Promoting Best Practices for Conservation and Sustainable Use of Biodiversity of Global Significance in Arid and Semiarid Zones in the Developing World

Summaries of selected case studies and innovative experiences throughout the South

- Third World Network of Scientific Organizations (TWNSO)
- United Nations Environment Programme (UNEP)
- Global Environment Facility (GEF)
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A project of the United Nations Environment Programme (UNEP), Global Environment Facility (GEF), and Third World Network of Scientific Organizations (TWNSO)

More than one-third of the earth's land area is dryland; up to one billion (mostly poor) people depend on drylands for their survival; the biological resources of drylands are both unique and vulnerable; and loss of dryland species increases the threats to the lives of millions of people. These are some of the reasons why the protection of biodiversity and sustainable use of resources in drylands is an important concern.

In developing countries, successful experiences in conserving biodiversity and utilizing sustainable resources have not been widely publicized and hence have not been replicated in other relevant circumstances. For example, much of the available information on a wide variety of best practices and lessons learned for protecting and sustainably using biodiversity in arid and semiarid zones remains within the institutions in which it has been generated and has not been shared with others working on similar issues. Such shortcomings preclude valuable knowledge from being applied for the benefit of the global environment. Lack of financial resources represents a major constraint for Southern nations and their scientific institutions: it prevents them from disseminating the results of their studies and projects and, as a consequence, hampers the strengthening of partnerships and effective capacity building efforts between institutions and stakeholders. If scientists, decisionmakers, and other stakeholders had easier access to more information on best practices and lessons learned, project activities would have a broader impact and costly duplications could be avoided.

The purpose of this project is to increase the size of the “portfolio” of case studies aimed at protecting and sustainably utilizing biodiversity of global significance in arid and semiarid ecosystems in developing nations to ensure that interested parties have access to them. The project focuses on lessons learned – for science, for public policy and management, for increasing the participation of local people in decisionmaking, and for increasing partnerships and capacity building.

The Third World Network of Scientific Organizations (TWNSO) has sought to promote effective science capacity building programmes among nations throughout the developing world ever since its establishment in the late 1980s. TWNSO’s goals are twofold: to establish an archive of successful experiences that others can learn from, and to help create networks of specialists that will facilitate communication – not just during the implementation of a particular project but long after.

TWNSO is grateful for the financial support from the United Nations Environment Programme and the Global Environment Facility which has made this initiative on dryland biodiversity possible. We would also like to thank the many scientists and scientific administrators whose hard work and dedication have proved instrumental in the design and implementation of this project.

For additional information, contact Helen Martin, TWNSO Secretariat, Strada Costiera 11, 34014 Trieste, Italy; e-mail: info@twnso.org; fax: + 39 040 2240689. The project’s website is www.gefbiodiversity.org.
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Sub-Saharan Africa

BOTSWANA

Promoting agriculture and biodiversity conservation in Africa through indigenous knowledge systems

M.B.K. Darkoh, Department of Environmental Science, University of Botswana, Gaborone, Botswana (darkohmb@mopipi.ub.bw)

devising strategies for melding agricultural production and biodiversity conservation

This case study explores some of the important relationships between agriculture and biodiversity. Based on an examination of the characteristics and advantages of indigenous management systems, the authors contend that agriculture and biodiversity conservation can complement rather than conflict with one another.

Indigenous or local farmer knowledge about production systems has often been overlooked despite the fact that indigenous people and farmers are often partners in the conservation and management of biodiversity whether for nature reserves or the improvement of crops and livestock yields. It is the central thesis of this report that local knowledge systems, traditions, institutions and environmental conditions are fundamental to biodiversity conservation and management. In terms of policy, the authors advocate that agricultural programmes and biodiversity conservation projects should ensure that indigenous knowledge is incorporated into their design and implementation. A blend of modern science and indigenous knowledge will be required to face the challenges of increasing agricultural production and managing the environment on a sustainable basis in the decades ahead in Africa. It is also important to ensure that the relevant local communities are given appropriate control over and access to land and other resources as well as management responsibility for the natural areas upon which their continued prosperity depends. Furthermore, development assistance to agriculture and biodiversity conservation and land management will be most beneficial when it attempts to enhance existing agricultural systems.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Sub-Saharan Africa

BURKINA FASO

Participatory approach for conserving forest genetic resources in Burkina Faso

Lambert G. Ouedraogo, Centre National de Semences Forestières, Ouagadougou, Burkina Faso (cnsf@fasonet.bf)

using traditional knowledge of crop seed storage to conserve forest genetic resources

In Burkina Faso and other Sahelian countries, people rely on trees and shrubs for their daily life. Despite the importance of forest resources for the livelihood of rural people, Burkina Faso loses approximately 32,000 ha of forest annually. To protect forest genetic resources and improve the well-being of local populations, the National Forest Seed Centre of Burkina Faso developed and implemented methods to utilize local peoples’ knowledge of crop seed storage and improve on this knowledge and ability to better protect forest genetic resources. All of the management areas were located in the Sudanian and Sahelian zones of Burkina Faso and part of the semiarid zones of West Africa.

Based on traditional local knowledge of crop seed storage and subsequent experimentation, the study describes innovative methods for characterizing and mapping forest areas for management; selecting the most important tree species whose growth and production should be increased; improving the handling and storage of forest seeds; determining practical and reliable methods to maintain forest seed viability and direct sowing efficiency; identifying simple traditional forest seed storage that allow protection of seeds and control of parasite attacks during storage; and evaluating direct sowing impact on forest regeneration. Finally, the study shows how involvement of local people in developing strategies to improve forest seed storage can generate jobs and income in rural areas while contributing to forest biodiversity protection.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Sub-Saharan Africa

BURKINA FASO

Experimental techniques for raising forest tree seedlings in earthenware containers in Burkina Faso

Lambert G. Ouedraogo, Centre National de Semences Forestières, Ouagadougou, Burkina Faso (cnsf@fasonet.bf)

preserving local biodiversity, restoring dryland ecosystems
and alleviating poverty

In Burkina Faso, large-scale plantation as well as local methods of forestry and agroforestry are implemented to prevent erosion of biodiversity and to contribute to the alleviation of poverty. Practically speaking, plantation trees must be produced in nurseries. This study describes a project on valorizing indigenous species in reforestation and reducing input costs in nurseries. Specifically, experiments assess different combinations of forest tree seedling substrates and traditional methods for generating plant propagation materials.

Earthenware containers based on local peoples’ traditional methods of making house bricks were made for growth of forest seedlings. Farmers then were trained to raise forest tree seedlings in the containers. One result is that to improve their revenues farmers are planting in their own fields, propagating ornamental plants for sale, and training other people in the techniques. In addition, using earthenware containers to raise forest seedling is less polluting than using polyethylene bags.

This study shows that if research programmes are based on local peoples’ knowledge and traditions, improvements in forest seedling production methods can be made and other local people will adopt the methods.

However, the study also shows that for large-scale biodiversity management, it is necessary to involve not only local communities but also governmental authorities and that knowledge must flow from the local level to the national and vice versa. Further, without international financial support, scientific exchanges and skilled staff, large-scale biodiversity conservation efforts will remain weak.
Sub-Saharan Africa

CAPE VERDE

Inventory of biodiversity programmes and projects in Cape Verde: Optimizing biodiversity management

Gaoussou Traore, Institut du Sahel, Bamako, Mali (gaoussou@agrosoc.insah.ml)

promoting biodiversity conservation by overcoming problems associated with localized and fragmented management

Despite the adoption of the Convention of Biodiversity in 1992 and increased awareness of decisionmakers in Sahelian countries of the importance of biodiversity, many conservation projects remain highly localized, fragmented, and lack adequate reporting mechanisms. Consequently, information about the projects and their outcomes is not available. This case study describes a project conceived by the Institut du Sahel (Mali) and U.S. scientific partners to optimize the management of biodiversity information in the Sahel.

The objectives were to develop strategies for more effectively acquiring information on biodiversity programmes in Senegal; develop an appropriate database for regional projects; disseminate project results to appropriate agencies, organizations, and individuals for review and evaluation; recommend more effective methods for biodiversity programmes based on the reviews and evaluations; and publish and disseminate project results and recommendations.

The study concluded that the project had a positive impact on the scientific and donor communities by exposing gaps in knowledge, increasing awareness of information needs, improving regional priorities for biodiversity protection among all stakeholders, and enhancing the quality of biodiversity education programmes.
Kenya

Information flow as a tool for rapid agricultural transformation and biodiversity conservation with special reference to the case of Kenya

Henry K. Cheruiyot, Kenya Agricultural Research Institute, Nairobi, Kenya (hkcheruiyot@kari.org)

improving quality and flow of biodiversity information for rural agriculture

Research in Kenya has contributed substantially to the development of agriculture through provision of hybrids, improved agronomic practices, post harvest technologies, enhanced livestock productivity and more advanced disease control measures.

Nevertheless, declining food production in rural areas and widespread animal diseases are still prevalent. In many rural areas farmers are poorer and more dependent on food relief than before. This study shows that despite the advances of technology stemming from modern research, many rural farmers tend to use only part(s) of innovative and effective technology. Further, as a consequence of the failure of some research to adequately take into account indigenous knowledge of key vegetation (e.g., herbal medicine), the application of some technologies, such as bush management, has been hampered. Other factors, such as poor linkages between agricultural and biodiversity stakeholders, unresolved donor preferences, low literacy levels among rural farmers, poor land use policies, and lack or limited infrastructure, have limited the development of more effective technologies to promote rural agriculture and conserve biodiversity.

