Environment & Natural Resource Management

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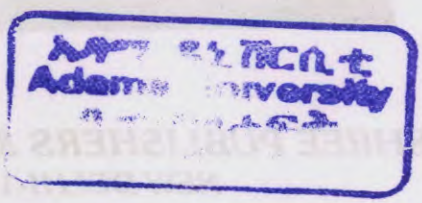

Preface

The science of environment and the practice of natural resource management are critical to our understanding of the Earth's ecosystems and our efforts to conserve them. This book attempts to bridge the gap between environmental science and natural resource management. It describes how concepts and approaches used by environmentalists to study communities and ecosystems can be applied to their management.

This book emphasizes the importance of thoughtfully designed and carefully conducted scientific studies to both the advancement of environmental knowledge and the application of techniques for the management of natural resources. It is aimed at natural resource managers, as well as graduate and advanced undergraduate students, who are familiar with fundamental ecological principles and who want to use ecological knowledge as a basis for the management of natural resources.

While writing this book, I have made references from various sources and have freely used the writings of outstanding scholars and researchers. I, hereby, acknowledge their contributions with sincerity and gratitude.

I am thankful to the publishers for bringing out this book within a very short period.

N.C. Gautam

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INTRODUCTION

Environmental management systems can assist an organisation to meet its increasingly heavy burden of responsibility for the future condition of our world environment. In many cases, the introduction of an environmental management system can also aid cost savings, and reduction of environmental liability.

There are a number of standards available, around which we can model our Environmental Management System, or EMS. On the international scene we will shortly have ISO14001. This standard is expected to be issued during 1996, and forms part of the ISO14000 series of standards providing not only a specification but guidance and advice on a wide range of environmental issues including auditing, labeling, life-cycle assessment etc.

At the European level we have EMAS, or the Eco-Management and Audit Scheme. This was introduced by a European Union council regulation (No.1836/93), requiring implementation in all European Union Member States. EMAS was formally introduced in the United Kingdom in April 1995. Although the scheme itself is mandatory in all EU Countries it is, at present, a voluntary scheme for individual companies who must be within the industrial sector. It is intended to provide recognition for those companies who have established a programme of environmental action designed to protect, and to

continuously improve, their environmental performance.

The UK has had its own EMS Standard, BS7750, since 1992 and increasing numbers of companies, within and without the UK, have achieved Registration to it. The requirements ofBS7750 are little different to ISO 14001; it is therefore suspected that BS7750 may cease to be relevant once its international brother is born.

Waste of resources and creation of pollution are normally indications of areas for significant improvement. All of the EMS standards stress the need for continuous, never ending, improvement in striving to protect the environment, not only for ourselves but for future generations to come. Achievement of registration to an Environmental Management Scheme should impress many groups of people, including:-

— Insurers

— Customers

— Employees

— Investors

— Regulators & Statutory Bodies

— Environmental Groups

It may also concern other groups of people, particularly your suppliers and sub-contractors, who may fear that in your drive to improve environmental performance you may cast a critical eye on their environmental achievements. It is in this way that the cause of Environmental Management Systems has spread to date, and will continue in the future. There is a great parallel in the development of ISO9000 Registration throughout the world, spurred on by customers expressing preference to suppliers.

Benefits of Environmental Systems

The benefits of an effective environmental management system can be realised in:-

— Cost Savings
— Customer Requirements
— Corporate Image
— Legislation
— Investment
— Insurance
— Marketing Opportunities

Cost Savings

Successful environmental management will evaluate all opportunities for cost savings, the most common benefits derive from a review of resource/ energy utilisation and its efficiency, forcing full consideration of alternative energy sources and their cost effectiveness. The other primary element will be minimisation of waste and result and cost of disposal.

Customer Requirements

Many companies have addressed the management system for customer requirements related to quality and ISO9000. The range and diversity of customer needs and expectations is constantly growing with many customers increasing preference for use of suppliers and sub-contractors who can demonstrate that they are good environmental citizens. No customer would want to risk a tarnished reputation (or non-compliance to legislation) from the poor environmental performance of their suppliers and sub-contractors. The safest option for the customer is to use suppliers and sub-contractors who can demonstrate their positive environmental performance.

Corporate Image

The ability to demonstrate a responsible environmental attitude can dramatically improve the image of the corporation fostering

better relations with the company's stake holders. Even more importantly, adverse publicity about the organisations environmental performance is always highly damaging.

Legislation

The scope and severity of environmental legislation is ever increasing. A management system that ensures recognition of the requirements and compliance with them will ensure that fines are avoided and staff are not imprisoned in addition to avoidance of the publicity that inevitably follows an environmental prosecution.

Investment

The investors are increasingly moving to green portfolio's, and it is interesting that the financial performance of these portfolio's has been good in comparison to more traditional investment. In seeking additional investment for the organisation it is sensible to ensure the widest scope and this is only aided by a demonstrably sound environmental performance.

Insurance

Insurance companies are fully aware of the risk to their policies from poor environmental performance of the insured. Companies with a sound and effective environmental management system are able to demonstrate that they pose less risk to the insurance company and creates a negotiating tool for lower premiums. Some insurance companies now require an environmental audit of the company prior to agreeing cover.

Marketing Opportunities

All companies seeking growth obviously want their product and services attractive to a widest possible market. Poor environmental performance will encourage many potential

customers to decide not to buy from the company, good environmental performance will ensure continuation of the widest possible market.

Environmental Management Standard

An environmental management standard or system or protocol attempts to reduce environmental impact as measured by some objective criteria. The ISO 14000 standard is the most widely used standard for environmental risk management. The ISO 19011 standard explains how to combine this with quality management.

Other EM systems (or EMS) tend to be based on this standard and to extend it in various ways:

— Natural Step focuses on basic sustainability criteria and helps focus engineering on reducing use of materials or energy use that is unsustainable in the long term

— Natural Capitalism advises using accounting reform and a general biomimicry and industrial ecology approach to do the same thing

— US Environmental Protection Agency has many further terms and standards that it defines as appropriate to large-scale EMS

— The UN and World Bank has encouraged adopting a " natural capital" measurement and management framework.

— The European Union Eco-Management and Audit Scheme (EMAS)

Other strategies exist that rely on making simple distinctions rather than building top-down management "systems" using performance audits and full cost accounting. For instance, Ecological Intelligent Design divides products into consumables, service products or durables and unsaleables - toxic products that no one should buy, or in many cases, do not realize they are buying. By eliminating the unsaleables from the

comprehensive outcome of any purchase, better environmental management is achieved without "systems".

Sound Water Management

UNESCO's contribution to the development of approaches for sound water management is primarily through the International Hydrological Programme (IHP) and through the UN system-wide World Water Assessment Programme (WWAP), as well through the Man and the Biosphere (MAB) Programme. At the regional level, in the Pacific, a series of studies have been carried out under the aegis of the IHP Pacific Working Group, including work on catchments and communities (Solomon Islands, Vanuatu), groundwater pollution (Tonga) and atoll groundwater recharge (Kiribati).

Field work in Kiribati has focused on freshwater groundwater lens recharge at Bonriki, part of the coral island of South Tarawa, including assessment of ground-water recharge in the presence of coconut trees and salinization effects caused by over-pumping of groundwater. Work at South Tarawa has also served to highlight two very widespread problems in freshwater management in small island situations: those of drought and of conflicts in groundwater use and management.

Placing work on water resources within the local socio-cultural context has included strong community involvement in the monitoring of groundwater pollution on the island of Lifuka in Tonga and the use of performance theatre in communicating with local people on water quality issues in Vanuatu. Future work proposals were elaborated at the IHP-SOPAC (South Pacific Applied Geoscience Commission) regional meeting in Fiji in October 2003. A multi-institutional partnership has been agreed for a long-term regional training programme for hydrological technicians and scientists.

Natural Hazards and Disasters

Many small island developing countries are particular

vulnerable to various types of natural hazards and disasters: volcanic eruptions, earthquakes, tsunamis, landslides, floods, hurricanes and cyclones. To the extent that more than half of the 25 most disaster-prone countries are SIDS. UNESCO's work focuses on efforts for identifying areas subject to natural hazards, improving risk assessment methods, and encouraging preparedness for hazardous events.

Work in the Pacific has focused on support to community-driven natural disaster/hazard reduction and mitigation in Tonga, Vanuatu and elsewhere, in collaboration with Massey University in New Zealand and other partners. For many years, UNESCO's Intergovernmental Oceanographic Commission (IOC) has sponsored the International Coordination Group for the Tsunami Warning System in the Pacific (and its work of disseminating tsunami watches, warnings and advisory bulletins), and the International Tsunami Information Center, which collects data and maintains records on tsunamogenic events.

For the past decade-and-a-half in the Caribbean, within a project on coastal and beach stability in the Lesser Antilles, coastal planners, governments and NGOs have been monitoring beaches and coastlines to determine wise developmental practices, in the face of the effects of hurricanes and storm surges on coastal strips. This work is now being extended to other island regions. Also in the Caribbean, a number of collaborative activities have been undertaken on educational and communication aspects of disaster mitigation, such as the preparation of a disaster preparedness manual for Caribbean schools through a joint initiative with the Caribbean Disaster Emergency Response Agency.

For many small-island countries, one important issue at the interface of education, science, culture and communication is the following: How can scientific knowledge and understanding, local content and the use of local languages be woven together in the warp and the weft of the educational tissue of the country?

One example of a response to this generic challenge is a volcano-awareness programme for schools on Niuafo'ou Island in the Kingdom of Tonga, undertaken as part of UNESCO's activities of natural disaster preparedness and prevention. Niuafo'ou is a still active volcanic island, whose periodic eruptions led to the destruction of many plantations and individual villages. As a result of the 1946 eruption, Niuafo'ou was evacuated, with the government finally allowing the islanders to return home in 1958.

Informing the young people of their volcanic heritage - and preparing for future hazards - has been approached through a project sponsored by UNESCO-Apia. A series of innovative learning materials have been prepared and tested, including a teacher/student resource booklet and four large format posters. These materials provide information on volcanoes in general and on Niuafo'ou in particular, and suggest educational and learning activities such as an evacuation game, community mapping and discussions on response strategies in the event of future eruptions.

In the late 1980s, the increasing evidence of sea-level rise was a major trigger in focusing world-wide attention on the implications of global climate change and on the special vulnerabilities of many small-island states to climate change. The Maldives took the initiative for developing the Alliance of Small Island States (AOSIS), which in 1989 adopted the Malé Declaration proclaiming that 'Sea-level rise threatens the very survival of some small island states' and pressing the international community to take immediate and effective measures to reduce the greenhouse effect.

A decade-and-a-half later, the adverse effects of climate change and sea-level rise continue to threaten the sustainable development, livelihoods and existence of many small-island nations. Faced with the implications of available scenarios, many have drawn up plans to protect their coastlines, through such measures as the construction of dykes. The Maldives, with its densely populated main island of Malé, has constructed an

artificial island for some of its citizens. And some Pacific islands, like Tuvalu and Kiribati, have been discussing plans for relocating their people to Australia, New Zealand and elsewhere within the next half century.

Meanwhile, the international scientific community has strived to advance the methods and procedures for the long-term monitoring and improved understanding of global environmental change, as a support to policy and management action.

Stewarding Coastal and Marine Resources

Small-island nations have a large coastal area to land-mass ratio; they are largely coastal entities. Their coastal environment is therefore particularly important, both socio-economically and culturally. Typically, there are high levels of conflict in the demands for coastal space and its resources. High and increasing population densities along the coast, as well as the increased development of economic sectors such as tourism, often accentuate this conflict.

For the size of their land mass and population, small-island nations often have large marine exclusive economic zones, which have vastly extended the fisheries and other marine resources available to small island developing states. Potential benefits may be great. But so too are the obstacles and challenges faced by the countries concerned in seeking to grasp and optimize these potential benefits. For both terrestrial and marine environments, difficulties in planning and implementing effective integrated approaches to resource management are reflected in over-exploitation of particular resources, pollution and degradation of land and water ecosystems, and acute conflicts between competing resource uses.

Within UNESCO, the IOC provides a main focus for improving scientific knowledge and understanding of oceanic and near-shore processes. Through the organization and coordination of scientific programmes and projects, support is

provided to Member States in building-up capacities and in the design and implementation of policies for the ocean and marine coastal zones. Activities include a programme on ocean sciences, with three main interactive lines of work: oceans and climate; science for ocean ecosystems and marine environmental protection; and marine science for integrated coastal area management.

Among the topics addressed are ocean carbon sequestration, benthic indicators, coral bleaching and reef monitoring, land-ocean-atmosphere biochemistry, harmful algal blooms, pelagic fish populations. Other initiatives include the testing of indicators as a tool in integrated coastal area management, participation in the multi-institutional Global Coral Reef Monitoring Network, and co-patronage of the Global Forum on Oceans, Coasts and Islands, created to reinforce the implementation of commitments made at the World Summit on Sustainable Development in 2002.

Also within the IOC, the International Data and Information Exchange programme facilitates and promotes the free exchange of oceanographic data and information amongst Member States, and also assists countries in capacity building for the purpose of managing and applying available data. Capacity enhancement through partnerships with the global community is not only a cross-cutting theme within IOC, but is central to the Training, Education and Mutual Assistance (TEMA) programme with its aim of developing local expertise and capacity at all levels in the areas of marine science and resource management. Major success stories have been the 'Training Through Research' programmes conducted at sea on board research vessels, and the 'distance-hands on' training activities on harmful algal blooms.

Coastline changes due to natural processes and human intervention represent a major concern to coastal planners in small islands the world over, and indeed of ordinary citizens who have real or potential interests in beaches and seaside property. In the Caribbean region, one collaborative research activity has focused since the mid-1980s on issues related to

coast and beach stability. Methods have been developed for the measurement of shoreline changes, and practical guidelines prepared and tested on what can be done in response to disappearing and degrading beaches.

Among the products of this work is a series of ten illustrated booklets on shoreline change in Caribbean islands. The booklets represent the dedicated work of government agencies, non-governmental organizations, teachers, students and individuals. Together, they have carefully measured the changes in their beaches over a number of years, and have combined scientific research and monitoring with educational and environmental stewardship activities of various kinds. Each booklet combines generic and island-specific information, on such issues as natural and human forces that affect beach areas, national initiatives to monitor and manage changes, recommendations on wise practices for a healthy beach. In addition to Antigua & Barbuda, individual booklets have been prepared for Anguilla, Dominica, Grenada, Montserrat, Nevis, St Kitts, St Lucia, St Vincent & the Grenadines, and Turks & Caicos Islands. And more recently, this work of monitoring and measuring beaches has been extended to small islands in other regions, including the Cook Islands, Palau and the Seychelles.

Caring for Island Biodiversity

UNESCO's interest in biological diversity dates back to the early days of the Organization, under its first Director General, biologist Julian Huxley. Among the early activities was joining with the French Government and the Swiss League for Nature in the founding of IUCN, the World Conservation Union, in 1948. In terms of island biodiversity, UNESCO's continuing concern is rooted in two complementary international initiatives for the conservation of biological diversity.

The Convention for the Protection of the World's Natural and Cultural Heritage is a binding legal instrument, which provides a permanent legal, financial and administrative

framework for international cooperation in contributing to the protection of the world's natural and cultural heritage. The focus is on unique sites of outstanding and universal value. The World Heritage List includes sites listed specifically for their biological processes and biodiversity values such as two sites in Cuba, Mornes Trois Pitons National Park (Dominica), Galápagos National Park and Marine Reserve (Ecuador), Pitons Management Area (St Lucia), Aldabra Atoll and the Vallée de Mai (Seychelles) and East Rennell (Solomon Islands).

The World Network of Biosphere Reserves, within the Man and the Biosphere (MAB) Programme, currently comprises 459 sites in 97 countries and territories, including Cuba, Dominican Republic, Mauritius, US Virgin Islands. At best, biosphere reserves are sites of excellence to explore and demonstrate approaches to conservation and sustainable development, with associated research, monitoring, training and education and the involvement of local people as the driving force for conservation.

In addition to these two concepts and tools for promoting the in situ conservation of biological diversity, other activities include studies on marine living resources within the IOC (e.g. coral reefs, benthic fauna, harmful marine algae), work related to the educational and ethical dimensions of biodiversity, and issues at the interface of biological diversity and cultural diversity.

Biodiversity conservation in small islands has also been addressed in a range of activities within the Coastal Regions and Small Islands (CSI) Platform. These include contributions to the discussion forum on wise coastal practices and field experience in such locations as Portland Bight in Jamaica, Trobriand Islands in Papua New Guinea, Saanapu-Sataoa in Samoa, Cousin Island in Seychelles, Chumbe Island in Tanzania and Surin Islands in the Andaman Sea, Thailand.

Renewable Energy

The development of alternative energy systems is a crucial issue

for many small islands. UNESCO's long-standing work on harnessing clean energy sources was boosted in the 1990s by the World Solar Summit process and subsequently through the Organization's contribution to the UN World Solar Programme. Capacity building aspects include the Global Renewable Energy and Training Programme (GREET) and a series of learning materials on new and renewable energies.

An ongoing initiative of UNESCO and UNDP - through their respective Apia offices, and in collaboration with SOPAC, USP and other bodies - provides support to a range of regional and national Pacific sustainable energy projects, such as a national energy policy and strategic action plan for Tokelau, options for uninterrupted power for Apolima Island (Samoa), increased use of renewable energies in the Cook Islands and training in photovoltaic solar home systems.

Toolkits have recently been published on such topics as solar voltaic systems and geothermal energy. A video and associated booklet (Rays of Hope) highlights the importance of renewable energy in the Pacific, with interviews and project insights from several countries.

— In Kiribati, solar panels power rural health centres and remote radio-telephone sites.

— In Fiji, a village cooperative runs a small-scale hydro-electric project providing electricity for over 200 homes in a settlement deep in the interior of the main island.

— In Papua New Guinea, a hybrid renewable energy system (involving wind turbines and solar panels) provides an independent supply of power to a highlands school.

— In Samoa, a medium-scale hydro-project in Afalilo on the main island of Upolu has resulted in a switch in the energy supply feeding a hydro-electric power plant, from 20% hydro and 80% diesel to 80% hydro and 20% diesel.

— In the Cook Islands, coconut oil is being used as fuel in a normal diesel engine, and has been used in Vanuatu to fuel

buses, taxis and other vehicles, as well as generators that power a hydroponics project (growing plants in a medium other than soil). Given that nearly every Pacific island country has a large supply of coconuts, the fact that diesel engines and generators can be run on coconut oil holds exciting possibilities for the future of renewable energy in the region.

Future UNESCO work on renewable energy includes support to a capacity building programme in the Caribbean.

INSULA and insular energy

Among the international NGOs that work closely with UNESCO, the International Scientific Council for Island Development (INSULA) has a strong programme on renewable energy, in Europe and the eastern Atlantic in particular. This work includes the organization of international conferences and the diffusion of conference publications and other information materials, such as those related to an Island Solar Summit and an associated Island Solar Agenda, a Euro-Caribbean conference on sustainable energies and follow-up discussion forum, and an international conference on renewable energy systems for islands, tourism and water desalination.

Several issues of INSULA's International Journal of Island Affairs have been focused on renewable energy, such as policies and strategies for desalination and renewable energies and biosciences and biotechnologies.Other INSULA-sponsored activities include technical support to renewable energy projects at the field level. An ongoing example is that on promoting energy self-sufficiency for El Hierro in the Canary Islands. This involves a three-pronged programme of energy saving, electricity production and transport, with support from the European Commission and a consortium of partners coordinated by the Instituto Tecnologico de Canarias.

Natural Resource Management: A Case Study of United States

In US, the National Park Service Organic Act of 1916 directed the Park Service to preserve these resources and to leave them unimpaired for the enjoyment of future generations. As a result of a number of factors, including the size of the park, a shortage of personnel available to study the environment, and the status of the monument as a historic site, the management of natural resources remained secondary to the rehabilitation of the ruins and the interpretive program. In the last two decades, however, the Park Service has been broadening its responsibilities at Fort Union. The conservation of the physical environment is becoming a priority at the monument.

For years, natural resource management was nonexistent at Fort Union. Established to preserve the remnants of an old military post, the monument, more like a history museum than a scenic park, concentrated its efforts on management of the cultural resources. Even if there was an interest in the park's environmental aspects, the small permanent staff --usually three to four persons—limited the park's ability to conduct any large-scale scientific research. In contrast to many other units in the park system, Fort Union occupies a small area encircled by vast private lands. In the beginning there was no immediate need to consider a natural resource management program. Accordingly, the Park Service simply reacted to most natural resource issues. It responded to them only when nature posed an impending threat to the ruins.

A passiveness and unsophistication characterized all of the park's early decisions and activities in dealing with natural resources. For a long time, natural resource management and protection had been synonymous, encompassing such actions as suppressing fires, controlling floods, stopping trespassers, and guarding the flora and fauna from damage. Although Superintendent Kittridge Wing lacked any experience whatsoever in natural resource management, his intuition told him to protect

the integrity of the fort as much as possible. Intended to preserve the ruins, not the environment, some of the measures implemented by his administration nonetheless benefited the natural world of Fort Union.

To save the remains of the old fort, the monument lost no time in enclosing its newly acquired property. Since the last of the troops marched away from the post in 1891, the Union Land and Grazing Company had allowed its cattle to feed freely in the fort area. Gradually the land became overgrazed; certain plant species increased at the expense of others, leaving the land in poor condition. After regaining control of the area, the National Park Service prohibited grazing. Wing decided to fence the monument's boundaries. In April 1956, he secured enough funds to fence the territory. Two months later, the regional office granted a $5,048 contract to Steve Franken of Las Vegas. Following the marking stakes set by Regional Engineer George Johnston, Franken fenced both sections within five weeks. The final exclusion of stock assured the recovery of the vegetation.

It was much harder to exclude fire, particularly unpredictable wildfires, from the park. This destructive natural force often posed a threat to the ruins. As early as January 1956, a wildfire engulfed 100 acres of short-grass sheep pasture ten miles south of the park, along Highway 85. Greatly concerned, Superintendent Wing observed, "if such a burn can happen in January in short grass, the alarming possibilities of a warm-weather burn in the long grass at Fort Union are evident." There was an urgency to prepare for fighting wildfire, which could occur at anytime and anywhere. The following month Wing contacted the regional forester in regard to a fire fighting jeep for the monument. Although the regional office had promised to deliver a jeep, it ruled out any hope that the Park Service would furnish a tank and pump equipment. Because of a previous agreement in which the Union Land and Grazing Company donated all of the needed fire-fighting equipment, the Park Service agreed only to maintain the property and personnel at the site. Thus, Wing's continuous appeal for help did not change

his superior's mind. For quite a while, Fort Union had little fire equipment.

Despite little assistance from Santa Fe, Fort Union tried its best to cope with the problem. In August 1957, Wing, in cooperation with the Union Land and Grazing Company, made arrangements with the New Mexico State Highway Department to rent a grader to create firebreak lanes along the entrance road. In addition, the visitor area of the monument received firebreak lanes on three sides with Wolf Creek forming a natural defense on the western side. The measure reduced the fire threat from outside. In 1958, a wildfire on the adjacent ranch property burned 200 acres. remaining calm, the park employees trusted to the utility of the firebreaks.

Nevertheless, the park was vulnerable to any fire hazard within the monument's boundaries. This situation did not change until 1959 when Fort Union got its first running water system. In January, the Star & Cummins Company of Albuquerque installed a 50,000-gallon water tank in the northwest corner and laid all the pipes to the main sections of the monument. The modern water system provided not only drinking water for the employees but fire protection for the previously unprotected ruins. Hose houses were erected at each fire hydrant. They increased the park's fire-fighting capabilities. Meanwhile, the park administration continued to highlight weed control and personnel training. The accumulation of dry weeds in arroyos and along the fences became fire hazards and required constant removal. Superintendent Homer Hastings hired Margarito Lovato and his team to mow undesired plants. In the fall, the New Mexico Highway Department again helped clean the firebreaks along the entrance road and inside the eastern edge of the monument. Also, Hastings conducted a fire control inspection and instructed the employees on the proper use of the fire-fighting equipment. By the end of the 1950s, the monument staff had acquired the basic skills and equipment for fire control.

In managing water resources, Fort Union encountered a different situation. The problem was one of scarcity rather than

abundance. The operation of the monument entailed furnishing a supply of water adequate for the needs of both the employees and visitors. A small spring meandering in the gully just west of the Third Fort could not meet the demand of ten-gallon-per-minute. The Park Service had to find other sources. To determine the feasibility of obtaining a ground water supply, the Park Service requested that U.S. Geological Survey study and assess ground water conditions. In addition to the field survey in July 1956, samples of well and spring water were sent to the laboratory in Albuquerque for chemical analysis. After the study, the surveyors affirmed the quality and quantity of ground water in the area. Later they helped select a suitable location for the well.

As the first scientific study of the monument's natural resources, the survey gave people a better understanding of the fort's environment. While they searched for water, geologists examined various aspects of the park's geography, geology, and topography. The essential motive of the survey, however, came from a need to acquire water, not from a desire for more knowledge. As soon as fresh, pure water gushed out of the well, the Park Service lost interest in learning more about the area's environment. Accordingly, the Regional Office failed to conduct another scientific study on the natural resources at the monument for another 14 years.

The pragmatic and utilitarian approach to natural resources also guided erosion control and landscaping. Although annual precipitation measured only 18 inches, occasional rainfalls could leave their distinct mark on the once overgrazed land, washing away topsoil and creating small ravines. As a by-product of the ruins stabilization work in 1957, Superintendent Wing initiated efforts at erosion control by dumping unwanted earth and broken bricks into a gully at the northeastern corner of the Third Fort. The work eased the erosion problem for a small section. Except for this experiment, there is no record showing any other erosion control in this early period.

During the construction of support facilities, bulldozers made people realize the need for landscaping. In Wing's view, "a great amount of regrading and reseeding" in the residential and visitor center areas was "required to make the environs of the new homes presentable." Paul Gensemer of Las Vegas received a contract to beautify the natural scenery of the park. Although the Park Service expected him to complete the work before the formal dedication of the monument in June 1959, he did not meet the deadline. By the end of August, with exception of four loads of manure scattered over designated places, no progress occurred. In the following month, the Park Service terminated the contract, and later awarded it to James Vander Sys, a nurseryman from Santa Fe. Securing a number of Apache plum trees, salt bushes, and sumacs in Watrous, he planted them around the new visitor center and the residences. On April 29, 1960, he fulfilled his contract.

Leaking sewer water caused by the inconsistent construction activities was another problem. It remained difficult to get the newly completed sewer lagoons to hold water due to the porous soil in the area. No sooner did the water enter the lagoons than it soaked into the ground. In the spring of 1958, Acting Superintendent George Cattanach made arrangements with Fort Union Ranch to put a dozen horses, loosely roped together, into each lagoon for a few hours to help compact the loose soil on the bottom. This method proved effective, and the lagoons began holding water in a sufficient quantity to permit them to function properly.

The park administration realized the impact of nature on cultural resources. Wind, rain, snow, hail, drought, and fire threatened the historic structures at Fort Union. To protect the ruins, the monument staff had to pay attention to the area's natural resources. Although none of them had any formal training in natural resource management, their daily actions, as mentioned above, benefited the environment. Meanwhile, the fort sought to collect weather information by recording daily temperatures, wind speeds, and precipitation. In May 1957, Fort Union began

submitting monthly precipitation reports to the Albuquerque Office of the U.S. Weather Bureau, in the hope of encouraging a systematic study of the climate of the Mora Valley.

The monument carried on its traditional trouble-shooting strategy for handling natural resources into the 1960s. In the new decade, this passive and reactionary attitude still dominated all the decision-making processes. As long as the ruins and other man-made structures were safe, there remained no clear agenda for natural resource management. This did not forestall the fort administration in improving its ability in certain fields such as fire control. For example, in 1960 an additional tank and slip-on pump arrived at the fort, supplementing the existing fire equipment. Six years later, a new fire attack unit consisting of a 110-gallon water container and a one-horsepower pump replaced all existing equipment, which had proved unreliable in cold weather.

Meanwhile, weed control efforts continued. The maintenance crew constantly inspected and cleaned the fire-breaks. Sometimes they had to work extra hours due to excessive weeds and grass caused by unusually wet weather. In August 1963, about six inches of rain fell, damaging the fire-break and the service roads north and east of the Third Fort. The maintenance crew quickly repaired them but correcting the soil erosion was beyond the park's capabilities. Again in 1965, more than 22 inches of precipitation, 15 percent above normal, resulted in abundant plant growth, which became a fire hazard. After failing to control weed growth in the summer, the maintenance workers had to conduct a controlled burn inside the foundation outlines of the historic buildings.

The growing interest in natural resource management at Fort Union resulted from the changing cultural climate in the United States. The passage of the Wilderness Act of 1964 announced the third natural preservation movement, following those of the Progressive and New Deal eras. This time, the noble cause attracted powerful grassroots support. Throughout the

second half of the sixties, Americans, led by burgeoning environmental groups like the Sierra Club and the Wilderness Society, began to introduce environmental agendas into both local and national politics. The entire country articulated concerns about the state of America's physical environment. The "Keep America Beautiful" campaign that Lady Bird Johnson initiated during her husband's presidency educated the public on the issue. Environmental movements won a significant victory in 1970 when the federal government proclaimed "Earth Day."

Americans cared about their land and the Park Service responded to the nation's call. The tone of the era made the agency reconsider its priorities and responsibilities. The MISSION 66 program was designed to provide visitors with high standard services that would encourage maximum enjoyment for those who used the parks. In 1966, the 80-million-dollar program ended successfully. However, an increase in visitation brought a need to protect the natural resources from the depredations of people. If the Park Service hoped to continue quality service in the future, the natural resources in its domain required more attention. After a decade in which the use of the nation's parks overwhelmed the system's capabilities to preserve its resources, Park Service policy began a dramatic shift in the opposite direction.

Astute officials in Santa Fe lost no time in implementing Washington's policy. Recruiting enthusiastic young preservationists armed with the latest scientific knowledge, the Southwest Region began to implement various environmental programs. As early as 1969, it launched a campaign for environmental awareness and education. Regional Environmental Education Coordinator William Brown arranged a field exercise, in which people contributed their ideas and suggestions about the program, at Bandelier National Monument on February 27 and 28. Representatives from the different park units in New Mexico, including Fort Union, attended the meeting, and the participants were "imaginative and positive in their commitment

to the environmental management concept." Each unit drew up its own plan.

In comparison with its counterparts, Fort Union's plan for environmental education appeared a little sketchy but practical. According to the plan, the staff was going to discuss the issue during daily coffee breaks and scheduled monthly meetings, with the hope that various themes for natural resource management could be developed before the end of 1969. In the following year, the monument would create an environmental study area for the use of Las Vegas schools. Thus, students would gain first-hand experience in the program. Also, Superintendent Hastings contacted the local agency of the Forest Service and Highlands University in order to obtain their advice.

The environmental education program continued through the early 1970s. After Superintendent Hastings' retirement, park ranger Robert Arnberger carried on the unfinished mission, laying the groundwork for the establishment of an environmental study area at the First Fort. Like his predecessor, he solicited the local schools and college for support. With the help of professors Werner Muller and Bob Lessard, an introductory course on the environment became a part of the teachers' preparation program at Highlands University. A group of public school teachers also showed an interest in taking an active role in the program.

Applying the same tactics used in the interpretive program to natural resource management, Fort Union sought to build close relations with the community. The park personnel frequently contacted preservation organizations such as the Sierra Club and the Adelante Conservation to recruit assistance. Arnberger was invited to speak to the local Sierra Club. These contacts and meetings helped the park determine its agendas and goals. Meanwhile, environmental education materials were distributed at the visitor center. As a result, both the Park Service and society benefited from the environmental education program. It strengthened the public's belief in conservation. For the first time, the monument devoted much time to environmental issues.

Indeed, a balance between cultural resource and natural resource management began to emerge.

As natural resource management formally occupied the fort's administrative calendar, a series of actions involving preservation and research occurred at the site. One of the priorities was soil conservation, because erosion threatened the safety of the historic structures. Every cloudburst washed away dirt and created unwanted ravines in the park. Although Fort Union occasionally conducted a few emergency measures to fight erosion, the problem was beyond the park's capabilities. It had neither the money nor sufficient knowledge to retain the soil. This situation lasted until 1970 when the National Park Service addressed the issue in a serious manner. In November, Assistant Park Service Director Edward Hummel sent to the regional headquarters guidelines for soil and moisture conservation at each unit. Washington also agreed to appropriate more funds for such purposes.

Under the guidance of Washington and Santa Fe, Fort Union started planning soil erosion control. For the first time, the Park Service asked the experts to conduct a systematic study on both the conditions of, and the solutions to, soil erosion. In October 1973, U.S. Soil Conservation Officer Harold Dineen inspected the situation of arroyo erosion at the monument and outlined the necessary measur es. According to his suggestions, masonry check dams and ripraps should be placed in arroyos to stabilize the banks. In the following year, the maintenance crew experimented with his methods and filled some of the arroyo heads with rubble and debris. Their work proved effective against the severe summer storms.

The preliminary research and experimentation led to a well-planned and funded project for soil erosion control. In 1975, Fort Union and the U.S. Soil Conservation Service Mora-Wagon Mound District reached a cooperative agreement. It required the district to prepare a land inventory map of Fort Union National Monument, showing the soil, water, and vegetation potentials and limitations. Also, the conservation officers were willing to

supply available technical assistance and information on how to treat the land. In return, the monument followed the district's instructions and recorded data about its soil, water, and vegetation. The chief beneficiary of this agreement was Fort Union, which received a detailed proposal for soil erosion control.

Designed by conservation specialist Gary Storch, the proposal detailed work that was to occur in two stages. During the first year it focused on diverting water. Sheer vertical arroyo banks would be sloped and cut to no greater than a 2:1 slope to limit damages from runoff to downstream areas. Several new waterways with erosion-resistant rock lining were to be constructed to help dispose of large quantities of runoff water more efficiently. For 1976, the second season, the main objectives were rack building and grass seeding. Certain spots would receive either wooden posts or metal bars to catch debris in the arroyos and reduce the speed of flux after a rain. But nothing was more effective than grass cover. Thus, the plan suggested that workers seed the disturbed sections with native grasses such as blue grama, little bluestem, and western wheat. Careful planning was the first step toward success.

Meanwhile, the Park Service received funds for a number of projects from the Economic Development Administration as part of the Job Opportunity Program. Fortunately, Fort Union was a chief beneficiary, and got a lion's share of the funds with $71,000. The unexpected funds enabled the monument to hire twenty unemployed veterans from Mora County and to execute its elaborate scheme for erosion control immediately. Following the plan, the workers accomplished their assignments and went home before Christmas. In the spring of 1976, eleven returned for the second season. They labored through early December until both the Job Opportunity Program and the erosion control project were completed.

As a result, the two-year program eased most of the troubles concerning soil erosion. Although it was impossible to solve all the problems at once, this intensive conservation

program stopped the further depletion of the earth to a great degree. For the time being, park administration could shift its attention to other natural resource issues.

Certainly, water was another long-forgotten aspect, that required more study. Since the U.S. Geological Survey effort of 1956, the Park Service had shown little interest in water resource management at Fort Union. In the late sixties, the predominant national mood favoring environmental preservation influenced the attitudes of government bureaucrats at every level. Concerning the safety of visitors and the potential for future consumption, the Southwest Region decided to examine both the quality and the quantity of water in the fort area. In 1970, hydraulic engineers suggested that the fort keep records of water use, including domestic consumption and irrigation. The absence of meters, however, made it difficult for the monument to provide accurate data about water use. Without basic cooperation from the local unit, the regional office had no alternative but to postpone water resource research indefinitely.

The 1970s witnessed no activity in hydraulic studies at the fort except for a brief test of the well. After the Red Top Drilling Company installed a new pump, the Park Service did a routine check of the new system. In April 1974, Hydraulic Engineer Garland Moore and his team arrived at the site. They inspected the well and the new pump. Surprisingly, they found that the water table had dropped from 85 feet in 1957 to 91.7 feet. Because the team could not decide why the underground reservoir had shrunk, the test remained inconclusive. To the monument, a comprehensive hydraulic study remained unavailable.

Nevertheless, the quality of the groundwater at Fort Union remained unchanged throughout its history. Beginning in 1960, the park staff collected water samples twice a month for bacteriological tests by a state-approved laboratory. Thorough analyses were made every three years. The chemical quality of the groundwater always met the drinking water standards set by

the Public Health Service in 1962. Also, the maintenance crew regularly cleaned the water tank to keep the artisan water pure.

When Fort Union merged with Capulin Mountain National Monument, water resource management received new attention. Both Santa Fe and Capulin bosses requested an inventory of water resources in the fort area. With some assistance from natural specialists from Capulin, unit manager Carol Kruse prepared a detailed report entitled "Water Resources Management Profile for Fort Union National Monument." Based on previous information and recent studies, the document dealt with various aspects of water resources such as physical description, legal rights, problem identification, recommended strategies, and bibliographical references. For the first time, the Regional Office received an overview of the fort's water assets and problems. Despite its primitive nature, the profile reflected a new approach toward resource management, from trouble-shooting to systematic studies.

Although the small number of personnel limited Fort Union ability to conduct any large-scale research, the monument sought to learn more about water resources. After his field trip, Werrell compiled a detailed report about his survey. It suggested that a new well be drilled even though the existing one might be productive for a few more decades. His study gave the Park Service a better understanding of the groundwater situation at Fort Union. In addition, the monument employees themselves continued to inquire into water resources. Throughout the 1980s, each management plan or superintendent's annual report showed progress in the field.

Unlike water resource management, which could pause at any time as needed, fire control required constant attention such as personnel training and equipment improvement. Because of its location where water was scarce and grass was abundant, wildfire posed the most dangerous threat to the park. Thus, the park employees were constantly on fire alert. They regularly checked and repaired the old fire-fighting tools. Every few years, new equipment was purchased and fresh ideas surfaced. In 1972,

the monument redesigned its four fire hose houses and made them fireproof.

Five years later, all the equipment was upgraded again. In April 1977, workers completed a new fire-resistant fire cache building in the maintenance area. The 300-gallon pump trailer received a new pump, improved hose reels, and other gear. Also, the monument procured a portable, backup fire pump for forest fire control use. Later in the season, four sets of bunker gear, including helmets, gloves, boots, turnout coats and pants, and self-contained breathing units, came to Fort Union to arm its mini-fire department. By the late seventies, with sufficient modern equipment, the monument had greatly increased its fire-fighting capability.

The development of training in fire control went even faster. Wildfires in the neighboring areas offered the park staff good opportunities to acquire real battlefield experiences. In the seventies, natural fires broke out more frequently in the region than they did in previous decades. For example, one fire in April 1974 engulfed 1,500 acres of grassland belonging to the Union Land and Grazing Company. Armed with modern weapons, the park employees responded to calls for help and fought the fire effectively. The only rewards for their sweat and bravery was enhanced skills and experience.

The park's amateur fire fighters also participated in suppressing wildfires in other regions and states. In June 1977, the La Mesa fire at Bandelier National Monument destroyed large portions of the Upper Canyon and Frijoles Mesa areas. Answering an emergency call for assistance, Superintendent Hopkins and ranger Thomas Danton, with their recently acquired equipment, quickly drove to the burning area. Both spent six consecutive days in the blazing forest. No sooner did they put the equipment back into the cache building than a fire broke out at Sequoia National Forest in California in August.

Besides reliable equipment and proper training, cooperative activities within government, community, and

citizenry were crucial for the suppression of large fires. In 1968, the Southwest Region of the National Park Service and the state of New Mexico reached agreement on mutual aid in the case of natural disasters. Although the agreement covered the Mora Valley, the management sought additional cooperation from the surrounding communities. In 1975, Superintendent Hopkins and Andrew Marshall, then treasurer of the Union Land and Grazing Company signed an agreement on a joint effort to deal with fire disasters. A revised version appeared three years later. During the same period Fort Union and the Watrous Volunteer Fire Department struck a similar deal. With these agreements, the monument bore more responsibilities, but in trade for better fire protection.

The best protective measure was to prevent fires in the first place. After improving its fire control abilities, the monument exhibited a growing interest in scientific studies. In April 1983, Fort Union installed a fire weather station near the visitor center to collect data on wind, precipitation, temperature, and humidity trends. High winds often proved to be a major factor in determining fire hazards. Because the highest recorded winds usually occurred in August, that became the most dangerous month for wildfire threats. So the preparation began before each summer.

Learning from other parks' experiences, Fort Union tried a new fire control method--"prescribed burn." It was an effective tool used to restore the historic scenery and reduce fire hazards by carefully burning small sections of the vegetated area under closely supervised conditions. On April 10, 1985, the maintenance crew burned off five acres at two sites. Minimal pre-burn information was available, but the revegetation was documented with photographs for the following six weeks. The prescribed burn slowed the growth of woody plants and in return, the prairie grass made a comeback.

The monument continued to improve its fire management capabilities in every way. In 1990, the draft of the fire management plan for Fort Union arrived at Santa Fe for review.

It showed the maturity of fire control. Recent decisions by the Park Service, however, prohibited any prescribed burn due to "safety" reasons. The maintenance workers returned to more traditional ways of limiting the growth of unwanted plants by regularly cleaning the firebreaks and mowing the overgrown areas. But in general, fire management at Fort Union was successful as no fire has ever damaged any park property since its establishment.

As a part of the cultural and natural resources of the monument, the Santa Fe Trail ruts raised a new issue for resource management. In the late seventies and the early eighties, the 800-mile Santa Fe Trail was developing a reputation in the public's eye as a significant historic resource in its own right. At Fort Union, the trail became a major attraction in addition to the ruins. A hundred years of revegetation, weathering, and erosion had changed the original appearance of the trail by either deepening the ruts into arroyos or filling them with earth. Sections of the trail, within the monument grounds, were lost through the construction of the visitor center, residential houses, and maintenance buildings.

Beginning in 1985, a soil erosion control project helped care for the Santa Fe Trail ruts. Assisted by the U.S. Soil Conservation Service Mora District, Diane Jung and Keith Yarborough from the Southwest Region authored a plan for a two-year arroyo stabilization program at Fort Union. As soon as they finished the blueprint, the maintenance crew started constructing, mulching, and seeding earthen dikes. Banks of an arroyo at the northeast corner of the monument were sloped. In the summer of 1986, 45 Boy Scouts labored for 179 hours on the erosion control program. The project was completed in 1986 when the ruts of the Santa Fe Trail stood more firmly against the threat of erosion.

