting more obvious in the region through increased coastal erosion, more frequent coral bleaching events etc, the interest for learning how to mitigate these impacts increase. More tree and mangrove planting projects is an example of activities undertaken with some of the environmental clubs in collaboration with the Department of Commercial Crops Fruits and Forestry in Zanzibar.

CONCLUSION

In response to the urgent need to create public awareness about the need for sustainable management of marine and coastal resources in Zanzibar, CHICOP, a financially self-sustaining conservation initiative, has been actively involved in several Environmental Education projects. Firstly, the successfully developed Education Programme on Chumbe Island has shown that both students and teachers are very enthusiastic about environmental education and are taking steps to incorporate more hands-on activities in their daily teaching methods. It is hoped that the environmental education model practised on Chumbe Island will be adopted and utilized by other areas of environmental significance in Tanzania. Secondly, the contribution of the park rangers and other Chumbe staff members to increased public awareness of the importance of marine protected areas, sustainable resource use, sound waste management and value of the healthy seascape to protect the shoreline from increased coastal erosion has played and will continue to play an important role in the environmental education of the entire Zanzibar community.

5. EVALUACIÓN DEL ESTADO DE CONOCIMIENTO BASE PARA LA TOMA DE DECISIONES EN CAMBIO CLIMÁTICO

Impactos en la biodiversidad

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Palabras clave: bases de datos, colectas científicas, línea de base, modelación, servicios de los ecosistemas

INTRODUCCIÓN

México es un país de megadiversidad y en su territorio -alrededor del 2% de las tierras emergidas del planeta- se concentra el 10% de las especies conocidas y una variedad enorme de ecosistemas, terrestres, marinos y dulceacuícola. A las amenazas tradicionales que han afectado esta diversidad, como son la destrucción de hábitats, la sobreexplotación, las especies invasoras y la contaminación, se ha agregado una nueva amenaza, el cambio climático. Los pronósticos indican que en el 2050 algunas regiones del país la temperatura podría aumentar 3°C, además de que se esperan profundas variaciones en el régimen pluvial. Si bien de manera general se conocen los efectos que el calentamiento global tendrá sobre la biodiversidad, el conocimiento más preciso del impacto de estos cambios sobre la diversidad de México es incipiente. Por esta razón es de suma importancia evaluar el estado del conocimiento actual en este tema, de manera que podamos establecer las prioridades para adquirir datos, información y conocimiento y con esto crear una base sólida para la toma de decisiones.

¿QUÉ SABEMOS HASTA AHORA?

En relación con información de clima, se cuenta con escenarios climáticos para la actualidad basados en climatologías generadas con información proveniente de las estaciones meteorológicas y con el uso de técnicas de interpolación. Para escenarios futuros un primer acercamiento fue optar por el 'downscaling' de escenarios generados a nivel mundial, utilizando datos de las estaciones meteorológicas para la calibración de estos modelos. Sin embargo el nivel de incertidumbre de estos modelos es alto, lo que a su vez genera incertidumbre en cualquier análisis posterior que se desarrolle con estos datos. Para generar información climática con mayor grado de certidumbre, apropiada para análisis básicos y en general para la toma de decisiones, se están elaborando escenarios para México basados en información local, aunque esta labor se ve limitada por el reducido número de estaciones que cuentan con series de datos suficientemente largas (Pavia et al. 2009).

México cuenta con información de biodiversidad resultado de una larga historia de exploración del territorio mexicano, junto con 15 años de organizar e integrar este conocimiento (CONABIO-PNUD, 2009). Se cuenta con bases de datos que contienen los registros de las colectas de especies georreferenciados, que si bien se trata de información incompleta (se tiene información para ciertos grupos taxonómicos, particularmente terrestres) y tiene sesgos importantes (las colectas se centran en determinadas regiones del país y son escasas en ambientes acuáticos), es información útil para analizar los efectos del cambio climático en la biodiversidad. Por ejemplo, con esta información se realizaron los primeros ejercicios para conocer la distribución futura de algunas especies de interés (*i.e.* Peterson, et al. 2002) y hoy es la base de nuevos análisis. Es menester continuar con los esfuerzos a nivel nacional de recopilación y generación de información básica, incluyendo especies del medio marino, pero también hace falta información sobre aspectos biológicos de las especies, especialmente datos poblacionales, información sobre los rangos de tolerancia, entre otros.

A nivel de ecosistemas se cuenta con distintas fuentes de información cartográfica que describen la distribución de los tipos de vegetación de México. A partir de esta información se analizó la distribución futura de la vegetación en distintos escenarios de cambio climático (Villers-Ruiz & Trejo-Vazquez 1997) lo que permitió obtener una idea de los cambios que se esperan a nivel de ecosistemas. En el presente se realizan distintos esfuerzos para obtener información actualizada, como por ejemplo el mapeo de los manglares del país, basado en información satelital y de campo (CONABIO 2009). Es necesario que se realicen ejercicios similares para otros ecosistemas, incluyendo el medio marino, de manera que se establezca una línea de base robusta para dar seguimiento en el tiempo a los cambios a nivel de ecosistemas.

Hasta ahora los esfuerzos para evaluar el efecto del cambio climático en la biodiversidad se han centrado en la modelación de los cambios en la distribución de especies y de los tipos de vegetación y hay un rezago importante respecto a la realización de estudios en campo. Un paso necesario es establecer protocolos de monitoreo a largo plazo tanto para especies de interés (prioritarias, indicadoras, de uso humano, etc.), así como de ecosistemas de interés, incluyendo ecosistemas marinos. Con este enfoque, la información resultante de los procesos de modelado adquiriría mayor confiabilidad para la toma de decisiones.

Por otro lado, los escasos estudios que se han generado en el país acerca de los bienes y los servicios que los ecosistemas proporcionan a la sociedad se centran en el papel de los bosques y de la vegetación en la captura de carbono. Este aspecto requiere ser reforzado y que se incluyan otros servicios como por ejemplo, la polinización. De igual forma es necesario valorar bienes y servicios de ecosistemas marinos y dulceacuícolas para los cuales se cuenta con aún menos información.

CONCLUSIONES

En conclusión, la toma de decisiones en materia de cambio climático para un país de las dimensiones y de la complejidad climática, fisionómica y natural de México es una labor que requiere, para empezar, contar con un conocimiento básico que proviene de distintos campos como la climatología, la biología, entre otros. Hoy se cuenta con una base de información pero los requerimientos son aún inmensos. Hemos definido siete líneas temáticas que deben de impulsarse de manera prioritaria para continuar con la adquisición de estos datos e información: Evaluación de especies, Evaluación de ecosistemas, Generación de datos básicos, Efectos combinados de cambio climático y otras amenazas a la biodiversidad, Conservación de la biodiversidad, Monitoreo, y Métodos y herramientas. Generar esta información es fundamental para avanzar en el conocimiento de los efectos del cambio climático en la biodiversidad de México.

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6. TRANSHIMALAYAN TRANSECTS

An Approach for Long-Term Ecological Research and Environmental Monitoring to Enhance Climate Change Adaptation in the Hindu Kush-Himalayas

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Keywords: regional learning, awareness, national capacity, and regional framework

LONG TERM MONITORING IN THE HINDU KUSH–HIMALAYAN REGION

The Trans-Himalayan Transect Initiative engages regional, national, and local partners and the global research community in a participatory and consultative process which encourages regional cooperation and national ownership, to build and enhance capacity for long-term environmental and ecological research and monitoring across the Hindu Kush–Himalayan (HKH) region. This Initiative provides both a geographical sampling frame and a supportive policy framework which builds on national and regional efforts. The improved understanding that it will provide will form the scientific basis for informed decision-making for conservation, adaptation, and sustainable development in the context of a rapidly changing climate. The transboundary approach will develop a regional knowledge base, regional baselines, policy frameworks for knowledge and information sharing, capacity building, and national ownership of monitoring and research efforts by promoting practical approaches for the maintenance and conservation of local ecosystem and by strengthening the resilience of mountain communities.

THE RATIONALE FOR A TRANS-HIMALAYAN TRANSECT INITIATIVE

Climatic, environmental and other change processes taking place across the HKH region are readily evident and increasingly controversial, as evidenced by the recent debate on glacial melting and the consequences it can have for the 1.3 billion people who live within the 10 downstream river basins. The HKH region is one of the least studied and least understood areas in the world; so much so that it was categorised by the recent IPCC Fourth Assessment Report as a 'data-deficit' region (IPCC 2007). Throughout the HKH, basic hydro-meteorological data, notably climatic time-series data and cryosphere measurements are either lacking or not readily available. The same is true for data on biodiversity, land use change, sustainable land management, the impacts of climate change on farming systems and genetic resources, ecosystem services, and carbon cycles. An improved understanding of the regional climatic change processes is essential for informed decision-making, risk and vulnerability mapping, sustainable (i.e. climate proof) development, the delineation and development of both adaptation and mitigation strategies, and effective biodiversity conservation and management. In the absence of consistent, long-term environmental data the impact that global warming and other change processes can have across the region are, and will continue to be, poorly understood and largely uncertain (Schild 2008, 2009). Effective ecosystem management, and the conservation of biodiversity and genetic resources, are all hindered by the lack of basic information. In addition, improved socioeconomic data is needed to understand the impact that climate change can have on communities and livelihoods, and to identify adaptation options and long-term strategies.

A REGIONAL APPROACH TO LONG-TERM ECOLOGICAL AND ENVIRONMENTAL MONITORING IN THE HKH

The Transect Initiative builds upon the concept of regionally agreed upon and identified regional-level 'transects' (i.e. mega-transects, or sampling corridors), and includes the concept of nested 'transboundary landscape complexes' (Figure 1) as focal points for in-depth studies and action research (Messerli 2009). The approach will be implemented based on consultations with, and the initiative and ownership of, the responsible national institutions. The transects, or sampling corridors, are delineated so that they are representative of the conditions and variability along several important gradients. Along longitudinally correlated moisture gradients, conditions range from dry in the western parts of the region to very wet in the eastern parts. Along altitudinal gradients, conditions range from tropical to alpine/nival. The transects cut cross the crests of the ranges along latitudinal gradients from south to north, and across a climatic gradient from tropical monsoon to continental climate regimes (Chettri et al. 2009). The transect approach, with nested transboundary landscapes as focal areas, allows for synergistic benefits from co-location of monitoring and studies, and provides the spatial and conceptual basis for a regional long-term monitoring strategy. As a geographically defined sampling frame, the transect is designed to enhance sampling efficiency since it encompasses both the scope and scale of the monitoring and data collection efforts required to represent the diversity and variability which exists across the HKH. Geographically defined transects allow for co-locating research, monitoring and sampling sites, in-depth studies, and action research projects across the region, and for both comparative research and synergistic efficiencies. Transects are selected to be representative of environmental conditions and inclusive of important selected parameters such as biodiversity hotspots, agricultural production systems, and socio-economic, cultural and institutional diversity. The spatially delineated sampling framework, identified to be representative of environmental variability, includes critical sections of river basins (recognising important upstream-downstream linkages) and biodiversity rich sites across the region. This is likewise intended as the basis for facilitating policy initiatives and regional cooperation on various issues related to climate change, such as biodiversity, livelihood improvement, and a better understanding of water resource management (especially with respect to adaptation to climate change). A regional cooperative approach built around the transect creates a policy-enabling environment based on common protocols and principles of open data exchange.

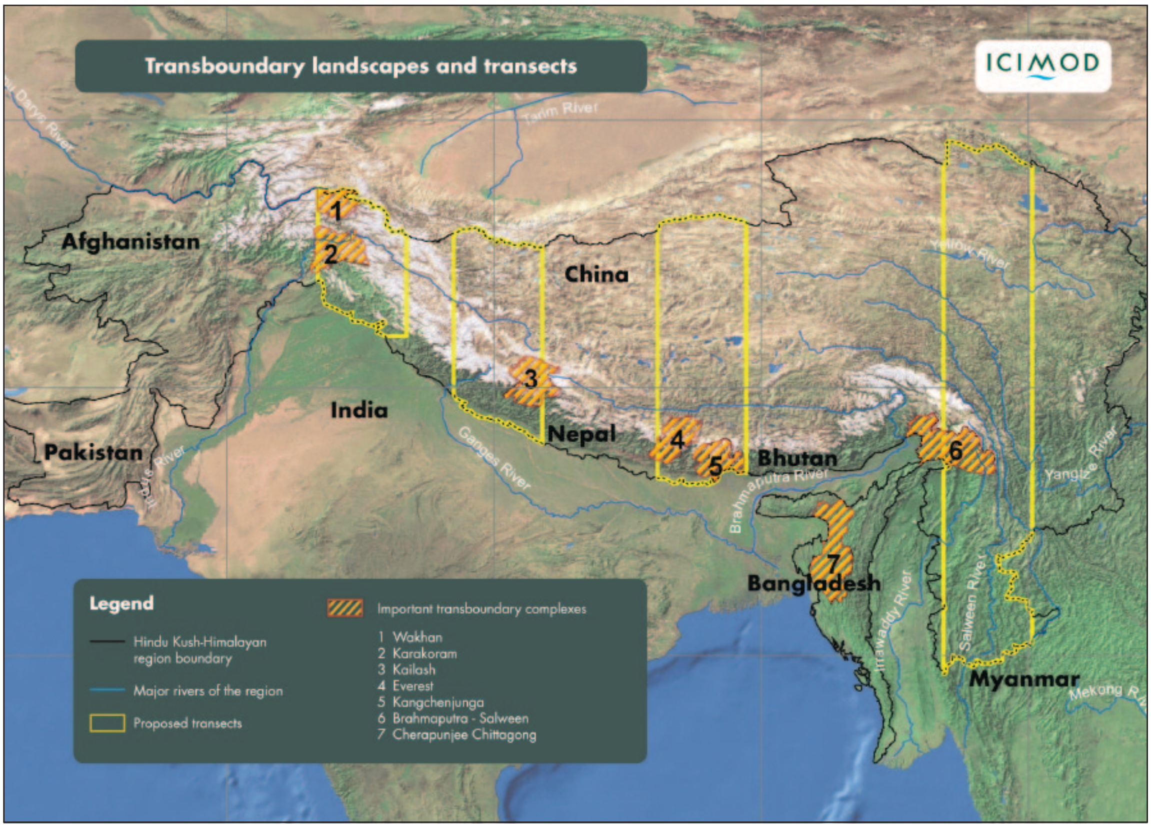

FIGURE 1: Trans-Himalayan transects and nested transboundary landscapes provide both a geographic sampling frame and a policy-enabling environment for long-term environmental monitoring and ecological research.

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7. RESPONDING TO THE VALUE OF NATURE

The Economics of Ecosystems and Biodiversity for National and International Policy Makers—A Summary

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Keywords: economics, global biodiversity, natural capital, ecosystem services

INTRODUCTION

The executive summary provided below is from the summary document TEEB released in November 2009 entitled *The Economics of Ecosystems and Biodiversity for National and International Policy Makers—Summary: Responding to the Value of Nature* (TEEB, 2009a). This document is a summary of the TEEB D1 Report for national and international policy makers released in November 2009 (TEEB, 2009b). It should be seen in the context of TEEB's efforts to engage a wider audience when this is both constructive and timely. In September 2009, for example, TEEB released its Climate Issues Update (CIU) (TEEB, 2009c) with the December climate change negotiations in Copenhagen in mind. The TEEB CIU demonstrated that analysing the value of biodiversity and ecosystem services not only enhances the case for strong international action to curb greenhouse gas emissions, but also highlights the inherent value for money in investing in natural capital to help both climate change mitigation and adaptation. Further TEEB reports will be released during 2010.

The aim of the TEEB D1 Report is to highlight the relevance of our work to mainstream policy making. We show that the failure of markets to adequately consider the value of ecosystem services is of concern not only to environment, development and climate change ministries but also to finance, economics and business ministries. Evidence presented here shows pro-conservation choices to be a matter of economic common sense in the vast majority of cases. At the heart of this complex problem is a straightforward and well-recognised issue in standard microeconomics. The lack of market prices for ecosystem services and biodiversity means that the benefits we derive from these goods (often public in nature) are usually neglected or undervalued in decision-making. This in turn leads to actions that not only result in biodiversity loss, but also impact on human well-being. The scale of current losses is imposing. The loss of tropical forest ecosystems alone accounts for about one fifth of global greenhouse gas emissions, yet the impact of such losses goes way beyond climate change. Loss of other valuable ecosystems also directly impacts food, fresh water and energy security, all of which are likely to be growing global issues affecting all countries in years to come.

The TEEB D1 Report for policy makers takes as its starting point that by failing to account for the value of ecosystems and biodiversity, we will make the wrong choices in responding to these and other challenges. It demonstrates that understanding and capturing the value of ecosystems can lead to better informed and possibly different decisions; accounting for such value can result in better management; investing in natural capital can yield high returns; and sharing the benefits of these actions can deliver real benefits to those worst off in society. This evidence and the arguments we develop in the Report provide a strong case for broad policy action. Put simply, making the benefits of biodiversity and ecosystem services visible to economies and society is necessary to pave the way for more efficient policy responses.

EXECUTIVE SUMMARY

Part I: The global biodiversity crisis: challenges and opportunities for policy makers

Natural capital—our ecosystems, biodiversity, and natural resources—underpins economies, societies and individual well-being. The values of its myriad benefits are, however, often overlooked or poorly understood.

They are rarely taken fully into account through economic signals in markets, or in day to day decisions by business and citizens, nor indeed reflected adequately in the accounts of society. The steady loss of forests, soils, wetlands and coral reefs is closely tied to this economic invisibility. So too are the losses of species and of productive assets like fisheries, driven partly by ignoring values beyond the immediate and private. We are running down our natural capital stock without understanding the value of what we are losing. Missed opportunities to invest in this natural capital contribute to the biodiversity crisis that is becoming more evident and more pressing by the day. The degradation of soils, air, water and biological resources can negatively impact on public health, food security, consumer choice and business opportunities. The rural poor, most dependent on the natural resource base, are often hardest hit. Under such circumstances, strong public policies are of the utmost importance. These policy solutions need tailoring to be socially equitable, ecologically effective, and economically efficient. Solutions are already emerging from cooperation between economists and scientists—and being tested and refined around the world. They point to four urgent strategic priorities:

- **to halt deforestation and forest degradation: (i)** as an integral part of climate change mitigation and adaptation focused on 'green carbon' and **(ii)** to preserve the huge range of services and goods forests provide to local people and the wider community;
- **to protect tropical coral reefs—**and the associated livelihoods of half a billion people—through major efforts to avoid global temperature rise and ocean acidification;
- **to save and restore global fisheries** and related jobs, currently an underperforming asset in danger of collapse and generating US$ 50 billion less per year than it could;
- **to recognise the deep link between ecosystem degradation and the persistence of rural poverty** and align policies across sectors with key Millennium Development Goals. Two related challenges lie ahead. The first is to understand the values of natural capital and integrate them into decision-making. The second is to respond—efficiently and equitably.

Part II: Measuring what we manage: information tools for decision-makers

Unlike economic and human capital, natural capital has no dedicated systems of measurement, monitoring and reporting. This is astonishing given its importance for jobs and mainstream economic sectors as well as its contribution to future economic development. For instance, we have only scratched the surface of what natural processes and genetic resources have to offer. As part of good governance, decision-making affecting people and using public funds needs to be objective, balanced and transparent. Access to the right information at the right time is fundamental to coherent policy trade-offs. Better understanding and quantitative measurement of biodiversity and ecosystem values to support integrated policy assessments are a core part of the long-term solution.

The first key need is to improve and systematically use science-based indicators to measure impacts and progress and alert us to possible 'tipping points' (sudden ecosystem collapse). Specific ecosystem service indicators are needed alongside existing biodiversity tools. Another key need is to extend national income accounts and other accounting systems to take the value of nature into account and monitor how natural assets depreciate or grow in value with appropriate investments. New approaches to macroeconomic measurement must cover the value of ecosystem services, especially to those who depend on them most—'the GDP of the Poor'.

Part III: Available solutions: instruments for better stewardship of natural capital

TEEB's analysis highlights existing and emerging solutions suitable for wider replication.

Rewarding benefits through payments and markets: Payments for ecosystem services (PES schemes) can be local (e.g. water provisioning) up to global (e.g. REDD-Plus proposals for Reduced Emissions from Deforestation and Degradation, as well as afforestation, reforestation, and effective conservation – if designed and implemented properly). Product certification, green public procurement, standards, labelling and voluntary actions provide additional options for greening the supply chain and reducing impacts on natural capital.

Reforming environmentally harmful subsidies: Global subsidies amount to almost US$ 1 trillion per year for agriculture, fisheries, energy, transport and other sectors combined. Up to a third of these are subsidies supporting the production and consumption of fossil fuels. Reforming subsidies that are inefficient, outdated or harmful makes double sense during a time of economic and ecological crisis.

Addressing losses through regulation and pricing: Many threats to biodiversity and ecosystem services can be tackled through robust regulatory frameworks that establish environmental standards and liability regimes. These are already tried and tested and can perform even better when linked to pricing and compensation mechanisms based on the 'polluter pays' and 'full cost recovery' principles—to alter the status quo which often leaves society to pay the price.

Adding value through protected areas: The global protected area network covers around 13.9% of the Earth's land surface, 5.9% of territorial seas and only 0.5% of the high seas: nearly a sixth of the world's population depend on protected areas for a significant percentage of their livelihoods. Increasing coverage and funding, including through payment for ecosystem services (PES) schemes, would leverage their potential to maintain biodiversity and expand the flow of ecosystem services for local, national and global benefit.

Investing in ecological infrastructure: This can provide cost-effective opportunities to meet policy objectives, e.g. increased resilience to climate change, reduced risk from natural hazards, improved food and water security as a contribution to poverty alleviation. Up-front investments in maintenance and conservation are almost always cheaper than trying to restore damaged ecosystems. Nevertheless, the social benefits that flow from restoration can be several times higher than the costs.

Part IV: The road ahead: responding to the value of nature

The need to move our economies onto a low-carbon path and the benefits of doing so are now widely acknowledged—yet the need to move towards a truly resource efficient economy, and the role of biodiversity and ecosystems in this transition, are still largely misunderstood or under-appreciated. Building momentum for the transition to a resource efficient economy calls for international cooperation, partnerships and communication. Every country is different and will need to tailor its responses to the national context. However, all may stand to gain – countries, businesses, people on the ground—by sharing ideas, experience and capacity. Policy champions can lead this process and use windows of opportunity to forge a new consensus to protect biodiversity and ecosystems and their flows of services. The TEEB studies and analysis hope to contribute to this new momentum.

ABOUT TEEB

TEEB, a study on The Economics of Ecosystems and Biodiversity, draws together experience, knowledge and expertise from all regions of the world in the fields of science, economics and policy. Its aim is to guide practical policy responses to the growing evidence of the impacts of ongoing losses of biodiversity and ecosystem services. It was initiated by Germany and the European Commission in response to a proposal by the G8+5 Environment Ministers in 2007 to develop a global study on the economics of biodiversity loss. This independent study, led by Pavan Sukhdev, is hosted by the United Nations Environment Programme with financial support from the European Commission, Germany and the UK, more recently joined by Norway, the Netherlands and Sweden.

In May 2008, the TEEB Interim Report (TEEB 2008) was released at the Convention on Biological Diversity's ninth meeting of the Conference of the Parties. TEEB for National Policy Makers report was released in November 2009. In July 2010 the TEEB for Business report will be released, followed by TEEB for Local and Regional Policy Makers and Administrators in September 2010. The final findings of the complete TEEB study will be presented in October 2010 at the CBD COP10 Meeting in Nagoya, Japan. More information, including reports, can be found at: www.teebweb.org.

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8. LESSONS LEARNT IN DEVELOPING BIODIVERSITY INDICATORS FOR A GLOBAL TARGET

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Keywords: indicators, awareness raising, improved decision making, mainstreaming, communication

INTRODUCTION

The International Year of Biodiversity is upon us, and the time of reckoning as to whether we have achieved the 2010 Biodiversity Target of "*significantly reducing the rate of biodiversity loss*" is imminent. The 2010 Biodiversity Indicators Partnership (2010 BIP) is a global initiative mandated by the Convention on Biological Diversity (CBD) to develop a suite of indicators to assess our efforts to progress towards the 2010 Target. The Partnership has been working with the scientific community and the CBD Secretariat to release the results in time for the 14th meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) and to support the discussions on the post-2010 agenda.

The 2010 BIP, with major support from the Global Environment Facility (GEF), brings together over forty organizations working internationally to further develop and promote indicators for the consistent monitoring and assessment of biodiversity, thereby providing the best available information on biodiversity trends to the global community. The 2010 BIP has three main objectives: (i) to ensure improved global biodiversity indicators are implemented and available; (ii) to generate information on biodiversity trends which is useful to decision makers; and (iii) to establish links between biodiversity initiatives at the regional and national levels to enable capacity building and improve the delivery of the biodiversity indicators.

KEY LESSONS LEARNT

Since the adoption of the 2010 Target in 2002, the process of identifying, developing and communicating the associated indicators has seen steady progress. With the results presented in the third edition of the *Global Biodiversity Outlook* (SCBD 2010a) and Butchart *et al*. (2010), the opportunity has arisen to review the overall process.

In July 2009, the CBD Secretariat and the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) jointly convened an *Expert Workshop on the 2010 Biodiversity Indicators and Post-2010 Indicator Development* to review the use and effectiveness of the 2010 biodiversity indicators and to consider the implications for the development of post-2010 targets and indicators. The workshop, held in Reading, UK, brought together 75 participants including government nominated experts and representatives of biodiversity-related conventions, UN agencies, academic and research institutions and other relevant international, intergovernmental and non-governmental organizations.

The outcome from the discussions highlighted both positive and negative aspects to the process and the indicators themselves (UNEP-WCMC 2009). The flexibility of the framework, allowing it to be implemented at a range of scales, has encouraged political adoption and support, although its CBD-focus does not make the relevance to other sectors and MEA processes clear. However, the complexity of the concept of biodiversity, and of the framework, is a continuing problem in terms of communicating to a wide range of audiences.

The use of the target and the associated indicators framework has collectively concentrated minds and spurred engagement, but the absence of clear targets and awareness raising is a barrier to arousing public interest. This is especially true for national level indicator development and use.

Awareness and action on climate change has become increasingly mainstreamed since the setting of the 2010 Target, and is conspicuous in its absence from the indicator suite (Mace & Baillie 2007). However, it is recognised that both climate change mitigation and biodiversity conservation need to be tackled together to effect real and sustained success (Campbell *et al.* 2009).

THE CBD POST-2010 STRATEGIC PLAN & CLIMATE CHANGE

The post-2010 CBD Strategic Plan is being developed taking into consideration the lessons learnt and recommendations arising from the range of meetings and workshops, and published reviews, to address the shortcomings in the 2002-2010 Strategic Plan (SCBD 2010b). It has been proposed that climate change considerations be specifically stated in the targets listed in the 2011–2020 Strategic Plan. By highlighting the mutual influences of climate change and biodiversity loss, and thereby encouraging appropriate action by all stakeholders, the achievement of the Vision and Mission statements may well be feasible.

As the climate change negotiations continue, the benefits of setting appropriate targets and the use of relevant indicators are becoming increasingly clear. The existing Copenhagen Accord (UNFCCC 2009) and the upcoming negotiations under the UN Framework Convention on Climate Change (UNFCCC) look to Parties to set or agree to binding targets on emissions reduction and other mitigation measures. However, the challenge is gathering political consensus in setting such "SMART" (specific, measurable, ambitious, realistic, and time-bound) targets, and developing scientifically-rigorous and compelling indicators.

The current CBD indicator framework (see www.twentyten.net) can be adapted to consider the biodiversity impacts or policy responses associated with climate change. For instance, forest extent and associated degradation and deforestation are being tracked, with clear relevance to the debate on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD). The beneficial role of protected areas in carbon sequestration has been highlighted (Campbell *et al.* 2008), and effective management of such areas would clearly be appropriate. The global ecological footprint indicator is an established measure for the degree to which humans, in particular in the developed world, are exceeding the planet's biocapacity. In addition to the above, the post-2010 indicator suite will itself also be revised to reflect emerging issues, such as climate change.

As has been widely reported, the climate change issue has gathered increasing interest within with the world's media, policy makers, and the general public. While the 2010 Biodiversity Target has raised awareness about the loss of biodiversity, and associated ecosystem services, there is considerable impetus for collaborative activities to build on the successes of the two sectors, and to highlight the potential mutual benefits from appropriate policies and financial investment.

The challenge for the CBD 2011–2020 Strategic Plan is to ensure that the momentum generated over the past eight years will not dissipate. Rather, it should increase in the coming years as efforts to harmonize the climate change agenda with biodiversity conservation are moved forward. The CBD Secretariat should, in particular through the Joint Liaison Group, be working closely with the other Rio Conventions to ensure that biodiversity is central to the climate change agenda. The 2010 Biodiversity Indicators Partnership will continue to support the global discussions on indicator development and use, produce policy-relevant information on biodiversity and ecosystem services, and aid appropriate capacity building at the national and regional levels with respect to mitigating climate change, while also supporting the achievement of the post-2010 CBD Vision.

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B

DIRECT DRIVERS OF BIODIVERSITY LOSS

9. BIODIVERSITY, CLIMATE CHANGE AND DESERTIFICATION ISSUES AFFECTING THE INDIGENOUS COMMUNITIES OF AFRICA

A Case Study of the Sahel and the Horn

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Keywords: climate change, desertification, Africa, Lake Chad, indigenous communities

INTRODUCTION

This Sahelian environment stretches all the way from Senegal to Somalia cutting across over ten African countries bordering the " Sahara desert" in the north and the "Sudan savannah" in the south, with an annual rainfall of less than 50cm per annum, is the home for many indigenous communities like the Mbororo (Cameroon and Chad republics), Tuareg (Niger) and the Kanuris (Nigeria, Niger, Cameroon and Chad republics) who depend on pastoralism, fishing, irrigation farming and mineral extraction as their main activities of livelihoods.

Desertification which is increasing at a rate of 0.8 kilometres per annum is a primary issue faced by Sahelian communities; the indigenous communities are continuously losing their grazing fields, farmlands, and even villages to the encroaching "Sahara desert" from the north. Food security is under threat from this because of losses in agricultural output. Indigenous communities in the Sahelian region are currently trying their best in control of the desert encroachment through tree-planting campaigns and other programmes on their own; however, the UN does not currently recognize their contributions and does not include their participation in its desertification activities in the region.

A second issue is the rapid decline in the volume of the water of the "Lake Chad" as a result of climate change, because this Lake is the main source of water supply, fishing and some other natural resources like the potassium, in addition to irrigation and pastoral farming by the indigenous communities along the shores of the lake. Sahelian indigenous peoples depend on Lake Chad, so the more the climate changes the more the Lake dries, poverty and unemployment increases among indigenous communities. There is currently far too little attention paid by governments and UN agencies working in the area to address the impacts of the climate change and the declining Lake Chad upon the futures of Sahelian indigenous communities.

In the more recent times flooding has become another major issue or an additional new challenge threatening the indigenous communities as well as the entire sahelian region as a whole ,for example in September 2009 many lives and propertises were destroyed by the flooding; In total, around 430,000 people in Burkina Faso, Senegal, Ghana, Mali, Mauritania and Ivory Coast (Cote I devoir) have seen damage to their homes or are facing health risks linked to the lack of fresh water, deteriorating hygiene or other problems as reported by "Reuters—AlertNet" (http://www.reliefweb.int/rw/rwb.nsf/db900SID/RMOI-7VMMC8?OpenDocument)

RECOMMENDATION

1. I call on Sahelian governments via the African Union and UN development agencies such as CBD,UNDP, UNESCO, UNEP, FAO, and IFAD, to ensure the participation of the indigenous communities of the Sahel and the Horn in all decision-making related to desertification, climate change, land and territory in Africa.
2. Indigenous issues should be mainstreamed into the UN Convention on Control of Desertification (CCD) and related desertification conventions. Indigenous peoples should be recognized as a 'major group' for the CCD Conference of Parties.

3. Recognition by African governments to communal lands and stopping to give lands and territories to bio-fuels.
4. Constructions of dams along all feeder rivers of the Lake Chad should be stopped. Just like Nigeria, all the other countries bordering Lake Chad should establish Lake Chad Development Authorities in their respective countries in order to promote irrigation and pastoral farmings in the Sahelian environment.
5. Cooperation with UNFCCC, UNESCO, CCD and CBD on traditional knowledge of biodiversity and sustainable development of arid areas in the Sahelian region; indigenous peoples must be involved in decision-making processes.

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10. DESERTIFICATION AND CLIMATE CHANGE IMPACTS ON NIGERIA'S DRY LAND RESOURCES

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Nigeria is frequently affected by climate change impacts as a result of natural processes. These are related to extreme weather and climate—desertification, drought, deforestation, loss of biodiversity etc. changes in global climate pattern will have serious implication for Nigeria as most of her social-economic activities especially in the drylands are extremely sensitive to current and abrupt climate change. Nigeria's challenges is to anticipation and prevent those impacts through application of adaptation measures.

According to Food and Agricultural Organization (FAO) forecast, 50% growth is required in food production by 2030, but this is being threatened by desertification. The current food crises in Africa need to be examined in line with the environment challenges of desertification and land degradation in drylands. Desertification is land degradation in arid, semi-arid and dry sub-humid areas. It is a major threat to the ecosystem and biodiversity that is worsening with climate change, drought occurrences, water crises, deforestation, overgrazing, etc. It has been estimated that as much as 45 million Nigerians lives in area prone to drought and Desertification and that Desertification is moving inward from Northern Nigeria at 0.6 km per year.

Climate change impacts and vagaries are clearly visible in this Nigeria Dry lands. The visible signs of desertification here is the gradual decrease of vegetation cover, water shortage, overgrazing, desertification etc. this dry lands has also recorded the highest incidences of property. 75% of Nigerians are said to be living below the poverty line by UNDP/FOS and 45% of this are in the dry lands. The link between climate change, desertification and reduction of poverty and hunger are especially obvious in marginal lands of Nigeria. This poster provides graphic details of the above scenario as well as preferred solutions.

11. CLIMATE CHANGE AND FORESTS
Dealing with an Uncertain Future

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Keywords: forests, climate change, adaptive management, uncertainty

INTRODUCTION

Global climate change—e.g., rising temperature, changing precipitation, rising atmospheric [CO_2]—is poised to become a major driver of changes in plant abundance and distributions in the 21st century. Some of the most important ecological and economic impacts will be associated with changes in the abundance and distribution of dominant tree species. Models of vegetation responses to climate change are beginning to play a key role in planning for adaptive management and are driving decisions about the importance of climate mitigation. Decision makers and natural resource managers may, however, hesitate to act on such scenarios until there is a strong consensus within the scientific community that these predictions are sound and that uncertainty in the scenarios has been properly addressed.

Our work focuses on developing quantitative estimates of changes in forest ecosystems in France that could occur due to changes in climate and atmospheric [CO_2]. It focuses on comparisons between models as an essential tool improve the confidence in our predictions and as a means of estimating uncertainty in the risks posed by changing climate and rising [CO_2]. Our goal was to generate estimates of risk for major tree species in France due to climate change, and to develop a better understanding of the mechanisms that underlie plant response to climate change. This modeling work is coupled with discussions with forest managers as a means of developing adaptive management plans for French forests.