The Kenya Agricultural Research Institute has designed an initiative focusing on development of an information technology transfer system that is farmer friendly, increases contacts with clients, and improves collaboration. This system enhances rural farmers’ abilities to make their needs better known to agricultural service providers and increases the effectiveness of intermediary groups whose goals are to increase farmers’ well-being as well as to conserve biodiversity. Scientists are gaining farmers’ confidence and are now testing key indigenous knowledge in areas of ethno-veterinary science, soil fertility, evaluation of indigenous food preservation technologies and general team building in technology development. In addition, farmers’ confidence also is growing in other new areas such as biodiversity, land degradation and desertification.
Sub-Saharan Africa

KENYA

Development of strategies for in situ conservation of crop genetic resources in semiarid areas of Africa

Mikkel Grum, International Plant Genetic Resources Institute, Sub-Saharan Africa Group, Nairobi, Kenya (m.grum@cgiar.org)

implementing actions to reduce loss of genetic biodiversity caused by drought and desertification

The overall objective of this action-oriented research programme is to develop interventions designed to reduce the loss of genetic biodiversity caused by drought and desertification in the dryland ecosystems of Africa. The aim is to mitigate the impact of temporary drought-induced conditions through the development of comprehensive community-based strategies for monitoring, analysing, assessing and addressing desertification.

The project attempts to understand the complex role that genetic diversity plays in the planting strategies of farmers. Research focuses on descriptions of crop genetic diversity, its extent and distribution, the socioeconomic situation of farmers, environmental factors, and opportunities for stakeholder participation in decisionmaking. The project also examines the dynamics affecting the status of genetic resources and loss, including traditional management practices for selection, conservation and multiplication of genetic resources.

The effectiveness of traditional management practices and the difficulties encountered by farmers in their management of genetic resources has been studied to better understand the impact of continued deterioration (or sub-utilization) of genetic diversity.

Finally, the project is testing models of community-based activities, such as community gene banks, improved seed storage systems, seed diversity fairs, farmer field schools, and on-farm seed production systems.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Sub-Saharan Africa

KENYA

Medical plants used for gastrointestinal conditions in Makueni district, Kenya

Daniel Kisangau, Phytochemistry Department, National Museum of Kenya, Nairobi, Kenya (kisangau@yahoo.com)

identifying priority medicinal plant species for conservation programmes

Gastrointestinal diseases account for a significant percentage of morbidity and deaths in Kenya. A previous study carried out in the semiarid Makueni District of Kenya showed 66 plant species in 30 families and 55 genera were of ethno-medical interest as sources for possible treatments of diarrhoea, amoebic dysentery, typhoid fever, stomach ache and colic, constipation and flatulence, and indigestion and dyspepsia.

To obtain information on the use of plants for treatments of these diseases, the study examines application of “consensus” as a quantitative criterion for obtaining and recording more accurate information (obtained in the field) on local peoples’ views of the value of plants for the treatment of the diseases. Oral interviews were used in collecting ethno-medical information on the plants and descriptive statistics were used in data analysis. The study indicates a steady decline in the availability of wild medicinal plants as well as an increase in their demand. Combined with knowledge of farmers’ experience in conserving and successfully propagating the species for use in treatment of diseases, the information has led to conservation status of the five most utilized species.
Environmental problem solving for sustainable development

M.K. Seely, Desert Research Foundation of Namibia, Windhoek, Namibia (drfn@drfn.org.na)

Improving decisionmaking on issues related to development, poverty alleviation, land degradation, and biodiversity management

Training for policymakers, planners and managers in the conservation of biodiversity and sustainable use of natural resources in arid and semiarid lands requires a broadly based experienced team effort. In 1992, an intensive 10-week field experience in environmental problem-solving for future decisionmakers was established in Namibia focusing on the interrelatedness of development, poverty alleviation, land degradation and biodiversity management. The course addressed such politically sensitive issues as social equity. Graduates were sought-after by government and other employers for their enhanced skills and their ability to express their understanding of the interrelated components of sustainable development. Impact on biodiversity conservation and sustainable development can be achieved by students using simple, focused approaches coupled with analysis of existing and/or easily obtained information.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Sub-Saharan Africa

NAMIBIA

Best practices in the world’s oldest desert
M.K. Seely and J. R. Henschel, Desert Research Foundation of Namibia, Windhoek, Namibia (drfn@drfn.org.na)

showing how the tourist value of the Namib Desert has been enhanced through research

Promoting conservation and sustainable use of biodiversity in the arid and semiarid areas of Namibia has been undertaken by an informal public/private nongovernmental (NGO) partnership. The public sector manages established national parks and, more recently, in partnership with NGOs is promoting community-based natural resource management on farmlands, while the private sector is involved in tourism that provides the foreign exchange income motivating the public sector to retain interest in biodiversity protection. Long-term ecological research in support of best practices covers a wide range of basic and applied research. For example, lessons learned concerning environmental variability include the role of ephemeral rivers that cross desert areas while supporting a riparian forest with its associated fauna and farming opportunities and recharging underground aquifers upon which urban coastal development depends. Several research projects undertaken with the indigenous community focus on developing markets for fruit products, community-based tourism and harvesting fog. Public policy is driven by changing global perceptions of biodiversity values. This, in turn, fuels international tourism. The tourist value of the Namib Desert thus has been enhanced by the dissemination of the results of biodiversity research. As vast protected mining areas are opened up to alternative use, their status as a biodiversity hotspots influences public policy and future use. This case study focuses on the Desert Research Foundation of Namibia and on the roles of other institutions participating in the government’s biodiversity task force.
In Senegal, as in many other developing countries, some species used in traditional medicinal uses are overexploited and threatened or endangered. The purpose of this case study is to increase knowledge of the species so that their genetic diversity can be protected while allowing their continued use by humans.

This case study assesses the use of the species in traditional medicine and the resulting impacts on genetic resources. It also analyses research and development strategies to conserve and domesticate the species. Key species are: *Fagara xanthoxyloides* (leaves and roots are used to combat diarrhoea, enteritis, and to treat wounds and migraine headaches); *Securidaca longopedunculata* (possible use as an antivenom and in destruction of certain insect pests); *Tinospora bakis* (roots are used to treat yellow fever and hepatic problems); *Kigelia africana* (roots and bark are used to treat leprosy); *Moringa oleifera* (leaves, bark, roots, and gum are used to treat fevers, migraine headaches, and rachitis). In addition, the study examines seed conservation and physiology, and development of appropriate vegetative propagation methods.
Value of indigenous knowledge for the development of information systems for conservation management

K. Kellner, School of Environmental Sciences and Development, Potchefstroom University for CHE, Potchefstroom, South Africa (plbkk@puknet.puk.ac.za)

developing more effective tools and processes to capture different forms of information for conservation and sustainability programmes

This report provides a comprehensive overview of the need to develop and disseminate more effective tools and methods to obtain information for conservation and sustainability programmes, especially in situations where the use of local indigenous knowledge is important or essential.

The development of inventories and information systems in which indigenous and scientific knowledge are incorporated into single expert knowledge systems will not only help in the connection of science and community action but also in the awareness, education, training and capacity building of agriculturalists and conservationists.

It is important that information systems also include the verification and validation of local knowledge based on literature, statistical analysis and scientific experimentation, as well as sampling theory and logical analysis of data. Difficulties in obtaining sustained long-term funding in arid and semiarid environments often leads to discontinuity in the research process and demoralization of the land managers. It is therefore essential to develop processes and mechanisms whereby such knowledge-building processes as community-based research, adaptive management, monitoring, feedback and community dialogue can be institutionalized or embedded in the community before external funding is terminated. In this way, knowledge building becomes an ongoing process and the information system in which the knowledge is captured evolves as more information becomes available either through research or management.

Gathering information is a much easier task than disseminating it. Identifying the most appropriate databases and information systems that will serve the needs of a specific target group is of great importance. The mode in which the analysed data from research and transformed knowledge is transferred and disseminated will depend on the availability of technology and the level of understanding by the end-users. This often requires use of computerized databases linked to expert systems that can be incorporated on internet websites for the distribution of best practices not only locally but internationally.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Sub-Saharan Africa

SOUTH AFRICA

EcoRestore: Decision support system for rangeland restoration

K. Kellner, School of Environmental Sciences and Development, Potchefstroom University for CHE, Potchefstroom, South Africa (plbkk@puknet.puk.ac.za)

creating networks for the exchange of information technologies in biodiversity restoration programmes and projects

In this report, case-based reasoning (CBR) methodologies are used to gather and structure community knowledge within a single accessible computerized system. The methodology has been developed to diagnose problems and to find the best solutions to problems by searching through a data base of previous cases.

The CBR method involves reasoning from old cases (experiences) to help find or infer solutions to new problems. The database currently contains 210 case studies. Questionnaires and quantitative sampling techniques capture information on specific environmental and restoration techniques. Each case describes the situation or problem, followed by the possible solution(s), which is expressed as a specific action that has been undertaken. During the search, the objective is to locate a case or set of cases that are similar to the problem and conditions. The degree of match between the description of the problem and the answers will call up a previously stored case from the database. The better the match, the higher the probability of finding the most appropriate solution. The best action to be taken to restore the degraded area will then be described.