But the problem was far from resolved. Since the visible ruts of the Santa Fe Trail stretched through the entire valley, their preservation as a whole seemed unrealistic. All wagon wheel ruts could eventually erode away. Even if the Park Service

discovered a reliable way to preserve a small section of the ruts, it still could not restore the integrity of the historic trail. Realizing the situation, the fort administration pleaded with the regional office for further study on both the strategy and the tactics of preservation. In recent years, Superintendent Harry Myers made a few contacts with the Santa Fe Trail Association and the U.S. Soil Conservation Service to discuss possible measures. There was no quick answer. As are many interested citizens and government agencies, Fort Union is still searching for a solution.

One of the best studies on the park's natural resources was Sandra Schackel's Historic Vegetation at Fort Union National Monument, 1851-1983. Then a history graduate student at the University of New Mexico, she accepted the Park Service's contract to produce an in-depth investigation of the fort's flora. Because the prairie environment affected Fort Union's physical condition regarding such things as soil erosion, fire hazards, animal habitats, and natural scenery, the Southwest Region decided to approach natural resource management at the "grassroots" level. Schackel pioneered the task. Working closely with the U.S. Soil Conservation Service, she investigated various species of plants and searched government documents to determine whether there was biological continuity or change through the park's history. In 1983, the first study on the history of the park's vegetation appeared.

According to Schackel's study, vegetation conditions at Fort Union in the early 1980s appeared similar to those documented in the historic records of the mid-nineteenth century. The valley possessed rich blue grama and other grasses interspersed with a great variety of beautiful wild flowers until the coming of U.S. troops in 1851. The construction of buildings, gardens, corrals, and the parade ground gradually turned the once luxuriant pasture into a barren, dusty area. In American frontier history, ranchers often followed soldiers. After the closing of this frontier post, the commercial grazing company replaced the military as the catalyst for environmental change. Cattle grazing continued to

diminish the remaining vegetation cover for 65 years. However, the establishment of Fort Union National Monument brought new hope for environmental protection as the Park Service fenced the land and allowed the start of a recovering process. In the last 36 years, vegetation at the monument was gradually restored. Today the prairie is once again growing toward a potential climax.

Simultaneously, several other research projects, not funded by the Park Service, were under way. In 1982 while Schackel was studying the park's vegetation, Lee Boyd of West Texas State University came to Fort Union to research the geological features of the nearby Turkey Mountains, which formerly were included in the military reservation. This year-long study resulted in a scholarly work, Geology and Joint Pattern Study of the Turkey Mountains. Park volunteers Charles and Peggy Matlock performed the first survey of birds at the monument and the surrounding areas. They lived at the fort in the fall of 1983. Incorporating data from personal observations and previous records, the Matlocks compiled a report about bird activities in the area. These research projects broadened the park's scope in fields from geology to flora and fauna.

In accordance with the Endangered Species Act of 1973, the U.S. Fish and Wildlife Service defined and listed all endangered species of flora and fauna in the nation. Fort Union was home to none of them. The threatened creatures of Mora County, the black-footed ferret, the swift fox, and the spotted bat never visited the fort. Only bald and golden eagles occasionally stopped at the fort during their long flights.

Of all the fauna at the park, snakes received the most attention. A considerable snake population lives in the Third Fort and the Depot, with sightings recorded in all months except January and February. Unchecked activities by these reptiles, particularly rattlesnakes, threatened public safety. Rattler sightings in public use areas averaged 25 per year, about half of which involved confrontations with humans. Concerned with the safety of visitors, the Park Service, since the establishment

of the monument, placed warning signs along the interpretive trail and asked people to stay out of the grass, where poisonous serpents were likely to linger. In past years, the warning sign helped reduce the chance of snake confrontations.

Throughout the history of Fort Union National Monument, there was only one recorded incident of a snake bite. On August 18, 1983, a boy, Nathan Hagman, walked off the marked trail and into the grass. Suddenly, a rattlesnake bit his left leg about six inches above the ankle. It took only five minutes for his father to report the matter to the park staff. Under park ranger Carl Friery's advice, Dale Hagman properly kept his son still with his legs lower than his heart, and rushed the boy to the Northeast Regional Hospital in Las Vegas.

Although only one rattler attack was recorded, the search for a proper way to handle potential confrontations between humans and snakes was needed for both public safety and resource management. Historically, neighboring ranchers killed rattlesnakes on sight. From 1958 to 1971, records indicated that Fort Union exercised the same extermination policy as its neighbors. The environmental preservation movement made the Park Service realize the importance of ecology and the coexistence of various species. Consequently, Fort Union shifted its policy from extermination to relocation. In the last two decades, the relocation philosophy remained the standard. Whenever a rattlesnake moved too close to the public use areas, trained park personnel quickly captured the errant reptile. Each captured snake was marked with brown paint on its tail and released on the northeastern boundary near the water tank. This method met the demands of public safety as well as environmental protection.

In 1984, Fort Union issued its first written rattlesnake policy. Concise and perceptive, it gave an initial account of the park's experience in snake management, with thoughtful comments and practical goals. Approved by the Southwest Region, the rattlesnake policy became effective. In addition to the existing methods of warning and relocation, the park rangers

began to encourage visitors to report rattler sightings. Public cooperation helped the Park Service gather more information for further research. The change of policy from extermination to relocation showed that the park administration supported "the native animal life of the parks for their essential role in the natural ecosystem."

During the 1980s, natural resource management developed significantly. It became as important as preservation and interpretation. In 1976, personnel at Fort Union wrote a "Statement for Management," which gave natural resource management minor attention with only one short sentence that mentioned the desire to enhance the park's environmental quality. Soon, this attitude changed. Under pressure from the public and the Park Service, the monument began to prepare for a comprehensive management plan in 1979. It took about two years before unit manager Carol Kruse submitted the plan for approval. This time natural resources received significant attention; a natural-cultural resource balance in management began to arise.

As the first plan of its kind, the "Resource Management Plan and Environmental Assessment" guided the fort's operations through the decade. Every three or four years the park administrators made efforts to revise and update it. The public was encouraged to provide input. In essence, by creating such a written document the administration saw the need for a natural resource management entity at the monument.

In comparison with the ruins preservation and historical interpretation programs, natural resource management in the last two decades failed to cover the many problem spots that revealed themselves in management operations. Today, some areas are still waiting for research. For example, a pollen and soil study will augment Schackel's work and allow the mapping of soil as well as vegetation. A climatological study is needed to provide some insights into weather patterns and to predict their effects on ruins preservation. The animal population at Fort Union remains largely unstudied. Ground squirrels, whose burrows have severely weakened the trails and ruins, are not understood. The

increased presence of rodent families raises additional concerns for human exposure to bubonic plague. Indeed, a careful appraisal of all these aspects of the environment is required before the park's natural resource management meets Park Service standards.

While quietly enduring the subversive impact of nature, the weather-beaten ruins at Fort Union National Monument faced unnatural threats to their existence and integrity. It is true that sometimes human wrongdoing, either malicious or negligent, are more evasive and destructive than natural forces. Without exception, both people and the civilization they created often posed "external threats" to disturb the peaceful park. In the first 36 years of its history, the monument achieved a good safety record with only minimal damage caused by people due to geographical isolation, limited territory, and low visitation. But Fort Union never appeared as a safe haven for those to seek an escape from the dangerous world. Various undesired human activities, such as theft, vandalism, encroachment, pollution, careless fire, commercial development, and low-flying aircraft generated enough concerns for the Park Service.

The concept of outside human threats to the existence of Fort Union surfaced rather slowly; it took no less than 25 years to reach its maturity. During the first decade after the establishment of the monument, the enthusiastic park administration paid little attention to such issues. The staff concentrated on ruins preservation and interpretation. More importantly, the location of the fort induced people to minimize their worry about human malice toward the ruins. Surrounded by a 97,000-acre cattle ranch, in single ownership, Fort Union was separated from civilization because no large population center existed nearby. The isolation was bad news for visitation but an advantage for protection. The dead-end eight-mile entrance road appeared less inviting for the visitor to come and more difficult for the criminal to escape. According to the park records, serious incidents involving human mistakes rarely occurred

during the 1950s and 1960s. Therefore, the Park Service believed that Fort Union was immune to the outside world.

Beginning in the mid-1960s, this belief began to erode as the conservation movement in the nation took a holistic approach to preservation. Changing perceptions of American society contributed to more aggressive vigilance on the part of the Park Service. The new concerns stretched beyond the borders of park areas. By the 1970s, the National Parks and Conservation Association (NPCA) and other environmental groups that supported the park system had expressed concerns for the lands surrounding park areas. In 1976, Director Gary E. Everhardt declared that the most severe threats the system faced were external. The issue immediately became prominent on the agenda of the agency. A Park Service study conducted in 1980 identified over two thousand outside activities affecting various units of the national park system. Suddenly, many people felt that the national parks had been "islands under siege."

The combination of the new perception of threats and the growing pressure upon resources demanded attention from the staff at Fort Union. In accordance with the Park Service's policy to identify and counteract the broadening range of potential threats, fort management stepped up responses to once neglected outside threats. Within its ability, the park began to keep good records on incident cases. Also, the superintendent's annual reports focused more attention on the subject. It was unknown whether a growing notion of outside threats and an increasing number of incidents were coincident or not. Perhaps increased visitation was the cause. In any case, available documents enable us to examine the issue of management concern about outside threats.

As a part of President Lyndon B. Johnson's Great Society, the War on Waste had reinforced the Park Service's determination that the safety of both employees and visitors was crucial. In 1964 when the MISSION 66 program was entering its final stage, the Park Service launched a new campaign,

MISSION 70, which aimed at accident reduction. According to program, each unit in the Park Service system would apply safety measures to prevent human-caused accidents and fires. Starting in the same years, the six regions and 221 units of the national park system participated in a five-year contest for the lowest record of accident and fire loss. Each year the winners would receive certificates. In 1965, after the first season, Fort Union won an award for excellent safety performance in which no disabling injury, motor vehicle accident, and structural fire occurred at the site. After the good start, for the next four years, the monument achieved a perfect record under the mission safety 70 program.

Throughout the history of Fort Union National Monument, the safety record of visitors was nearly perfect. No person ever died or was fatally injured in the park. Besides the previous mentioned snakebite incident, only one visitor required emergency care. In the morning on June 24, 1977, a female visitor appeared at the visitor center, calling for help. A few minutes before her husband had collapsed in front of the quartermaster's quarters. Ranger Robert Hoff rushed to the scene to assist the patient and then drove him to Las Vegas Hospital. The patient soon recovered from the illness caused by a combination of high blood pressure, high altitude, and irregular potassium levels. The quick and proper response to the emergency call avoided any serious consequences.

Although no fatal injury or death occurred in the park, the administration prepared for any possible emergency situation. In 1973, Chief Ranger Robert Arnberger initiated a program to bring public safety operations up to Park Service standards. His actions included purchase of first-aid equipment, improvement of the record-keeping system, and training of qualified personnel. In 1974, training received top priority. The slow spring season allowed all park employees and their family members plus neighboring ranchers, a total of 22 persons, to attend an American Red Cross multimedia standard firs-aid course. In

addition, Superintendent Hopkins, Chief Ranger Arnberger, and Park Technician Ella Rayburn completed a 52-hour emergency medical technician course, sponsored by the American Red Cross and the New Mexico State Police, in Las Vegas. Thereafter, the park kept trained personnel at the fort to cope with emergencies.

In 1979, students from New Mexico Highlands University broke the monument's perfect fire-control record of almost a quarter-century by kindling two grass fires among the ruins. In the afternoon of March 13, eight art students accidently threw lit material into the grass while they were painting. The fire broke out at 3:30 p.m. A visitor from Las Vegas, William Johnson, reported it to Ann Belen at the visitor center. She gave him a CO_2 fire extinguisher to take to the site. Three other park employees rushed to the fire scene with the 300-gallon pumper and equipment. They found that two grass sections were burning; one was east of the northernmost company barracks and the other was east of the prison.

Fortunately, the wind was calm at the time, and the flames did not spread out of control. With the assistance of eight visitors, the park staff extinguished the fires in a few minutes. Since each student told a different story about what happened, Ranger Hoff was unable to identify the person who ignited the fire, and the students were released from the investigation. But the park staff did not cease their vigilance. On the contrary, they realized that human mistakes and outside threats could be devastating to the park resources. As with the students who almost caused a fire disaster, other negligent visitors and their careless behavior put different pressure on resource management. As a small historic site, Fort Union provided visitors with no lodging or campgrounds except a few picnic tables for day use only. The beautiful valley in which the fort was located often tempted travelers to stay overnight. Sometimes, they illegally pitched tents near the residential area outside the monument.

Several unauthorized camping cases occurred each year. The campers made the park authorities nervous because their

campfires or gas stoves could start a grass fire if the wind suddenly gusted. The park enforced the non-camping rule without compromise. As soon as the unwelcome travelers were discovered, the park rangers evicted them by issuing a verbal warning. This house-cleaning policy went on effectively.

2

Natural Resource Management and Environmental Protection

In the past decade, the development and implementation of environmental protection tools and strategies has vaulted to the forefront of many communities' agenda, as a means to protect what is important to the community and the region. Natural resources such as wetlands, lakes and woodlands are important features in many developing countries; providing low-cost storm water management and flood control, providing a purification system for drinking water and surface waters, contributing to air purity, increasing property values, and creating a sense of place and identity to the community.

Management of Natural Resources and Strategies for Environmental Protection

Woodbury is fortunate to be part of a progressive Washington County and three active watershed districts that have in-depth inventories and resource management plans. This type of regional planning allows for better protection of natural systems that may cross municipal boundaries. Woodbury is also fortunate to have the leadership and citizen interest and commitment to work together in protecting the environment.

This chapter of the Comprehensive Plan addresses the management of natural resources and strategies for protecting the environment. The plan carries forward many of the principles, goals and policies established in previous comprehensive plans for Woodbury, as well as identifies new tools and strategies to help implement the goals and policies for protecting the environment.

The City of Woodbury was once covered in oak savanna, wetlands, and prairie. As Europeans settled the land in the 1800s, the more level and dry land was extensively farmed and turned into fields and pastures. Nearly all the land suitable for agriculture was cleared for farming by the early 1900s. The southwest corner of the city, being too hilly to farm, has retained a canopy of mature oak trees under which residents have built their homes.

The wetlands also were unable to be farmed. Wetlands that weren't drained or tiled have remained as a habitat refuge for wildlife. The Tamarack Swamp is a unique natural community that has had community importance throughout history, and has now become a park, where residents walk through this unique plant community. The lakes in Woodbury provide enjoyable places for swimming, fishing and boating. The subtle hills to the east offer scenic views of open space and give present residents a sense of place. Productive agricultural lands to the southeast are valued as a community asset and give areas of Woodbury a rural character.

As growth pushes outward from the urban core, it is increasingly important for Woodbury to be able to protect its significant environmental resources. Natural areas are sites that have had limited human disturbance. Although natural disturbances do occur that change plant community patterns, native vegetation still makes up the majority of the plant community of these sites. Few quality natural areas remain within the metropolitan area and priority should go to preservation efforts over creating or restoring poorer quality sites. While most of the vegetation was stripped away for agricultural needs, small

parcels of natural communities were left, namely the Tamarack Swamp and other wetlands and canopies of oak trees used for cattle shade and wind breaks. In February of 1997, the City completed a Natural Resources Inventory Report, which provided a detailed description and quality ranking system of some key remaining natural areas within Woodbury's borders.

Open Space

Open space is a resource many residents use in describing what they like about Woodbury. Open space includes undeveloped sites that do not meet the criteria for natural areas, but still provide habitat, scenery and other community benefits. Open spaces can include areas such as farm fields, golf courses, utility corridors, wetlands, woodlots, and simple views with no developments or parkland. While Woodbury acknowledges that it cannot prohibit future development from occurring, it can create a plan that preserves resources that will continue to give residents a sense of open space within their community.

The citizens of Woodbury have taken particular interest in preserving open space and through the efforts of the Parks/ Natural Resources/Open Space Committee, have established a thorough description of what defines open space. This definition also distinguishes between passive and active open space areas.

Woodbury's topography is gently rolling with a wide central draw running north and south that drains most of the City's surface water and includes a chain of lakes and wetlands. Topography will play an important role in Woodbury's character, not so much for its dramatics, but due to the fact that presently there are miles of rolling fields with no trees to block views. As these areas become developed, instead of open views of rolling hills, residents will view miles of rooftops. A policy to provide a greenway overlay on some of these hill crests is intended to break up the sea of roof tops, and provide open space that can be seen from around the community.

Soils can be both a resource and a constraint for communities. Areas with bedrock near the surface, steep slopes, wet or periodically flooding, or soils with slow percolation rate have severe limitations for the functioning of on-site septic systems and farming. These were mapped in the 1980 Comprehensive Plan. The Soil Survey of Washington and Ramsey Counties, published by the United States Department of Agriculture Soil Conservation Service generally reveal that soils in the southeast corner of Woodbury are the better producing agricultural soils.

Watersheds are areas of land that drain surface water into a common steam, river or lake. Most of Woodbury's land is in the South Washington County Watershed District, draining south into Bailey Lake. The northwest corner is in the Ramsey-Washington Metro Watershed District, and a small piece in the northeast corner of the city falls into the Valley Branch Watershed District. These watershed districts are important planning agencies and Woodbury will continue to work with them in managing water resources.

Wetlands perform many important functions in the environment. The most important functions include providing stormwater storage, groundwater recharge areas, reducing and buffering nutrient loads in surface water, providing wildlife habitat, and aesthetic and recreational enjoyment for Woodbury residents. There are many types of wetlands, each serving a slightly different function. The national wetland inventory (NWI) is a general mapping inventory that represents approximate locations of these types. Other sources for wetland mapping include the DNR, the South Washington County Watershed District, and the Ramsey-Washington Metro Watershed District.

The Tamarack Swamp is a fine example of a tamarack-hardwood swamp at the southern limit of the tamarack's range1. This unique and diverse plant community deserves a strong management plan to protect it from adverse impacts due to surrounding development. Lakes are surface water bodies of 10 acres or more. There are seven lakes in Woodbury that provide

recreation, groundwater recharge, flood retention, and fish and wildlife habitat among other benefits. Undisturbed shoreland is important to the water and habitat quality of lakes. The city has acquired much of this shoreland making it easy to better manage the quality of the lakes. The following table illustrates the City of Woodbury's shoreland classification and riparian dedication requirements.

"Washington County has substantial reserves of high quality groundwater. Due to the geological conditions of the County, most of these reserves are highly sensitive to contamination. If not protected, they will become unusable as a source of potable water."2 The Geologic Atlas Series, published by the Minnesota Geological Survey, maps geological and hydrological conditions in the County. These maps can be used to determine the general locations where appropriate land uses might occur in order to avoid groundwater contamination. The biggest threats to groundwater are non-point source pollution, fertilizer and pesticide use and feedlots/manure storage. Other threats, which are carefully regulated and monitored, include problems associated with septic systems, solid and hazardous waste and well construction. The City of Woodbury currently obtains its municipal drinking water from the Prairie du Chien-Jordan aquifer out of a well field generally located north of Valley Creek Drive east of Tower Drive.

Plan for Natural Resources and Environmental Protection

As Woodbury becomes a more popular place to live, the environmental resources need ever more protection and management. In order to protect these resources the city must have policies and guidelines for natural areas, open space, slopes, soils, surface waters, and groundwater. In addition the plan needs to recognize special areas and issues that impact the natural environment, and establish direction or guidelines to help minimize negative impacts on the environment. This section

includes a discussion of the special natural resource issues and a list of general goals and policies that direct the community in the management of natural resources and protection of the environment.

Special Natural Resources Issues

The headwaters of Valley Creek lie within the northeast corner of Woodbury. The majority of the Valley Branch Watershed within Woodbury drains toward a land locked basin in Afton or into the freeway ditch system. A smaller portion in Woodbury drains towards the Valley Creek. This creek is one of the few naturally reproducing trout streams in the metro area. Trout streams are endangered resources in the metro area, and many agencies are involved in protecting them and the watersheds they are a part of.

The Valley Creek watershed lies within Woodbury's northeast corner and also happens to be within a prime commercial and industrial development corridor along Interstate 94. The future land use plan designates the northeast area as "places to work." It is anticipated that this corridor will see commercial and industrial development with urban services before 2020. Studies, which will test different development scenarios to determine future development impact on the watershed, are presently underway. The St. Croix Research Station is preparing these studies with assistance from the DNR, the Cities of Woodbury and Afton and the Valley Branch Watershed District. It is anticipated that some type of Overlay District, with special development standards, will be applied in the areas of the Valley Creek Watershed that are determined to affect Valley Creek.

Bailey Lake Stormwater Management

South Bailey Lake was created in 1994 to manage Woodbury's stormwater run-off. Most of Woodbury's surface water run-off

drains south into Bailey Lake. As Woodbury's population grows, and more areas become paved, there is a need to carefully study the effects additional run-off will have on the capacity of Bailey Lake. An advisory group consisting of health and technical advisors, officials and citizens from Cottage Grove and Woodbury is studying all the possible options. These options include a range of ideas, such as infiltration, storage and piping techniques. The South Washington County Watershed District is studying the possibility of having additional infiltration open space areas near Bailey Lake. These areas would be managed to accept excess run-off during storm events, and function as open space or recreational areas at other times. The City of Woodbury will continue to work with the City of Cottage Grove and the South Washington County Watershed District to resolve issues associated with future surface water run-off.

Tamarack Swamp Management

The Tamarack Swamp that lies within Woodbury's boundaries is one of the furthest south plant communities of its type and is listed on the Minnesota Biological Survey as a significant Natural Plant community. Surrounded by development, its water quality and quantity is difficult to manage. The Ramsey-Washington Metro Watershed District is studying various methods to preserve the valuable plant species found in both the east and west sections of the swamp while accommodating the increase in surface water run-off from surrounding new developments.

Tree Preservation and Restoration

Because of Woodbury's intense use as a farming community since the 1900s, few sizable stands of trees remain. While wide-open fields and expansive views are a character of rural Woodbury that many residents like, it is less appealing as a place for homes. Some remaining woodlots could be subjected to the threat of future development. As future development occurs on sites with existing significant tree standings,

mechanisms should be used to preserve as much of the tree stand as possible. The City intends to investigate establishing a tree preservation ordinance in addition to using simple subdivision design tools such as density transfer to encourage preservation of trees.

Wetland Protection

Woodbury incorporated the requirements of the 1991 Wetland Conservation Act, which follows a "no net loss" policy. The draining or filling of wetlands is prohibited unless wetland areas of equal public value are restored or created. By ordinance, the City can require up to a 75-foot buffer around wetlands decided on a case-by-case basis. The South Washington County Watershed District is presently finishing a wetland inventory and a set of management guidelines.

Woodbury will review and work to incorporate the new guidelines. While ecologically sound wetlands are better protected than replaced, Woodbury is working on a wetland-banking program for wetlands that cannot be saved on City projects. The banking plan includes restoring previously filled or drained wetlands as part of an overall plan that benefits the public. Through the Shoreland Ordinance, Woodbury also actively works to preserve and protect shorelands of selected major water bodies by acquiring a 150-foot strip of natural vegetation around the perimeter.

Greenway Corridor

The greenway corridor is planned to identify and connect Woodbury's natural systems and areas. Greenways are often defined as continuous corridors that provide for the movement of wildlife and protection of natural resources. They are generally vegetated, linear in shape, and following natural waterways or land features such as wetlands, slopes, valleys, and ridgelines. Greenways enhance the ecological function and aesthetic quality

of natural areas and open spaces by interconnecting them, thereby countering habitat fragmentation and loss.

In Woodbury, the proposed greenway corridor serves to protect environmentally sensitive areas such as natural habitat, wetlands, tree canopy, drainage ways and excessive slopes. While these remnant pieces of nature are presently disconnected by agricultural lands, further opportunity exists to reconnect these systems through re-vegetation to create continuous greenways that will function more like natural systems, creating better habitats and water management systems.

Land within this corridor will be comprised of a combination of public and private open space. Development will not be prohibited within the greenway but will be reasonably restricted to ensure that development is carefully integrated with the natural environment.

Establishing guidelines for this greenway corridor will be a first step in the goal of keeping natural systems intact and incorporating them into developments in an environmentally sensitive way. Special management guidelines will be developed to preserve and improve the habitat, natural functioning and scenic qualities of the greenway.

Not all important natural resources can be protected within the greenway boundaries. Natural resources such as clean water and air have no boundaries. Choices we make in how our city is developed and how we live our day to day lives affects the quality of our natural resources everywhere. Thus Woodbury has a set of goals and policies that apply over the entire city.

The following are the City's goals for Natural Resource Management and Environmental Protection. Some of these goals were established in previous planning documents that were completed by the City of Woodbury.

1. To preserve and protect the natural environment with emphasis on the conservation of needed and useful natural resources for the present and future benefit of the community.

2. To use natural resource areas to provide an overall open space system to satisfy the physiological and psychological needs of the people, considering their needs as individuals and as a community.
3. Create a livable community where future development respects and integrates the natural resources of Woodbury.
4. To reduce the waste stream and create a sustainable environment by recycling, reducing and reusing.
5. To have a continuous green corridor that connects existing natural resource areas, thus providing a more ecological system of open spaces.

It is the policy of the City to:

1. Protect wetlands, excessive slopes, tree canopy, significant natural habitats, and scenic views from environmentally insensitive development.
2. Encourage activities that conserve energy and result in less/no pollution output such as waste reduction, recycling, alternative transportation modes, alternative energy sources and composting.
3. Support and encourage community efforts in environmental awareness and education.
4. Encourage re-vegetation and management of areas to restore native habitat and natural aesthetic qualities that contribute to environmental quality.
5. Encourage and support sustainable farming practices, Integrated Pest Management (IPM) and the Minnesota Department of Agriculture's "Best Management Practices" for specific crops.
6. Encourage and support tree planting and restoration efforts.
7. Encourage and support composting by providing appropriate site(s) and education for Woodbury residents.
8. Encourage limited and responsible use of herbicides, pesticides and fertilizers on residential and public lands.

9. Continue to provide and encourage curbside recycling of reusable waste materials through educational events, promotional materials and volunteer efforts.
10. Monitor and manage lakes for water quality.

Policies as referenced in the 1977 Park Comprehensive Plan

11. Conserve a variety of natural resource areas including wetlands, peat soils, ground water recharge areas, woodlands, lakeshore lines, and watercourses.
12. Encourage the assistance of metropolitan, state, and federal agencies to preserve natural resource areas that may serve outside of the City of Woodbury.
13. Use open space areas as a structuring element linked to other park and open space areas whenever possible.
14. Ensure natural resource open space areas planned in conjunction with a PUD be coordinated with and contiguous to the open space areas of existing adjacent development. It shall be accessible to all units within the PUD.
15. Use natural resource open space to physically separate elements, which are incompatible by scale or function.
16. Preserve natural drainage ways, and where feasible, reconstruct former natural drainage ways to handle stormwater runoff.
17. Establish and maintain conservation areas for wildlife management and educational and scientific purposes.

Policies as referenced in the 1980 Comprehensive Plan

18. Develop a framework for management of constraint areas.
19. Encourage through development incentives, the preservation and management of all natural resource amenities. Policies specific to the Greenway Corridor

20. Support a greenway plan that works towards linking together areas of natural resources that include wetlands, slopes, tree canopies, drainage ways and other significant natural resources as to create a continuous greenway corridor.
21. Create mechanisms that allow landowners to achieve reasonable development on lands through which the greenway passes, while preserving a portion of the land as open space.
22. Allow opportunities for neighborhood parks to occur within or adjacent to the greenway corridor such as a tot lot or nature observation area. Physical development of a neighborhood park should minimize disturbance of natural resource areas.
23. Develop partnerships with non-profit or private organizations, neighborhood groups or other interested parties for the purpose of acquiring targeted open spaces, which may be part of the greenway.
24. Promote management efforts that work to improve the habitat and scenic qualities of the greenway corridor.

Implementation Tools and Strategies

Past comprehensive planning efforts and more recent action initiated through citizen involvement demonstrate the community's strong interest in the protection of open space and preservation of natural resources. As one reaches the eastern and southern edges of Woodbury, they are presented with open agriculture fields, rolling hills and pockets of woodlands, wetlands and lakes. Located on the rural-urban fringe of a major metropolitan area, these open fields will soon become the home to future Woodbury residents and businesses. Identifying strategies and tools for implementation of the goals and policies are critical components to preserving the remaining natural resources and ensuring that development respects the community's desires for open space and environmental protection.

The following is a list of tools and strategies available to the community for protecting the environment, preserving natural resources and ensuring the protection of quality open space.

— Ordinances
— Open space preservation techniques
— Design guidelines and performance standards
— Educational outreach
— Intergovernmental cooperation

Ordinance Development

Local zoning ordinances are the primary tools for implementing the goals, policies and standards set forth in the Comprehensive Plan. A variety of ordinances are principally designed to protect the environment and thus the health and safety of the general public. The following are zoning ordinances specific to the preservation and protection of the environment.

Open-space zoning or cluster zoning

The purpose for establishing an open-space or cluster zoning district is to direct development in an effort to preserve contiguous open space and protect natural resources that otherwise may be destroyed. These zoning techniques do not reduce overall density rather they simply transfer density from desired preservation areas to development areas. This way, private property owners are granted the reasonable economic use of their property without negatively impacting the remaining natural or open space areas that the community strongly desires. In areas where it is appropriate, residential developments will be clustered together in effort to minimize street and utility construction needs and to systematically provide contiguous open space areas. Primary components of open-space or cluster zoning:

— Smaller lot sizes, street widths, or setbacks in effort to maintain an overall density on a portion of the site that

otherwise would be spread over an entire site.

— The developer would be required to preserve a percentage of the land within the development as permanent open space by placing the land in a permanent conservation easement or other land preservation tool such as dedication to the City.

— Identification of preservation areas on a community-wide basis, such as the greenway corridor or the four large areas of significant natural resources as identified in the 1996 Natural Resource Inventory.

The purpose of this designation is to provide protection and preservation for corridors of continuous open space throughout the future developing areas of the city. Law already restricts development in many areas within the greenway corridor, such as within wetlands and shorelands. The greenway corridor is intended to protect as permanent open space, lands that have other desired natural features or open space characteristics which may not already be protected under existing laws. Developable lands which contain part of the greenway system should not lose density but should plan development to minimally impact the greenway, preserving the greenway as permanent open space. While the greenway corridor may be as narrow as 100 feet in many areas it may be as wide as 500 feet in other areas. It is intended that the greenway corridors work in conjunction with open-space or cluster zoning and open space preservation techniques such as cluster housing or density transfers.

Greenway Corridor Map

The greenway corridor map reflects preferred opportunities for the continuous greenway corridor. It is important to understand that the actual physical location of the greenway corridor needs to be delineated as property develops. This map uses lines to represent desired routes for the greenway, following such natural features as wetlands, drainage ways, woodlands, and ridgelines, which were identified using USGS maps and aerial photography.

Also reflected on the maps are routes that may not contain significant natural resources, but could be important in creating links which would create a continuous greenway corridor system. These areas have the potential to be restored as a natural area or simply managed as other open space opportunities. Primary components of the Greenway Corridor:

— Requirement of natural resource inventories for developments, which contain land in or adjacent to the greenway corridor.

— Further delineation of the greenway corridors based on inventories designating significant natural resources, creating a continuous corridor that connects existing wetlands, drainage ways, woods, natural areas, hill crests, and community parks.

— Establish development guidelines for areas within the greenways that address building materials, setbacks, lot sizes, view sheds and landscaping requirements.

— Requirement of management plan for open space areas that describes how land will be maintained as permanent open space.

— Use the greenway plan as mapped, allowing for on-site evaluation of exact boundaries, and allow for variations in route if new route achieves the same goals.

The purpose of the Shoreland Management Ordinance is to maintain natural shorelines along streams, lakes, and wetlands and employ measures that minimize the adverse impacts of storm water runoff on surface water bodies. The City will continue to ensure its Shoreland Ordinance stays current with Minnesota Rules governing shoreland management.

Primary components of Woodbury's Shoreland Management Ordinance

— Shoreland buffer distances for selected lakes and streams

— Restrictions on setbacks, lot sizes, impervious surface coverage, and other site development issues

— Riparian dedication

Tree Preservation Ordinance

The City currently does not have a tree preservation ordinance, however, the City does require in its subdivision ordinance and zoning ordinance planting of trees on a per lot basis. The City also encourages tree planting through site plan review. Trees can function as windbreaks, snow fences, and buffers between incompatible land uses. Trees reduce wind erosion, improve water quality, screen unsightly areas, provide habitat for wildlife, reduce energy consumption, enhance community identity and image, and improve the quality of air and water.

While the main purpose of a tree protection ordinance is to protect the remaining significant stands of mature trees in the community, care must be taken to insure that current owners of large stands of mature trees are not given incentives to log their property before an ordinance is passed. A tree protection ordinance, in addition to protection strategies, could also provide incentives for urban reforestation and restoration efforts. The City will assemble a task force of interested parties to examine establishing a tree protection ordinance.

Primary components of a tree preservation ordinance

— Establishment of tree preservation criteria: minimum sizes of trees to be preserved, significant tree species to be preserved, identification of significant tree stands or urban forests that need protection.

— Establishment of tree restoration criteria: proper species to be introduced to area, minimum size of tree to be restored, number of trees to be restored, methods and best locations of planting.

— Developers fee to fund public tree restoration and education efforts.

The purpose of the Individual Sewage Treatment System Ordinance is to ensure proper installation and maintenance of future and existing on-site septic systems and to protect the health and welfare of the general public. The City of Woodbury currently has approximately 700 on-site septic systems, most of which are located in the Rural Estate areas of the community. The City currently monitors its own systems however, Washington County also performs this task. The City will work with Washington County for future implementation of an Individual Sewage Treatment System Ordinance. The City will also work with Washington County to do the required inspections. This system also ensures compliance with Minnesota Rule 7080 for on-site septic systems.

The purpose of a wellhead protection program is to ensure the siting of pubic wells provides for clean drinking water and that surrounding land uses pose minimal threat to groundwater contamination. As new wells are developed, the City is required by the Minnesota State Health Department to identify wellhead protection areas. The City must also do potential contaminant source inventories for these areas. The City has already done this for the existing wells. As part of a wellhead protection program, the City will develop a Wellhead Protection Ordinance as a next step in protecting groundwater quality, and will update the ordinance as necessary as new wells are brought online.

The City has officially adopted the requirements of the Wetland Conservation Act of 1991. These requirements are applied to all wetland draining and filling activities in the City. At the present time, a wetland inventory is being completed by the South Washington Watershed District. The inventory includes all wetlands within the SWWD, and includes a functions and values assessment of each wetland. From this, a set of recommendations for buffer requirements for different types of wetlands will be developed. The Ramsey-Washington Metro

Watershed District has developed a similar set of recommendations. The City will develop a Wetland Protection Ordinance that incorporates the recommended buffer widths after the SWWD inventory is completed.

Primary components of a wetland protection program

— Inventory
— Management standards
— Development plan review procedures
— Riparian treatment and dedication requirements
— Mitigation requirements

Open Space Preservation

Many development tools and techniques are available to private landowners and local municipalities for the preservation of open space. These techniques and tools are discussed thoroughly in a variety of books and publications designated to conservation planning and open space preservation. The City will consult with organizations such as the Department of Natural Resources, The Nature Conservancy, The Trust for Public Land, The Minnesota Land Trust, and The Urban Land Institute for information on open space preservation tools and techniques. A few of the tools that will be considered are summarized below.

Conservation easements are the voluntary transfer of specified development and land use rights from a landowner to a qualifying organization such as a public body or non-profit agency. Conservation easements can be in the form of permanent easements or "term" easements. Conservation easements in Woodbury will be used to protect natural resources or to permanently preserve areas of the greenway corridor.

Transfer of development rights (TDR) allows landowners that may wish to preserve their lands to still profit from the sale of development rights. The purchaser of the development

rights would then be able to develop at greater densities. This technique requires the community to establish sending zones, which are areas the community wishes to preserve, and receiving zones, which are areas that are most easily served by utilities and are the most logical growth expansion areas. Examples of sending zones may include lands within the greenway corridor or lands identified as containing significant natural resources. Receiving zones may be located where utilities are readily available or could be easily extended or possibly within the existing MUSA area.

Purchase of development rights (PDR) operates basically the same way as in the TDR program except instead of transferring development rights, the development rights are basically retired. Development rights are typically purchased by the government or non-profit organizations and the land is put into a permanent conservation easement. This program is more of a tool to reduce total growth and can potentially lead to sprawl or leap frog development when areas adjacent to urban services lose their development rights. This program should be used carefully. Residential lands with the most environmental impact on the Valley Creek trout stream may be good candidates for the PDR program.

Preferential taxation can be used to protect wetlands, agricultural lands or open space. Several of these programs currently exist such as the Agricultural Preserves and Green Acres program, which provide tax breaks for agricultural uses and the Wetland Tax Exemption program which exempts wetland areas from property tax assessments. The purpose for preferential taxation programs is to level the playing field by acknowledging the land's actual use rather than a market value based approach on uses to which the landowner has no intention of putting the land.

Property acquisition is probably the simplest form of open space preservation to understand in that it simply means the public buys the land. This is currently a technique being implemented by the City of Woodbury with the recent approval

of a referendum for open space acquisition. This technique gives the public control over the use of the property; however, this technique can be very expensive and may not always enjoy strong public support. The City should continue to pursue the target areas for open space acquisition as determined by the Open Space Committee Report.

Design Guidelines/Performance Standards

Design guidelines and performance standards are used to ensure that new development blends in rather than clashes with the natural landscape. These standards should ensure that development compliments the environment and vice versa. Performance criteria can be found in the future land use plans that are used to evaluate the affects of private development on the environment. While development and performance standards may increase the cost and approval process for developers, it also helps in maintaining the quality appearance of the community and builds upon its identity. Some examples of these standards include:

- Minimizing the amount of turf area that needs herbicides, pesticides and fertilizers by using vegetative cover native to the area.
- Where appropriate, designing the storm water management system to utilize infiltration into the soil.
- Ensuring sites are landscaped and laid out to be energy efficient, utilizing shade trees for summer cooling and winter warming.
- Protecting scenic view sheds.
- Maximizing open space opportunities.
- Providing a management plan for open space areas.
- Adopt a checklist wherein environmental concerns will be specifically reviewed with each development.

— Ensure best management practices are adhered to during and after construction projects including the replacement of all vegetative cover removed for construction purposes.

An important implementation environmental protection strategy in any community is education outreach. Many people in the community do not realize the benefits of taking care of the environment. The City should continue to support and be a partner with organizations whose mission is to educate the public about environmental protection and natural resource management. Areas of education should be the do's and don'ts of composting, recycling, and gardening or how to take care of trees and yards in a non-chemical environment. Potential partners and resources for this type of educational programming include the Department of Natural Resources, Metropolitan Council and the Minnesota Sustainable Communities Network among others. The City has an Environmental Education Commission, which has played, and will continue to play, an active role in educating the people of the community about environmental issues.

3

Population Dynamics and the Local Environment

Human populations are dynamic entities; the numbers and distribution of inhabitants in a given region are constantly shifting due to births, deaths and migration. Regarding the total number of persons in a region, the calculation is very simple. Changes in population size are obtained by adding births and in-migrants and subtracting deaths and out-migrants in a given time period. Yet, not only changes in population size, but also the characteristics of the population can be of great significance for the local environment. Therefore, in addition to the total numbers of persons and the number of persons per unit of land, it is also useful to consider the distribution of a population in a territory with regard to various characteristics, e.g., age, gender, occupation, etc.

Population Density

The concentration of people in an area is a key indicator for assessing the relationship between a population and its territory. Commonly called the 'population density', this measurement is usually expressed as the number of residents per unit of land surface.

At the local level, the density of human populations is affected by environmental constraints, as well as by

technological, socio-economic and political factors. For example, hunter-gatherer populations that rely on wild food over relatively large territories are generally scattered and dispersed. In contrast, technological improvement and efficient management of domesticated plants and animals allow agricultural and pastoral communities to support higher densities of population per unit of land.

Taken by itself, however, the average density figure may be too rough an estimate to be meaningful. The calculation of population density can be refined by considering alternative denominators for the surface area that are ecologically or politically significant. For example:

— In 1977, Egypt had an overall density of 39 persons per square kilometer of its total land area; but due to the size of its deserts, this was actually about 1,276 persons per square kilometer of arable land.

— In 1992, the average density of the Shuar-Achuar population of the Morona-Santiago Province in the Ecuadorian Amazon was approximately 5.18 persons per square kilometer, but the actual density per square kilometer of legally entitled land was 18.7.

The way in which a population exploits and manages natural resources has major implications on its 'settlement pattern'. There are two basic types of settlement patterns:

— sedentary - people live permanently in a given place and continuously exploit the surrounding territory;

— nomadic - people move continuously over a large territory, and exploit its resources in a specific location only periodically.

A sedentary settlement pattern is typical of communities and societies that depend on agriculture for their survival. Nomadism is typical of herder populations who must constantly provide

forage and water for their animals. Pure sedentarism and nomadism are two ways of interacting with the environment that lead to opposing geographical distributions of populations. There are, however, many intermediate arrangements. Among the Batswana rural dwellers traditionally had a tripartite arrangement. During the cold part of the year, they were at the 'village', in the wet season at the 'lands' for planting and in the dry season at the 'cattle post' for herding. Many, if not most, rural communities combine a certain degree of nomadism and sedentarism.

Density and settlement patterns of human populations are also determined by economic and political factors. Not all the needs of a rural community can be fulfilled locally. Tools for working the fields, weapons for hunting animals, kitchen and housekeeping implements, clothes and personal commodities, drugs and medicine, and magic and religious salvation are almost always obtained through markets or trading centers that allow exchange with the external world. Contemporary slash-and-burn horticulturists, hunter-gatherers, nomadic herders and peasants with irrigated fields all depend, to a varying extent, on urban populations.

Access to marketplaces for selling rural products and buying urban-made commodities is, in fact, a key element in determining geographical location and distribution of rural settlements. In addition, denser urban settlements attract people because they provide political and military safety, as well as coordination of efforts for building and maintaining infrastructures.

Urban/rural interdependency has been a constant feature since the earliest urban centers and states. Modern technology and services that provide education, health, credit, and technical assistance have made towns and central governments ever more important to rural life. Still, many ecological, economic, political, and social problems affecting rural communities are deeply rooted in past and current inequities in the relationship between

village and town, community and state, and peasants and bureaucrats.

Migration

Migration can be a significant component of demographic change in small communities and a key factor affecting the way in which human populations relate to their environment. Immigration and emigration are not, however, usually documented routinely at the local level. Moreover, each local community is likely to have some unique migration characteristics. For many communities, temporary or even semi-permanent migration is a key survival strategy during periods of drought, natural disaster or civil disturbance. Based on the period of time involved, three main migration patterns can be identified:

— permanent migration (e.g., young adults leaving with their children to settle permanently in another location);

— temporary migration (e.g., men and/or women leaving for more than one year to find work and remit money to their families); and

— seasonal migration (e.g., active population looking for gainful employment for periods of less than one year).