METHODS

Seven models were used to explore the response of five of main tree species that dominate French forests: European beech (*Fagus sylvatica*), peduculate oak (*Quercus robur*), sessile oak (*Quercus petraea*), Scots pine (*Pinus sylvestris*), and holly oak (*Quercus ilex*). The models included three niche-based models, BIOMOD, Nancy-NBM and Stash, a phenology-based model, Phenofit, a mechanistic tree growth model, CASTANEA, a species-based dynamic global vegetation model, LPJ-Guess and two dynamic global vegetation models, ORCHIDEE and IBIS. The latter two models aggregate species into functional groups, of which we examined three: broadleaf deciduous trees, needle-leaf evergreen trees and broadleaf evergreen trees.

In order to make robust comparisons between models, the full set of models were run using a common set of climate, soils and initial tree distribution data. Climate was downscaled to a ca. 8x8 km grid for all of metropolitan France using a statistical method based on weather typing using a gridded construction of historical climate data for France. Large-scale weather patterns, temperature trends and atmospheric CO_2 concentrations were based on the IPCC AR4 (2007) A1B emissions scenario and the Arpège climate model of Méteo-France. All analyses presented here were based on a comparison of climate periods of 1971–2000 (present climate) and 2040–2060 (2050 climate window). In this climate scenario, temperatures increase by 2.3 °C during the growing season from the present to 2050 and precipitation declines by 27%. Soil texture data from a national soils database (INRA, Orleans), were used to derived plant available water. Future work will focus on running models with variants of the soils data and a broad range of climate change projections in order to have a much broader estimate of uncertainty in projections. Model comparisons presented here are based on the main bioclimatic regions of France. For each region we calculated the fractional change at 2050 compared to the projections for current distributions.

RESULTS AND DISCUSSION

In case of beech, the niche-based models BIOMOD and Nancy-NBM both projected nearly total loss of suitable climate space in the plains of France by 2050. At the opposite extreme, the LPJ-Guess model projects less drastic losses and only for the Southwest and Northwest regions of France. Beech fares much better in mountainous regions and in some cases its range expands significantly with models projecting that the distribution will move upward in altitude by ca. 100–300 m by 2050. Patterns are similar for the two deciduous oak species, but the contrast between models is much less pronounced with all models projecting substantial loss of suitable climate in the plains. All models project very severe loss of suitable climate for Scots pine by 2050 with almost total loss in Brittany, Southwest and Northwest regions. The is good qualitative agreement in models for substantial increases in the range of the deciduous evergreen, holly oak, although there is substantial variability in the degree of range expansion. In sum, most models predict moderate to severe losses of the temperate tree species in the plains of France, with the largest range of projected responses across models for Beech. All models project that temperate species will be relatively stable or increase their range in mountainous areas.

A discussion of the preliminary results of climate impact scenarios with managers of public and private forests suggests that there is a wide range of responses to reduce climate change impacts that are currently under consideration. Some forest managers tend to favor making large transitions in forestry practices to protect future income, this includes switching rapidly to warm and drought adapted tree species, with a strong emphasis on testing exotics, and the possibility of converting many forest short rotation tree crops, e.g., poplar. Others favor increasing the resistance and resilience of existing forest communities by increasing genetic and species diversity and by modifying forestry practices to minimize the impacts of drought. Further science/manager discussions will tackle the thorny issue of uncertainty.

Acknowledgements

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12. CONSERVATION CONNECTIVITY IN TRANSBOUNDARY LANDSCAPES

An Approach for Climate Change Adaptation in the Hindu Kush-Himalayan Region

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Keywords: biodiversity, Himalayas, climate change, conservation corridors, adaptation

INTRODUCTION

The Hindu-Kush Himalayas (HKH) are endowed with a rich variety of species and ecosystems of global importance and this region is on the priority list for many global conservation agendas (Brooks et al. 2006). The region provides numerous ecosystem services including freshwater that serves more than 200 million people in the immediate vicinity and 1.3 billion people living in the downstream river basins. All the eight HKH regional member countries[1] are signatories to the Convention on Biological Diversity and are committed to conservation. As a measure towards the immediate protection of globally significant landscapes, these countries have set aside more than 39 percent of their most biologically rich land terrain; the region now has a total of 488 protected areas, 29 Ramsar sites, 13 UNESCO Heritage sites and 330 Important Bird Areas (Chettri et al. 2008).

In spite of conservation efforts, the region faces overarching threats such as over extraction of resources, land use transformation, habitat degradation, and climate change (Eriksson et al. 2009). Above all, climate change poses a new challenge to the conventional approach commonly used to safeguard biodiversity within the boundaries of protected areas or reserves. Species living within the confines of protected areas cannot fully respond to climate change (by range shifts, by dispersion and by migration) within the ranges of these boundaries. Therefore, it is necessary to develop a network of corridors to aid connectivity between existing protected areas so that species can have a greater territorial area in which to adapt to the impacts of climate change (Williams et al. 2005). Today, many conservationists, including parties to the Convention on Biological Diversity, advocate an 'ecosystem approach' to conservation and management of the broader landscape matrix—this is a concept that is still evolving.

CONSERVATION IN THE CONTEXT OF CLIMATE CHANGE

Climate change can have significant implications for biodiversity conservation. Though the number of protected areas in the HKH region has increased over time, these are scattered and managed as 'conservation islands'; they lack the connectivity that is essential for species to thrive through the natural processes of speciation and evolution. The natural connectivity that exists in the region has been subjected to human-induced fragmentation that limits species dispersal, movement and migration that is key to species adaptation, survival, and evolution in changing scenarios. When protected areas are 'islands' surrounded by modified lands, there are fewer opportunities for the conservation of species diversity in the long term (Bennett 2003). Connectivity areas in the form of 'conservation corridors' may provide the needed natural environment that can assist species to respond and potentially survive the biome shifts caused by climate change since they will allow species to move freely between protected areas. However, establishing these will require regional understanding and cooperation between countries that share a political boundary across critical transboundary areas (Sharma et al. 2007). As discussed in the example of the Kangchenjunga Landscape below.

1 Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan

HIMALAYAN INITIATIVES: TRANSBOUNDARY LANDSCAPES AND CONSERVATION CORRIDORS IN THE HKH

ICIMOD and its partners have been instrumental in introducing both the concept of 'transboundary landscapes' and 'conservation corridors' for the HKH region. So far, seven transboundary landscapes have been identified in the HKH; these will promote connectivity across Himalayan ecosystems and encourage the cross-border research (see Figure 1). The broad objectives of these initiatives are:

- To facilitate an 'ecosystem management approach' in conservation. This will include inter-sectoral policy coordination through regional mechanisms that address transboundary issues such as wildfires, poaching, illegal trade, and climate change phenomena.
- To develop interconnectivity between the mosaic of protected area habitats in order to better allow species to cope and/or adapt to the stresses brought about by climate change.
- To increase ecological and socioeconomic resilience by promoting ecological integrity over a larger landscape. This will give species a greater chance to move over a larger territory in response to climate change and will also help the environmental processes and functions that maintain the ecosystem services for the well being of people living in these areas.
- To promote international scientific collaboration, and capacity enhancement in disciplines that will help to support mitigation activities such as prohibiting deforestation in the corridor areas, conserving exiting carbon pools, and promoting afforestation and reforestation.

IMPLEMENTING CORRIDORS AND A LANDSCAPE APPROACH IN THE KANGCHENJUNGA LANDSCAPE

In 2003, ICIMOD identified six conservation corridors which link 14 protected areas in the Kangchenjunga Landscape (KL) area. The KL is shared between Bhutan, India and Nepal, and each country has developed its own participatory corridor plans which are now being implemented through the development of a regional cooperation framework based on the guidelines of the Convention of Biological Diversity (Sharma et al. 2007). Establishing corridors and connectivity along a larger landscape required a thorough understanding of landscape structure, of the biodiversity present, and of the economic needs of the people who live there. Participatory planning led to the identification of corridors and to the development of strategies which conserve biodiversity while taking into account the livelihoods of the communities who live there through conservation–linked livelihood options. Corridor plans and conservation measures are currently part of their national strategies of all three countries. People living in corridor areas are now well-motivated to restore their local landscape and are supported by governments and community-based organizations.

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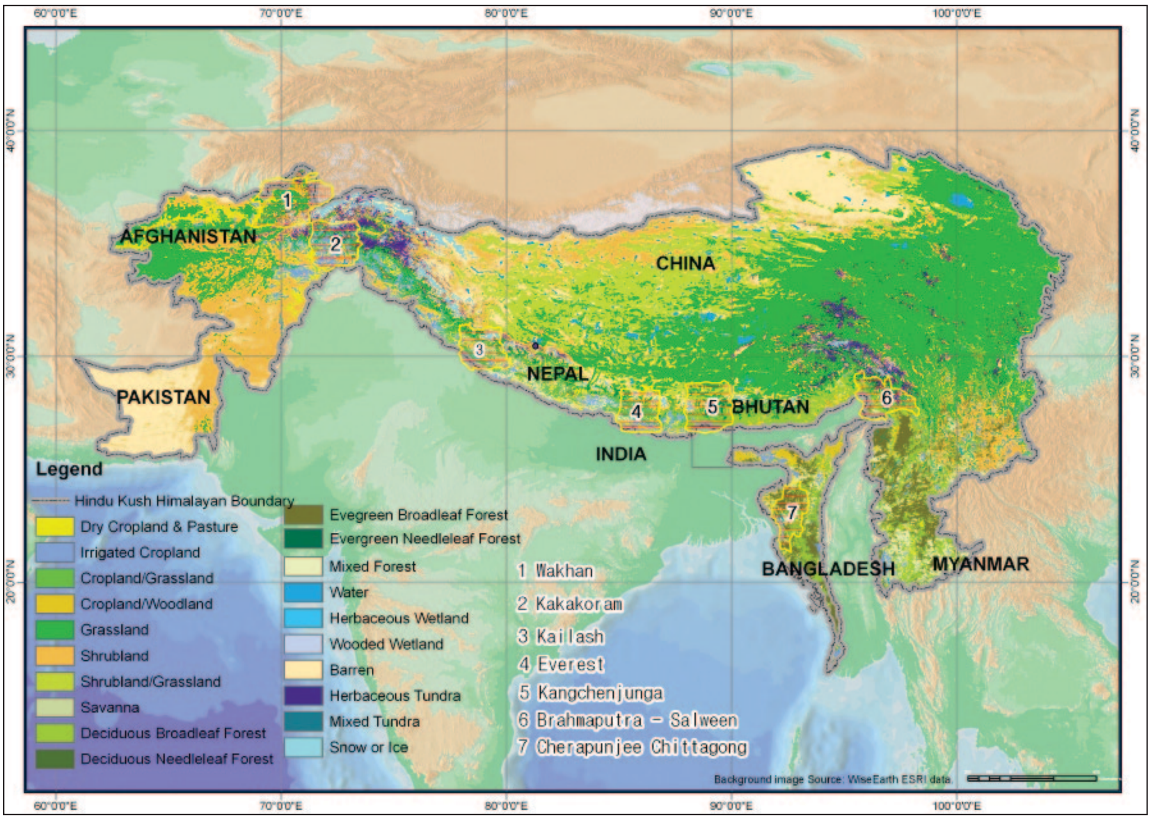

FIGURE 1: Seven transboundary landscapes in the Hindu-Kush Himalayas

13. EFFECT OF CLIMATE CHANGE AND DEFORESTATION IN THE DISTRIBUTION OF SOME VERTEBRATE SPECIES AND THE GENUS OPUNTIA INCLUDED IN THE STANDARD NOM-059-SEMARNAT-2001 IN MEXICO

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INTRODUCTION

Mexico is one of the countries considered mega-diverse. Mexico is home to an estimated 10% of terrestrial biodiversity on the planet, placing first in reptiles, the second in mammals, the fourth in amphibians and the fourth in plants. Mexico is not only known for its biodiversity but also for their high rates of endemism (Mittermeier and Goettsch 1992). Mexico as a mega-diverse country, is threatened by various factors. These factors include desertification of forests, loss and habitat fragmentation, inappropriate agricultural practices, land use change, the presence of invasive species and human population growth (Stedman Edwards 1998).

Also, another identified threat, though less known, is climate change, whose effect on the country's biodiversity has been poorly studied. It has been documented that fluctuations in the climate system elements (i.e. temperature, precipitation, pressure, etc..) have effects on biological systems, from ecosystems to the organisms that compose them. The consequences of these changes are likely to include the modification of the original distribution of species, increasing extinction rates and reduced levels of biodiversity on a global scale (IPCC 2002, Secretariat of the Convention on Biological Diversity 2003).

The Mexican standard NOM-059-SEMARNAT-2001 in Mexico is the red list of threatened species developed by the Mexican government as an effort to protect species at greatest risk.

OBJECTIVES

Identify the areas of potential distribution of selected species of terrestrial vertebrates and the genus *Opuntia*, considering scenarios of deforestation and climate change to identify areas of greatest risk of regional extinction and areas of greatest importance for conservation.

METHODS

This study integrates two research lines to evaluate the effect of habitat loss and climate change in the geographical distribution of selected species of terrestrial vertebrates and the genus *Opuntia* in Mexico. We generated ecological niche models projected as potential distributions of a representative sample of terrestrial vertebrate species and the genus *Opuntia* in Mexico and listed in NOM-059-SEMARNAT-2001. The "current" distribution of each species was estimated based on the loss of vegetation types which are associated, assessed from the map of land use and vegetation from INEGI (National Institute of Statistics, Geography and Informatics) (series 3). Also, projections were made based on climate scenarios A2 (severe stage or "pessimistic") and B2 (conservative scenario or "not pessimistic") for the years 2020, 2050 and 2080, in order to anticipate their effect on the distribution of the selected species.

Finally, we identified areas of greatest risk of regional extinction and areas of greatest importance for conservation.

RESULTS

We obtained the distributions models for 93 species of terrestrial vertebrates and the genus *Opuntia*. In both cases we obtained the potential distribution patterns and the current distribution patterns of these species, and then, we adjusted the distribution based on deforestation information. Finally, we analyzed the impacts of climate change on species distribution under different scenarios.

We note that deforestation and climate change have different impacts on the distribution of the species studied. Overall, it appears that the priority sites for conservation correspond to the Gulf of Mexico coast, as well as significant portions of the states of Tabasco, Chiapas and Yucatan. In northwestern Mexico highlights the Gulf of California.

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14. CORAL REEFS, BIODIVERSITY, ECOSYSTEM SERVICES AND CLIMATE CHANGE
A Post-Copenhagen Strategy

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Keywords: coral reefs, climate change, ocean acidification, biodiversity, ecosystem goods and services

INTRODUCTION

By 2008, 19% of coral reefs had been lost and 35% were threatened through direct human impacts (Wilkinson, 2008). In addition to coral reefs being the most diverse marine ecosystems on the planet, half a billion people depend to some degree on the goods and services provided by coral reefs (Wilkinson, 2008). Many within the coral reef research community believe that climate change is already forcing coral reefs into an irreversible decline which may lead towards ecosystem collapse in the next thirty years (Veron et al, 2009). The UNFCCC COP15 in Copenhagen in December 2009 failed to produce a binding agreement to halt or limit carbon dioxide emissions. In light of this, a comprehensive strategy that will address the compounding impacts of direct human stressors on coral reef ecosystems in order to increase their resilience to climate change is imperative.

THE VALUE OF CORAL REEF ECOSYSTEMS

Tropical coral reefs are the most biodiverse marine ecosystems and amongst the most diverse ecosystems on the planet. Although coral reefs represent just 0.2% in area of the marine environment, they are estimated to harbour around one third of all described marine species (Reaka-Kudla, 1997), and more than a quarter of all marine fish species. More than 93,000 coral reef species have been described to date and tropical coral reef ecosystems are estimated to support 1–3 million species (Reaka-Kudla, 1997). Some researchers estimate the number of animal and plant species on coral reefs as at least or more than 9 million (Sheppard et al, 2009).

Tropical coral reefs are also amongst the most productive ecosystems. More than 100 countries have coastlines with coral reefs and almost half a billion people (8% of the world's population) live within 100 km of a reef (Moberg and Folke, 1999). Consequently, tens of millions of people depend on reef ecosystems for food, coastal protection, building materials and income from tourism. Coral reefs supply about 10% of the world's marine fisheries landings and are of particular importance to small-scale fishers (Allsop et al, 2009; Wilkinson, 2008). The values of goods and services provided by reefs have not been accurately determined, but estimates range from $172–375 billion per annum (CI, 2008; Fischlin et al, 2007). This is probably an underestimate as many of the benefits of coral reefs pass through non-market economies or involve ecosystem services such as nutrient cycling, which do not have a market value (Moberg and Folke, 1999).

CURRENT STATUS AND THREATS

Despite their critical importance in terms of biodiversity and human well-being, it is estimated that 19% of the world's coral reefs were lost by 2008, with a further 15% under imminent threat and 20% under threat of loss in the next 20 to 40 years (Wilkinson, 2008). The major causes of coral reef degradation are overfishing and destructive fishing practices, sedimentation and pollution arising from land use change, agriculture and industry; unsustainable and destructive coastal development; and diseases, plagues of coral predators and introduced species (Wilkinson, 2008).

However, these estimates do not take into account the combined effects of climate change on coral reefs such as acidification, increases in sea temperature, sea level rise and more frequent occurrence of large storms

(Wilkinson, 2008). When these are factored in, all remaining coral reefs are categorised by the Global Coral Reef Monitoring Network as critically endangered or threatened with destruction (Wilkinson, 2008).

CORAL REEFS AND CLIMATE CHANGE

Global climate change will threaten all coral reefs through increased frequency of coral bleaching events, ocean acidification and increased frequency of serious storm events (Wilkinson, 2008; Carpenter et al, 2008). Temperature-induced mass coral bleaching causing widespread mortality on the Great Barrier Reef and many other reefs of the world started when atmospheric CO_2 exceeded 320ppm (Veron, et al, 2009). At today's level of ~390ppm CO_2, reefs are seriously declining and time-lagged effects will result in their continued demise with parallel impacts on other marine and coastal ecosystems. To ensure the long-term viability of coral reefs it has been strongly recommended that the atmospheric CO_2 level be reduced significantly below 350ppm (Veron, et al, 2009). Given the above, and the lack of a firm decision at Copenhagen to reduce the level of carbon emissions, ecosystem-based management to prevent or significantly reduce the direct anthropogenic stresses on coral reefs is essential over the next decade to increase to resilience of the ecosystem to the effects of climate change.

THE NEED FOR A CORAL REEF EMERGENCY STRATEGY

Given that there is a clear and increasing need to address current anthropogenic and also future climate change impacts on coral reef ecosystems it is essential that actions and mechanisms to protect and restore coral reefs are well coordinated and implemented at multiple levels. In April 2010, a web-based workshop will be held at the Zoological Society of London with coral reef specialists representing a wide range of research, governmental and non-governmental organisations to work collectively and agree on a coral reef emergency strategy that will provide a framework for such a global approach. The strategy aims to address the following:

- Identify current gaps in knowledge, monitoring and management of coral reefs
- Identify future short/medium and long term needs to sustain and restore coral reef ecosystems in terms of the:
    - Technical and logistical capacity required for effective management
    - Elimination or reduction of the main threats and drivers
    - Mitigation of and 'adaptation' to the effects of climate change
- Set up or improve effective co-ordination between:
    - The main organisations involved in coral reef conservation
    - Existing and proposed coral reef initiatives (e.g. Coral Triangle Initiative, Caribbean Challenge, Micronesia Challenge, Indian Ocean Challenge)
    - Regional management bodies
    - Coral reef nations through global fora
- Identify priorities for action such as the:
    - Specific coral reefs or regions that need immediate attention
    - Main threats and drivers of degradation
    - Current bottlenecks preventing progress e.g. lack of capacity

The draft strategy will be presented in more detail during SBSTTA 14 and will be finalised in time for presentation at the CBD COP10 in October 2010.

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15. PLANNED ADAPTATION
Increasing Habitat Biodiversity Under Climate Change By 2020

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Keywords: biodiversity baseline, planned adaptation, historical rate of loss, regulation, climate change

Land surveys of southern Ontario, Canada, dating from 1792 help define the baseline levels of habitat biodiversity that existed prior to European settlement. By using this data to identify the starting point for the present decline in habitat biodiversity, we were able to establish and quantify the historical rate of loss and to subsequently predict changes in habitat biodiversity by 2020 and beyond through climate-biodiversity modelling.

PRE-SETTLEMENT BASELINE BIODIVERSITY DATA (1792)

The pre-settlement survey data encompasses the 19 counties from Bruce to Norfolk and Essex to Durham and documents native biodiversity that existed before the conversion of forested land for agriculture or development. In southern Ontario, more than 30% of the native biodiversity has been lost over the last 200 years. At this rate, a further 20% is predicted to be lost over the next 100 years due to creeping climate changes, land-use changes, agricultural expansion, wetland drainage and insect/disease losses.

The climate of southern Ontario is already warmer and wetter, thereby causing biodiversity to adjust to these changes. Some of the greatest changes have been observed in the Carolinian zone, a narrow band which extends along the north shores of Lake Erie and Western Lake Ontario, including Long Point and Essex. In the Essex region, for example, the frost-free season has increased by 25 days from the 1940s to the present. The opportunity to plant new varieties of high value agricultural crops, combined with the already mild climate and existence of rich soils, led to the complete drainage of wetlands and the conversion of forested land to agricultural land. Prior to European settlement, 89% of this stretch of land hugging Lake Erie consisted of forest, wetlands and marsh; today, only 5% of the original forest remains.

NATIONAL BIODIVERSITY OBSERVING SITES (NBOS)

The Smithsonian Institution, under the auspices of UNESCO, initiated a global biodiversity observing program in 1992. Its Smithsonian Institution Biodiversity Monitoring (SI/MAB) network now numbers more than 500 sites in approximately two dozen countries. All of them have standardized one-hectare plot sizes and measurement protocols for multi-taxa monitoring. Canada has 104 SI/MAB sites based largely in southern forest ecosystems where impacts on biodiversity are the highest. Southern Ontario alone has at least 25 SI/MAB sites, including the Long Point Biosphere Reserve in Norfolk County.

In Canada, heat has been identified as the primary driver of climate-triggered changes in habitat biodiversity. Increases of 1°C or 2°C translate into significant biological impacts, adaptations and vulnerabilities for tree species. Thus, the heat unit by family diversity model is a helpful tool for predicting and evaluating the impacts of climate change on native biodiversity. Analyses based upon this model rely on data from climate stations placed within or near SI/MAB sites. Bioclimate profiles for at least 500 Canadian climate stations predicting future changes in the climate have already been developed by the Canadian Climate Change Scenarios Network (www.cccsn.ca) using Global Climate Model (GCM) and Canadian Regional Climate Model (CRCM) simulations.

The relationship between heat units and habitat biodiversity (> 85% explained) using data from international SI/MAB sites, with a special emphasis on southern Ontario and the Long Point site, is shown in Figure 1. Long Point is the most biological diverse SI/MAB site in Canada and is subject to Canada's highest loading of ground-level ozone, as well as high UV-B and exceedences of acid deposition targets. The increased mortality rate (> 75% since 1995) of flowering dogwood at this site was attributed to Dogwood anthraconose (*Discula destructiva*), a fungus believed to have been recently introduced to Canada and able to thrive in warming temperatures. So in addition to being one of the few sites in which a climate station and SI/MAB plot are co-located, Long Point also makes for an excellent case study for climate-biodiversity modelling on its own representative merits: it is surrounded by the pressures of development and agriculture, vulnerable to invasive species and disease, and affected by documented climatic stressors.

Based on the success of this modelling, we were able to predict the number of families at Long Point for the 2020s, 2050s and 2080s. Figure 2 shows substantial temperature increases at Long Point, resulting in increased habitat biodiversity under climate change and planned adaptation. Since one climate model by itself led to inflated results, we chose a synthesis of models: ensemble values from seven GCM and RCMs were selected with a threshold cut-off of ±0.5°C for the 2020s (1.2°C), 2050s (2.6°C) and the 2080s (4.1°C).

CLIMATE CHANGE IMPACTS ON HABITAT BIODIVERSITY

Figure 3 documents the sustainable biodiversity baseline, defined as the biodiversity established at the time of the pre-settlement survey in 1792. Loss of biodiversity when no land-use regulatory and agricultural expansion controls are in effect is illustrated by the Essex curve, which shows only 5% of the original habitat remaining. The Long Point curve reveals the initial high level of biodiversity in pre-settlement times and the decline in present-day biodiversity relative to the baseline due to development, agriculture and the slow cumulative impacts of invasive species and disease prior to land-use regulations.

The incremental warming of the climate system will create a more favourable environment for a 25% increase in habitat biodiversity (native and new species) over the next 100 years. Thus, provided habitats are protected from land-use changes and other human stressors, climate change will not only help slow the rate of loss but can also result in significant increases in biodiversity if planned adaptation options are implemented, such as proactive planting with new species.

CONCLUSION

Mere protective measures to conserve native tree species, given their historical losses, will prove limited in the long term. Not only will native species be stressed under changing climate conditions, but the combined impacts of invasive insects/diseases and land-use change will continue to further deplete native biodiversity. It is possible to re-establish the pre-settlement biodiversity baseline under climate change by 2020, but it will require both land-use regulation and the proactive planting of a combination of native and new species. Planned adaptation entails planting new species better suited to changing climatic conditions. Such measures have been tested for the last seven years at an experimental SI/MAB site at Humber Arboretum, Toronto, Canada to evaluate the success of both native and new species in the context of an altered climate. Additional risks with new forest species will require new management solutions. In the meantime, however, urgent action is needed now to implement aggressive insect/disease control actions, develop new policies to govern land-use changes and, above all, plant new forest species on a large scale.

Acknowledgements

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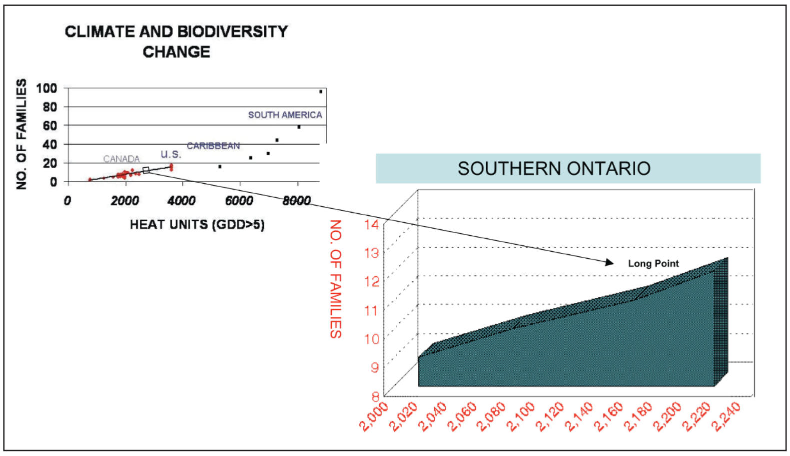

FIGURE 1: National Biodiversity Observing Sites (NBOS) and the Heat Unit by Family Biodiversity Model

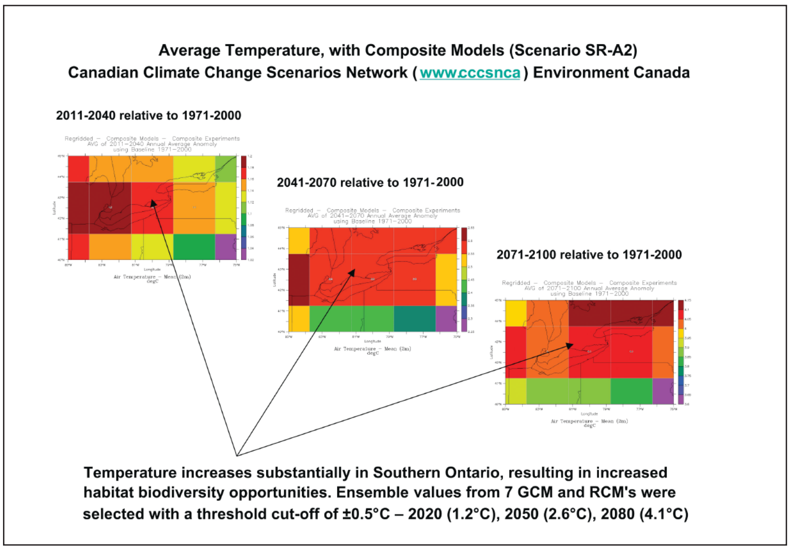

FIGURE 2: Modeled warming in southern Ontario using an ensemble of climate change models

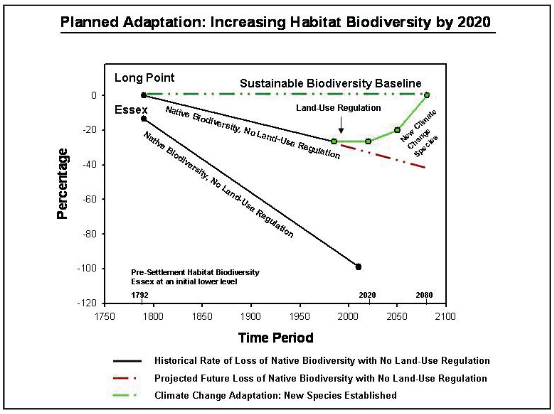

FIGURE 3: Historical rate of loss of native biodiversity and responses of biodiversity under climate change along with land-use regulation, insect/disease controls and planned adaptation

16. MODELING SYNERGISTIC EFFECTS OF CLIMATE CHANGE ON BIODIVERSITY

A Case Study in the Grijalva-Usumacinta Watershed, Mexico

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Keywords: threats to biodiversity, interrelation and synergy, modeling framework, land use & cover change, invasive species

INTRODUCTION

On a general level, it is well known that impacts on biodiversity caused by anthropogenic threats are interrelated and its effects can be differential depending on the combination of threat factors. The effect is not necessarily the sum of separate impacts but can be synergistic (Folke *et al.* 2004), as has been observed in the case of global decline of amphibian populations.

It is recognized that for making sound environmental management and conservation planning decisions it is necessary to consider future anthropogenic impacts on biodiversity which determine the long-term persistence of species and ecosystems. Especially under the expectation that climate change (CC) will contribute to amplify such impacts and complicate efforts to forecast their responses it is required to research the combined effects (McRae *et al.* 2008).

Yet few studies on how various anthropogenic actions impact biodiversity collectively have been carried out, especially concerning interactions and synergies of several threat factors and their impact. The research on impacts of threat factors on biodiversity is still very little comprehensive and most work is focused on assessing only one threat factor at a time; while the few works which include several threat factors treat them as additive. There are also studies on species level about the impacts from one single threat to biodiversity (McRae *et al.* 2008).

Based on an exploratory analysis from a case study on a regional scale in SE Mexico considering land use and cover change (LUCC), alien invasive species (AIS) and CC as threats to biodiversity and their spatial interaction under current conditions and two contrasting scenarios we propose a methodological framework to consider synergistic effects in our threat modeling approach. Our aim by developing this framework is to build impact scenarios for priority conservation areas resulting from CC and LUCC in combination with other threats and stresses, which we will apply to our regional case study.

THE CONCEPTUAL FRAMEWORK

Natural impacts have stronger effects in areas previously disturbed by human activity like it has been argued in the case of coral reefs and wetlands (Dale 1997). It has been recognized that LU/LUCC, CC and AIS are major drivers of biodiversity loss. These threats are interrelated (Opdam *et al.* 2009) and the joint effect on biodiversity can be differential depending on combinations of pressures and is not only the sum of separate impacts since they all lower the resilience of ecosystems through removing response diversity and the alteration of disturbance regimes (Folke *et al.* 2004)

LUCC is especially important as a major threat factor because it causes habitat degradation or destruction and shapes the spatial pattern of the remaining habitat which is a key factor for the persistence of biodiversity. In general LUCC acts as an initial disturbance in the ecosystems, entailing other disturbances (like wildfires, establishment of AIS, among others) and lowering the resilience of the affected ecosystems, making them more susceptible to other natural o not natural impacts, like CC. This results in a synergistic affectation of biodiversity through various impact factors (Laurance 1998).

A number of alien species become invasive following an initial disturbance, since the changed competition conditions favor rapid species replacement. Through the competition with native species, ecosystem processes are altered and there may be even a positive feedback because some invasive species change the microclimate where they occur so they are even more favored (Dale 1997).

It is being discussed that climate change may exacerbate current threats to biodiversity through various modes of action like phenological changes, range shifts, changes in the food web and other species interaction (McRae *et al.* 2008). Climate plays an important or even determinant role in disturbance regimes, so that CC can cause changes in disturbance regimes which lead to a movement, adaptation or extinction of species (Dale 1997).

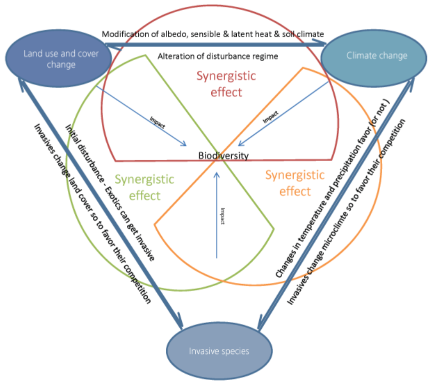

FIGURE 1: Conceptual framework of synergistic impacts on biodiversity from combined threats.

Besides the accumulation of several impact factors which can act synergistically on biodiversity by themselves, the loss of resilience of natural systems can exacerbate the synergistic effect of several impacts. Resilience may be lowered through removing response diversity, removing functional groups of species or removing whole trophic levels (Folke *et al.* 2004), which can be done through various anthropogenic actions, like LUCC and the introduction of AIS. Also the alteration of disturbance regimes as suggested from CC impacts have these effects. "The combined and often synergistic effects (…) can make ecosystems more vulnerable to changes that previously could be absorbed" (Folke *et al.* 2004).

CONCLUSIONS

The threat and impact studies on biodiversity usually represent an oversimplification of a complex thematic because it is widely unexplored field and specific data are mostly lacking. Given the potentially severe impact of coupled threats in priority sites for conservation it is important to forecast the combined impact in order to assess the suitability of those areas. Since field studies or experiments are too costly and timely in a megadiverse country, we propose that modeling is a suitable way to track how multiple anthropogenic threat factors interact with biodiversity. We suggest an alternative framework for considering not only additive impacts, but also non additive (or linear *vs* log, exp, penalty factor) combination of impacts considering spatial heterogeneity. Part of this challenge involves translating impacts on ecosystem processes into indicators resulting from LU, CC and AIS into effects on different aspects of biodiversity (composition, functioning and processes). Doing so requires the linkage of mechanistic models of climate, LU and behavior of AIS under scenarios of CC and LUCC and the interaction between them in one methodological framework. We present an example application of the proposed framework in a case study on a regional scale.

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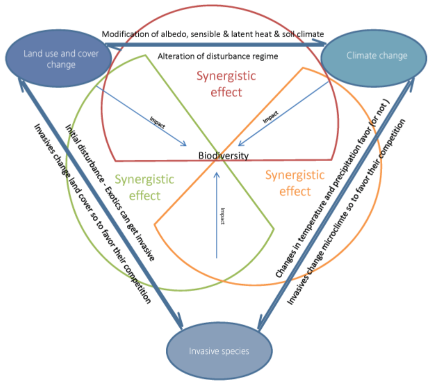

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17. ADDRESSING BIODIVERSITY LOSS THROUGH BIO-CONTROL AND MONITORING OF ALIEN AQUATIC INVASIVE SPECIES (*SALVINIA MOLESTA*) IN THE OKAVANGO DELTA

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Keywords: Salvinia molesta, Cyrtobagous salviniae, invasive species, biodiversity, OkavangoDelta

INTRODUCTION

The issues of climate change and biodiversity are interconnected, not only through climate change effects on biodiversity, but also through changes in biodiversity that affect climate change. Sustainable management of freshwater ecosystems is essential because ecosystems play a key role in the global carbon cycle and in adapting to climate change, while also providing a wide range of ecosystem services that are essential for human well-being and the achievement of the Millennium Development Goals (Secretariat of the Convention on Biological Diversity, 2009). Climate change is a rapidly increasing stress on ecosystems and can exacerbate the effects of other stresses, including from habitat fragmentation, loss and conversion, over-exploitation, invasive alien species, and pollution. Where species and ecosystems are well protected and healthy, natural adaptation may take place, as long as the rate of change is not too rapid and the scale of change is not too great. However, where climate change stacks as an additional threat upon other stresses such as pollution, overuse or invasive alien species, natural adaptive capacity may be exceeded.