By using the decision support system, land managers do not have to rely on their own experiences to find possible solutions, but can share cases and knowledge from many experiences. The principles and concepts used by EcoRestore not only facilitate technology transfer but help with training and capacity building of agricultural extension or conservation officers. It also serves as a guide to community-based policymakers and managers for identifying and focusing future environmental strategies and needs.
Gauteng, located high on the central plateau of South Africa, includes both grassland and savanna biomes where vast herds of game once roamed freely. Rich in biodiversity, Gauteng is now home to Johannesburg. This industrial heartland sits on a major catchment area with rivers carrying polluted water into the east and west of South Africa. Urban sprawl is at the highest level in the country. More than 50 percent of the natural area has been developed, industrialized, mined, or cultivated.

Historically, protected areas were designated on an ad hoc basis, creating potential islands isolated from one another by large areas of mostly transformed land. The level of transformation leaves the province of Gauteng and the city of Johannesburg with the stigma of being unsustainable. South Africa, with its varied and complex land tenure systems and ongoing process of political and social transformation, together with a high level of poverty, imposes additional constraints on sound conservation planning and sustainable use of biodiversity. Further, models of climate change reveal that the remnant grasslands are threatened by desertification spreading eastward.

The Department of Agriculture, Conservation and Environment, and Land Affairs is a provincial authority committed to conserving Gauteng’s remaining biodiversity. This case study describes the department’s higher level biodiversity planning that includes a new integrative approach encompassing “gap analysis” to improve land use planning techniques; monitoring and evaluation through proactive research; protected area management, including establishment of buffers and corridors; establishment of nature conservancies; and ultimately education of communities through integrated participatory approaches. Lessons learned from the study are of potential benefit to people in other cities in Africa struggling to meet the needs of development while simultaneously conserving their heritage.
Promoting conservation farming in areas with globally significant biodiversity in South Africa

Ingrid Nänni, Conservation Farming Project, National Botanical Institute, Cape Town, South Africa (nanni@nbict.nbi.ac.za)

obtaining knowledge of processes controlling habitat and ecosystem integrity essential to prevent biodiversity loss in agricultural landscapes

South Africa comprises less than 0.8 percent of the world’s total land area, but contains approximately 8 percent of the world’s vascular flora, as well as between 2 to 7 percent of the world’s amphibian, reptile, avian and mammalian species. Despite a reserve network that covers about 6 percent of the land area, a significant proportion of South Africa’s biological diversity exists only outside reserves, mainly in agricultural landscapes.

Conserving biodiversity in agricultural landscapes is therefore critical for the conservation of biodiversity in this region. In some biodiversity hotspots in South Africa, farmers have experimented with alternative land use practices to secure ecosystem goods and services and preserve the natural assets on their farms.

This case study focuses on one study site in a semiarid region on the Bokkeveld Plateau (Northern Cape province) in South Africa. Data are presented as a preliminary model in which land use options influence both biodiversity and the provision of ecosystem goods and services. Included are preliminary data on the risk of extinction for plant and animal species under different forms of land use, as well as ecosystem goods and services related to water infiltration, soil health, carbon sequestration, and production. The ecological components of the project will be integrated with social and economic studies to develop an ecological-social-economic model to guide land use planning in the region.
Example of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Sub-Saharan Africa

REGIONWIDE

Domestication of indigenous trees as the basis of a strategy for sustainable land use

R.R.B. Leakey, Agroforestry and Novel Crops Unit, School of Tropical Biology, James Cook University, Cairns, Australia (roger.leakey@jcu.edu.au)

developing national strategies for sustainable land use

Land-use sustainability in the tropics has typically been undermined when species-rich natural vegetation has been cleared to make way for monocultures of improved staple food crops grown intensively with high inputs of agrochemicals. These intensive farming systems have indeed helped feed growing human populations, but at an environmental cost that cannot be sustained.

As this study suggests, an acceptable alternative that both feeds the people and restores some of the diversity found in natural vegetation has been found in the development of lower input agroecosystems that combine the cultivation of “green revolution” staple food crops with indigenous food-producing tree species that can restore ecosystem function. Such a return towards more traditional land use practices can be enhanced by the judicious development of high quality, high yielding cultivars of trees through the adaptation of standard horticultural practices and the planting of these cultivars in agroforests.

In dryland Africa, many traditional tree species serve as the basis for non-timber forest products that have the potential to be domesticated in this way. The techniques, methodologies and strategies exist and are being implemented in small ways. A few species are already being domesticated with the participation of local communities. The potential exists to expand these programmes to a scale where they can begin to have a meaningful impact on land use and create new and more biologically diverse functioning agroecosystems that can also support and enhance the livelihoods of local people.
**Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones**

**North Africa and the Arab Region**

**EGYPT**

**Conservation and sustainable use of natural vegetation in the north western coast and Sinai peninsula of Egypt**

*Ahmed Morsy Ahmed, Desert Research Centre, Cairo, Egypt (h_hendy@hotmail.com)*

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*sustainably using natural resources in fragile arid ecosystems*

This case study focuses on the northwestern coast and the Sinai Peninsula of Egypt. For each site and associated habitats (e.g., swamp and saline habitats, sand and gravel habitats), detailed descriptions are provided on climate, geology, habitat and plant diversity, identification of native and introduced species, human use, and governmental actions for conserving the species.

Based on the descriptions, recommended actions include identification of hotspots or reserves rich in endemic and/or endangered species; improvement of rangelands using indigenous and/or exotic palatable perennials as alternative refugial sites; increasing availability of alternative energy sources to reduce the demand for fuel wood by local communities; domestication of endangered plants by *ex situ* cultivation; improving the social and economic well-being of Bedouins in the areas; improvement of partnerships to share experiences.
The dry Badia region of Jordan comprises more than 75 percent of the country's area. The region's floral and faunal biodiversity is both high and unique. This study presents baseline information on the threats to the Badia's biological diversity with emphasis on important bird habitats, wetlands, and other sites of biodiversity significance to assess current impacts due to increasing human population and pressures for economic development.

Specifically, the study notes that one endemic freshwater fish (*Aphanius serhani*) occurs in Azraq Oasis, and three endangered lizards (*Uromastix aegyptia*, *Chamaeleo chamaeleon* and *Varanus griseus*) listed as CITES species inhabit the region. The study also documents that the Badia is a focal zone for the evolution of species of *Acanthodactylus*, a large number of bird habitats, and wetland areas important to migratory and water-dependent bird species. Many bird species are threatened from habitat loss, especially raptors. Almost half of the mammals of Jordan also inhabit the region and the status of these species is documented in the study.

The study also identifies threats to the area's biodiversity: overgrazing, withdrawal of surface and underground water, reduction of water quality, habitat fragmentation, removal of vegetative cover on which other species depend, unsustainable agricultural practices, uncontrolled industrial development in rural areas, hunting, mining and oil transportation.

The study recommends that action plans to protect the Badia's biodiversity be based on improved knowledge of the biodiversity; empowering local people to become more involved in decisionmaking; improvements in local and national governance; and more effective operational mechanisms for implementing protection of biodiversity.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

North Africa and the Arab Region

JORDAN

Farm-scale water harvesting practices for improving soil fertility and genetic diversity of fruit trees in southern Jordan

Abed Al-Nabi Fardous, National Centre for Agricultural Research and Technology Transfer, Amman, Jordan (agrobio@ncartt.gov.jo)

Severe water shortages since the 1960s have stymied efforts to increase agricultural production in Jordan. During this same period, the country’s overall demand for water has grown more rapidly than the development of new water sources. Environmental, agricultural, and socioeconomic problems ensue when water supplies fail to meet domestic and agricultural demand. Increased demand for water has led to overdrawing of groundwater. That, in turn, has reduced the level of water quality.

The main objectives of this case study are to evaluate different water harvesting techniques, test their suitability to specific field site conditions, improve agricultural production, and promote genetic diversity of fruit trees by ensuring adequate water supplies. The study has four components: (1) to collect, document, and analyse existing information concerning water harvesting techniques; (2) to select suitable field sites for implementing water harvesting techniques through appropriate land use planning; (3) to analyse rainfall data and runoff relationships to determine appropriate water harvesting techniques; and (4) to conduct educational/outreach programmes and visits to field sites for representatives of government ministries, interested groups from neighbouring countries, farmers, and other stakeholders in agriculture and environment.

The study concludes that appropriately designed water harvesting techniques mitigate water shortage problems.
Conservation and sustainable use of biodiversity in Jordan

Abed Al-Nabi Fardous, National Centre for Agricultural Research and Technology Transfer, Amman, Jordan (agrobio@ncartt.gov.jo)

This study describes the historical and current threats to Jordan’s biodiversity in the context of increased concerns of the global community to better protect drylands. Reasons behind biodiversity loss include pressures of human population growth, demand for natural resources, introduction of exotic species, natural disasters, and pollution. The study focuses on the importance of the Dana Natural Reserve (DNR) in enhancing the protection of Jordan’s biodiversity.