In most developing countries, urbanization in the form of permanent emigration from rural areas to large cities has become a major trend, related to demographic, ecological, economic and socio-cultural changes. Southern Africa has seen rates of urban population growth that are double the overall growth of the national populations; because of wars, refugee movements and the social upheavals of apartheid, more than 40 percent of the region's population now live in urban areas.

Urbanization at these levels causes tremendous problems. Housing and other services are often unable to keep up with demand, leading to squatter settlements and unsanitary conditions. Urban and peri-urban areas strain the capacity of

accessing water and fuel resources. Cities also produce huge amounts of waste, polluting the water of rivers and lakes.

In the past 20 years, various agencies have attempted to control the trend towards urbanization by launching large-scale agricultural development, watershed management and colonization projects. The principal ration-ale behind these projects is the concept of integrating previously under-exploited regions into the national economic system. The 'surplus' of rural population generated by natural growth is supposed to be redistributed among these areas.

The socio-economic consequences of such ruralization initiatives are controversial and politically very sensitive. Resettlement and colonization, for instance, can be carried out at the expense of the pre-existing communities in the new settlement areas. These communities, which frequently consist of ethnic minorities, may be greatly affected by a large inflow of immigrants, which they do not have the political power to control or discourage.

Immigration may affect the natural resource base of these communities, bringing about resource scarcity and complex cultural changes, often with disruptive effects. Ethnocide or genocide of indigenous peoples are among the potential negative outcomes of colonization and resettlement.

Gender Roles and Sex Distribution

Women play an essential role in shaping the population outlook of a community. In addition to bearing and rearing children, they frequently take care of the sick and the elderly. Women are also the developers and custodians of a wealth of unique knowledge and skills, often closely related to the environment. Most cultures ascribe special responsibilities and roles for environmental care to women. Gathering water and fuel for household consumption is often exclusively done by women or girls. World-wide, girls and women are responsible for an

important percentage of food production, and in some communities this contribution can range up to 90 percent.

Nonetheless, women's economic contributions are too often underestimated. Development initiatives, and the attendant new technologies and increased economic power, tend to be taken over by men and may thereby worsen the role of women in society. The breakdown of traditional customs and rules contributes to their disadvantages.

For instance, female-headed households, which generally depend on a single income-earner, are likely to be among the poorest households. Environmental deterioration results in dramatic increases in the workload of women, who must travel further to gather fuel wood and spend more hours in carrying water. Women are generally omitted or relegated to minor roles in most development activities.

Although women supply the majority of the labor when local projects require it, they have the least access to information, educational opportunities or participation in decision-making. This is particularly unfortunate because women, as the principal caretakers of rural families, are extremely practical. If not excluded from the process, women could contribute a degree of common sense which is too often missing in development planning.

A gender analysis of population can be of great use in planning or implementing programs involving the use of natural resources, since in many societies access to and control over the resources are gender-based. Basic demographic questions about population and women can help to reveal the nature of the labor force, as well as gender-based roles in the household, in the community, and in various sectors.

A key indicator of women's status is education. In fact, a strong correlation has been seen in many studies around the world between mothers' formal education and decrease of infant and child mortality, decrease of household size, and increased acceptance of family planning and child spacing methods.

The sex ratio is an indicator of the sex distribution of the population, and it is defined as the number of men per 100 women. If it is under 100, it means that there are more women than men in the population; if it is over 100, there are more men than women. When the sex ratio dips below 90, it is often an indication of very high male out-migration. In such areas, it is common to see many female-headed households.

Table 1. Some indicators to assess women's status in the community

Topic	*Indicators*
Demographic indicators of women's status	— average size of family and household; — sex and age distribution of the local population; — average frequency of pregnancies and deliveries; — average interval between pregnancies; — maternal mortality rate; — abortion rate (especially induced abortions); — migration rate and gender-specific migration. . — average number of hours worked per day (work-load of women); — role in household decision-making;
Other indicators of women's status	— percentage of women involved in community development activities; — gender differences in employment rate and types of work; — percentage of women members of local political or development committees; — existence of gender-based segregation patterns; — existence of female genital mutilation practices and percent of women affected.

The difference between the number of births and deaths occurring in a given period of time is the natural population growth. This natural increase excludes changes in a population size due to migration. For the sake of comparison, natural population growth is usually expressed as a percentage increase with respect to the population existing at the beginning of the time period considered. A three percent rate of growth translates into a population doubling time of 23 years.

A negative rate of population growth, i.e., a natural decline in population size, occurs when the number of deaths exceeds that of births. This category of 'natural' population decline is separate from changes in population numbers due to migration or displacement. As human populations in the developing world generally tend towards increasing in size, negative rates of population growth are often the result of natural or man-made disasters.

Some population declines have been linked with severe environmental degradation, as for the lowland Maya of Yucatan during the ninth century AD. More recently, genocide has caused substantial population losses. 'Natural' population declines have also been observed in some affluent communities in developed countries. Population growth may also be equal to zero. The zero-growth situation, frequently termed 'population stabilization', develops when the difference between the numbers of live-births and deaths in a given period of time is equal to zero. This situation is an index of balanced population dynamics, which, in fact, is what has happened for most of mankind's evolutionary history, with high child mortality balanced against high fertility.

Today, births and deaths tend to balance in populations with an older age distribution in which each couple averages only two children that survive to reproductive age. This kind of zero natural growth, achieved by a reduction in both mortality and fertility attained throughout the globe, would be a powerful component of sustainable livelihood.

Population and culture

High numbers of offspring are encouraged in many rural communities. In fact, most ethnic and peasant groups worldwide set a high value on fertility. Among the Akan of Ghana, for example, a woman who gives birth to ten children is rewarded with 'the tenth-child sheep', so that she would not stop at the seventh, eighth, or ninth child.

In settings where no social security system is available, sons and daughters are the only security a parent has in his/her old age. Moreover, beginning in childhood, sons and daughters often work to provide additional income for the household. Once grown up, they play a major role in strengthening, through marriage, the social links between their parents' household and other members of the community. This often represents important economic and social advantages for the families involved, in terms of capacity to mobilize extra labor, exchange of goods and services, maintenance of property rights, social status, etc.

The economic and social advantages of high fertility are often embedded in deeply rooted social and religious values. With the exception of Catholicism, no major religious tradition contains an unequivocal and universally accepted prohibition against contraception. Even so, many traditional communities still rely on religion for arguments opposing the limitations on fertility and family size advocated by external development agents. For example, while religious scholars are divided on the attitudes of Islam towards contraception, the widespread belief among many practicing Muslims is that modern contraception is incompatible with religious teachings.

Until recently, only Western Europe and societies with European ancestry in the New World looked negatively on fertility. These societies are characterized by nuclear families, late marriages and parents contributing to their children's economic well-being: all factors that would favor smaller families and lower population growth. In contrast, the predominant family pattern in much of rural Asia and Africa is extended families,

early marriages and 'adult' children who economically assist their parents. These factors tend to encourage high fertility and high population growth rates. In both cases, cultural attitudes toward fertility appear based on the predominant social and economic conditions in a given community. In the long run, both cultural systems are unsustainable, because growth in either population or consumption cannot continue indefinitely into the future.

Throughout history, the high fertility of human beings has been balanced by both natural and cultural controls. Natural controls include biological determinants of natural fertility, such as women's monthly menstrual cycles, their nutritional status, and infectious or degenerative diseases. Culture, which broadly includes clusters of shared values and behaviors, controls fertility through practices related to conception, as well as to the care of fertile and pregnant women, infants and children. Cultural controls affect population dynamics in two complementary ways:

— by determining and shaping behaviors that result in the reduction of women's natural potential for fertility, e.g., late age of marriage and first births, prolonged breast-feeding, prolonged separation of parents after a birth, use of family planning methods, etc.

— by defining the sets of values, beliefs, and specific attitudes that influence the context of reproduction and parenting, e.g., perceptions of the best age to start parenting, stigmatizing new pregnancies that occur when the previous child is still breast-feeding, giving special names to persons who bear twins or triplets, etc.

Cultural regulation of sexual activity is the most direct means of controlling conception. In all societies, this is achieved through rules which limit potential sexual relationships. Age-at-marriage and sexual taboos preventing intercourse during specific periods can be considered mechanisms for controlling sexual activity, and therefore the potential for reproduction.

A second way of controlling conception by cultural means is contraception. Contraception also includes regulating sexual activity based on scientific or folk knowledge of reproductive anatomy and variations in fertility during the menstrual cycle, as well as contraceptive herbs and medications.

An important means of controlling conception, practiced by most pre-industrial societies, is prolonged breast-feeding. Folk wisdom in many regions includes awareness of the relationship between breast-feeding and length of post-partum amenorrhea. Research studies have shown that under favorable conditions, prolonged breast-feeding can result in birth-spacing intervals of three or more years, with a reliability comparable to modern medical and chemical contraceptives.

In addition, harsh living conditions tend to affect fertility. According to Harris and Ross, the way in which women are physically treated can raise or lower the age of the first menstruation, lengthen or reduce the period of adolescent sterility, increase or decrease the frequency of amenorrhea, and hasten or retard the upper limits of the fertility age. Variation in nutritional intake, physical workload and harsh living conditions may decrease fertility and increase the risks of natural abortion, maternal mortality and infant mortality.

In many rural communities, various traditional forms of planning and controlling births are far more prevalent than the modern methods. In fact, most individuals or couples who utilize modern methods are also likely to be using one or more of the traditional methods. Thus, measurements of the impact of family planning interventions that are only linked to levels of acceptance or use of specific modern methods may be of little value in determining actual practices that are regulating population size in a community.

Over-emphasis on modern methods can also lead to discounting traditional values in the community. A good method of assessing the effects of any intentional change in population control-related behaviors in a community is to measure birth

intervals, i.e., the average period of time between consecutive births among those women who are having children in the community. This can be a very sensitive measure at local levels, able to show changes rapidly and inexpensively.

Intra-uterine death and spontaneous abortion are high among human females, i.e., up to 25 percent of pregnancies during the first month. Although this pattern is partly due to natural anatomical and physiological factors, such a high abortion rate cannot be explained without taking into account the effects of harmful cultural practices.

Among such behaviors are not reducing the workload of women during the early months of pregnancy or not providing them with a high-quality diet. Additionally, intentional abortions are practiced in many cultures as a child-spacing device. The impact of these practices may reach far beyond the direct effects on the new life - unsafe abortions can cause anatomical and physiological damage that reduces a woman's fertility.

More or less deliberate infanticide has also been widely reported in historical and anthropological literature. In addition to direct killing, at least five other forms of infanticidal behavior occur in several cultures: placing an infant in dangerous situations; abandonment with little chance of survival; negligence resulting in accidents; excessive physical punishment; and lowered biological support. Not only infants, but also children are the victims of direct or indirect forms of homicide.

Concern over population growth is not new to the domain of public health. Since the late 1960s, when the assumption that a decrease in infant and child mortality would automatically lead to a reduction in the birth rate proved to be questionable, a family planning component has been added to most national health service delivery systems. In 1978, family planning was acknowledged by WHO as a basic element of comprehensive Primary Health Care, and some years later it was endorsed by UNICEF as a key component of its child survival strategy.

Nonetheless, in many countries - particularly those in Sub-Saharan Africa - the short-term impact of family planning programs on fertility rates has proven to be limited. Cultural acceptance, physical and financial accessibility for users, and costs of service delivery have been shown to be major constraints. Actual use of modern family planning technologies is the result of complex socio-cultural changes that sometimes unfold through generations.

Furthermore, important gender differences exist in many societies con-cerning the perceived advantages and disadvantages of having many children. Because women disproportionately bear the costs of child-bearing and child-rearing, they are often more interested than men in limiting and spacing births.

Today, there are high levels of unmet need for family planning among women in the developing world. Unmet need is a measure that represents the percentage of women of reproductive age who wish to space or limit births but who are not currently using a contraceptive method. The Program of Action that emerged from the 1994 International Conference on Population and Development emphasized that organized family planning programs are but one component of a broader strategy to stabilize population growth rates and improve well-being.

The other ingredients include improving women's status, expanding reproductive health services, poverty alleviation, improving infant and child health services, education of the girl child, and increasing male responsibility. Work on all of these fronts together is likely to have a greater impact on fertility than would investment in family planning alone.

Health Status and Quality of Life

Decreased mortality and a related increase in life expectancy are evidence of a general improvement in the health status of human populations. This phenomenon, which is in contrast to the sometimes apocalyptic news and images of poverty, disease,

malnutrition and death spread by the media, has intrigued demographers and epidemiologists and incited them to ask: "Why is mortality decreasing?"

Caldwell on a sample of 15 developing countries showed that a strong correlation exists between health success and the educational levels of women of maternal age, followed closely by the practice of family planning and the education of men, and to a lesser extent by the density of doctors and levels of nutrition. Per capita income seemed to have little effect. Based on these and other similar data, Murray and Chen suggested that improvement in health status is related to two types of health promotive assets:

— physical assets, including health-care infrastructure, schools, transportation facilities, housing, water supply and sanitation; and

— social assets, including education and health-related perceptions and behaviors.

The summative effect of physical and social health assets should be considered as the leading cause of recent mortality decreases in the developing world. Meanwhile, the example from Ghana shows that mortality and morbidity rates alone are not appropriate for describing the health status of a community. The definition of health as comprehensive well-being requires that health status be assessed not only in terms of decrease in mortality and morbidity, but also with respect to quality of life.

This raises some ethical dilemmas. King has suggested re-defining health as a sustainable state of well-being. This state can be achieved and maintained by keeping both population and consumption within the limits set by the carrying capacity of local environment. Public health interventions could thus be improved by including efforts aimed at limiting both population growth and the exploitation of the natural resource-base

Table 2. Some indicators of health status and quality of life at the local level

Topic	*Indicators*
Reproductive health	— average age at marriage, by gender; — average age at first and last birth; — average number of deliveries in women's reproductive life; — average length of child spacing, i.e., average duration of intervals between consecutive births to the same woman; — percentage of women who wish to delay childbearing or stop having children who are not currently using modern contraception; — percentage of women of reproductive age with access to health care and family planning services; — percentage of pregnant women without anemia; — percentage of deliveries with trained attendant at the birth; · percentage of pregnant women under age 25 who test negative for syphilis or HIV/AIDS infection.
Mortality and morbidity (conventional health status indicators)	— mortality rates (infant, child, maternal); — top five causes of morbidity and mortality by age group (infants, under-5s, adolescents 10-19 and adults); — rates of diarrhea or acute respiratory infection in children under 5; — incidence of vaccine-preventable diseases (i.e., whooping cough, measles and poliomyelitis) in children under 5; — prevalence of TB in different age groups; — prevalence of malnutrition in 1-5-year-old children;

- prevalence of anemia in pregnant women;
- incidence or prevalence of endemic diseases (such as malaria, schistosomiasis, guinea worm, leishmaniasis, leprosy, etc.) in different age groups;
- prevalence of alcoholism and drug addiction (by age and gender);
- accidental death rate (by age group and gender);
- rates of intentional deaths by age and gender (homicide, suicide).

In addition to considering the ethical dilemmas which population management and health promotion situations pose, some point out that the conventional definitions of health are incomplete. Health equated to "absence of disease" or defined in Primary Health Care as "complete physical, mental and social well-being" does not include one fundamental aspect: that the health of a human community is directly linked with the health of its natural and social environment.

Together with conventional 'negative' health status indicators such as mortality and morbidity rates, positive indicators of health could thus be examined, focusing on issues such as reproductive health, sustainable use of natural resources and satisfaction of basic needs. A non-comprehensive example of a list of indicators for assessing health status and quality of life at the local level is provided in Table 2.

Management Status of Natural Resources

This section briefly illustrates the management status of some natural resources of great importance for human populations. Ideally, sound management incorporates both preservation and sustainable use, i.e., the maintenance of viable ecosystems capable of sustaining biodiversity and providing resources for future generations, coupled with uses of such resources to satisfy today's needs.

Water

The current world supply of renewable fresh water per capita is only 60 percent of what it was in 1970. Water is becoming scarce due to growing populations, increasing demands for agricultural and industrial use and inefficient water management. At the local level, specific causes may include man-made changes in watersheds (e.g., dams, irrigation systems), changes in vegetation coverage (deforestation, erosion), increased pumping of underground water, and waste in water distribution systems.

Decreased availability of water is coupled to worsening of water quality. Excessive exploitation of surface and underground water for irrigation purposes may lead to salinization and water logging due to poor drainage. Increased use of surface water by human and livestock populations increases the risk of biological contamination of streams, ponds and lakes. Uncontrolled industrial and agricultural use may cause chemical pollution of both underground and surface water. Community-based initiatives for improving local water management may include:

— protection of water sources (e.g., building a cement cover and outflow pipes for a spring so that animals and people do not contaminate the source);

— construction of rain-water harvesting systems (e.g., a system of pipes or channels to capture water from the roof of a house and store it in a cistern);

— improvement and maintenance of water distribution systems (e.g., providing ideas about the technology of a water system, labor for its construction, and arranging for the training of local mechanics to maintain the system):

— monitoring of the quality of water for human consumption;

— building appropriate human sanitation facilities (e.g., latrines, toilets);

— afforestation, building bunds, and contour plowing for increased soil moisture and groundwater recharge.

Another important natural resource linked with water is wetlands, e.g., swamps, sloughs and shorelines. Many useful items are extracted from wetlands, e.g., food (fruits, meat, fish), building materials (trees, reeds), water (for irrigation, drinking, washing), traditional medicines, etc. In addition, wetlands are important locations for cultivation and dry-season grazing.

For instance, the moist dambo lands along the upper valleys of streams in Malawi are able to produce two crops per year compared to the single growing season on the surrounding eroded and semi-arid hillsides. Wetlands, and the plants and animals which are adapted to such regions, are under tremendous pressure from expanding populations. Drainage for agriculture is estimated to have resulted in the loss of 26 percent of wetlands worldwide.

Soil

Between 1945 and 1990, over one-tenth of the world's vegetated land has suffered at least moderate soil degradation as a result of human activity. Cultivation has reduced the world's pre-agricultural supply of organic carbon by about 15 percent: about 60 billion tons of soil carbon have risen from the soil to the atmosphere as climate-warming carbon dioxide. In recent times, the most widespread soil degradation has occurred in Asia and Africa, mostly because of extending agricultural frontiers, overgrazing and deforestation. At the local level, processes of soil degradation may include:

— decrease in depth of the humus stratum (the unconsolidated mineral and organic material on the immediate surface of the earth, which serves as a natural medium for the growth of plants);

— decrease of soil fertility and productivity (fewer varieties of plants will grow and their yields are lower);

— increase of the surface exposed to erosion phenomena (i.e., total wash-out of the humus stratum); and

— desertification (the extension or development of barren lands in areas previously covered by vegetation).

Soil conservation and recovery action is usually undertaken in the framework of extensive public-works programs. Actually, conservation measures usually require a surplus of land or labor, which cannot generally be afforded by small-farmer household economies. Even so, if sound income-generating incentives are provided, relevant initiatives can be implemented at the local level with limited investments. Community-based initiatives for soil conservation and recovery may include:

— building slow formation terraces on slopes;

— gully and land-slide control (e.g., by contour farming, small-scale afforestation, planting soil-binding grasses in high-risk areas, etc.);

— improvement of cultivation practices (e.g., planting wind-breaking hedges, introducing nitrogen-fixing crops);

— promotion of biological and/or proper chemical manuring;

— introduction of crop-rotation;

— improvement of irrigation and drainage systems;

— introduction of stable livestock-rearing technologies.

Before introducing new soil conservation technologies, it may be crucial to determine whether the local culture is familiar with techniques and means to control erosion and maintain fertility of the soil. Reviving and strengthening peasant know-how in this area is often the best way of dealing with problems related to soil management at the local level.

Forests

Before the agricultural revolution, forests were the most prevalent

biome on Earth. Currently, only 9.4 percent of the planet's surface is covered by forests. Over the centuries, due to the growing demands for large-scale timber production and agricultural land, forests have been replaced by secondary woodlands, savannah, pasture areas and cultivation. Timbering for local uses and fuel wood has also contributed to deforestation, especially around settlements.

Today, deforestation continues, despite widespread awareness of the many environmental benefits provided by forests, such as:

— protection of watershed and regulation of water flow;
— prevention of soil-erosion;
— contribution to the balance of the carbon cycle; and
— giving back moisture to the atmosphere.

Forests also provide important economic benefits to local communities, such as game, wild fruits, mushrooms, timber, fuel wood and other vegetal products. Sustainable exploitation of the forests is a basic component of local subsistence strategies, especially in the tropics, where a significant proportion of dietary proteins and micro-nutrients is obtained through hunting, fishing and gathering. In addition, forests supply well over 90 percent of the total energy used for domestic purposes in poorer nations.

Large-scale reforestation and afforestation are strategies at the national level for improving forests. Frequently, however, these plans clash with the short-term interests and immediate needs of local communities. An important alternative is the community forestry approach. In this community-based strategy, local people are actively involved in planning and managing activities that, on the one hand, protect the forest as a whole and, on the other, assure them access to fuel, food and other forest items necessary for livelihood and income-generating activities.

Forestry management can be an opportunity for community development. Since a forest is better protected as a whole than in isolated patches, forestry activities offer the rationale for organizing (e.g., in a local users' association) to distribute the benefits that come from the forest (e.g., fodder or water) in an equitable way. The objective of community forestry is to promote sustainable use of forest areas by the local population. Conservation of the forest base thus represents a means of:

— ensuring availability of fuel, building materials, and other goods (e.g., forest foods, traditional medicines, etc.);
— providing the environmental stability necessary for food production (e.g., maintaining the water table, preventing erosion, etc.); and
— generating income and employment.

To achieve the above objectives, agro-forestry technologies have been developed, often on the basis of local knowledge. These include:

— semi-cultivation of timber and other valuable species;
— management of animal and vegetal species important to the local diet;
— improvement in the efficiency of cooking-stoves;
— selective cutting of trees for timber and fuel wood;
— pest and fire control; and
— development of ecological tourism.

4

Matrices of Historical Trends

Historical trends matrices often show that local people recognize long-term trends in their environment and in their interaction with it. They usually have hypotheses about the causes of such trends, even if they do not fully understand the causes. Trends matrices are a good example of an information-gathering tool that is also in part an analytical tool; they automatically organize environmental information in a way that helps people think about cause and effect, and identify problems and opportunities.

Creating trends matrices using participatory techniques can be an effective way to assess people's awareness and knowledge of an environmental trend. This assessment is important because the assumption that people lack knowledge and awareness is often used to argue for environmental education activities.

Wealth ranking is a simple method of gathering information about perceptions of socioeconomic status at the village or community level. Key informants are asked to sort cards with the names of each household in the community into piles representing wealth or well-being categories. Comparing the results of the rankings obtained from a number of key informants can give a fairly accurate picture of the socioeconomic situation at the local level.

A number of techniques can be used as part of a participatory process to rank, prioritize, or quantify importance. A pairwise ranking tech-nique using a matrix format to compare

a number of threats to sustainability was used in the Ranomafana National Park area of Madagascar.

Decision trees and flow diagrams are tools for systematically asking questions or gathering information. Typically, a question is asked, and depending on the answer to that question - often "yes" or "no" - the tree of questions forks or branches to a pair of questions. Each of these likewise can be answered "yes" or "no," leading to further branches of the tree.

In various combinations, have been developed for, or combined into, what could be called "methodologies." Methodologies are approaches to social assessment, each of which uses a suite of diverse information-gathering and analytical tools. Some of these methodologies also involve the planning, implementation, and evaluation of activities, projects, and programs.

Rapid Rural Appraisal

Rapid rural appraisal, or RRA, was developed to fill the gap between highly structured, quantitative methods of social research and the informal, rapid, intuitive assessments of rural situations that are sometimes used by development agencies. "RRA recognizes that a certain amount of rigor is essential in order to have confidence in the results of a field study and to persuade other people of their validity. But, it also believes that intuition and a certain informality and flexibility are essential to obtaining quality information from the field.

Thus RRA offers methodological guidelines intended to improve the quality of information gathered, but it also insists that there can be no 'cook-book' guide to its use. Such a crutch would dangerously inhibit the flexibility and creativity which are pillars of the method". RRA was developed in part to obtain accurate information at low cost in terms of time and money.

In practice, RRA makes use of interdisciplinary teams that use a range of methods, including a number of those discussed

above. Semistructured interviews "may be the only tool used in every RRA". RRA typically avoids formal surveys and questionnaires, substituting more qualitative and flexible techniques such as semistructured interviews. In RRA Notes to Accompany Introductory Training Module, Karen S. Freudenberger and Bara Gueye present a list of key RRA concepts, including the following:

— it is a learning process that takes place in the field; information is analyzed as it is collected in the field

— it tries to tap local, indigenous knowledge

— it is iterative; RRA "encourages the team to change its approach and revise its hypotheses" in the field as new information becomes available

— it is multidisciplinary

— it is flexible, innovative, and exploratory

— it strives for rapid results that can inform decisions and actions

— it encourages participation

"Triangulation" is an essential methodological concept in RRA. "...looking at something from only one perspective introduces serious biases into the analysis. If you can introduce two, three, or even four different points of view into your analysis, you will begin to get a more complete and more accurate picture of the situation you are trying to understand". The composition of the RRA team can be triangulated by selecting members of different disciplinary backgrounds, both men and women, and both insiders and outsiders - people who know the local situation well from experience, as well as people who do not and so can bring a fresh perspective. Using a diversity of methods can help overcome the biases inherent in any single method. Encompassing all the social diversity present in the situation - learning from both men and women, young and old, well off and poor, for example - is also an important kind of triangulation.

"Optimal ignorance" is another key concept of RRA, according to Freudenberger and Gueye. This is the argument they give for choosing to remain ignorant of some factors that could be studied: "Because the team is trying to get as much useful information as it can in a short time, it is essential that it focus on what is most important - and leave the rest aside. The funny, almost backward phrase, 'optimal ignorance' is a reminder that we can't learn and don't need to know everything in a brief field study. The team must be willing to remain ignorant in some areas, in order to spend time on other things which are more important".

On a rapid rural appraisal carried out in Senegal provides a number of examples of how this method can be used to identify and focus on important natural resource management behaviors. The RRA identified many practices farmers used to conserve and regenerate natural resources, including fallowing, crop rotation, spreading manure on fields, rotating cattle among fields at night to fertilize the fields, cutting firewood in a certain way from certain tree species to encourage resprouting, and carefully protecting certain tree species when fields are plowed. This RRA exercise also developed a list of behaviors used to secure rights of possession to both trees and land. An excellent source for examples of the use of methods and tools of rapid rural appraisal is Tree and Land Tenure: Rapid Appraisal Tools.

Participatory Rural Appraisal

Participatory rural appraisal, or PRA, and rapid rural appraisal are closely related methodologies. According to Robert Chambers, "RRAs began as a better way for outsiders to learn. In answering the question 'Whose knowledge counts?' they sought to enable outsiders to learn from rural people and to make use of indigenous technical knowledge to assist outsiders' analysis. Its mode, however, is mainly extractive. Outsiders go to rural areas and obtain data from the local people, bring it away, and process it....

The knowledge of rural people counted but for the outsiders' use. They were the ones that could carry out the analysis and provide the solution. Recognizing the weakness of leaving this responsibility to the outsiders, PRAs evolved. Outsiders still go to rural areas, but more and more as learners, conveners, catalysts, and facilitators".

The goal of PRA is to "help rural communities define problems, prioritise project activities, and adopt village-based resource management plans". In practice, PRA is a semistructured process conducted in the field, usually involving a number of steps. First, a PRA team visits the site and holds planning meetings, initially with local leaders, then with other local stakeholders. Such teams are typically multidisciplinary, composed of technical specialists from external institutions such as donors, NGOs, and project implementing agencies. The team gathers information, including simple spatial data, such as sketch maps prepared with local peoples' help, and time-related data, such as seasonal calendars and trend lines.

Household interviews are usually carried out, and a local institutional analysis is done. Visual tools such as maps, trends matrices, and calendars help the team organize information and present it to the community at meetings. The team uses a variety of techniques to help the community define problems, prioritize those problems and the opportunities for solving them, evaluate local capacities for solving them, and prepare a systematic action plan for the community to adopt and implement.

The use of participatory rural appraisal is becoming more widespread, and many excellent sources of information about this evolving methodology are available. "While PRA has grown from a research focus ... it has developed beyond that and is used in planning, implementation, moni-toring and evaluation of work with communities.

Like rapid rural appraisal, PRA is meant to be a relatively rapid method of assessment. While this speed has advantages, an appraisal that is too quick and superficial may fail to

understand the complexities of a community's behaviors. No matter what the methodology, a day or week of research can never produce all the information that a month, year, or decade yields. A danger is that people may take the results of rapid appraisals more seriously than they should. Another issue is that building trust and rapport and developing active community participation take time.

Participatory research has many affinities with the RRA and PRA methodologies described above. Not only are many of the same information-gathering methods and tools used in these approaches, but they have similar philosophical orientations as well. For example, participatory research emphasizes local people's participation in, and ownership of, the research process and results as do both RRA and PRA.

Rapid rural appraisal "encourages researchers to view their informants not just as objects of study, but as participants in the research process. They should be included as fully as possible not only in the collection of information, but also in its analysis.

"Participatory action research" (PAR), one "school" of participatory research, is "a process of research, education, and action conducted by a community of relatively powerless people in collaboration with specialized researchers. Its goal is to generate new understandings that guide the community in its struggle for survival, opportunity, and empowerment". Participatory action research is distinguished from conventional social science research in four ways:

— Knowledge is pursued as a means of social change.

— Community members as well as those with specialized training are researchers; together, they define, plan, and conduct the research; analyze and evaluate data; and decide what course of action to follow.

— Knowledge can be obtained through both scientific and indigenous methods.

— The research process and products are owned by the community, not outside researchers.

Rapid rural appraisal and participatory rural appraisal have evolved in the direction of participatory action research in the work of an NGO called MYRADA in South India. "What was required was a method which did not stop just at the 'appraisal' but which went beyond it into a shared analysis and understanding of rural situations. This, in turn, should lead to development activities that are creative, productive, and sustainable over a period of time". MYRADA calls its adaptation of RRA and PRA "participatory learning methods."

Participatory Planning

Participatory planning and decision-making methods involve a diverse group of stakeholders from the very beginning of the planning process. Participatory planning is sometimes called "open decision making." An open sharing of information is required, with the group generating and evaluating alternatives and trying to reach a consensus about a solution. Guidelines for participatory problem solving include the following:

— encouraging frank exchanges among all parties, especially at the beginning before positions harden

— encouraging parties to share information

— identifying opportunities for joint problem solving

— clarifying how decisions are reached by making the decision-making process transparent

The main advantage of this process is that it "gives all participants full access to information and the opportunity to participate in dialogue about and resolution of issues". In the United States, decision makers are required by laws such as the National Environmental Policy Act (NEPA) to share decision making with the public. Jeff Sirmon and his co-authors suggest

the relevance of this kind of process: "Controversy and conflict over resource decisions appear to be intensifying.

To counter this, we need to find new ways to get people to talk to one another about what they really want from the forests, and find effective ways to engage them in civil dialogue and mutual education about their needs and values". In confronting difficult policy issues, people must struggle with "their orientation, values, and potential tradeoffs.... Only the group - the relevant community of interests - can do this work".

By trying to build consensus about solutions to specific problems, participatory planning highlights true differences of interest or goals. The process recognizes that disputes are inevitable and potentially useful. Meanwhile, it helps to avoid the kind of negative attitudes that top-down management styles sometimes create. It often improves the quality of decisions and solutions by increasing the quality and quantity of information that goes into them. Finally, it can increase all parties' commitment to solutions, since all parties played significant roles in crafting those solutions.

Some approaches to environmental education merge into participatory decision-making and problem-solving processes. Because these processes require key actors and interested parties to share information and communicate, they naturally include an educational dimension.

Participatory planning does have some drawbacks. One major disadvantage is that reach-ing a decision can take much longer, and reaching consensus may not even be possible. If poorly designed, participatory planning processes can do more harm than good. Public hearings or debates can polarize communities. The result can be bargaining between rigid positions instead of an exploration of mutual interests and mutually beneficial solutions.

Another problem is that most methods used in participatory planning were developed for literate audiences. Administrators use flip charts or other written records to maintain a "group

memory" and to help organize and communicate ideas rapidly, for instance. Methods that allow illiterate audiences to participate are more difficult and less well developed. An interesting example of one such method is the GRAAP Technique, developed by the Groupe de Recherche et d'Appui á l'Autopromotion Paysanne, a French private volunteer organization based in Bobo-Diolasso, Burkina Faso.

This group "has developed an extension education method called the GRAAP Technique, which uses visual images to teach illiterate people and to promote self-help efforts in rural communities. Foresters in several West African countries have used the GRAAP Technique to help rural populations become increasingly aware of the utility of trees and the consequences of desertification on their lives and to promote forestry programs by involving rural people in planning and decisionmaking processes".

Promoting Sustainable Behaviors

This section has focused primarily on the assessment and research stage of the process of understanding and influencing conservation behaviors because we found that too often conservation projects have started implementing activities without careful attention to assessment. Only when at least some assessment and research has been done can conservation practitioners plan appropriate and feasible actions. Planning involves matching available resources with activities and actors to influence the factors that motivate critical behaviors. Using resources to carry out activities with actors is the implementation stage of the process. Different kinds of activities are needed depending on which factors are key determinants of critical behaviors. A number of general types of activities, each of which is most appropriate for influencing one or several of the factors that motivate behavior, will be discussed below:

— influencing knowledge, values, and social norms: education, communication and social marketing approaches

— influencing sociocultural factors: education, communication, and social marketing approaches
— influencing options and skills: extension, training, and technical assistance
— influencing economic factors: enterprise development, markets, and incentives and disincentives
— influencing laws and policies: legislation and policy reform

When stakeholders differ widely in their values, interests, and views about what should be done, resolving disputes may be the most appropriate and feasible thing to do, at least as a first step. In those situations it may make more sense for conservation practitioners to support a process of resolving natural resources disputes, rather than an educational campaign or new enterprise development scheme.

A framework or typology of activities for influencing behavior, based on research in behav-ioral science in the past two decades. Some argue that such a typology is needed because the research they reviewed suffers from "lack of a clear organizational framework for studying the applicability of behavior-science techniques to the complex domain of environmentally relevant behavior." Their typology differs somewhat from that used here. It categorizes activities according to whether they change "antecedent conditions" that affect behaviors, such as information, goals, and commitment, or "consequence conditions" such as rewards and penalties. They also conclude that while many activities appear to influence behaviors for short periods, much more research is needed on how to make behavior change more permanent.

Behavioral psychologists have found, for example, that while it is often possible to achieve short-term behavior change with the use of incentives such as monetary rewards or disincentives such as fines, such behavior change isn't very durable. It often disappears if the incentives or disincentives are removed.

To influence behaviors, practitioners and communities must design activities that somehow lower the barriers to sustainable decisions, practices, and actions or that raise the benefits of sustainable behaviors or that do both. The inputs and activities of one group of stakeholders, the promoters of sustainable natural resources management and conservation, are exchanged with other stakeholders - natural resource users, policy makers, or other environmental actors - for behavior maintenance or change.

Natural resources managers and conservationists could be thought of as producers of certain values and benefits that are exchanged for something from other stakeholders. This concept of behavioral exchange is well devel-oped in the field of social marketing. As stated, one of the fundamental assumptions of our study is that people behave in ways they perceive to be in their own best interest. Thinking of activities aimed at influencing people's behavior as transactions or exchanges is a way of respecting them while still trying to influence what they do.

In the planning and implementation stages of the process, it is useful to remember that tak-ing a positive view and emphasizing opportu-nities rather than problems is an underexploited approach to conservation and natural resources management. Practitioners should look for sus-tainable behaviors to maintain, promote, and enhance, not just unsustainable practices to change.

It is also important to remember that complex mixtures of factors, rather than one single factor, often act as benefits and barriers to motivate a given behavior. Moreover, since communities are not homogeneous, different actors perceive different mixtures of benefits and barriers for the same behavior. The problems of multiple factors and of complex mixtures of benefits and barriers usually means that no single strategy or activity will be sufficient. Practitioners and communities seeking to promote environmentally sustainable behaviors may, therefore, have to plan and implement activities to affect several kinds of factors that influence behavior.

Recognizing the need to influence several factors based on adequate assessment is very different, however, from taking a "shotgun" approach to changing conservation behavior, in which a spectrum of activities ranging from environmental education to economic incentives and legal and policy reforms are automatically planned.

Influencing Values, Knowledge, And Social Norms

Environmental and conservation education is often viewed as one of the main ways to influence people's behavior toward the environment and thereby solve natural resource management problems. Most integrated conservation and development projects have an education component.

In some people's view, the primary role of environmental education is to convey information and improve knowledge. Such an information-only view of environmental and conservation education has not been sufficient, in many cases, to create good natural resources management practices because it is based on the assumption that knowledge is the key factor determing behavior.

Those with this view assume that programs to teach people about the problems caused by deforestation would lead them to stop cutting trees and start planting them. Giving people new information, however, does not necessarily change their behavior. In the complex and often difficult situations in the real world, especially in poorer regions, this strategy often did not work. People sometimes were aware of the problem and knew they should not cut trees, but they needed more land for growing food crops and fuel for cooking their food, and had no alternatives. So they cleared forests despite their knowledge, because other motivating factors were overriding.

Most environmental educators have recognized the inadequacy of the simplistic assumption that giving people more information will automatically influence their behavior.

Throughout the world, however, it is still easy to find examples of environmental and conservation education programs based on such an assumption.

Modern Environmental Education and Communication

Modern environmental education recognizes that environmental behaviors are influenced not only by knowledge, but also by values, options, skills, and many other motivating factors. Modern environmental education attempts, therefore, to communicate more than just knowledge. It is "a process that enables people to acquire knowledge, skills, and positive environmental experiences in order to analyze issues, assess benefits and risks, make informed decisions, and take responsible actions to achieve and sustain environmental quality".

Another way to describe the goal of environmental education is "to motivate people to implement solutions to environmental problems". Modern environmental education is concerned with communicating environmental values and ethics, not just knowledge and information. A recent chapter in the UNESCO-UNEP Environmental Education Newsletter, titled "A Universal Environmental Ethic: The Ultimate Goal of Environmental Education," illustrates this important trend. Harold Hungerford and Trudi Volk synthesized recent research on environmental behavior and found that the research suggests three main kinds of factors contribute to behavior change:

— "entry-level" factors, which include environmental sensitivity, awareness, and knowledge of ecology

— "ownership" factors, which include in-depth personal knowledge of, and personal "investment" in, environmental issues

— "empowerment" factors, which give people the sense that they have the power and skill to act in ways that will resolve environmental issues

Entry-level factors appear to be prerequisites for making sound environmental choices. Environmental sensitivity, described by Hungerford and Volk as "an empathetic perspective toward the environment" - in other words, perhaps, a strong general sense of environmental values - is a somewhat troublesome factor for many traditional educators because this sensitivity does not seem much affected by formal environmental education.

Instead, developing environmental sensitivity seems to require contact with, and positive experiences in, natural environments over long periods of time, according to Hungerford and Volk. They note that knowledge of ecology, while apparently a prerequisite for sound environmental decisions, "does not, in itself, produce environmental behavior."

Ownership factors are related to personal relevance, understanding of, and identification with, environmental issues. Economic benefits or costs can make certain environmental issues very relevant to individuals, but so can other kinds of less tangible environmental values.

Empowerment factors are crucial in influencing environmental behavior, and one of the best predictors of behavior is "perceived skill in using environmental action strategies." Such skills are fairly easy to teach, but they are "often neglected in educational practice". A person's belief that he or she will experience success in carrying out a certain action is related to empowerment. Of course, such a belief is reinforced by the actual experience of success.

Finally, Hungerford and Volk recognize that what they call "situational factors" - the many other factors that can potentially act as behavioral benefits and barriers - interact with the entry-level, ownership, and empowerment factors to determine environmental behaviors.

Hungerford and Volk critiqued current environmental education methods in light of those research findings. They found that most environmental education focuses almost exclusively at the knowledge and awareness level, which tends to be

ineffective in changing behavior. Too few environmental education programs, either formal or nonformal, "incorporate serious attempts to develop ownership and empowerment in learners". Kathleen Blanchard and Martha Monroe make a similar point: "Most education programs only provide information in an attempt to change attitudes without regard for social norms, group leaders, communication channels, intrinsic motivations, etc. Actually, most education programs try to reach such a diverse audience that these elements are rarely identified, known, or manipulable."

A study developed a database of USAID-funded projects in Africa with environmental education and communication components. Few USAID-funded environmental education and communication activities, at least as reflected in project documentation, are making full use of modern concepts of environmental education, communication, and social marketing. They are therefore not likely to be as effective as they could be. If assessment shows that a lack of knowledge is a barrier to the adoption of a new behavior or maintenance of an existing one, providing information is a logical strategy for influencing behavior.

Even if lack of knowledge is identified as a key factor that influences a critical behavior, providing information in a form appropriate for a given audience can be a complex task, requiring further social assessment to be done effectively. Questions about what messages and communication channels to use, for example, must still be answered. An excellent example of an environmental education and communication approach that helped solve a wildlife management problem in a complex cross-cultural setting comes from the Yukon-Kuskokwim Delta of Alaska. In this case, an Interagency Information and Education Task Force played a major role in implementing the Yukon-Kuskokwim Delta Goose Management Plan, which restricted the harvest of several species of geese whose populations were declining. Fifteen diverse case studies of the use of education and communication approaches in international wildlife

conservation are described in Conserving Wildlife: International Education and Communication Approaches.

Environmental Social Marketing

Environmental educators have learned a lot from the fields of behavioral psychology and social marketing in recent years. This is especially true of educators interested in the growing field of nonformal environmental education, which typically occurs outside of schools and targets diverse audiences that include adults.

Social marketing can be defined as "the analysis, planning, implementation and control of programs designed to create, build, and maintain beneficial exchange relationships for the purpose of achieving ... the adoption of a social idea, service, or practice". In environmental social marketing the "product" might be tree planting, water conservation, use of terracing to reduce soil erosion, or having fewer children. Environmental education activities sometimes target a broad audience, such as all primary school students. In contrast, social marketing programs tend to target the specific groups practicing specific behaviors. Broad audiences can be broken into smaller subgroups, or "segmented," according to a variety of characteristics, including demographics, behavior, or geography.