In Botswana, the Okavango Delta, one of the largest Ramsar site in the world, and a relatively undisturbed and near-pristine ecosystem, stands out as a major storehouse of global significant biodiversity. While the ecological integrity of this wetland remains largely intact, alien aquatic invasive species, specifically *Salvinia molesta*, is posing as a serious threat to biodiversity. IPCC climate change models also indicate that the Okavango River Basin is likely to experience greater variability in spatial and temporal rainfall patterns and a larger number of hot days without cloud cover, which is likely to lead to increased evaporation. The effects of the invasion by the weed are likely to be exacerbated by climate change. Therefore there is need to put interventions in place to maintain the Okavango Delta ecosystem in its natural status, so as to cushion the impacts of climate change.

The Government of Botswana, United Nations Development (UNDP), and Global Environment Facility (GEF), through the BIOKAVANGO Project, is building the capacity of the private tourism operators in the Okavango Delta to control and monitor the *Salvinia molesta* weed (Figure 1).

METHODOLOGY

A mechanism to control and monitor the infestation of the *Salvinia Molesta* weed in the Okavango Delta is being implemented. Tourism operators in the Moremi Game Reserve, a protected area at the core of the Delta, covering 4888 km^2, have been capacitated to control the weed using biological means Four camps/lodges belonging to Desert & Delta Safaris (Camp Moremi), Moremi Safaris (Xakanaxa Camp), & Beyond (Sandebi Camp), and Orient Express (Khwai River Lodge)) were identified to become the champions of these demonstration projects. The camps identified at least two tour guides that were introduced to the weed and its biological control agent, the *Cyrtobagous salviniae,* and equipment for breeding and extraction of the weevils set up (Figures 2 and 3).

The biological control mechanism has been used by the Department of Water Affairs (DWA) in the Okavango delta since 1986. The *C. salviniae* destroys the weed through two mechanisms: (i) the larvae tunnels the weed rhizome, causing the plant to collapse and sink; (ii) adults feed more or less exclusively on the critical growth points such as apical buds and young leaves. Severely damaged plants would appear as dark brown foliage with very few green young leaves, while moderately damaged plants have a mixture of chocolate brown and green foliage indicating significant egg incubation, larval and adults' development. Healthy plants are green but have a few brown leaves indicating weevils' breeding and egg laying.

FIGURE 1 (a) and (b): Water exposed after the sinking of the *S. molesta* mat at the Paradise Pools, Okavango Delta

RESULTS

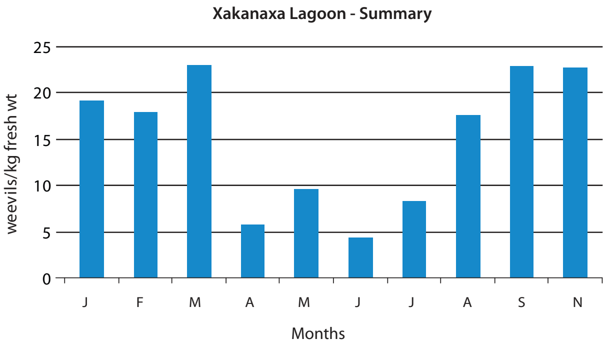

FIGURE 2: Mean number of weevil densities in Xakanaxa Lagoon

- This effort resulted in successful knowledge transfer from local government authority to tour operators/ local resource users on biological control techniques of *Salvinia molesta* weed. Owing to the successful piloting, the project was launched for replication throughout the delta and elsewhere (Figure 6). This is considered as reinvestment of nature-based tourism into biodiversity conservation.
- As a result of combined efforts, *Salvinia molesta* weed is now under control in the Okavango Delta (Figure 5). Monitoring is ongoing to identify new infestations and keep under control already infested areas.
- The biological control agent has been found to be target-specific, hence posing no threat to the broader ecosystem in which it has been introduced.
- The weevil population reduces during winter months because of lower temperatures (Figure 7). Breeding and adult development from egg, larva and pupa requires temperatures above 26^{0}C and declines significantly below 19^{0}C. This shows that there may be need to integrate both the physical and biological methods for effective control.

CONCLUSION

Monitoring of key indicators of ecosystem health, including parameters related to *S. molesta* are being linked hydrological patterns experienced in the Delta. This linkage forms the basis for climate change related responses of the monitored ecosystem indicators (hydrology, hydraulics, channel form, water quality, vegetation, aquatic invertebrates, fish, birds, river-dependent terrestrial wildlife, resource economics and socio-cultural aspects).

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18. CLIMATE CHANGE THREATS TO BIODIVERSITY IN GERMANY AND AUSTRIA

The Potential Distribution of Alien Plants

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Keywords: Central Europe, climate change, invasive alien species, modelling, plants distribution, nature conservation

INTRODUCTION

Biological invasions are recognized as an important element of global change and as a major threat to the conservation of biodiversity (Ruiz & Carlton 2003). Invasive alien plants can transform ecosystems by establishing viable populations with growth rates high enough to displace native species and thereby damage ecosystem structures and functions. Likewise it is expected that climate change will have essential impact on the development and growth of plants by which biodiversity will be directly or indirectly affected (Woodward 1987). The question of how climate change will interact in this global process of introduction and expansion of alien species is becoming highly relevant for nature conservation management.

The German Federal Agency for Nature Conservation picked up this question and commissioned a project to the Austrian Federal Environment Agency. The project prepared the application of the precautionary principle of the CBD which is transferred into national law by the German Federal Nature Conservation Act (BNatSchG 2010) by modelling the potential habitats for invasive and potentially invasive plant species in Germany and Austria under different climate change scenarios. Both countries, located in Central Europe, have undergone "typical" European land use histories, are similar in regard to their biogeographic setting and to invasion-relevant socio-economic drivers (e.g. gross domestic product per capita, trade intensity). On the other hand, they differ in regard to some other factors (e.g. size, population density, access to coasts). Shifts in species distribution induced by climate change are likely to be transnational. With regard to the two countries, species are expected to expand their distribution range rather from Austria to Germany than otherwise.

The project focused on 30 alien plant species which include some of the worst invasive alien species (IAS) in Europe and for which good quality data on their ecology and distribution are available (Table 1).

ASSESSING THE MAGNITUDE OF POTENTIAL DISTRIBUTION CHANGES OF ALIEN PLANT SPECIES BY CLIMATE CHANGE

We quantified changes in the potential distribution of the examined species under four climate change scenarios from the climate normal period (1961–1990) to a scenario period in 2050–2060. Species were selected to represent different stages of invasion, pathways, and life histories. Species listed on the German and Austrian interim black and grey lists of alien species were preferred (BfN in prep.). A methodical limitation was given by the minimum number of different records which is necessary to use statistical methods: species less than 30 records were excluded from the analysis. Modelling of the future potential distribution was based on the species' current distribution in Germany and Austria (fine-scaled grid-based distribution maps, cell size appr. 35 km2) and environmental predictors (baseline 1961–1990). The distribution data of the 30 species were extracted from the databases of the floristic mappings of Germany (BfN) and Austria (University of Vienna). Floristic data was completed by additional data from literature and herbaria specimen. The set of environmental variables included topography (elevation), infrastructure (highways, railways, streets), settlements, preferred land cover types (extracted from CORINE land cover units) and river density as well as various climate variables (temperature, precipitation), which are expected to determine current distribution of alien plant species. We used recently favored ensemble forecast techniques to predict current distribution of potential habitats. We employed generalized linear models (GLMs) and generalized additive models (GAMs) in combination with gradient boosting machines (GBMs). Predictions to the decade 2051–2060 were performed using the Global Circulation Model HadAM3 with four different European climate change scenarios (PIK 2004) resulting from four emission scenarios (A1f, A2, B1 and B2), each of which emphasizes a different set of social, environmental and economic ideals (IPCC 2001). All in all these climate change scenarios are relatively similar to each other, however, they show regional differences, e.g. in the increase in the annual mean temperature (Figure 1).

CLIMATE CHANGE WILL INCREASE INVASION RISKS

Our results clearly show differences in current patterns among species which reflect different habitat requirements. With the exception of alpine regions, almost all grid cells provide suitable habitats for at least one of the selected species. Under current climate, "invasion hot spots" are primarily large cities and their surrounding areas, warm regions like valleys as well as margins along important water ways and motor high ways. In Germany the Ruhr district and cities like Berlin, Dresden, Frankfurt/Main, Hamburg, Karlsruhe, Munich and Stuttgart as well as large water ways like the Danube and the Rhine provide suitable habitats for a wide range of alien plant species (> 20). In Austria cities like Vienna, Linz and Klagenfurt as well as the warmer eastern and southeastern regions are hot spots for alien plant species (Figure 1).

Further climate change will influence the geographical distribution of many species and will lead to significant changes in native biocoenoses. Higher temperatures will also favor the survival capability of alien species from subtropical regions. Several alien species already introduced into southern European areas will also expand their distribution range northwards as temperatures rise. Furthermore our results suggest that climate change will reduce the currently tight association of alien plants to German and Austrian metropolitan areas and transport infrastructures and will be responsible for an increasing occurrence of alien plant species in wide areas of the rural regions of Germany and Austria (Figure 1). Climate change induced expansion will lead to increasing problems in nature conservation, especially if invasive species are involved. Today invasive plant species already impose a significant threat on native species in Germany and Austria by inter-specific competition (e.g. *Fallopia japonica,* which finds suitable habitats in about 50% of the quadrants under current climate, Table 1), by hybridisation (e.g. *Populus x canadensis*) and by altering the invaded habitat (e.g. *Robinia pseudacacia*, with actually suitable habitats in about 60% of the quadrants, Table 1).

Despite uncertainties in bioclimatic modelling linked to biases in data sampling, modelling technique, spatial autocorrelation, biotic interaction or species evolution, the results of our transnational study may serve as a general model for predictions of climate induced shifts of species distribution. Finally, our results will provide an important basis in discussions about the development of more extensive prevention measures to stop the introduction of alien species, the arrangement of an early warning system on IAS in both countries and in the EU as well and a forward-looking nature conservation policy and planning to protect native biodiversity in a changing world.

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TABLE 1: List of modelled alien plant species and percentage of suitable quadrants of Germany and Austria under current climate conditions.

SPECIES	SUITABLE QUADRANTS	SPECIES	SUITABLE QUADRANTS
Acer negundo	33.08 %	*Impatiens parviflora*	60.21 %
Ailanthus altissima	18.05 %	*Lupinus polyphyllus*	54.00 %
Amarantus retroflexus	46.49 %	*Mahonia aquifolium*	38.29 %
Ambrosia artemisiifolia	27.21 %	*Parthenocissus inserta*	28.90 %
Amorpha fruticosa	26.56 %	*Paulownia tomentosa*	6.05 %
Artemisia verlotiorum	22.30 %	*Pinus strobus*	33.24 %
Asclepias syriaca	29.42 %	*Prunus laurocerasus*	16.89 %
Buddleia davidii	22.50 %	*Prunus serotina*	39.92 %
Bunias orientalis	40.70 %	*Pseudotsugo menziensii*	34.83 %
Duchesnea indica	16.93 %	*Quercus rubra*	48.67 %
Fallopia japonica	49.57 %	*Robina pseudacacia*	59.59 %
Fallopia sachalinensis	45.65 %	*Rudbeckia laciniata*	34.68 %
Helianthus tuberosus	47.04 %	*Solidago canadensis*	59.90 %
Heracleum mantegazzianum	44.96 %	*Solidago gigantea*	52.83 %
Impatiens glandulifera	55.53 %	*Sorghum halpense*	25.69 %

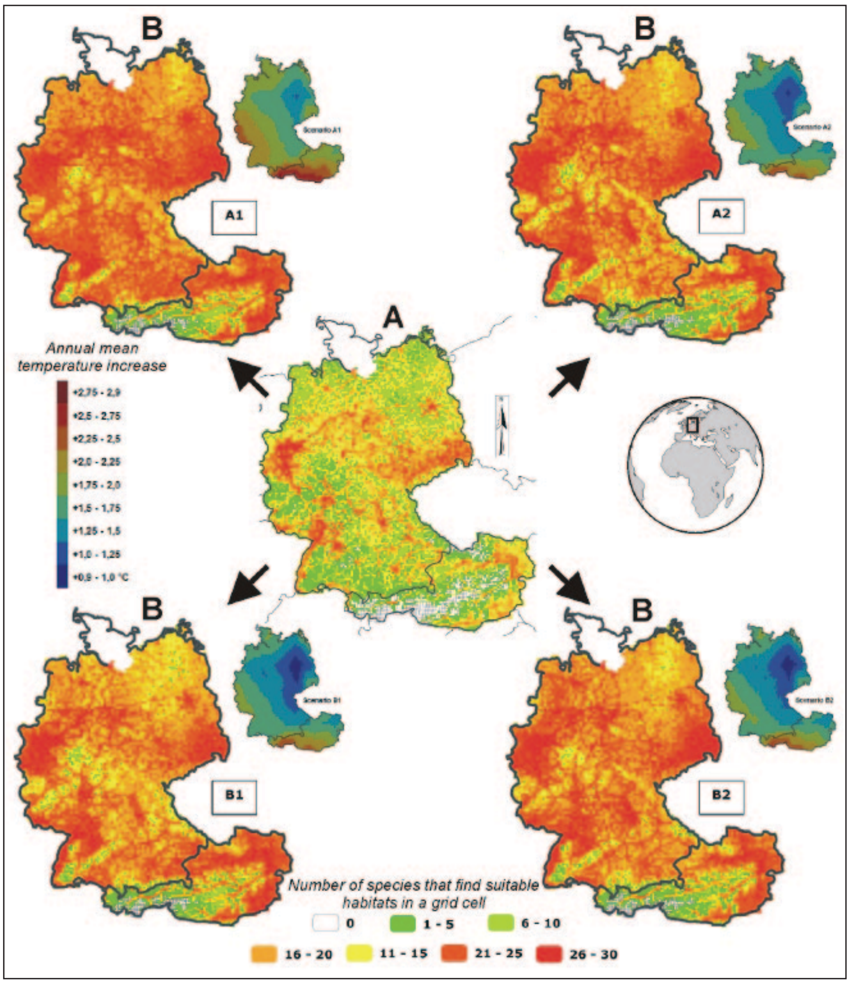

FIGURE 1: Invasion hot spots of alien plants in Germany and Austria. Cumulative map of potential habitat suitability A) under current climate and B) under four different climate change scenarios by 2051–2060.

19. THE SOLUTION TO GLOBAL WARMING COULD BE IN THE SOIL

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Keywords: carbon sequestration, soil fauna, global warming, climate change

INTRODUCTION AND CONCEPTS

Soil carbon is the generic name for carbon held within the soil, primarily in association with its organic content. Over 2700 Gt of carbon is stored in soils worldwide, which is well above the combined total of atmosphere (780 Gt) or biomass (575 Gt), most of which is wood. Carbon is taken out of the atmosphere by plant photosynthesis. About 60 Gt annually becomes various types of soil organic matter including surface litter while about 60 Gt annually is respired or oxidized from soil (Lal, 2008).

The two cornerstone processes of every ecosystem are photosynthesis and decomposition. Usually, decomposition involves a succession of different organisms. One set of organisms takes over after the last one has eaten what it can, and in doing so, changed the physical and chemical composition of its environment. Thus, ecological succession takes place in the microenvironment created by any decomposing log or animal corpse. For example lignin and cellulose are the major structural components of plant material, and these compounds are very difficult to break down. Only certain organisms can produce the enzymes needed to break the chemical bonds in lignin and cellulose and thus return them to the ecosystem. Fungi and bacteria are by far the most active decomposers. They are remarkably efficient, and the smaller the pieces to be decomposed, the faster these microorganisms are able to do their job. Organic waste, such as leaf matter and the droppings of herbivores, first feeds a host of small animals including insects, earthworms and other small invertebrates living in the plant litter. In turn, soil macro-fauna affects SOM dynamics through organic matter incorporation, decomposition and the formation of stable aggregates that protect organic matter against rapid decomposition. Figure 1 shows our conceptual thinking on the role of soil organisms in carbon sequestration. Our objective was to demonstrate that soil organisms offer processes and mechanisms by which elevated atmospheric CO_2 could be sequestered in to the soil to increase the soil carbon reserve and thereby mitigate climate change caused by global warming.

METHODOLOGY

The methodology supporting the above objective was a combination of the review of literature and output of a global project on the conservation and sustainable management of below ground biodiversity being implemented in seven tropical countries including: Brazil, Cote d'Ivoire, India, Indonesia, Kenya, Mexico and Uganda. The project inventoried the occurrence of soil organisms in diverse land use kinds ranging from forests to cultivated land. Soil samples were collected to determine the abundance, diversity and composition of the soil organisms while at the same time analyzing to determine the soil physical and chemical properties based on several methods. The organisms ranged from microbes (bacteria and fungi) to meso-fauna (collembolans, mites, etc) and macro-fauna (Earthworms, Ants, Termites, etc).

RESULTS AND DISCUSSIONS

The results show that soil carbon is mostly correlated with indigenous forests, with planted forests and with fallow systems which also coincide with the occurrence of the majority of the soil organisms. These findings coincide with observations of Marshall (2000) that simple communities of soil organisms present from the earliest stages of forest soil genesis become more complex and grow to astronomical numbers in mature for-

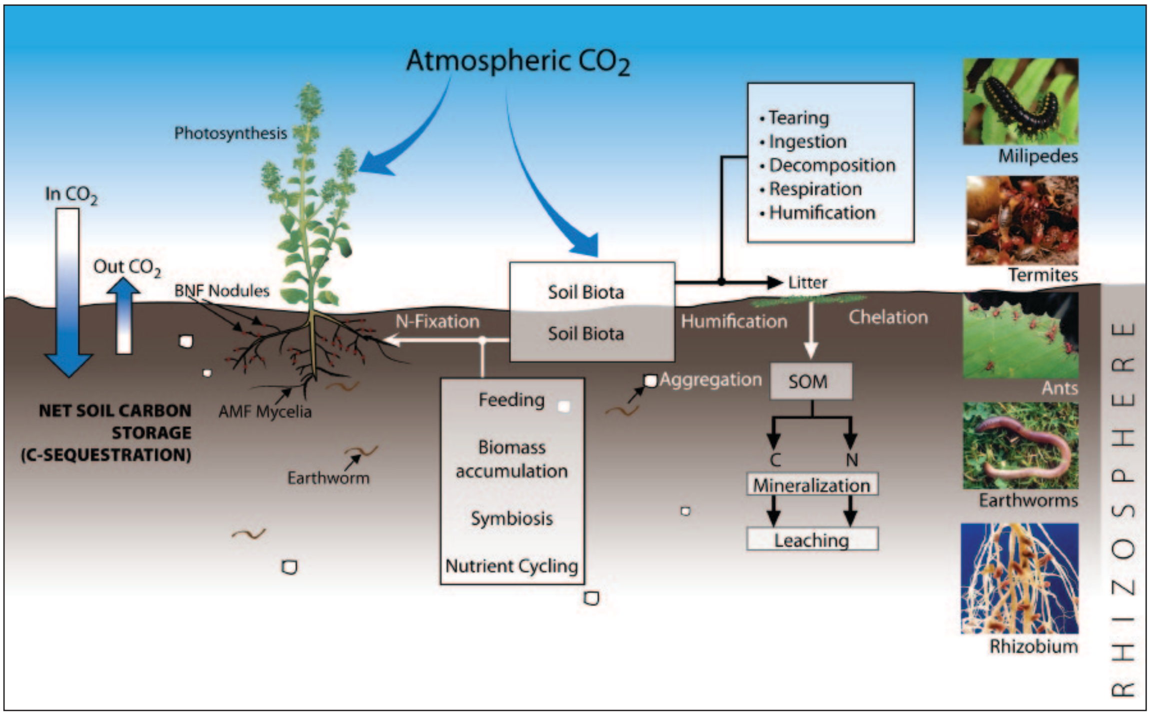

FIGURE 1: The different processes that contribute to carbon dioxide absorption and subsequent carbon sequestration into the soil by soil organisms

est soils. Several studies (Snyder et al., 2009; Ayuke, 2010), show that earthworm abundance, biomass and diversity are more important drivers of management-induced changes in aggregate stability and soil C and N pools than other macro-fauna. Carrera et al., 2009 concluded that temperature change alone does not explain all the observed increases in soil respiration and dissolved organic carbon (DOC) produced in peatland soils but rather soil invertebrate responses to warming are crucial in controlling C fluxes in peatland soils.

CONCLUSION AND TAKE AWAY MESSAGE

Soil biota can be used to sequester carbon in the soil. Important in this prospect are the possibilities of increasing soil macro-fauna abundance and their diversity to enhance vegetative decomposition, humufication, soil aggregation and increased biomass accumulation. Increasing microbial abundance will accelerate biological Nitrogen fixation, decomposition, chelation, and mycilial growth in the root hairs including controliing diseases in crops. Increased soil carbon will certainly increase the soil and crop productivity and hence more food. Planted and natural forests, fallows and agro-forestry systems are the best options to manage above ground carbon sequestration while inoculation should be used to increase the abundance of soil organisms above and beneath the soil.

Acknowledgments

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20. MARINE RESERVES—A POWERFUL TOOL FOR BUFFERING MARINE ECOSYSTEMS AGAINST THE IMPACTS OF CLIMATE CHANGE

Proposals from the Mediterranean, Pacific and Southern Ocean

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Keywords: marine ecosystems, resilience building, marine reserve, high seas

The resilience of the oceans and their ability to adapt to rising temperatures, changing currents, receding sea ice, changes in species distribution and abundance, rising sea levels and increasing acidification is vital if the oceans are to survive the onslaught of increasing CO_2 levels and global climate change. Experts recommend we reduce our exploitation of fish and other maritime activities in order to maintain healthy marine ecosystems, protect their vital functions and ultimately safeguard their role in stabilising the climate. Radical action is needed now to reduce greenhouse gas emissions, eliminate unsustainable practices in our oceans and establish networks of large-scale marine reserves to conserve marine ecosystems and safeguard the livelihoods of the many people who depend on them.

MARINE RESERVES: AN INSURANCE POLICY AGAINST CLIMATE CHANGE

A marine reserve is an area closed to all extractive uses, such as fishing and mining, as well as disposal activities. Marine reserves can protect near-pristine ecosystems as well as offer respite to heavily depleted stretches of ocean, allowing areas to recuperate, recover and ultimately regain some level of natural resilience. They are scientifically selected pockets of protection, which boost the overall health of the ocean, enabling increases in abundance, diversity, size and productivity of organisms in their immediate and adjacent areas. Marine reserves may also benefit highly migratory and endangered species, such as sharks and tuna, if placed along important migratory routes, nursery or spawning grounds. They help insulate marine species from overfishing, destructive fishing practices or pollution, giving them a greater chance to adapt to the effects of climate change. There is also increasing evidence that networks of large-scale marine reserves will be more effective at buffering environmental variability and providing greater protection for marine communities, as well as providing stepping stones for species driven out of their natural habitat by warming waters.

Greenpeace is campaigning for a global network of high seas marine reserves, covering 40% of our oceans, including 3 high seas areas: the Pacific, Mediterranean and Southern Ocean.

PACIFIC: WEST AND CENTRAL PACIFIC HIGH SEAS ENCLAVES

Greenpeace is campaigning to protect 4 distinct high seas enclaves that are surrounded by countries' Exclusive Economic Zones (EEZs) in the Western and Central Pacific region (see Figure 1). The majority of the region consists of open-ocean and deep-sea habitats, and include migratory routes for sea turtles, spawning grounds for yellowfin tuna and fragile and sensitive tropical coral habitat. These enclaves are found within the world's largest tuna fishery. Total landings of tuna are increasing, despite clear signs of overexploitation. These areas also have a high level of illegal, unregulated and unreported (IUU) fishing. Marine reserves in these areas would provide a safe haven for marine life, as well as a range of conservation, management and economic benefits to the region, including closing the loophole whereby IUU fishers can disguise their illegal catches taken from EEZs.

MEDITERRANEAN: THE SOUTHER BALAERICS AND SICILIAN CHANNEL

As part of a proposed network of marine reserves in the Mediterranean, Greenpeace undertook research to explore in greater detail the biological and ecological characteristics of the Southern Balearics and Sicilian Channel, identifying areas that should be set aside as marine reserves (see Figure 2). These areas are one of the most species rich and ecologically significant marine regions in Europe. Habitats range from shallow-water maerl beds, seamounts, canyon systems, trenches and submarine ridges. The areas include reproductive and nursery grounds for the great white shark, spawning and nursery grounds for bluefin tuna, nesting colonies for loggerhead turtles, as well as habitat to species such as sperm and fin whales. Large-scale marine reserves in both regions would provide protection to biodiversity currently threatened by longlining, purse-seine fishing for bluefin tuna, shallow and deep water demersal trawling, artisanal gillnetting, and recreational fisheries, as well as coastal development, chemical and plastic pollution, shipping, invasive species, tourism and climate change.

SOUTHERN OCEAN: THE ROSS SEA

The Ross Sea is the least affected oceanic ecosystem remaining on Earth. The Ross Sea shelf and slope cover approximately 3.2% of the Southern Ocean but support unusually large populations of many Antarctic species, including penguins, petrels, seals and killer whales. The unique ecology and relatively undisturbed state of the Ross Sea make it a 'living laboratory' for the study of marine ecosystems and the effects of climate change independent of complicating factors. However, the ecological integrity of the Ross Sea is in jeopardy because of a longline fishery for Antarctic toothfish. Currently under the Commission for the Conservation of Antarctic Marine Living Resources and the Antarctic Treaty is a process to establish a network of protected areas across the Southern Ocean—the global significance of the Ross Sea makes it a clear priority for protection. Greenpeace (and ASOC) are calling for the whole of the Ross Sea shelf and slope (i.e. to the 3000m isobath) to be made a marine reserve (see Figure 3) to ensure its values be preserved for the future.

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FIGURE 1: Location of the Pacific high seas enclaves

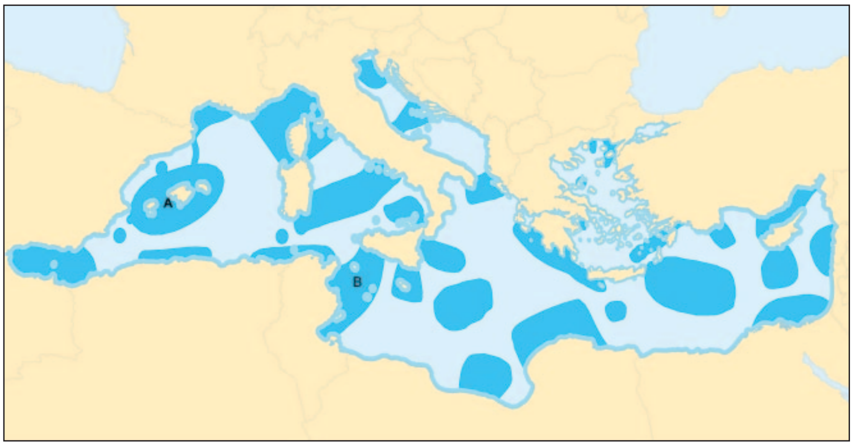

FIGURE 2: Proposed marine reserves in the Mediterranean—A: Balearic Islands; B Sicilian Channel

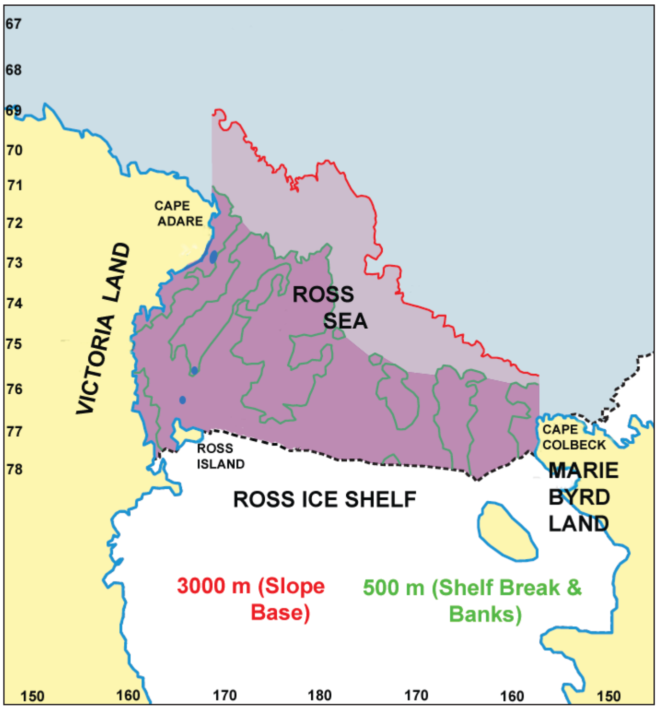

FIGURE 3: Proposed marine reserve in the Ross Sea

21. CLIMATE CHANGE AND QUARRIES IMPACT ON FLORISTIC COMPOSITION

Case Study of Vegetation Assessment on Limestone Hills in Bogor, West Java

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Keywords: limestone flora, quarries, Bogor, conservation

SIGNIFICANCE OF LIMESTONE AND ITS FLORISTIC ASSESSMENT

Species extinctions reach catastrophic levels in vast areas. To mitigate such a disaster, areas within biodiversity hotspots, i.e. regions exceptionally rich in endemic species and facing massive habitat loss, need to be identified for priority conservation. Economically valuable ecosystems within hotspots, however, may not be adequately protected because of vested commercial interests, weak legislation, or deficient biological data. Limestone karsts are a prime example of an ecosystem in this predicament (Clements *et al.*, 2006).

On the highly fragmented Sunda Shelf, karsts have formed "islands within islands", and these are known to contain reservoirs of biodiversity with high level of endemism (Clements *et al.*, 2006). Isolation within edaphically unusual karsts also exerts strong selective forces, which may lead to the evolution of endemic plant species (Kruckeberg and Rabinowitz, 1985). The many karst hills in Bogor have been saved from agricultural threats for their rugged terrain, but they are now prone to quarrying.

In Indonesia, quarrying has caused water shortages in human settlements because, in the absence of water storage in karsts, rain flows directly into underground streams that empty into the sea (Bambang and Utomo 2003). The mining of limestone and basement minerals are a primary threat to karst biotas because they cause extirpations of site endemic taxa.

In addition, very limited study has been carried out for limestone karst vegetation, particularly in Java, which is vulnerable to intensive anthropogenic activities and urban development. Many species extinctions have probably gone unnoticed on karsts that were destroyed before they could be sampled. Unless biodiversity surveys of karsts are intensified, the true magnitude of extinctions will never be ascertained.

Climate Change and Limestone Flora

Climate change leading to predicted dry season and warmer climate will affect the sensitive flora of limestone. Hence, it is fundamental to run biodiversity monitoring programs to understand the effects of climate change on the biota and to be able to adjust management and conservation accordingly. Limestone species and other soil-restricted taxa, that mostly endemics, may be presumed to face extraordinarily high risk from climate change because their narrow edaphic niches limit their possibilities to adapt through migration. However, their distinctive life-history traits and their competitive relationships with faster-growing soil generalists may complicate this picture and produce unexpected outcomes (Harrison et al., 2009).

ASSESSMENT

Sampling for vegetation survey took place on two limestone hills situated in west of Bogor (West Java) i.e. Gunung Kapur Ciampea (106° 41' 00.0" E and 06° 33' 00.0" S) and Gunung Nyungcung (106° 38' 00.0" E and 06° 27' 00.0" S). The two sites were already quarried since 1980s.

Importance values referring to the measure of the relative dominance of plant species in a forest community was counted. Importance values rank species within a site based upon three criteria viz. how common a species occurs across the site (relative frequency); the total number of individuals of the species (relative density);

and the basal area the species (relative dominance). Besides vegetation analysis, test for species potential for rehabilitation, i.e. *Ficus fistulosa* was carried out under competition with a grass species, *Tridax procumbens* in a greenhouse experiment.

FLORISTIC COMPOSITION OUTLOOK

The dominant families in Nyungcung were Euphorbiaceae, Myrtaceae, Sapotaceae, and Moraceae whereas in Ciampea, they were Euphobiaceae, Sapindaceae, Moraceae, and Rubiaceae. In both site it can be referred that Euphorbiaceae, and Moraceae were dominant. *Antidema montanum* is the most important species encountered in Nyungcung, whereas *Macaranga rhizinoides* that of in Ciampea (Satyanti and Kusuma, *in press*). There was a difference in floristic composition in Nyungcung and Ciampea, even though this was not statistically significant. The origin of floristic composition reported by van Steenis in 1931, i.e.: *Dipterocarpus hasseltii*, *Stelechocarpus burahol*, and a number of *Diospyros* species (Whitten and Soeriaatmadja, 1997) were hardly found in the area at present. Only a species of ebony, *Diospyros maritima* can still be found.

Site-endemic species face the greatest extinction risk when a karst is completely quarried, e.g. *Zeuxine tjiampeana* that is confirmed to be endemic by Comber (1990) to Ciampea limestone area. The species was not found in the two hills. Most probably this terrestrial orchid species has gone extinct. Extinctions of at least 18 karst plant species have already been documented in Peninsular Malaysia (Kiew, 1991). Furthermore, a new species of *Begonia* sp. nov. was reported as a new species. Other species, potentially endemic, were still probably to be occurred as all microhabitats on the hills have not been surveyed.

EX-SITU CONSERVATION

Karsts are major foci for speciation and important biodiversity arks. Considering the immense financial returns from cement manufacturing, their continued exploitation for limestone cannot be stopped. In Southeast Asia, karsts warrant greater conservation attention, given the relatively high limestone quarrying rates (Clements *et al.*, 2006). With respect to these, upon assessment several specimens of interesting limestone flora were collected from the field. These collections were then kept as ex-situ conservation collection in Bogor Botanical Garden West Java.

CONCLUSION

The number of flora richness in the two limestone hills exceeds 101 species which belongs to woody perennial species solely. Current figures of karst floral richness, however, may be underestimated as a result of the difficulty of sampling inaccessible areas such as cliff faces and summits. Limestone ecosystem is an example of ecosystem facing multi threats including anthropogenic induced climate change. Therefore, a more intensive floristic survey must be conducted to cope with the pace of its species extinction, together with an effort for ex-situ conservation.

Acknowledgement

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22. FOSTERING SYNERGIES BETWEEN BIODIVERSITY CONSERVATION AND FOOD SECURITY

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Keywords: agricultural biodiversity, food security, sustainable land use, adaptation to climate change

INTRODUCTION

Biodiversity, and especially agricultural biodiversity, is the basis of world food security and, thus, essential for the sustainable production of food and other agricultural products. However, global loss of agricultural biodiversity continues at an alarming rate as a result of intensification of land use, growing demand for biofuel and specialisation processes in agricultural production (IAASTD, 2008). At the same time, the predicted impacts of climate change and the increasing agricultural area affected by land degradation further increase the pressure on natural resources. In addition, by 2050, global demand for food is expected to increase by 70%, as a result of a growing world population and rising incomes (FAO, 2009). Thus, conserving agricultural biodiversity, using scarce land and water resources more efficiently and adapting to climate change are the main challenges world agriculture will face in the coming decades.