Following a description of the DNR’s climate, geology and hydrology, soils, biological habits, ecological communities and species, human use and culture, and past and current research and monitoring of the area, the study describes the objectives of plans and actions implemented for comprehension protection of the DNR. These include: working with local communities to protect the DNR as an integral part of Jordan’s national heritage; conserving all species of wildlife at ecologically viable population levels by minimizing human disturbance in the DNR and surrounding buffer zones; monitoring of habitat and species to conserve the ecological integrity of the DNR; implementing zoning plans for different areas of the DNR; managing grazing to preserve biodiversity; creating links between the DNR and local communities by promoting development projects to help minimize the impact of human activities detrimental to biodiversity while generating income for local communities; managing Cypress (Cupressus sempervirens) and Mediterranean semiarid forests to minimize damage caused by human activity and the expansion of exotic species; promoting agricultural extension projects focused on organic farming; encouraging development of sustainable ecotourism; ensuring that local people and communities benefit from the development of sustainable ecotourism; promoting research and monitoring of the DNR’s biodiversity; and developing environmental education programmes to generate long-term support for the DNR.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

North Africa and the Arab Region

LEBANON

Farmer and funder priorities for biodiversity conservation in Lebanon

Rami Zurayk, Environment and Sustainable Development Unit, American University of Beirut, Beirut, Lebanon (rzurayk@aub.edu.lb)

Improving the prospects for meeting the agendas of GEF, implementing agencies, national government, consultants, and local communities

Achieving various stakeholders’ agendas for implementing sustainability of biodiversity is complicated and requires resolving many different stakeholder conflicts. If conflicts are not sufficiently resolved and harmonized, prospects for achieving sustainability are small. A recent GEF thematic review of the nature of conflicts among stakeholders draws attention to the importance of: increasing political will through the strengthening of local participation and debate over resources and priorities, and promoting partnerships and participatory implementation activities among international agencies, governmental and nongovernmental agencies, and scientists and local communities.

A critical analysis of conflicts between stakeholders is timely because few projects would be judged capable of meeting sustainability if strict criteria are applied. In part, this stems from the fact that the needs and goals of stakeholders are divergent and often contradictory.

This case study presents the results of a critical analysis of participatory approaches that are a main ingredient of the success of interventions to protect biodiversity. The study, which is based on experiences in Lebanon’s GEF–funded nature reserves, underscores the difficulties of meeting the agendas of GEF, implementing agencies, national governments, consultants, and local communities. Only when such difficulties are better understood and minimized will prospects for achieving sustainability of biodiversity be improved.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

North Africa and the Arab Region

MOROCCO

**In situ conservation of crop biodiversity in Morocco**

Fatima Nassif, Institut National de la Recherche Agronomique, Settat, Morocco (fnassif@iam.net.ma)

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strengthening scientific basis of in situ conservation of agricultural biodiversity

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This *in situ* on-farm conservation project in Morocco, which involves nine countries, has provided a rich learning experience for all those involved, including farmers, scientists, and development workers. The most important lesson learned is that the *in situ* conservation of on-farm agrobiodiversity is a very complex and multifaceted process. Scientific lessons learned include: the need to establish multidisciplinary teams that include not only agricultural and genetic scientists but social scientists; the need to include a balance of gender perspectives in the study of *in situ* conservation of on-farm crop genetic diversity; the need to understand that landraces of crops are used by farmers because they represent the best options from the farmers’ points of view. Public policy and management lessons learned include: the most important gap between Morocco’s official policy and implemented measures towards conservation and sustainable use of crop biodiversity stems from the absence of a national strategy plan on biodiversity as well as from the absence of a national gene bank. The main lessons learned for assisting local populations in utilizing and managing biodiversity are: that it takes time and effort on the part of researchers to understand and respect local knowledge systems and management practices and farmers’ points of view, and that there is a need to empower the local population by recognizing the critical contributions of farmers in the management of crop biodiversity.
Site selection criteria for mangrove afforestation projects in Oman

Peter Cookson, Department of Soil and Water Sciences, Sultan Qaboos University, Muscat, Sultanate of Oman (peterc@squ.edu.om)

identifying soil criteria for selecting suitable transplanting sites for mangroves

The Sultanate of Oman’s Ministry of Regional Municipalities, Environment and Water resources recently declared the extension and conservation of mangrove (Avicennia marina) to be of national importance in maintaining the nation’s biodiversity. Mangrove forests are habitats recognized for a wide range of marine organisms and bird life. Mangroves also provide forage for animals. Consequently, a long-term afforestation project of some 20 coastal sites has been proposed, in addition to conservation measures for the more than 1000 ha of existing mangrove forests. Commencing in 2001, mangrove seedlings have been raised in nurseries and transplanted to several sites. Transplanting activities are into their second year and seedling survival rates at different sites have ranged from 0.1 to more than 80 percent. In this study, salinity and soil physical properties at four transplanting sites with a range of seedling survival rates were compared. The study concludes that anaerobic soil conditions are closely associated with seedling death. Based on the study’s conclusions, recommendations have been made for selecting suitable transplanting sites for mangrove seedlings.
Habitat degradation and loss of biodiversity: A case study of coastal lagoons in southern Oman

Reginald Victor, Centre for Environmental Studies and Research, Sultan Qaboos University, Sultanate of Oman (victor@omantel.net.om)

obtaining knowledge of processes for controlling habitat and ecosystem integrity essential to prevent biodiversity loss

In 1986, several proposals were made for the conservation of coastal lagoons in southern Oman. This case study critically reviews the history of conservation, biodiversity and habitat degradation of these lagoons. Using a Pressure-Status-Response (PSR) approach, the impacts of habitat degradation on conservation strategies and proposals are analysed. Present policies and implementation schedules for the protection of coastal lagoons are reviewed. The role of public participation in decisionmaking is discussed.

In these lagoons, habitat loss precedes biodiversity loss. In many cases, it continues during the implementation phase of the conservation process and even afterwards. Because a complete assessment of biodiversity, even in such small and special ecosystems as coastal lagoons, is a difficult task, this study contends that the protection of habitats and habitat diversity require urgent action. Conservation of habitat diversity will go a long way toward protecting biodiversity. Knowledge of processes controlling habitat and ecosystem integrity is essential to preventing biodiversity loss.
Palestine

Status of biodiversity in Palestine

A. Sufian Sultan, Ministry of Environmental Affairs, Hebron, Palestine
(sufian48@hotmail.com)

examining threats to biodiversity and recommending policies
and actions for improved conservation and sustainability

Palestine’s size means that its distinctive natural reservoir of plant and animal species takes place within a very small area. For example, approximately 2500 of Palestine’s 4000 plus plant species are found in the West Bank and Gaza strip. Many of the wild and domesticated species in these two areas have unique genetic varieties and habitat preferences that are increasingly being threatened or destroyed. A major cause of the threats and destruction stems from local communities of Bedouins, fishers, and farmers placing more pressure on an already shrinking resource base. This pressure has increased over the last 30 years due to economic, industrial, urban, and political changes that have occurred in the Palestinian territories. Experts contend that urgent conservation measures are required for more than 40 species.

Through an evaluation of the composition and distribution of species, this case study identifies and examines threats to biodiversity and comments on prospects for improving sustainability.
TUNISIA

Conservation and use of local fig and pomegranate varieties in southern Tunisia

Messaoud Mars, Institut des Régions Arides, Settat, Medenine, Tunisia
(mars.messaoud@ira.mrt.tn)

strengthening conservation and use of local genetic resources

Because fig (Ficus carica L.), pomegranate (Punica granatum L.), and other traditional fruit trees in Tunisia are well adapted to arid and semiarid environments, they have important ecological and socioeconomic roles and can valorize marginal soils and saline waters. Local varieties are numerous but face pressures related to genetic erosion. A project has been conducted since the early 1990s for the conservation and use of local genetic resources; ex situ collections have been established and in situ and on-farm replantation have been undertaken. Results show considerable diversity of local germplasm. Rural areas and home gardens remain the main source and final destination of these fruit crops. It has been relatively easy to demonstrate to growers the importance of local genetic resources, but difficult to convince them to conserve cultivars with low economic value.

The project shows that the conservation of local cultivars is improved by strengthening relationships between all partners (research institutions, development agencies, local organizations, local communities, authorities and growers). However, conservation of local genetic resources requires new approaches and techniques and additional collaborative efforts, especially if the conservation is to be integrated in sustainable rural development programmes. The project also shows that it is necessary to emphasize in situ preservation of local genetic resources. Ex situ collections of perennial woody plants present many technical problems, particularly in arid zones with scarce water resources.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

North Africa and the Arab Region

**TUNISIA**

**Conservation, domestication, and valorization of the spontaneous plants of the desert zones of Tunisia**

*Mohamed Neffati, Institut des Régions Arides, Medenine, Tunisia (neffati.mohamed@ira.rnrt.tn)*

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**assessing the potential for domesticating and conserving rangeland species**

Due to the increasing number of livestock and loss of habitat plant species diversity is rapidly declining in desert rangelands in southern Tunisia.

The main focus of the gene bank programme is to characterize and conserve indigenous plants in the arid zones of southern Tunisia that may be utilized economically and/or in rangeland restoration. In part, the programme was developed in response to the failures of past attempts to introduce exotic species for these purposes. The gene bank programme, which was created in 1986 at the *Institut des Régions Arides* (IRA) in Medenine, Tunisia, has been a national priority. It has received not only national funding but financial support from international and regional institutions. The programme, in fact, has been retained as one of the highest priority programmes within the framework of Tunisia’s National Strategy to Combat Desertification and its National Programme for Biodiversity Conservation.

Suitable techniques for collecting, cleaning and conditioning the seeds of several species were developed and optimal germination and growing conditions for some of these species were determined. The programme has supplied standard plant material of some promising species (*e.g.*, *Rhus tripartitum*, *Periploca laevigata*, *Stipa lagascae*, *Atriplex* sp.) to commercial operators and development agencies and has exchanged plant material with national and international partners. Personnel in the programme also have provided technical services in capacity building and outreach activities to foster public awareness about the importance of plant diversity conservation.