Identifying specific audiences and doing thorough audience research makes possible a careful tailoring of messages that directly address the values, beliefs, and needs of the target audience. Audience segmentation and research have been neglected in many environmental education and communication campaigns. Social marketing makes extensive use of the concept of behavioral "exchange." Social marketers believe that people will change their behavior when someone offers a benefit they want in exchange for the behavioral change. If social marketing can show that the costs of changing a behavior are less than the benefits, people are more likely to change. Although a social marketing campaign may try to change people's knowledge,

social marketers recognize that transferring knowledge is often not enough of an exchange to change a behavior.

Environmental education and communication and environmental social marketing are complementary, not competitive, processes. "Tools that are commonly associated with social marketing may enhance the ability of environmental educators to target their efforts and set realistic goals for themselves, even if the social marketing framework is not adopted intact".

Balancing Short-Term and Long-Term Approaches

Lori Mann suggests that some environmental issues are acute issues, such as the imminent extinction of a species or extremely rapid local deforestation. These are immediate and specific problems in a particular place that demand quick attention and action. Mann suggests that the targeted strategies of social marketing may be most appropriate to address those issues. Other issues, such as the loss of tropical rainforests or the destruction of coral reefs, "may imply a longer time frame, a broader range of behaviors to affect, or a less specific population focus." These, she suggests, "may be more appropriately addressed with environmental education techniques and materials aimed at certain issues, but not designed for specific populations." In any case, she argues, practitioners should "choose strategies appropriate to different types of issues." Mann also suggests that it might be possible to "work with large learner populations to give them generalizable skills to apply throughout life with all environmental issues".

Considering a specific case may illustrate some of the complexity of short-term versus long-term approaches. In some African countries extracurricular wildlife clubs for school children have existed since the colonial period. These clubs, it has been argued, change the way children feel about wildlife, and some of these children may make decisions affecting their country's wildlife decades later when they become adults. In

some cases, long-term educational approaches like wildlife clubs may set the stage for sustainable natural resources management later; in other cases, by the time the children grow up to be decision makers, wildlife may be gone.

The synthesis of research on environmental education by Hungerford and Volk sug-gests that both long-term and short-term processes have a role to play in fostering environmentally sustainable practices. Long-term activities that develop environmental values and sensitivity are needed, as is education to develop environmental knowledge. But such activities alone are not sufficient. The research strongly suggests that environmental education programs need to reach beyond knowledge and do a much better job of influencing ownership and empowerment factors on shorter time scales. There seem to be some successful methods for doing so.

Most natural resource and conservation issues have both short-term and long-term dimensions. Focusing on only one of those dimensions may not be sufficient. An environmental education and communication program that offers a balance between long-term and short-term approaches to influencing behavior may ultimately be the most effective.

Traditional environmental education has not always been successful partly because it has often emphasized influencing behavior in the long term rather than short term. Developments in environmental education that bring in lessons from psychology and social marketing about influencing behavior in the short term can be viewed as attempts to balance long-term approaches with short-term ones.

Influencing Sociocultural Factors

Assessment may show that sociocultural factors such as traditions, customs, beliefs, and taboos are keys to influencing critical behaviors. Sociocultural factors are perhaps most closely related to values and social norms, factors that were discussed earlier. Just as for values and social norms, education,

communication, and social marketing approaches seem the most appropriate for influencing sociocultural factors. Planning and implementing activities to influence sociocultural factors abound with ethical complications and dilemmas, however.

In some cases, sociocultural factors motivate sustainable decisions, practices, and actions. Some describes a general "reverence for natural resources" in many African societies. "The reverence of Africans towards nature and natural places was a religious attitude and practice which, while it developed around the religious thought and history of a particular social group, indirectly served other social functions in the whole community. In the case of shrines and initiation rite centres, taboos developed around the destruction of trees, shrubs, and the sacred places themselves.

The forests, certain kinds of trees, animals, and sources of water were preserved in the name of religion." In Madagascar, taboos and beliefs in some tribal groups are important motivations for protecting lemurs. In Ghana and throughout much of Africa, people conserve certain forest areas because they view them as "sacred groves".

Some actors and stakeholders outside of that cultural group may hold values - of progress, development, or modernization, for example - that put them in conflict with efforts to maintain the traditional cultures. International human rights law, however, generally supports the ethical right to maintain one's culture. Sociocultural traditions, customs, and beliefs do not always lead to ecologically sustainable behaviors, however. They may once have motivated sustainable practices in the context in which they developed, but given the rapid changes that have occurred in both the social and ecological contexts of many cultures, that may no longer be true.

One possible example mentioned earlier comes from Madagascar, where conservation practitioners working in some areas would like to change the traditional practice of maintaining large cattle herds for funerary sacrifices. Those cattle do not

contribute much to the quality of every-day diets, they argue, but have a large negative impact on the environment. Cases in which it appears that changing sociocultural factors would enhance sustainability require especially careful assessment and research. And, even if that assessment convincingly demonstrates that sociocultural factors motivate unsustainable behaviors, there are still ethical dilemmas. One consideration has to do with the human right to culture. Another has to do with the systemic nature of culture. Changing a sociocultural factor to influence one critical environmental behavior may lead to other social, economic, or political changes that have even more serious impacts on natural resource sustainability than the target behavior did. Without a perfect understanding of the dynamics of the social system - an impossibility - such sociocultural tinkering can be counterproductive. This is the so-called "precautionary principle" as applied to social systems.

Despite the ethical complexities, practitioners and communities working toward sustainable natural resources management - as actors and stakeholders themselves - will undoubtedly be faced with situations in which they will seek to influence sociocultural factors, just as they will seek to influence values, social norms, laws, policies, and economics, and other factors that motivate behaviors toward the environment.

Influencing Options and Skills

In many cases it may not be values, lack of knowledge, or social norms that lead to unsustainable behaviors. Assessment and research may instead identify lack of options and alternatives or lack of skills as barriers to maintaining or adopting sustainable behaviors. In such cases, providing viable options through extension programs or technical assistance, or imparting skills through training, are logical activities for influencing behaviors.

Hand washing required a lot of water, which took time and effort to carry home. Reducing this barrier seemed likely to increase the practice of hand washing, so health promoters

introduced a simple hand-washing device originally developed in Africa that dramatically reduces the amount of water needed for hand washing, and thus the amount of time women must spend carrying water home. In this case, a technological alternative was a way to reduce the costs of hand washing and promote behavior change.

Cheetah Conservation

The Cheetah Conservation Fund (CCF) is a nongovernmental organization focused on cheetah conservation. Cheetahs are an endangered species, and Namibia has the largest number of cheetahs in the world - approximately 2,500 individuals, estimated to be about one-fifth of the total world population. Cheetahs eat small game such as springbok, the young of some larger antelope species, warthogs, hares and rabbits, and game birds. Ironically, the best cheetah habitat in Namibia is in the heart of the livestock farming country on the plateau north of Windhoek and south of Etosha National Park.

Land here is mostly privately owned by white farmers. In other parts of Africa the main threat to cheetahs is habitat destruction or lack of prey, but in this area the main threat is from farmers shooting or trapping them as livestock pests or because they reduce the amount of game on their land. From a base on a farm in the area, CCF co-directors Daniel Kraus and Laurie Marker-Kraus are engaged in research and educational activities to help protect cheetahs.

"The Cheetah Conservation Fund has concentrated its efforts in working with Namibia's farmers. Our motto is 'We Can Live Together,' and this means preserving the livelihood of the farmers while also securing habitat for the cheetah. The Fund's approach can be described as multifaceted and involves research, livestock management, and conservation education, with the active participation of the livestock farming community".

Their current radio-tracking research is designed to learn more about cheetah movements and territories. This information,

shared with farmers, is invaluable in developing ways to help the farmers co-exist with cheetahs. The work of the Cheetah Conservation Fund has both long-term and short-term goals.

The short-term objective of its program is explicitly behavioral: to get Namibian farmers to stop shooting or trapping cheetahs. Social assessment and research, mainly involving semistructured individual interviews with farmers, provided an understanding of why they now kill or trap cheetahs on their land. This information was used to develop appropriate activities. Farmers themselves suggested three main ways to help reduce cheetah-livestock conflicts: (1) changing livestock management practices in ways that reduce conflicts, (2) managing wild game to provide an adequate wild prey base for cheetahs on farmlands, and (3) increasing awareness and knowledge about cheetahs and how to live with them.

The Cheetah Conservation Fund is working to give farmers the options, skills, and knowledge to solve their livestock and game management problems without killing cheetahs. Farmers have started to adopt new livestock management practices that reduce problems, such as bringing cows closer to the farmhouse and checking them more often during calving season, keeping a herder with small stock, and using livestock-guarding dogs or donkeys to protect stock from cheetahs.

Protecting cheetah habitat and populations in the long term is another objective, addressed through more traditional conservation education activities for school children. Through school visits and the distribution of informational materials such as bookmarks, coloring books, and activity sheets, CCF staff give children basic knowledge about the ecology of cheetahs and their conservation status. Much of that information probably reaches their parents, the farmers, as well.

Although knowledge, values, and social norms influenced farmers' behavior toward cheetahs, options and skills also seemed to be important. During the assessment stage of the process used by the Cheetah Conservation Fund, farmers suggested that

changing livestock management practices could help reduce livestock-killing by cheetahs. They needed some new options and skills to reduce conflicts between cheetahs and livestock. Consequently, the Cheetah Conservation Fund has worked to teach farmers new livestock management techniques, such as bringing cattle closer to farm buildings for calving. They have also introduced the use of stock-guarding dogs to protect herds from cheetahs.

Kerr and Sanghi examine the interaction between technological options and indigenous knowledge and practices. They discuss the factors that motivate indigenous soil and water conservation practices in India and argue that outsiders who desire to promote technological innovations must keep such local logic in mind and incorporate it into the design of the technological options being promoted, or the alternative practices are likely to be rejected by local people.

Skills

In the example of condom use by Tanzanian women and their partners, doers and nondoers differed significantly on several skill-related measures. In the Honduran immunization example, the health workers' skills deficit in interpersonal communication resulted in intangible barriers to getting mothers to bring children to the immunization clinic for repeat visits. In both cases, skills training was a logical way to try to influence behavior.

When assessment shows that economic factors are key determinants of decisions, actions, and practices, influencing those behaviors requires activities that change the underlying economic benefits and barriers. Such activities could include development of new enterprises, new markets, economic policy reform, or changes in economic incentives or disincentives. Some argue that conservation and sustainable natural resources management can be promoted by developing more sustainable enterprises that compete for labor or capital with unsustainable

practices or that return a higher value from sustainable uses of resources than from unsustainable ones.

Integrated conservation and development projects, or ICDPs, are one attempt to link economic development and sustainable natural resources management. Some ways of linking sustainable natural resources management and conservation with direct material economic benefits are clear. Harvesting sustainable amounts of wildlife, fish, or forest products from an area is one example. Irrigated agriculture made possible by stable flows of water from a protected watershed is another. Income generated from ecotourism and pharmacological prospecting by international drug companies are economic benefits local people can derive from natural ecosystems.

The work of the Biodiversity Conservation Network, which with support from the United States-Asia Environmental Partnership and USAID, is exploring the role of community-based economic enterprise development in biodiversity conservation in the Asia-Pacific Region. When economic needs or aspirations are moti-vating unsustainable resource use, alternative practices that sustainably meet those economic needs are the obvious solution. This is often easier said than done, however.

Many schemes to develop substitutes for overexploited resources, to generate income from other natural resources, or to compensate for loss of resource access have had problems. Providing employment for wages is often not a compelling substitute for access to natural resources in rural communities. Alternative prac-tices must serve "a purpose in a community's livelihood which is similar to the activity forgone.

The common practice of comparing different income sources only in terms of their monetary equivalents is often misleading, yet all too common. Compensation must reflect, first and foremost, what communities feel they are forgoing, rather than some measure determined by external technicians". The unexpected results of the activities imple-mented in the hypothetical ICDP in Madagascar illustrate this kind of problem.

The project's designers had mistakenly assumed that increasing rice production and income from rice sales in local markets would substitute for environmentally destructive practices such as charcoal making and slash-and-burn cultivation of cassava in the reserve. Adequate assessment is needed to understand the economic factors that motivate behaviors before activities that will influence those behaviors in the desired direction can be planned.

In planning activities to influence behavior through changes in economic factors, it is essential to keep in mind that traditional livelihood practices may be motivated more by the desire to reduce long-term risk than for short-term economic gain. This desire has important implications for what kinds of new economic arrangements will be sustainable in a given situation. Developing economic alternatives can influence behavior "provided that the linkage between receipt of the benefit and the desired conservation behavior is clear".

Often, however, conservation promoters working with a community will identify the development needs and priorities of the community - such as schools, clinics, roads, or access to markets - but not clearly link those priorities with conservation needs and priorities. If a conservation project funded by a foreign donor promises to build a school, a clinic, or a road for a rural village in exchange for protecting a natural forest or local wildlife, there may be no clear link in the minds of local people between conservation and the development benefit.

They are likely to think of the money for the school, clinic, or road as coming from the donor, not from the conservation activity - as a bribe for conservation, rather than development through conservation. The problem is that conservation motivated by bribes from international donors is not likely to be sustainable. Unequal distribution of direct material (economic) costs and benefits within heterogeneous communities can lead to unsustainable behaviors, and it is critical to keep this problem in mind when planning and implementing activities to influence economic factors.

"A major cause of nonsustainable development is that benefits to particular individuals or groups from overexploitation may be great, whereas losses are shared broadly by society as a whole. Therefore, a cost-benefit calculation by the profiting individuals usually favors nonsustainable use because those profiting do not bear the true costs. Achieving sustainable development in such cases requires some combination of regulations to govern use of resources and altered economic incentives that internalize total societal costs so that the exploiter must pay for the costs inflicted on the public".

Most commonly it is resource access and tenure issues that underlie this problem. Omari laments the loss of traditional values that in many African societies led to a "reverence for natural resources" and hence to their conservation. He attributes much of the unsustainable use or exploitation of natural resources now found in Africa to changes in social and economic values and practices: "African societies are now undergoing great changes due to the impact of Western value systems, especially as they are embodied in Western economic systems.

A money economy has not only altered social relations among people, but it has also affected people's attitudes towards nature and natural resources. Many of the economic activities which seem to threaten the African ecology are done in the name of development. The mismanagement of the environment and the imbalance in the ecological system brought about by modern economic and value systems have led to 'environmental bankruptcy' in Africa".

Again, it is important to remember that many of the benefits and values people derive from natural resources are not direct material benefits in the traditional economic sense. Unanticipated problems can develop when practitioners assume, without adequate social assessment, that such economic motivations are always most important. Such an assumption can lead practitioners to ignore or minimize the many other factors that affect behavior.

Influencing Laws And Policies

When assessment shows that laws or policies are key factors influencing critical behaviors, practitioners and their community partners will need to plan and implement activities to influence those laws and policies. Practitioners used to working at the local level sometimes treat laws and policies as external or structural factors; they may even consider them beyond their control. And yet, these factors can sometimes be powerful motivators of behavior. Laws and policies sometimes provide incentives for sustainable - or disincentives for unsustainable - behaviors. However, laws and policies sometimes motivate unsustainable practices, such as when legal title for a piece of land can be obtained automatically by cutting down primary forest and converting the land to pasture or crops.

Laws and policies related to resource access and tenure are especially likely to be key factors influencing behavior toward those resources. In Namibia, for example, wildlife law and policy until recently provided an incentive for individuals on communal lands to kill roan antelope for meat; and in Mali, the national forestry code may work to discourage tree planting by individual farmers.

It is important to remember that decisions, practices, and actions at all levels of political and economic organization - local, national, regional, and international - are important for sustainable natural resources management and conservation. Focusing only on local-level behaviors would leave out key stakeholders and actors, in particular key "institutional actors".

Robert Chambers believes that senior government officials who make decisions and formulate policy often lack recent direct knowledge of the people and situations that their decisions affect, and argues that their participation in rapid rural appraisal (RRA) or partici-patory rural appraisal (PRA) exercises would improve their decisions.

It is important for practitioners and local people participating in these forms of social analysis to keep in mind

the influences that originate beyond the boundaries of the land area in question and to include them in the analysis. Otherwise the process may be based on a false assumption that local actors alone can bring about desired changes. Sometimes they can, but more often policy changes are also required." Working for legal and policy change requires political organization and action, such as grassroots organization, lobbying, and litigation.

Of course, this is not easy, and sometimes not safe, in many countries today. Perhaps that is one reason some conservationists and communities have chosen not to try to influence the legal and policy factors that motivate natural resources management behaviors. It is also important to remember that working to maintain laws and policies that motivate sustainable behaviors is just as important as working to change those that motivate unsustainable behaviors.

Resolving Disputes

Conflicts about how natural resources should be used and conserved are inevitable for a number of reasons. There are usually many stakeholders with interests in the natural resources of any given place; stakeholders can range from the local to national and international levels; and they can differ widely in economic and political power and options. Even local communities are not homogeneous. Conflicts arise because of differences in the values and interests of diverse actors and stakeholders.

Because conflicts are inevitable, processes for dealing with them as constructively as possible are needed. Societies, both traditional and modern, have methods for managing conflicts, of course. But rapid social and environmental change has increasingly stressed those methods, leading to destructive responses to conflicts. In response to this trend, scholars and practitioners have given increased attention to understanding and constructively managing conflict, establishing a field called "dispute resolution" - or sometimes "alternative dispute

resolution," to distinguish it from more tradi-tional and sometimes adversarial, destructive ways of resolving disputes.

The field of dispute resolution recognizes the inevitability of conflict, and some dispute-resolution practitioners view conflict as natural, necessary, and creative - as an opportunity rather than a problem. Some professionals in this field distinguish between a conflict and a dispute.

"Conflict" is used by them to refer to a fundamental difference in values and interests among actors and stakeholders; "disputes" are episodes of disagreement and controversy that erupt repeatedly over specific issues from a base of conflict. They emphasize that it is constructive conflict management or dispute resolution that they work toward, not necessarily the resolution of the underlying conflicts themselves. To manage conflicts and resolve disputes, an understanding of the factors that cause them is required. Many of the methods and tools for assessment that we have already discussed provide information that can give an understanding of the roots of natural resources conflicts.

According to Karen Freudenberger, "The matrix helped them to see the importance of problems between people starting gardens/orchards and goat owners. It was discovered that due to ... the conflicts that had arisen, goat owners had gotten rid of all of their animals." Practitioners and communities not only need methods and tools for understanding the causes of natural resources conflicts; they also need guidance about what to do to manage such conflicts as constructively as possible.

Dispute resolution involves many of the things we have already discussed, such as good communication, the involvement and participation of all stakeholders, and the importance of building trust and rapport among all stakeholders. The field of dispute resolution has developed its own special methods and tools, however, and some of these could be useful to people involved in conservation and natural resources management.

— Separate the people from the problem. Negotiators should see themselves as attacking a common problem, not each other.

— Focus on interests, not positions. Positions are a rigid statement of what you want; interests are the underlying reasons for your positions. Focusing on interests may reveal the existence of mutual or complementary interests that will make agreement possible.

— Invent options for mutual gain. The authors call these options "win-win" solutions. To do this requires truly understanding the other party's values and interests. It also requires real communication, which can only come from mutual respect and a sincere desire to solve the common problem.

— Insist that objective criteria be used to determine fair and equitable actions to be agreed upon. Enforcing vague requirements is impossible. Vagueness can also lead to cheating or the suspicion of cheating, which can ruin the agreement.

— Know the best alternative to a negotiated agreement. The reason to negotiate with someone is to produce better results than you could obtain without negotiating. If you have not thought about what results you could obtain without negotiating, you risk rejecting an agreement you would be better off agreeing to, or agreeing to something you would be better off rejecting.

There is a relatively rich literature reflecting the experience of a decade or more of efforts to apply basic principles of conflict management to environmental and natural resources disputes in developed countries. John Hough reviewed this literature and applied some of the key principles to conflicts between national parks and surrounding human communities in developing countries. He identified eight key obstacles to the effective management of park-people conflicts in developing countries:

— the institutional environment of national parks
— lack of trust between park authorities and local people
— poor communication
— the large number of stakeholders involved
— large power differences between park authorities and local people
— the risk and uncertainty of entering into a dispute resolution process
— the problem of enforcing agreements
— lack of clarity about best alternatives to a negotiated solution among all stakeholder groups

Natural resource managers in developing regions, including Africa, are showing increasing interest in adapting and using dispute resolution methods from developed regions. The International Institute for Environment and Development (IIED) in London, for example, is working to adapt PRA techniques to environmental conflict situations, according to Charles Lane of IIED.

One potential weakness of the basic dispute resolution principles described above, including those adapted for natural resources disputes, is that they have been developed in a modern, Western cultural context. Different cultures view conflict in different ways and have their own disputing styles and indigenous methods for managing conflict.

In many cultures conflicts may not be openly discussed, for example. There is a substantial body of literature on how cross-cultural issues influence conflict management, especially how they influence international negotiations. Adapting the lessons from this literature to conservation and natural resources management conflicts would be very useful.

5

Integrated Natural Resource Management

Emerging natural resource management methods illustrate the paradigm shift that is occurring in agricultural sciences: from classical agronomy to ecological sciences, from analytical research to systems dynamics, from top-down to participatory approaches, and from factor-oriented management to integrated natural resource management.

New agricultural techniques will have to be rigorously assessed before being introduced in order to avoid potential negative impacts on ecosystems. Technical changes, as well as social, economic, and institutional changes, will have to be seen as modifications of the whole system in which they are included, not simply as independent introductions. Innovations in production systems will thus have to be considered as sets of changes related to strategies addressing the entire System. Integrated approaches to the study of system change will be needed.

Agro-ecological systems management will therefore become a major research area. Ecosystems management in a wide sense-cropping systems, livestock systems, fisheries, forestry, agro-forestry, and the interaction with the surrounding ecosystems-is based largely on Natural Resource Management (NRM) and policy management. The purpose of these management

approaches is to guarantee ecological and economic viability and sustainability, as well as the social acceptability of technical, economic, and institutional changes. It is well known that the yields obtained by farmers with long-established varieties or landraces are often far below their potential for reasons related to NRM-that is, NRM problems are at present causing enormous yield losses. If the Consultative Group on International Agricultural Research (CGIAR) pulled out of NRM research, it could be left in the position of providing steadily improved varieties that farmers were quite unable to use effectively for NRM reasons.

Natural resources are abundant. Most are renewable, although some are not. Each can be considered separately in order to understand their flows and cycles, such as nutrient cycles, organic matter cycles, and water cycles. But all resources form a system that must be analyzed in order to characterize its replenishment capacity and further develop solutions to maintain it and make it more productive through appropriate management. Research programs have been organized through the years to progressively integrate management practices around extended pieces of ecosystems: integrated pest management; integrated soil, water, and nutrient management; integrated crop management; and integrated resource management. Advances in methodologies for ecological analysis and in modeling allow progressively more comprehensive approaches. Nevertheless there are still many difficulties in representing ecosystems, particularly over-exploited and cultivated ones.

First, ecosystems are scale-embedded and are spatially organized at different levels through the plot, the farm, the local landscape unit, the catchment unit, and then the economic and social unit-extending to continental and global levels-all of which are interconnected.

Second, there are also different temporal scales and cycles, for example those related to climate, economic cycles, or household time-life cycles.

Third, many actors are involved in the evolution of an ecosystem, such as agricultural producers, cattle breeders, fishers, people dependent on forest resources, village institutions, local governments, traders, enterprises, banks, public services, and so on. Often no institutions exist to facilitate coordinated and integrated management.

In the rural areas of developing countries, where poverty is extensive, ecological crises result from the exploitation of natural resources in a manner that far exceeds their carrying and replenishment capacities. Thus it is necessary to define methods that will make it possible in the future for all players in a local area to commit to a durable agricultural and rural development system-that is, to ensure the viability of ecosystems, farmed or not, and the societies that use them. To define an NRM approach in agricultural research using the best new scientific tools and methods for NARS is an important objective that can be realized through eco-regional site-specific case studies. From such projects, many general lessons can be learned.

Why does the CGIAR need NRM research? Any organization dealing with land use, agriculture, and forestry must protect the basic resources of those systems, including soil, water, rivers, and forests. NRM research is an essential component of the integrated agronomy that advances the agriculture of an area. Without it, the potential of improved germplasm cannot be obtained. NRM research is also essential so that new methods and new germplasm do not produce results that damage the immediate productive resources or the wider environment.

At present, 26 percent of the CGIAR Centers' expenditures on soil and water research go to off-site effects. For most of the large commodity Centers, the figure is 10-15 percent. If the major objective of NRM work is productivity enhancement, such a distribution can be understood, but the increasing importance of off-site effects must not be underestimated.

The CGIAR has not moved assertively enough to address international environment/natural resource issues. It could and

should move proactively to occupy the "high ground" of global, problem-solving environmental science. It has to attract environmental organizations to its meetings, invite environmental scientists to serve on its committees, and place environmental concerns on its agenda. The comparative advantage of the CGIAR for natural resource and environmental research lies in world-level analysis. Center for International Forestry Research (CIFOR), for example, derives considerable comparative advantage from its ability to build links between the scientific communities in the three tropical regions.

The basic challenge facing the CGIAR is to extend Green Revolution-type productivity increases through the rainfed areas of the tropics. This calls for much more careful NRM work than before, so that drought resistance and suitable growth duration in the plant is matched with maximum soil water storage in the field. Most of the so-called marginal lands are marginal or fragile because of NRM problems caused by the climate and soil composition, so that their unimproved economic output will naturally be low and irregular.

In practice, the main types of NRM issues relevant to the CGIAR would be as follows, bearing in mind that all of these can occur in many different variants, and that the reversibility of the processes varies considerably.

— Soil physical degradation
— Soil chemical degradation
— Soil biological degradation
— Water quality degradation
— Forest degradation
— Loss of biodiversity
— Coastal zone degradation

Global Management of Environmental Problems

Global change resulting from human-induced climate change,

regional climate change, desertification, water scarcity, and reduction of the diversity of species are all matters affecting ecosystems from the local to the global level. For the future, research at the different levels will need to become more integrated, and the CGIAR Centers have a strategic advantage in this. The CGIAR has a unique capacity to combine the expertise of its specialists to improve understanding of the dynamics at all scales of land use change.

This is particularly true in the area of forestry and agro-forestry research. Forests play an important role in maintaining biodiversity in in situ conditions, in improving water availability, and in moderating local climates and mitigating the impact of global change by carbon sequestration. Reduction of forest areas and particularly devastation by fires can reduce biodiversity, increase desertification in the long run, reduce water availability, and increase the greenhouse effect.

Forests also play an important role in food security-some 500 million people, most of whom are very poor, depend on wood and non-wood forest products for their livelihoods. An important challenge for the future is to define land-use planning methods acceptable to local populations that can help to increase production while maintaining the favorable ecological role of forests. This includes agro-forestry production, establishment of protected areas, and sustainable management of forest areas. Scientific land-use planning is an essential prerequisite for sustained advances in crop production.

An integrated NRM approach will involve three basic steps. The first is to identify the extent of the resource degradation and rural poverty problems to be addressed, place these problems in their relevant spatial and temporal scales and identify their driving forces, and then predict their future trends and patterns. Farmers and other local stakeholders need to be involved from the beginning of the process. The research questions to be answered by biophysical and social scientists working cooperatively are:

— What is the overall importance of the problem we are trying to address relative to other problems within our domain of expertise, mandate, or comparative advantage?

— Where does the problem occur, what is its relative magnitude, and if and where is it likely to become a problem over the planning horizon considered?

— What are the foreseeable options, strategies, or solutions available from CGIAR Centers and partners?

— What would be the expected relative efficiencies and net benefits (including potential "spin-offs") should various options/strategies be implemented at specific places and at specific points in time?

Addressing these questions should lead to the identification of priority research themes, priority geographical areas for the work, and priority target groups of stakeholders for the interventions. The second step is to undertake research activities to enhance the food production services of existing land use systems in a sustainable manner. The questions to be addressed include, Which crop/tree species, which animal or fish species, which techniques should be the focus of the work, and why? How should the work be spatially organized through the farm, landscape, and region to assure the continuous improvement of the externalities generated by these systems? What are the prerequisites for successful adoption? This leads to the identification of a range of resource management options that should increase food production and farmers' incomes.

Those activities require interdisciplinary work, including policy specialists. There should be a strong focus on capturing indigenous knowledge concerning resource use, as well as on marketing issues related to new products. The third step is to do on-farm research to assess the trade-offs among the options arrived at thus far. This leads to the identification of projects to be handled by various partners and Centers. Here an active interaction is needed with stakeholders of the region so that the

priorities of the CGIAR are compatible and supplementary to those of the national programs and research agendas of NARS. Clearly, the implementation of the NRM approach necessitates the establishment of partnerships with concerned stakeholders-including policy-makers at different levels, from the village to the international sphere-as well as new collaborative modes among the CGIAR Centers, NGOs, NARS, and ARIs. The emphasis is no longer on largescale adoption of a single solution, such as an improved crop variety, by one category of stakeholders, but on ensuring that a given problem that occurs in a variety of environments is solved in a sustainable manner through the adoption of ranges of options by farmers, regional bodies, and policy-makers at the national and international levels.

It is critical that a proper match be achieved between the precise needs of a NARS and the programs of IARCs. This will call for the joint preparation of an agricultural research strategy for each country by the respective NARS and a consortium of IARCs. Highest priority should go to the training of scientists and to the promotion of farming methods based on natural resource conservation. The CGIAR System must aim to do a much better job of developing bottom-up, demand-driven projects in which the main potential users of new knowledge have real ownership.

Current CGIAR Efforts on NRM

The CGIAR has many advantages. It is at the cutting edge of the production of new plant varieties, which is a critical part of the complex of factors that can drive forward agricultural productivity. It has an unrivaled string of research sites around the developing world. It has generally close and good relations with NARS, without which NRM improvements are unlikely to be developed and will almost certainly remain unused. CGIAR has the advantage of being international, thus bypassing some of the political problems that may beset work in developing countries, especially where NRM problems cross frontiers. The CGIAR both needs to and is well-placed to do NRM research.

Most Centers have now been established in one or more regions for a number of years, and should have built up a strong collective knowledge of their mandate territory. Each Center will need to define the sequence in which it applies its resources to different NRM problems, depending upon TAC's defined priorities and its judgment on the likelihood of success in each case. Given true partnerships with the NARS, an eagerness to draw in partners, well-supervised on-farm work with farmers, and careful attention to the policy environment, this type of NRM work is extremely useful. We believe that it would best satisfy the motivations behind the eco-regional approach adopted by the System.

Centers will, of course, specialize in appropriate aspects of NRM. Thus International Maize and Wheat Improvement Center (CIMMYT) focuses largely on residue management and conservation tillage subjects, International Rice Research Institute (IRRI) has a special focus on the treatment and behavior of flooded soil, International Centre for Research in Agroforestry (ICRAF) now called World Agroforesty Centre deals with the competition of mixed tree-crop species through the distribution of resources between them, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and International Center for Agricultural Research in the Dry Areas (ICARDA) are strongly involved in soil-plant-water relations in drought conditions, and International Center for Tropical Agriculture (CIAT) and International Institute of Tropical Agriculture (IITA) have more general roles.

This concentration of effort is entirely proper in terms of the Centers' mandates, but it is not certain that it produces a logical CGIAR cover of the NRM subject area in total. A more extensive analysis of work on the soil and water topics is given in TAC's 1997 Priorities and Strategies for Soil and Water Aspects of Natural Resources Management in the CGIAR. International Irrigation Management Institute (IIMI) has now changed its scope to cover all forms of water use rather than just irrigation water. IIMI's work carried out in collaboration

with NARS has shown that the scope for improving irrigation water use efficiency is large.

IIMI's analysis has shown that about half of the increase in demand for water by 2025 can be met by increasing the effectiveness of irrigation. In fact, excessive water application is leading to problems of water logging and salinization in many irrigation projects. Water is likely to become the most limiting factor in agriculture in several parts of the world. Consequently, there are several global initiatives to deal with issues in the areas of water conservation and sustainable and equitable use, such as the Global Water Partnership and the World Water Council. UNESCO and the Government of Spain plan to establish an International Center for Cooperation in Water Management at Valencia, designed to assist in a proactive resolution of emerging water conflicts. IIMI will have to work with such centers, so that water-related issues are dealt with in an integrated manner at the international level.

The various challenges to sustainable management of natural resources for agricultural development are largely eco-regional in nature and require eco-regional solutions. The CGIAR has placed emphasis on the eco-regional approach, although this is not yet well defined. In some ways it appears that the original spirit of the ecoregional approach-to create a force to address specific critical problems in specific areas-has been diluted.

Much of the lack of progress in implementing the eco-regional approach can be attributed to the reorganization required within Centers to develop a new paradigm for research and to form the wider partnerships required for these global imperatives, the lack of appropriate governance mechanisms, mechanisms based on participatory decision-making across large numbers of national agricultural research institutes (NARIs).

Active interaction is needed with regional stakeholders so that CGIAR priorities are compatible with and supplementary to NARS' programs and research agendas. Ecoregional research requires increased collaboration with NARS and ARIs, and a

stronger emphasis on incorporating indigenous and farmer knowledge and innovation systems. The CGIAR needs an effective management model for eco-regional research.

Conservation of natural resources is essentially a national task. IARCs can assist in scientific soil health and water management through a few well-designed eco-regional research and demonstration projects. A series of such pioneer projects could be linked in the form of an International Network for Integrated Natural Resource Management, promoting the conservation and enhancement of the ecological foundations of sustainable agriculture. Enhancement of crop productivity without damage to the ecological foundations is the pathway to an evergreen revolution. This will include emphasis on precision farming methods and environmentally benign technologies such as efficient water use, integrated pest management, and integrated nutrient supply systems. Precision farming helps reduce costs and enhance net income. At the same time, it helps avoid environmental damage.

The proposed network will be a learning experience both for scientists and for farmers. It will have to be organized in a participatory research mode. Systems of measuring the impact of new technologies on environmental capital stocks will have to be developed. The science of ecological economics is still in its infancy. IFPRI, in association with other advanced research institutes working in this area, will have to develop reliable indicators and monitoring tools for measuring sustainability. To create awareness of the need to maximize resource use efficiency, IARCs should develop ecological methods of expressing productivity- for example, yield per cubic meter of water and kilogram of nutrients rather than merely yield per hectare of area.

There are vast opportunities for integrating the principles of ecological economics with field-level agronomic methodology. This is an area where the international network can lead the way. An international network of the kind proposed will require

the support of a coordinating center. Because of its active involvement in the sustainable management of natural resources over many years, CIAT could be considered for this role.

There is also need for the sustainable management of marine resources. Countries with large exclusive economic zones will have to develop monitoring tools for ensuring the sustainable use of living aquatic resources. World Fish Centre (ICLARM) could take the lead in the development and dissemination of tools and indicators for measuring the longterm impact of current methods for exploitation of ocean resources.

6

Natural Resource Management and Poverty Reduction

The economic value of environmental goods and services is receiving greater attention, as environmental degradation has been most devastating for the poor. Current economic growth is accompanied with ecological poverty—the lack of healthy natural resource base for safeguarding public health and local economies. This in turn is driving increasing numbers of people into economic poverty. All this has grave consequences for future growth prospects as the environmental resource base necessary for growth and poverty alleviation is continually 'mined'. To overcome this scenario it is important to incorporate sustainability in growth policies, but what is even more important is the need to incorporate sustainability in poverty alleviation strate

The Europe and Central Asian (ECA) Region is the largest in terms of land area of any of the Bank Regions. It also has the largest forest area and the most water resources. The Region is highly diverse, in terms of geography, climate, and natural resources, of human well-being, and of the policy directions of its governments. Broadly, the north and west of the Region is abundant in forests and water but possesses agricultural lands of only moderate quality; the central belt of the Region has abundant arable land; and the south and east, including Turkey,

the Caucasus, and Central Asia, faces water scarcity and limited water and fertile land resources.

There are wide disparities across the Region in the types and level of environmental damage and in the institutional capacity and political readiness to address such damage. In the north and west, the major health-related environmental issues are poor air quality from industrial emissions and, increasingly, from motor vehicles; and poor water quality from industrial and municipal effluent and nonpoint agricultural sources. In the south and east, poor water and sanitation services is the primary environmental health issue, though there are also risks from industrial and hazardous waste, including mercury and oil. Chernobyl and other nuclear installations pose a special hazard.

The CIS and Southern European non-EU-accession countries generally have had the most difficulty achieving political consensus for reform. While air and water pollution have declined due to the collapse of industry, the dilapidation and destruction of environmental infrastructure in some countries aggravated by military conflict-continues to pose serious problems. Increasing poverty has contributed to unsustainable forest and rural land use management.

There has been little new investment in less polluting industry, and energy is still not used efficiently. In Russia, Ukraine, Belarus, and Moldova, slow restructuring, low energy prices and inefficient collection of energy payments, and lax enforcement of environmental regulations have contributed to increasing pollution intensities. In Armenia, Azerbaijan, and Georgia, crumbling water infrastructure and the contamination of groundwater has caused serious public health problems. In Central Asia, including Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan, the most critical environmental issues are poor water quality and resource management, due to intensive irrigation and poor water and drainage management.

Major Environmental Issues

The key environmental problems can be grouped into those affecting health, livelihoods, and security, and those that have a global and transboundary impact.

Health: In the more industrialized northern CIS and CEE countries, air pollution is the principal health problem. While industrial emissions in the CIS have dropped with declining industrial output; the growing transport sector is generating emissions at levels higher than before the transition.

In Central Asia, the principal problem is inadequate water and sanitation. An estimate from 57 cities in ECA suggests that premature death caused by air pollution alone increased in the CIS from about 25,000 to 40,000 between 1990 and 1995. The cost of health damages for Volgograd in Russia is alone estimated at $330 million a year.

Livelihoods: Environmental liability issues have concerned potential investors in several countries, and have impeded implementation of successful privatization programs. Pollution and poor solid waste management have also reduced potential income from tourism, especially on the Black Sea coast. The EU-accession countries will need to invest heavily to meet the environmental standards of the community; a study in Poland indicated that the cost of compliance with EU legislation in the water sector alone will be about US$22 billion.

Security: The Region also suffers from accumulated industrial waste that threatens public health and ecosystems, particularly in hot spots that have a large concentration of industrial production from the Soviet period. Examples include Azerbaijan, where there is a risk of soil, water, and air contamination from mercury; a recent oil spill in Russia; and a cyanide spill from a mining operation in Romania. There are also concerns about nuclear safety. The risk of industrial accidents is higher than in OECD countries, and deteriorating equipment exacerbates this problem. Mining accidents are a particular hazard.

Global and Regional Environment: Global issues relate primarily to climate change, the phase-out of ozone-depleting substances (ODSs), and the conservation of biodiversity. ECA countries account for 20 percent of global greenhouse gas emissions, more than any other Bank Region. Worldwide, Russia is the third-largest emitter, although it also has the world's largest forest area to serve as a carbon sink. ODS phase-out is, however, well advanced, pending the closure of ODS production in Russia. The Region accounts for valuable biodiversity, specifically in the Caucasus and Central Asia, but this is under pressure from pollution and development.

The unsustainable use and pollution of regional seas-seas that are now under international management by several newly independent states-have led to a decline in fisheries, such as in the Caspian Sea, and ecological disasters, such as the shrinking of the Aral Sea. Transboundary air pollution of persistent organic pollutants (POPs) is an emerging issue. Countries have entered into international agreements at global and regional levels addressing these issues, but need assistance to comply with their requirements.

Natural Resource Management Issues

Natural resource management issues are dependent on geography and climate and vary across the Region. The Region has 7 percent of the world's population, 23 percent of its forest area, 19 percent of its arable land, and 12 percent of its annual renewable freshwater resources. Unusually, most of its countries have stable or even declining populations. However, much of the soil in the northern part of the Region is of moderate to low fertility and production is limited by short growing seasons. Many of the forests also protect watersheds or are inaccessible in harsh climates, and harbor fragile ecosystems. Russia's rivers, which account for the majority of the Region's waters, mostly flow into the Arctic. And although resources overall may be abundant, poor use of them at the local level has led to unsustainable management.

As a result, although there is less pressure on natural resources in ECA than in some other Regions, the Region is not as resource-abundant as the figures imply. There are also major regional inequalities: Per capita internal renewable water resources range from 232 cubic meters in Turkmenistan to 29,000 cubic meters in Russia. Similarly, arable land varies from 0.15 hectares per capita in Tajikistan to 2.1 hectares in Kazakhstan, and forest land from 0.1 hectares in Armenia to 6 hectares in Russia. The principal issues facing the Region are summarized below:

— In Central Europe and the northern EU-accession countries, the main challenges are to establish farming practices that reduce run-off into water bodies and that meet the EU environmental requirements for water quality. The cost of improving urban wastewater treatment to EU standards is a particular issue. A second challenge, especially for Poland and Hungary, is flood mitigation and of balancing control measures with ecosystem management and economic development. A third challenge, especially for the Baltics and Poland, is to help new forest and agricultural landowners to manage land sustainably and profitably in the context of a declining rural and farm population. Most of these countries also export forest products, and must manage their forests to meet the certification standards required by Western European importers.

— In the Balkans, the main challenges include improving coastal zone, forest, and mountain system management to maximize tourism and conservation values and, in the poorer countries, to achieve sustainable resource use in the context of rising poverty and governance problems. For Romania and Bulgaria, low-income countries preparing for EU accession, an additional challenge is that of careful planning to minimize the cost of meeting EU environmental standards.

— For the fertile black soils belt of Eastern Romania, Moldova, Ukraine, and Southern Russia, the key issue is fertility

management of arable land, where soils have been heavily compacted by the use of heavy machinery. Lack of soil and moisture conservation measures, together with the dramatic decline in input use, threatens the fertility of these soils.

— Turkey's population and economy are growing rapidly. Its coastlines are threatened by poorly managed tourist, urban, and industrial development, and resource management issues related to rural poverty and overuse of resources are problems, especially in Central and Eastern Anatolia. Turkey and the Caucasus are particularly vulnerable to earthquakes, and disaster preparedness programs are essential. In the Caucasus, rapidly rising poverty and deteriorating governance have put pressure on forests to meet subsistence needs, and the collapse of irrigation and drainage infrastructure and regional water shortages threaten rural livelihoods.

— In Central Asia, the key issue is to improve water resource and salinity management, specifically to prevent the continuing excessive and mismanaged development of the Aral Sea river basin waters for irrigation. A second issue is management of the vast rangelands of the north, much of which has been converted into fragile arable lands that are now heavily eroded. Better management of the upper watersheds, to improve flood and sedimentation control and to enable sustainable, resource-based rural livelihoods, is also necessary.