Methodology

It was upon this background that a study was commissioned recently by the German Federal Agency for Nature Conservation (BfN). The study aimed to identifying synergies and to discuss best practices in terms of approaches and instruments promoting an environmentally-sound land use with a special focus on conservation of (agricultural) biodiversity and its role for global food security. The leading question was, what actions and policy support are needed to foster synergies between food security and biodiversity conservation.

The study entailed a literature review, nine semi-structured expert interviews and a final expert workshop.

SYNERGIES BETWEEN BIODIVERSITY CONSERVATION AND FOOD SECURITY

The study focused on highlighting the synergies between food security and the conservation of biological diversity and agricultural biodiversity in particular. According to the Convention on Biological Diversity (CBD), agricultural biodiversity "includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agro-ecosystem."Agricultural biodiversity provides humans with food, raw materials and with incomes, including those derived from farming. Agricultural biodiversity also maintains ecosystem services, including soil and water conservation, maintenance of soil fertility and biota, and pollination, all of which are essential to maintaining agricultural production and food security. In addition, the genetic variability of crops and livestock, including wild varieties, enables crop and animal species to adapt to a changing environment and develop tolerances to extreme natural conditions (e.g. drought, water-logging) as well as resistances to particular pests and diseases. This is particularly important in the light of climate change. In addition, agriculture and other land use management activities can also make an important contribution to climate change mitigation, while contributing to biodiversity conservation (Convention on Biological Diversity, 2009). Examples of agricultural activities that can deliver multiple benefits include conservation tillage and other means of sustainable cropland management, sustainable rangeland management agroforestry systems, reduction of drainage systems in organic agricultural soils, improved fertilizer management and maintenance or restoration of peatlands and other wetlands (Bundesamt für Naturschutz, 2009). Thus, sustainable agricultural systems can play a major role in achieving global goals pursued by the Framework Convention on Climate Change and the CBD.

ACTIONS AND POLICIES REQUIRED TO FOSTER SYNERGIES

In order to achieve the above mentioned synergies, actions are proposed at different levels of intervention.

At the local level, practices of sustainable land management, such as smallholder farming, organic agriculture, adapted shifting cultivation practices, and other low input systems, can ensure sustainable food security without affecting biological diversity and contributing to greenhouse gas emissions. Sustainable land management systems are highly diverse and vary from location to location. One important aspect in promoting sustainable land management at the local level is strengthening the financial and technical capacity of farmers and local support institutions. At the same time, economic incentives need to be created for farmers that maintain sustainable agricultural practices, e.g. through payment of ecosystem services (PES) systems and enhanced access to markets for products based on agricultural diversity .

At the national level, policies need to create an adequate enabling environment in order to foster the implementation of sustainable land management at the local level. This includes investments in research, institutions, infrastructure, training and extension services as well as adopting conducive legislation and setting up incentive systems. Mainstreaming of conservation into rural development policies, poverty reduction and climate change strategies must underpin these efforts. Monitoring progress towards the expected impacts generated by investments and policies is crucial.

At the international level, there is a need to increase the collaboration, coordination and coherence of relevant conventions, i.e. UNFCCC, CBD and UNCCD, in order to build on synergies at the international level. Financial mechanisms that foster sustainable land management on non-forested land with the aim to achieve conservation, climate mitigation and food security goals are needed. CDM and REDD may play a role in this respect. The GEF as the major global fund for environmental initiatives already increasingly invests in initiatives across focal areas and moves towards a more integrated approach.

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23. THE IMPACT OF CLIMATE CHANGE ON THE VEGETATION OF THE REPUBLIC OF MOLDOVA

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Climate changes have a direct influence on the development of organisms (their growth, behaviour, etc.), on the modification of populations (efficiency, age group, etc.), on the structure and function of ecosystems (stability, cycles of mineral nutrition, humidity content, species' composition and interaction etc.), on the ecosystems' distribution in space, as well as some indirect influences, for example, modifications of climatic perturbations regime. All the changes that occur in the structure and function of natural ecosystems are connected with biodiversity changes.

According to climatic data from meteorological station Chishinău we can conclude that air temperature has a tendency to rise in the last 40 years (1961–1990) with 0,3° C, and the average temperature in this period is 9,5° C. However, there is an insignificant increase in annual rainfall – 72 mm, the average perennial – 476 mm. The aridity coefficient on the largest part of the territory of the Republic of Moldova is 0, 51 – 0, 65 or, there is a sub-humid dry climate, and in the south of the country (Cîmpia Bugeacului) the coefficient is 0,44, which is specific to semi-arid climate. The northern regions and partially the region of "Codrii Centrali" are zones with sub-humid and humid climatic conditions (K>0,65).

This diversity of climatic conditions directly reflects the territorial repartition of three botanico-geographical vegetation regions of our country:

1. Central-European mesophytic forests, preponderant of humid climate.
2. Sub-Mediterranean oak woods (forest steppe), preponderant of semi-arid climate.
3. Euro-Asiatic steppe vegetation, preponderant of arid climate.

Climate change impact on the vegetation of mesophilic woods of *Quercus robur L., Q. petraea Liebl., Fagus sylvatica L.* leads to a considerable reduction of the habitat on altitude and latitude. The rise of air temperature causes the intensification of vital processes in plants, requiring more water resources. The insufficiency of water leads to stressful situations in the activity of living organisms. Due to water scarcity, some species of plants of Northern, Euro-Asiatic or Central-European habitats, are forced to retire to the center of the habitat and they could extinct from the flora of our country. On the point of extinction are such forest plants as: *Alnus glutinosa, Alnus incana (L.) Moench, Cephalanthera rubra (L.) Rich., Gymnocarpium dryopteris (L.) Newn., Gymnocarpium robertianum (Hoffm.) Newm., Dryopteris cartusiana (Vill.) H.P. Fuchs, Dryopteris caucasiana (A. Br.), Fraser-Junicius et Corley, Padus avium Mill., Polypodium vulgare L., Telekia speciosa (Schreb.) Baung.* Some species of forest plants could retire their present habitat (which now is rather reduced): *Viburum opulus L., Sorbus aucuparia L., Actea spicata L., Orchis morio L., Cephalanthera rubra (L.) Rich., Maianthemum bifolium (L.) F.W. Schmidt, Orchis purpurea Huds., Dentaria quinquiefolia Bieb., Platanthera bifolia (L.) Rich., Orthilia secunda (L.) Hause, Anemonoides nemorosa (L.) Holub, Epipactis purpurata Smith., Euonymus nana Bieb., Hepatica nobilis Mill., Luzula multiflora (Retz.) Lej., Luzula pallescens Sw.), Aconitum anthora L., Dryopteris filix-mas (L.) Schott., Lilium martagin L., Listera Ovata (L.) R-Br., Pari quadrifolia L., Salvia glutenosa L., Scrophularia umbrosa Dumar, Stellaria nemoriun L.,Veratrum nigrum L.,* and many other species of mesophilic plants, and of soil with neutral or slightly acidified substrate. A group of thermophilic plants belonging to the Mediterranean, Balkan, Pontic and Dacian geoelement, would benefit from this considerable climate dryness and they will expand in the areas, liberated by the mesophilic species. These could be such critically endangered species of plants as: *Crataegus pentagyna Waldst. et Kit., Paeonia peregrina Mill., Carpinus orientalis Mill., Nectaroscordum bulgaricum Janka, Sorbus domestica L., Pyrus eleagrifolia Pall., Vinca minor L., Galantus elwesii Hook fil., G. plicatus Bieb., Lunaria annua L., L. rediviva L., Ornithogalum flavescens Lam., Scopolia carniolica Jacq, etc.* As arguments to those specified, we can mention that some species of thermophilic plants, characteristic only for southern forests, were recently found in the mesophilic forest body from Condritsa (for example *Carpinus orientalis*). Also, in the oak, durmast and beech forests can be found thermophilic plants from southern habitat: *Nectaroscordum bulgaricum Janka, Lunaria annua L., Lunaria rediviva L., Ornithogalum flavescens Lam., Doronicum hungaricum Reichenb. Fil., etc.*

The woods of *Quercus pubescens* and *Quercus pedunculiflora*, with all the species characteristic of Sub-Mediterranean xerophytes forests, will overrun the areas liberated by the mesophilic plants by the end of the 21st century.

C

BIODIVERSITY CONSERVATION

24. THE PROTECTION OF FORESTS UNDER GLOBAL BIODIVERSITY AND CLIMATE POLICY

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Keywords: REDD+, biodiversity, governance, monitoring

INTRODUCTION

Deforestation and forest degradation are the largest source of greenhouse gas (GHG) emissions in tropical developing countries. In a post-Kyoto agreement, which is currently negotiated under the United Nations Framework Convention on Climate Change (UNFCCC), deforestation and forest degradation are to be tackled through a REDD+ mechanism (Reducing Emissions from Deforestation and Forest Degradation in Developing Countries). It compensates developing countries that succeed in reducing their emissions from deforestation and forest degradation, respectively succeed in enhancing carbon stocks. Although many technical and political issues remain unsolved, REDD+ will have an impact (positive or negative) on numerous environmental services and political processes. A well designed REDD+ mechanism could therefore serve different environmental and development objectives and deliver "co-benefits" – in particular for the conservation of biodiversity. However, social and environmental co-benefits through REDD+ do not simply happen, especially if the focus of the mechanism remains on mitigating GHG emissions. In fact, the REDD+ mechanism entails numerous potential risks for biodiversity, storage of carbon and the rights of local indigenous peoples depending on the solutions found to as yet unresolved question in the current negotiation process. These potential risks can be reduced by a foresighted and careful design. In its decisions on the Programme of Work on Forest Biodiversity from May 2008 the Convention on Biological Diversity (CBD) refers to this problem by stating that future activities in the context of REDD+ should not run counter the CBD activities for protecting biodiversity in forest ecosystems (CBD decision IX/5, 2a). In fact, the creation of synergies between the different goals of UNFCCC, CBD and the Millennium Development Goals need to be considered in the political negotiations.

AIMS OF THE PROJECT

The project "The Protection of Forests under Global Biodiversity and Climate Policy" was initiated in order to analyze and discuss potential risks and synergies of different REDD+ options. It focuses primarily on issues of biodiversity conservation while recognising that biodiversity and developmental issues are intricately linked. It is divided into two sub-projects: Whereas sub-project 1 analyzes the discussion process at the international level and the development of national strategies, sub-project 2 focuses on how different environmental objectives are integrated in the implementation of REDD+ pilot projects.

RESEARCH FOCUS OF THE PROJECT

The research focus of sub-project 1 lies on the framework conditions and governance of REDD+. Effective and environmentally integer governance of REDD+ includes per definition the pursuit of collective interests, e.g. the development and implementation of biodiversity safeguards. This refers to the design of the mechanism itself as well as to its implementation at the national level. Good governance could ease the cooperation of responsible institutions and of the stakeholders who are to 'deliver' governance in the climate and biodiversity sectors at different policy levels. The international REDD+ mechanism, which is yet to be agreed upon under the UNFCCC, will only provide a rather general framework while the implementation of concrete activities and projects will be facilitated by national or sub-national policies and strategies. In order to adequately approach problems related to multilevel governance, there is a need for coherence between the different international policy objectives and the national REDD+ strategies, which currently evolve within capacity building initiatives ("readiness") such as the World Bank's Forest Carbon Partnership Facility (FCPF) and the UN-REDD programme. In the light of the agreed broadening of scope, including enhancement of carbon stocks and sustainable management of forests, a revision of the Sustainable Forest Management (SFM) concept could play a key role for governance, operationalization and implementation of biodiversity safeguards under REDD+. Sub-project 1 analyzes and accompanies the relevant international political processes, mainly UNFCCC, CBD and UNFF, as well as bi- and multilateral initiatives, e.g. UN-REDD and FCPF. At the national level, the development of national country strategies that actually consider biodiversity just to a minor degree, are analyzed.

Sub-project 2 focuses on the processes at project level. The promotion of synergies between climate and biodiversity objectives requires the stringent assessment and communication of the effects of REDD+ pilot projects on forest ecosystems, which may be achieved by well designed systems for monitoring, reporting and verification (MRV) which include surveillance of the so-called co-benefits. While there are widely recognized and operational techniques for the MRV of carbon and biomass, there are not yet any monitoring systems in place that consider the impacts of REDD+ on forest biodiversity in a comprehensive way. This is despite the fact that many aspects of biodiversity, e.g. ecological stability, are considered as crucial for the long-term viability of forest ecosystems and thus for REDD+. The sub-project aims to analyze existing REDD+ demonstration activities in order to develop options on how MRV systems for biodiversity could be developed, taking into account existing standards and the expertise of the CBD and other organizations. Assuming that the monitoring of biodiversity is an integral management practice of forest protected areas, corresponding MRV experience can possibly be translated for broader usage in forest management and under REDD+. Therefore case studies in two tropical countries—Peru and a country in Eastern Africa—will be conducted, including an interview survey with REDD+ stakeholders at different organizational levels.

The project "The Protection of Forests under Global Biodiversity and Climate Policy" is funded by the German Federal Agency for Nature Conservation (BfN) and the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and runs from 2009 until 2012; The presented poster describes the methodological concept of the project and first results.

25. RESPONSIBLE FISHING TECHNOLOGIES TO MINIMIZE BIODIVERSITY LOSS

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Keywords: biodiversity, responsible fishing technologies, bycatch reduction devices, turtle excluder device, semi-pelagic trawl system

INTRODUCTION

The importance of reducing bycatch and minimizing ecological impacts of fishing operations has been emphasized by scientists and fishery managers and recognized by fishermen. The shrimp trawl is a nonselective gear that commonly has an associated catch of non-targeted organisms such as finfish and miscellaneous invertebrates. Trawl fisheries in different parts of the world are now being required to use bycatch reduction devices as result of pressure from conservation groups and legal regimes introduced by the governments. The Code of Conduct for Responsible Fisheries (FAO, 1995), which gives guidelines for sustainable development of fisheries, stresses the need for developing selective fishing gears in order to conserve resources, protect non-targeted resources and endangered species like sea turtles. Semipelagic trawl system is known to minimize the impact on sea bottom and benthic communities (Brewer et al., 1996; He, 2007). Maintenance of stock size and spawning biomass at sustainable levels and protection of biodiversity and ecosystem integrity though control on fishing capacity and adoption of responsible fishing will ensure better resilience of the species towards fishing pressure and climate change impacts.

TECHNOLOGIES FOR BYCATCH REDUCTION

Various types of bycatch reduction technologies have been developed in the fishing industry around the world (Eayers, 2005; Kennelly, 2007; Boopendranath *et al.*, 2008; Boopendranath, 2009). Devices developed to exclude the endangered species like sea turtles, and to reduce the non-targeted species in shrimp trawling are collectively known as Bycatch Reduction Devices (BRDs). These devices have been developed taking into consideration variation in the size, and differential behaviour pattern of shrimp and other animals inside the net. The salient features of some of the promising BRDs appropriate for tropical trawl fisheries are described below:

Escape windows

Escape windows made of square meshes, simple slits kept open by mean of floats and sinkers (bigeye BRD) or opening with a rigid frame (fisheye BRD) are provided on the upper side of the codend or belly and they function based on the differential behaviour of fishes and shrimps. Fishes that have entered the codend tend to swim back and escape through the openings, at the top in the front section of the codend. Square mesh has the advantage that the mesh opening is not distorted while under operation, unlike diamond meshes (Broadhurst and Kennely, 1994; 1996; Brewer *et al.*, 1998; FAO, 1997; Robins *et al.*, 1999; Boopendranath *et al.*, 2008). Bycatch exclusion rates of 35–51% with a shrimp loss of 0.8–2% have been reported during trawl operations in Indian waters, using 200x300 mm semi-circular fisheye BRD (Boopendranath *et al.*, 2008).

Sieve net

Sieve nets (also known as veil nets) are cone shaped nets inserted into standard trawls which direct unwanted bycatch to an escape hole cut into the body of the trawl leading to a second codend. The large mesh funnel inside the net guides the fish to a second codend with large diamond mesh netting, while shrimps pass through large meshes and accumulate in the main codend. Bycatch exclusion rates of 15–50% with shrimp loss of 5-15% have been reported in sieve net installed trawl operations in different fishing grounds (Polet *et al*., 2004; Catchpole, 2008; Boopendranath *et al*. 2008).

Rigid grid sorting devices

Several designs of rigid grid sorting devices have been developed for separation of shrimp from non-shrimp resources, such as Nordmore grid (Isaksen *et al.*, 1992), Juvenile and Trash Excluder Device (JTED) (Chokesanguan *et al.*, 2000) and rectangular and oval grid BRDs (Boopendranath *et al.* 2008). Bycatch exclusion rates of 54–64%, with a shrimp loss of 10–13% have been reported during trawl operations in Indian waters, using rigid sorting devices.

Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD)

Trawler fishermen in India and other tropical fishing nations depend on both finfish and shrimp catches to keep the commercial operations economically viable. Trawl bycatch in the tropical waters has a significant percentage of juveniles. The Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD) is a Smart Gear (WWF) award winning design developed by Central Institute of Fisheries Technology (CIFT) which brings down the bycatch of juveniles and small sized non-targeted species in commercial shrimp trawl and at the same time enables fishermen to harvest and retain large commercially valuable finfishes and shrimp species (Boopendranath *et al*., 2008). In addition, the fishermen would benefit economically from higher catch values due to improved catch quality, shorter sorting time, longer tow duration, higher catch and lower fuel costs. JFE-SSD operations off Cochin (India) have realised bycatch reduction up to 43% with a shrimp retention of 96–97%.

Turtle Excluder Devices

TEDs are recognized internationally as a convenient and effective measure for protecting sea turtles from trawling-related mortality and also for reducing bycatch in shrimp landings. Many trawl fisheries throughout the world are now required to use TEDs for their shrimp trawl fisheries (Boopendranath, 2007). There are a variety of TED designs available today, which vary with regard to construction details, principle of operation, materials for construction and depending on the target resource groups and conditions of fishing (Mitchell *et al.* 1995; CIFT, 2003; Boopendranath *et al.,* 2003; 2009). CIFT-TED is an efficient turtle excluder device developed at CIFT with focus on reducing catch losses, which is a cause of concern for trawler fishermen in adopting the device. Catch losses during the operations due to installation of CIFT-TED were in the range of 0.52–0.97% for shrimp and 2.44–3.27% for non-shrimp catch components (Dawson and Boopendranath, 2001; Boopendranath *et al.*, 2003; CIFT, 2003).

SEMIPELAGIC TRAWL SYSTEM

Demersal trawls are generally non-selective and a large number of non-targeted species and juveniles are landed during trawling, in addition to its impact on benthic communities. Resource specific trawls for semi-pelagic resources have comparatively low impact on the benthic biota (Brewer et al., 1996; He, 2007). CIFT Semi-pelagic Trawl System (CIFT SPTS-I) has been developed as an alternative to shrimp trawling in the small-scale mechanized trawlers operating in the tropical waters (CIFT, 2007). The system consists of an 18 m four panel semi-pelagic trawl with double bridles, front weights and vertically cambered high aspect ratio otter boards of 85 kg each. It is capable of attaining catch rates beyond 200 $kg.h^{-1}$ in moderately productive grounds and selectively harvest fast swimming demersal and semi-pelagic finfishes and cephalopods, which are mostly beyond the reach of conventional bottom trawls, currently used in commercial trawl fisheries in India.

CONCLUSION

BRDs and TEDs most appropriate for the regional fishery conditions need be adopted and enforced legally, after careful scientific evaluation and commercial trials. Enforcement of BRDs and TEDs and promotion of low impact semi-pelagic trawl system for demersal finfish resources in small-scale mechanised fisheries in the tropics as alternative to shrimp trawling, along with regulation on total fishing effort at sustainable levels will facilitate protection and restoration of biodiversity and enhance the resilience of the fish stocks to fishing pressure and climate change impacts through enhanced stock size and breeding biomass.

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26. ANALYSIS OF IMPLEMENTATION OF THE CONVENTION ON BIOLOGICAL DIVERSITY IN THE HINDU KUSH-HIMALAYAN (HKH) COUNTRIES

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Keywords: CBD, mountain biodiversity, analysis of, implementation of, Hindu Kush-Himalayas (HKH)

INTRODUCTION

In the Hindu Kush-Himalayan (HKH) region, an estimated area of 4.5 million km^2 directly supports the livelihood of over 200 million people and an estimated 1.3 billion more people living in the downstream basins. This region contains a great diversity of habitats and supports a wide range of biological species; it also hosts different ethnic groups who have a rich culture and traditional knowledge on the indigenous biodiversity. In recognition of the particular importance that mountain ecosystems have for biodiversity conservation, the Seventh Meeting of the Conference of Parties (COP-7) to the Convention on Biological Diversity (CBD) selected mountain biodiversity as one of three themes for in-depth consideration. It adopted the specific Programme of Work on Mountain Biodiversity (PoW-MB) with a goal to protect mountain biodiversity at the global, regional, and national levels. In the HKH region, different countries are at varying stages of implementing relevant legislation but to date, a summary of implementation status for the entire HKH region is not available. This paper highlights some of the findings of PoW-MB in the HKH region.

IMPLEMENTATION OF THE CBD

The implementation of the CBD can be challenging especially since some of the substantive provisions in Articles 5-12, and 14 include phrases such as: "as far as possible and as appropriate", "in accordance with its particular conditions and capabilities" and "taking into account the special needs of developing countries", all of which are open to interpretation. Other provisions, such as Articles 15–20, which suggest institutionalised forms of cooperation contain formulations such as: "shall be provided", "shall take", "shall facilitate", "shall promote", "shall consider", "shall also take into consideration" and "subject to national legislation", all of which indicate a promotional pattern of seeking implementation. It seems that strategizing could have been necessary as the Preamble of the CBD emphatically recognises that the "states have sovereign rights over their own biological resources" as well as their responsibility "for conserving their biological diversity and for using their biological resources in a sustainable manner" (CBD, 2001). Thus, the traditional mechanical approach of 'quantification' in analysing implementation may not necessarily work in the case of CBD-related legislation. In the regional member countries of the HKH[1] it may be more appropriate to adapt the degree of implementation as needed and to adjust the 'level' at which the contracting states can implement the CBD objectives. The language itself suggests that this is what the negotiators had in mind. Therefore, some flexibility is required when analyzing the HKH country reports.

National policies and action plans have emerged as the major tools for analysis. In HKH countries, the National Biodiversity Strategy and Action Plan are particularly useful in this regard. Most of the HKH countries want to promote sustainable development in collaboration with concerned stakeholders. In this context, the implementation of the CBD can be used as an indication of the degree to which they have advanced good governance and mainstreamed national environmental concerns. In particular, the implementation of specific CBD articles

1 Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan.

[such as article 15 and article 8(J)] can reveal the extent to which they value their biological resources and the traditional knowledge of their indigenous and local communities.

Throughout the region, the advent of the CBD has stimulated debate on the extent to which indigenous/marginalized local communities have 'rights' over biological resources. Access to biological resources, traditional knowledge, and benefit sharing is now at the forefront of all discussions on conservation in mountain areas. Progressive policies for the conservation and management of biological resources are also emerging. As part of the complex web of regulatory frameworks suggested by the CBD, the region has witnessed a flurry of developments such as: national biodiversity strategies, biodiversity action plans, promulgation of new policies, national legal instruments and institutional structures to help promote the goals of the CBD.

CONCLUSION

2010 was declared the *International Year of Biodiversity* to raise awareness of biodiversity and to provide an opportunity to take stake of the progress that has been made over the last two decades in achieving the broad goals of the CBD. ICIMOD has been involved in helping the HKH regional member countries to implement the CBD; however, implementation throughout the HKH is still in its early stages. This analysis provides important feedback both to the regional member countries as well as to the Subsidiary Body (SBSTTA). It should also help the regional member countries to work on mechanisms for implementation at the national level and to consider the possibility of joining forces with like-mined countries on a common negotiating position at COP meetings. It may lead to the formation of alliances between HKH regional member countries to implement COP for the protection of shared mountain biodiversity. The analysis can also provide material for consideration at the upcoming COP-10 by providing lessons learnt and by summarising an understanding of the key challenges in the HKH region.

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27. GROW AFRICA

Planting Endangered African Trees for Forest Restoration and Carbon Sequestration

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Keuwords: Africa, forest restoration, botanic gardens

SUMMARY

Reducing terrestrial carbon emissions and increasing sequestration is now central to the climate change agenda. Dangerous climate change will not be avoided without improved management of the world's terrestrial carbon, especially that which is stored in old-growth forest ecosystems. Reforestation has long been recognised as an important aim, but tree-planting projects have in many cases focussed primarily on the quantity of carbon sequestered. Ecologically inappropriate, exotic tree species have been planted as a consequence, with negative impacts on the environment and local communities.

Botanic Gardens Conservation International (BGCI) is proposing to use the skills and expertise of African botanic gardens to propagate endangered, indigenous tree species for the restoration of robust, diverse forests enabling long-term, secure carbon storage.

BACKGROUND

Deforestation is a leading cause of climate change. Most deforestation is driven by demands from industrialised countries for forest products or for commodities that compete with forests for use of land, such as beef and soya production.

Climate change is impacting plant distributions globally (IPPC, 2001) and forest plant communities are particularly vulnerable in Africa (UNEP, 2008; Leal, 2008). Africa's forests are essential stores of carbon but degradation, deforestation, over-exploitation, and agricultural expansion are steadily converting African forests into greenhouse gases. The region also possesses enormous potential to prevent dangerous climate change via carbon absorption and storage (FPAN, 2009).

The United Nations Reducing Emissions from Deforestation and Forest Degradation (REDD) programme could be a catalyst for improved forest governance and could provide vital support to local communities, whilst protecting biodiversity and water resources and helping countries adapt to climate change (Solheim, 2009). However, some fledgling REDD projects have been shown to cause social conflict and land use disputes (Vidal, 2009). Many large scale tree-planting schemes have been criticised for planting tree species that are inappropriate to a particular region (such as non-native, fast-growing species) and not valuing attributes such as forest diversity and number of endangered species in accompanying carbon crediting systems. In some cases, in the name of carbon sequestration, plantations of non-native trees have replaced pristine tropical forests. Studies have shown that extensive planting of fast-growing tree species has suppressed the abundance and species richness of native plant communities (Kotiluoto & Makandi, 2004).

BGCI & BOTANIC GARDENS

BGCI exists to ensure the worldwide conservation of threatened plants. BGCI's membership network includes over 700 institutions, mostly botanic gardens, in over 120 countries. We achieve our conservation goals by supporting and empowering this network, building and applying our collective knowledge and expertise to reverse the slide towards extinction faced by one third of all plants. BGCI provides the secretariat for the

IUCN/SSC Global Tree Specialist Group and is a lead partner in the Global Trees Campaign (www.globaltrees.org) with Fauna and Flora International.

As centres of botanical and horticultural expertise, botanic gardens across Africa play hugely important roles in plant conservation, environmental education and improving livelihoods. Over 150 botanic gardens currently exist in Africa (see Figure 1) ranging from the oldest in Durban to recently established gardens such as Calabar Botanic Garden in Nigeria, and from large gardens such as Kirstenbosch (Cape Town) to small gardens run by one or two dedicated staff.

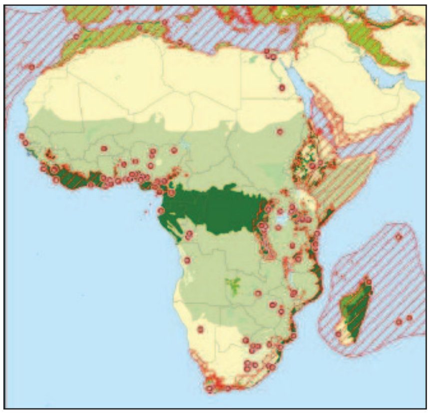

FIGURE 1: Map of botanic gardens and biodiversity hotspots on Africa

THE PROJECT

With this project we aim to promote direct action to safeguard and restore biodiversity and related ecosystem services, and contribute to climate change mitigation and adaptation.

This project will review the potential for African botanic gardens to develop propagation protocols and grow indigenous tree species for carbon capture and storage projects. A particular emphasis will be placed on African tree species that are threatened with extinction in their natural habitats.

KEY QUESTIONS ADDRESSED BY RESEARCH

1. Which threatened trees are in cultivation in African botanic gardens?
2. Which African trees show the greatest potential to be used in carbon capture and storage projects?
3. What capacity do identified African gardens have to support *ex situ* conservation and restoration of threatened trees? (in terms of information management, propagation, staff)
4. Where should the trial sites be located?
5. Can these schemes link into current forestry policy mechanisms whilst remaining community-led?

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28. CONSERVATION OF CROP WILD RELATIVES IN THE FACE OF CLIMATE CHANGE

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Keywords: crop wild relatives, in situ *conservation, climate change impacts, protected areas*

INTRODUCTION

Crop wild relatives (CWR) are wild plant species that are more or less closely related to a particular crop and to which it may contribute genetic material but unlike the crop species has not been domesticated. Collectively they constitute an enormous reservoir of genetic variation that can be used in plant breeding and are a vital resource in meeting the challenge of providing food security, enhancing agricultural production and sustaining productivity in the context of a rapidly growing world population and accelerated climate change. The adaptation of crops to gradual change in the climatic conditions will require screening of existing cultivars and breeding of new ones for adaptation to drought, temperature stresses, sustained productivity, diseases resistance and other factors and highlights the importance of maintaining the pools of genetic variation in CWR. They occur in a wide range of habitats but as numerous assessments testify, habitats continue to be lost or degraded across the world, putting many of these species at risk. It is essential therefore that urgent steps are taken to conserve them both in the wild (*in situ*) and in genebanks (*ex situ*) while the genetic diversity they contain is still available.

IN SITU CONSERVATION OF CROP WILD RELATIVES

In situ conservation is the preferred option: it allows the populations of the wild relatives to continue to evolve and generate a continual supply of novel genetic traits that will be needed to adapt crops to rapidly changing climatic conditions. Many developing countries, located within centres of plant diversity and centres of crop diversity, contain large numbers of important CWR. Although most of these countries have included the conservation of CWR within their national biodiversity strategies and their agricultural development strategies, few of them have prepared a list of these species or possess sufficient resources to enable them to invest in their effective conservation and optimal use. The UNEP/GEF-supported project, '*In situ* conservation of crop wild relatives through enhanced information management and field application' was specifically designed to address these issues and aims to seek ways of satisfying national and global needs to improve global food security through effective conservation and use of CWR. Five countries are involved in the project though their governments—**Armenia, Bolivia, Madagascar, Sri Lanka and Uzbekistan**—each of which has significant numbers of CWR, many of which are at risk and in need of conservation. Over the last 10 years, the GEF has supported a number of projects at the national, regional and global level that seek to enhance the conservation and use of CWR. Most of these projects and initiatives have focused on the conservation in CWR in protected areas focusing on the integration of CWR into management plans and other considerations.

IMPACT OF CLIMATE CHANGE ON CROP WILD RELATIVES AND THEIR CONSERVATION

Few studies have yet been made on the impacts of climate change on the survival chances of CWR but the evidence so far published, based on the use of bioclimatic modelling, suggests that many will be put at risk. One of the few studies so far published (Jarvis et al. 2008) used current and projected future climate data for ~2055, and a climate envelope species' distribution model to predict the impact of climate change on the wild relatives of peanut (*Arachis*), potato (*Solanum*) and cowpea (*Vigna*). They considered three migrational scenarios for modelling the range shifts (unlimited, limited, and no migration) and found that climate change strongly affected all taxa, with an estimated 16-22% of these species predicted to go extinct and most species losing over 50% of their range size. Another study (Lira et al. 2009) in Mexico used bioclimatic modelling and two possible scenarios of climatic change to analyze the distribution patterns of eight wild cucurbits closely related to cultivated species. The results showed that all eight taxa showed a marked contraction in area under both climate scenarios and that under a drastic climatic change scenario, the eight taxa will be maintained in only 29 of the 69 protected areas in which they currently occur. To date, the scale at which bioclimatic modelling is undertaken is not sufficient to give precise indications of the probabilities of the future migrations of species and much more detailed work is needed. Whether a species is able to migrate or not to new climate envelopes depends largely on its dispersal capacity and ability to establish and spread. The threats posed to the existence of CWR highlight there is an urgent need to identify priority species and areas for conservation and to develop integrated *in situ* and *ex situ* conservation strategies to ensure that the rich genetic diversity of CWR is protected for the benefit of future generations.

THE FUTURE OF CROP WILD RELATIVES *IN SITU* CONSERVATION

The effects of global change on protected areas will force us to rethink the role of protected areas in biodiversity conservation. The political boundaries of protected areas are fixed but the biological landscape is not (Lovejoy 2006). It is clearly difficult for a fixed system of protected areas to respond to global change and considerable rethinking in the design of such areas will be needed if they are to survive and remain effective. There will need to be more flexibility in size and scale so that a connected network of patches of habitats at various scales is created so as to allow species to migrate and adjust their ranges in response to climatic and other change. Various papers suggest that many protected areas will suffer moderate to substantial species loss and some protected areas may disappear altogether with catastrophic species loss but the evidence is still equivocal and is likely to remain so while there is still uncertainty as to the scale and extent of climatic and other change. For example, an assessment was undertaken by Araújo *et al.* (2004) of the ability of existing reserve-selection methods to secure species in a climate-change context. It used the European distributions of 1200 plant species and considering two extreme scenarios of response to climate change: no dispersal and universal dispersal. The results indicate that 6–11% of species modelled would be potentially lost from selected reserves in a 50-year period. A study by Hannah *et al.* (2007) on protected area needs in Mexico, the Cape Floristic Region of South Africa and Western Europe under changing climatic conditions suggested that protected areas remain effective in the early stages of climate change, while adding new protected areas or expanding current ones could maintain species protection in future decades and centuries. On the other hand, the role of protected areas in maintaining viable populations of target CWR or of any other individual species depends not only on proper management of the areas themselves but on the effectiveness of the management interventions undertaken at the species/population level to counter the threats to which they are subject. Even without accelerated climate change, this is seldom undertaken.

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29. ENABLING LONG-TERM CLIMATE AND BIODIVERSITY POLICY

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Keywords: climate change, policy

ABSTRACT

Current global environmental changes, including climate change are unprecedented in cause, in that they are increasingly understood to be man-made. As the architects of these changes, we are also the solution. Finding solutions requires access to high quality, and tools for analysis.

Mobilising the millions of biodiversity records already in existence world-wide is critical to establishing baseline knowledge of species and ecosystems, against which changes can be tracked and enabling forecasts of future trends. Of critical importance is the ability to agree on common global standards for biodiversity data to enable tracking of progress towards or away from the post-2010 biodiversity targets. This process of transforming data to knowledge will improve decision-making around threat mitigation, resilience and ecosystem restoration. The Global Biodiversity Information Facility (GBIF) is a multi-lateral initiative, currently involving 55 countries and 44 international organisations, to mobilise these data. GBIF has been in existence for nine years and has catalysed agreements on the standards and protocols required to make disparate datasets compatible and accessible. Over 195 million records from over 8000 datasets from 260 institutions worldwide are now accessible online through the GBIF data portal (http://data.gbif.org), creating a global biodiversity commons, as a 'public good'. GBIF enables access to previously inaccessible information, and analyses which were previously impossible, improving understanding and informing new policy development.