A specialized national unit for the conservation and domestication of the spontaneous plants of the desert rangelands has been established and could serve as a model for countries facing similar ecological problems.
Plant diversity in the process of succession of artificial vegetation types and environment in an arid desert region of China

Li Xin-Rong, Shapotou Desert Experiment and Research Station, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, Lanzhou, China (lxinrong@nz.lzb.ac.cn)

This study documents plant diversity changes in desertified areas where attempts have been made to restore vegetation. In the areas studied, after more than 40 years of succession, the composition of restored vegetation species tends to become dynamically balanced as plant diversity increases with the succession of plant communities. Measurements show that the succession of restored vegetation experienced several relatively rapid stages of species turnover: for example, when restored shrub species became less abundant while the percentage of annual herbaceous plants increased as succession progressed. These findings have implications for management efforts to restore vegetation because they contribute to the theoretical understanding of vegetation restoration in desertified areas.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Asia

CHINA

Relationship between productivity and plant diversity at different desertification stages in the Horqin sandy grassland region of China

Chang Xueli, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, Lanzhou, China (resdiv@ns.lzb.ac.cn)

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devising programmes to restore and rehabilitate vegetation in the Horqin sandy grassland ecosystem

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This study focuses on how theoretical and practical knowledge of the relationship between plant productivity and diversity facilitates the rehabilitation and restoration of vegetation in desert regions. The study shows that the relationships between plant productivity and diversity depend on the specific structural or functional indices chosen at different desertification stages. This dependency has not always been recognized by ecologists and natural resource decisionmakers.

In the Horqin sandy grassland of China, the desertification process distinctly affects the numerical values of the diversity indices calculated for sandy grassland vegetation. The various stages of desertification affect species richness by influencing the species.

Generally speaking, the study shows that during the process of desertification the numerical relationship of diversity based on plant species composition and productivity is highest; the relationship of plant functional diversity and productivity is moderate; and relationship of simple species diversity and productivity is lowest. The relationship of the composition diversity and the productivity is a negative correlation in all of the stages except the earliest desertification stage, thereby indicating that the simple components of plants’ life forms correlate more closely with higher productivity than diversity indices based on more complex components. The functional diversity is both (relatively) high and positively correlated with productivity during early desertification stages. Some of the study’s results conflict with others published in the open literature. This points to the need to refine studies on the relationships between plant productivity and diversity at different desertification stages so that scientific capability can better inform decisionmakers to protect arid and semiarid grassland biodiversity.
Conserving biodiversity in arid regions: Experiences with protected areas in India

Malavika Chauhan, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India (mach0400@mail.jnu.ac.in; malavikachauhan@hotmail.com)

The main lesson learned from years of protected area management in the arid regions of India is that the survival of these ecosystems is not necessarily enhanced by simply leaving them alone. An understanding of the science behind the resilience of the protected areas in the face of occasional human disturbance and the fact that the areas have thrived in continuous interaction with human and domestic animal populations is required. The continuation of ecological linkages of protected areas with surrounding areas and their biotic communities may be necessary for ecosystem health. Further, the maintenance of biodiversity in the areas depends upon numerous smaller management issues linked with human communities from outside the protected areas, and on a holistic approach integrating the economics, industry, health and the resources of the people and the region.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Asia

INDIA

Aquatic biodiversity in arid and semiarid zones of Asia and its linkages with water resource management

Brij Gopal, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India (brij@123india.com)

increasing awareness that conserving biodiversity in arid and semiarid zones requires greater knowledge of understudied and undervalued linkages of native biodiversity and natural hydrological regimes

Most scientific studies of biodiversity and its management focus on terrestrial species and ecosystems and overlooks aquatic habitats. Management that focuses on aquatic biodiversity in arid and semiarid zones often fails to take into consideration the unpredictable variability in precipitation and its relationships with native biota and loss of biodiversity. Whereas natural aquatic habitats are being lost due to excessive withdrawal of water for various purposes, overexploitation of natural resources and changes in land use, numerous aquatic habitats have been created by transporting water through extensive networks of canals and constructing water storage reservoirs. In arid and semiarid regions, human-made water bodies are causing salinization, loss of biodiversity and a plethora of socioeconomic problems. Pollution of water from industrial wastes, increasing salinity in coastal areas, and introduction of exotic species are other major problems affecting native biodiversity.

This report highlights important but understudied characteristics of aquatic habitats and their biodiversity in Asia’s arid and semiarid regions. Threats to aquatic biodiversity are discussed, particularly in the context of water resource management practices. Though aquatic habitats throughout the arid and semiarid zones of Asia (from the Middle East to Central Asia and Mongolia) are examined briefly, examples come mainly from the Indian subcontinent.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Asia

INDIA

Domestication of indigenous trees as the basis of a strategy for sustainable land use

K.G. Saxena, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India (kgsaxena@mail.jnu.ac.in)

Typical rural landscapes in cold arid regions of India are differentiated into ecosystem types in terms of land use, species richness, community structure, and the nature and intensity of human alterations in biodiversity and ecosystem processes. This study documents areas of agreements and/or conflicts between local peoples’ traditional use of biodiversity and government public policies and management of biodiversity in these regions.

The study shows that local peoples’ concepts of the values of biodiversity have been key organizing principles in their traditional and sustainable landscape management practices. However, the importance of local peoples’ practices is diminishing largely because of government conservation policies and programmes that fail to take into account traditional practices.

Specifically, policy- and management-driven changes establishing government rights in areas traditionally used by local communities have not enhanced either the economic values of biodiversity and/or its protection. Such shortcomings have been exemplified, for instance, in the transfer of decisionmaking powers from the village communities to government institutions and in government incentives to increase the yields of food crops. According to this study, government policies and management practices fail to take into account local peoples’ wide-ranging knowledge and uses of biodiversity, especially with respect to food, fodder, fuel wood, and medicinal plants. Consequently, this study shows that the goals of biodiversity conservation and its sustainable utilization can be better achieved if conservation and development policies build on strengths and weaknesses of local peoples’ traditional knowledge and institutions.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Asia

KYRGYZ REPUBLIC

Biodiversity conservation problems in the Kyrgyz Republic

D. Akisheva, Ministry of Ecology and Emergency Situations of the Kyrgyz Republic, Bishkek, Kyrgyz Republic (min-eco@elcat.kg)

strengthening decisionmaking strategies for protecting biodiversity and improving the livelihoods of the people of the Kyrgyz Republic

Threats and risks to many of the species and habits of the Kyrgyz Republic have significantly increased over recent years. For example, forest cover has been reduced by more than 50 percent; pasture lands have been severely degraded; economically important species are less accessible to humans; habitats have been degraded by overuse, mineral extraction, and pollution; and more than 190 species of animals and plants are threatened with extinction.

This case study presents a comprehensive overview of understudied conservation problems in the Kyrgyz Republic by critically analysing the status of biodiversity; the significance of the country’s biodiversity to biodiversity of global significance; direct and indirect uses and values of biodiversity; various threats to biodiversity; existing programmes to protect biodiversity; government and civil society programmes and administrative structures for protecting biodiversity; role of education in biodiversity protection; and efficacy of legislation and policies to protect biodiversity. Because these problems have been understudied, the dissemination of information contained in this comprehensive review can help to improve decisionmaking strategies for biodiversity protection.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

**Asia**

**MONGOLIA**

*Conservation and sustainable use of globally significant biodiversity in the Trans-Altai Gobi Desert in Mongolia*

Ch. Dugarjav and B. Tsetseg, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia (mbiol@mobinet.mn)

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*laying a foundation for the further development of conservation activities*

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The Trans-Altai Gobi Desert, which includes the UNESCO Great Gobi Strictly Protected Area (SPA) Biosphere Reserve (the largest protected area in Asia and the fifth largest in the world), is one of the world’s most extreme arid and unique deserts. The desert has remained relatively intact, ecologically speaking, because historically it has been used by relatively small numbers of nomadic people in traditional ways. However, intensification of desertification and threats to biodiversity are increasing due to greater industrialization and collectivization of animal herds; economic difficulties encountered by Mongolia during its transition to a free market economy; increasing poverty; and industry’s increasing emphasis on profit making. Based on analyses of renewal of biodiversity legislation, establishment of the Great Gobi SPA, development of international cooperation and funding for biodiversity protection, and the active involvement of scientists and broad application of research, lessons learned are discussed that can provide a foundation for the further development of conservation activities.
Ecological assessment of degradation processes in the ecosystems of the Mongolian part of the Baikal Basin

P.D. Gunin, A.N. Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, Moscow, Russia (pgunin@online.ru)

Identifying the most serious risks to Mongolia’s ecosystems and their potential impact on the Russian part of the Baikal basin

Despite various international laws to conserve Lake Baikal and its designation as a World Heritage Site by UNESCO in 1996, threats to the region’s biodiversity and watershed continue to rise. These threats must be dealt with more effectively if the environmental quality of the region is to be preserved. For example, more than 50 percent of the Lake Baikal watershed and two-thirds of the Selenga River are in central and northern Mongolia, and are relatively densely populated (for the country) and heavily polluted by industry.

Specific objectives of this case study include: development of an ecological and socioeconomic inventory of the basin’s ecosystems; identification and analysis of the sources and processes of degradation; and examination of public policies and management strategies to resolve conflicts between short-term socioeconomic development and long-term ecological protection.

Based on data collected for human-induced changes in the Baikal basin, overgrazing has heavily and/or very heavily modified over 13 percent of the area; over 50 percent of rangelands have been moderately modified; over 20 percent of the forest-covered territory has been heavily and/or very heavily modified by felling of forests and fires; and virtually all agroecosystems have been heavily and/or very heavily degraded.