— Russia accounts for 22 percent of the world's forests, thus giving resource management here a global dimension. Restoring sound forest management should be the country's first challenge: Russia's forests, sustainably managed and with the input of reputable investors in resource utilization, could provide livelihoods for 10 million people and generate substantial foreign exchange and public revenues. Russia must also address fertility and erosion management on

agricultural land and improve water quality management of its major rivers, to better balance different uses.

— Water quality and water and land resource management of the ECA Region's seas and rivers are issues that must be addressed Regionwide. Of critical concern are the Aral Sea basin, the Caspian Sea, the Danube basin and Black Sea, and the Dnieper and Volga River basins.

Much sustainable management is concerned with achieving a balance between different uses, while conserving land and water quality and quantity for the future. There tradeoffs between population pressure, short-term economic development needs, the way that people use scarce abundant resources, and sustainable and unsustainable resource management. The pattern of use is, in turn, affected by policies addressing access to resources, the incentive framework for their use, and governance. Natural resources have a number of unique dimensions that make markets work imperfectly and that often require government intervention, as follows:

— Natural resource management has an intertemporal dimension. Excessive groundwater withdrawals, for example, may provide irrigation water in the short run but will over time lead to increased costs of pumping as groundwater tables fall, and will eventually lead to water shortages. Forests that are logged take 90 years to regenerate in boreal and temperate climates, so conventional discounting techniques are not adequate instruments for making investment or management decisions.

— Natural resource management has a spatial impact. For example, deforestation upstream in a watershed can lead to an increased risk of flooding for downstream areas, and excessive water withdrawals for irrigation can lead to lakes downstream drying up. These are classic externalities.

— Poor natural resource management may have irreversible impacts, as when species or ecosystems are lost. The ECA Region's steppe ecosystems, in particular, are threatened.

— Some aspects of natural resource management have a global dimension. Examples include the impact of changes in the use of Russia's forests, arctic ecosystems, and northern rivers on the global climate.

— Land and water management are closely interlinked. Inadequate drainage of irrigation water, for example, can lead to waterlogging and salinization of land, and poor farming practices can increase run-off and the pollution of water bodies.

There are many aspects to natural resource management that have an impact on the public good, and which therefore justify public intervention if these resources are to be sustainably managed. This applies even in cases where land, forests, or water rights are privately owned. Regulations and economic instruments require both sound institutions and good governance to be effective.

Most countries in ECA have already carried out extensive programs for natural resource development, and the information base is therefore good. The challenge is to take into account the spatial, intertemporal, cost-effectiveness, and intersectoral dimensions of sustainability, and to ensure equitable access. The privatization of land and other assets, changes in the price regime, and increasing governance problems and social hardship that in many countries followed transition also pose new challenges.

The World Bank's involvement in urban and industrial environment has in the past been aimed at assisting the clients in improving environmental management, specifically in the areas of incentives, institutions, investments, and information, through: (a) helping to shape environmental strategies and improve policies, regulations, and planning; (b) building stronger environmental institutions; and (c) financing priority investments for environmental improvement focused on urban and industrial pollution. There has been a wide diversity in the speed at which ECA countries have been able to adopt environmentally sustainable policies.

In the early years of the transition, it was hoped that broad policy reforms in ECA would enable private sectorled growth and agricultural and income growth to take off. There has since been increasing acknowledgment that the reforms will need time to take effect, especially in the CIS countries, and that more direct assistance is needed to prevent poverty increasing and to sustainably manage the natural resource base. In addition to policy reform, which can help create the framework for economic growth and improved natural resource management, it is clear that support for the improved management of water (irrigation), land (seeds, extension, inputs, salinity control), and forests (forests and watersheds) can directly assist farmers to increase their incomes. Similarly, sound urban and industrial environmental policies need to be complemented by investments in energy efficiency; water, wastewater, and solid waste management; and less polluting industrial technologies.

Past Strategy Formulation

The Bank contributed to the regional environmental agenda in 1993 through the Environmental Action Program for Central and Eastern Europe (EAP), adopted by the Lucerne Ministerial Conference and setting the agenda for the CEE countries; and for the CIS in 1998 through the Transition Toward a Healthier Environment paper, prepared for the Århus Environment for Europe Ministerial Conference.

Through its support for National Environmental Action Plans (NEAPs), the Bank has additionally helped to translate the principles of the Regional strategy into country-specific priorities. The Bank has also provided other nonlending services, including advice to EU-accession countries on cost-effective strategies to comply with EU environmental regulations; support for regional efforts to build commitment to phase out lead from gasoline and to improve urban air quality; and assistance with strategic work in a variety of areas, including biodiversity, forest policy, the phase-out of oxygen-depleting substances (ODSs), and planning for better management of regional seas.

Environmental Institutions

The Bank has supported capacity building both through stand-alone loans, such as the Poland Environmental Management Project (EMP), and as part of environmental investment projects. The results have been mixed. Good results have been achieved where (a) technical assistance has delivered tangible results for the client, and hence has won the client's political support (demand-driven); (b) technical assistance has served as a catalyst for interagency collaboration, such as in water basin management; and (c) capacity building focused on smaller pilot regions and subsequently replicated the test results at the national level-a practice that is particularly valid for large federal states, such as Russia.

Sustainability of these efforts is a major issue. Governments have increasingly used funding from these projects to substitute for declining local budgets, and willingness to borrow for capacity building has decreased. In addition, trained staff often leave to join the private sector, and frequent political changes undermine the establishment of stable systems. The Bank's portfolio of projects that include environmental objectives covers water and sanitation projects, irrigation and drainage, solid waste, industrial pollution abatement and air quality improvement, forestry, biodiversity and watershed management projects, Global Environmental Facility (GEF) projects (biodiversity and ODS phase-out) and regional seas activities, and energy and infrastructure sector projects.

Experience shows that there is much to be gained from linking the Bank's assistance at the strategy level to Bank lending, as was done in the Azerbaijan Urgent Environmental Investment Project, which focuses on four top priorities identified in the NEAP. The Bank has had less success with credit lines for industrial pollution abatement. A project in Russia experienced long delays and required substantial restructuring, and a similar effort in Ukraine had to be abandoned for lack of creditworthy and environmentally relevant subprojects. New

approaches are now being tested to mobilize private sector resources for sustainable development. The Bulgaria Privatization Support Adjustment Loan is designed to attract responsible private investors in industrial modernization by creating a transparent legal framework for dealing with past environmental damages and by strengthening capacity to enforce compliance with environmental standards.

The Bank also manages 20 GEF grants, for a total of US$213 million and therefore comprising a substantial proportion of environment portfolio. The GEF portfolio has grown steadily in recent years, and its composition is changing from a focus predominantly on ODS phaseout toward one supporting biodiversity, climate change, and regional sea programs, including the Aral Sea, Caspian Sea, and Black Sea program. The challenge will be to further integrate GEF operations with regular Bank projects.

Future Strategy

Within the broader framework of the Bank's emerging Corporate Environment and Natural Resources Strategy and the Regional strategy, the environmental and natural resource strategy for ECA will pursue the following three objectives:

— Contribute to poverty reduction through reducing health damage caused by pollution, increasing opportunities to realize higher incomes and sustainable livelihoods, and reducing vulnerability to natural and manmade disasters.

— Establish public policies with transparent regulatory frameworks and adequate monitoring and enforcement mechanisms for sustainable private sector-led growth.

— Support equitable solutions to regional and global challenges through continued assistance to clients addressing global environmental issues, in particular climate change, ecosystems conservation, and protection of international waters.

There are differences between the brown environmental agenda, concerned largely with urban and industrial pollution issues, and the green agenda, which is concerned with land, water, and biological resource management. While both have strong cross-sectoral linkages, for natural resource management these linkages are largely with sustainable rural development and river basin management; for pollution-related issues they are with energy, transport, industrial, and municipal economic activities. A natural resources strategy or substrategy developed by a client country within this broad framework and based on an assessment of the natural resource base should:

- Evaluate alternatives for sustainable use, balancing cost-effectiveness and intersectoral, spatial, and intertemporal dimensions.
- Develop plans, investment programs, and environmental assessments for sustainable natural resource management and use, and assure adequate implementation, monitoring, and evaluation.
- Modify regulation and governance of natural resources to assure transparent management. Clear rules, supported by consensus, are needed to ensure equitable access to resources. Decentralized, participatory approaches are often effective, but they require transparency in local power structures.
- Assess prices, taxes, and incentives. If these reflect scarcity, they are more likely to lead to sustainable management. Where resources are abundant, pricing should reflect the costs of renewal.

Poverty Reduction

Refocusing environmental work in the ECA Region toward poverty reduction will require some effort, especially regarding the brown agenda. The refocusing work will require a better understanding of poverty-environment linkages, analysis at the

design stage of the poverty impact of proposed activities, and, on the part of clients, understanding of new priorities and agreement on those activities that are expected to have a tangible poverty impact. Natural resources management-within the sphere of rural development-has for several years had a poverty focus.

(i) Improving health

We will support activities designed to improve the health of poor people, by reducing waterborne disease-in Central Asia, increased groundwater salinity has affected drinking water quality (blowing sand, dust, and salt, the result of wind erosion, also contributes to poor air quality)-and by providing cleaner air and safer water in urban areas.

Clean Air for Better Health: Support for cleaner air will likely focus on (a) the reduction of fine particulate matter (PM10) emitted by transport and by heating systems. This will in part be achieved through seeking greater energy efficiency, through the use of tariffs and incentives. We may also continue to support the phase-out of lead in fuel and industry, and improvements in the refinery sector; (b) capacity building in air quality management, including improved monitoring by local government; (c) project preparation support for the Clean Air Investment Program, likely to be funded by a combination of Bank lending, donor financing, and private sector investments; and (d) establishment of the Clean Air Initiative, which would offer selected cities the opportunity to exchange experiences with other cities in the Region.

Safe Drinking Water and Sanitation for Urban and Rural Areas: The approach will include: (a) integration of hygiene, sanitation, and other health interventions with infrastructure investments in the project design to improve the health outcome; (b) a better integration of upstream water resource management with downstream urban water use; (c) continued utility reforms and policies for demandside management; and (d) financing of water and sanitation investments with an increasing share of utility self-financing and private sector participation.

Sustainable Cities Approach: Traditionally, water and air issues have been approached separately on a sectoral basis. However, there are clear advantages to defining urban environmental priorities within a broader citywide framework - specifically, the more effective allocation of resources and greater coherence of policies. We will explore opportunities to assist regional and city governments in preparing environmental action plans as part of their overall city development and land-use planning; and we will assist them in seeking finance for priority investments. Jointly with the Bertelsmann Foundation, the Bank has already started the Cities of Change program, which provides a forum through which 10 medium-size cities in EUaccession countries will develop best practice policies for solid waste management, a major concern for each of these cities.

Solid Waste Management: Involvement in solid waste management to decline as the current projects, including those in Uzbekistan and Lithuania, come to an end. This is an area we can see potential for the increased participation of the private sector and the introduction of cost-recovering tariffs, since good solid waste services are typically valued highly by the population. Development partners such as the European Bank for Reconstruction and Development (EBRD), for example, are well positioned to provide financing for solid waste management. The World Bank may nonetheless continue its involvement in this area through selected cases, such as addressing methane recovery from landfills.

(ii) Improving livelihoods

This translates into increased incomes and improvements in living standards through more sustainable use and management of natural resources (land, water, and forests). Rural populations are generally poorer than urban ones, and more dependent on natural resources for their livelihood. Better natural resource management usually has a key role to play in poverty-focused improvement of rural living standards. In general, the experience

has shown that decentralized, community-based approaches are the most effective in securing sustainable improvements to natural resource management. In some cases, such as in Albania, we have been able to form a traditional association with community-based forest and range management; in others, such as the forest work in Slovak republic and water work in Bulgaria, this has for political reasons been more difficult. The major components of the work include improved forest, water, land, biodiversity, and coastal zone management.

Well-Managed Forests for Better Livelihoods: The strategy also focuses on helping the clients achieve transparent and sustainable resource management, separating public from commercial functions, and assuring equitable rules for access by local populations and investors to forest resources. We can provide support for improved forest taxation and incentive systems, and training in forest enterprise management. New projects in Russia, Romania, and Georgia include these elements. The poverty reduction in mountain regions is community-based forest and natural resource management-we have had good success with this approach in Turkey and Albania and hope to expand it to other countries. The support of forest planning using landscape approaches, fire and pest management, and regeneration has also been successful. A further objective is to improve the policy and regulatory environment for increased private sector investment in sustainable forest utilization.

Increasing farm incomes through better water management.

Restoration of irrigation and drainage infrastructure and control of salinity is central to the assistance in the water management area. This is especially true in Central Asian countries, whose economies depend on irrigated agriculture and where poor water resource management in the Aral Sea basin causes GNP losses estimated at US$2 billion annually. Key features of the policy are the support of institutional reforms aimed at decentralizing management to users, introducing water pricing that will cover

maintenance costs, and providing incentives for resource conservation. Eight water management projects are under implementation and eight more are being prepared.

Ecosystems Conservation and Sustainable Use: Ecosystems conservation and management programs that aim to maintain landscape and biodiversity values while increasing access to resources of the local population. Examples of this work include projects in Ukraine, Romania, Turkey, and Central Asia.

Maximizing the Potential of Coastal Areas: Coastal zone management is key to sustainable tourism in several ECA countries, but with the exception of Georgia, the assistance has been limited to small grant-financed institutional strengthening activities. Making successful trade-offs between tourism, ecosystems conservation, urban, port, and industrial development is a particular challenge for coastal zones.

Increasing Farm Incomes through Better Land and Crop Management: Farmer support services that respond to the requirements of restoring soil fertility and helping new owners with sustainable land, livestock, and biological resource management practices, but this process is at an early stage.

(iii) Improved security

Better security and safety, achievable through the financing of urgent environmental investments, translates into lower vulnerability and thus into more robust production and ecosystems better able to cope with droughts, floods, and other disasters. Security and safety measures encompass better farming methods, increased access to irrigation water, better river basin management, and improved access to forest, crop, and animal protection services. The World Bank is currently assisting with flood mitigation in Poland and Turkey and with earthquake reconstruction in Turkey.

In addition to mitigating the consequences of natural disasters, we will also help clients to prevent manmade disasters,

including industrial accidents, and to improve dam safety. In Russia, with clean-up following an oil spill, and in Azerbaijan are helping to address mercury contamination and industrial pollution from the oil industry. We are also considering support for preventive measures for other types of industrial hazards, such as the recent cyanide spill in Romania, but further work is necessary to establish rapid response mechanisms.

We will also help contain hazardous industrial pollution where the risks to public health and economic productivity are high. For industrial waste, the approach will be to finance clean-up costs for which the public sector is responsible, and to support legislation and policies to encourage the private sector to undertake clean-up. The Bank will maintain its policy of noninvolvement in issues of nuclear safety.

Protecting Populations from Floods and Disasters: Flood management, disaster planning, and dam safety projects can help reduce the vulnerability of countries—Poland, Turkey, Armenia, the Kyrgyz Republic, and Tajikistan.

Public Sector Management for Sustainable Growth of Private Sector

Most countries are still experiencing transition-induced recessions and have not yet recovered to pretransition levels of GDP. There are three basic directions:

(a) integrating environmental concerns in sector and macroeconomic strategies;

(b) strengthening environmental management as part of public sector and governance reforms; and

(c) removing environment-related impediments and risks to private investment.

Integrating Environmental Concerns in Sector Reforms: Environmental performance in the transition economies remains closely linked to progress in macroeconomic and sector policy reforms, such as the achievement of more rational energy pricing and the better collection of energy payments.

Macroeconomic, Cross-Sectoral and Poverty Linkages: Analytical and strategic work in understanding the poverty-environment linkages, and in working these into the PRSPs and CDFs. The approach includes: (a) additional analytic work on environmentpolicy linkages; (b) building local capacity to prioritize interventions by using modern methodologies for valuation of their potential environmental benefits, damages, and bioresources; and (c) building environmental policy reforms into structural adjustment operations where they have national strategic significance, such as natural resource taxation in Russia.

NEAPs: In the past most of the countries in the preparation of NEAPs. Not only have the NEAPs helped these countries to identify their national environmental priorities-and they have often been followed by a lending activity-but the consultative and widely participatory process of NEAP preparation has also created environmental constituencies in many countries; it has improved cooperation between organizations responsible for environmental management; and it has increased public awareness.

The NEAPs were intended to be working documents, however, and in many countries they must now be revisited. In order to ensure stronger cross-sectoral support for the environment and the further mainstreaming of environment within country strategies, the process of NEAP update must be carried out as part of the overall PSRP discussions.

Linkages with the Energy Sector: In FY00, the Bank's Board approved Fuel for Thought, an environmental strategy for the energy sector. In Armenia, Moldova, and Bosnia, projects prepared for funding in FY00-FY02 will promote energy efficiency through infrastructural improvements in the energy sector and will encourage conservation through sectoral reforms. In Central Asia and the Caucasus, a Regional program, Cleaner Transportation Fuels to Improve Urban Air Quality, is designed to identify cost-effective measures to protect human health in urban areas and to improve fuel quality-including the phase-out of leaded gasoline-and fuel efficiency in the short and long terms.

Good Governance: The substantive improvement in environmental management practices will not be possible without improvement in public sector governance.

Empowering Civil Society through Environmental Education and Good Governance: We need to be more sensitive to achieving broad political consensus for environmental priorities. The approach includes support for (a) integration of the environment into general education reform and curriculum development (a pilot is currently being developed in Azerbaijan); (b) good governance in environmental management as part of broad public sector reform, including the separation of regulatory and economic production responsibilities and the creation of modern environmental institutions; (c) participation of communities in the design and implementation of all activities, but in particular in natural resource management and rural water supply and sanitation; and (d) development of high quality, consistent, replicable environmental information systems that are publicly available, and regulatory frameworks and public institutions that are transparent and accountable.

(iii) Removing Environmental Impediments to Investment: Few countries have addressed the question of responsibility for past environmental damage. It is therefore difficult to find strategic foreign (Western) investors for enterprises that may potentially have environmental liabilities, even when the comparative advantage of investing is clear. To encourage privatization by responsible investors and to promote environmentally sound industrial modernization, support activities that address environmental liability, that reduce private sector risk, and that harmonize the procedures for environmental assessment.

There are two examples of Bank operations in this area: The Bulgaria Environmental and Privatization Support Adjustment Loan helps newly privatized industries address past environmental liabilities, and the Russia Coal and Forest Investment Risk Guarantee aims to increase the flow of private

investment into sustainable coal and forest utilization through helping to insure investors against noncommercial risks, including arbitrary changes in taxation and regulation and the confiscation of property.

Global Activities

The third objective is to contribute to the global and regional environment agenda while at the same time reduc-ing industrial and urban pollution on a national level. The GEF has supported the Bank in operations addressing global environmental sustainability in four areas: biodiversity, ODS, climate change, and regional seas. In addition, several regular Bank projects have significant objectives in these areas-notably the energy-related projects that aim to reduce greenhouse gas (GHG) emissions. The future operations will investigate the synergies between measures to address global environmental issues and those that would address poverty reduction.

(i) *Climate Change:* The Prototype Carbon Fund (PCF). The PCF, a new instrument, is expected to finance activities that reduce or sequester GHG emissions in return for the generated Emission Reductions agreed by many countries through the Kyoto Protocol. The PCF is established with an initial fund amount of around US$150 million, provided mostly by private enterprises and donor countries. The fund may take the place of GEF funding, as in Lithuania. Russia and Kazakhstan are likely candidates for future PCF activities.

(ii) *Biodiversity:* Efforts to protect biodiversity, emphasizing community-based management of natural resources. In support of the Bank's overall mission of poverty alleviation, biodiversity projects in the ECA Region are moving away from stand-alone forest or wetland protected areas projects into a framework based more on integrated rural development. These will likely become important elements of the ECA Region's work in the less industrialized countries

of Central Asia and the Caucasus, where livelihoods are more dependent on the rural environment. The recent Turkey Biodiversity Project aims to improve natural resource management and the conservation of biological resources in agricultural and livestock production systems around protected areas; new initiatives in Central Asia should also address integrated ecosystems management.

(iii) *Regional Seas and River Basins:* Development of integrated river basin and regional seas management programs has been a feature of the assistance since the early 1990s in the Caspian and Baltic Seas, the Black Sea and Danube basin, and the Aral Sea.

Priorities by Subregions

The CIS countries (a) anticipate less demand for Bank lending from EUaccession countries, which will have increasing access to EU funding; (b) CIS countries continue to face major transition challenges and have limited access to alternative sources of funding; and (c) the CIS countries have, in general, higher poverty levels.

Increasing levels of assistance to the CIS will not be easy. Priority given to the environment is generally low, in particular at the level of the central finance and economic ministries. These countries face serious public finance constraints, which limit counterpart funding and therefore the ability to leverage Bank resources. The approach to this region will include (a) analytic work to identify those environmental issues with the strongest impact on growth and sustainable development, and the subsequent incorporation of these in the country dialogue; and (b) increased use of GEF and other grant funding to overcome limitations on investing for public goods, particularly where benefits accrue both at the local and global level.

Small pilot projects can prepare the way for larger projects backed by combined Bank/GEF funding. Within Central and Southeastern Europe, the non-EU-accession countries affected

by the Balkan conflict, in line with the Strategy for Stability and Prosperity in Southeastern Europe that was devel-oped jointly with the EU. In the EU-accession countries, cofinance projects with the EU, which is providing grant funding for the environment sector, and to continue providing advice on EU accession strategies. Bank involvement in the accession countries to concentrate on Bulgaria and Romania, which are facing environmental and natural resource management issues connected with land restitution, lower incomes, slower reforms, major challenges of ownership change, and other conditions that together make accession a bigger challenge.

Strategy Implementation

The strategy will also include partnerships with other agencies.

Lending

Lending will be shaped by the willingness of the client countries to borrow for natural resource and environmental management activities, many of which have only long-term benefits. In natural resource management, we are likely to focus on irrigation and drainage infrastructure and on dam safety and flood control. In forestry, we will help with participatory watershed and forest management, on improved forest management, and on providing assistance to new forest owners.

In land management, the strengthening of agricultural services that support fertility and biological resource enhancement, erosion control, and range management. Investments in the brown agenda are likely to focus on water and sanitation, air quality management, increased energy efficiency, and the clean-up of industrial hot spots. Where possible, the Bank should pursue cofinancing or complementary financing with other partners or with the GEF, especially when supporting projects with externalities or public goods elements.

Program investment guarantees, or guarantees to input providers, help to insure investors against noncommercial risk, including arbitrary changes in policies and regulations. They can act as a powerful market-based mechanism for encouraging private investment and for encouraging governments to create sound regulatory environments. A guarantee guarantee operation for investment in sustainable forest utilization is under preparation for Russia.

Global Environment Facility

The GEF has frequently provided us with opportunities to work in the forest sector on conservation management, thence to move on to broader areas of reform. The GEF has also provided the catalyst for us to work on international waters programs. GEF assistance in three ways:

— Through increasingly combining lending and GEF operations to match loan/credit and grant funds for project activities with local and global benefits, respectively.

— Through promoting complementarity between GEF and Bank operations, using the GEF as catalyst funding for international benefits, while focusing on country-specific investments.

— By providing assistance to NGOs and local communities, using the medium-size grant window that has been little used to date in ECA.

Safeguards

Safeguards are used to address the potential adverse environmental impacts of development projects. In imposing such safeguards, the Bank also disseminates related information and tries to achieve the ownership of and compliance with environmental safeguards of its borrowers. The special Internet-based program to match investors and projects, and the IFC has, in addition to its regular Bank will continue to refine its

safeguards policies and to enforce compliance through its main tool of Environmental Assessment (EA).

EAs also represent an opportunity to integrate environmental objectives into the general portfolio. While there is still room for improvement, we have made good progress in ECA in mainstreaming environmental assessment and environmental management plans into the investment operations in all sectors. The challenge now is to strengthen supervision of the actual implementation of environmental management plans, and to find practical applications of EAs for adjustment operations. The approach to improving the use of EAs for mainstreaming includes:

— Developing techniques for and training staff in the assessment of adjustment lending operations, working jointly with the network.

— Building a requirement for supervision of EA implementation into loan agreements and ensuring that an environmental expert joins the supervision team.

— Training environmental and nonenvironmental staff in EA review techniques to help identify early in the project cycle opportunities to enhance the quality and impact of environmental operations. This goes beyond the "do no harm" approach of the EA standards toward finding opportunities to "do good."

7

GENETIC RESOURCES

The Genetic Resources Division (GRD) acts as a world repository of sorghum, millet, chickpea, pigeonpea and groundnut genetic resources and provides diverse and viable germplasm to scientists of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), NARS and elsewhere. From 1972 to 1995 the GRD provided more than 1.15 million individual samples, 529,000 within the centre, 330,000 within India, and 296,000 to other countries. Over the years research support has accounted for most of the activity of the GRD and its predecessor, the GRU.

A Genetic Resources Unit (GRU) was established in 1979 by incorporating various crop germplasm activities of the Institute into a coordinated unit to "enhance ICRISAT's services as a world centre for the improvement of the genetic potential of the mandate crops". The unit's objectives were collection, evaluation, maintenance, documentation, conservation, and distribution of the mandate crops and six minor millets. Its initial holdings were sorghum, pearl millet, pigeonpea, chickpea, groundnut, minor millets, for a total of 58,067. Since that time it has nearly doubled its holdings, and materials from 128 countries are stored in the genebank at Patancheru.

ICRISAT's germplasm collections are central to all its crop improvement activities. Germplasm samples are collected jointly with scientists of national research programmes and are shared

between the host country and ICRISAT. The assembled germplasm is characterized, evaluated, documented and conserved for current and future use in research.

In November 1993, in a major reorganization of its research programme, ICRISAT reorganized its staff into seven global research divisions, one of them, a new Genetic Resources Division which replaced the GRU. During that year, 13 GRD staff members took voluntary retirement, resulting in a 30% staff reduction, and causing considerable difficulties in GRD operations.

In 1996, the GRD combined its activities into a single global project, "Genetic resources collection, conservation, evaluation, and utilization", with six subprojects: ex situ conservation, in situ conservation, collection, evaluation, enhancement and training, with four subprojects for research targeted at specific regions.

At present, the GRD has one internationally recruited staff position, the Director, three nationally recruited scientists, and 20 technicians, four of whom are temporarily employed on SINGER. Most of the work of the division is research support related to its genebank. Although the Director and some of the staff want very much to do research, limitations of time and budget allow little time for research.

The Panel was aided in its evaluation by two recent external experiments of ICRISAT's Genetic Resources Division. First was a Centre-Commissioned External Review (CCER) conducted at the request of the ICRISAT Board by a four-person panel headed by Dr. G.C. Hawtin, Director General of IPGRI. The external review of the CGIAR genebank operations commissioned by the CGIAR Systemwide Genetic Resources Programme and conducted by a four-person panel chaired by Dr. N.L. Innes.

The Panel was grateful for the reviews and has some observations on their recommendations. In the CCER report in particular, it was often difficult to determine just who or what

group was proposed to be the recipient of the particular service or responsibility indicated by the CCER to be required from the GRD; was it aimed at: (a) service within ICRISAT and its programmes? (b) service directly to NARS? or (c) service to the broader needs of global germplasm management?

Some of the recommendations appeared more suited to the responsibilities of the International Plant Genetic Resources Institute (IPGRI) or to the Systemwide Genetic Resources Programme (SGRP) than to ICRISAT. The Panel recognizes the need for ICRISAT, in its responsibilities in managing the conserving major germplasm collections, to be involved outside the Institute, but the Panel does not consider that ICRISAT should undertake work that does not relate, in large measure, to its own mandate crops and programmes.

Achievements

The GRD has a long list of accomplishments to its credit, perhaps the greatest being the trustee and custodian for nearly 112,000 samples of germplasm for its five mandate crops and the minor millets. ICRISAT's collections represent nearly 20% of all the germplasm held by 11 CGIAR centres. While the collections have not been completely evaluated, some accessions have been identified with desirable traits. This has involved collaboration of GRD with other divisions in the Centre.

An important contribution has been the wide crossing programme which is carried out in the crop improvement projects. In groundnut, genetic traits from a number of wild relatives have been incorporated into the genepool of the cultivated groundnut. Wide crossing in pigeonpea, pearl millet and sorghum has been accomplished using materials identified from the genebank as having desirable traits for the cultivated forms of the crops. Inter-specific crosses of pigeonpea are being used to develop cytoplasmic male sterile systems which will allow hybrid production in this formerly traditional crop.

Numerous sources of resistance to diseases have been found in the collections, notably rosette virus of groundnut in West Africa, and downy mildew and ergot in pearl millet in India. Genes have also been found for short-duration pigeonpea.

The future for the GRD should be bright, holding as it does the genetic wealth of the most important food crops of the SAT. The germplasm held, and the successes to date in utilizing it in crop improvement auger well for the future. And that future can be even brighter if the GRD and its valuable collections are provided more financial and staff support and ways are found to exploit the collections even more systematically and scientifically.

Collections

Table 1 below summarizes the present germplasm collections held by ICRISAT in its genebank at Patancheru.

Table 1. Ex situ Collections of Crops Held at ICRISAT

	Advanced Breeding Lines	*Cultivars & Landraces*	*Released Cultivars*	*Weedy Species*	*Wild & Others*	*Total*
Sorghum	4,359	30,511	-	420	935	36,225
Pearl Millet	142	19,446	-	740	936	21,264
Chickpea	660	16,123	-	135	332	17,250
Pigeonpea	1,764	10,024	-	545	682	13,015
Groundnut	4,666	5,701	324	456	4,033	15,180
Minor Millets	98	8,802	-	115	-	9,015
Total	11,689	90,607	324	2,411	6,754	111,949

Although still not fully adequate to meet its responsibilities, the GRD has reasonably good facilities, including:

— Seed laboratory (seed germination, seed physiology, cytology).

— Screenhouse for wild groundnut accessions.

— Short-term seed storage (600 m^3).

— Medium-term seed storage (532 m^3) with capacity for 20,640 groundnut accessions and 500 m^3 capacity for nearly 120,000 accessions of other crops.

— Long-term storage for conservation of base collections (250 m^3 capacity for 65,000 cereals and 21,000 pulses and 125 m^3 for storage of 10,500 groundnut accessions).

— Extensive field facilities for evaluation and seed production.

The Panel notes with concern that total long term storage capacity is below the amount needed to store the entire global collections, although this situation is not yet critical as transfer of collections to long-term storage is progressing slowly. The Institute also stores groundnut germplasm which requires specialized facilities. The SGRP report praised the new screenhouse for wild groundnut, pointing out that it could be used for materials that could only be propagated vegetatively as well as in characterizing and obtaining seed of wild species under disease-free conditions.

Genebank Management

GRD responsibilities include managing the flow of germplasm through collection, receiving, initial characterization, entry into medium-term storage, documentation, multiplication, distribution, etc. in a systematic manner. Many hands and activities are required in carrying out these steps, and the number of samples handled is daunting. Genebank management also includes the process of placing germplasm into long-term storage as base collections.

Many bottlenecks arise in this process, limiting the rate of transfer to long-term storage. So far, only about 20% of the collections has been placed in long-term storage, and at the current rate will take more than 20 years to complete the task.

This is unacceptable. Both the SPGR and CCER reports recommended urgently speeding up this process, including accelerating germination tests, seed multiplication and drying.

The Panel fully concurs with the recommendations and urges ICRISAT management and Board to expedite the work, noting that a new dryer under order will help speed the effort. For accessions that have sufficient amounts of seed and that meet international germination standards for long-term storage, the Director has a plan to speed up the process.

In such cases, rejuvenation in the field would not be done but once germination tests and drying were completed, samples would be moved to long-term storage with the view that these would be safe for 25 years or so. Thus the collections would be protected while a comprehensive process was followed, including rejuvenation of a new set destined for long-term storage. The Director believes this could be completed in two years. The Panel endorses that approach as an interim measure to protect the collections.

The Panel is concerned that financial and staff limitations hamper genebank operations, believing that the importance of the work justifies more staff and operating funds. The genebank needs a curator to oversee its operations. At present, the Director is trying to carry out these duties in addition to many other responsibilities in the division. The SGRP report commended ICRISAT's Plant Quarantine Unit for its close links with India's NBPGR Service, in dealing with import and export of germplasm, including phytosanitary certificates for ICRISAT materials. The Panel joins in that commendation, considering it an important and valuable partnership.

Globally, the knowledge base is woefully lacking for genetic resources conservation and evaluation, as well as for research on the collections that is necessary to support utilization. Previous warnings about this global knowledge gap have gone unheeded. The knowledge base is insufficient at best for ex situ conservation, the method of conservation and storage that is

essential for crop improvement. Even so, the knowledge base for ex situ conservation is much better than for in situ conservation, on which so many groups and donors are placing their hopes and financial resources.

Also, a fundamental lack of understanding exists about the complementary roles of ex situ and in situ conservation of plants. The discrepancy in understanding is wide. Slogans will not save genetic resources for the future, but research can help. The CGIAR must take the necessary steps to secure the knowledge base.

In ICRISAT's case the international knowledge gap is especially serious, because the Institute's mandate crops have received much less research attention than other major crops. An urgent need exists for ICRISAT to undertake, purposely and systematically, a greatly increased strategic research effort on conservation, evaluation and enhancement of its mandate crops.

The Panel recognizes that ICRISAT is aware of some of these needs and has taken commendable steps to carry out some of the work in the GRD, and by dealing with genetic enhancement in its commodity improvement projects. The Panel commends ICRISAT for the results and scientific quality of much of this work, but has concluded that the scale and intensity of the work is well below what will be needed, and that an even more focused approach in strategic germplasm research will be required.

The strategic germplasm research envisioned by the Panel will require specialists from many disciplines working in three areas that are closely linked in a continuum of (a) germplasm conservation and management; (b) systematic evaluation of collections for resistance or tolerance to biotic and abiotic stresses, along with identification of novel traits; and (c) genetic enhancement. Figure 1 illustrates the Panel's concept of linkages between these three key areas of strategic research on the germplasm collections.

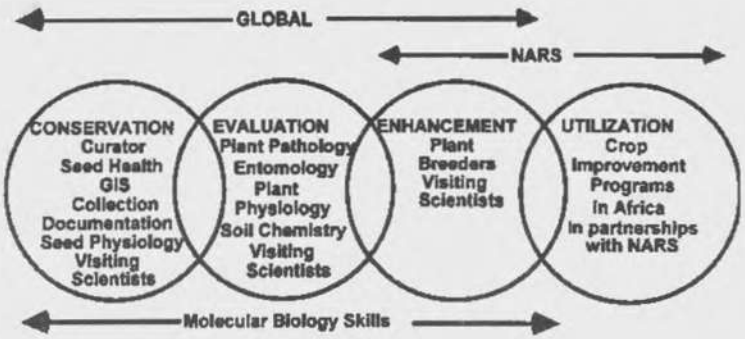

Figure 1. Global Strategic Germplasm Conservation, Evaluation, Enhancement and Utilization Continuum.

The strategic research agenda envisioned would include the following major elements:

— Strategic research aimed at germplasm management and genebank management, including ecogeographic studies of biodiversity of target crops and wild relatives, collecting methods, conservation and handling, including seed physiology and seed health studies aimed at storage of ICRISAT's mandate crops.

— Strategic research on the collections themselves, using an interdisciplinary team approach to understand the genetic makeup of the collections, search for specific traits needed in production systems, find sources of resistance to pests and diseases, locate sources of tolerance to abiotic problems, and support genetic enhancement for raising productivity.

— Strategic research in genetic enhancement using conventional and non-conventional means coming from 'new science' to transfer needed traits into suitable genetic backgrounds to produce parental materials for use by NARS in crop improvement.

Disciplines required will likely include plant pathology, plant physiology, entomology, genetics, molecular and cellular biology,

enhancement breeding, soil scientists, agroecologists, GIS specialists, and germplasm documentation specialists. It is envisaged that the strategic research centred on ICRISAT's global collections will create a centre of excellence that will serve as a 'magnet centre' for such work. It is conceivable that IPGRI might wish to station some of its staff at ICRISAT to participate in hands-on research on global germplasm problems that require - indeed cry out - for research. The 'new' ICRISAT will be an exciting place in which to work and learn.

In reviewing the research recommendations of the two review panels it is noted that in some cases the recommendations tend to lie in two categories: (a) those that relate to the needs of ICRISAT and its programmes; and (b) those that relate more to meeting global gaps in knowledge. The Panel understands the need for more research on genetic resources per se, but urges that ICRISAT's research effort should give highest priority to research on germplasm management, evaluation and enhancement of its mandate crops.

The Panel understands the Systemwide SGRP contains three elements: (a) programmes of the CGIAR centres, in which each programme is unique, independent and self-managed; (b) a coordination mechanism essentially comprised of the Inter-Centre Working Group on Genetic Resources (ICWG-GR) and its linkage and coordinating role; and (c) collaborative research to work on areas of specific cross-centre activities established and monitored by the ICWG-GR.

The Panel has concerns about the CCER recommendation that ICRISAT conduct its research in the context of the SPGR research Systemwide programme. The Panel understands the need for ICRISAT to work with other centres in matters of common interest, but is concerned that: (a) to avoid detracting from its own high priority research needs, ICRISAT should not carry out Systemwide research that should be done by organizations that have global responsibility for such research, unless ICRISAT has a compelling comparative advantage in doing so; and (b)

that the amount of funds available to ICRISAT from the SGRP Systemwide research programme may be too small to support even one internationally recruited staff member. Thus, questions of research priorities, relative responsibilities and roles of individual IARCs in germplasm research, and, at present, apparently high transaction costs of the SCGP, cause the Panel to urge caution in participating in research aimed mostly at the goals of SGRP and having little to do with the mandate of the Institute.

The GRD of ICRISAT has a major global responsibility; that of collecting, conserving, documenting and making available useful materials from its world collections of the important food crops of the semi-arid tropics. Indeed, ICRISAT's genebank is a global resource that also represents the Institute's major long-term research asset. ICRISAT also has responsibility to contribute to improvement of agricultural production as a means of reducing poverty and resource degradation for some of the world's poorest people, and strategic research in germplasm evaluation and enhancement is a crucial strategy to achieve this.

To give some idea of the importance of the ICRISAT genebank, it should be pointed out that of the total germplasm holdings of the CGIAR, constituting more than 593, 000 accessions being held by 11 centres, ICRISAT holds 112, 000 or nearly one-fifth. Despite its importance in the CGIAR, however, ICRISAT's genetic resources work appears under-funded.

During the period 1994-96, total average annual expenditure of the eleven centres on genetic resources activities was US$ 27.2 million, and of that average annual total, ICRISAT spent 3%, not counting what was spent on germplasm enhancement within the crop improvement projects. The Panel acknowledges that the estimated expenditure for the eleven centres mentioned above may be "soft" in terms of defining what to include in the germplasm work of individual centres. At ICRISAT, germplasm enhancement has been done within the crop improvement projects, and therefore it is not easy to arrive at a figure for

annual investment in enhancement research. In 1996, ICRISAT budgeted US$ 0.99 million for genetic resources work.

The Panel estimates that if US$ 2 million had been expended by ICRISAT in 1996 for germplasm enhancement within the crop improvement projects, and if that US$ 2 million was added to the 1996 budget figure for GRD, it would raise the estimated annual investment by ICRISAT in genetic resources and enhancement to about 11% of the CGIAR total effort. This adjusted amount is still below what might be expected in a congruence analysis.

The Panel does not intend these estimates to be critical of ICRISAT, but rather wishes to point out the need for increased investment in strategic germplasm research at ICRISAT. The Panel commends the GRD and its staff for its hard work and good efforts in assembling and managing the large germplasm collections of the mandate crops and the six minor millets. The collections have already shown their potential in yielding genetic traits important to improvement of ICRISAT's mandate crops.

The staff has carried out their work with dedication in a mostly research support mode, without fanfare and probably without enough credit. The Panel realizes their work has been made more difficult by limited funds and staff, and recognizes that some bottlenecks in the genebank and its operations are not easy to overcome under any circumstances, and are made more difficult when workloads are heavy and resources are limited.

To build on the good work to date, the Panel concludes that the present status of the genetic resources work at ICRISAT needs considerable change, and that genetic resources work requires higher priority and greater support in the Institute. The time is ripe to achieve this by rethinking the entire strategy and programme of genetic resources work at ICRISAT, so as to make these valuable collections more accessible to NARS for productivity improvement and improved food security. ICRISAT has shown that effective collaboration between the GRD and

scientists in genetic enhancement can be very effective in SAT crops. Now is the time to utilize ICRISAT's worldclass research facilities at Patancheru and the global germplasm collections as a magnet centre for strategic germplasm conservation, evaluation and enhancement research for the major crops of the SAT.

The paradigm envisioned is one of strategic research centred on the global collections, employing the long research experience of ICRISAT in three continents to identify the major biotic and abiotic problems that need solution. The programme would include research across a continuum from collection, evaluation and enhancement of germplasm, involving applications of modem molecular biology as well as more conventional scientific techniques, and would undergird the genebank's dual service responsibilities in conservation and utilization of its holdings.

Indeed, the paradigm would overcome the long-standing problem of a major gap in the global germplasm system between the curators on the one hand and the breeders on the other. It would decrease the reliance in many genebanks on chance or lucky dips, as one panel member put it, to find valuable traits among the thousands of accessions that are held. Lucky dips will just not do as the world faces a challenging future. A more powerful research approach is needed.

ICRISAT's valuable collections of crops have received much less research attention internationally and in NARS than many others, and enhanced scientific knowledge of the crops and collections is of strategic importance to global food security and therefore constitutes a strategic international public good. Thus strategic germplasm research on crops of the SAT has a valid claim on greater international resources for study and improvement of those crops. Also, ICRISAT's world class research facilities and its global germplasm collections at Patancheru present a major opportunity for the CGIAR to find a new way forward in plant genetic resources research to achieve more effective utilization and protection of biodiversity.

In view of ICRISAT's large international genebank holdings of its mandate crops, its world class research facilities at Patancheru and the need for greater emphasis on strategic research in germplasm of SAT crops, the Panel recommends that ICRISAT adopt a new paradigm in strategic germplasm research using all necessary disciplines and 'new science' to exploit, more scientifically, systematically and fully, the genetic endowment represented in the genebank.

8

Natural Resources Management Research

Natural resources management (NRM) research has been one of the major programmes at ICRISAT since its inception. In fact, the first experiments at ICRISAT Asia Centre included a catchment study on water conservation techniques and management of Vertisols. According to the 1994-98 MTP, NRM research at ICRISAT is aimed at designing strategies for sustainable food production in rainfed areas of SAT while improving the nutritional status and general economic well-being of low income peoples. The overall goal is to provide farmers with low cost sustainable technologies. This strategy is implemented through projects with specific objectives and measurable outputs.