This poster reviews the negotiation process that lead to the formation of the GBIF as an OECD 'mega-science' project, the benefits accruing from such multi-lateral cooperation, and the lessons learned in overcoming the political, social and technological impediments to establishing and developing such global initiatives.

30. MOBILISING INFORMATION FOR ADAPTING AGRICULTURE TO CLIMATE CHANGE

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Keywords: climate change, agriculture

ABSTRACT

Access to biodiversity-related information is increasing rapidly through the Internet. However, a major obstacle to transforming these data into knowledge is a lack of digital species-occurrence data and associated heterogeneity of data formats. For example, in many regions we are still unable to quantify the impacts of climate change on biodiversity, particularly in the tropics. A partial solution to the problem of data availability is agreement on a mechanism to facilitate sharing of existing and future biodiversity data world-wide.

Through the Global Biodiversity Information Facility (GBIF), scientists can publish their specimen and observation databases online, while retaining ownership and custodianship, and thus become part of a growing distributed global network of shared biodiversity data. For many research communities, GBIF has been instrumental in enabling link-up of their distributed information resources.

Through the GBIF global network, information on more than 195 million primary biodiversity data is currently accessible. The information in the GBIF network is vital to the range of scientific communities investigating impacts of global change on species, crops, forestry, aquatic and livestock resources and related ecosystems services. GBIF has demonstrated the feasibility of linking existing data–holding institutions and individuals at national, regional and thematic levels to enable global on-line access to widely distributed, but related, datasets. However, much more is needed to create the capacity to observe, monitor and model global environmental and social change.

Global warming is projected to have significant impacts on agriculture, mediated through changes in temperature and precipitation. A recent study published in Science suggests that "southern Africa could lose more than 30% of its main crop, maize, by 2030 [from climate change]. In South Asia losses of many regional staples, such as rice, millet and maize could top 10%". Most agronomists believe that agricultural production will be most strongly affected by the severity and pace of climate change, and less by gradual trends in climate. If change is gradual, there may be time for some biota to adapt. Climate change is already impacting agricultural production, and could jeopardize food security in many countries, especially those with poor soil and climate conditions. Using analyses of species distributions and ecological niche modelling, we present a series of cases illustrating the potential for climate adaptive agricultural practices. These examples highlight the urgent need to contribute to global initiatives, such as GBIF, aimed at sharing biodiversity information resources to facilitate such analyses.

31. PROVIDING MEANS FOR EVALUATING THE IMPACT OF CLIMATE CHANGE ON CROP WILD RELATIVES

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Keywords: climate change, crop wild relatives

ABSTRACT

Access to biodiversity-related information is increasing rapidly through the Internet. However, a major obstacle to transforming these data into knowledge is a lack of digital species-occurrence data and associated heterogeneity of data formats. For example, in many regions we are still unable to quantify the impacts of climate change on biodiversity, particularly in the tropics. A partial solution to the problem of data availability is agreement on a mechanism to facilitate sharing of existing and future biodiversity data world-wide.

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This poster will present a series of cases from various regions of the world, using GBIF-mediated data and climate change projections for 2050, demonstrating the potential threats to ecosystem services. We illustrate the potential for using GBIF data resources to help inform decision-makers about the increasing impacts of climate change on selected ecosystem services and the costs of making these services resilient to climate change. There is an urgent need to contribute to global initiatives such as GBIF, aimed at sharing information about biodiversity resources in order to facilitate such analyses.

32. USING GBIF TO FORECAST CLIMATE CHANGE IMPACTS ON MARINE RESOURCES

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Keywords: climate change, marine

ABSTRACT

Access to biodiversity-related information is increasing rapidly through the Internet. However, a major obstacle to transforming these data into knowledge is a lack of digital species-occurrence data and associated heterogeneity of data formats. For example, in many regions we are still unable to quantify the impacts of climate change on biodiversity, particularly in the tropics. A partial solution to the problem of data availability is agreement on a mechanism to facilitate sharing of existing and future biodiversity data world-wide.

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Global warming is projected to have significant impacts on marine resources, through rising sea water temperatures and ocean acidification. If change is gradual, some biota may be able to adapt. Rapid climate change, however, will diminish marine productivity in many countries, with significant socio-economic impacts on communities and economies dependent on marine resources. Using species distribution analyses and ecological niche modelling, we present a series of case studies demonstrating the potential changes forecast in marine biota, based particularly on temperature changes. These studies illustrate the urgent need to contribute to global initiatives such as GBIF aimed at sharing information about biodiversity resources to facilitate such analyses and inform climate-adaptive policies.

33. INSECT MASS OUTBREAKS
An Increasing Risk of Losing Biodiversity and Carbon in Forests?

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Keywords: insect mass outbreaks, forest biodiversity and functioning

Outbreaks of insects causing a moderate disturbance level are known to serve as important drivers of forest dynamics (at the biogeochemical as well as the organism scale); disturbances such as defoliation events enhance the amount of light and heat reaching the forest floor, subsequently triggering nutrient availability and boosting species richness in forest ecosystems.

Nevertheless, exceeding this outbreak level in terms of frequency, severity, and spatial magnitude, insect mass outbreaks can cause considerable damage and lead not only to high economic losses (productivity sector) but also to a reduction of wildlife habitat quality and species richness if adequate, effective measures are not taken in time. Considering pest-antagonist relationships, high insect abundance will enhance the abundance of predators and parasitoids as well, followed by an increase of multitrophic interactions in above- and below-ground systems, where plants and deep tree roots in particular, play an important role.

However, when looking at the organism scale, these rather short-term effects are outweighed by more serious effects in the long run: Climate change-induced alterations in precipitation and temperature patterns will affect occurrence patterns of xylophagous and phytophagous insects by changing the natural cycles of mass outbreaks associated with the frequency, intensity and duration of the reproduction characteristics of insects.

It can be foreseen that limitations of water availability during growing season will not only affect the metabolism of plants by lowering the photosynthetic activity and thus biomass ecosystem productivity, but will also increase the susceptibility of trees to insect attacks. Thus, insects will attack trees that are weakened due to unfavourable environmental conditions. Trees serve as habitats for many animals and plants - however, - mass outbreaks of insects can within only a few months lead to a high percentage of damaged forest area, followed by the dieback of the insect-attacked hosts. Hence, habitat utilized by many animals associated with this specific tree species is lost. Moreover, in some cases, after heavy outbreak events, the natural regeneration of the forests is heavily impeded by competition between young trees and other forest floor vegetation such as grass. Naturally-occurring disturbance, such as insect mass outbreak events, which are often accompanied by drought and other disturbances (e.g. forest fire and overgrazing), commonly result in the transition of forested areas into grassland.

In such cases, not only has tree species composition changed but also the character of the entire landscape, resulting in an increased deterioration of forests and their associated fauna and flora. This phenomenon is known to occur in managed forest systems as well as in their unmanaged counterparts.

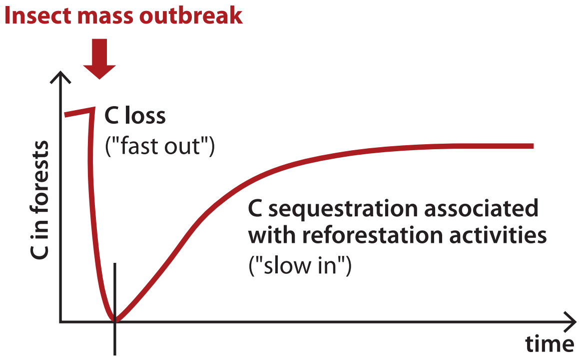

FIGURE 1: Insect mass outbreaks and ecosystem feedbacks: Considering the fact that carbon sequestration related to reforestation activities takes much more time ("slow in") than the loss of carbon during mass outbreaks of insects ("fast out"), it is of utter importance to safeguard our existing forests and provide protective strategies for managed as well as for unmanaged forest ecosystems. Additionally, more frequent disturbances do not allow full recovery of C. In this context it is indispensable to take preventive measures such as identifying issues that make forests more predisposed to the predicted potential impacts (adapted from Körner, 2003 and slightly modified).

At the biogeochemical scale, forest insects also have the potential to greatly affect nutrient cycles in terms of quantity and quality, with substantial consequences for C and N storage capabilities in above- and below-ground systems. For example, our studies have shown that during mass outbreaks (defoliation), insect-mediated organic matter fluxes from canopy to soil foster soil decomposition activity of microorganisms and subsequently elevate CO_2 and N_2O production significantly (le Mellec et al., in prep.). In forest ecosystems, insect mass outbreaks following severe or repeated periods of drought might therefore serve as a trigger for converting carbon sinks turn into carbon sources due to limited C sequestration in woody material and enhanced soil-induced respiration. Due to an insect induced limited above and below ground C sequestration ability and an enhanced production of CO_2 and N_2O forest stands with an enhanced susceptibility to mass outbreaks are likely to occur with an increased global warming potential (GWP). If climate change does enhance the frequency, magnitude and interannual activity of forest disturbances such as forest fires and insect outbreaks, forest ecosystems will lose their ability to sequester C (Lyssaert et al., 2008) and more frequent disturbances might not allow full recovery of C (**Figure 1**).

It remains uncertain how forest ecosystems will respond to the changing environmental conditions in the long run. It can be assumed that in some regions forests will not offer sufficient resilience to adapt to these rapidly changing climatic conditions and the associated increased occurrence of forest disturbances such as fires and mass outbreaks of insects. Thus, it is of utter importance **to preserve our existing forests** to maintain a high diversity of ecosystem functions and services such as the ability to sequester carbon and provide habitat for a large variety of species.

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34. CLIMATE CHANGE AND THE EUROPEAN NATIVE SEED CONSERVATION NETWORK SEED COLLECTING PROTOCOL

A Best Practice Example to Contribute to the New Strategic Plan of the CBD While Safeguarding Europe's Native Flora

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Keywords: seed conservation, climate change, bio-geographical region, Global Strategy for Plant Conservation, collecting

SYNERGIES BETWEEN CLIMATE CHANGE AND *EX-SITU* CONSERVATION RESEARCH AND PRACTICE

This best practice example shows how the European Native Seed Conservation Network seed collecting protocol and other *ex-situ* (= off site) conservation activities contribute to the new strategic plan of the Convention on Biological Diversity (CBD). In particular, they are linked to the achievements of the CBD Strategic Goal C and more specifically targets 12, 13 and 15, whilst also interacting with climate change research, adaptation and mitigation. Synergies exist between research into climate change and *ex-situ* conservation and their practical applications. Integrated climate change and conservation research include:

- Using climate change models to identify populations most at risk of extinction due to climatic shifts and to predict suitable areas for adaptation, restoration and assisted migration
- Monitoring phenology across altitudinal ranges to observe responses to climate change
- Understanding germination requirements of widespread plant species to plan habitat management under changing conditions
- Identifying material which may be able to cope with predicted climatic conditions for crop breeding.

EX-SITU CONSERVATION AND THE GLOBAL STRATEGY FOR PLANT CONSERVATION

Against the background of climate change, seeds banks are one of the most powerful *ex-situ* conservation tools. They are an insurance against the extinction of plant populations and species in the wild. By making high-quality seed material available, they are part of an overall conservation strategy for plant species. This fact is recognised by the Global Strategy for Plant Conservation (GSPC), whose target viii reads "60 per cent of threatened plant species in accessible *ex-situ* collections, preferably in the country of origin, and 10 per cent of them included in recovery and restoration programmes". The basis for such accessible *ex-situ* collections is a standardised, high-quality seed collecting protocol. Protocols are mentioned in target iii of the GSPC ("Development of models with protocols for plant conservation and sustainable use, based on research and practical experience").

Looking at the European continent, the conservation and the sustainable use of biological diversity is one of the main political goals of the European Union which encourages, both within and outside its boundaries, adequate *ex-situ* conservation of genetic resources and the promotion of collection-based facilities. *Ex-situ* collections provide plant material for integrated conservation, involving a combination of various conservation techniques (Figure 1). As such, they are not only relevant for example for the reintroduction of plant species into damaged natural habitats, to bolster populations as part of ecosystem management, for education or as measures to mitigate climate change, but also for agricultural and ecological research.

NEED FOR HIGH QUALITY SEED SAMPLES IN EUROPE

Today, the biggest problem limiting access to native seeds is the lack of high quality seed samples which cover the genetic diversity of native plant species and populations from within and between different bio-geographical

FIGURE 1: *Ex-situ* seed collections of native plant species from over 130 countries are held at minus 20 °C at the Millennium Seed Bank, UK. Photo: Royal Botanic Gardens, Kew

FIGURE 2: Collecting seed from European native plants on the Bulgarian coast. Photo: Institute of Botany, Bulgarian Academy of Sciences

regions in Europe. Samples from less common, endemic or threatened plant species are difficult to obtain. With respect to plant species with a recorded value to humans, there has been no co-ordinated effort on a European scale to collect species aside from a limited number of the wild relatives of major crops that will be useful to underpin Europe's research and horticultural base.This situation currently leaves Europe vulnerable to species loss, particularly at a time when successful human adaptation to climatic change appears evermore necessary.

THE EUROPEAN NATIVE SEED CONSERVATION NETWORK ENSCONET

The European Native Seed Conservation Network ENSCONET (funded by the European Union as a FP6 Co-ordination Action between 2004 and 2009) unified for the first time all key facilities for European native seed banking and storage. One of the major outcomes of the project is a European native seed collecting protocol, which has set a new international standard for seed collection. This protocol has considerable positive effects on the conservation of Europe's unique flora. It will not only help safeguarding Europe's plant but also help meeting Europe's political obligations to the CBD and other international treaties, contributing to the new strategic plan of the CBD and to human well-being in Europe.

THE ENSCONET SEED COLLECTING PROTOCOL

The ENSCONET seed collecting protocol (Collecting Manual) for wild species documents best practice for collecting seed from Europe's native plant species. The manual was developed through a series of targeted workshops and extensive testing in the field (Figure 2). It will directly contribute to the Strategic Goal C ("Promote direct action to safeguard and restore biodiversity and related ecosystem services, and contribute to climate change mitigation and adaptation"). In a coordinated approach, the ENSCONET seed collecting protocol will be used to optimise the sampling strategy for native seeds across the continent. This approach is based on detailed and constantly improved collecting plans for all bio-geographical regions in Europe.

The following topics are covered in the main sections of the seed collecting protocol: Planning seed collecting expeditions, Sampling, Seed collecting techniques, Plant identification and documentation, and Care of collections after harvest. The individual chapters are kept short and illustrated by intuitive pictures. Very importantly, a data passport form is included which helps to ensure that accurate and detailed data is collected in the field.

The protocol has been received very positively. It has been prepared in nine European languages (English, French, Greek, German, Hungarian, Italian, Polish, Portuguese and Spanish) in order to maximise its utility and distribution. It can be downloaded free from the following webpage www.ensconet.eu/download. It is hoped that it will contribute safeguarding plant diversity even outside Europe.

35. UNDERUTILIZED SPECIES AND CLIMATE CHANGE: CURRENT STATUS AND OUTLOOK

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Keywords: underutilized species, adaptation, nutrition, in situ *conservation, genetic diversity*

INTRODUCTION

Underutilized species are wild or cultivated plants of significant food and nutritional importance to local communities, and owing to their high adaptation to marginal, complex and difficult environments, they can contribute significantly to diversification and resilience of agro-ecosystems. One particular group of under-utilized wild species of special value in our response to climate change is the wild relatives of crops (Heywood *et al.* 2007). Meaningful examples of cultivated underutilized species are the minor millets. Their drought resistance coupled with an excellent nutritious profile offer tremendous opportunities for the development of areas increasingly affected by water shortages such as those in the marginal hills of Tamil Nadu or Karnataka States of India (Bala Ravi 2004, Padulosi *et al.* 2009). With regard to resistance to cold weather conditions, an interesting case is that of cañihua (*Chenopodium pallidicaule*), an underutilized Andean grain which has remarkable frost tolerance and used for such reasons by local farmers around the Titicaca Lake in Bolivia and Peru in their coping strategies to face climate change (Rojas *et al.* 2009).

CLIMATE CHANGE AND UNDERUTILIZED SPECIES: CURRENT STUDIES AND GAPS IN KNOWLEDGE

The potential impact of climate change on the diverse range of underutilized species has not so far been assessed. With regard to underutilized species that are wild, the impact will affect *taxa* differently depending on where they occur and the detail of the climatic changes that are anticipated, their adaptive and resilience capacities, their ability to migrate, their dispersal capacity, the nature and ecology of their new bioclimatic envelopes and their ability to survive in them and spread, the availability of pollinators and dispersal agents, the environment and the management practices that might be associated with the species (e.g. timing or intensity of the wild harvests made by local populations). Models to predict these changes are still not accurate enough to allow the development of specific coping strategies to make optimal use of underutilized species, although some studies represent a good basis for moving towards that direction (van Zonneveld *et al.* 2009). Studies carried out on underutilized wild *Vigna* species estimate that almost half of the natural distribution area of these species will be lost by the middle of this century due to climate change (Anonymous 2007). As for cultivated underutilized species, those that will not be particularly threatened by climate change may though become still endangered or even extinct as a result of other socioeconomic trends that are currently marginalizing their continued use in production systems.

FUTURE OPPORTUNITIES AND PRIORITIES FOR UNDERUTILIZED SPECIES UNDER CLIMATE CHANGE

The prioritization and research challenge

Although there has been work in the past on the prioritization of underutilized species (Padulosi 1999), this has not been done in the context of climate change. Whether there should be a detailed (inclusive) or a definitive (exclusive) list of priority underutilized species for variable environments has been the subject of much debate and there seem to be no agreement on which species are best suited for particular contexts or scenarios. Assuming there are criteria and processes that we can use to prioritize underutilized species what approaches might we use to evaluate or assess candidates for their adaptation potential to climate change calls for greater investments in research and development (Tanton and Haq 2008).

The ex situ conservation challenge

Today, some 7.4 million accessions of plant genetic resources for food and agriculture are stored in some 1,700 germplasm collections around the world (FAO 2009). The poor representation of underutilized crops in *ex situ* gene bank collections (Padulosi *et al.* 2002) has dramatic repercussions on access to this diversity by users. The issue of broadening the mandate of national and international gene banks with the objective of including at least a modest representation of the thousands of underutilized species used locally around the world should thus receive greater attention of policy makers. Unfortunately, the focus of the international community continues to be geared towards major crops and in particular those species listed in Annex I of the International Treaty on PGRFA (Fujisaka *et al.* 2009).

The in situ conservation challenge

The little attention dedicated to on farm conservation represents a major shortcoming of the world's approach in safeguarding the agricultural biodiversity. Among the reasons of concerns is the impact of climate change on the seed systems of underutilized species and efforts should be made to facilitating informal seed networking outside original areas of their diffusion (De Schutter 2009). In view of the fact that climate change impact would vary across the landscape, specific adaptation programs and policy measures should be thus developed in close collaboration with communities where farmer-managed seed networks will need to be properly assessed and strengthened.

The use enhancement challenge

Enhancing the use of underutilized species to strengthen adaptation and resilience of agricultural systems is a complex endeavor that requires a highly multi-disciplinary and multi-stakeholder approach (Jaenicke and Höeschle-Zeledon 2006, Padulosi *et al.* 2009). Efforts are highly interlinked internally and with cross-cutting themes such as germplasm conservation, capacity building, policies and public awareness (Rojas *et al.* 2009). With regard to needs related specifically to climate change and use enhancement research, the following seem to emerge as priority areas of intervention: 1) comparative studies to assess adaptation and resilience capacities of species and varieties in different contexts; 2) capacity building of researchers in modeling for climate change adaptation using the experience developed on major crops and 3) socio-economic studies to predict impact of climate change on seed systems and local markets.

CONCLUSIONS

Strategic interventions needed to promote more sustainable conservation and use of underutilized in a climate changing scenario include: 1) Map out their geographic distribution and shed more light on the complex linkages between their diversity, production and stability of agro-ecosystems; 2) Explore the trade-offs between the role of a few species with important traits over that of many species with less important traits in view of the fact that too many species may lead to high transaction costs in accessing markets, particularly for the poor; 3) Promote nation-wide campaigns to remove the image of food of the poor attached to underutilized species as a way to reinforce food and nutrition security; 4) Raise awareness among the younger generation over the importance of safeguarding healthy food habits and traditions associated to local crops as a way to move away from the current dependency over few crops and species; 5) Establishing a monitoring and early warning systems for underutilized species in the context of greater interventions in support of *in situ*/on farm conservation of local biodiversity; 6) Promotion of greater access and exchange of diversity of underutilized (incl. expansion of Annex I list of the Treaty on PGRFA) as a critical element in support of crop diversification strategies.

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36. THE ROLE OF BOTANIC GARDENS IN SUPPORTING REDD-PLUS INITIATIVES

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Keywords: REDD+, climate change, botanic gardens, biodiversity, capacity building

FOREST LOSS

Threats to forest ecosystems including accelerated population growth, land clearance for agricultural activities and demand for timber are all drivers of significant global deforestation and forest degradation (Blaser and Robledo, 2007). This loss yields significant consequences for the Earth's climate. In fact, deforestation and forest degradation is believed to contribute approximately 20% of global greenhouse gas (GHG) emissions, a figure significantly higher in Africa where deforestation and forest degradation accounts for 70% of GHG emissions (Gibbs *et al*, 2007). Given this contribution that global forests currently make to GHG emissions, Reducing Emissions from Deforestation and Forest Degradation (REDD) has been identified as crucial to the mitigation against climate change.

THE REDD-PLUS MECHANISM

The premise behind REDD is to provide financial incentives to those involved in deforestation and forest degradation "…pay those that reduce Deforestation and Degradation" (Angelsen and Atmadja, 2008, p.2). Initially proposed during the 1990 Kyoto Protocol negotiations, but subsequently rejected, REDD resurfaced at the 11th United Nations Framework Convention on Climate Change (UNFCCC) Conventions of Parties (COP) in Montreal in 2005. At COP 13, in Bali 2007, REDD emerged as a serious contender in the fight against climate change and was subsequently included into the Bali Road Map, which outlined the decisions required to tackle climate change. It was in Bali where the concept of REDD evolved to include the role of "conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries", resulting in the formation of REDD-plus (UNFCCC, 2008, p.3). At the 15th COP in Copenhagen 2009, negotiations took place for a legally binding REDD+ mechanism. Although negotiations failed to agree on a legally binding document, the draft outcome, the Copenhagen Accord, recognises the important role of forests in the global fight against climate change, urging "the immediate establishment of a mechanism including REDD-plus" (UNFCCC, 2009, p.2). It is anticipated that a legally binding mechanism will be negotiated and signed at COP16 in November 2010 in Mexico.

REDD-PLUS READINESS

In preparation for REDD-plus, many initiatives have been mobilised to ensure appropriate "readiness" for the delivery of future REDD-plus projects. This has allowed lessons to be learnt and capacity issues to be identified (Angelsen and Atmadja, 2008). From these projects a number of widespread capacity gaps have been highlighted as threatening the consistency, transparency, comparability, completeness and accuracy of REDD-plus projects. These include: insufficient baseline data, poor institutional and human capacity and lack of technical equipment. For example, insufficient or inaccurate figures for an area's carbon stock history means that projects are based on imprecise baselines, thus jeopardising the success of project implementation. Limited institutional and human capacity to develop, implement and monitor a large scale REDD-plus project is also an example of a serious potential barrier to project success.

ROLE OF BOTANIC GARDENS

There are over 2,500 botanic gardens in existence around the world. These institutions are home to the most specialised plant knowledge in the world. From the genetic to the habitat level, experts at botanic gardens have a detailed understanding of plants and how to manage them, both at individual plant level and as components of ecosystems. The species identification skills and in-depth knowledge of habitat systems present amongst botanic gardens means that they are well placed to play a significant role in supporting and informing REDD-plus projects at all stages of development and implementation.

For example, initial inventories are frequently required during the planning stages of REDD-plus projects and species-specific data is crucial to ensure that baselines are based on accurate data. Furthermore, the expansion of REDD to include co-benefits such as the conservation of biodiversity and ecosystem services requires the application of the specialised knowledge available in botanic gardens to ensure the achievement of such co-benefits. Extensive species and habitat knowledge for example will be beneficial to informing site selection to ensure the preservation of plant and habitat biodiversity.

Another great asset which botanic gardens could use to support REDD-plus projects is their extensive experience in capacity development. Capacity development is a hugely efficient approach to supporting REDD-plus as addressing capacity issues and allowing them to cascade within institutions and countries, has the potential to facilitate far-reaching benefits. Many botanic gardens such as Missouri Botanic Garden in the US already include capacity development as one of their key roles. Expanding existing initiatives with the development of REDD-plus networks would enable botanic gardens of all sizes to share experiences and develop key REDD-plus capacity. Aligning existing capacity development initiatives with REDD-plus therefore has the potential to yield significant benefits

There are many ways in which botanic gardens could feed into and support future REDD-plus projects. What is important is that botanic gardens recognise this potential and begin to develop individual and network strategies to ensure that their expertise is available and utilised. Although evidence suggests that gardens currently have a limited awareness of the potential role that they could play in supporting REDD-plus, at the international level REDD-plus is still currently under negotiation. This provides an ideal opportunity for botanic gardens to start considering their own contributions to REDD-plus. It is with this intention that this research will help to inform botanic institutions of their role in supporting REDD-plus, providing them with a foundation from which they can begin to develop their support for such projects. Using case studies, this poster illustrates how botanic gardens can play a role in supporting a REDD-plus future.

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37. EFFECTS OF CLIMATE CHANGE ON GERMAN FAUNA SPECIES OF CONSERVATION PRIORITY

A Contribution to Safeguard and Restore Biodiversity

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Keywords: priority species, fauna, Germany, climate change, conservation

INTRODUCTION

This study, commissioned by the Federal Agency for Nature Conservation, aims to provide an overview of recent scientific activities and literature on the impact of climate change on animal species in Germany. This was done by establishing a searchable literature database (Reference Manager), a questionnaire send out to relevant representatives of the scientific community, and by developing a climate change sensitivity analysis for species of high conservation priority. Based on the results of the study options for management and action towards safeguarding and restoring animal species of high conservation priority in Germany are derived.

METHODS

Review of currrent literature and inquiry of relevant German experts and institutions dealing with climate change was realized for the entire fauna. Species of high conservation priority for Germany were selected according to national law ("streng geschützte Arten, BArtschV), the Habitat Directive (Annex II, IV, V) and a preliminary list of selected species for which Germany has been estimated having high conservation responsibility, due to mainly biogeographical reasons (see Gruttke 2004). Altogether, this selection comprised 515 animal species of high conservation priority for Germany (see Rabitsch et al. 2010). Literature was surveyed by searching the ISI Web of Knowledge database and a selected search in non-indexed local and regional journals and grey literature. A questionnaire asking for recent projects and literature was send out to more than 100 relevant representatives of the scientific community. Sensitivity to climate change was evaluated by using a point-scoring system of information on eight climate change relevant and species-specific criteria: habitat preference, ecological plasticity, dispersal capacity, range size, population size, altitudinal distribution, reproductive capacity, and Red List Status in Germany.

RESULTS

The literature survey revealed that most publications deal with birds (40%) and butterflies (15%), whereas there is only limited information available on the effects of climate change for many other groups (Figure 1a). The expert inquiry resulted in a broader spectrum of taxonomic groups studied, but still some taxa were under-represented.

In the sensitivity analysis most species of high conservation priority being assessed have a medium risk (77%), only 11% a low risk and 61 species (12%) a high risk of negative reactions to climate change (HR) (Table 1). The

TABLE 1: Selection of species of high conservation priority in Germany having a high risk to climate change.

TAXONOMIC GROUP	SPECIES
Mammalia	*Microtus bavaricus (Bavarian Pine Vole)*
Aves	*Fratercula arctic (Atlantic Puffin)*
Amphibia	*Salamandra atra (Alpine Salamander)*
Reptilia	*Vipera aspis (Aspic Viper)*
Pisces	*Coregonus bavaricus (Ammersee-Kilch)*
Mollusca	*Bythinella badensis*
Araneae	*Mycula mossakowskii*
Odonata	*Aeshna caerulea (Azure Hawker)*
Orthoptera	*Bryodemella tuberculata*
Coleoptera	*Carabus variolosus nodulosus*
Lepidoptera	*Parnassius phoebus (Phoebus Apollo)*

taxonomic composition of these HR-species revealed that molluscs (all of them snails), butterflies and beetles are higher represented (Figure 1b) compared to all species included in the literature review (Figure 1a). An assignment of the HR-species to broad habitat categories showed a dominance of species living in raised bogs and peatland, followed by natural forests and dry meadows (Figure 2). A spatially explicit analysis of the HR-species at a subnational biogeographic scale revealed that most species occur in the north-eastern German lowlands, the south-western uplands/cuesta and the alpine foothills (Figure 3).

CONCLUSIONS

Options to be taken for the protection of animal species of conservation priority in Germany:

- Climate change is primarily perceived as catalyst of range expansions and less as a factor of endangerment for cold- and warm-adapted (stenotopic) species. But climate change should also be considered as a threat to many species, particularly to those of high conservation priority.
- Species protection programmes should be adapted, validated, and modified with regard to the possible effects of climate change.
- Species living in peatland habitats deserve highest attention.
- Within Germany, species having a high risk to climate change predominantly live in the north-eastern lowlands, the south-western uplands/cuesta and the alpine foothills. Those regions deserve particular attention for the effects of climate change.
- The knowledge of the effects of climate change on many invertebrate groups is insufficient. Beetles and snails particularly appear too much disregarded in this respect.
- GIS-based overlays of relevant attributes (species and habitat distribution, land-use, climate scenarios, other pressures) may provide a risk map of those areas within Germany, where several animal species of high conservation priority coincide in occurrence. Such information may help in targeting conservation efforts to safeguard and restore biodiversity.

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a)

b)

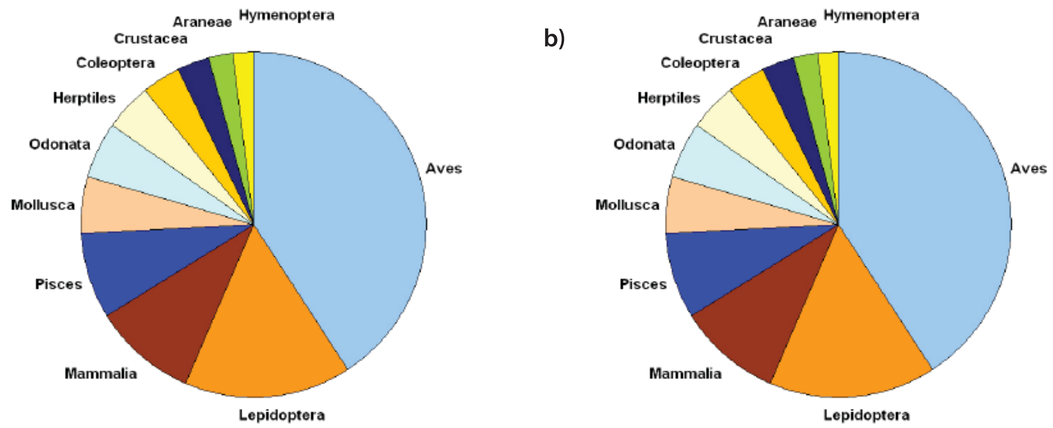

FIGURE 1: Taxonomic distribution of (a) scientific publications (n=441) on climate change with relevance for Germany and (b) priority species (n=61) of high risk assessed in a climate change sensitivity analysis.

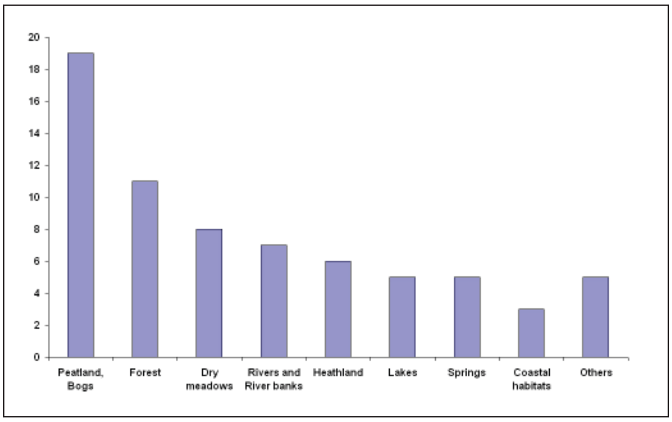

FIGURE 2: Habitat preferences of the species of high conservation priority in Germany having a high risk assessed in a climate change sensitivity analysis (y-axis: no of species; n=61).

FIGURE 3: Map of the occurrence of species of conservation priority in Germany at a subnational biogeographic scale having a high risk assessed in a climate change sensitivity analysis (n=61). Major German landscape regions shown: "Nordwestdeutsches Tiefland", North-western German lowlands; "Nordostdeutsches Tiefland", North-eastern German lowlands; "Westliche Mittelgebirge", Western uplands; "Östliche Mittelgebirge", Eastern uplands; "Südwestliche Mittelgebirge/ Stufenland", South-Western uplands/cuesta; "Alpenvorland", Alpine foothills; "Alpen", Alps.

38. AN INTEGRATED APPROACH TO SAFEGUARD WILD AND CULTIVATED PLANT DIVERSITY

The Pannon Seed Bank Life+ Project

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Keywords: seed bank, plant diversity, wild and cultivated plants, Pannonian biogeographical region, ex-situ preservation

The main goal of this project is the long-term seed preservation of the wild vascular flora of the Pannonian biogeographical region in order to assist and complement *in situ* species conservation activities. The project is planned in such a way that facilities and experiences in seed storage technologies accumulated in the crop gene bank at Tápiószele could be fully utilized. In addition to the increased safety in case of accidental loss or degradation of endangered populations of rare species in the natural, native habitats, *ex situ* seed banks may provide additional possibilities for monitoring genetic changes in wild populations, facilitate access to research material without increasing the rate of disturbance of and pressure on the original habitats, and assist multidisciplinary studies on factors involved in the maintenance of diversity and stability in plant associations. These efforts will expectedly result in a comprehensive seed repository system serving the *ex situ* maintenance of the diversity of native and cultivated flora in the Pannonian biogeographical region.

Seed collection strategy and methodologies is to be developed by the Institute of Ecology and Botany of the Hungarian Academy of Sciences with the involvement of prominent botanists. Based on this scientifically well-founded strategy, collection will be carried out by botanical experts and the national park directorates. By the end of the project, approximately 50 percent of the wild native flora will be collected and stored in cold seed stores for medium and long term.

Due to its special objectives (establishment of a representative seed bank for an entire biogeographical region), the project affects a high number of species and habitats. While 2 200 wild vascular plant species occur in Hungary, the Hungarian native flora consists of approximately 1 600 species. As the collection of the seeds of approximately 50 percent of the Hungarian native vascular flora (800 species) is a real objective, the priority order/schedule of collection is to be determined. Collection of endangered taxa shall be a priority.

THE TARGET GROUPS ARE:

Species with nature conservation importance

Endemisms occurring solely in the Pannonian biogeographical region: Most of these species have isolated, small populations, e.g.: Linum dolomiticum; Vincetoxicum pannonicum;

Sub-endemism, approximately 800 species, occurring in the neighbouring regions as well, however the Pannonian biogeographical region provides the most optimal environment and habitats for their conservation, e.g.: Cirsium brachycephalum;

Other threatened (protected and strictly protected) species in Hungary, e.g.: Gladiolus palustris; Pulsatilla patens.

Species with ecological importance

These species are either **environmental indicators** (refer to site conditions) or nature conservation indicators (refer to the state and stability of habitats and associations).