Recommendations to protect the basin’s biodiversity and environment include: ensuring that social and economic public policies are consistent with national and international biodiversity laws and the area’s status as a World Heritage Site; establishing a network of strictly protected areas, especially within the central Selenga River watershed; considering establishing a joint Mongolia-Russia Biosphere; and improving monitoring of the dynamics of aquatic and solid runoff in sediments of the Selenga River and its tributaries.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Asia

PAKISTAN

Overview of the biodiversity of arid and semiarid parts of Pakistan

Surayya Khatoon, Department of Botany, University of Karachi, Karachi, Pakistan (hej@cyber.net.pk)

improving the monitoring of threats of human activities
to indigenous flora

To improve the monitoring of floral biodiversity changes due to human influences, this case study presents an overview of knowledge concerning Pakistan’s floral biodiversity that includes the following factors: physical features of Pakistan; phytogeographic regions, higher vascular plants and associated fauna; endemic species; sources of human threats to floral biodiversity; status of inventorying and monitoring of floral biodiversity; status of in situ and ex situ floral conservation programmes; and the state of the country’s Biodiversity Action Plan. Drawing on this descriptive information, the case study makes recommendations to scientifically improve inventorying and monitoring; to increase institutional capacity building to better conserve floral biodiversity; to make agricultural practices more sustainable and protective of indigenous floral biodiversity; to improve the coordination among scientists, academicians, and government policymakers and decisionmakers; and to ensure that the conservation of indigenous biodiversity is better incorporated into policymaking at all levels.
Stabilizing roles of artificial biodiversity in the form of protective forest stands in agrarian landscapes of arid zones in Uzbekistan

E.K. Botman, Uzbek Scientific Research Institute of Forestry, Tashkent, Uzbekistan (nii@les.org.uz)

Stabilizing erosion-prone soils with artificial protective forest stands

Increasing use of Uzbekistan’s arid and semiarid lands for agriculture has reduced forest cover, increased wind erosion of soils, removed nutrients from soils, increased the levels of salinity and other contaminants of soils, altered soil and air temperatures, and changed soil structure and formation processes. All of these consequences have increased the risks to the region’s natural and agricultural biodiversity.

The purpose of this study is to scientifically assess whether and to what extent artificial forest stands would reduce soil erosion in irrigated arable lands in arid zones of Uzbekistan. The effects of the artificial stands on wind velocity, air humidity, soil and air temperature, species composition of insects, microflora and microfauna, soil formation processes, and rates of soil erosion have been observed. The study concludes that artificial protective forest stands help to restore ecological structure and function to irrigated arable lands, reduce the rate of loss of biodiversity, and make agricultural systems more sustainable.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Asia

REGIONWIDE

Role of common property regimes for conserving biodiversity in semiarid alpine rangelands: Case studies from the Tibetan plateau

Camille Richard, International Centre for Integrated Mountain Development, Kathmandu, Nepal (camille@icimod.org.np)

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Indigenous “Common Property Regimes” (CPR’s) are an effective means to manage and protect common pool resources, especially among pastoral communities in dryland regions where survival and the maintenance of a healthy rangeland ecosystem depends upon collective action. However, pastoralists face several natural, socioeconomic, organizational and policy challenges, especially “one size fits all” policies and development programmes that have promoted intensification and land tenure models that are more appropriate to moister lowland regions.

A set of hypothetical rangeland tenure models from the Tibetan Plateau in China are presented to highlight the distinction between local autonomous control of pasture, top–down imposition of policy, and a co–management model that brings indigenous and scientific knowledge systems together to promote collaborative action. Given the advantages of the latter model in today’s rapidly changing pastoral landscapes, such participatory processes will not be sustained without a supportive external environment that protects the rights of users, facilitates conflict resolution, and promotes timely financial, marketing and technical inputs. A conceptual framework and set of strategies are proposed, based on the experience of the International Centre for Integrated Mountain Development’s Regional Rangeland Programme on the Tibetan Plateau, fostering a more collaboration–friendly organizational and policy environment within which pastoral communities can more effectively influence the course of their own development.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Latin America and the Caribbean

BOLIVIA

Sustainable use of Andean wildlife for conservation of biodiversity and local development of rural communities in arid and semiarid zones

Bernardo Peredo, IRPAVI, La Paz, Bolivia (berbolivia@yahoo.com)

Conservation of biodiversity in arid and semiarid zones in Bolivia depends on their sustainable use by local communities for social and economic development. At the same time, the commercial and other uses of native wildlife species without proper management diminishes their populations and thereby threatens both the conservation of those species and their resource values. Proper management requires that social, economic, cultural, biological, and ecological values of wildlife be integrated into alternative strategies for their sustainable use and community capacity building. This case study focuses on this management requirement for three Andean species: vicuña, quirquincho or hairy armadillo, and Andean ostrich.

Population recovery programmes based on sustainable use have increased the number of vicuña but threats to the species remain; meanwhile, the numbers of the other two species may be declining due to unrestricted use. Studies and plans are being developed to improve the quality of vicuña fibre and distribute the benefits of the animal’s sustainable use; and to enable the sustainable use of the quirquincho and the Andean ostrich, respectively, in traditional cultural activities. Local communities are being provided with alternatives that will contribute to the conservation of these species as well as to the biodiversity of the Andean region of Bolivia. The case study draws important lessons on the need to use multidisciplinary approaches and to empower local people in decisionmaking.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Latin America and the Caribbean

BRAZIL

Sustainable system for animal production a semiarid region of Brazil

Gherman Garcia Leal De Araujo, Embrapa-Cpatsa, Petrolina, Brazil (ggla@cpatsa.embrapa.br)

reducing deterioration of natural resources and
increasing sustainable production of animals

There are approximately one million farming units in the semiarid region of northeast Brazil. The majority of farms practice subsistence agriculture and have low and unsustainable levels of production due to unfavourable soil conditions, insufficient availability of water, lack of modern technology, and insufficient income for investment.

Scientists at Embrapa-Cpatsa in Petrolina (with technical support from Institut Français de Recherche Scientifique pour le Développement en Coopération) have developed a caatinga-buffel-leucaena (CBL) system of livestock production for the semiarid region of northeast Brazil. This system utilizes caatinga (semiarid) vegetation on a minimum of 30 percent of a farm’s total area; utilizes drought-tolerant cultivated pastures under a rotational system to provide feed supply to livestock; takes advantage of hay and silage produced from protein/energy banks for supplemental feeding of animals during critical periods (e.g., drought); maintains a strategic reserve area with forage species of high drought tolerance to assure reasonable animal production during “subnormal” years; and interacts with other aspects of the area’s agroecological and socioeconomical farm production system.

This case study documents factors leading to development of the CBL system by examining the CBL system’s basic features and technical components; livestock performance under the CBL; such socioeconomic benefits of the CBL system as improved and more equitable distribution of income; and the sustainability of caatinga for animal production. Importantly, under the CBL there is less environmental and resource degradation than with current subsistence farming.
BRAZIL

Conflicts and dilemmas between survival and biodiversity: Designing a sustainable development plan for a semiarid region in northeastern Brazil

Eleonora Tinoco Beaugrand, Department of Economics, Universidade Federal do Rio Grande do Norte, Natal, Brazil (nora@natalnet.com.br)

reducing conflicts between long–term goals of sustainable development and short–term economic goals

This case study analyses the current “Plan for Sustainable Development of the Serido Region” of northeastern Brazil, particularly with respect to the ceramics sector, which is one of the region’s most important social and economic sectors. Many government and nongovernment institutions and stakeholders representing 28 municipalities in the region were involved in development and implementation of the plans. The ceramics industry is the primary source of jobs and income for local people in the region; few other employment opportunities exist for local people. However, industry practices have significantly degraded both terrestrial and aquatic resources of the region. Based on an analysis of the “plan’s” environmental, scientific, economic, social, political, and administrative indicators of sustainable development and their efficacy in achieving sustainable development goals, the study reveals broad participation by local people in the plan’s development and implementation. Poverty and lack of social and economic opportunities for local people of the region create pressures for regional policymakers and managers to focus on short–term employment and economic opportunities while taking necessary precautions to protect the long–term sustainability of the region’s environment.
Latin America and the Caribbean

BRAZIL

Biota/FAPESP: A Brazilian virtual biodiversity institute as a model for biodiversity conservation and sustainable use research programmes

Carlos Alfredo Joly, Departamento de Botânica, Universidade Estadual de Campinas, Campinas, Brazil (cjoly@unicamp.br)

Despite increasing awareness of its importance, information on biodiversity is not easily available. Too often, information is dispersed, fragmented, difficult to access, not integrated with other information, out-of-date, and underused. To help overcome such problems, in 1999 the Research Programme in Conservation and Sustainable Use of Biodiversity of the state of São Paulo, Brazil (Biota/FAPESP) and the Virtual Biodiversity Programme (www.biota.org.br) were established. The programmes are based on the premises contained in the Convention on Biodiversity.

The primary objective of these programmes is to study biodiversity of the state of São Paulo. Objectives focus on: understanding the processes that generate and maintain biodiversity; understanding the processes that threaten biodiversity; standardizing ways to gather and make information available to the public, policymakers and decisionmakers; ensuring easy public access to this information; and improving teaching standards on conservation of biodiversity and sustainable use.