During the period under review, NRM research has been undertaken primarily by the Soils and Agroclimatology Division, Agronomy Division, and the Socio-Economics and Policy Division, through four Integrated Systems Projects (ISP). These projects focus on specific production systems that appear to be stable in various agroecosytems:

— ISP1 covers production systems in the most marginal environments of the SAT, with a focus on pearl millet-based production systems in low rainfall environments where food security and sustainability are the most important objectives.

— ISP2 covers production systems in more favourable but fragile environments, where closing the yield gap and sustainability are the principal objectives with focus being on sorghum and groundnut production systems on sandy soils.

— ISP3 covers relatively well-endowed environments, where the main concern is crop intensification and closing of the yield gap between research station and the farmer.

— ISP4 involves rice and wheat-based systems, in which rainfed legumes may be grown in rotation.

These production systems, emphasis is placed on generic and integrative research; use of GIS and modelling as tools to generate research outputs of wide applicability; integrated resource management; and ultimately, enhanced analysis of on-site/off-site impacts of natural resource management and land use. Besides these studies, ICRISAT has established a series of long-term NRM studies on large plots in small and well-instrumented watersheds at Patancheru, and to a lesser extent at ISC.

The original watersheds at Patancheru were established to evaluate the long-term benefits of new Vertisol technologies in soil and water management and the water use efficiency of the major crops featuring in Vertisol-based production systems. Effects of agronomic practices on the nutrient and soil moisture profile have also been monitored. In response to a 1990 EPMR recommendation, a new watershed experiment was installed in the same area, but focusing on a Vertic Inceptisol to study methods of rehabilitating degraded lands.

The new watershed is intensively instrumented to monitor soil erosion, nutrient and water balances, and the effectiveness of agronomic practices in restoration of soil fertility. The two-year-old studies have already produced promising results. The Indian NARS has expressed interest in the high yields being achieved, and is prepared to finance demonstration of the

technology in a rural setting and related technical training. A socioeconomist has recently been added to the research team. At ISC, watershed studies have focused more on soil erosion.

Achievements and Impact

In May 1996, the ICRISAT Board commissioned an external review CCER of the Soil, Water and Nutrient Management Research within ICRISAT. The CCER report has documented a number of achievements in terms of research findings. In agroclimatology, analysis of rainfall of the SAT has resulted in the development of a computer model relating probable length of rainy season to the date of onset of the rains in the West African SAT.

In agronomy, cropping systems for optimum utilization of rainfall have been developed for different rainfall and soil regimes in the Indian SAT. Results have also been obtained on the influence of plant populations and water deficits on the water use efficiency of pearl millet and groundnut crops in the Sahel. Collaborative research with IFDC at ISC has also demonstrated suitability for direct application of three of the rock phosphate sources available in the Sahel. In general, natural resource management research could be expected to show progress at three levels:

— At the policy level, an improved understanding of the socioeconomic constraints to adoption of improved technology options may change policies and enhance adoption.

— At the research level, a better characterization of the natural resources and of adoption constraints may lead to more efficient use of research resources through a better focus on constraints and transferability of results.

— At the production level, improved technologies should be accepted and widely adopted by farmers as means of

reducing the cost of inputs, and increasing productivity and sustainability of production systems.

Progress at the research level has been achieved, as can be seen in the adoption of the agroecological classification of the SAT as a basis for targeting breeding and agronomy programmes at ICRISAT, and to some extent the collaborating NARS. As observed in the CCER report, ICRISAT has generally not been able to establish strong collaborative linkages in NRM research with NARS, especially in Africa. A notable exception is the collaborative experiments with the Institute for Agricultural Research of Ethiopia at Ginchi on the use of broadbeds and furrows technology in the management of Vertisols.

Good collaboration has also been established with the Indian Council for Agricultural Research (ICAR) scientists at Hyderabad, Anantapur, Indore and Akola, where the stations have been adopted as benchmark sites for some of the major production systems identified in the SAT. Collaboration has also been established with scientists at Zaloke in Myanmar. Technologies generated at ICRISAT are jointly tested and refined at these and other sites and it is evident that techniques for agroclimatic characterization of the environment and production systems are finding increasing application in planning and prioritization of research.

Progress at farm production level implies widespread adoption of technologies by farmers and is dependent on many socioeconomic factors. For example, studies have shown that although modified broadbeds and furrows (BBF) technology for management of Vertisols has proved popular with farmers in certain areas, for example in Ethiopia, adoption of the complete package of Vertisol technology, including changes in cropping systems, is closely tied to the agroecology and to the levels of economic returns to the higher investments of labour and capital that the technology demands. At ICRISAT, no effort has been made thus far to quantify the overall impact of BBF technology on land productivity at farmer level.

Over the years, ICRISAT scientists have collaborated with a large number of institutions in their work on soil and water management, nutrient management, modelling and soicio-economic studies. During the period under review, ICRISAT has made valuable contributions to NRM research, especially in the application of agroclimatic models for agroecological characterization of the SAT, and the use of the CERES model to estimate potential yields of mandated crops under different agroecological conditions.

However, collaboration with NARS has been strongest in Asia, particularly in delineation of production systems, and NRM, and certain upstream modelling work. This is due largely to the steady improvement in the strength of the Asian NARS over the years. ICRISAT's work on NRM research in Africa involving NARS collaboration has focused on agroclimatic characterization in West Africa, surface management and soil erosion, fertility management including evaluation of the use of rock phosphate and methods of application of N and P fertilizers, and the BBF technology for Vertisols in Ethiopia.

Based on its own assessment of the ICRISAT-ICAR relationship, the Panel is convinced that ICRISAT is over-committed in India to commodity improvement, including production systems research. Also, it is apparent from the consultant's say and the Panel's observations and discussions, that the Indian national collaborators in NRM consider themselves undervalued and underutilized by ICRISAT and believe they should have been given a greater role in the execution of ICRISAT's integrated systems projects, particularly ISP2 and ISP3, and other NRM activities.

The Panel concludes it is now opportune for ICRISAT to confine its NRM research efforts at its headquarters in India to mainly strategic aspects. At the same time, ICRISAT should shift the balance of its work in NRM towards Africa where it needs to broaden its scope along the whole of the strategic/applied/adaptive research continuum.

The Panel concurs with the CCER conclusion that ICRISAT has had a long record of research achievements in the domain of socioeconomic aspects of NRM. These studies have however been largely confined to the Indian environment. The CCER team observed that at the IAC, more on-farm research of a strategic nature in collaboration with the NARS, would be beneficial to the scientists engaged in soil, water and nutrient management work. The Panel concurs with this view, but considers that research on socioeconomic aspects of NRM will have to be strengthened especially in Africa where such issues probably constitute the main barrier to adoption of improved technologies.

The CCER report also draws attention to some deficiencies in the ICRISAT programme on NRM research, notably: lack of clear linkage between the modelling activities and the evolution of technologies for removal of production constraints; lack of a long-term strategy in development of crop models, their validation and broad applicability across different production systems; inadequate integration of soil physics, crop water use and hydrology; and domination of nutrient management studies by biological nitrogen fixation at the expense of fertilizer/manure studies.

Regarding nutrient management research, the Panel reiterates that maintenance and improvement of soil productivity are major limiting factors to agricultural production in the tropics, and are more so in the SAT where many soils are intrinsically of poor fertility. Investment in fertilizers within rainfed agriculture in these regions is, however, discouraged by the low and erratic rainfall which often results in low yields or total crop failure.

The Panel believes that emphasis on relatively inexpensive and locally available rock phosphate as a source of P, and biological nitrogen fixation as a source of N has been well placed and productive. Commensurate efforts should be directed to strategies for building up the level of organic matter in the soils and adaptive trials on farmers' fields. The Panel commends

ICRISAT for the ongoing collaboration with ICRAF and ILRI in West Africa, and the workshop on crop residues, a key issue in the management of livestock and soil fertility in the African SAT. ICRISAT activities in NRM have concentrated on West African environments and therefore results will need considerable adaptation in their application to the more complex agroclimatic and socioeconomic production systems of Eastern and Southern Africa.

Integrated Natural Resources Management (INRM) Research Framework

It is now widely accepted that the traditional disciplinary approach to problems of agricultural production systems tends to emphasize the individual factors without considering the interactions between such factors that ultimately determine the success and sustainability of production systems at farm level. One of the outcomes is the realization of the importance of addressing, in an integrated manner, NRM issues alongside those concerned with crop improvement and protection, livestock management, and socioeconomic factors. This more holistic approach has been endorsed by TAC as the way forward for NRM activities supported by the CGIAR.

In a recent TAC study on priorities and strategies for soil and water aspects of NRM research, TAC concluded that the CGIAR System could benefit from the introduction of a more consistent, systematic, and environmentally-sensitive INRM framework for research. The framework would provide: (a) a logical framework for linking the various NRM activities at the Centre and in the CGIAR System as a whole; and (b) a better means of showing the rest of the world how the CGIAR System is addressing the interrelated set of environmental and natural resources issues that are of common concern in moving towards sustainable production. Such a framework would involve four sets of interrelated linkages:

— Links between productivity-enhancing and resource-conserving research, for example, crop improvement and natural resources management.

— Spatial or landscape level linkages, for example, on-site/off-site linkages in a watershed framework.

— Temporal linkages (sustainability considerations).

— Linkages between research and the diffusion/adoption of results from such research.

TAC emphasized that the linkages covered within the INRM framework need to be introduced into the CGIAR System not only through Centre activities, but also to a great extent through work in the Systemwide programmes, essentially those involving implementation of the ecoregional approach.

The current effort by ICRISAT towards integration of research on soil, water and nutrient management with socioeconomic and biological factors of agricultural production - through its integrated systems projects - is therefore a timely step towards INRM research. ICRISAT has gone even farther in its global project approach to identify specific production systems which will provide a sharper focus on the key problems associated with the productivity and sustainability of land use systems. The new projects are however still in their formative stages.

The Panel, while commending ICRISAT for this initiative, observes that successful implementation of the strategy will be influenced by the accuracy with which the production systems can be defined. For example, unlike in Asia and to a lesser degree in WCA, it has proved difficult to identify in the Eastern and Southern Africa region, production systems that are uniquely and geographically associated in content with the natural resource characteristics in which the systems are found.

The Panel shares the concern expressed by the CCER regarding the dangers inherent in the current expectation that the relatively small team of NRM scientists can provide adequate

inputs within a wide range of integrated system projects. Given the resource constraints, such broad coverage can only be achieved at the expense of research depth and scientific impact.

The priorities established in consultation with NARS should therefore be used to ensure that ICRISAT research activities are limited to those areas of generic importance, such as: varietal differences in water and nutrient requirements; climatological and varietal influences on biological nitrogen fixation and recovery by crops; nutrient cycling under different crop rotations; soils and climatic conditions; integrated pest management, etc., in which ICRISAT may have a comparative advantage.

Because the Panel strongly supports the use of watersheds by ICRISAT as a basis for understanding production constraints, and notes the existence of seven on-station watershed experiments which occupy an area of 80 ha at Patancheru; and because the long-term data accumulating from these experiments are very valuable and already have been used in development and validation of biophysical production models; and considering that very few such watershed research facilities exist in the developing world and that their presence at Patancheru is unique in the SAT, the Panel recommends that ICRISAT give high priority to the maintenance of watershed facilities and studies at Patancheru, and in particular to the maintenance and analysis of the data which have accumulated over time from these experiments.

Watershed-based research is however time-consuming, demanding in resources and interdisciplinary collaboration, and requires long-term commitment to produce results. The Panel therefore suggests that ICRISAT selects and concentrates on methodological studies of critical components, such as nutrient flows and socioeconomic parameters, which may be less well understood. In order to do this, it will be necessary to speed up and intensify the analysis of data thus far accumulated in order to determine which trials are still needed, the levels of management desired and the intensity of data to be collected. Such an opportunity, if well publicized, could attract visiting

scientists, research fellows and trainees who could help offset the cost by carrying out some of the tasks in return for their access to, and use, of the data sets.

On-station watershed experiments cannot adequately replicate the real situation in community-managed land use systems. Population densities, for example, have an influence on socioeconomic factors which in turn impact on the dynamics of biophysical resources through changes in land use. The main value of on-station watershed studies therefore lies in the development and testing of methodologies and models relating to biophysical factors. The results obtained at such sites must then be validated within community managed watersheds.

The Panel considers that ICRISAT can play an important role by promoting such watershed-based studies in different regions of Africa. The studies will however involve many players, including NARS scientists and technicians, policy makers and farmers. ICRISAT activities will therefore have to be restricted to a few benchmark sites selected to cover a range of population densities and located in countries where a high level of participation by NARS can be reasonably assured. The Desert Margins Initiative provides a valuable opportunity and a potentially long term framework for such activities.

Simulation Modelling

Simulation modelling that is complemented by on-farm research with farmer participation can be an efficient way of identifying critical factors and knowledge gaps and eventually facilitate application of research findings to the large variety of micro-environments which characterize the semi-arid tropics. ICRISAT has devoted considerable effort covering two decades to the evolution of agroclimatic and crop models. The former have contributed to a better delineation of agroclimatic environments within the SAT and, when enhanced with the GIS technology, should provide a powerful tool for better focusing of research programmes at ICRISAT as well as the relevant NARS. The

CCER report is however critical of the balance between development, validation and application of models within ICRISAT. One reason for the time lag in application of such models to production systems is that there are still many relationships, for example interactions between physical environment, biotic stresses and plant genotypes, and the influence of the socioeconomic factors that need to be quantified through experimentation and on-farm surveys.

This is a gigantic task that will require active participation by all scientific disciplines and many partners. The Panel therefore suggests ICRISAT gives high priority to working with NARS towards the early interfacing of available climatic, soil, water, socioeconomic and crop data and models, with GIS technology. The resulting databases would then provide an invaluable resource to both ICRISAT and the NARS for identification of the critical constraints to agricultural production in different regions of the SAT.

An interesting project on application of simulation models to production systems, CARMASAT, is now underway at ICRISAT. The goal is to develop a farming systems research capability in ICRISAT that combines simulation of crop production systems with agronomic experimentation and socioeconomic research.

Specific objectives include: training of ICRISAT staff and collaborators in the use of simulation modelling; enhancement of a new model under development, APSIM, to improve simulation of cropping systems in SAT; testing of the model's performance against field measurements; and eventually to apply APSIM in conjunction with NARS and NGOs in evaluating farmers' management options. In order to fulfill these objectives, an APSIM Support Unit has been established at ICRISAT.

This unit is expected to work with the developers of the model (APSRU) and modelling working groups in the crop improvement and NRM research divisions, eventually linking up and extending its services to the ISP projects in Asia and

Africa. A new ACIAR/ICAR/ICRISAT project using APSIM for supporting sorghum genetic improvement for rabi production is proposed along similar lines.

The Panel supports participation of ICRISAT scientists in validation and adaptation of integrative production system models. The Panel has, however, some concerns regarding APSIM that will need to be addressed:

— There is a problem of integration of CARMASAT activities with the research projects at ICRISAT. As a result, many scientists see their role in the project as suppliers of data rather than as collaborators in a potentially productive scientific development. Modelling is basically a mathematical way of setting hypotheses and representing the complex natural and socioeconomic phenomena. Any obstacles, real or perceived, to full participation by scientists in this project should be removed as early as possible.

— Although ICRISAT scientists and other collaborators in CARMASAT are contributing to the development and validation of APSIM, there are proprietary rights attached to APSIM which affect free access to the model. It is therefore not clear what credit will eventually accrue to ICRISAT and whether and under what conditions the improved model will become international public goods.

The Panel therefore suggests that ICRISAT reviews especially the conditions attached to access to APSIM and their possible impact on the implementation of CARMASAT. The present internal arrangements for the APSIM Support Unit and GIS Unit in relation to the research projects also need attention. While the relatively rare programming expertise should be placed where it can be shared equitably between projects, scientists in all projects should also be equipped and encouraged to develop the necessary skills to participate fully in the use of their experimental results in validating the available model sub-routines.

A lot of information needed for validating models, such as dates of planting, daily rainfall, yield responses to fertilizer application and socioeconomic data are located within NARS and are not always documented in readily available formats. It may therefore be necessary to mount special projects in collaboration with NARS to assemble and collate the available data in formats that are amenable to computer applications.

Collaboration with NARS at all stages will therefore be essential for the success of such an exercise. An important constraint is that there is still a dearth of trained personnel and physical infrastructure for such activities within the majority of NARS. Their effective participation in this type of research may therefore initially be low but could be improved through professional development programmes at ICRISAT.

The Panel therefore strongly suggests ICRISAT give priority, especially within the evolution of ecoregional initiatives and training in Africa, to activities that assist the NARS in developing sufficient capacity for truly collaborative research programmes in INRM.

Future for Natural Resources Management Research

It is explicitly stated in CGIAR policy documents that as the NARS become sufficiently strong to implement more of the applied and adaptive research, CGIAR Centres should adjust to complement the activities of national programmes through concentrating on global strategic issues in which the Centres will have comparative advantage. At the same time they would be expected to help build bridges between the national programmes and global scientific and technological developments relevant to alleviation of poverty and hunger. The Panel believes that this time has now come in the case of ICRISAT programmes in India.

The implications in the field of NRM are that ICRISAT should in future concentrate more on collaborative activities with NARS in Africa, with emphasis on applied and adaptive research

and socioeconomic analysis of the factors hindering adoption of known technologies. The new Africa-based programme, which should promote the INRM approach, should focus on selected benchmark sites where research activities, along the whole of the strategic/applied/adaptive continuum would be undertaken. It will need strong linkages with the strategic germplasm and NRM research at ICRISAT headquarters.

System-wide initiatives such as the Desert Margins Initiative, and other relevant programmes worldwide. Given the importance of livestock and trees, and the importance of cowpea in the SAT cropping systems in Africa, the Africa-based INRM projects should also have even stronger collaborative linkages with ILRI, ICRAF and IITA. The concept of strengthened NRM research in Africa and the expected linkages between strategic and applied/adaptive research is presented diagramatically in Figures 1 and 2.

An area of concern to the CGIAR, noted in the TAC study on NRM, is the widespread lack of adequate information on land and water degradation and the state of the environment, and knowledge of the impacts of environmental change, including both enhancement and degradation of the natural resources, on crop production and land potential over time. Arguments regarding the seriousness of the problem at the present time have added to the confusion in the understanding of the issues.

Deficiencies in basic data, and differences in interpretation of the limited information available, are the source of such disagreements. Given the need for transnational information and research on the condition of natural resources and the environment, and particularly on the extent and impact of degradation and enhancement of the environment by humans, the Panel concurs with TAC that the Centres should play a role in developing a better understanding of some of the linkages between land use and the condition of the environment and the natural resources base. The Panel is pleased to note that some

of these issues feature prominently in the Desert Margins Initiative and the Rice-Wheat Cropping Systems Consortium in which ICRISAT has a facilitating role.

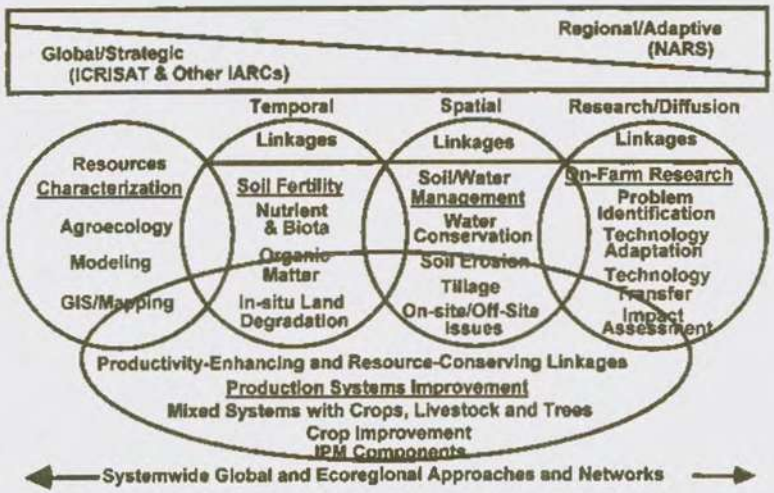

Figure 1. Integrated Natural Resources Management Research Framework in Africa

However, since the CGIAR has only limited resources to devote to filling information gaps, it must choose carefully what aspects of this momentous task it undertakes. TAC has recommended that the focus should be primarily on generating evidence on the impacts of natural resources degradation or enhancement on future production, and vice versa.

The Panel concurs with TAC that this is an area in which CGIAR Centres collectively can be involved with other partners in generating and interpreting improved scientific evidence on the extent and magnitude of the impacts on production and food security, and suggests that ICRISAT explore the possibility of such a coordinated action.

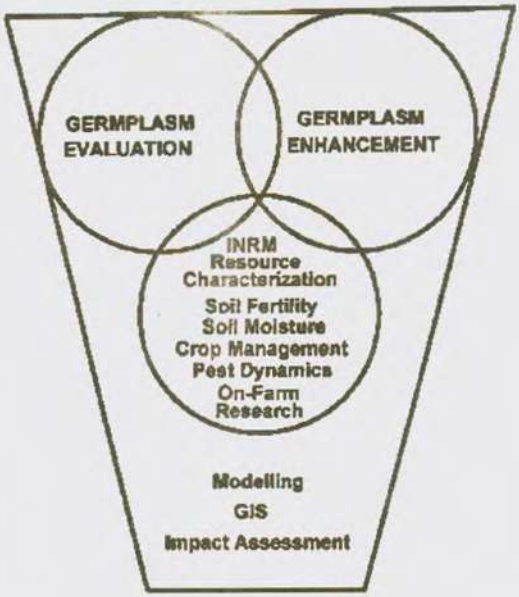

Figure 2. Strategic Integrated Natural Resource Management Research at Patancheru.

In the light of: (a) the need to rationalize the balance and emphasis of natural resources management (NRM) research activities between Africa and Asia; (b) the complexity of NRM research; (c) the history and present state of NRM research of ICRISAT; (d) the need to adopt an Integrated NRM (INRM) research framework in Africa; (e) the need to give priority to strategic germplasm research at Patancheru while reducing commodity improvement and NRM work in India; and (f) the Panel's proposal to focus the bulk of the INRM work in Africa, the Panel recommends that the Institute should undertake a collaborative strategic planning exercise in INRM to formulate research priorities and operational strategies, particularly in fostering effective partnerships with NARS.

Evolution and Strategy

The International Institute of Tropical Agriculture (IITA) for the lowland humid and subhumid tropics in Africa, and its sister institute, the Centro Internacional de Agricultura Tropical (CIAT) for the lowland humid and subhumid tropics in Latin America, were established in 1967, and later incorporated into the Consultative Group on International Agricultural Research (CGIAR) System. The suggestion had also been put forward from time to time by various agencies or persons concerned with international agricultural development that an international institute for the improvement of agriculture in the semi-arid tropics be established.

At the first meeting of the CGIAR's Technical Advisory Committee in mid-1971, a team was commissioned to examine this need, and recommended "the establishment, along the general pattern and principles of IRRI, of an International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) to be located in India, which would serve as (a) a world research centre for improvement of sorghum, millets, pigeonpeas and chickpeas; and (b) a centre to promote the development and demonstration of improved cropping patterns and systems of farming which optimize the use of human and natural resources in low rainfall, unirrigated, semi-arid tropics".

The team also recommended that "if major attention is to be given by the Institute to additional crops such as groundnuts, additional resources would be required". Groundnut was added to the list of crops in 1976. Thus, unlike IRRI and CIMMYT which had been established with responsibility for only one or two commodities, ICRISAT had a mixed and broad responsibility that included commodity improvement for a basket of crops as well as for the development of production systems for the semi-arid tropics.

ICRISAT began formally on 5 July 1972 with the adoption of its constitution and the establishment of its Governing Board. ICRISAT defined its formal mandate, ICRISAT is to:

(i) "serve as a world centre for the improvement of grain yield and quality of sorghum, pearl millet, chickpea and pigeonpea. Groundnuts will be added as a fifth crop next year;

(ii) develop improved farming systems which will help to increase and stabilize agricultural production through better use of natural and human resources in the seasonally-dry semi-arid tropics;

(iii) identify socioeconomic and other constraints to agricultural development in the semi-arid tropics and to evaluate alternative means of alleviating them through technological and institutional changes; and

(iv) assist national and regional research programmes through cooperation and support and contributing further by sponsoring conferences, operating international training programmes, and assisting extension activities".

In 1982, the Institute celebrated its 10th anniversary with no further change in its formal mandate beyond the addition of the groundnut crop. By that time ICRISAT had research teams or scientists located in Mexico, Mali, Burkina Faso, Niger, Nigeria, Sudan, Kenya, Malawi, Zimbabwe, and Syria. In 1986, the ICRISAT Sahelian Centre (ISC) was established at Niamey, Niger, to serve as a regional centre for research and training.

Some two years before its 20th anniversary, ICRISAT developed its first Strategic Plan which was adopted by its Board in 1990. Finger millet was added to the mandate crops because of its importance in eastern and southern Africa. According to the Plan, ICRISAT's strategy for combining research with technology exchange is based on the concept of centres, teams and networks.

ICRISAT Centre in India serves as the global centre where most of the strategic and upstream applied research and most of the advanced training is being done. ICRISAT Sahelian Centre serves as a regional centre where some strategic research and

most of the applied research relevant to the West African semi-arid tropics and training are conducted. In 1993, ICRISAT restructured itself into a corporate organization with four regional entities: Asia, Southern and Eastern Africa (SEA); Western and Central Africa (WCA); and Latin America and the Caribbean (LAC).

The former ICRISAT Centre now comprises the Corporate Office and the ICRISAT Asian Centre (IAC). The ICRISAT Sahelian Centre (ISC) at Niamey (Niger) serves as the regional headquarters for Western and Central Africa, together with the teams at Kano (Nigeria) and at Bamako (Mali). The facilities at Matopos (Zimbabwe) serve as the regional headquarters for Southern and Eastern Africa, together with teams also at Lilongwe (Malawi), Nairobi (Kenya) and Addis Ababa (Ethiopia). No special facilities for Latin America and the Caribbean region have been established. For each region, a Regional Executive Director (RED) was appointed for the management and support of research focused on the main production systems of that region.

To facilitate the definition, development, management and conduct of global research and related projects, a two dimensional matrix management system was developed and introduced in 1994. One axis of the matrix includes the four geographic regions, each led by an Executive Director, and the other axis includes the seven disciplinary research divisions, each led by a Research Division Director (RDD). These divisions are global, including all scientists and senior technical staff within a cognate disciplinary area.

The RDDs remain active scientists within projects, committing a portion of their time to human resource management and quality control. According to ICRISAT, the axes of the matrix are designed to emphasize shared responsibilities, goals and outcomes through development and delivery of a global research project portfolio. In contrast to the previous hierarchical set up, the objective of the matrix approach was to devolve the responsibility for the management of research

and resources to project teams and leaders, along with increased accountability.

At the time of the last External Review, ICRISAT's programmes were made up of 280 projects. In 1995, these were reduced to 22 global projects, and will be reduced to 12 in 1997. The research projects are based on the 92 core research themes embedded in the ICRISAT 1994-98 MTP. ICRISAT's relative resource allocation by activity category has remained unchanged during the review period. ICRISAT allocates 52% of its resources to increasing productivity; 19% to protecting the environment; 8% to saving biodiversity; 7% to improving policies; and 14% to strengthening NARS. Regional resource allocation is 56% to Asia and 44% to Africa.

ICRISAT's Strategic Plan of 1990 was entitled "Pathways to Progress in the Semi-Arid Tropics: ICRISAT's Strategic Plan for the Nineties". The Plan defined the future challenges as follows: "If present trends of underproduction and population growth continue, the net food production shortfall in the Third World will be 100 million tonnes by 2000. Africa will be the major victim of this deficit, but Asia also will experience severe shortages. Global growth in demand for cereal feed for animals in the SAT will also continue to rise.

The productivity of ICRISAT's mandate crops must be increased within the SAT to guarantee adequate supplies of food for the small-scale farmer's household and to assure that grain surpluses are available for sale as food, feed, and other uses. Surpluses will provide food for urban populations and income for the farmers.

ICRISAT, an agricultural research and training centre within the CGIAR System, must fit its mandate crops into different fanning systems, while addressing a range of ecologies and demand and providing an array of options to farmers."

ICRISAT 's role is reflected in its mission statement which states that "the rainfed semi-arid tropics (SAT) and other resource-poor regions growing ICRISAT mandate crops must be

made productive and their agriculture more profitable and sustainable. Only then can people in these regions improve their lives and contribute effectively to national development and achieve food self-reliance. To this end, ICRISAT's mission and approach, as defined in its Strategic Plan document, is to:

— "foster, facilitate, and conduct research on mandate crops, resource management, technologies and institutions;

— aim to increase productivity, versatility, and stability of ICRISAT's mandate crops and suggest appropriate ways of fitting these crops into existing and improved farming systems;

— emphasize a more judicious use of natural and human resources;

— undertake its mission in partnership with NARS and other institutions;

— encourage NARS increasingly to accept research responsibilities in order to solve their own problems and quickly provide technologies to their farmers; and

— adjust its research to meet shifts in research responsibilities within this partnership."

In the draft 1998-2000 Medium-Term Plan, currently under preparation, the above role is elaborated further as follows: "In the world's poorest and most fragile area - the semi-arid tropics (SAT) - ICRISAT works to contribute to the relief of poverty, hunger, and environmental deterioration.

Agricultural activity is inextricably linked to both the causes of, and potential solutions for, these three afflictions. ICRISAT's expertise in science-based agricultural development, together with its international, apolitical, non-profit, and humanitarian nature - uniquely position it to help the peoples of the SAT to work together to achieve effective practical solutions ... ICRISAT, as a global centre of scientific excellence, contributes the broadly applicable international public goods, while its regional, national

and local partners translate these goods into the final products which help to improve the lives of the rural poor in their areas of responsibility."

Currently, ICRISAT serves as the Convening Centre for the Desert Margins Initiative in Sub-Saharan Africa, a component of the ecoregional approach for the arid and semi-arid tropics in Sub-Saharan Africa. ICRISAT also serves as the Facilitating Centre for the Rice-Wheat Consortium for the Indo-Gangetic plains, an element of the ecoregional approach for the arid and semi-arid tropics and subtropics in Asia. Ecoregional approaches are designed to bring about:

(a) the integration of crop improvement research with strengthened natural resources management research;

(b) a new quality of IARC-NARS partnerships and interactions along the research-adoption continuum; and

(c) improved linkages with global strategic commodity and subject matter IARCs in the CGIAR System.

ICRISAT added the groundnut crop to its mandate in 1976. This mixed and broad mandate has proved complex and difficult to implement for several reasons, mainly because:

— The global responsibility for improvement of yield and quality of the five mandated crops is not restricted to germplasm conservation, and genetic enhancement and breeding, but includes also the agronomic and natural resources management aspects to achieve improvement in crop productivity.

— The semi-arid tropics and subtropics are extremely variable with respect to their biophysical and socioeconomic environments, offering a large number of natural resources management domains from which to chose.

— The mandate crops are part of many production systems, and ICRISAT's research targets 29 production systems.

— The mandate crops are not confined to the production systems of the semi-arid tropics and subtropics, but are important crops outside the semi-arid areas.

— The cost of undertaking research in Sub-Saharan Africa has remained high, and poor communications has added further to research costs.

— There are significant differences in the institutional environment between Asia and Sub-Saharan Africa, and whereas the NARS capacity in Asia has strengthened considerably since ICRISAT was established, the NARS in Sub-Saharan Africa have remained weak.

Consequently, ICRISAT must relate to a large array of partners, stakeholders and clients across the four regions, ranging from NARS, other IARCs, other research institutions active in the regions, to NGOs and farmers. To implement its broad and mixed mandate, ICRISAT currently manages 22 projects, 108 subprojects and some 1,200 activities; with a single activity sometimes spread over several ICRISAT locations and involving several scientists. Despite the broad and difficult mandate, ICRISAT's 1990 Strategic Plan proposed adding finger millet to its crop commodity mandate for Eastern and Southern Africa, thereby adding to the difficulties. The 1990 External Review Panel concluded that ICRISAT's formal mandate as described above was very comprehensive, and that there was a need to exercise restraint in research.

The Panel pointed out that ICRISAT's comparative advantage was in strategic research requiring a closer interaction with advanced institutions conducting basic research, and with institutions and scientists conducting applied and adaptive research in order to ensure the continued relevance and applicability of ICRISAT's research.

The 1990 Panel recommended that not only should ICRISAT resist the strong pressure to go beyond the limits of its formal mandate, but that the Board should formulate an

operational mandate which was well within the boundaries of the formal mandate, but at the same time more open to change. In its response to the 1990 Panel's recommendation, ICRISAT has argued that the 1994-98 Medium-Term Plan (MTP) was intended to define the operational mandate for ICRISAT for that period, and that financial constraints since 1992 had narrowed the dimensions of research, not broadened the mandate.

In the opinion of this Panel, the 1994-98 Medium-Term Plan does not contain a clearly formulated operational mandate that would define the scope, strategic focus or directions of ICRISAT's formal mandate. The 1994-98 MTP constitutes ICRISAT's proposals for research and related activities for the plan period. The MTP takes ICRISAT's complex and broad formal mandate as a given and assumes that it is an appropriate guide to setting research priorities and strategies. Consequently, ICRISAT's research agenda for the 1994-98 period could not be anything but broad and complex.

The Panel believes that there is now a strong and urgent need for ICRISAT to rationalize its broad formal mandate and to formulate an operational mandate so that the strategic elements and focus of work are clearly spelt out. The Panel commends ICRISAT for adopting a transparent and quantitative approach to priority setting but does not consider the approach or the 1994-98 MTP in the form submitted to be a substitute for a clearly formulated operational mandate to underpin the longer-term institutional strategy.

ICRISAT's Strategic Plan defines the Institute's strategy for its operations in the 1990s in the context of priorities based on experience acquired from 18 years of research in wide-ranging locations in the semi-arid tropics. The Plan assesses the nature and essential elements of the challenge facing the Institute, anticipates the external environment in 2000, describes the target groups and partners, the guiding values and internal environment in which ICRISAT's work is done, and the regions where the Institute operates.

The nature and elements of the challenge are assessed in terms of: crops and natural resources management research, including impact assessment research; training; technology exchange; the global and political environment; the physical environment; sustainability; partners; women in agriculture; new technologies; and new crop uses.

Future ventures in crops, environmental and impact assessment research as well as in human resource development and technology exchange are described. The Plan ends with an assessment of the operational pathways by which the Institute's mission can be achieved, in collaboration with national programmes.

The Panel has no quarrel with the way the Strategic Plan is crafted except to note that until 1989 ICRISAT's global mandate for crop improvement covered five crops, sorghum, pearl millet, groundnut, chickpea and pigeonpea. However, the 1990 Strategic Plan implied that ICRISAT's global crop improvement mandate covered six crops by stating that "ICRISAT's mandate crops include three cereals and three legumes".

The Panel finds this statement puzzling. The Panel failed to find in the Strategic Plan either any solid analysis to support the basis for this decision, or any indication of the priority to be given to finger millet relative to the other mandate crops. The 1994-98 MTP states that "ICRISAT's 1990 Strategic Plan has served as a valuable foundation" in the preparation of the MTP. The Panel questions whether the 1990 Strategic Plan provided a foundation for ICRISAT to formulate a clearly focused and manageable research agenda. If anything, the Strategic Plan recommended an expansion of the crops mandate without offering the much needed help towards making the implementation of the broad and complex formal mandate more manageable.

The Panel does not believe that the existing Strategic Plan can continue to serve the best interests of ICRISAT and its

national partners in the future. ICRISAT's 1994-98 MTP was formulated in the light of the Systemwide issues affecting the CGIAR. The MTP is a compilation of prioritized research themes designed to address the major biotic, abiotic, and socioeconomic constraints to sustainable growth in agricultural productivity in the SAT. Research has continued to emphasize the solution of priority constraints and the realization of new opportunities towards ICRISAT's goals of increasing efficiency, internationality, equity and environmental sustainability. These four criteria have been used to rank the 92 themes.

Priority research areas are: cereals improvement: sorghum and pearl millet; legume improvement: groundnut, pigeonpea, chickpea; genetic resources research; integrated pest management; production systems research: rainfed short-season; rainfed intermediate-season; rainfed low to intermediate-season; legumes in rotational cropping systems; socioeconomics research; and evaluation and impact assessment. ICRISAT's agreed agenda is implemented through 22 global projects, 108 subprojects and some 1,200 activities, and targets 29 production systems in the three regions. The Panel commends ICRISAT for developing and applying a quantitative and analytical approach to priority setting, and for creating a transparent and structured research agenda.

9

PARTICIPATORY ACTION RESEARCH (PAR)

People's participation is nothing less than the basic texture of social life. For millennia, people have 'participated' in shaping their cultures and survival strategies in an immense variety of ecological environments. For the greater part of the existence of Homo sapiens, this sharing of tasks and responsibilities has taken place in self-regulated small groups - 50 to 60 individuals who interacted in a face-to-face way and shared the hunting, gathering, leisure and learning of daily life. With the advent of agriculture, and even more so with the advent of industrial production, social units grew in size and became internally diversified and specialized. Regulations and enterprises developed and promoted by special groups had to face the consensus, the indifference or the opposition of the rest of the people. Spontaneous participation became an important test of confidence and trust.

In recent decades, large-scale planning, governmental services and regulations, entrepreneurial projects and development schemes have increasingly dominated socio-political life. To begin with, participation is a condition by which local knowledge, skills and resources can be mobilized and fully employed. Local people may know very well the causes and possible remedies of deforestation or soil erosion in their

environment. They may know where to find and how to use plants of unique properties or how to prevent animals from damaging new seedlings. They may be able to offer labor, land, food, shelter or tools for the running of a project.

Contributions like these increase the flexibility of an initiative and its responsiveness to local conditions, they reduce the chances of mistakes with major environmental consequences and often make up most of the difference between success and failure. In fact, the overriding benefit of people's participation is the increased effectiveness of any initiative. Another major benefit is a more efficient use of resources. In fact, local knowledge and skills help minimize waste and obtain results with limited investments; participation can bring to the project the full benefits of human and material resources that would otherwise remain idle or poorly utilized; and local monitoring discourages the undue use of assets and promotes accountability and the respect of rules.

Most of all, however, the participation of local people provides a unique assurance of the sustainability of conservation initiatives. In fact, local people are - at least potentially - the most directly interested in the positive results of such initiatives. When they initiate them or participate in setting them up, when they invest in them their own hopes and resources, they are likely to remain motivated to sustain them in the long run. In fact, most local communities possess greater stability and continuity than national governments; their investments are made for the next generations rather than for the next elections.

Agencies concerned with the effectiveness, efficiency and sustainability of conservation and development initiatives can thus profit from people's participation. But participation directly benefits local people as well. When people take part in assessing population dynamics, environmental problems, resources and opportunities, they acquire information and enhance their awareness of factors playing a role in their lives. When they act and contribute, they often acquire new skills and face the

opportunity of organizing themselves - with a variety of returns for local equity, self-reliance and building of community or group identity.

In fact, the benefits of genuine people's participation in initiatives for the common good are so many that for some authors the concept merges with other concepts, like democracy and development, and makes the whole difference between a mature and free society and a paternalistic and possibly oppressive one. Given all the benefits listed above, is participation universally desirable? Could any problem arise? The management of a conservation initiative may wish to take into consideration the following potential issues and constraints:

— Full local participation and empowerment are best developed in a democratic society. Yet, several communities affected by conservation initiatives are highly hierarchical in nature and generally follow the decisions of their leaders. In those communities, the participation of certain disadvantaged groups may clash with local customs.

— The very concept of 'stakeholder participation' may be quite alien to some cultures and groups. For instance, it may be that the self-assertion required to express one's 'stake' is considered unseemly and clashes with accepted behavioral norms. In fact, the participation of various stakeholders presupposes that different interests exist within a community, which is a concept largely derived from the economic and cultural context of modern western society.

— National governments may not support local participation or empowerment, especially if they regard it as a threat to their own authority, or as an encouragement to opposition groups. The participatory approach also may not be viable because of local political opposition or sheer lack of norms and institutional support.

— Participatory processes require specific investments of time and resources. In particular, the process of participation

needs expert facilitation and clear objectives, to avoid chaotic meetings and a general loss of direction for the initiative. The needed resources may not be available or the relevant activities may not have been foreseen in the original plan of the conservation initiative. In these cases, creativity and managerial initiative are necessary.

— Participatory approaches require commitment over time and results may take a while to appear. This can tax the patience of donors, managers, staff and local people alike. Threats against natural resources may be escalating, and the urgency of taking action may discourage people from undertaking lengthy participatory processes.

— Time and resource investments may be required to reach a good level of communication between the local people and the national or expatriate staff in the conservation initiative.

— Some compromises in conservation objectives may need to be made. For instance, a conservation initiative designed by outsiders may propose a total ban on local access to natural resources, which may be simply unacceptable to the locals. Also, emphasis on the process of participation may take attention and resources away from the 'technical content' of the initiative.

In short, participation requires time and effort, not to mention additional resources and socio-political sensitivity. But the rewards, in terms of the sustainability of project interventions, local empowerment and promotion of democratic processes, can more than make up for the costs and potential frustrations encountered.

In participatory project management two frequent practices are given below:

— the top-down decision-making process;

— the 'blueprint' approach to project planning and implementation.

Many, if not most, of the existing development and conservation initiatives around the world are the result of top-down decision-making processes. What is to be done, as well as how, where and when it will be done, is decided by agencies from outside the local community. Institutional desires and the wishes of 'well-meaning' outsiders carry more weight than the felt needs and know-how of local actors. Even when local participation is actually pursued, the rhetoric of program documents may talk about the 'poorest of the poor', but those who are consulted are usually local leaders and prominent people.

In addition, the administrative needs and bureaucratic rules of donors and implementing agencies pressure development and conservation initiatives into standard project documents. These documents contain rigid sequences of outputs and activities, based on forecasting which may have been fixed even before a preliminary contact with the local community has taken place. Despite their coherent and meaningful appearance, these project documents do not usually survive the reality of implementation.

Delays, deviations, unforeseen constraints, incidental events, unexpected outcomes and missed opportunities are the daily lot of many conservation or development initiatives. Unfortunately, in the usual development and conservation practice, a written project document is more important and more 'real' to the funders and supervisors than a project in the field. Requirements for delivery of inputs and production of outputs, as stated by the project document, are a straitjacket for project managers and communities, preventing them from creatively exploring alternative courses of action based on what they learn during project implementation.

To overcome these limitations, some development and conservation agencies have started to experiment with a new project management style, which is based on the following:

— Flexible and relatively open-ended project documents. Lists of objectives, outputs and activities are presented as an open set of alternative courses of action. Their relevance to local

needs and resources is to be field-tested and validated, with the active involvement of local actors, at the start-up of the project and during its lifetime. Selection within this list, as well as reasonable shifts from the initial plan, is foreseen at any time of the project. Consequently, timing, delivery of inputs and achievement of results are left as open-ended as can be acceptable for the donor and the implementing agency.