Character **species of rare and special associations** (e.g. pioneer associations, sensitive grassland associations like rocky grasslands) are also of great ecological importance. Fragmented plain land associations deserve particular attention, where increasing average temperature is an acute threatening factor.

Plant associations linked to wetlands are under double pressure as these are endangered both by climatic and social factors.

Species with economic importance

Species of dry habitat types: Hungary is particularly rich in dry habitat types, the character of which is partly continental, partly Mediterranean and consists of species that are unique in the European flora.

Dominant species of forest associations and other association with high biomass production: Forests are the most affected habitat types by climate change. The structure of forest associations may change significantly. Due to the unpredictable effect of these changes it is important to preserve with *ex situ* methods the current species composition of forests as far as seed storage is applicable for their conservation.

Crop wild relatives and wild species with importance as genetic resources for food and agriculture.

Native weed species that have been disappearing and becoming rare.

EX SITU SEED BANK FOR CROPS AND CROP WILD RELATIVES

Ex situ conservation of plant genetic resources started in Hungary more than fifty years ago. Since the foundation of the Institute for Agrobotany at Tápioszele in 1959, the activities of the Institute, in addition to the establishment of crop genetic resources collections, included the exploration, collection and *ex situ* conservation of crop wild relatives, grasses, medicinal, ornamental and forage plants native to Hungary.

The *ex situ* collections preserved in cold stores include 5369 accessions of wild relatives of crops (138 taxa) from which 985 accessions collected in Hungary. Several population samples of crop wild relatives, ecotypes of forage species, medicinal and ornamental plants have been collected from natural and semi-naturalhabitats. The collections also include 35 accessions from 12 endangered species protected by law in Hungary. Experiences obtained during the work with these wild species can be utilized in the establishment of the Pannon Seed Ban project.

Although Hungary comprises only 1 percent of the territory of the European Union she is extremely rich in unique biological resources. According to our current knowledge, approximately 42 000 animal and 2 200 vascular plant species occur in Hungary. Some 1 600 of the 2 200 wild vascular plant species are native to Hungary, several of which occur only in the Pannonian biogeographical region. This means that the Carpathian Basin is an extremely important part of Europe from the point of view of biological diversity. The Pannon Seed Bank aims to support long-term survival of diversity represented by crops crop wild relatives and wild species of this region.

D

BENEFITS FROM BIODIVERSITY

39. ECOSYSTEM-BASED ADAPTATION OF LAND USE TO CLIMATE CHANGE

A Pilot Project in Central- and East-European Microregions

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Keywords: multiple win solution, local community involvement, multi-stakeholder cooperation, ecosystem approach, multifunctional landscape

INTRODUCTION

The Carpathian Basin, together with the surrounding Carpathian Mountains, represents a centre of extensive biological diversity in the European continent (UNEP 2007). Its ecosystems are highly endangered by climate change both in terms of prognosticated alteration of species compositions (UN SEG 2007) as well as in terms of reduced migration potential of species due to natural barriers (Araújo et al. 2004).

In most Central and East European (CEE) governments' climate change policies, priorities are put on cutting down the direct greenhouse gas (GHG) emissions, and the significant role of ecosystem functions both in mitigation and in adaptation are underestimated (CEEweb 2008). However, it is very important that ecosystem-approach should be applied already at the planning phase (Heller et al. 2009). If we apply win-win-win solutions in time, namely, beneficial for the climate, for the ecosystems and for the people too, the area will get a substantial benefit in the coming decades (Miko et al. 2009). Therefore, implementing measures of spatial planning and land management that is safeguarding the coherence, connectivity and functionality of ecosystems should be one of our most urgent tasks (Heller et al. 2009).

METHODS

CEEweb for Biodiversity is a network of several dozen non-governmental organizations from Central and Eastern European countries. In 2009, CEEweb initiated a series of pilot projects on adaptation to climate change in terms of sustainable land use and spatial planning in various parts of the CEE region. The subjects of our projects are microregions. We selected our project areas according to the following criteria: (i) the landscape is predominantly agricultural, (ii) the area's strength is its high biodiversity due to the still widespread traditional land use schemes and extensive agriculture, (iii) there is a tendency of shift from small-scale family farms to large-scale farms with intensive land use techniques and machinery, projecting a considerable loss of biodiversity in the future and decrease in employment in the agricultural sector.

During the first project period reported in this paper, we have initiated pilot projects in three microregions of NE Hungary (Mezőtúr, Tokaj, Gödöllő), organizing the first round of workshops with the financial support of the Hungarian Ministry of Environment and Water. We have targeted wide representation of stakeholders, such as farmers and land managers, local municipalities, conservation organizations and local NGOs. The objectives of the workshops were (i) awareness-raising, helping the local farmers and other stakeholders understand the climate change—biodiversity nexus and adopt the ecosystem-approach, (ii) enhance intersectoral discussion and coordination between local stakeholders and experts, and (iii) encourage the target groups to find their own specific solutions for adapting land use and spatial planning to climate change, using the ecosystem-approach. During 2010, two further Romanian microregions (Nyárád - Kis-Küküllő, Rika) are going to join the above described first phase of the project.

FURTHER STEPS AND EXPECTED RESULTS

Following the first set of stakeholder workshops, we are going to further elaborate the methodology and involve further CEE microregions in the project.

As a support for the above, we are conducting a study, with the aim of finding measurable indicators of CO_2 source and sink potentials and water retention potentials of agricultural systems, and applying these indicators for comparing various land use schemes typical in our pilot microregions. Using the findings of the study as well as the experiences of the workshops, we are going to publish a know-how guidance and disseminate it for targeted stakeholders in other regions of CEE countries. The publication will present a set of ecosystem-based climate change adaptation principles and recommendations for some selected types of CEE agricultural systems, describing the results of the workshops as case studies. According to our knowledge, such guidance is missing so far although needed (Heller et al. 2009).

As a practical result of the project, we expect planners and managers of our pilot microregions to get more aware of the role of biodiversity in climate change adaptation. This will influence their decisions, making them adapt measures resulting enhanced landscape and biological diversity, enabling ecosystem functions operate, ecosystems adapt to climate change, and species migrate.

CONCLUSIONS

As a general conclusion of the results drawn in the project so far, we can summarize that a mosaic-like, diverse landscape providing coherence of natural or semi-natural habitats by ensuring permeability for its species is the most viable in a rapidly changing climate. Legally protected areas and ecological networks are extremely important, but on their own are not likely to be sufficient for the adaptation of biodiversity to climate change. For that more is needed: our landscapes as a whole should remain or become climate-friendly, strengthening the resilience and adaptive capacity of ecosystems. In all three microregions included in our project so far; traditional, extensive and small-scale agricultural methods are likely to be more adequate for the above requirements than modern, intensive techniques. To achieve a multiple win solution (i.e. beneficial for biodiversity and ecosystem functions, for adaptation to climate change and for local communities), relatively well-preserved traditional landscapes need to be maintained, as well as those which are already degraded need to be restored, where it is possible.

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40. CARBON, BIODIVERSITY AND ECOSYSTEM SERVICES
Exploring Co-Benefits

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Keywords: REDD-plus, climate change mitigation, co-benefits, protected areas, ecosystem services, biodiversity priorities, carbon, land use planning

INTRODUCTION

Emissions from land use change, mainly tropical forest loss, contribute an estimated 17.4% of total anthropogenic greenhouse gas emissions (IPCC 2007). The maintenance and enhancement of natural forest carbon stocks, e.g. through **Reducing Emissions from Deforestation and forest Degradation (REDD)**, is now considered a key climate change mitigation measure.

Ecosystem co-benefits (also called multiple benefits) are positive impacts of climate change mitigation measures that are additional to emissions reductions. These include the conservation of biodiversity and the maintenance of other ecosystem services. Depending on where and how mitigation measures are implemented, the nature and scale of ecosystem co-benefits can vary. Promoting ecosystem co-benefits in the planning and implementing climate change mitigation measures can play a crucial role in achieving biodiversity conservation targets and in helping countries to identify ways to align the agendas of the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC).

THE ROLE OF UNEP-WCMC

Beginning with the release of 'Carbon and biodiversity: a demonstration atlas' (Kapos *et al.* 2008), a UNEP-WCMC publication that was launched at the UNFCCC COP 14 in Poznan, Poland, the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) has worked to promote the inclusion of ecosystem co-benefits in planning for REDD and other mitigation measures. The initial global overview of carbon and biodiversity priorities (e.g. CI's Hotspots and WWFs global 200 terrestrial and freshwater ecosystems), which helped to demonstrate the potential of spatial analysis and visualisation tools, generated significant interest in applying these approaches at national level. Accordingly, UNEP-WCMC is working to support countries in preparing and planning for climate change mitigation measures, including REDD, while simultaneously targeting co-benefits. The support is adapted to the countries' needs and priorities. It includes maps on the distribution of carbon in relation to protected areas, biodiversity, and other ecosystem services, as well as other guidance and tools developed in collaboration with national experts and using the best available national and sub-national level data.

CURRENT WORK

As a starting point for national scale work, the global carbon map that was produced for the 'Carbon and biodiversity: a demonstration atlas' has been updated by including improved information on soil carbon (Ruesch & Gibbs, 2008; Scharlemann *et al.* 2009 and Scharlemann *et al. in prep.*, see figure 1) and further improvements of the dataset based on more recent data from remote sensing are expected in the future.

Supported by the German government and the UN-REDD programme, UNEP-WCMC has so far worked at more detailed scales with colleagues in Tanzania and China. These analyses help to highlight areas where securing existing forest cover can achieve both high carbon benefits and address biodiversity priorities (see figure 2) and to identify the role that protected areas (and other management types) can play in securing

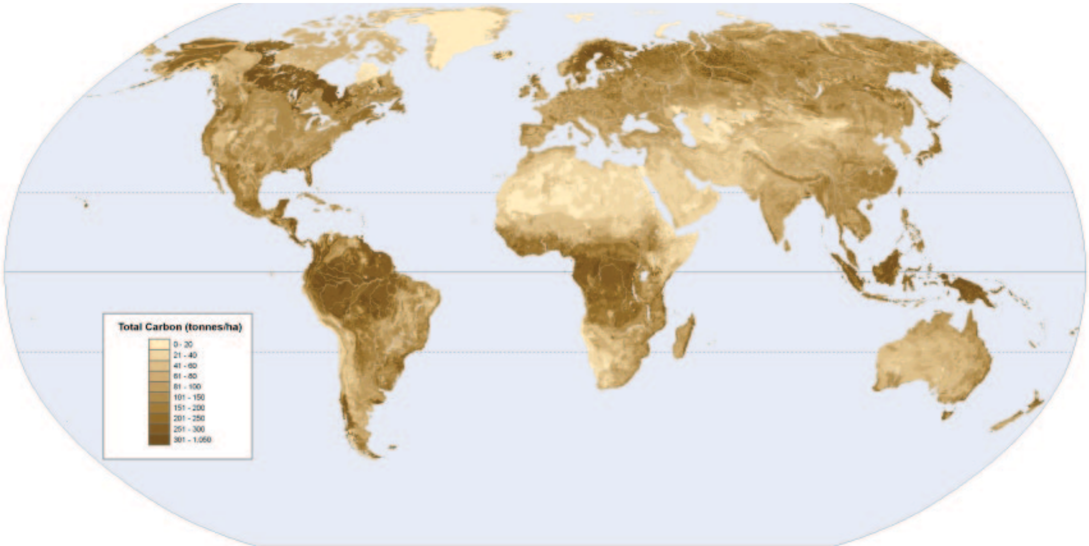

FIGURE 1: Global map of carbon stored in ecosystems (Ruesch & Gibbs, 2008; Scharlemann *et al.* 2009 and Scharlemann *et al. in prep.*).

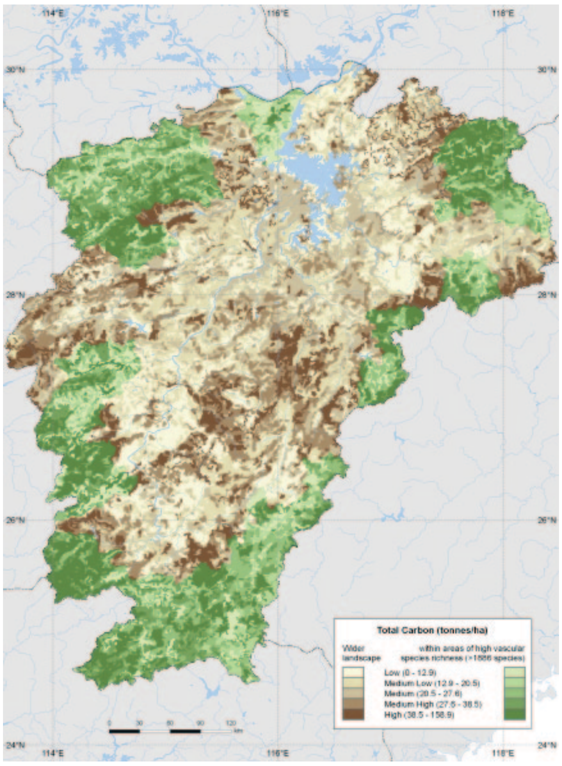

FIGURE 2: Carbon density and areas of high vascular plant species richness in Jiangxi Province, China (Li *et al.* 2009).

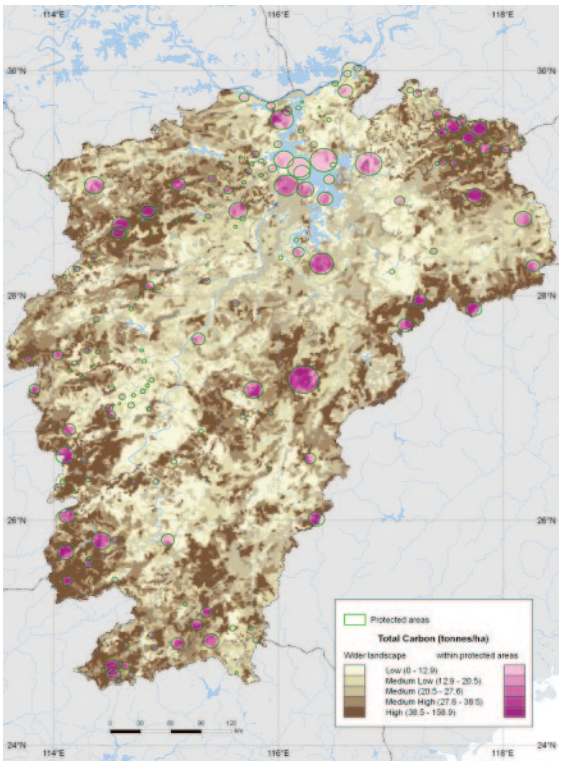

FIGURE 3: Carbon density and protected areas in Jiangxi Province, China (Li *et al.* 2009).

carbon and co-benefits (see figure 3). Additionally, they begin to explore how areas are distributed in relation to populations that may derive benefits from them and other services they may provide and have also begun to address in a spatial context some of the pressures that will have to be addressed in order to achieve successful climate change mitigation measures. These approaches are being developed further with existing partners and will also play a role in new collaborative work under discussion with other countries, such as Cambodia, Ecuador, Honduras and Nigeria.

UNEP-WCMC welcomes new data and perspectives on carbon and co-benefits. Furthermore, we are keen to collaborate with other countries who wish to develop and apply tools to support decision-making about climate change mitigation at national and other scales. Please visit http://www.unep-wcmc.org/Climate/ for more information and contact us at val.kapos@unep-wcmc.org.

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41. CLIMATE CHANGE AND AGROBIODIVERSITY

Strengthening Adaptability and Resilience, Facilitating Adaptation and Transition

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Keywords: agrobiodiversity, adaptation, mitigation, traditional knowledge, indigenous people

INTRODUCTION

Agrobiodiversity plays a central role in the coping strategies of rural communities and indigenous peoples. It is an important part of the livelihood strategies providing for many of the ecosystem services that ensure livelihoods by creating resilient landscapes and diversification which is key to well being.

The Platform for Agrobiodiversity Research (PAR) has undertaken a survey aimed at identifying the extent to which farmers around the world are using agrobiodiversity to cope with climate change.

Some of the coping lessons come from coastal, mountain, freshwater and forest biomes in India, Peru, Ghana, Central Niger (Ensor and Berger, 2009) and China (Salick et al.,2008) amongst the others. (Fig. 1)

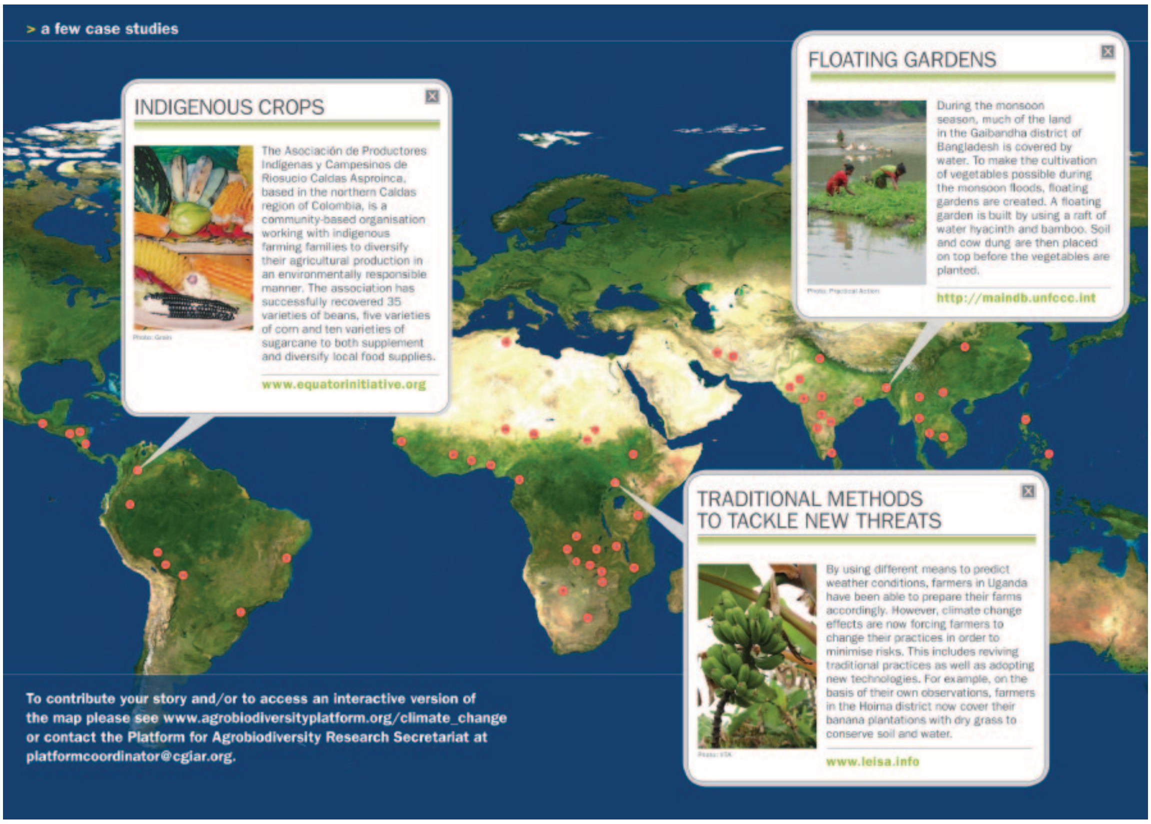

FIGURE 1: A few case studies illustrating the use of agrobiodiversity to cope with climate change

SOME FIRST RESULTS FROM ANALYSIS OF THE INFORMATION

Below are some key points that emerged from the coping strategies:

- The importance of maintaining traditional adapted materials (crop and livestock varieties) within production systems and of allowing them to evolve and adapt to changing conditions;
- The need for new materials in many situations and hence improved methods of dissemination and exchange of resources and information;
- The important role of buffering, reforestation and introduced landscape features (e.g. ditches, terraces, water harvesting) in mitigating the effects of climate change;
- The importance of combining Traditional Knowledge (TK) and experiences with new scientific developments. As weather events predictability decreases, TK needs to recalibrate
- The need to adapt to climate change has encouraged the revival of traditional seeds, practices and agricultural systems. This has enabled the communities to sustain food production under the increasing conditions of stress.
- The need to ensure that there is sufficient species and genetic diversity within production systems to maintain adaptability.

CONCLUSIONS

We recognize that farmers, pastoralists, forest dwellers, and fisher folk are having to adopt alternative livelihood strategies and need to exchange skills, knowledge, practices and experiences. It is crucial to support rural communities and farmers around the world to meet these challenges by facilitating the generation and exchange of new knowledge and partnerships that embed agrobiodiversity maintenance and use in climate change response strategies.

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42. PAYMENT FOR ENVIRONMENTAL SERVICES AS AN APPROACH FOR BIODIVERSITY CONSERVATION AND ECONOMIC DEVELOPMENT IN THE CONTEXT OF CLIMATE CHANGE

An Overview of Issues from Nepal

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Keywords: awareness, governance, equity, carbon trading, community development

INTRODUCTION

Payment for Environmental Services (PES) schemes are gaining increased attention as a policy instrument for the management and conservation of biodiversity, as well as for promoting local economic development. Such schemes have been successfully applied in different parts of the world to supply clean water to urban populations, reduce soil erosion, and promote biodiversity conservation and climate change mitigation and adaptation. Nepal, a mountainous country, hosts a rich diversity of flora and fauna, genetic resources, ecosystems and associated traditional knowledge. However, the country has lost more than half a million hectares of forest in the last 50 years, resulting in the loss of biodiversity, increased soil erosion, downstream sedimentation and reduced agricultural productivity (UNDP, 1998). PES schemes aiming to assure environmental services, forest conservation, reducing poverty and climate change mitigation and adaptation are becoming popular in Nepal. An emerging mechanism known as 'reducing emissions from deforestation and forest degradation (REDD)' is gaining particular attention as Nepal embraces the promise of international carbon markets as a possible means of mitigating the impacts of climate change while promoting economic development of both the country as a whole and its forest-dependent communities. Currently, projects focusing on three types of PES (Wunder 2005) exist; *biodiversity protection* in Shivapuri National Park, *watershed protection* in the Kulekhani watershed and *carbon sequestration and storage* under various REDD piloting initiatives. The equitable distribution of benefits among the providers of these services, and an overall governance system for PES schemes, are important prerequisites for the success of current and future efforts. Furthermore, lessons can be drawn from existing PES schemes for the prospects and design of a national REDD strategy. Whether these schemes can really make a significant contribution to reducing the global threats of climate change, biodiversity loss, and poverty reduction of the most vulnerable people, and help in achieving 2020 targets, remains to be seen.

ISSUES RELATED TO PES IN NEPAL

PES regimes in Nepal are receiving increased attention as a potential means of enhancing forest conservation while providing vital environmental services. An integrated national policy related to the provision of diverse environmental services should be formulated so that the local inhabitants can benefit from the schemes contributing to conservation and management of various parks and watersheds.

In the former case, there is lack of awareness about environmental services provided by the park to the dwellers of the Kathmandu metropolitan city and the local communities living in the proximity of the park who are the service providers. Issues related to the governance mechanism and to equity in decision-making and associated outcomes (Corbera et.al 2007), should also be considered. If these issues are addressed, the PES scheme in the Shivapuri National Park could serve as a model for contributing to the three broad goals of the Convention on Biological Diversity (CBD): conservation of biological diversity; sustainable use of the components of biodiversity; and fair and equitable sharing of benefits arising out of utilization of genetic resources. It could also contribute to reducing greenhouse gas emissions in the context of climate change. In the

Kulekhani watershed, a reward mechanism for upland communities is in place. Local people are encouraged to change their land use patterns to avoid sedimentation in the water reservoir. About 50% of the people in watershed are under the poverty line and a certain percentage of hydropower revenues go to the community for conservation and community development activities, which is currently insufficient for poverty reduction and conservation activities. Similarly, the reward mechanism doesn't consider equity and governance mechanisms. For instance, some poor upland communities, like the Tamang ethnic community, who have been managing and using highland forests in the watershed, are excluded from the current financial benefits. If such issues are resolved, the PES scheme in the Kulekhani watershed could offer a useful lesson in the country for forest conservation and community development.

REDD initiative in which the government is formulating a national policy and institutional framework, and various piloting activities are being initiated. However, the benefits from carbon credit under REDD to the existing community forests is doubtful. Although Community forestry seems to be an appropriate strategy for REDD in Nepal because of its success in achieving its environmental objectives, the existing community forests may not be qualified for carbon credit but they might be qualified for PES as they have been promoting forest conservation, watershed management, increased scenic beauty and generating income for local communities. Therefore, piloting activities for developing methodologies on PES and crafting governance mechanism and payment system for the same would be more appropriate in Nepal.

CONCLUSION

In the context of climate change, PES initiatives and associated reward mechanisms in Nepal represent a promising strategy for promoting biodiversity conservation, watershed protection and climate change mitigation and adaptation. If PES schemes are to succeed, however, they should be carried out in a way that promotes poverty alleviation, equity, and good governance. If implemented properly, they also have the potential to serve as an adaptation strategy for climate change by ensuring the continued provision of critical environmental services and contributing to the economic development of rural communities. It is therefore important to pursue existing PES projects and models for awarding communities for their attempts through community adaptation and mitigation measures that they have adapted in community and private land. Lessons from localized PES schemes; key elements of governance at multiple scales (i.e., laws, institutions, decision-making and information-sharing processes, local norms and systems of accountability), the interests of local communities and marginalized groups, and the roles of diverse stakeholders would be crucial. Finally, to ensure long-term benefits for biodiversity, watershed conservation and the livelihoods of rural communities, it is crucial to study the outcomes of existing PES schemes, draw lessons from them to inform the implementation of REDD projects if any.

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43. BIODIVERSITY—VITAL FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

Forests as a Case Study

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Keywords: forest biodiversity, plantations, sustainable forest management, REDD, forest definition

INTRODUCTION

Climate change mitigation practices (e.g. under UNFCCC) may, or may not, take biodiversity considerations into account. The benefits of considering biodiversity in these practices extend well beyond reducing the rate of biodiversity loss. Using forests as a case-study, the benefits described include: enabling adaptation to climate change, continued C sequestration in ecosystems, resilience against impacts of climate change and hence retention of essential ecosystem services to humans. This has implications for the design of REDD and to achieving targets to reduce the rate of biodiversity loss.

HUMANS NEED BIODIVERSITY

Forest biodiversity and forest ecosystems are closely connected to each other, and to Earth's climate. They are crucial for both mitigation of, and adaptation to, climate change. Often considered "nice-to-have", biodiversity is actually essential for mankind's continued existence on this planet. Biodiversity forms ecosystems, and ecosystems provide services. Without biodiversity, or degraded biodiversity, many of the ecosystem (and their services) from forests that we rely upon would probably collapse. Without these ecosystem services, the planet would be uninhabitable for humans (and many other species).

Ecosystem services can be local, regional or even global. Local (direct) services include medicine, food and shelter whilst regional or global (indirect) services include rainfall. For example, modelling suggests that loss of forests in areas such as Amazonia and Central Africa can severely reduce rainfall in the U.S. Midwest, at times when water is crucial for agricultural productivity in these regions (Avissar & Werth, 2005). Forests are also important for transferring moisture from the ocean into continents. They create a pump that causes ocean-fed rain to fall many hundreds, and even thousands, of kilometres inland (Makarieva et al., 2009). Modelling suggests deforestation will dramatically reduce waterfall in inland areas, and that historical deforestation in Australia has contributed to the Australian drought (McAlpine et al., 2007). Thus, forests provide ecosystem services that we are often unaware of, but are nonetheless vital.

LOGGING MAGNIFIES THE IMPACTS OF CLIMATE CHANGE ON FORESTS

Logging, even selective logging under sustainable forest management (SFM) regimes, degrades forests. Forest degradation magnifies climate change impacts in tropical forests by fragmenting the forest, making it drier and more vulnerable to drought-induced fire. These effects magnify each other in a destructive cycle of logging, drought, fire, which could destroy significant parts of the Amazon forest by the end of the century (Malhi et al., 2009; Lenton et al., 2008). Thus, logging increases the possibility that we will lose vital ecosystem services with climate change.

The more vulnerable a forest to climate change, the more vulnerable the carbon stocks are to being lost to the atmosphere, increasing greenhouse gas (GHG) concentrations in the atmosphere. In addition, it is estimated that land-based ecosystems currently take up approximately 30 % of anthropogenic carbon emissions, proving a vital buffer for atmospheric carbon concentrations (SCBD, 2009). Degradation of forest ecosystems results in a decreased ability to take up carbon from the atmosphere. The loss of this service, together with the loss of carbon stocks, increases the risk of runaway climate change. Hence, it is important to maximise the resilience of forests to climate change by preserving intact primary forest landscapes (see http://www.intactforests.org for definitions and maps of intact forest areas), rather than simply altering logging regimes (e.g. to SFM).

Forests are also important for adaptation to climate change as they protect from extreme weather events such as high winds and coastal floods. Loss of forests, either by climate change or by logging means this protection would be seriously reduced.

PLANTATIONS DO NOT PROVIDE THE SAME ECOSYSTEM SERVICES AS FORESTS

A REDD mechanism solely focusing on carbon could lead to the replacement of forests by plantations. Under current UNFCCC LULUCF definitions, a plantation could count as a forest, as a forest is simply defined by perecntage crown cover (UNFCC, 2002). Plantations are monocultures – or at best a mix of very few species. Plantations do not harbour anywhere near the same degree of biodiversity, sustain freshwater cycles, nor adequately provide the other essential ecosystem services that natural forests do. There is a critical need to adjust the definition of forests within UNFCCC to differentiate between plantations and forests (Sasaki & Putz, 2009). One possible interim option would be to adopt the UN FAO classification scheme as used in the 2010 Forest Resource Assessment (FAO, 2007).

CONCLUSIONS

Mainstreaming biodiversity into REDD would not only facilitate achievement of targets to halt the loss of biodiversity, but also of aid adaptation to climate change. Biodiversity considerations in REDD will also increase ecosystem resilience to climate change, thereby maintaining essential ecosystem services that humans rely on, including continued carbon sequestration.

In order for REDD to provide maximum benefits to biodiversity, it would need to focus on conserving existing natural forest, especially intact primary forest, rather than altering logging practices. Adoption of UN FAO classification schemes by UNFCCC would be of benefit in distinguishing between natural forests and plantations.

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44. WORKING WITH NATURE
Ecosystem-Based Approaches to Climate Change Adaptation and Mitigation

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Keywords: biodiversity, ecosystem services, climate change adaptation and mitigation

Managing, restoring and protecting biodiversity and ecosystem services provides multiple benefits to human society. These ecosystem-based approaches also contribute to societal climate change objectives by conserving or enhancing carbon stocks, reducing emissions caused by ecosystem degradation and loss, and providing cost-effective protection against some of the threats that result from climate change. For example, coastal ecosystems such as saltmarsh, and barrier beaches provide natural shoreline protection from storms and flooding and urban green space cools cities (reducing the urban-heat island effect), minimises flooding and improves air quality. Ecosystem-based approaches provide multiple benefits, are cost-effective, ready now and likely to be more accessible to rural and poor communities. Thus they can align with and enhance poverty alleviation and sustainable development strategies. There are also powerful economic and social arguments for taking action to protect biodiversity and ecosystems.

Nevertheless, true integration of climate and biodiversity policies remains the exception, outside of forest protection (i.e. REDD+). Where climate change programmes include biodiversity sections, they often only tackle climate change impacts on biodiversity, while in biodiversity action plans climate change aspects are often limited to adaptation measures for biodiversity. The role of biodiversity and ecosystem services in achieving climate goals is often overlooked, as is the potential of other sectors such as agriculture, transport and energy to respond to climate change in a way that uses ecosystem-based approaches to enhance the resilience not only of biodiversity, but of the wider sector.

Ecosystem-based approaches, including green infrastructure planning, coastal habitat restoration, peatland restoration and catchment management, maintain ecological functions at the landscape scale in combination with multi-functional land uses and contribute to ecosystem resilience. These approaches can be applied across a range of ecosystems, at all scales from local to continental and have the potential to reconcile short and long-term priorities. While contributing to halting the loss and degradation of biodiversity, they also enable the functions and services provided by ecosystems to provide a more cost-effective and sometimes more feasible adaptation solution than can be achieved by relying solely on conventional engineered infrastructure or technology-led measures. In addition, these approaches reduce the vulnerability of people and their livelihoods in the face of climate change. They also help to maintain ecosystem services that are important for human well-being and vital to our ability to adapt to the effects of climate change.

Biodiversity conservation issues should be incorporated into climate change adaptation and mitigation policies, sectoral policies and sustainable development strategies. In particular conservation and sustainable use of biodiversity needs to be built into the adaptation plans of other sectors. Not only will this will help deliver nature conservation goals and ensure that natural resources such as water and wetlands, remain available at current and preferably increasing levels, it will also contribute to adaptation and mitigation objectives.

Biodiversity and ecosystem services are crucial to the alleviation of poverty, as human populations in poor countries depend directly on them and they play a key role in helping society achieve mitigation and adaptation goals. They are integral to key development sectors, such as agriculture, forestry, fisheries and tourism. Sustainable development cannot be achieved if biodiversity is compromised by development efforts. Consequently, mainstreaming biodiversity into climate change and development strategies and programmes is essential to poverty alleviation and development. Ecosystem-based approaches, as outlined above are a smart, innovative and simple way of contributing to the objectives of combating climate change, conservation and sustainable use of biodiversity and poverty alleviation.

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45. CLIMATE ADAPTATION FOR BIODIVERSITY, ECOSYSTEM SERVICES AND LIVELIHOODS IN RURAL MADAGASCAR

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Keywords: climate adaptation, conservation, biodiversity, forest regeneration, community livelihoods, Madagascar

INTRODUCTION

Madagascar, with its high biodiversity and high level of human dependence on agriculture, fisheries and local ecological resources for survival, presents immediate challenges for both human adaptation to climate change and for adapting biodiversity conservation to address climate induced threats.

Approximately 80% of Madagascar's population lives in rural areas with subsistence agriculture a primary means of survival. Slash and burn, shifting agriculture *(tavy)* has been identified as the main cause of environmental degradation and forest loss. Lack of adequate infrastructure in many rural regions limits access to information, agricultural inputs and credit, and to markets—all of which are factors contributing to a perpetuation of *tavy* (Erdmann, 2003). In addition, rain-fed rice production can be combined with other crops and the low-input nature of *tavy* makes it a risk-averse practice (Erdmann, 2003). These factors also contribute to making human adaptation under climate change more challenging, for example, by limiting options for agricultural diversification and market access, and setting up farmers reliant on rain for irrigation as more vulnerable to changing seasonal precipitation patterns. Combined with other land and resource use practices, *tavy* presents enormous conservation challenges in Madagascar primarily due to habitat destruction and degradation.

Climate change is projected to exacerbate these threats, while creating an increased need for habitat restoration in order to facilitate species migration and survival. Projected changes in climate for Madagascar show warming across the island and areas of both increased and decreased precipitation (Tadross 2008). Southern Madagascar is projected to have the greatest warming, with the coast and north showing lower projected temperature increases. Precipitation increase is centered in the northwest, while drying is projected in the east. These spatial characteristics are biologically significant because the south is already the driest region in the country, while the eastern forest is highly fragmented and vulnerable to drying

Responding to these challenges, an experts' driven workshop assessed specific ecosystem and rural livelihoods' vulnerability to climate change in Madagascar. Adaptation recommendations emerging from this assessment are now being tested for feasibility in phase two of this effort.