All projects are linked through the environmental information system of the Biota/FAPESP. This system, in turn, is linked to a 1:50 000 electronic map of the state of São Paulo. These systems, which are freely available on the internet, are being used by state branches in charge of biodiversity protection and social and economic planning. Finally, the Biota/FAPESP has also launched an electronic peer-reviewed journal to publish research on conservation and sustainable use of biodiversity in the neotropics (“Biota Neotropica” www.biotaneotropica.org.br).
Managing biodiversity for recovering degraded mining areas in the semiarid zones of Brazil

Paulo César Fernandes Lima, Embrapa-Cpatsa, Petrolina, Brazil (pcf Lima@cpatsa.embrapa.br)

selecting multipurpose species
to aid recovery of areas degraded by mining

This study presents results of a project designed to analyse the processes of species and ecosystem recovery in an area degraded by copper mining and prospects for choosing multipurpose trees for recovery.

The first phase consisted of soil analysis, characterization of climate and vegetation, and descriptions of local and commercial farming systems. The second phase consisted of experimental planting of possible species for recovery; and the third phase validated innovative technological alternatives for rehabilitation of the degraded area.

Flora in the degraded mining area and surrounding unaffected areas were identified and characterized for their species, structure, frequency, abundance, dominance, value index of importance, vulnerability to mining operations, and potential for rehabilitation.

Thirty-five families, 60 genera and 85 species were found in the study area. Based on the value index of importance, the most important species were Caesalpinia pyramidalis, Commiphora leptophloeos, Schinopsis brasiliensis, Mimosa arenosa and Jatropha sp. The composition and distribution of trees and shrubs were heterogeneous but characteristic of the “caatinga” biome of northeast Brazil.

In the caatinga vegetation surrounding the mine, the survey identified 902 plants per hectare, 67 tree and bush species (30 families and 31 genera). The area directly affected by mine activities averaged 18 plants per hectare (two families, two genera and two species). The two species found in this area were Prosopis juliflora and Nicotiana glabra. The former had high frequency, abundance, and dominance values indicating evidence of invasion of the area degraded by mining. There is no evidence of invasion of Prosopis in areas unaffected by mining.

Of the species studies for possible use in recovery of degraded areas, the best results were obtained for Leucaena leucocephala and Prosopis juliflora, both of which are exotic. A decision was made to plant both species in recovery areas because they are fast growing and hence help to meet federal and state regulations requiring recovery of lands disturbed by mining. However, because Prosopis is a very invasive species it will be closely monitored. In addition, native tree, shrub, and grass species will be tested on areas disturbed by mining under different cropping systems for possible use in future recovery of degraded areas.
Latin America and the Caribbean

BRAZIL

Plants of Northeastern Brazil: A programme in sustainable use of plant resources

Ghillean Prance, National Tropical Botanical Garden, Hawaii, USA (gtolmieg@aol.com)

promoting sustainable use of plant resources for local people

The programme *Plantas do Nordeste* [Plants of Northeastern Brazil] is run by a consortium of Brazilian governmental and nongovernmental organizations (NGOs) in the region in cooperation with the Royal Botanic Gardens, Kew, England. It is led by the Brazilian NGO Associação *Plantas do Nordeste*, based in Recife in the state of Pernambuco. The goal is to promote sustainable use of the plant resources in the arid regions of northeastern Brazil. It operates under the motto of “local plants for local people.” Activities are divided into three subprogrammes: biodiversity, economic botany and information. The biodiversity subprogramme focuses on a basic survey of plants and vegetation types of the region to facilitate their identification and use. The economic botany subprogramme seeks to promote the sustainable use of regional plants. It consists of projects on medicinal plants, fodder plants, and fuel wood. The information subprogramme has set up a plant information centre in the botany department of the Federal University of Pernambuco in Recife that collects and disseminates information resulting from the other subprogrammes, so that it may be used effectively by those aiming to improve the region’s environment. More recently, the programme has focused on integrated projects that combine the elements of the different subprogrammes.
Capture and use of creeping fog water as a nontraditional water resource

Jorge Araya-Valenzuela, Departamento de Física, Universidad Católica del Norte, Antofagasta, Chile (jaraya@ucn.cl)

Northern Chile and southern Peru contain some of the world’s driest deserts. The growth of small villages and increased mining activities in this area is boosting demand for both surface and underground water resources. As a consequence, much floral and faunal biodiversity of the area is threatened or endangered because of diversion of water resources for human uses.

On some sites, it is possible to use artificial static fog collectors to capture creeping fog water for limited use. For more than 40 years the Catholic University of the North (UCN) has conducted experimental programmes to use creeping fog captured with fog collectors. The overall purpose of the programmes has been to increase availability of water for species and ecosystem recovery, establish new areas with endemic species cover, and assist in establishing small communities around stable (fog-collected) water resources or to supply some existing communities with such water.

This case study comprehensively describes creeping fog formation and characteristics; factors influencing collection of fog; different fog collector designs (e.g., utilitarian fog collectors, flat two dimensional fog collectors, and ecological fog collectors) and their technical advantages and disadvantages; and recommendations on which fog collectors are most efficient and economical in different environments and situations. Major emphasis has been placed on the use of fog water to minimize risks to threatened and endangered species from water scarcity caused by increasing human use of water resources.

Specifically, experimental result are presented for the use of fog-collected water for ecosystem recovery in the Paposo National Reserve north of the port of Taltal (Antofagasta); establishing horticulture and fruit orchards near Taltal; and a drinking water system in the village of Chungungo on the northern Chile coast. Overall, the study shows that fog collection for such purposes can be efficiently and economically developed and implemented.
Latin America and the Caribbean

CHILE

Importance of fog for arid and semiarid ecosystems and as an economical and social water resource in the Tarapacá region of Chile

Pilar Cereceda, Instituto de Geografía, Pontificia Universidad Católica de Chile, Santiago, Chile (dcereced@puc.cl)

assessing possibilities of using fog as a water resource to help conserve scarce water supplies in small fishing villages

Deserts located along the western coasts of northern Chile are often subject to fog. Water contained in the low clouds reaching these deserts creates a fragile ecosystem known as “fog oasis.” Recent studies have shown that fog can be used as an economical and social resource by collecting its water through artificial devices. Studies of projects using this water for human consumption have demonstrated (with varying success) that they can increase the availability of water for local people in water–scarce regions as well as contribute to the savings of water in conservation programmes.

Currently, there are three locations in Chile where fog water is being used as potable water and for irrigation. Scientific assessment of the potential use of fog water in these locations builds on previous studies in other areas. For example, Peru has an experimental fog project for regeneration of Lomas ecosystems; in the Canary Islands fog is used as a water source in national parks; South Africa, Namibia and Nepal are using fog water in poor villages; and additional studies are being conducted in Chile. Surveys conducted in the Atacama desert of northern Chile have found places with high yields of fog-water collection that can be used for different purposes. For more than seven years, a village of 500 people in this desert has had its water demands met by 100 fog collectors.

This case study reports on the possibility of using fog as a water resource in small fishing villages in the arid coastal region of Tarapacá, Chile, emphasizing the temporal and spatial distribution of fog, as well as fog’s water collection potential.
Latin America and the Caribbean

CHILE

Theoretical models of regeneration for medicinal plants: An example of the use of science in promoting sustainable wild-harvesting

Gloria Montenegro, Departamento de Ciencias Vegetales, Facultad de Agronomía e Ingeniería Forestal, Pontificia Universidad Católica de Chile, Santiago, Chile (gmonten@puc.cl)

evaluating plant resources used for medicinal plants threatened by overexploitation

Working closely with people selling medicinal plants in local markets, harvest areas were studied to calculate the biomass produced for local and commercial markets. Researchers observed the frequency of plant collection and shared that information with their local partners. Theoretical models for regeneration based on the location and dispersion of the plants’ renewal buds were developed. Studies on plant growth both in the field and clipping pots were conducted to evaluate post-harvest regeneration rates and plant response to biomass extractions. Models based on these studies led to predictions of potential plant regeneration for each of the species studied in different ecological zones on the Andes coast. Cultivation and reforestation programmes have followed the scientific studies.
Management and sustainable use of *Jubaea chilensis* (Mol.), the longest lived palm of the world

*Mauricio Moreno, Fundación para la Recuperación de la Palma Chilena, Santiago, Chile (info@fundacion.cl), and M. Paulina Fernandez, Departamento de Ciencias Forestales, Facultad de Agronomía e Ingeniería Forestal, Pontificia Universidad Católica de Chile, Santiago, Chile (pfernan@puc.cl)*

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restoration of *Jubaea chilensis* (Mol.)

and the associated sclerophyllous forests of Chile

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Chile's sclerophyllous forests have a high percentage of endemic floral species (many classified as endangered, threatened, or rare), and provide habitat for a rich diversity of birds, reptiles, as well as a few mammals. An important species of the forests is the Chilean palm *Jubaea chilensis* (Mol.), which is the world's longest–lived palm. Due to cutting of the palms for agricultural land clearing, the number of Chilean palms has decreased from an estimated 5 million to about 12,000 over the past 500 years. This case study describes the projects undertaken by the Chilean Palm Foundation, which was created with private-sector funding as a nonprofit entity to restore the Chilean palm and its associated sclerophyllous forests.

One project includes reproducing the palms in the foundation's nurseries, planting them on its own lands, and donating plants to schools, institutions, and local people. An important component of this project is an outreach and technology transfer programme that has now produced 200,000 seedlings of the palm, and 300,000 seedlings of 24 other species from the sclerophyllous forests, with a planned annual production rate of 100,000 new palms and 200,000 other native trees. A second project supports local communities that have shown interest in restoring their ecosystems by giving them technical training for the construction of nurseries and afforestation on degraded soils. Support for reestablishing the Chilean palm has been provided to Easter Island, numerous local communities, and local schools and hospitals. A third project focuses on increasing scientific research and collaboration on the Chilean palm (and associated ecosystems) in universities and institutions. Some of the collaborating institutions include the *Universidad de Chile* (Faculty of Forestry), *Pontificia Universidad Católica de Chile* (Faculty of Agronomy and Forestry, Faculty of Engineering), *Universidad Mayor* (Faculty of Agronomy and Forestry), technical institutions (e.g., INTEC), and such vocational training institutions as the *Instituto de Capacitación Profesional*.