— Field-based participatory appraisal, feasibility analysis and strategic planning. Whatever the general objectives of the initiative are, time and resources are allocated for carrying out a preliminary appraisal and feasibility analysis with the full involvement of local actors, i.e., a participatory baseline assessment. This exercise usually leads to lists of problems and possible solutions as perceived by different groups of local persons. Planning decisions are eventually made by collectively negotiating these lists against the mandate of the external agency and the policy priorities of other local institutional actors. It is only on this basis that a detailed short-term plan and timetable is prepared.

— Participatory implementation and monitoring. The responsibility of carrying out decisions negotiated through participatory planning is shared by the different actors involved, such as community groups, local authorities, NGOs and external donors. Each actor is supposed to contribute its own resources to implement the common plan. Due to the variety of actors involved and the flexibility of planning decisions, continuous monitoring by all the concerned parties becomes an important component of implementation. The monitoring helps to control the flow of inputs and the deployment of activities, as well as to identify and settle conflicts and problems which may arise, and to take advantage of opportunities as they come.

— Participatory evaluation and re-planning. The open-ended and iterative orientation of the participatory process means that on-going evaluation is essential. In contrast to

summative evaluations that decide whether to continue a project or not, evaluations in participatory processes generally have a 'formative' focus. Their aim is to extract lessons learned during the implementation and use them to guide the future evolution of the project. Re-planning of each ensuing activity or phase is thus an expected part of such evaluations.

The new project management style entails several technical difficulties. Repeating, open-ended and comprehensive processes are much more complex to manage than pre-defined one-time interventions in a single sector. Engaging full participation calls for effective means of communicating, building consensus among different actors and, whenever needed, helping them to solve their conflicts. Important goals in potential opposition, such as the exploitation of natural resources for economic development and their conservation for future gains and ecosystem functioning, need to be composed and harmonized. Working at the local level is possible only if the political and economic links with the national and international situation are acknowledged and strategically managed.

To meet these challenges, the professionals working with initiatives aimed at participatory and sustainable development have looked for new and appropriate technologies for project management. Various participatory methods for information gathering and assessment, planning, implementation and evaluation have evolved in response to this demand.

The process of responsible and informed decision-making at community level about environment and population issues can become more effective by merging local knowledge and resources with external skills and inputs. This is the justification for establishing a partnership between local actors and non-local professionals with the aim of improving quality of life in the community and optimal management of its natural resources.Ideally, such partnerships are based on the following principles:

— *Mutual respect:* People from different backgrounds and social realities seem to live in different worlds. Yet, if one is open minded, tolerant and respectful, meetings of this kind can be among the most rewarding events that life can offer.

— *Complementarity of capacities:* Most often, local and non-local actors have diverse comparative advantages and skills, which can complement one another and at times develop into true synergies.

— *Working for a common goal:* At best, collaboration develops on the basis of a shared vision of what is appropriate and desirable in a given context. When particular benefits and interests merge into a mutual goal, all parties are more motivated to act.

— *Process orientation:* A collaboration is best considered as an organic and evolving phenomenon, rather than a way to produce a project plan that will stand forever. Partners should feel that agreements can be changed, but they should respect them as they stand until all interested parties agree to modification.

Development of Participatory Action Research

Growing from experiences in applied research in the social sciences, community-based development and participatory project management, participatory action research (PAR) has been used widely around the world. For instance, PAR has been applied to plan, implement, monitor and evaluate many kinds of projects, such as community organization and development, community health and nutrition, agricultural extension, community forestry, urban environmental improvements, education and training, etc.

Many variations on the theme exist. Some of the better known examples include: rapid rural appraisal (RRA), participatory rural appraisal (PRA), rapid assessment procedures (RAP), activist research and farmer participatory research. While there are differences in emphasis, orientation and sector of

application for these methods, all of them share some common features which allow us to group them under the label of 'participatory action research'. Such features include:

Local focus:

— An orientation towards the felt needs of local people and institutions. PAR deals with issues directly experienced and explicitly acknowledged as problems by local people and institutions.

— A strong link with locally generated initiatives. PAR aims at generating information and supporting decision-making processes useful for local aims and applicable to local initiatives.

— The involvement of non-local actors as partners in a learning process. When non-local actors are involved, they contribute to PAR via discussions and negotiations with local actors.

Action focus:

— A minimal time-gap between data collection, analysis and feedback. Timeliness of analysis and rapidity of feedback are sought, to increase the cost-effectiveness of the research and promote the practical use of its results.

— A direct feeding of research results into planning and action. PAR goes beyond 'recommending' changes based on the findings. The action research process incorporates methods for translating the knowledge gained directly into practical decisions and/or feasible courses of action.

Process focus:

— *An equal concern for process and results:* PAR consists of collecting 'fairly quick and fairly clean' information, but it doesn't stop there. It also aims at making all participants

aware of the implications of the issue being investigated and supporting them in undertaking relevant action.

— *A built-in communication strategy:* While final written reports are useful for institutional or training purposes, meetings and workshops are the most important means to provide feedback to local institutions and the community at large.

— *The re-definition of the role of non-local professionals:* Non-local professionals are expected to leave behind their attitudes as 'experts' and to act more as providers of views and information that need to be evaluated for appropriateness and usefulness by the local people. At times, they may serve more as facilitators than experts. Precision and accuracy of findings are balanced by the timeliness and user-friendliness of research and decision-making techniques.

Basic Methods and Techniques

Participatory action research includes an increasing array of techniques and tools designed for dealing with a variety of management issues and problems. For simplicity of presentation, all of these techniques can be brought back to three basic methods for generating information and making decisions. These three methods, which have been widely used and tested by applied social science, are: participant observation, individual interviewing, and facilitated group meetings and exercises.

Participant observation consists of taking part in social situations with the aim of discovering issues, events and interactions which may be obvious for the local actors but unknown to the external observer. Extensively used by anthropologists, participant observation has proved to be especially useful in the framework of participatory action research for:

— understanding the way in which local people use natural resources and manage their environment;

— understanding the local social environment, with special emphasis on status, roles and behaviors related to gender, age, wealth, social status and ethnic differentials;

— understanding the daily relationships and communication flows existing among non-local professionals and different groups of local people;

— analyzing daily, weekly, monthly or yearly patterns of activities and the time allocated by local actors to perform them.

As used in conventional anthropology, the technique of participant observation typically entails a regular routine of being there - taking notes, reflecting, hypothesizing and making many repeated observations for confirmation. Such a time-consuming procedure does not usually fit well the practical needs of participatory action research. While failing to provide the in-depth understanding of local society and culture which comes after several months of full-time participant observation, a few days spent walking around and visiting people and places with an open mind are a good entry point for a professional new to a particular community or project setting. The discussion of insider/outsider experiences in the participant observation method is a key component of any action research process.

To get the most out of a rapid participant observation of a local setting, PAR practitioners tend to focus this practice on situations directly relevant to specific issues of interest. For instance:

— *transect observational walks:* walking with one or more residents across the area surrounding a village can be useful for obtaining information about patterns of natural resources and their exploitation or use;

— visiting places where different community groups meet: people tend to gather in places like markets, coffee shops,

football grounds, religious buildings, water source points, etc. Observations can be made at such locations to identify patterns of social interaction among different groups;

— *attending official meetings and ceremonies:* observing at events, such as community meetings and ceremonies can generate insights about the political and social dynamics in the community;

— observing service delivery and project activities: many kinds of services are provided in communities; observing the process can help in assessing the reciprocal attitudes and behaviors of providers and users.

Traveling along during regular project activities, such as agricultural extension visits, natural reserve patrolling or family planning outreaches is a very good way to understand the communication flows between external agencies and local people. While it is desirable to remain neutral relative to either the project or the community, assisting with some simple tasks during the activity is generally appreciated by staff and recipients. In this way, participant observation can lead to closer rapport and good opportunities to engage in discussions with local people, service providers and project staff.

In most observation sessions, note-taking is appropriate and necessary. Jotting down what has been observed is not only an aid for memory but also a way to focus the observer's attention on issues directly relevant to the problem(s) for which the action research is being done. Pre-set observational check-lists can be used, but they are more controversial. The advantages—standardization and systematization of observing specific items - will need to be weighed against the risks of losing an open-ended, discovery-oriented and relaxed approach which is a basic strength of participant observation.

Participant observation is usually combined in action research with various individual interviewing and group discussion techniques. Indeed, verbal interaction on the spot, i.e.,

talking with the people who happen to be there, can help to elicit insider interpretations of an observed behavior, event or situation. Most importantly, as PAR is principally for the benefit of local people, any observation collected by outsiders needs to be communicated to the insiders and discussed/evaluated together with them.

Interviewing is basically a process of inquiring into another person's perceptions about a particular issue. It can include exploring their knowledge, feelings, attitudes, opinions, past experiences and expectations for the future. Interviewing can be useful for a wide range of concerns, such as:

— *local knowledge of the natural and social environment:* natural resources available and their traditional use; local technologies; means to mobilize labor; social organization of the community; gender and age issues; etc.;

— *felt problems and needs:* related to household economy, conservation of the resource base, education and health; access to reproductive health, family planning, credit services, etc.;

— *perception of existing initiatives in the area*: relationships among local actors and staff; relevance of the initiative to local needs; functioning, acceptability and appropriateness of the services provided; etc.;

— *time trends in the life of the community:* effects of seasonality on social life; distribution of activities throughout the year; local history; life histories; expectations about the future; environmental and population coping strategies in the past; etc.

Two main interview approaches are used by social researchers: open-ended and closed-ended interviewing. Open-ended interviews are based on a more or less organized and standardized sequence of questions whose answer are richer than a plain 'yes' or 'no' statement, a numerical figure or a categorica

judgment. As with participant observation, open-ended questions aim at discovering elements of the insiders' perceptions of the topic under investigation, which are likely to be almost unknown to the interviewer. Open-ended interviewing is thus a powerful means to catch 'qualitative information'. Widely used in anthropology, psychology and other traditions of applied qualitative research, open-ended interviewing is a key component of participatory action research.

Choosing the proper respondents is an important element of open-ended interviewing. Some respondents could be selected because they have special knowledge about the topic of the action research - they are key informants. It also helps if they are ready to talk and they are somewhat reflective or analytical in their thinking.

Other respondents might be selected for their representativeness as members of different interest groups, or on the basis of any special social status accorded to them, either formally or informally. Open-ended questions can also be addressed to a group of respondents. Groups may be spontaneously set up or convened by the interviewer.

Most often, the sampling of respondents for open-ended interviews is based on judgmental criteria rather than random chance. Such purposeful sampling is quite different from the random sampling useful to draw statistical probabilities in quantitative research. Statistical sampling is based on randomness so that researchers can confidently generalize results from a small sample to a larger population. The power of purposeful sampling lies in selecting information-rich cases for in-depth analysis related to the central issues being studied.

The success of an open-ended interview depends very much on the communication skills of the interviewer, which are needed to keep the discussion as a relaxed dialogue. These skills include helping the interviewee feel at ease, phrasing questions in clear but not leading ways, and introducing probing questions appropriately.

Confidentiality can be an issue for some participants. Although the potential topics for interviews mentioned earlier in this section are not generally very sensitive for most individuals, the nature of the interview process, especially qualitative open-ended interviewing, can result in respondents disclosing information which they would prefer to keep confidential. It will be important for the interviewer to respect such wishes if they arise.

Open-ended interviewing techniques are best carried out with detailed note-taking aimed at catching the exact words and phrasing of respondents' answers. Tape recording can be of great assistance in this effort, but only where and when it is fully acceptable to the respondent. Once data are collected, good summarizing skills and insight capabilities are needed to extract meaningful content from the statements provided by respondents, which at times can be long and wandering. The latter task can be facilitated by the use of qualitative analysis matrices.

The qualitative information provided by open-ended interviews of individuals or groups is often counterchecked and completed by other methods and techniques, including participant observation and closed-ended interviewing. This is especially important when it is desirable to assess the generalizability of the data for a larger group of people than the small numbers directly interviewed.

Closed-ended interviews use carefully organized questions which allow only a limited range of answers, e.g., a yes/no answer, a categorical answer, a preference answer or an answer expressed by a number. The series of questions in this type of interview are usually presented with structured questionnaires. These are pre-set formats in which the interviewer marks responses against a given group of possible answers for each question. To allow generalizing from these kinds of results, different statistically random sampling procedures are at times used to select the respondents, with the aim of interviewing a representative sample of the population under study.

In applied social sciences, such as demography and epidemiology, structured questionnaires are widely used for collecting quantitative data. Many research practitioners share a critical view of rural surveys which are solely dependent on questionnaires. Two major complaints about questionnaires relate to the loss of human touch and the extent of technical expertise required.

Structured questionnaires are often poorly understood by respondents and there are problems with the reliability of the information collected. Moreover, carrying out high-quality quantitative surveys requires specialized skills for questionnaire design, as well as the capacity to cope with the sophistication and abstractions of statistical analysis. PAR, however, may also need quantitative information. In other words, it may require a blend of qualitative data about the nature of a problem or a situation combined with quantitative data about the distribution or extent of the problem to ensure a full and reliable analysis of a given situation.

To meet these needs, PAR can indeed combine qualitative and quantitative methods. This can be done sequentially, e.g., by doing open-ended interviews first to assess the range and nature of responses, followed by closed-ended questionnaires to check on the prevalence and distribution of responses.

Semi-quantitative and participatory methods of ranking can then help individuals and groups of respondents to express judgments and opinions about the results of a questionnaire. Discussions of specific findings can also be held with groups which are representative of specific social actors, interests and/or the community at large. These discussions can focus on the interpretation and validity of the findings derived from questionnaires.

Group Meetings and Exercises

Participant observation and individual interviewing are powerful ways to elicit information about a local social setting. The action

research approach, however, does not stop at this point. As soon as possible, the 'research' interaction needs to become a partnership among local and non-local actors aimed at taking action - if action is due - on the basis of the research findings. The basic method which enables this to happen is facilitated group work.

Participants for action research group exercises can be recruited through purposeful sampling strategies, such as those employed for open-ended interviewing. Another strategy is to use spontaneous clusters of community members on the basis of a common interest, e.g., women farmers, herd-boys, water vendors, traditional birth attendants, etc. Such natural groups - which often coincide with, or can lead to identify, specific interest groups - are actually the core actors of the PAR process.

Frequently, members of interest groups will already be participating in the organized or informal indigenous social groups that are typically found in most rural communities, e.g., farmers' groups, burial societies, self-help groups, mothers' unions, revolving credit clubs, etc. A core concern of many of these social groups is mutual aid or assistance.

At times they constitute themselves as community-based organizations to support the socio-economic and environmental interests of their individual members or of the community as a whole, e.g., as a user group, a local cooperative, a village council, a residents' association, etc. Where such groups exist, they are very important actors to involve in assessing the local environmental and social situation and in planning some initiatives to ameliorate it.

Action research practitioners rely on a large selection of techniques and tools to promote participatory appraisal, planning, monitoring, evaluation and re-planning among the members of interest groups. They include group exercises that focus on:

— collection and organization of information owned by different local and non-local actors;

— discussion and validation of information collected in the field or from existing secondary sources;

— building consensus, resolving conflicts, setting priorities and making decisions;

— learning by doing during the implementation of decided activities.

Experience has shown that group work with local actors is more likely to be effective and efficient when a neutral and coherent facilitation is provided by an experienced person who is not a member of the community. A good facilitator helps the participants to think and communicate with one another, and avoids imposing his/her personal view or suggesting the 'right' answer or decision either explicitly or implicitly. He/she takes care of helping the group achieve the results the group itself wishes to achieve, managing interpersonal dynamics, ensuring that the discussion is kept on a relevant track, and keeping the length of the exercise within reasonable limits.

To carry out this role, the facilitator needs a good understanding of the social and cultural reality of the participants. This awareness is essential so that his/her personal style can be adapted to the rules of behavior, the communication and analytical skills and the cultural attitudes of the participants.

A good facilitator will be able to strike a balance between the need to achieve some positive results in the group work and the need to keep the interaction among participants as smooth and relaxed as possible. Maximizing the contribution of each participant in the group exercise, settling conflicts and building consensus are the facilitator's main responsibilities. As part of skillful and non-intrusive facilitation, the creative use of visual aids is an important strategy for supporting group exercises in action research. Some examples of visual techniques include the following:

— Maps and transect representations can be used very effectively in groups to describe and analyze the

community's spatial distribution of features of special interest.

— Drawings, posters, pictures and slides as well as open-ended stories, popular theater and community-directed videos can be an excellent entry point for group discussions.

— Sorting, counting and ranking exercises may be done in written form but, if literacy is low, they can equally be carried out with everyday objects, such as seeds, stones or simple sketches on small slips of paper.

— Graphic representations by means of pie charts or bar charts are suitable for conveying quantitative information even to non-literate participants. The pictograms can be used to describe and analyze time trends, patterns of relationship among different actors, or sequences of causes, problems and solutions.

— Analytical tools can be used to organize and analyze findings, including qualitative statements. They can also be used on flipcharts or chalkboards for assembling the ideas developed in a brainstorming session with a group.

Support for Development Initiative

Participatory action research can provide effective support to any conservation or development initiative. Though based principally on common sense, PAR exercises have some pre-conditions, and entail several potential technical and attitudinal difficulties.

Community acceptance

An underlying assumption of the PAR approach is that the people in the community are willing and can afford to invest energy and time in the process. Another assumption is that the non-local partners and facilitators in PAR have the trust and confidence of the local community. This kind of trust is not

developed overnight, and in some cultures it develops only over months, and perhaps years, of working together.

It is unrealistic for people unfamiliar with a community or the local context to have the kind of understanding and local acceptance necessary to become partners or facilitators in the PAR process. Therefore, it would be advisable for at least one or two of the non-local support team to take the time to get to know the community and build rapport with community members.

Generally, this will mean either living within a community for a period of time, or maintaining contact with the community through regular visits. This contact could be on the basis of regularly scheduled meetings or on the basis of a long-term conservation or development initiative that require frequent visits to the community for coordination. Once trust is established, it is far easier to collaborate with community members in PAR or any other activity.

To enable those non-local partners who have not had extensive contact with the community to get to know community members and vice versa, it may be useful at the outset of a PAR to engage in some kind of ice-breaking activity. For example, the non-locals might participate in traditional village tasks such as gardening, construction or clothes washing. This can serve to build rapport while at the same time helping community members to see that they possess a unique body of knowledge and skills not necessarily shared by outsiders. It may also help the non-local partners to address their work with more humility.

After taking the initial decision to adopt participatory action research, some specific know-how can be transferred to its staff via training by an experienced practitioner. Regional and sectoral networks of concerned institutions may provide technical assistance and open fora for discussion and exchange of experiences.

The availability of qualified support and literature alone, however, cannot ensure the deeper attitudinal change that the practice of action research demands from project managers, conservation and development professionals and field workers. While this change usually occurs spontaneously in the process of field experience in participatory action research, it can be facilitated by attention to a number of general cognitive and behavioral points:

— Knowledge is for the community, not for the non-local partners. The most important objective of action research is to strengthen local abilities to seek, organize and utilize relevant information to solve problems. Participatory exercises are not the time or place for academically oriented research. Collecting data in a participatory way may be initially greeted with interest, but later resented by the community as a waste of time if the results are not returned promptly and applied within their territory.

— Non-local partners in participatory action research need to have something to offer. To be useful and justify their presence, the non-local partners and facilitators in an action research process need to master their technical background as well as research and communication skills. Unskilled facilitators are useless or even detrimental and expose everyone to frustrating experiences. The best way to learn how to facilitate action research exercises is by doing it with an experienced colleague.

— Local culture deserves respect. An action research process which is conducted and managed according to local customs is much more likely to be successful in the eyes of all participants. Information should be handled carefully. Whenever requested, anonymity and discretion in sharing information with others should be assured. Communities appreciate respect for local traditions, e.g., following local protocols for introductions. At the same time, partners and facilitators should be aware that cultures and communities

are dynamic entities: they change, and often rapidly. Attempts to restore customs and practices which the community has already dismissed are un- likely to succeed and may cause resentment. People do not like to be told what to maintain and what to change in their culture.

— Communication is a major concern. Conducting action research exercises in the local language ensures full participation by the local community, regardless of education. Consecutive translation is tedious, boring to participants and not appropriate. If the PAR partners are not comfortable with the local language, bilingual facilitators can be recruited and trained.

Simple written materials are often very useful, yet their value is limited in situations where literacy is low. Visual aids, such as drawings, maps, photographs, slides and videos, are always recommended, and they are essential when the majority of participants are non-literate. It is, however, a good strategy to test the cultural acceptability of these tools beforehand. At times, specific colors or images may be culturally sensitive or linked inappropriately with local political, religious or ethnic divisiveness.

As crucial as it is to recognize the central role of the local actors through these behavioral rules, participants and facilitators will need to avoid an oversimplified conclusion that local perceptions, knowledge and experience are the final or only truth. Just like academic institutions and development agencies, local communities are influenced by many forces that can bias their capacity to analyze their situation and make effective decisions for improving it. Prejudices, conflicts, corruption, privileges, resistance to change, indifference and discrimination are widespread among all types of societies, agencies, institutions and communities. Therefore, a good action research process engenders among its participants an open and possibly critical attitude towards both indi-genous and external points of view.

In practice, this means that an action research process entails an exchange and possibly a mediation between what local

people think and wish to do and what is suggested by other sources of knowledge, including development professionals and various kinds of research. Where population dynamics and natural resource management are concerned, the findings of biological, ecological, medical, demographic, economic, social and cultural studies carried out by outsiders have an important complementary role together with local knowledge of the environment and society. Participatory action research methods can also be used in facilitating the presentation of technical findings to non-specialized audiences.

Validity and Reliability

In conventional research, validity is taken to mean how close the findings are to reality; and reliability is equated with constancy of findings. When it comes to participatory action research, the concepts are interpreted somewhat differently. In striving for sustainable development, PAR results may be considered valid and reliable when their application is environmentally beneficial and/or brings about an actual improvement of the living conditions of the people, which can be sustained over time with minimal cost to the environment. In other words, 'valid' and 'reliable' are understood from the perspective of local people. The results of the research have to be first of all meaningful and positive for them.

By starting from local knowledge and wishing above all to empower people to define what constitutes problems, opportunities and solutions for them, participatory approaches challenge the conventional tendencies to rely on 'scientific' knowledge and external authorities. Yet, validating findings is an important concern which, in PAR, is dealt with by a method known as triangulation. In a strict sense, to triangulate means to utilize at least three different points of view to analyze a given event or situation. More generally, triangulation is based on the idea that using multiple sources and methods is the best assurance of the validity, reliability and completeness of the

collected information. Two basic modes of triangulation are used in action research: external and internal triangulation.

'External triangulation' involves a comparison between the information generated by participatory action research and data from external sources, such as censuses, official statistics, aerial photographs, or local independent research and technical studies. External triangulation is often based on a review of secondary data, i.e., information already existing and available from national and local agencies and academic institutions or published in papers and books. Less frequently, additional studies, such as quantitative surveys, are used to validate qualitative action research findings.

'Internal triangulation' refers to a set of techniques for strengthening validity within the action research exercise itself. These techniques include:

— *Comparison of different perspectives:* Different interest groups may have views and perceptions of 'reality' that are different from each other. One way to understand these co-existing views is for different interest groups to go through the same exercises, e.g., to compile their own separate lists of concerns and then - possibly - compare and discuss them.

— *Use of different methods and techniques for exploring the same topic:* For instance, a description of the way in which the community uses its territory may be developed through a combination of observational walks, interviews with groups and a participatory mapping exercise with community members.

— *Involvement of non-local professionals with different disciplinary backgrounds:* Different disciplines will raise different questions about the same issues, thereby stimulating deeper analysis by the participants. For instance, family planning needs among the women of a community might be assessed through a combination of open-ended interviews by an anthropologist, reproductive life histories

collected by a nurse and a group discussion with the local women's association, where the first two types of information can be presented, reviewed and additional ideas elicited.

External and internal triangulation helps to show that participatory action research describes and analyses problems or situations through an overlapping variety of techniques, perspectives and social interests. Therefore, multidisciplinary teamwork, capability to combine local understanding with scientific explanation, and readiness to shift from theoretical reasoning to concrete decision-making are key elements for the successful application of participatory action research in real-life settings.

10

PAR on Population Dynamics and the Local Environment

A participatory action research process begins with some steps that help communication flow between the relevant community and the non-local professionals and focus the exercise on topics of common interest. This includes building a support team for PAR, making contacts with influential community persons, carrying out preliminary participant observation sessions and interviews, reviewing secondary (i.e., existing, already compiled) information, and drafting the participatory appraisal design.

The best support for participatory action research is a professional team that is sensitive and technically skilled. An ideal support team for a participatory appraisal exercise is comprised of a balanced mix of people with theoretical and practical expertise. The most appropriate members will be persons who are knowledgeable about the local setting, language and culture and have a record of good relationships with the local communities. As gender issues are critically important in such a process, it will help to include both men and women as active members of the team.

The team will be strongest if a variety of expertise is represented. Depending on the scale of the project, the professionals for a participatory action research team focused on environment and population might include persons with

training in environmental sciences, public health and social sciences. The size of the team should be proportional to the size and accessibility of the territory and the community population to be involved in the activities: 5-10 full-time persons may be sufficient to manage a PAR initiative at district level within a reasonable number of months. Smaller teams are more appropriate if the territory is limited to a selection of 'pilot' villages or settlements.

If none of the selected team members has solid experience in PAR methods, it is recommended that a resource person (consultant) be recruited for a start-up and training period. Terms of reference for the consultancy could stress the need for transferring sufficient skills and knowledge to the team to enable them to facilitate a comprehensive PAR activity. Training will be most effective when provided in a 'learning by doing' format, with the external consultant acting more as a supporter than a director of activities. In this learning process, special attention can be given to the attitudes of the members of the support team, which should be conducive to a genuine participatory approach.

Once the team is set and oriented to the purposes and methods of action research, exploratory field visits can be carried out in the concerned communities. An important task in these visits is establishing contact with the local leaders, authorities and other influential persons. These initial contacts can be done in a relaxed and relatively informal way by small sub-groups of 2-3 team members. The scheduling of such meetings is best arranged at the convenience of the local people - which, in most rural communities, is usually late afternoon.

Meetings with local authorities and leaders will be an occasion to present the reason for the team's presence in the community. Permission may need to be requested for team members to contact local people and observe the community setting. There is a risk of raising unrealistic expectations or creating distrustful feelings during this first encounter and in subsequent interactions with community members. It is important

to be clear up front about the ability of the support team to commit to long-term follow through, or to bring funds into the community. Also, a good understanding of local etiquette will be extremely useful to the successful introduction of the PAR initiative. The team will also need to remain sensitive to excluded or minority groups who may not be represented among or even mentioned by the community leaders. Conducting regular evening debriefing sessions among team members will help to monitor the state of the relationship between the team and the community.

Preliminary Participant Observation Sessions

Once introductions are made and, if necessary, formal permission is obtained, team members may spend some days in the community observing what is going on and finding ways to talk with people. Opportunities to meet natural groups for an informal conversation occur in many everyday activities, such as: queuing for the bus, drinking tea at a public stall, taking a walk though the fields, sitting in the village square and, in some cultures, visiting private homes. Natural groups might include women waiting for their turn at a water source or washing clothes, men engaged in community work or sitting together socializing, youngsters playing football, etc.

In these preliminary observations and informal interviews the team can identify existing interest groups in the community. Such groups are more or less organized clusters of persons who share a common interest, e.g., bicycle taxi drivers, woodcutters, women market vendors, traditional birth attendants, farmer clubs, etc. As interest groups are usually the main actors in the action research process, this task is of great importance. Readiness and capability of local leaders, school teachers, community workers and aged influential persons to collaborate as key-informants can also be explored during these visits. Various kinds of information can be gathered informally in these initial contracts, including main livelihood activities, common age- and gender-related roles and behaviors, and typical daily or seasonal activities in the village.

Discreet note-taking after observation sessions will help to gradually build a data base, which the team can review during debriefing sessions. Grids can be created to help identify and summarize the clusters of persons likely to form an interest group and the interest which is keeping them together. If needed or applicable, a comparison between different sites may help to identify patterns of interest groups in the region to be covered by the action research initiative.

Secondary Information

The preliminary interaction with the community can be complemented by a review of existing compiled information (secondary information). Types of data and documents likely to be available and useful include:

- local population figures from the last national census;
- local/regional statistics from education, agriculture and health sectors;
- geography and resource maps;
- documents on local economy, ecology and culture (e.g., ethnographies, church records, records of market fees);
- project documents, annual reports, reviews, etc., from local organizations, institutions and agencies involved with population or environment issues.

Reviewing this information will help in compiling a baseline profile of the community that includes demographic, environmental, economic and socio-cultural aspects. It is worth remembering, however, that finding a figure in printed form does not necessarily mean that that figure is accurate. Among the potential difficulties likely to be encountered are contradictory statements in different sources, and information which is outdated or no longer relevant for various reasons.

The secondary information can be compared against the 'primary' information collected during the initial observations and

interviews. Similarly, interviews with knowledgeable persons can be used to check for the current validity of printed data. Calculation of quantitative indicators may help to summarize some scattered information.

Participatory Appraisal

A possible next step is to generate a list of specific action research questions concerning environment and population dynamics in the relevant communities. These have to be the community's own questions, although some of the members of the support team are likely to be professionally interested in the matter. Such team members may contribute to phrasing the questions, making them more specific or proposing to add some dimension of concern. The questions can be elicited through individual interviews, group discussions or even in an open community meeting. Once various questions have been listed, they can be clustered by main topic by the community and the support team.

Next is linking the topics to be investigated with the community persons having the strongest concerns about each topic, i.e., their 'interest groups'. A matrix can be generated by overlapping the research questions list with the interest groups list. Based on this matrix and on the direct knowledge of persons and place gained by interaction with the community, the support team can invite some members of relevant interest groups to participate in the action research process. As a first step, it will be important to discuss issues affecting their capacity to participate, e.g., available time, willingness, literacy and any special skills. Literacy can be helpful, e.g., for taking notes, but should never be an essential requirement for participation. Also, interest groups can be involved in a prominent way to explore questions of importance to them, but should not be the only people involved in exploring such questions. Ideally, a few members of each interest group will agree to participate in all PAR exercises in an active way.

Carrying out Participatory Appraisal

Four clusters of action research techniques are especially relevant for dealing with population dynamics and the local environment in an integrated way:

— Participatory environmental appraisal (environment profile)
— Participatory censuses (population profile)
— Participatory health appraisal (health profile)
— Gender analysis focusing on reproductive issues

While the descriptions included here assume that the participatory action research is done prior to starting any new initiative, the same techniques could also be used for assessing an existing project. Repeated collection of the same data over time will allow comparisons of the situation before and after the project intervention, which is helpful for evaluation. In the following will describe generic approaches, but those will obviously need to be bent around the specific questions to be answered and information already available.

Participatory Environmental Appraisal

The purpose of a 'participatory environmental appraisal' is to assess the situation of natural resources in the community's territory. A well-run appraisal can help to enhance or focus the awareness and concern of interest groups and the community at large on natural resource management. Interest groups and the community may find out together what is locally achievable to prevent or reduce environmental degradation. The participatory environmental appraisal can also provide data to improve district-level planning for natural resource management.

A typical participatory environmental appraisal will use a combination of two or more of the following methods of data collection:

— observational walks and transects;
— participatory mapping;
— ranking exercises;
— slide-language.

Literacy is not necessary for participation in any of these exercises, which can be carried out with elders, women, men, youngsters and even children. For an environmental appraisal, the most desirable or appropriate participants will be community members directly engaged in exploiting and/or managing key natural resources. Due to the typical patterns of labor division by gender in most rural economies, participation of both men and women representatives from the same households, in joint or separate settings, is strongly recommended.

An observational walk across the territory with interest group members is often a good starting point. As much as possible, it is desirable that the walk follows a meaningful route, such as a straight line across a slope valley or going downstream-upstream. Things to watch for include changes in the landscape relevant environmental features and interaction of people and resources These observations can be discussed with participants and persons met on the way, and then jotted down in a logbook. Ideally, the jotting will be a combination of sketches and words and will be jointly prepared by the support team and local PAR participants.

Because of the objectivity and detail in pictures, photography can also be used. Yet, the method has some drawbacks, including cost, delays between taking the pictures and being able to show the results to the community and difficulties showing slides in remote areas that lack electricity. In addition, the method can shift ownership of the process away from the community because the technology may not be locally available or locally controlled.

Information on the current environmental situation provided by the transect walks or mapping become most

enlightening and effective when reviewed from a historical perspective. This can be done by discussing the findings with some local elders who can recall details about the environmental situation and local interactions with the environment more than one generation ago. The historical data produced in this way will permit focusing on environmental changes that have occurred during the last generation.

Importantly, the historical perspective will help in assessing how the local environment has been influenced by the community's economic or cultural needs, by population dynamics and by external phenomena. The development and analysis of a historical transect and/or map can in fact become the central and most useful moment in the participatory appraisal of population dynamics and the local environment.

A comparison at different points in time can also be projected into the future - e.g., participants can be asked what they expect the situation to be like in 30 years if the present trends continue. This question is best coupled with a historical mapping exercise that compares the present and past situations. Discussions about alternative courses of action arise easily after this type of analysis.

Alternative visions of the future will likely involve discussions surrounding the use of land and other natural resources in the next 20-30 years. Community members may wish to produce a third map, depicting the ideal future, in which, for instance, common lands and resources are well managed; water supply and sanitation are greatly improved; and soil conservation practices, agro-forestry and other efforts are in place to rehabilitate croplands and pasture.

When a mapping exercise is completed, the PAR support team and community participants may wish to transfer the map of current environmental and social features to a computer mapping software such as Map Maker. This easy-to-use 'shareware' package allows one to create a basic geographic information system, in which layers of information can be added

together to create maps of varying complexity, and specific variables can be stored in a simple data base. These locally created maps can also be compared with professional maps to locate specific details.

Whether the map is transferred to a computer and printed out, or copied on to a flipchart, it is important to remember that the map belongs to the community. In other words, the support team may want to make a copy for their own use, but the original copy should stay in the community. Another way to build on the information generated by the environmental appraisal is to use ranking exercises. Ranking exercises are a way for community interest groups to prioritize their concerns or preferences about the situation of different natural resources.

Ranking exercises carried out by gender-based groups are a useful way to initiate a gender analysis of the collected information. When combined with data on gender-related rights and responsibilities in resource management, the gathered information offers a fairly complete picture of gender-based interests and roles in the community.

photographed images to promote reflection and awareness and/or collect specific information. Local people are trained to use a simple camera to take pictures of significant aspects and good and bad features of their lives and their environment. It is important to recruit a variety of photographers as each will have a different perspective of what is relevant, and this can reveal important differences in environmental perceptions. The pictures or slides are exhibited and discussed in a group or community meeting.

Slide language is an attractive and fun way of identifying environmental issues and the various perspectives on these in the community concerned. Letting the community members identify the messages and the scenes to be used encourages them to study and analyze their environment, and it is an effective way of giving a voice to disadvantaged groups. However, slides are a relatively expensive tool, they take time to develop and

slide projectors may not be available in all contexts. Where slide projectors are not available, or there is no electricity, photo montages may be a suitable alternative.

Whatever the tool used for data collection and analysis, a major aim of a participatory environmental assessment is the creation and discussion of a detailed list of environmental concerns and key resources as perceived by the community. These may be related solely to the research questions identified at the beginning of the PAR, or expanded on these. Brainstorming and group discussion can facilitate making amendments and additions, so that a group consensus on the list can be reached.

Participatory Censuses

In many countries, fairly good data about the size and dynamic trends of populations are available from national censuses and civil registers. These data include measures of mortality, natality, fertility, natural growth and migration. Valuable as this information is, it normally has limitations. The census data are generally analyzed at the national, provincial and district levels; and a breakdown of census information for small municipalities or rural villages is seldom available. Census data are usually collected only at quite long intervals, e.g., once per decade, and thus may be out of date for specific local needs. Moreover, civil registers in rural areas are generally not reliable: births may be registered with a delay of several months, infant deaths may not be recorded at all, and temporary and seasonal migration may not be considered.

To get an accurate and current profile of the population situation and trends at the community or village level, a local participatory census may be appropriate. It has a two-fold purpose: to provide valid, reliable and up-to-date demographic information based on the local people's knowledge of local vital events; and to arouse local concern - if appropriate - with respect

to existing patterns in population dynamics. Two main data collection methods can be used to conduct a participatory census:

— social mapping;

— semi-structured household interviewing.

Social mapping is an exciting and popular exercise in most communities. Community people collaborate in drawing a map of the territory and locating households and compounds. The community members involved in the exercise are then asked to recall the number of people living in each household/compound, including all members by age and gender.

This participatory technique is extremely effective for performing a rapid, low-cost census in small communities, even where literacy rates are very low. The validity of participatory census figures generated by the local people is usually quite high. If detailed and accurate information is needed about population dynamics and the population of the settlement is relatively large a door-to-door household census is recommended. This method relies on semi-structured interviews with each household of the village or locality. As some important questions in the interviews are related to pregnancies, deliveries and children, the preferred respondents are generally women.

Ideally, the household interviews would be carried out in the local language by literate persons of the community, preferably female. Adult women, however, are often busy with economic and/or domestic activities and may have little time or interest in interviewing others. As an alternative, teenage girls could be trained as interviewers. Male interviewers may be considered if female school enrollment and literacy are especially low, but gender rules and interaction within the community need to be carefully considered before making such a decision.

Questionnaire design and interviewer training will also need to consider any local cultural sensitivity about openly discussing pregnancies, births and deaths. Key elements to the success of

the exercise include a relaxed but attentive attitude during the interview, good note-taking, and the quality and promptness of systematically organizing the raw data collected. Role-playing among members of the participatory census team may help them to acquire and develop these skills in a practical and active manner.

Analysis of the data from a census can be aimed at developing local demographic indicators. Simplification of calculations and use of local concepts and terms may render this component of the exercise more relevant and accessible for the participation of community members. The census exercise provides good occasions to discuss the local population situation and dynamics with various interest groups and the community at large. Meetings can be arranged for this purpose with different community audiences. Pie charts, bar charts and pictograms can be useful to illustrate the results of the census.

Ideally, the community would have gone through a historical mapping exercise and the maps could be discussed again in the light of the data collected on population dynamics. The measures of population size and dynamics obtained in the local census can also be used to calculate the more sophisticated demographic indicators, such as life expectancy. In this way, the participatory census can provide accurate local data for a district or municipal demographic database and be used for local demographic projections.

Participatory Health Appraisal

The health status in a given locality affects and is affected by the community's population profile and its patterns of using natural resources. A comprehensive local environment and population appraisal will thus elicit information also on the local health situation. In particular, the nutritional status, the most common health problems and health risks present in the community, and the available medical and public health services will need to be investigated.

In the last 15 years, rapid, qualitative and participatory methods have been tested and accepted in many countries as an important aid for health services decision-making. Labeled 'rapid epidemiological appraisal' or 'qualitative health services research', these methods can be useful for dealing with the health-related aspects of participatory action research. The following, in particular, are good as entry points for interest groups assessing their health needs and linking those to environmental and population variables:

— health-risk mapping;

— child nutrition assessment;

— strengths, weaknesses, opportunities and limitations (SWOL) analysis of available health services.

Health-risk mapping is a variant of participatory mapping in which community members:

— start with a brainstorming on the most common health problems felt in the community in the last six months or a year, and draw up a list of those problems;

— draw a map of the area or settlement, plot the distribution by household of the identified health problems (e.g., malaria, tuberculosis, child malnutrition, pregnancy-related deaths, accidents) and note if there is any clustering of problems or noticeable distribution across the village;

— use brainstorming again to identify some risk factors or conditions, in the household or the community, which participants perceive as likely to have made households vulnerable or to have contributed to the occurrence of the health problems; such factors may include poor sanitation, poverty, crowded living conditions, recent migration, too large or too small household, croplands affected by floods, etc.;

— insert in the map specific symbols to record the location and distribution of these risk factors.

The best length of time for the recall period may take some discussion with the group. In many regions of the world, six months is too short a period of time to reflect seasonally related health patterns. For example, diarrhea is often worst in rainy seasons when ground water contaminates water sources, or meningitis is most common during the Sahelian dry season when dust is blowing in the Saharan harmattan. At the same time, research has shown that the longer the time period covered by the recall request, the lower the reliability of the information about the reported events.

Risk mapping relies very much on local perceptions about the determinants of health and disease. It is thus a powerful entry point to identify and discuss local (indigenous) medical beliefs and practices, and a challenge to health professionals with limited acceptance of different cultural understandings of health conditions. A medical anthropologist may help the PAR support team to interpret the findings and understand them within their bio-medical and 'scientific' system of reference.

The local point of view expressed by risk-mapping exercises can be compared with conventional epidemiological and health services information from existing documents. This blending of viewpoints may yield a new, integrated perspective on the community health profile and help improve communication between various kinds of health service providers and users.

The support team should facilitate the drawing of connections between the identified health issues and other phenomena and features encountered while assessing the environmental and population situation in the area. In fact, many environmental and demographic features may be health-risk factors in themselves. For instance small-size household plots and poor productivity of the hillside land can be risk factors for child malnutrition and high mortality. Large-size households or seasonal male migration can be risk factors for tuberculosis.

A child nutrition assessment will enable the community to get a grasp on the prevalence of child malnutrition. The standard

means of assessing malnutrition is to measure children's height and weight and compare those among themselves and to average heights and weights of children of the same age in a comparable group of reference. In communities where this kind of nutritional monitoring has never taken place, the methods presented below can be used to gain an approximate measure of local malnutrition. They also accompany the community into the identification and analysis of the problem, thereby bringing them a step closer to devising potential solutions.

There are two seasonal analysis of food availability and brief, structured interviews with mothers. The seasonal analysis method involves using sticks of varying lengths for each month of the year. Together with a group of villagers, place 12 small stones in a line, each separated by a few centimeters. Having at their disposal sticks that can be broken off for varying lengths, villagers select a long stick and place it close to the month that has the greatest food availability. Then, they place progressively smaller sticks close to months that have less food availability. Typically, the 'leanest' month will be just prior to harvest of the new crop. The result is a histogram that visually represents the good and the bad months.

A better mutual understanding of the dynamic relations between communities and the health services available to them can be facilitated by a strengths, weaknesses, opportunities and limitations (SWOL) analysis. Many action research practitioners consider a community SWOL analysis to be a good way to promote a frank discussion of the positive and negative sides of local service availability, linking past experience with desired improvements to be achieved in the near future. As health services are often the subject of sharp and contradictory judgment by actual or potential users, the use of this technique is especially effective to investigate the quality of the provided services in specific terms.