ENHANCING ECOSYSTEM & LIVELIHOOD RESILIENCE

The highest priority for building resilience to climate change for terrestrial biodiversity is to increase forest connectivity throughout Madagascar, particularly for areas that species will need as they adapt to future changes and areas critical for the continued provisioning of vital ecosystem services. Thus, in addition to protecting existing forests, facilitating species' adaptation will also involve restoring habitats in degraded landscapes to increase forests connectivity. One of the important areas for protection and restoration are riverine forests based upon the hypothesis that these forests could play a major role in facilitating the movement of species in response to climate change (Wilme et al 2006). We are conducting an inventory of the existing riverine forests to identify those that could serve as potential migratory corridors for species based on a range of species' niche modeling analyses and ground surveys. Applying lessons learned on forest restoration costs and techniques in representative ecosystem types across the country will inform the development of detailed, site specific restoration plans for improving forest connectivity.

In order to increase the relevance of restoration efforts to local forest communities and enhance community resilience, we are assessing the effectiveness of sustainable livelihood activities in improving livelihoods to provide incentives for restoration. These activities include facilitating market access for farmers living in extremely remote areas, demonstrating the feasibility of eco-agricultural techniques as alternatives to *tavy* and introducing agricultural diversification options.

We will consider the potential increase in pressure on natural forests as a result of human adaptation needs in response to climate change driven food security threats. This analysis is based upon agricultural risk analyses and community experiences of productivity changes driven by climate change. The results from this component will help identify priority regions where human needs and conservation efforts under climate change will need to be addressed simultaneously.

CONCLUSION

Human well-being, functioning ecosystems and climate change are interlinked: conserving biodiversity can moderate the impacts of climate change on human communities by maintaining ecosystem function and services. As biodiversity declines, so does the resilience of ecosystems and the services they provide to humanity. The results of this pilot phase of testing various adaptation approaches will inform a comprehensive adaptation program for building community and ecosystem resilience to climate change in Madagascar.

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46. CROP BIODIVERSITY TO REDUCE PEST AND DISEASE DAMAGE
A Competitive Solution for Poor Farmers Under Climate Change

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INTRODUCTION

Occurrence of pests and diseases in crops is the result of the interaction of three factors: the hosts, the pathogens and the environment. Under any given equilibrium it is this interaction determining the progression of a disease epidemic or pest outbreak. However, due to evolutionary forces operating in both hosts and pathogens, management choices of the agricultural ecosystem and environmental changes, the three factors are constantly changing; changes in any of the three legs of this triangle can lead to changes in the progression of a disease (http://www.climateandfarming.org/index.php). For this reason 30% of the world's annual harvest is lost to pests and diseases and most of it in developing countries.

Climate change with the associated variation in CO_2 concentration, increased temperature and modification in drought can have an impact in all three factors affecting diseases and pests. It can entail the occurrence of new strains of pathogens, increase the frequency of outbreak of pests and, together with reduced yields, can seriously affect the resilience of an agro ecosystem and the capacity of farmers to cope with the changes (Oerke, 2006; Easterling et al 2007) and as a result it can exacerbate the potential negative consequences of planting large areas to single crop cultivars with uniform resistance to pests and diseases.

In order to cope with the threats posed by climate changes options were proposed under an Integrated Pest Management (IPM) framework, e.g. Wilby et al. (2007) and Glantz et al. (2009) for a review**.** However, there has been a tendency to exclude the potential resistance to pests and diseases inherent in different varieties, for example through genetic mixtures. A diverse genetic basis of resistance is beneficial for the farmers because it stabilizes the system and it allows a more stable management of pests and diseases even under changing scenarios, e.g. different pathogens immigrating due to climate changes, more severe pests outbreak occurring due to more favorable conditions. This is because when resistance in a monoculture breaks down the whole population succumbs, while in a genetically diverse field it is much less likely that different type of resistance will all break down in the same place when a new pathogen enters the system.

However, using diversity to manage pests and diseases under a climate change scenario might not be feasible everywhere and it is important to understand when and where genetic diversity of the target crop can be recommended to manage pests and diseases now and in the future. Here we present preliminary results of participatory assessment conducted in 4 countries, namely China, Ecuador, Morocco, and Uganda, on 6 crops, barley, common bean, faba bean, maize, plantain/banana, and rice. Data were obtained in the framework of the project UNEP/GEF project "Crop Genetic Diversity for Pest and Disease Management"

METHODOLOGY

Information about on farm diversity and management practices was collected through Focus Group Discussions (FGD) and household surveys - from 22 sites in 4 countries and on 6 crops as shown in Figure 1. Fifty farmers per site (divided into 5 groups of 10 people ,elder male, elder female, younger male, younger female and leader) were consulted through FGD, and 60 farmers in each site were interviewed during the household survey, totaling 1800 farmers. Additional information on tools and methodology adopted can be found at the following site: www.bioversityinternational.org/publications/publications/publication/issue/crop_genetic_diversity_to_reduce_pests_and_diseases_on_farm_participatory_diagnosis_guidelines_ver.html.

RESULTS AND CONCLUSION

Results show that useful diversity with respect to pests and diseases exists in all sites and countries. An analysis of site characteristics that can influence the effect of pests and diseases pressure was conducted based on the information collected through FGDs and household surveys. Overall results confirm that climatic conditions play a very important role in determining outbreaks of pests and/or diseases and that farmers are knowledgeable about resistance of different varieties. Farmers tend to consider resistance to pests and diseases as an important character when they have to choose which varieties to plant, but the importance of this trait compared to others, such as yield, depends on the pest and disease pressure which varies among sites and countries. In Ecuador diversity in maize and bean is high and pest and disease pressure is low. It is important to investigate if the low pressure of pests and diseases is due to the high richness maintained by farmers (up to seven varieties in maize and ten in bean per plot). In China there is a tendency to use more pesticide compared to other countries to control pests and diseases due to the subsidized pesticide price. However, in areas and for crops where this is not the case, such as barley in Songming and Shangri La, results showed that there is an effect of mixtures in reducing pest and disease pressure. In Uganda pest and disease pressure is high in bean and banana fields. Results show that mixtures can reduce pest and disease pressure in banana. This was said by farmers and confirmed by field observation. In Morocco results show that farmers tend to plant different varieties in different plots for barley. Experiments will tell if the combined effect of varieties resistance in mixtures can help reducing pest and disease pressure.

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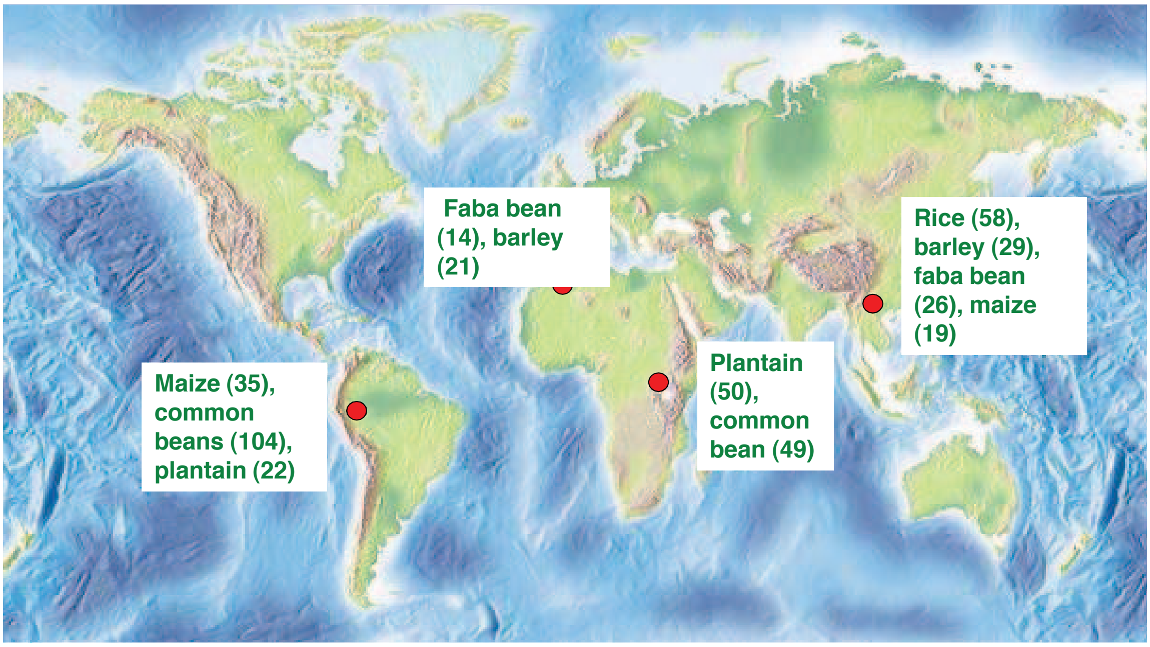

FIGURE 1: Map showing the crops under investigation in the 4 countries. Between brackets the number of varieties identified

47. ADAPTATION STRATEGY TOWARDS CLIMATE CHANGE FOR THE VULNERABLE FISHERIES OF INDONESIA

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INTRODUCTION

Indonesia covers a vast archipelagic area consisting of more than 17,000 islands stretching about 5,000 km from East to West and about 2,000 km from North to South with a coastline of 80,000 km. The total area of Indonesia is about 1,919,317 sq. km with a total population of about 210 Million in 2009 with a growth rate is 2.34% per annum (BPS, 2009). The situation of vulnerable fisheries resource somehow made fishers and other related parties uncomfortable. As of now, many parties have not prepared for the climate change. From many of landing places in Java reported for changes in: fish production, season time, sea-tides and others indicators of climate change.Therafter to outline the grass-root strategy on adaptation for the climate change in fisheries sector is necessary. The past 25 years since 1980 to 2008, a significant impact of climate change in terms of ecological or oceanographical variables had been detected (such as the Sea Surface Temperature (SST) positive anomaly, the seasonal extreme changes of ocean wind , wave height, etc). These phenomena will change on nutrient cycles, microbial, planktonic and larval community, fish behaviour such as spawning cycles, and ultimately to the marine fish production.

MATERIALS AND METHODS

The objectives of the study are: (1) to identify the climate change in the fisheries sector; (2) to analyse the vulnerability of the fisheries sector; (3) to formulate a strategy on adaptation for the fisheries sector due to climate change. The main data used in the study are marine meteorology indicators such as wind speed and direction, sea surface temperature (SST) for 30 years, 1971–2000 which were collected from National Center for Environmental Prediction (NCEP). Interview with fishers in the study area were also carried out with suitable sample frame. Discussion with key-persons and other competence persons were also done accordingly. The study employed a GIS in marine meteorology (Hartoko and W. Sulistya, 2009) and socio-ecnomics approaches (Susilowati et al., 2004, 2005; 2009) with necessary modification.

The study area are located along the North coast of Java sea with 22 stations. The phenomena of climate change and vulnerability of the fisheries resource are estimated. The world geodetic system (WGS84) for geodetic datum and Geodetic for map projection was used in the digital mapping process. The necessary indicators of GIS in marine meteorology which may affected by the climate change then will be socialized to the competence persons for adaptation using empowerment strategy employed by Susilowati et al. (2004; 2005; 2009).

RESULTS

The sea surface temperature (SST) plays an important role since it indicates the interface from the atmospheric to the oceanographic environment. In general there were two peak and two crest for SST in a year periode. There were two cycles of low (February and August) and high (May and November) SST in avearage for 30 years (1971 -2000). The most important analysis on SST variability has been done that is the yearly SST variability for 30 years based (1971 to 2000). Before 1980, the anomaly of SST was in below normal, or cooler than its average value. But after 1980 the SST anomaly is above normal. This means that the SST of the Java sea was tends to increase after 1980. The global ocean phenomena may incurred due to global warming effect. The fisheries stock in Java sea is found to be declining (Squires et al., 2003; Susilowati et al., 2004b). This was due to a heavy fishing efforts have been put on by fishers, especially with multi-gears. The impact on vulnerable fisheries in fish stock and environment quality toward the economic gain of micro-and small-fish processors in the study area (Pekalongan, Central Java) was significant. In general the economic gained by fishers in the study area were marginalising and tend to be dissipated particularly due to a fragile of the stock supplied to sustain the food security. Mostly fishers in the study area were powerless (Susilowati et al., 2004a; 2005) and the other hand, the behavior of fisheries resource has changed vulnerably inline with the global change. Therefore, it is indeed need to provide a sufficient prescription to a wake the micro- and small-scale of fishers in adjusting their behavior and habits towards the vulnerable changes in fisheries resource (Susilowati et al., 2008; 2009).

The key indicators of marine meteorology and geophysics (among others are seasonal pattern and climate zonation, wind variability, variability of sea surface temperature, sea water spatial distribution, etc) need to be disseminated to the fishers and the competent parties as a public information. Thereafter, fishers will be well informed about the current of vulnerability of fisheries resource. Moreover, the fast action on the campaign program (by all means), training or simulation, extensions program, etc are necessary needed to be designed and faster launching accordingly by the competent and relevant stakeholders.

CONCLUSION

Small-scale fisheries sector in Indonesia which is mostly composed by fisher with 5–30 GT engine fleets are the mainly party who affected by the vulnerable fisheries phenomena. At the moment, mostly small-scale of fishers (hunter, processor, traders, etc) are powerless. They likely have not aware and neither well-informed about the performance nor indicators of vulnerable fisheries. Therefore, empowerment action to the competent stakeholders (academician/NGO; business, Government; Community) need to be launched simultaneously and integratedly with consideration on climate change and its biodiversity. With a help of the Department of Fisheries, a Board of Meteorology and Geophisics; Office of Community Empowerment; Department of Agriculture; Department of Industrial and Trade; and the Local Government in the respected regions, thus the powerment action could be designed and subsequently launched properly. Lastly, co-managment approach seems will provide a good promise.

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48. PARTNERS WITH NATURE

How Healthy Ecosystems are Helping the World's Most Vulnerable Adapt to Climate Change

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Keywords: ecosystem-based adaptation, ecosystem resilience, community-based adaptation, local knowledge, local-to-global

THE ROLE OF ECOSYSTEMS IN CLIMATE CHANGE ADAPTATION

Healthy, bio-diverse environments play a vital role in maintaining and increasing resilience to climate change, and reducing risk and vulnerability (Millennium Ecosystem Assessment, 2005; TEEB, 2009; RSPB, 2009; Secretariat of the Convention on Biological Diversity, 2009). This is particularly critical to many of the world's 2.7 billion poor people, who depend on natural resources most directly for their livelihood and survival.

BirdLife International's experience shows that supporting the application of local knowledge and community engagement can build the resilience of natural and societal systems, delivering locally appropriate solutions to help communities, countries and economies adapt to climate change.

The role of ecosystems in climate change adaptation can usefully be applied at all scales: local, landscape, national, transboundary and international. The BirdLife Partnership's unique local-to-global structure has enabled structures and processes to be established that contribute to long-term and flexible approaches to climate change adaptation. Of BirdLife's 100-plus national Partners, more than 60 are in low income countries. Partners are working in many areas already impacted by climate change, and in others where it will add to current vulnerabilities.

PARTNERS WITH NATURE

Partners with Nature, published by BirdLife in December 2009, includes 14 examples of BirdLife Partners' work with vulnerable communities in Important Bird Areas (IBAs) (places of international importance for bird conservation, forming part of a global network of sites (BirdLife International, 2009)). See: http://www.birdlife.org/climate_change/adaptation/index.html. The case studies, drawn from different geographic regions, include:

- conserving and restoring forests to stabilise slopes and regulate water flows, preventing flooding and landslides as rainfall levels and intensity increase (Palas Valley, Pakistan; Macaya Biosphere Reserve, Haiti; Tumbesian forests, Peru/Ecuador)
- establishing diverse agroforestry systems to cope better with the changing temperatures, water shortages and pest infestations associated with climate change (Kikuyu Escarpment Forest, Kenya; Mbeliling, Indonesia; Mount Siburan, Philippines)
- sustainable management of wetlands and floodplains for maintenance of water flow and quality, acting as floodwater reservoirs and as important stores of water in times of drought (Lake Oursi-Lake Darkoye, Burkina Faso; Hadejia-Nguru Wetlands, Nigeria; Koshi Tappu Wetland, Nepal; Ooijpolder, The Netherlands)
- coastal defence through the maintenance and restoration of mangroves and other coastal wetlands, which act as coastal buffers, helping to reduce flooding and erosion and protect against cyclone damage (Upper Bay of Panama, Panama; Samoa; Babeldaob Island, Palau; Humberside, UK)
- integrating 'nature-based' infrastructure and technology into hard engineering approaches, to avoid damage to ecosystems (Hadejia-Nguru Wetlands, Nigeria; Humberside, UK)

The case studies demonstrate that including the role of ecosystems in different approaches to adaptation can provide many benefits. They are accessible to rural and poor communities, and are often more cost-effective and enduring, because they provide local benefits, and can be locally managed and maintained. They balance immediate needs with preparation for long-term impacts, providing alternative livelihood options in the face of climate change uncertainty. They combine indigenous and local knowledge with external expertise. They contribute to the conservation and sustainable use of biodiversity, and to climate change mitigation by maintaining carbon storage.

MAKING IT HAPPEN

The importance of healthy ecosystems must to be effectively written into local, national, regional and international climate change and development policy and practice. To create a climate-resilient society, adaptation priorities need to be agreed in-country, through nationally-led, inclusive and participatory processes. **Governments** need to base policy on sound science, recognise ecosystems as cross-cutting and underpinning for adaptation, and address ecosystems effectively within national adaptation frameworks, strategies and plans. Governments should significantly step up efforts to protect nature and biodiversity, as a prime strategy to ensure ecosystem resilience, recognising this as vital to addressing climate change.

Local **communities** and resource users should be fully involved in adaptation planning, implementation, monitoring and evaluation—and support and information should be readily available to enable this. **Sectors** such as agriculture, energy and transport should apply an ecosystem approach to business planning and delivery, and ensure that ecosystem resilience is strengthened rather than weakened by their activities. Sectors should work together in assessing risks posed by climate change and find sustainable adaptation solutions that where possible work for all. The **international community** (including governments, international and regional institutions, and multinational corporations) has a vital role to play in preventing dangerous climate change and helping those most affected adapt. The interlinkages between biodiversity, climate change, and sustainable development, must be effectively recognized within the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD), as well as other international fora.

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49. GLOBALLY IMPORTANT AGRICULTURAL HERITAGE SYSTEMS
Community-Based Biodiversity Conservation and Adaptation to Climate Change

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Keywords: agricultural heritage, dynamic conservation, adaptive management, agricultural biodiversity of global significance

INTRODUCTION

Recognizing the important contribution of indigenous agricultural practices, in 2002 FAO presented a Partnership Initiative on "Conservation and Adaptive Management of Agricultural Heritage Systems (GIAHS)[1] and adopted in the World Summit on Sustainable Development (WSSD). The initiative seeks to promote the international recognition, conservation and adaptive management of these systems, including where necessary the revitalisation and outstanding role of these systems in the conservation and sustainable use of agricultural biodiversity, as well as their contribution to increasing food security and poverty reduction. GIAHS initiative recognises and is centred on the profound inter-relatedness of biodiversity, agriculture, ecology, culture and social organisation and institutions, ethics, local livelihoods security and food sovereignty. The initiative attempts to mitigate threats to the resilience of GIAHS by supporting family farming communities and enhance their capacity to continue to manage their agricultural heritage systems, with the involvement of national governments, scientists and other stakeholders. It also seeks to support these communities and their governments in developing enabling and appropriate policy environments conducive to continued existence of GIAHS which will allow its evolution and development. The initiative offers an opportunity to build in a step-by-step, cooperation amongst communities that effectively manage their agricultural heritage systems, in a sustainable (and self-reliant) development context.

DYNAMIC CONSERVATION OF GIAHS

The overall goal of GIAHS Initiative is to contribute to the implementation of the CBD Article 8j "protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements", specifically within agricultural systems. Since its launching, FAO is focusing in both process and on the ground activities, such as: (i) formulation of a framework of action through multi-stakeholder mechanism for each case; (ii) discussion and interaction of natural resource management and socio-economic problems and potentials related to the specific GIAHS; (iii) analysis and prioritization of needs for the dynamic conservation of GIAHS; (iv) identification of positive features of existing systems (diversity of local varieties, ingenious soil conservation practices, etc) that need to be strengthened or optimized; (v) identify and implement concrete interventions; (vi) implement an agreed action plan for dynamic conservation of target GIAHS; and (vii) monitor and evaluate impacts and benefits of GIAHS conservation interventions.

CLIMATE CHANGE OPPORTUNITIES TO CONSERVE BIODIVERSITY

Throughout history, climate variability has continually transformed biodiversity, resulting in evolution *in situ* of individual species, changes in species distributions in time and space, and changes in associations between species with concomitant changes in species communities and in ecosystems. Species survive in what are known as environmental or climate envelopes—the temperature and moisture regimes to which they are adapted

1 GIAHS are defined as "remarkable land use systems and landscapes which are rich in globally significant biological diversity evolving from the co-adaptation of a community with its environment and its needs and aspirations for sustainable development". Detailed information can be found at www.fao.org/nr/giahs

physiologically. For some species, these envelopes, and hence their distribution ranges, are quite small, whereas for others they may be quite large. Species also have different capacities to migrate and colonise in order to keep up with movement in their climate envelopes as the climate changes: thus, the responses of different species to climate change are individualistic. In many areas of the world, small farmers/family farming communities have often developed farming systems adapted to the local conditions enabling farmers to generate sustained yields meeting their subsistence needs, despite marginal land endowments, climatic variability and low use of external inputs. Part of this performance is linked to the high levels of agrobiodiversity exhibited by traditional agroecosystems which in turn positively influences agroecosystem functions. Diversification of crops is therefore an important farming strategy to manage production risk in small farming systems.

COMMUNITY-BASED BIODIVERSITY CONSERVATION THROUGH ADAPTIVE MANAGEMENT OF AGRICULTURAL HERITAGE SYSTEMS

One of the main ecological features of GIAHS is the capacity to dynamically conserve agricultural biodiversity and associated biodiversity. Some GIAHS are even linked to important centres of origin and diversity of domesticated plant and animal species, the *in-situ* conservation of which is of great importance and global value. They provide many ecosystem goods and services; functioning and regulation of water, carbon and nitrogen cycles; soil and water conservation and restoration; carbon sequestration and climate regulation (micro and macro), resilience and adaptation to climate variability, pests and diseases outbreaks (Altieri and Koohafkan 2008). Other benefits are the livelihood services they provide, which include: food security; housing, fuel/energy, farm income; health and related needs; social and cultural services (equity, cohesion, security, identity), quality of life (opportunities, leisure, education, arts, ethics, spirituality) and technological and knowledge services such as local and indigenous knowledge and value systems and innovative agricultural production and household technologies. To promote community-based biodiversity conservation, FAO GIAHS initiative is supporting adaptive management of some agricultural heritage systems of local and global importance. Characteristics and features of the systems adapting and mitigating climate change while promoting the conservation and sustainable use of agricultural biodiversity and associated biodiversity. Some of the pilot systems are as follows:

1. Andean Agriculture (Peru). The Central Andes are a primary centre of origin of potatoes. Up to 177 varieties have been domesticated by generations of Aymara and Quechua in the valleys of Cusco and Puno. One of the most amazing features of this agricultural heritage is the terracing system used to control land degradation. Terraces allow cultivation in steep slopes and different altitudes. In the high plateau, around Lake Titicaca, farmers dig trenches (called "suka collos") around their fields. These trenches are filled with water, which is warmed by sunlight. When temperatures drop at night, the water gives off warm steam that serves as frost protection for several varieties of potato and other native crops, such as quinoa (figure 1).

FIGURE 1: Andean Agriculture System (Peru)

2. Chiloé Agriculture (Chile). The Archipelago of Chiloé, in the south of Chile, is one of the centers of origin of potatoes and is an extraordinary biodiversity reserve. It is temperate rainforests that hold a wide range of endangered plant and animal species. The Chilotes—Huilliche indigenous populations and Mestize—still cultivate about 200 varieties of native potatoes, following ancestral agricultural practices transmitted orally by generations of farmers, mostly by women.

3. Ifugao Rice Terraces (Philippines). The ancient Ifugao Rice Terraces (IRT) is the country's only remaining highland mountain ecosystem featuring ingenuity of the Ifugaos and a remarkable agricultural farming system which has retained the viability as well as the efficacy of the 2000 year-old organic paddy farming. The muyong is managed through a collective effort and under the traditional tribal practices. The communally managed forestry area on top of the terraces mostly contains about or more than 264 indigenous plant species, mostly endemic to the region. They serve as a rainwater and filtration system and are saturated with irrigation water all year round. A biorhythm technology, in which cultural activities are harmonized with the rhythm of climate and hydrology management, has enabled farmers to grow rice at over 1000 metres.

THE ROAD AHEAD

Aside from the systems mentioned above, GIAHS initiative shall continue to address the important connectivity between *agri-cultural* and biological diversity that converge and co-evolves in agricultural systems (accumulated good practices), synergy building, integrated and holistic management of GIAHS and its key elements. The year 2010 is declared International Year of Biodiversity, recipient governments of the GIAHS Initiative strives to promote and create awareness raising on the importance of biodiversity in the lives of our people. The sustainable management, adaptive and mitigation measures against climate change to conserve and sustainably use biodiversity is crucial to ensure continued benefits. In line with this, the initiative shall continue to draw lessons learned from the practices and experiences of dynamic conservation of agricultural biodiversity and associated biodiversity from its pilot countries and will target at least 100–150 systems around the world.

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50. LIVELIHOODS, CLIMATE ADAPTATION AND MITIGATION & RENEWABLE ENERGY AROUND LAMBWE VALLEY ECOSYSTEM

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All the residents of Lambwe Valley ecosystem are victims of Tsetse fly infestation and wild animals from Ruma National particularly, those residing on the peripheries of 2–3 kilometres from the fence. This subjects them to the full vagaries of disaster and hopelessness in several ways.

LIVELIHOODS, DISASTER

The most imminent disaster here is the biological crisis of the Tsetsefly which creates room for sleeping sickness as for Human Beings, and the menace and havoc it creates on domestic cattle—cows, goats, sheep etc. Again, the other challenge here is floods as one side of the ecosystem is such that there must be floods during the heavy long rains. These address the facts that livelihoods here are based on survival as the economy and social growth is hampered by circumstances that local populations are not technically prepared to address.

The two administrative regions here are Ndhiwa District and Suba with the former being geographically and historically placed to benefit from the revenues from Ruma National Park; however, for political realities; this appears in reverse.

In 2004, a legislator from Suba echoed the failing, that the protected area facility be De-Gazetted. This call met public outcry and resistance by environmental Civil Societies, which are not keen on the area; but only thirsty for media attention as concerns the area.

This area is predominantly agricultural, but with the protected area facility; it extends its benefits to tourism and eco-tourism opportunities; which unfortunately has not been realized due to infrastructure growth which is not yet to be standards or basic minimum.

The vegetation here is diverse with indigenous twigs, trees and shrubs and do other zoological livelihoods.

One prominent feature here that can only be private sector managed is a hill viable for a wind turbine, small to the extent of supporting off-grid power status to he minimum. This point borders Lambwe Forest, managed by Kenya Forest Services (KFS) and Ruma National Park, managed by Kenya Wildlife Services (KWS).

African Centre of Technology Studies (ACTS) have been called upon to help us edit the aerial photography of this ecosystem, to be acquired from the Kenya Government; Department of Resource Surveys & Remote Sensing (DRSRS), Geomaps, Photomap East Africa. Other photos we shall make are on indigenous forest cover, land use patterns through and by the subsistent farmers in their respective farm yards, other ecological benefits worth exploiting through the available market potentials. Some terrestrial photos may punctuate the aerials.

In summary and for all purposes, the installation for the imminent wind turbine and fuel Bio-Digester will bring all economic and social opportunities like fish farming, tree-nursery, bee-keeping, eco-tourism, accommodation facilities instantly. This will be particularly on the Sidede Hills side of Ndhjwa district.

Pan African Tsetse eradication campaign (PATTEC) has particularly called for effective land use as a means of eradicating tsetse fly.

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ACTS aerial photography.

51. INTEGRATED BASIN FLOW ASSESSMENT FOR ECOSYSTEM SERVICES
A Case Study of the Okavango River Basin

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Keywords: environmental flows, development space, ecosystems services, Okavango River Basin

INTRODUCTION

The availability of water and other ecosystems services have been affected by the deterioration of ecosystems due to human activities and human induced phenomenon like climate change, over use, pollution and others. The Millennium Ecosystems Assessment shows that fifteen of the twenty four ecosystems services studied were in a state of decline, while fresh aqua-ecosystems impacted upon the most. This deterioration has direct impact on the livelihoods base, particularly for the rural poor and compromises the integrity of ecosystems to naturally adapt to climate change. There is therefore an urgent need to address the resilience of the functioning of ecosystems, specifically fresh water ecosystems which host more than one third of global biodiversity.

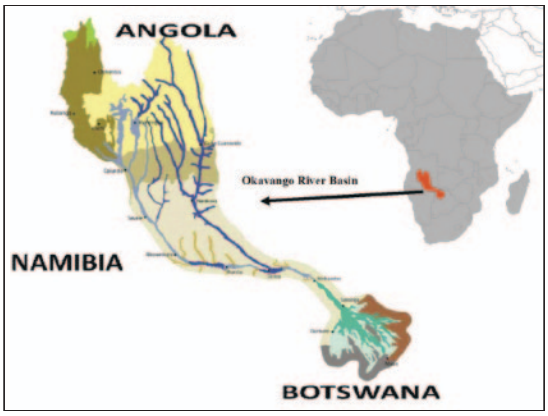

FIGURE 1: The Okavango River Basin

The environmental flows/integrated basin flow management concept1 is likely to have profound positive impact to watershed management, with the view to sustaining the functioning of ecosystems and ultimately contribute to sustainable development. However, significant investment still needs to be made in better understanding the environmental flows concept, and testing its relevance, applicability and effectiveness. The now broadly documented deterioration of ecosystems and the climate change phenomenon present a huge opportunity and need to apply the concept. To address the above challenges, the concept was applied to the Okavango River Basin (Figure 1), where the Permanent Okavango River Basin Water Commission (OKACOM) formed by its three riparian states, has one of its objectives as being to "prepare criteria for conservation, equitable allocation and sustainable utilization of water" (http://www.okacom.org) within the Basin. The basin wide environmental flow assessment modelled how planned developments within the basin would affect relationships between flow regimes, ecological processes, and human livelihoods (OKACOM, 2009).

METHODOLOGY

A multi-disciplinary team was appointed in each riparian country with specialists covering the natural, physical and social sciences fields. A baseline assessment was initiated to establish the present state of the Okavango and also informed the development of water resources scenarios for the Basin. Three hydrological models were then developed to describe the actual hydrological response to the described water uses. Through extensive participatory field work and workshops the project built up a database of ecological responses to these hydrological changes. Ultimately the ecological responses were translated into socio-economic impacts based on community direct and indirect livelihood dependence on river resources identified through detailed com-

1 The environmental flows concept under consideration goes beyond the initial 'conservation' based approach with focus on 'minimum flow required' to maintain biota downstream. It refers to the flows required to sustain the desired suite of ecosystem services. What is happening beyond the in-stream i.e. adjacent the river is considered. The focus is on "Ecosystems Service Flows"

munity surveys in the basin. Eight representative sites were chosen across the basin and an in-depth assessment provided the scientific basis for the analysis by linking water resources development with flow, ecology and socio-economics. Further basin-wide studies allowed these observations to be extrapolated to the rest of the basin and also highlighted basin-wide trends and issues possibly emerging from the changes in the river. The 'links' connecting developments in one country to impacts in another are the four characteristics of flow: timing, quantity, quality and sediment. Climate change as an overarching factor was judged important enough to be given its own separate study.

RESULTS

It was established that the population of the three riparian countries is steadily increasing at 2.7% in Angola, 1.5% in Botswana and 1.5–2.5% in Namibia. The basin is experiencing increased urbanisation, which is characterised by 2.5% growth rate versus 1.5% in rural areas. Also apparent is the fact that food self-sufficiency policies are expected to increase irrigation from 3000ha to 200,000ha by 2025, in the basin. A projected basin-wide tourism growth exceeding 3% per annum is recorded, while up to 12 hydro-electric projects are under consideration in response to regional demand for energy. Climate change models predict long-term variability of wet and dry seasons.

Four development scenarios[2], based on actual proposed development, were identified. The scenarios are directed at creating understanding of potential impacts rather than predicting specific outcomes (OKACOM, 2009).

Expected changes in ecosystem integrity for the scenarios are highlighted in Figure 2. Present day conditions are estimated as B-category in the Legend. Degradation is indicated from low (A) to high (E). The following results emerge from Figure 2

i) Medium development scenario: some risk of severe degradation at some points in the catchment
ii) High development scenario: greatly increases the risk of severe degradation and its spatial scale
iii) Low and medium development impacts are predominantly in-country impacts
iv) High developments impacts are transboundary

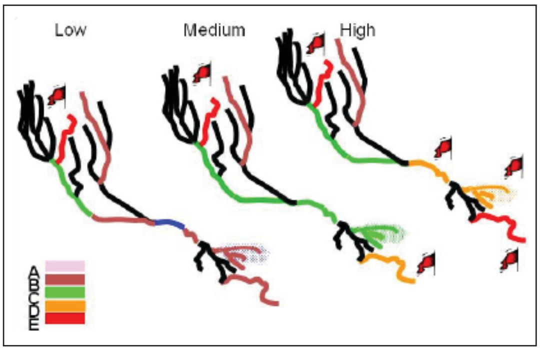

FIGURE 2: Expected changes in ecosystem integrity for the scenarios

LESSONS LEARNT

i) The social and ecological impacts of development can be quantified
ii) Scenarios provide basis for basin development plan against which projects can be appraised
iii) Development space allows for identification of limit of acceptable change (Figure 3); the limit of acceptable change is a societal value
iv) Basin flow assessment can be used to enhance other tools such as payment for ecosystem services and benefits sharing

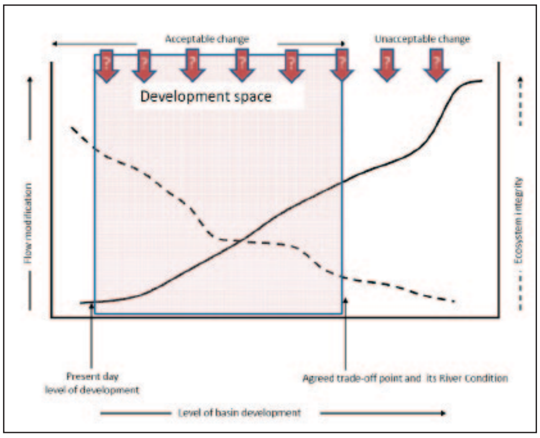

FIGURE 3: Development space allows for identification of limit of acceptable change

2 Scenarios: i) Present (2700ha of irrigation, urban water demand in three centres); ii) Low (Increased urban consumption due to Angolan resettlement, 2100ha irrigation, one storage and three run-of-river hydrostations; iii) Medium (205,000ha of irrigation. One storage and four run-of-river hydrostations, and one interbasin transfer of 17Mm3 per annum; iv) High (350,000ha irrigation, one storage and nine run-of-river hydrostations. Extended interbasin transfer of 100Mm3 per annum. Additional urban water development scheme

52. GENERAL LEGAL PROCESS FOR ACCESS AND BENEFIT SHARING

From Genetic Resources and Associated Traditional Knowledge in The Context of Climate Change

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Keywords: access and benefits sharing (ABS), traditional knowledge, biodiversity laws, Hindu Kush-Himalayas (HKH) region

Millions of people in the Hindu Kush-Himalayan (HKH) region[1] depend on biological resources and associated traditional knowledge for their livelihoods. The challenge for sustainable development in the 21st Century is to limit the extent to which climate change can degrade biological resources and to address poverty and deprivation. The countries in the HKH region have undertaken a number of policy initiatives at both the national and regional levels to promote conservation and the sustainable use of biological resources and to optimise benefit sharing from their use by implementing the Convention on Biological Diversity (CBD). Article 15 of the CBD provides a framework to facilitate access to biological resources and associated traditional knowledge, while ensuring that the benefits are shared with the custodians of these resources. These countries have also used the Bonn Guidelines to develop legal mechanisms on Access to Genetic Resources and Fair and Equitable Sharing. Access and benefit sharing (ABS) regimes in the HKH region are relatively new and legal mechanisms are only now emerging; however, given the abundant biological resources found in the region, the benefits are likely to be substantial and the ABS mechanism can be an effective tool for poverty reduction.