The case study concludes with an assessment of strengths and weakness of using existing knowledge and techniques to implement basic actions to restore the Chilean palm and other species; combining expert and local knowledge of the trees and natural resources; and working with the private sector to better protect endangered species.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Latin America and the Caribbean

JAMAICA

Dryland farming in South St. Elizabeth, Jamaica

Vincent Campbell and Gerald C. Lalor, International Centre for Environmental and Nuclear Sciences, University of the West Indies, Kingston, Jamaica (lalor@uwimona.edu.jm)

lessons learned in achieving a balance between environmental protection and application of capital and labour in achieving social and economic goals

To deal with existing semiarid conditions, local dryland farmers in Jamaica have evolved (technologically speaking) relatively simple but effective dryland farming systems. Farmers have been assisted by Jamaica’s Ministry of Agriculture, the Jamaica Agricultural Society, private companies, and individuals. The systems are the result of collaborative approaches between government, local farmers, and other stakeholders in agriculture and environmental protection.

This case study describes systems of dryland farming that depend on economical crop selection, mulching, water storage, fallowing, crop rotation, soil fertility management, integrated disease and pest management, appropriate timing of operations to maximize advantages at the market place, and judicious use of capital and sharing of labor. The study also documents the role of government- and private-sector support for research and technology transfer in achieving effective systems of dryland farming.

The systems have changed a dry and sparsely populated area into a productive area where farmers now enjoy a relatively high standard of living compared to small farmers elsewhere on the island, and where commercial and local community stakeholders are more invested in increasing the area’s capacity to achieve social, economic, and environmental well-being.
Latin America and the Caribbean

MEXICO

Latin American Plant Sciences Network: Higher education programme for the development of plant sciences and conservation of biodiversity in Latin America

Susana Maldonado, Instituto de Ecología, Universidad Nacional Autónoma de México, Mexico City, Mexico (susana@ecologia.unam.mx)

increasing the number of qualified botanists capable of protecting the biodiversity of native flora

Many arid and semiarid areas in Latin America are losing native species and ecosystem services at an unprecedented rate due to such factors as ecosystem conversion, inefficient agricultural and grazing practices, and exploitation of timber resources. These factors often are driven by poverty, economic marginalization and undervaluing of natural resources, and low participation of local people in decisionmaking processes concerning the conservation and use of natural resources. In turn, these factors are exacerbated by constraints to educational opportunities at all levels. Despite the large amount of biodiversity in the neotropics, there is a dearth of human scientific and technical capacity. This case study describes the development and design of the Latin America Plant Sciences Network, which is a consortium of 23 academically prestigious institutions in Argentina, Brazil, Chile, Costa Rica, Mexico, and Venezuela that have worked together since 1988 to offer graduate level training to students from Latin America; organize scientific meetings and workshops; and undertake collaborative research projects. Through these activities, the consortium has helped to increase the number of well-trained people capable of protecting the biodiversity of the region’s native flora.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Latin America and the Caribbean

PERU

Genetic diversity, management and conservation of the Peruvian vicuña

Jane C. Wheeler, Coordinadora de Investigación y Desarrollo de Camélidos Sudamericanos, Lima, Peru (rrosadio@terra.com.pe)

demonstrating how advances in population genetics research are an important tool for monitoring efforts to preserve the vicuña

Results of population genetics research indicate that individual Peruvian vicuña populations are characterized by relatively low levels of genetic diversity and that high levels of genetic differentiation exist between these populations. Such patterns are commonly observed in threatened species with formerly large ranges that have become isolated from each other, and in species that have suffered drastic demographic contraction in recent generations. These patterns may be becoming more predominate in populations of the Peruvian vicuña and therefore should be taken into account in future conservation strategies designed to minimize further loss of genetic diversity within vicuña populations. In Peru, four demographically distinct vicuña population groups have been identified that should form separate management units: northwest Junin, south Junin, central Andes (Huancavelica to Arequipa) and Puno. Preservation of this vicuña genetic biodiversity is becoming critical. Although Peru’s current rational utilisation policy has produced an increase in vicuña numbers, demands for greater control over the species through construction of fences, intensive rearing and selection are growing. Such approaches are inherently unsustainable and represent a serious threat to survival of the vicuña. Population genetics research is an important tool for monitoring the impact of these activities and designing best management practices.
Impact of past and present metal mining activities on the distribution and survival of metal tolerant plants in Latin America

Rosanna Ginocchio, Departamento de Ecología, Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile, Santiago, Chile (erginocc@genes.bio.puc.cl)

assisting in the protection of metal tolerant plants before they are endangered or eliminated by mining activities

In most of Latin America, mining of metals is threatening or endangering many of the plant species surrounding the mines.

Few metal tolerant and metal hyperaccumulator plants (MTPs) have been reported in South America compared to other areas of the world. One reason is that there have been relatively few scientific studies conducted in the region on native vegetation existing in natural mineralized or metal polluted areas. However, as more studies of plants in Latin America’s mining areas are published, there is increasing evidence of MTPs. Detection of MTPs is important for people interested in conservation and sustainability because of the ability of the MTPs to clean, stabilize, and phytomine metal polluted soils.

Recent evidence indicates that arsenic–accumulating plants are growing near a copper mine in the Peruvian Andes; 11 nickel-hyperaccumulating plants have been reported in the serpentine flora of Goiás State, Brazil; and a copper-tolerant plant has been described growing near a copper mine in the Chilean Andes. South America is, however, a potential area where many more MTPs could be found, not only due to the presence of a high number of ore deposits and metal polluted areas (mines and their abandoned tailings and dumps), but also because of the region’s high and unique plant diversity. However, to date there has been a lack of funding to support scientific studies to locate MTPs. If this situation continues then the likelihood of finding more MTPs will remain small. Therefore, funding and capacity building to support research on the detection and study of MTPs that may exist in the region should soon be undertaken.
Latin America and the Caribbean

REGIONWIDE

Capacity building to conserve and sustainably use biodiversity of global significance in arid and semiarid regions of Latin America and the Caribbean

Leonard Berry, Florida Center for Environmental Studies, Florida Atlantic University, Palm Beach Gardens, Florida, USA (berry@fau.edu)

improving institutional partnerships and capacity for biodiversity conservation

Latin America and the Caribbean are well known as the site of great biodiversity, but attention has most often focused on the admittedly important world heritage of the tropical and mountain rainforests and wetlands of the region. Nevertheless, there is an increased need to improve funding, develop partnerships, and enhance capacity building to better protect biodiversity in the arid and semiarid zones of the region.

This report reviews investments in the conservation of biodiversity in the region; the need for improved networking of scientists; the need for networks to focus more efficiently and comprehensively on particular arid and semiarid ecosystems; the need for development of networks that make greater use of ethnoscientists; the need for more effective networks of scientists and public policymakers with educational institutions; the need for greater balance between regional, national, and global networks; and the need for institutional development to make greater use of practical but innovative communication methods and technologies to promote capacity building. Based on this review, the author recommends more effective processes to build on and expand the already sound capacity of the region to conserve biodiversity.
Examples of Conservation and Sustainable Use of Biodiversity in Arid and Semiarid Zones

Latin America and the Caribbean

REGIONWIDE

Barriers and methods to achieve institutional cooperation for implementation of sustainable development plans and strategies

Donald A. Brown, Office of Chief Counsel, Pennsylvania Department of Environmental Resources, Harrisburg, PA, USA (brownd@state.pa.us)

overcoming barriers for better cooperation between institutions

This study presents the results of a critical analysis of problems and prospects for implementing sustainable development strategies.

First is the failure to fix responsibility for rigorous interdisciplinary strategic planning to solve sustainable development problems; this can stem from a lack of institutional focus on strategic planning, or from institutional fragmentation about the scope of responsibilities.

Second is the failure to understand or consider what is necessary for implementation of sustainable development plans and strategies. Plans or strategies are often prepared by organizations that have no legal authority to implement them. Where cooperation is needed among many institutions to implement plans or strategies, they often are prepared without full agreement by all the persons who must implement them. This limits their efficacy.

Third is a failure to match the scope of scientific investigation with the scale of the problem. Sustainable development problems often transcend ecological boundaries and political jurisdictions. Yet decisionmakers who authorize the development of plans and strategies only have authority over decisions within their jurisdiction. For this reason, plans and strategies that match the scale of problems often are not implemented.

Fourth is a failure to build an information base that is practicable to use in implementation plans and strategies, particularly at different spatial and temporal scales. For instance, the United Nations Commission on Sustainable Development created a list of sustainable development indicators that are being used by many nations in a way that allows international comparison of success. Yet some countries have developed their own methods and indicators that cannot be aggregated at global scales because of incompatibility with the United Nations’ indicators.

Fifth is a failure to consider prior plans, decisions, or information in decisionmaking. Many international bodies meet and discuss problems with insufficient understanding of the prior legal or institutional decisionmaking that has considered the same or similar issues. For instance, for many years various international institutions have placed the conservation of fresh water on their agenda, including UNCSD, UNEP, WHO, UNDP, and the Global Water Forum. As each new institution has considered global water issues they have often begun deliberations without an understanding of prior decisions on the very same subjects under consideration.