GENERAL LEGAL PROCESSES UNDER BIODIVERSITY LAWS IN HKH COUNTRIES

The legal mechanisms for regulating ABS systems in HKH countries are not uniform. For example, China has made some amendments to the existing laws and the regulatory framework developed under the rules. Nepal and Bangladesh are still dwelling on their draft legislation. In India and Bhutan, biodiversity laws primarily address issues concerning access to genetic resources (and associated knowledge) by foreign nationals, institutions and companies and the equitable sharing of benefits arising from the use of these resources by the country and its people. Most laws either directly or indirectly subscribe to the key components of ABS: (i) sovereignty of the state over genetic resources, (ii) prior informed consent (PIC) by the party providing access to biological resources and associated traditional knowledge, (iii) mutually agreed terms for access and use of biological resources and benefit sharing, and (iv) benefit sharing from access to and use of genetic resources and associated traditional knowledge.The laws regulate ABS through a three tier system, i.e. a National Biodiversity Authority (NBA) at the national level, the State Biodiversity Board (SBB) and Biodiversity Management Committees (BMCs) at local level. In India, for example, trust funds have been created at each level.

Article 15(5) of the CBD requires the 'prior informed consent' of the contracting party providing genetic resources. Parties to the CBD are also required to respect, preserve, and maintain traditional knowledge [Article 8(j)] and to protect and encourage customary use [Article 10(c)]. According to the evolving laws, the accessing party must inform the resource provider of the intended use of the genetic resources/traditional knowledge, the monetary and non-monetary benefits, whether or not the genetic resources/traditional knowledge will be used by a third party, and what the benefit sharing arrangements will be. All of this information must be imparted to the contracting party before permission to access/use the genetic resources and associated traditional knowledge is granted.

While there is a growing awareness of PIC in mountain countries, ABS laws on PIC are either unclear (e.g., the Indian Biodiversity Act 2002 is silent on PIC) or involve complex legal procedures. According to the CBD

1 Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan

(and evolving national laws in the region), any bioprospector wishing to access biological resources needs to acquire PIC from the concerned government authority. After the government gives its consent, the accessing party must obtain the PIC of the community/individual concerned. In addition, depending on the status of the resource to be accessed, an environmental impact assessment may be needed. If the biological resources are under the jurisdiction of a protected area, procedures for access and PIC may be different yet again.

ABS REGIMES IN HIMALAYAN COUNTRIES: ISSUES AND CHALLENGES

It is widely held that if ABS regimes are implemented appropriately they can bring important benefits; however, since monetary benefits from the trade of traditional knowledge and genetic resources is relatively new in the region, clear procedures for sharing benefits are lacking. Even though the many provisions of the CBD including Article 8(j) are subject to national legislation (CBD 2001), national action alone is not sufficient and an internationally recognized regime gives added perspective to ensuring the rights of communities. To secure the communities' rights, the prospectors need to disclose the source of knowledge and biological material and must respect the laws and practices of the country of origin. Surveillance and enforcement, however, are extremely difficult. Further, since the needed legal tools are just now being refined, for the moment, they do not differentiate between different uses. Since biological materials (such as seeds or parts of plants or animals) can be owned by individuals and communities, defining ownership over genetic resources and associated traditional knowledge is extremely difficult. The legal procedures in relation to PIC and benefit sharing, as set out in national legislation, are unclear. In addition, some local communities, indigenous groups, and individuals, want to exert exclusive rights. Safeguarding their rights is important, but at the same time, the rights of users and others must also be respected.

Most countries in the Himalayan region do not have sufficient scientific data on which to formulate ABS policies. Without sufficient scientific information on biological resources and associated traditional knowledge, regulating ABS will be difficult. In recent years, the impact that climate change has had on Himalayan biodiversity has been the subject of much speculation. The disappearance of particular species will be a loss for the world's genetic heritage but, more immediately, it will be a loss for the communities who depend on them for their livelihoods. In India and other countries, biodiversity laws have been in force since 2004, both by default and legal amendments; however, formal estimates of the economic benefits/losses of biological resources and traditional knowledge due to climate change impacts in the region are not yet available.

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FIGURE 1: General legal process for access and benefit sharing from genetic resources and associated traditional knowledge

53. ADAPTING BIODIVERSITY LAW AND REGULATION TO CLIMATE CHANGE

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Keywords: uncertainty, adaptive management, regulatory design

ADAPTIVE MANAGEMENT REDUCES UNCERTAINTY FROM CLIMATE CHANGE

Despite the potentially devastating impacts of climate change on ecosystems and resource-livelihood communities, conservation officials struggle to respond and adapt (U.S. GAO 2009). They lack funding to include climate considerations in planning, clear mandates to take proactive measures to prepare systems for impacts, or a procedural framework for iterative decision making to reduce uncertainty.

Adaptive management provides a structured approach for informed action to respond to emerging climate threats despite scientific uncertainty (Arvai 2005). Adaptive management involves 'synthesizing existing knowledge, exploring alternative actions, making explicit predictions of their outcomes, selecting one or more actions to implement, monitoring to determine whether outcomes match those predicted, and using these results to adjust future plans' (Murray and Marmorek 2003). It is often expressed in the simple phrase, 'learning-by-doing,' and it is a critical element of biodiversity adaptation in a period of climate destabilization and uncertainty.

The Environmental Law Institute (ELI), an internationally respected organization with over forty years of experience in environmental governance, is working with countries around the world to assess capacities for adaptive management in laws governing biodiversity and ecosystem-services sectors. Guidance materials, reports, and other resources can be obtained by contacting ELI.

DESIGNING LAWS AND REGULATIONS FOR ADAPTIVE MANAGEMENT

Existing laws governing biodiversity may be a poor fit for adaptive management (Ruhl 2005). Current laws often rely on 'front-end' decision making that is difficult to adjust or modify. They may not adequately equip managers and stakeholders with the regulatory tools and resources to proactively track emerging threats and take early steps to respond (Smith 2009). Conversely, adaptive management in the absence of clear rules of procedure has been criticized for increasing discretion at the expense of accountability. Agencies are met with skepticism and litigation out of fear that minimum protections will be lost (Karkkainen 2003).

But within a legal framework that includes strong oversight mechanisms, adaptive management is *more* rigorous than conventional approaches because it compels managers to incorporate new information into decision making. The best legal frameworks for climate adaptation will not be overly flexible but create feasible, enforceable programs for adaptive management. Policymakers can use laws to give managers tools to learn, adapt, and respond to climate change. The following are priority areas for immediate policy action:

- Using scenario-planning techniques that incorporate uncertainties into long-term strategies while fostering tangible goal-setting to drive conservation policies forward
- Establishing baselines, identifying information gaps, and monitoring to capture changes in ecological conditions and ecosystem health over long time periods
- Assessing and adjusting policies, plans, quotas, and standards as circumstances change through iterative and periodic rather than front-loaded decision-making processes
- Coordinating and integrating conservation policies and programs across sectors and government agencies to foster regional ecosystem approaches to governance

- Building adaptive capacity in non-government, community, and business institutions through stakeholder engagement and collaborative or joint management

PROCESSES FOR REVIEWING AND REVISING LAWS AND REGULATIONS

Processes are available to assess laws' capacity to respond to climate change. Many countries have strategic environmental assessment (SEA) laws that require them to review the efficacy of their environmental policies (OECD 2006). Additionally, the National Adaptation Programmes of Action (NAPA) process countries use to assess their vulnerability to climate change includes 'policy reform' as a 'key adaptation need' (UNFCCC 2002). Non-government actors can assist.

There are many options for moving forward. New legislation could take the form of a broad-reaching National Adaptation Law or a National Adaptive Management Act (Ruhl 2005). Such a law would apply to all ministries, cutting across resources, institutions, and sectors to build adaptive techniques throughout administrative processes (Flournoy 2009). Alternatively, in some countries, a broad new law may not be feasible or appropriate. In such cases, sector-specific laws could be evaluated individually for adaptive capacities and weaknesses. Adaptive measures could be incorporated as amendments to existing legal authorities or take the form of decrees or regulatory guidance directing resource agencies to use existing authorities to undertake adaptive management and other measures for adaptation. Regardless of form, the time to act is now.

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54. PROTECTING AFROMONTANE RAINFORESTS THROUGH THE CONSERVATION AND SUSTAINABLE USE OF WILD COFFEA ARABICA IN ETHIOPIA

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Keywords: genetic and species variability, wild coffea arabica, rain forests in Ethiopia, biosphere reserve, REDD, livelihood

BACKGROUND AND PROBLEM

Coffea arabica originates from southern and south-western Ethiopia, where its wild populations naturally occur in the understory of the montane rainforests at altitudes between 1,000 and 2,100 m. Wild c*offea arabica* is not only consumed by local people, but it is also a cash crop for local and international specialty markets. Above all, it is a unique gene pool for national and international coffee breeding, due to its high genetic diversity. As forest land is increasingly converted to agricultural land, the wild coffee populations and their habitat, the montane rainforest, are highly threatened.

APPROACHING THE PROBLEM – FROM RESEARCH TO IMPLEMENTATION

Based on a multi-disciplinary research project (2003–2009, http://www.coffee.uni-bonn.de), science-based conservation and use concepts for the rainforest and the genetic resources of *coffea arabica* were designed and are now implemented. In the context of the research project, forest vegetation studies, forest mapping, molecular genetic analyses, phytopathological and ecophysiological surveys, quality screening, as well as institutional analyses and an economic valuation of the forest and the coffee gene pool were carried out. These studies were conducted on five major montane forest fragments with wild populations of coffee that are geographically separated and found along climatic gradients. In addition, various forest utilisation concepts and their impacts on the environment were analysed. Based on the findings, actions for the conservation of wild *coffea arabic* populations and theirs forest habitats are taken at local, regional and national level. These actions included awareness raising activities for the local population and decision makers, e.g. through a children competition award, multi-stakeholder dialogues, capacity building (training on landscape planning), fund raising etc.

RESEARCH FINDINGS AND IMPLEMENTATION RESULTS

The findings of the multi-disciplinary research project revealed the uniqueness and diversity of different forest fragments in terms of plant species composition and the genetic variability of wild coffee populations. The latter also showed significant differences in disease and drought tolerance. In addition, the importance of forests for ecosystem services most importantly carbon sequestration, climate regulation and watershed protection could be revealed. The socioeconomic analysis depicted the importance of wild coffee and other forest products for the local population and especially the poorer segment of society. In order to support the conservation of coffee forests, the Ethiopian Forest Coffee Forum (ECFF), a non-governmental organization, was established. ECFF organized a multi-stakeholder dialogue and other important capacity building and information forums. In order to protect specific sites, it was decided to apply the UNESCO biosphere reserve concept, an approach that combines conservation and sustainable developed based on zoning. As one of the pilot model sites Yayu Forest was selected. It is the largest and most diverse remaining coffee forests in both plant species and coffee genes. Following a process of community participation and other stakeholder participation, a biosphere reserve nomination has been submitted to UNESCO's Man and the Biosphere Programme. In addition, a project identification note (PIN) for the Reduced Emissions from Deforestation and Forest Degradation (REDD) scheme has been developed. The Yayu Coffee Forest Biosphere covers about 168,160 ha of land, of which 38,205 ha is dense forest, 47,632 ha disturbed forest and the rest agroforesty parklands and grassland. Avoiding the current 1.2% annual deforestation rate can store substantial amount of carbon and generate funding for conservation and the livelihoods of the local population.

CONCLUSIONS AND LESSONS LEARNED

Through the conservation and sustainable use of coffee forests in Ethiopia multiple goals can be achieved that contribute to the conservation of biodiversity and ecosystem services, the mitigation of climate change impacts and the sustainable development of the local population. Lessons learned from the case study show that the multi-disciplinary research provided an important data and information base for the development of adapted land use concepts. For implementation, however, an institutional backing is essential. In this case two elements were important: the establishment and, more importantly, long-term commitment of a supporting organisation (ECFF) and the identification and implementation of a well established, internationally recognised, structured but flexible approach (the biosphere reserve approach). These two elements provided the basis for long-term engagement. Financial support to be generated through REDD scheme carbon fund could contribute to long-term financing of the biosphere reserve management and local development activities.

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55. LINKING BIODIVERSITY CONSERVATION AND CLIMATE CHANGE PERSPECTIVES IN BIO-CULTURALLY RICH TRANSBOUNDARY AREAS IN THE KAILASH SACRED LANDSCAPE REGION OF CHINA, INDIA, AND NEPAL

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THE KAILASH SACRED LANDSCAPE

The Kailash Sacred Landscape (KSL) Conservation Initiative, a collaborative effort of ICIMOD, the United Nations Environment Programme (UNEP), and regional partners in China, India, and Nepal, was launched with an Inception Workshop and Regional Consultation held in Kathmandu in July 2009 (ICIMOD 2009). The KSL Conservation Initiative seeks to facilitate transboundary and ecosystem management approaches for biodiversity conservation and sustainable development through regional cooperation. The proposed KSL includes an area of the remote southwestern portion of the Tibet Autonomous Region (TAR) of China, and adjacent parts of northwestern Nepal, and northern India, and encompasses the cultural geography of the greater Mt. Kailash area (Figure 1). This region, famous from ancient times, represents a sacred landscape significant to hundreds of millions of people in Asia, and around the globe. This region comprises the source for four of Asia's great rivers: the Indus, the Brahmaputra, the Karnali and the Sutlej, which are lifelines for large parts of Asia and the Indian sub-continent. These rivers provide essential ecosystem goods and services vitally important within the region, and beyond.

GLOBALLY AND LOCALLY IMPORTANT BIODIVERSITY IN A SACRED LANDSCAPE

The Kailash Sacred Landscape (KSL) contains a broad range of bioclimatic zones and landscapes, rich natural and cultural resources, and a wide variety of globally significant biodiversity. The KSL provides an essential habitat for large numbers of endemic and endangered species, including large mammals like the snow leopard and the wild ass. This highly diverse and environmentally fragile landscape is home to a range of endemic flora and fauna important in maintaining local livelihoods (see Figure 1).

The KSL is an extremely important cultural and religious transboundary landscape of significance to Hindu, Buddhist, Bon Po, Jain, Sikh, and other related traditions, which attracts thousands of pilgrims every year. Pilgrims from around the world journey to this sacred mountain to circumambulate at the foot of its 6,714 metre high peak. Pilgrims from India and Nepal, as well as from the TAR, China, the central Asian region, and other parts of the world, create a transboundary cultural landscape.

MEETING THE CHALLENGES OF THE FUTURE

Population growth, increasing urbanization, tourism development, subsistence activities, and improved accessibility all contribute to the stresses on the natural environment and the cultural landscape of the region. As change within this area accelerates, poverty and limited livelihood opportunities exert increasing pressure on this fragile natural resource base, and the vital ecosystem goods and services essential for this vast region. In particular, global climate change is projected to have high impact across the HKH region (Erikkson et al. 2009). Limited livelihood options for poor communities throughout the region feed a cycle of resource degradation and widespread poverty, which will limit climate change adaptation options and imperil biodiversity resources.

LINKING BIODIVERSITY CONSERVATION AND CLIMATE CHANGE PERSPECTIVES IN A BIO-CULTURALLY RICH TRANSBOUNDARY LANDSCAPE

Transboundary landscape management promotes an integrated approach for the management of extended landscapes, defined by ecosystems rather than administrative boundaries, in which both conservation and the sustainable use of biological diversity are considered, and in which people and their socio-cultural resources are placed at the centre of the conservation framework. It has been strongly recommended to link conservation with sustainability by involving communities in the decision-making processes for effective management which will exploit biodiversity judiciously to secure sustainability. Transboundary landscape management was endorsed within the context of the ecosystem approach adopted by the Convention on Biological Diversity (CBD) in 2004, which highlighted the significance of regional cooperation in critical transboundary landscapes among the signatories to the convention (Sharma and Acharya 2004). An understanding of the socioeconomic, socio-political, and socio-cultural aspects of biodiversity and cultural conservation are essential, however, if biological conservation efforts are to be successful, and successfully translated into sustainable and equitable development of these fragile mountain areas. Mechanisms are required at the local, regional, and international level if the local ecosystem services, cultural integrity, livelihood strategies and tourism growth are to be balanced with environmental conservation. The KSL Conservation Initiative is engaging regional, national, and local partners and other stakeholders in a consultative process aimed at facilitating an integrated transboundary approach to sustainable development and conservation. Landscape and ecosystem management approaches are being promoted to address threats to the cultural and environmental integrity of this area, to analyze change processes, and to develop a knowledge base including a baseline upon which a regional conservation framework and implementation strategy can be built. Participatory conservation measures based on co-management and encouraging community-based organizations and approaches relevant to the region form the basis for improved environmental governance. Community-based conservation measures at both the landscape and ecosystem level, seek to strengthen the role that communities can play. Integrated ecosystem management and community-based approaches are evaluated through stakeholder consultation, supported by a knowledge-based process, with the intent to develop environmentally and culturally sustainable development and adaptation strategies, leading up to the development of a Regional Framework for conservation and sustainable development of the Kailash region. This is the first pilot activity under ICIMOD's trans-himalayan transect approach (see Chettri et al 2009).

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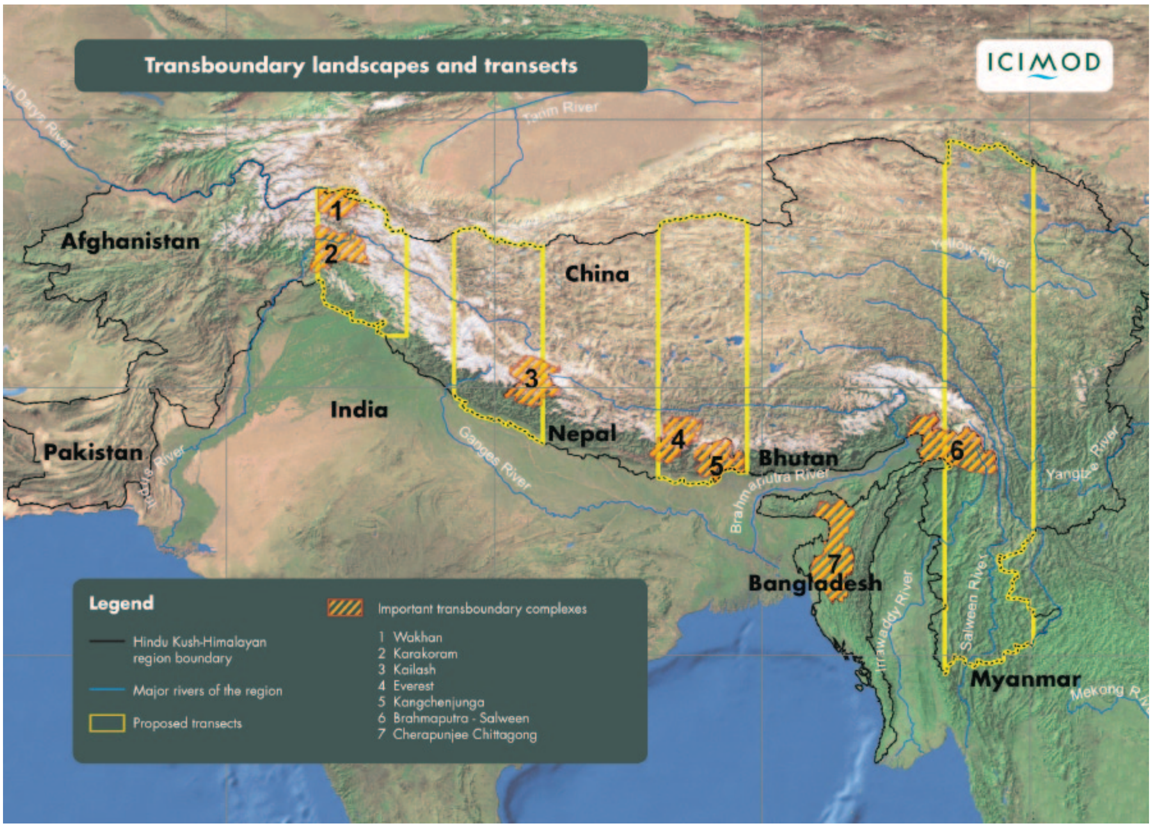

FIGURE 1: View of mountain Kailash with cultural monuments showing a glimpse of the high altitude part of the landscape.

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56. STRENGTHENING AND MAINSTREAMING VALUE CHAINS FOR MEDICINAL AND AROMATIC PLANTS

A Strategy for Adaptation to Climate Change

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Keywords: medicinal plants, climate change; value chain; adaptation, community based management

The Hindu Kush-Himalayan (HKH) region[1] has a unique flora and fauna that forms the basis for many of the cures used both in Asian systems of traditional medicine (Ayurveda, Unani, Sidda, Tibetan, and Chinese) and in Western medicine. An estimated fifteen percent, or 7,000, of the approximately 50,000 species of plants used in medicines world-wide are medicinal plants native to the Himalayas (Leaman 2010). This great diversity provides immense scope for resilience and enhances the adaptation potential of isolated mountain communities who can earn an income from harvesting and sale.

Climate change is causing noticeable effects on the life cycles and distributions of the world's vegetation. There is evidence to show that climate change affects vegetation patterns such as phenology (the timing of life cycle events in plants and animals, especially in relation to climate) and distribution (IPCC 2007). Wild medicinal and aromatic plants (MAPs) are no exception, and some are even more vulnerable because they are highly adapted to their particular extreme climatic conditions and are likely to have low adaptive capacity to the changes brought about by climate change. One major result of such climate alterations is the range shift in species occurrence and distribution.

All ecosystems contain a spectrum of species with varying degrees of migratory potential. At one end of the spectrum are species that can migrate rapidly and aggressively, and at the opposite end are specialist species with limited mobility (Neilson et al. 2005). Shifting phenologies and distributions of plants have been recorded worldwide, and these factors could ultimately endanger wild MAP species by disrupting synchronized phenologies of interdependent species, by exposing some early-blooming MAP species to the dangers of late cold spells, by allowing invasive species to enter MAP habitats and compete for resources, and by initiating migratory challenges. There is a need for enhanced efforts to understand more about ecosystem-specific MAPs since their survival ultimately impacts mountain livelihoods.

BROAD-BASING MOUNTAIN LIVELIHOODS, MAKING THE MOST OF BOUNTIFUL ECOSYSTEMS

Mountain communities can exploit ecosystems to their advantage by innovatively developing MAP-based enterprises using their local knowledge. It is reasonable to believe that if people can benefit financially from enterprises that depend on natural habitats, they will take action to conserve them and use them sustainably. Community-based enterprises have demonstrated the potential to create economic opportunities by mobilizing human and natural resources in different parts of the HKH (Choudhary 2005). Another option is to build up the resource base through augmentation via afforestation and/or cultivation. High value MAPs can be cultivated by integrating them into existing farming practices especially in places where there are poor crop yields. Ecologically, such integrated practices can help to conserve natural resources and can potentially aid farmers in coping with a number of ecological problems and with adaptation to climate change. A two-pronged strategy for the domestication of MAPs species can be considered with the intention of reducing poverty and

1 Afghanistan, Bangladesh, Bhutan, China, India, Nepal, Myanmar, and Pakistan

improving the overall socioeconomic condition. This would focus both on biodiversity conservation as well as on the gainful involvement of the local population (especially of disadvantaged segments).

In this context, it becomes necessary to assess the potential that MAPs have to contribute to the livelihood of the local communities. The value chain (VC) approach has components that help to facilitate such assessments. A VC describes the full range of activities needed to take a product or service from conception, through the different phases of production, to final delivery to the consumers, and ultimately to disposal after use (Kaplinsky and Morris 2000). One major caveat is that the VC (in its conventional form) can discourage participation by the poor thus excluding them and increasing their vulnerability. It can also promote environmental degradation, social inequity and gender imbalance by yielding excessively to market pressures.

THE NEED TO ADOPT A VALUE CHAIN APPROACH

Working out a value chain for MAPs requires a good understanding of species ecology and conservation approaches on which to base local management and cultivation strategies. Research will help to build in and add value to traditional knowledge while integrating modern scientific practices. In addition, an analysis of the different roles that women and men can play in protecting, propagating, managing, and harvesting *in-situ* and *ex-situ* MAPs needs to be incorporated into community-based MAP resource management practices. Ideally, there needs to be a synergy and regular dialogue between local communities and the trading and enterprise sector in order to ensure commercial viability. Recent research by ICIMOD shows that both appropriate technologies and effective policy and legal frameworks (for the *in-situ* management of locally prioritized species) are integral to effective strategies for the conservation and sustainable management of MAPs.

BUILDING LOCAL CAPACITY

It is important to build the capacity of the selected stakeholders who will be involved with the different stages of MAP cultivation and processing. Training programmes and participatory action research on strengthening and mainstreaming the MAP value chain are needed. As well, it will be necessary to gain a greater understanding of sustainable harvesting, to monitor species behaviour and the dynamics of change in populations, to investigate plant growth and phenology, and to monitor the active ingredients for developing quality planting material, etc. All these require strategic capacity building interventions. Training programmes should have follow-up sessions with guidelines to monitor impacts and deviations from the desired results. There should be processes set up to ensure implementation and to measure effectiveness.

Many countries in the HKH region have initiated community-based programmes for natural resource management. Management of MAPs can target the existing decentralized natural resource management programmes like community forestry in Nepal, community-based natural resource management in Bhutan and Joint Forest Management in India. There is a need to promote such joint efforts to involve communities in design strategies that not only enhance conservation but also provide options to adapt their livelihoods through knowledge-based management of MAPs in the context of a changing climate.

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FIGURE 1: Grading of bay leaf for demonstration purpose to participants during training at Gaighat Village Development Committee, Udaypur, Nepal

57. STRATEGY AND PRIORITIES FOR THE FRENCH RESEARCH ON BIODIVERSITY

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Keywords: biodiversity research, integrated approach, interdisciplinary, modelling, adaptive potential of biodiversity

Set up in February 2008 by the French Ministers for Ecology and Research and eight national research institutes working on biodiversity, the Foundation for Research on Biodiversity (FRB) is a foundation for scientific cooperation and an interface between science and society. It brings together public research bodies, the corporate sector involved in biodiversity management, environmental organisations and businesses, towards one goal: to meet the biodiversity challenge. Its stakeholders' advisory board, strong of 120 representatives, acts as an interface between academic research, the business world and civil society.

In 2009, at the request of the Research Ministry, FRB identified, through its scientific council and in connection with its stakeholder council, key strategic elements and priorities for the French research on biodiversity.

10 PRIORITIES FOR THE FRENCH RESEARCH ON BIODIVERSITY

Climate change and human pressures are major drivers of biodiversity dynamics, whereas biodiversity should be made a bulwark against climate change and should offer new opportunities to cope with global changes. In particular, the understanding of the impacts of biodiversity on climate change and *vice versa* needs further research, along with knowledge on and monitoring of biodiversity. This is key to understanding the processes at stake and helping to find solutions, e.g. through modelling and scenarios-building.

The following priorities, divided into three axes, have been identified:

Change frames and perception in the field of biodiversity:

1. Model and build scenarios on the dynamics of biodiversity: reinforce and federate research to anticipate and help decision-making;
2. Study ecosystem services and values of biodiversity, two concepts that will play an essential role in the accounting for biodiversity by human societies;
3. Develop the scientific bases for innovation: biodiversity is source for new biotechnologies and a basis for sustainable activities;

Unlock this domain:

1. Explore least-known compartments of biodiversity;
2. Monitor biodiversity over the long-term: observatories are essential to study pressures on biodiversity and man-environment coupled systems;
3. Study rapid adaptive processes and spatial distribution patterns: this is essential to understand and predict biodiversity dynamics;

Insure relevance and clarity of biodiversity research:

1. Develop an interdisciplinary research, which implies an integrated approach of life sciences, social sciences, engineering, physics, mathematics, economics and earth sciences;
2. Mutualise concepts and methods, which involves the cross-over between temperate, tropical, and Mediterranean, between terrestrial and marine, and between wild and domestic issues;
3. Rethink education and training to better respond to biodiversity challenges and to the need of pluridisciplinary knowledge;

4. Develop renewed interfaces between the scientific and civil society to better integrate biodiversity into human activities and to respond to the increasing need of expertise.

The document presenting the corresponding research strategy, and its summary in English, can be downloaded from FRB's website (www.fondationbiodiversite.fr).

FRB'S ACTION PLAN AND PRODUCTIONS

More specifically, FRB's work is built around four interlinked priority approaches:

1. Strengthen science-society dialogue and mobilisation of all the actors involved in biodiversity: mapping and development of the French scientific expertise on biodiversity through the development of a database on scientists and stakeholders and of a mechanism to mobilise French expertise; development of an interface between stakeholders and scientific councils.

2. Draw up state-of-the-arts and build forward strategic priorities for research on biodiversity: launch a national centre for biodiversity analysis and synthesis; work on legal issues regarding genetic resources; identify key strategic elements and priorities for the French research on biodiversity overseas; gather knowledge on indicators for genetic resources; develop state-of-the-art trainings.

3. Support a multidisciplinary and multi-actors research, with the aim of creating and sustaining ambitious and unifying programs: launch of a key programme on modelling and scenarios to predict biodiversity dynamics; work towards the harmonisation of monitoring tools; study of short-term adaptability of biodiversity; coordination of a network of European research on biodiversity (www.eurobiodiversa.org/).

4. Spread biodiversity knowledge and promote French research on biodiversity to inform the general public and policy makers, through the development of a website, newsletters, policy briefs, events and symposia.

Since 2008, FRB has supported a range of biodiversity research actions and events, aiming at promoting biodiversity research and strengthening its link with society, such as:

- Launch of four calls for proposals;
- Promotion of innovative biodiversity research activities in the areas of biodiversity indicators and observatories, values of biodiversity, legal issues, training, expertise and communication;
- Transfer of knowledge and mobilisation of expertise through (i) the publication of books such as "Integrating biodiversity into business strategies: a biodiversity accountability framework" (Houdet et al. 2008), (ii) the development of a database of 4500 research actors working in the field of biodiversity, and (iii) the launch of a thematic website on biodiversity and biodiversity research for scientists and the general public (www.cnrs.fr/biodiv/);
- Organisation of scientific events, such as the EPBRS conference under the French presidency of the EU or the French conference on "ipBes: stakes and state of progress".

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58. FRUITS OF HERITAGE
Central Asian Fruit Tree Diversity as a Basis for Coping with Change

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Keywords: Central Asia, temperate fruit crops, wild fruit species, changed environment, sustainable production systems

INTRODUCTION

Central Asia forms a vast region that stretches from the Caspian Sea in the west to the Tien Shan Mountains in the east. The region is composed of five independent countries: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Central Asia is a home to 8, 300 vascular plants of which approximately 10% are endemic. This great richness in genetic resources is the result of evolution processes taking place in diverse physical and climatic conditions.

Countries of Central Asia are extraordinary rich in crop wild relatives, landraces and different breeding varieties of cultivated plants. Wild ancestors of many of world's commodity crops (cereals, pulses, vegetables and fruit species) are still growing in nature. This offers a rich pool of gene resources for utilization in agriculture at present and in the future. Among those crops originated here, are over 300 wild relatives of fruit trees (s.a. almond, apricot, apple, pear, pistachio, cherry, plums, walnut, pomegranate, Russian olive, fig, mulberry, etc.). This rich diversity of fruit and nut species led the Russian geneticist and plant breeder N.I. Vavilov to consider Central Asia as one of the world's eight centres of crop origin and domestication. Many of the wild fruit trees form unique natural forests, important for both ecological and socio economic reasons. From the wild, these species have been domesticated and selected by local populations who have patiently developed thousands of valuable varieties, highly adapted to a broad range of climatic conditions.

DIVERSITY OF CENTRAL ASIAN FRUIT CROPS

The region is famous for its fruit crops whose diversity is one of the greatest in the world. Many valuable landraces and old local cultivars of peach, quince, cherry, pomegranate, persimmon and others are still maintained in home gardens and on small farms.

The recent surveys conducted by national scientists showed that great diversity of local varieties is still maintained by the famers and forest dwellers and amounts to 160 local varieties of grape, 145 - of apple, 103 – of apricot, 40 – of walnut, 32 – of pear, 26 – of pomegranate. 68 promising forms with economically valuable traits are distinguished by the forest dwellers in wild populations of pistachio, currant, sea-buckthorn, almond, apple and cherry plum. This local diversity possesses valuable traits as early maturation, resistant to spring frosts, tolerance to salinity and drought, bearing fruits in the off-season which could be valuable traits for efforts on breeding improved commercial varieties. Indigenous fruit crops diversity demonstrates "excellent horticultural characteristics including the capacity for fruit to hang on the tree past maturity in area with high heat units indicating potential for adaptation to areas with longer growing season" (*Horticultural reviews, 2003*). The high value of these varieties can be assessed in terms of their peculiar economic traits including taste and flavour, appearance, storability and shelf life, adaptation to drought (particularly in pistachio and pear), good quality of dried fruits (raisins, apricots). Latest scientific publications show that this germplasm is widely used in the breeding programs outside the region to improve fruit quality in terms of aroma and sugar content (*Ledbetter, 2009*).

Fruits and nuts in various types: fresh, dried, canned are essential part of the diet of local people and are the source of income and export commodity for most farmers. Wild stands of nut bearing crops as pistachio and almond are widely used by local people for harvesting pistachio and almond nuts. Along with that these two species are characterized with their high drought resistance and are widely used by local people for aforestation of dry bare hills where no any other crop could be grown. It is worth to note here that forests of walnut (*Juglans regia*) are still existing in Kyrgyzstan and wild stands of pistachio (*Pistacia vera* L.)—the only species with edible fruits in Pistacia genus are still growing in Tajikistan and Turkmenistan.

COPING WITH CLIMATE CHANGE

Central Asia faces serious climate change and environmental issues - from the melting of glaciers and depletion of water resources to deforestation, soil erosion, the loss of agricultural land and urban pollution. An increasing shortage of water, which is a key resources for agriculture is noticeable. The glaciers in Tajikistan lost a third of their area in the second half of the 20th century and Kyrgyzstan has lost over a 1 000 glaciers in the last four decades (*EU report, 2008*).

The region has important assets to cope with the challenge set by climate change: it has always been a hotspot of biodiversity concerning agro plants and successfully kept over decades a high number of varieties (total 124 agricultural crop species and 952 varieties/hybrids) and their wild relatives (*Christmann et al, 2009*). These plants are repositories of genetic diversity and vital to ensuring future food security in changing environment.

Acknowledgements

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KEYWORD INDEX

AUTHOR INDEX