The SWOL approach can also be useful for helping communities to think about potential solutions to local problems. Obviously the SWOL approach can be used to analyze other

kinds of services besides health, such as forestry extension, education or agriculture. There are some potential difficulties in the implementation of a SWOL exercise. Good facilitation, for instance, is essential for managing the sensitive issues that may arise. In fact, SWOL exercises are usually easier to conduct with homogeneous groups.

Gender Analysis Focusing on Reproductive Issues

In addition to biological differences, men and women in every culture have different roles, needs and responsibilities in fertility control, reproduction and child-rearing. These gender-based differences can vary from country to country, depending on traditions and on social, economic and environmental conditions.

Gender analysis is a method used for identifying and discussing the most important features of male and female roles within the local culture. This method can be applied for assessing gender divisions of labor, gender-specific knowledge and practices related to natural resources management, and reproductive behavior. In most rural communities, relationships between men and women, sexual behaviors and beliefs, and practices related to conception, pregnancy and delivery are extremely sensitive issues. Applying a gender analysis to these topics requires a good understanding of local culture and well-developed facilitation skills.

Facilitators of gender analysis exercises will need to practice some cultural relativism, i.e., they will need to put aside their own ideas about how men and women 'ought to' relate to each other. Outsiders need to be prepared to accept beliefs and behaviors which may be very different from their own. For example, insistence on promoting equality in women's conditions with respect to men's can be resented and disrupt the process of community-based exercises, unless such a need is clearly spelled out by the locals themselves.

On reproductive knowledge and behavior, the principal actors could be small gender-based interest groups supported

by a facilitator of the same gender. In many regions of the world, traditional culture, especially in rural areas, subordinates female involvement in public settings, such as meetings. Dividing men and women into separate groups for discussion can be an effective way of coping with this social norm. In a separate group, women can have the opportunity to organize their thoughts, prepare their own presentations and refine their opinions and wishes before meeting again with men. In this way, gender-separated groups can help ensure that women's insights are integrated into the discussions of the entire community. There are two basic methods, suggested for gathering and appraising information, which are specifically relevant to a gender analysis of reproductive behavior:

— semi-structured interviews on reproductive history;

— focus group interviews.

Women's reproductive history obtained through semi-structured interviews can be useful for collecting basic quantitative information on numbers of pregnancies, deliveries, potential problems, etc. These interviews are generally best carried out by literate members of the female interest group. While the ideal respondents for these interviews would be elderly women, there may be substantial differences in reproductive values and behaviors between generations of women. Therefore, a sample of female informants representing different age groups is suggested, e.g., some adolescents, some young women, some middle-aged and some elderly.

Focus group interviews are an appropriate strategy for eliciting women's and men's expectations, attitudes and needs with respect to fertility and parenting. They can provide qualitative data useful for interpreting the quantitative data collected from reproductive histories. A couple of cautions about focus groups: 1) the facilitator will need sensitivity in discussing sexually related topics in most communities; and 2) there will be a need for analytical skill in extracting the key points from

the large amounts of data likely to be generated. Training and practice with the support of an experienced facilitator can help to conduct the interview and to process and consolidate the raw data.

In a small village, two focus groups, one of five to ten males and the other of a similar number of female participants, should be sufficient to obtain a reasonably representative view of insiders' perceptions of fertility and parenting. The participants should be adult, married persons with some parenting experience. This perspective could be enhanced by obtaining opinions and perceptions also from adolescents and from elders.

Care should be taken to maintain a strict anonymity of sources. The local situation will influence whether to hold separate feedback meetings by gender, or report on the results in a general meeting. Although comparing the results from male and female groups could create a delicate situation, it can also be useful in identifying possible gaps and inconsistencies, and help to elicit any felt needs about changing the situation. To make the meeting more effective, the support team could prepare a list of questions to promote discussion and orient the meeting towards action.

11

Information Analysis and Planning by Participatory Research

During the analysis phase, the interest groups review and discuss the information they have collected, examine the causes and effects of the perceived problems in the community and identify and discuss possible 'solutions'. As the local organizational and institutional capacity plays an important role in implementing proposed actions, this is a good time to make a realistic assessment of the capacities of existing community organizations, local governmental agencies, non-governmental organizations and other potential partners. This is an essential component of the feasibility analysis of any concrete action to be undertaken.

Having collected information on their concern issues, the interest groups will wish to reviw the significance of that information for themselves and their community. To do so, separate or joint meetings of the interest groups can be organized to review the maps, transects, matrices and tabular data developed during the appraisal phase, synthesize the information, and provide answers to their own basic questions. Members of the PAR support team can assist and facilitate, as necessary.

Presentation of Preliminary PAR Results

The participatory appraisal phase provides the interest groups and the PAR support team with an information base about the most significant concerns of the local community. In carrying out the appraisal exercises and the subsequent analyses, the PAR support team works with interest groups within the community to examine perceived problems. Not every member of the community is willing or able to take part in the gathering of information and discussion of perceived problems, but it is important that everyone is given the opportunity to be informed of the results. Therefore, it is a good idea to hold a feedback meeting to present the preliminary PAR findings to the entire community. This meeting serves a number of purposes:

— *Information sharing:* Information is power, and all community members - regardless of whether or not they were able to directly participate in PAR activities - should have the opportunity to hear and discuss the PAR results. This may bring a wider group of people into the planning and implementation process.

— *External validation:* It is important that the data gathered are checked for validity by community members who did not participate in the process, and that any differences concerning perceived problems facing the village are discussed openly.

— *Setting priorities and building support:* Before the next phase of the PAR begins - participatory planning - it is important that a consensus be achieved concerning the most important problems and concerns of the community. For long-term sustainability, initiatives will need the support of most (or at least of many) community members.

Feedback Meeting

A number of logistical matters need to be addressed for the meeting to be successful. First, the interest groups and the PAR

support team must consider the scheduling. Ideally, the meeting will be held within a week or two of the participatory appraisal and analysis, while the activities are still fresh in people's minds. If there is over a month's delay between the appraisal and the feedback meeting, the process may lose momentum.

It is a good idea to pick a day of the week on which the maximum number of people will be able to attend, and a time of the day that is convenient for everyone. To ensure maximum attendance, the meeting should be announced at least a few days before being held, and those involved in the process thus far may wish to personally encourage friends and neighbors to attend.

In some parts of the world, village meetings are only attended by adult men, so special efforts may be required to ensure a balanced gender representation. It should be clearly stated that all community members are invited to attend. Especially when the village or community is large, a number of logistical questions need advance considerations. Will the meeting be indoors or outdoors? Will people sit on mats or chairs? Will there be a special place for village elders? What will be the seating arrangement, lighting, refreshments, etc.?

Prior to the presentations, each interest group will identify the key points coming out of the appraisal and analysis phases and select some support material (e.g., maps, lists, matrices) to illustrate them. A special emphasis should be given to the crucial problems identified and the feasible solutions that have emerged. Facilitator support may be useful in helping each group condense their presentation down to the most important statements and providing help in preparing relevant visual aids. If the slide-language technique was used, the groups may wish to make arrangements to show the slides.

The PAR support team can help to facilitate the agreement of the various interest groups on the agenda of the feedback meeting (order of presentations, etc.). A respected local leader may be asked to chair the meeting, in which case he/she should

be briefed on the meeting's purpose, and on the order of proceedings. Even in this case it may be advisable to designate one or two members of the PAR support team as facilitators, so that they can encourage the participation of women, youths and other groups that might otherwise be left out of the proceedings.

Once all community members have gathered for the meeting, it may be appropriate to begin with a prayer or a few remarks by the village leaders. During the presentations, the interest groups will explain their key concerns, illustrate them via collected data and outline some ideas they have for solutions. If they feel strongly about the desirability of a course of action, they will build a case for it. They may also wish to pose some specific questions to the community-wide audience.

A principal goal of the feedback meeting is to include those who have not been part of the process thus far in important discoveries about the problems facing the community and the opportunities to address them. Every effort should be made to avoid giving the impression that those who participated in the PAR are presenting an agreed-upon 'truth' to other community members. Rather, the meeting will be most effective when it will include a frank and open-minded discussion. It is also possible that the interest groups may have overlooked some important information or perspective in the collection and analysis of information, and the other members of the community will now have a chance to give their views.

During the feedback meeting, the community will offer general comments and discussion but will also contribute by 'scoring' the feasibility and appropriateness of alternative actions. A priority-setting exercise provides a practical method for facilitating decision-making in a large group. After a brainstorming discussion on the strengths and weaknesses of different 'solutions' to some problems, community members are asked to score some proposed actions on two criteria: effectiveness, and feasibility. All community members can then express their degree of support for the proposed actions by raising one hand, two hands and no hands. The facilitators can

then count hands and tally the votes on a flipchart. It may be decided ahead of time that children under a certain age will be excluded from the voting.

A scoring procedure provides an arithmetical basis for reaching a common decision. Facilitators and participants will need to understand, however, that this technique is only meant to serve as an aid for decision-making. Whatever the results of the priority-setting exercise, the facilitators should do their best to help the community to reach a final consensus about their preferred actions. Prioritization and decision-making are difficult and sensitive moments.

Community members may have trouble setting priorities because they are trying to avoid community conflicts; or they may feel very strongly that it is essential to achieve all the identified objectives. Yet, over-ambitious plans generally lead to failure and frustration. If the community does not manage to achieve a reasonable level of agreement over the actions to be taken in the near future, a possible strategy is to postpone the decision until all implementation issues have been identified and discussed. In this way, the group will have the opportunity to compare options on the basis of realistic estimates of time and resources necessary to carry them out.

At the end of the presentations and scoring, the chair or facilitators will summarize the resolutions from the feedback meeting and discuss next steps. These include negotiating a plan of action with external partners, implementing the plan and monitoring and evaluating the work accomplished.

Negotiating and Agreeing Upon a Plan

At this stage the PAR process should have achieved several results:

— an assessment of the local environment, population dynamics and health situation in the community at stake;

— the identification and consolidation of interest groups

through common work on participatory appraisal and analysis of specific problems and 'solutions' to address them;

— the identification of key potential partners from inside and outside the community and their potential roles in addressing the community's concerns; and

— communication and discussion about the appraisal and analysis with all community members and interest groups, and prioritization of actions to pursue.

It is now time to :

— contact the relevant potential partners and jointly negotiate a plan to implement the priority actions agreed upon by the community.

Workshops are appropriate methods to carry out this last step. Indeed, experience in participatory action research has shown that a structured discussion on specific issues of common interest, supported by a sensitive and diplomatic preparation and a shared information base, is likely to lead to mutually agreable 'solutions'. Suggestions for organizing, designing and implementing such a workshop are provided below.

Recruiting Participants and Organizing the Workshop

In principle, it is desirable to involve in a participatory planning workshop a variety of social actors, both internal and external to the community. Besides the interest groups that participated in the PAR process, this may include the community leadership and various partner institutions with a stake in the natural resources or economic development, education, health services, etc., as appropriate. For ensuring real participation and keeping group dynamics under control, it is advisable that not more than about 30 persons take active part in the event.

Keeping the planning workshop to a manageable size means that all the potential partners should be encouraged to identify suitable representatives. Ideally, each would be represented by the same number of delegates so that a numerical balance is

maintained. Depending on the internal structure and dynamics of the various groups, reasonable approaches to the identification of such people could be designation, election or volunteering. In any case, groups and institutions need to be encouraged and allowed to make their own selections, provided that the chosen delegates are entitled to a reasonable amount of negotiating power and authority on behalf of the group. Otherwise, their contributions could later be discounted or de-legitimized.

In some cases, it may be difficult to obtain the necessary support from government agencies, which may need to be persuaded to send a representative to the planning workshop. The support team may play a useful role in convincing local agencies of the importance of assisting communities in participatory appraisal and planning exercises, and of the need for their full support.

To ensure actual involvement of every participant and proper inter-change of ideas, the design of the workshop should be based on a balanced mix of small group activities and plenary discussions. General suggestions include the following:

— *The community is in charge of organization and logistics:* Even if an external budget is available, equitable cost-sharing by the community is recommended. Local residents might be able to assist with a venue, contributions of food and cooking fuel, help with cooking, etc. Most of all, the workshop should be 'owned' by the community and the PAR support team must make clear that they are present to assist, but they are not in charge. One or more local persons should be designated focal points for organization and logistics.

— *Finalize in advance a 'procedural' understanding:* This is an understanding among all the expected participants and chairing persons covering the workshop objectives, agenda, duration, organization, logistics and criteria for the selection of participants.

— *Plan the workshop's timing and schedule carefully:* The length of the workshop might vary according to the number

of topics to be discussed, the number of participants and the methods to be employed. As a rule of thumb, a participatory planning workshop should not last less than half a day nor more than three days. A weekend or any locally acknowledged rest day during the week can be appropriate for maximizing attendance by various representatives. In some situations, it works well to break the workshop program into two sessions, respectively devoted to information sharing and decision-making, which are carried out on two consecutive weeks on the appropriate rest days. This can help participants to digest the information and, if needed, consult their colleagues and leaders about acceptable commitments to be taken.

Have the workshop in an appropriate setting: The workshop venue needs to be comfortable and reasonably protected from external interference, yet not totally isolated from the places of daily life.

Pay attention to the communication support: Participants and other interested persons will appreciate short summaries of the main findings prepared and made available prior to the workshop. During the workshop, presentations should be very short (i.e., no longer than 10-15 minutes each) and supported by visual aids. If needed, translators should be available.

Facilitate official acknowledgment of the workshop: Conducting a formal opening and closing of the meeting according to local protocol helps all parties to accept the importance of the information being shared and the seriousness of commitments being made. If possible, the opening and closing will include the participation of local civil and religious authorities.

- *Take care of details:* It is very useful to make a list of all the equipment, supplies, materials and tools that may be needed and to check that everything is available before starting the workshop. The support team may assist to

anticipate and make provisions ahead of time for items and supplies not easily found in rural areas, such as lights, audio-visual equipment, stationery and a photocopier.

Sharing the Appraisal and Feasibility Analysis Information

Sharing the information generated by the appraisal and feasibility analysis exercises among interest groups and other local actors is the first task to be accomplished during the workshop. For this, each interest group may briefly recount the problem they wish to tackle, their analysis of causes and effects, the 'solution' they have identified, the actions necessary to achieve the solution and why the community believes that the action is feasible and can work.

Exchange of these elements in plenary will help the external partners get 'on board' with the results of the PAR process so far. Moreover, it will facilitate the participants' understanding of the inter-linkages existing between different problems, solutions and - in general - factors shaping the environment, health and population situation of the community. Oral presentations by interest group members are perhaps the best way to convey the PAR information. Conducting the sessions in this way carries the message that whatever is presented is the result of a learning process whose main actors are community members. Some poster drawings set up in the meeting room or written handouts made available to the workshop participants can be useful in supporting the presentations.

After each presentation, a reasonable amount of time for clarification and discussion is necessary. Members of the interest group can take advantage of questions or comments raised by the audience to provide further information which, due to time constraints, they were not able to include in the presentation. The discussion can also lead to new ways of looking at issues through the general contributions. The PAR support team has

some important facilitation functions to perform in these presentation. These include:

— assisting the chair in clarifying the modalities of group work, presentations, etc.;

— assisting the chair in coordinating presentations and the question-and-answer discussions to ensure that the workshop is kept on schedule;

— assisting in visually recording (e.g., on a flipchart or chalkboard) the key points arising from the plenary discussions (at best, however, this is done by members of the interest groups);

— keeping a record of the proceedings through note-taking.

Matrices and notes can be used at the end of the series of presentations and discussions for concluding the session. This task includes a very brief overview or summary of what has occurred. In some cases, it is appropriate for the overview to be done by a member of the support team. This is a good time to stress the inter-linkages existing among different environmental and population issues, as well as the need to coordinate efforts among various government agencies, local interest groups and other actors.

Negotiating a Suitable Course of Action

Once a common information base is shared among all the participants, small working groups are the most appropriate way to discuss the proposed solutions and actions in more detail. It is desirable that these groups consist of representatives from the concerned interest groups plus representatives of the institutions that were identified as potential partners in the appraisal phases. Likely, the interest group that proposes a certain 'solution' (e.g., strengthening family planning services, supporting community-based soil management, creating a rotating fund for young people's enterprises, etc.) will be appropriately matched with

institutions that have mandate and capacity to deal with the subject (e.g., health departments of the central or local governments, agricultural or environmental NGOs, international development agencies, etc.). If needed, members of the support team can participate as facilitators.

Once a working group is formed, it is good if people introduce themselves and state what they would like to achieve from the workshop. A facilitator can then initiate the working session itself by asking the interest group representatives to summarize briefly what they are suggesting to do and what kind of support they may need from the partners convened. After this beginning, the potential partners' representatives will comment, ask questions and present alternative options. The facilitator can use open-ended questions to help elicit comments about how the solution and required support fit with the institutional mandates, policies and resource capabilities of the participants in the small group.

Answers and other key points can be recorded (on flipchart, chalkboard, etc.) for the group to use in their discussion. In case the 'solution' and relative action are acceptable and feasible for the partners, the terms of reference of the collaboration could be drafted by summarizing or highlighting the main points of the discussion on the flipchart or chalkboard. Planning for action involves deciding which specific activities should be carried out by whom, where, when and with what means. In other words, the following questions should be clearly answered:

— What is to be achieved?

— What specific skills are needed?

— Who will be responsible?

— Who will actually do what?

— Where will activities take place?

— When will the activities occur (e.g., in relation to seasons and other pre-set activities of the community), and for what duration will they be happening?

— What material inputs will be needed (e.g., seeds, tools, family planning supplies, etc.) and how will they be provided or gathered?

— How much money is required, and from what source(s) is it to be provided?

In planning for specific activities in the community, it will be important to establish the 'ownership' of the project. Ownership relates to responsibility and control, especially for taking on-going decisions and distributing benefits. If this issue is not specifically clarified, participants may simply assume that the 'ownership' is commonly understood only to run into conflict when multiple perceptions become apparent (e.g., at the time of distributing benefits). Clear statements in the planning phases will help avoid subsequent disputes.

In order to implement one or more portions of the plan, the interest groups and/or pre-existing institutions in the community may wish to become more formalized, with rules of membership and procedures. Such groups will be stronger and more sustainable if they formulate a simple set of by-laws. Since many of these questions need to be answered by all the members of the relevant groups, further meetings may need to be scheduled to clarify all the points. These new or strengthened pre-existing institutions may be a most important and lasting benefit of the PAR process.

A good plan will include a monitoring component, i.e., a set of statements indicating how and by whom the implementation process will be checked to ensure that activities are taking place as planned and that the desired results are occurring. Members of the monitoring task group can assess inputs and outputs (e.g., quality, quantity, timeliness) and, if needed, check on accountability (e.g., profits and losses).

Monitoring is an especially important function to uncover problems as early as possible (e.g., constraints or unanticipated negative impacts), and thereafter to bring those problems out

into the open for group discussion and re-planning. In these ways, monitoring will help sustain community trust and legitimacy for the planned activities.

The facilitator should make clear that the purpose of the exercise is to define and agree on a framework for joint action whose validity is to be continuously checked. Conditions or terms of reference in the framework might, for example, say how the participants will:

— establish a management committee in which all actors (persons, groups and institutions) with a stake in the implementation are represented;

— monitor activities and results, i.e., what strategies and types of information will be used to keep track of what is happening and whether the desired outcomes are occurring.

Managing Conflicts

The success of a participatory planning workshop depends on the willing-ness of participants to share information and make common decisions. Involving local actors in such a process is a sensitive task, in which the PAR support team can provide good human, diplomatic and organizational support. There are many potential sources of conflict, including contrasting economic and status interests, ethnic and cultural differences, previous misunderstandings between the community and government or NGO representatives, bad records in personal relationships, family grudges and individual rivalries. Any of these can act against the efforts of the interest groups to establish agreements.

When there are strongly conflicting interests, it is generally wiser to acknowledge the difficulty of solving most of these conflicts and concentrate on suitable means of managing them. Experts in conflict management have identified three basic strategies for addressing a conflict: negotiation, mediation and conciliation. The support team can assist in the use of such

strategies if and when needed in the planning workshop. In all likelihood, conflicts that are serious and complex enough would surface and be dealt with before the workshop. If they come out during the workshop, the postponement of decisions may be needed.

Negotiation is a voluntary process in which parties meet face-to-face to reach a mutually acceptable resolution of a conflict issue. Mediation is the assistance of a neutral third party to bring about a negotiation process. Conciliation is an attempt by a neutral third party - such as the support team - to communicate separately with disputing parties for the purpose of reducing tension and agreeing on a process for resolving their disagreements. While in a formal judiciary system a conciliation has the power to decide the controversy, the PAR support team has usually only the mandate to assist and facilitate.

Getting conflicting parties to achieve a compromise agreement entails a strongly pragmatic attitude and behavior on the part of all the support team, including minimizing the bias of their own personal and political views. This is not to say that a support team can ever be totally neutral, but to stress that, in a facilitation role, its members should try to behave as much as possible as if they were neutral with respect to local interests and points of view.

Several difficulties can arise in the small group work. The time allocated for the workshop might not be sufficient to explore in detail all the implications of the conflicts which become apparent. Institutional representatives may have insufficient decision-making power without returning to their organizations to consult at a higher level. Resources required to implement the solution might not be available through any of the participating groups or partner institutions.

Sometimes, for a variety of overt or hidden reasons, one of the parties is not interested in actually reaching an agreement. In these cases, it might be appropriate to agree at least to explore the issue in more detail. This may include a schedule for further

meetings and reciprocal visits at which the PAR support team may again facilitate the process.

At the end of the specific planning session, the results of the working groups should be presented in plenary by spokespersons identified by the groups. The purpose of the short presentations is to make every workshop participant aware of the problem-solving, negotiating, and eventual agreements achieved within the groups. Stating the reciprocal commitments in front of a wider audience will powerfully strengthen the reached agreements.

The PAR support team members may comment and stress the importance of inter-linkages among the different types and levels of 'solutions' and activities. For instance, it can be mentioned that soil protection will benefit local productivity, and therefore income and nutrition, which will improve local health and well-being and encourage the youths to stay. New businesses will enhance the chances for local livelihood and encourage people towards sound environmental management.

The health and family planning services will mean that women will be much better off and have time to invest in sound environmental management, including soil preservation measures. And so on. This will help convey the idea - especially to the external workshop participants - that a comprehensive and integrated effort is needed to deal with the local environment and population dynamics. A comment might also be made about the need for on-going monitoring and evaluation, and the value of another participatory assessment exercise after a suitable period of time to assess the progress towards implementation.

It is important that the process itself be evaluated by the participants. The workshop participants should share their assessments of the procedures used and the results of the exercise. Copies of the final plans of action can be circulated among the interested people in the community and outside. In addition, summaries of the agreements can be posted at one or more suitable community locations as large semi-permanent

displays, which may include graphics or pictograms to aid non-literate members of the community. An official closing ceremony and a customary social event can be very appropriate to acknowledge the work of the interest groups and other participants in the planning workshop.

12

Policies and Programmes

A Conceptual Framework for Natural Resource Management

A conceptual framework for Natural Resources Management (NRM) is hierarchical and outcomes-based provides a theoretical structure within which to approach policy and programme evaluation. NRM and its supporting policies and programmes are by their nature complex for a variety of political, biophysical and institutional reasons. Perhaps more so than other kinds of public policies and their attendant planning and management systems. This may mean that, arguably, policy development and evaluation in this field is more difficult.

Inherent complexity implies that it may also be difficult to develop a set of meaningful and workable principles that can be used as a context-setting guide for the totality of work that makes up NRM. Nonetheless, there are some general principles that can be drawn, or inferred, from the literature. Most of the strategies, frameworks and supporting policies and programmes for NRM include an explicit description of the key principles that guide their further development and implementation. Principles serve at least three important functions in the formulation and execution of public policy, including:

— They serve to remind practitioners of the conceptual and/ or ideological foundations to the policy

— They provide an ordering structure and explicitly identify scope, coverage and approach

— They provide a basis for planning and scheduling the further implementation of policies and programmes

If principles are to be of any value, they should genuinely provide the conceptual and operational guidance that is consistent with the higher principles of our particular form of democratic governance. They also need to be more than platitudes but they should not be so binding that they do not allow for the diversity of NRM situations and activities.

The principles proposed here are formulated with the idea that agencies could build more specific objectives from them, though they are meant for discussion purposes at this stage. In order to steer a course between the general and the specific, each principle is accompanied by a rationale, and is not meant to be considered in isolation from that rationale, or from the other principles.

The rationale gives some explanation of potentially ambiguous terms, gives examples to illustrate points and notes the major assumptions. This set of principles has been synthesised from policy documents, policy literature, the interviews and reflections arising from the whole research project. Our starting point is the assumption of ESD as an overarching and agreed paradigm for the development of NRM policies and programmes. So in one sense, the challenge is to extend and qualify that. There is no great claim to originality here and it is recognised that some of these principles are well recognised and well integrated into some NRM policies and programmes, though sometimes they are expressed differently.

Principle 1

— NRM policies and programmes will be more effective if they optimise environmental, social and economic benefits, as anticipated in ESD

The ESD paradigm sets the general parameters for NRM policies. This framework attempts to integrate potentially conflicting values into policies and programmes. These values are derived from purported 'universal' values, as interpreted by the United Nations and other international political and economic organisations, but are interpreted in relation to the domestic political economy. The relative trade-offs between, or weightings of, environmental, social and economic goals will be negotiated in the political context of the time and perhaps in light of available knowledge of the issues.

The important word in the principle is 'optimise'. It means that if the benefits from one set of values can be increased with little or no diminution of the others, then this should be done. Using a rather simplistic example, consider a re-vegetation programme that is aimed at increasing aesthetic value, farm income and wildlife habitat.

There are several project options, based on various tree species and planting configurations. If it was found that the introduction of another species into the mix increased the conservation value with only a limited reduction in economic value, then the principle of optimal values would favour that option. This would be a form of bestpractice ESD.

Principle 2

— The overall effectiveness of NRM strategies should be assessed on a regular basis to ensure that, in their implementation, some values are not consistently favoured over others, in particular to ensure that environmental values are not marginalised

The term 'strategies' is used purposefully to mean the overarching direction or goals, on which more specific policies and programmes are based. Principle 1 allowed for situational decision-making but it should be recognised that this has the potential to allow for the favouring of economic values over

social and especially, environmental values. There are several reasons why this might happen.

Economic values are more easily derived and quantified than the other values, so some forms of policy analysis will favour them, especially if the discourse of public debate and decision-making is largely couched in economic terms If ESD is institutionalised compromise, then this can easily facilitate the erosion of environmental values. This is because if development is driven by the desire for economic growth, then this may lead to constant demands for use of resources. A series of short-term compromises then results in a long-term reduction in environmental values

Accepting an implicit or explicit evolutionary or complexity view, can lead to the conclusion that since change is a structural property of ecosystems and that complexity and stability are linked, there is little point to conservation efforts. This can be argued two ways. First, that change including extinctions and significant landscape transformation is inevitable even without human intervention so there no point in limiting human activities that contribute to such changes.

This argument has been used in an attempt to limit the protection of old-growth forests. Second, it can be argued that the idea of irreversibility in ecosystems means there is no point basing policy on some notion of 'what used to be'. We cannot re-create a 'natural' state or a wilderness. However, it is possible to derive environmental values, based on levels of biodiversity and ecosystem function and health. There are philosophical justifications for these and scientific inquiry provides ways of assessing and achieving them

Principle 3

— The genuine and orderly participation of the community and a wide range of stakeholders and interested parties in policy development, implementation and evaluation, will contribute

to more effective NRM. This means that prospective participants need sufficient capacity to meaningfully engage in policy processes

Participation ranges from informal consultation to formal policy development and review, through to partnerships, whereby stakeholders and interested parties have an ongoing involvement in planning, implementation and evaluation. The term orderly means some systematic and structured processes facilitating participation, although it does not mean they have to be mandatory or rule-based.

Stakeholder participation has purported moral and practical benefits. The first moral aspect is the idea that participative democracy is a good thing in itself, contributing to the development of individual citizens and the whole polity. The second moral benefit, following from Principle 1, is that wide consultation and interaction leads to the identification of a broad range of goals. It is then possible to consider optimising those goals. The practical benefit is based on the idea that interactive or 'bottom-up' policy development contributes to more effective outcomes.

Genuine participation means that participants have a real opportunity to affect the eventual policies or programmes, and some individuals and groups are not consistently favoured over others. However, there is a need to be mindful of Principles one and two, in that there is a negotiated hierarchy of values, and not all values can be accommodated. The adoption of some ideas may detract from the major values and goals.

Genuine participation also relies on policy actors and stakeholders having access to relevant information and knowledge and having the capacity to access and use relevant approaches and methods of information analysis. The provision of large quantities of unsorted data, reports filled with jargon or professional terminology or unmediated, complex intellectual frameworks, works against true participation.

Principle 4

— NRM policies and programmes will be more effective if different kinds of knowledge are better understood and more fully taken into account when policies are developed, implemented and evaluated

Recalling that knowledge acquisition has many cultural, scientific and individual sources, it is argued here that there are benefits in intellectual pluralism. First, it encourages inclusiveness, supporting Principles one to three. Second, multi-disciplinary activity ameliorates the problem of persistent professional bias, in relation to the selection of conceptual and analytical frameworks and tools. Third, if complex systems are characterised by multi-causality, varying internal relationships and a high degree of interconnectedness, then interdisciplinary analysis, planning and evaluation can counteract sterile reductionism.

Principle 5

— The optimal reconciliation of strategic management and wider participation in policy development, implementation and evaluation will make NRM policies and programmes more effective

Strategic management is the coordination of a range of policies and programmes, usually across agencies and sometimes governments, in pursuit of the high level goals of ESD. Optimal is used in the sense of striving for an increase in one, or more than one outcome to the extent that this does not compromise the other outcomes. Some degree of strategic, or centralised policy oversight is required in order to take account of the need to:

— Focus on higher level goals, especially where there is a strong tendency for agencies to pursue contrary goals

— Arbitrate/coordinate where NRM issues cross agency and/or jurisdictional boundaries. This is especially relevant

where there is a multi-tier system of government, or NRM issues have a global scale or dimension. In the latter case, policies and programmes would need to include internationally agreed plans, practices or standards aimed at ameliorating the whole problem

— Monitor resources use, especially where there is high potential for resource diversion, such as in a multi-tier system

These are the functions of government cabinets to some extent, and involve the exercise of authoritative power. However, some level of 'interactive' or 'bottom-up' policy development, implementation and evaluation is desirable because:

— there is the moral value of participation, discussed above

— target groups may reveal likely preferences or responses to a policy or programme

— community members can identify emerging issues, potential problems and even policy options and problem solutions. Some community members bring local knowledge, experience and a willingness to get involved. This helps develop the idea of 'duty of care'

— operational personnel, the 'coal-face' agency workers, can also contribute ideas and identify potential problems

— stakeholders, target groups and operational personnel may develop a greater commitment to the policy or programme's outcomes

Principle 6

— In multiple tier and/or multiple group systems of governance, clear and transparent agreement on the allocation of roles and responsibilities and regular review of these will contribute to increased NRM policy effectiveness

This does not exclude concurrent arrangements, rather it means a clear acknowledgment of who is to do what, and under what circumstances these might change.

Principle 7

— The development of an outcomes-based hierarchy of goals, objectives and plans,linked in a logical way, will contribute to more effective NRM policies and programmes

The complexity of NRM systems makes extensive control of large and interrelated activities quite difficult. Highly specified outcomes applied across ecosystems and jurisdictions are hard to achieve because of inherent uncertainty about the relationships within the system, the problem of occasional chaotic events, and the uncertainty about the way the systems will evolve.

Therefore, higher level goals that are too specific may lead to a sub-optimal allocation of resources just to fulfil the commitment. For example, if resources were allocated to a national tree planting programme with specified areas to be planted to combat salinity and during the course of that programme research suggested there were better courses of action in some regions, then adaptive management would be more appropriate. More specific goals might be better set at the programme and project level in order to focus the activity. These also provide criteria for evaluations.

This principle is however given with significant qualification and trepidation. The setting of very general goals at the higher level should not be used as a means of avoiding accountability. It is still possible to determine whether or not the specific programme and project level goals should contribute to achieving at least some of the higher order goals.

On the other hand, the specific goals should not be so rigidly pursued that feedback about side-effects of the policy, changes in the policy environment or the recognition of other benefits are ignored. There is a case for regular review of specific goals in response to feedback.

Principle 8

— NRM policies and programmes will be more effective if there is a clear commitment to, and demonstrable effort to apply, the precautionary principle

There are two consequences of this principle. There should be a demonstrable effort to gather information and knowledge about actions that will compromise environmental values. Environmental impact assessments are the manifestation of this part of the principle.

The second aspect relates to the uncertainty associated with complexity and the state of scientific knowledge. Uncertainty about NRM problems should not be a justification for policy inaction. There are discernible patterns and problems, such as deteriorating environmental resources and values. Even if we don't know the detail of the causal relationships, there is usually enough evidence to attempt to formulate some policies.

The 'threshold of knowledge' about NRM problems that trigger policy action, should be lower if the NRM problems appear to lead to severe ecological irreversibility, have a high future cost or are accelerating. In some interpretations there are qualifiers to this relating to the 'cost-effectiveness' of any action or the need to consider 'risk weighting'. If these are proposed as a justification for inactivity, there should be some accompanying analysis to show these purported high costs or high risk.

Given that decisions are made under uncertain conditions, policy actors and stakeholders need to have a robust capacity to assess different sorts of risk, and then be able to respond to that risk in a timely way. The development of relevant analytical tools and techniques can contribute to this.

Principle 9

— NRM policies and programmes that operate at a bioregional scale will contribute to more effective NRM outcomes

If people and human infrastructure have a better 'fit' with ecosystems and catchments, then this has the capacity to reduce the number of adverse effects. In addition, if political and administrative systems are adjusted to achieve a better 'fit' with ecosystems and catchments, then it is likely that policy priorities and citizen loyalties will be more strongly focussed on the ecosystems and catchments.

Principle 10

— The open acknowledgment and discussion of the inherent complexity of NRM systems amongst stakeholders and other policy actors will contribute to more effective policy development and evaluation

There is the understandable psychological tendency to seek simpler explanations for things, especially to simplify perceived causal relationships There is a tendency in the political arena for actors to simplify issues and propose simple solutions in order to appear decisive and in control

An example of oversimplification, and consequent unrealistic elevation of expectations, is the current focus on tree establishment programmes that are meant to fix the greenhouse problem, reduce salinity and improve biodiversity. These simplifications work against genuine discussion of the reality of many NRM issues. In communicating this complexity, care needs to be taken so that the discussion is appropriate. This does not mean that all stakeholders need be overwhelmed with all of the scientific information, or made aware of the details of the complexity of the problem, rather it means that any explanations need to be suitably pitched.

Principle 11

— The development and use of systems and techniques that contribute to enhanced adaptive management will lead to more effective policies and programmes

Enhanced adaptive management encourages 'policy learning' through the analysis and assessment of, and responses to, feedback. This leads to institutional evolution facilitated by institutional flexibility and a capacity to change. This is more than incrementalism. In light of the severity of some problems, innovative policy approaches are desirable, wherever possible. However, these innovative policies should be structured so as to allow for the incorporation of feedback and on-going adjustment.

Care needs to be taken that this adjustment does not deteriorate into the type of incrementalism in which the extent of small changes obscures, or detracts from, the broad NRM goals. In addition, and further to Principle 10, practitioners need to acknowledge, and be allowed to acknowledge, the complexity of the systems they work with, so that they can develop and maintain systems that provide feedback.

Principle 12

— Demonstrable and orderly efforts to develop and use systems that enhance'policy learning' by individuals and within organisations will contribute to more effective NRM policies and programmes

Policy 'knowledge' resides with individuals and institutions and is 'lost' because of agency restructuring, staff turnover or loss of contact with key community people. It is ignored because of changes in government, ideology and intellectual fashions in research, extension and management. Some of the means of retaining and enhancing policy knowledge are:

— Maintaining information about, and knowledge of, lessons from previous relevant policies and programmes and communicating these to policy actors

— Developing knowledge about, and lessons from, relevant policies and programmes from other jurisdictions. There are particular opportunities for this in a concurrent system because there are likely to be a range of programmes

targeted at one problem, with some in different regions. However, the comparisons will be more useful if there is some level of rigour in any analysis, with note taken of critical differences between the contexts

— Using benchmarks and best practice guidelines for planning and evaluation

Providing opportunities to enhance professional training and education, use mentoring and encourage career planning

Evaluation of NRM Policies and Programmes

Some principles for evaluation that pertain particularly to NRM are:

Evaluation Principle 1

— Evaluation of any given project or programme needs to be set within the context of the entire NRM outcomes framework

This means that part of the evaluation of any project, programme or policy will include an assessment of the extent to which it is effectively linked to other projects, programmes and policies in order to move towards intermediate, longer term and ultimate outcomes.

These links may be practical links that ensure that the projects actually work together in an orchestrated manner as an integrated mix of tools. The mix may work either concurrently or in such a way that one picks up where another leaves off. The links may also be analytical rather than practical in the sense that while different projects, programmes and policies may not work together in any direct way, each is formulated in recognition of what is happening in relation to other projects, programmes and policies. The issue here is more one of consistency and mutual support than of direct integration.

Evaluation Principle 2

— At different levels (national, state, local) it will be important to assess the combined impact of a mix of strategies as well as the impact of individual strategies

At the stage of whole of strategy planning and review, evaluation can assess whether there is a well balanced complementary mix of programmes, policies, and projects and whether the timing and manner of implementation of each is appropriate to maximise combined and complementary impacts. This is not an easy task because it often has to be undertaken on the basis of very inadequate or partial knowledge. However the outcomes framework should at least provide a starting point for asking the right questions. This framework can also be used to see if some values have been marginalised in the aggregate situation..

Evaluation Principle 3

— Because NRM is multi-faceted, there will be a need to identify a very wide range of evaluation methods coming from many disciplines.

Different policy tools try to achieve different types of immediate and intermediate outcomes using different mechanisms. The methodologies that are appropriate to the various mechanisms vary greatly. For example the evaluation of networks is likely to draw heavily on concepts and tools used by sociologists and social psychologists and on the work that has been undertaken in relation to the development and measurement of social capital. The evaluation of the effects of legislation is likely to draw on concepts and tools used in legal studies, criminology and so on. Evaluation methodologies do exist in the various disciplines although some are more highly developed than others. In some cases new methodologies may need to be developed. An assessment of the potential of the various disciplines to contribute to the evaluation of various aspects of NRM would be useful.

Evaluation Principle 4

— Because the NRM context is highly dynamic, evaluation methodologies should not be too tightly tied to assessing performance in terms of pre-ordinately specified objectives

NRM problems, perceptions of problems, priorities and solutions are constantly changing and objectives are often diffuse. Evaluation methodologies will need to ensure that they do not straight jacket programmes into achieving only those specific objectives that originally determined the direction of the programme.

Unintended outcomes and evaluation of the adaptiveness of programmes and policies to changing contexts and to the accretion of NRM knowledge will be more important in the context of NRM than is often the case in other policy and programme arenas. Measures of adaptiveness will include some assessment not only of immediate adaptive responses but also of the development of sustainable capacity to adapt. This de-emphasis on the measurement of highly specified objectives should not be regarded as an enjoinment to undisciplined reactivity.

Policies, programmes and evaluation methodologies will still need to be outcome driven in the general sense, for example at the level of specificity included in hierarchies of intended outcomes. How those general outcomes are operationalised at a given place and time should depend on continuing processes of situation analysis, and the development of responsive strategies. From time to time there may be a need to shift discourse altogether as particular problems come to be understood variously as individual behaviour problems, societal norm problems, market driven problems and so on. At this point it will be important that when evaluating programmes established under one discourse but moving to another discourse, the evaluation methodologies embrace the new discourse as well as the old.

Other general evaluation principles which, while not specific to NRM evaluation, apply to it, include:

- Evaluations should be conducted at various stages in the life cycle of a policy or programme
- Evaluation questions, methodologies, and approaches (for example internal /external) need to be appropriate to the purpose of an evaluation and the location of the policy or programme with respect to the various stages of planning and implementation.
- Evaluation questions should be derived substantially from the evaluation framework for a given programme or policy and this framework should itself be nested within the overall outcomes framework for NRM. The intended use or purpose of the evaluation will assist with the selection of outcomes from within the framework. The use of a full programme logic can also assist with the identification of more specific questions and with identifying issues relating to causal attribution
- Evaluation methodologies should be derived from evaluation questions and not vice versa
- Evaluation of appropriateness may lead to an assessment that an evaluation of effectiveness should not be undertaken until the programme is redesigned or implemented in a different way
- Evaluation processes and approaches to communicating findings should respect the importance of stakeholder consultation and participation.
- Evaluations should be planned and conducted taking into account accepted standards for evaluation. In general terms these concern usefulness and relevance of the evaluation process, feasibility and cost-effectiveness of the evaluation process, the technical validity and accuracy of evaluation methodology available and used, and issues of ethics and social justice. Any trade-offs amongst the standards - and these are almost inevitable - should be made both consciously and explicitly

Research and Development

Before outlining some of the areas that may warrant further research, it should be noted that this does not necessarily imply a recommendation for new research. Rather there is a strong case for compiling and synthesising existing research and information. In some cases, there is already relevant social science research available or being done, though some of this would need to be adapted to NRM. One of the more important research outcomes might involve the development and maintenance of research networks and information banks, to try and reduce duplication and increase value-added activity. Some of the suggestions are also predicated on the hope that there will be further efforts to conceptualise what ESD means at the regional level, as suggested by LWRRDC.

Institutions

- A review and analysis of models of 'fourth tier' governance across jurisdictions, and encompassing various formal and informal arrangements. There are several sub-projects in this, including:
  - best practice in fourth tier or bioregional governance identification of effective legal, policy and administrative frameworks or models interactions between the community and bio-regional systems of governance
  - The identification of appropriate ways to balance strategic and interactive approaches to policy in order to achieve optimal ESD outcomes

Attitudes and Values

An assessment of ways in which the categories of ESD are optimised in:

- various land-use systems and

— bioregional or catchment plans

  — Review NRM strategies, programmes and policies in order to determine how ESD has been interpreted in different agencies and jurisdictions

  — Review and monitor information on value changes in the community, especially those that show different values in different groups or communities. For example, studies of attitudes and personality types amongst landholders reveal some information relevant to participation and extension

  — Review information on responses to the nature of NRM problems. For example, responses to visible and 'hidden' problems

Monitoring, Evaluation and Feedback

For each of the types of activities undertaken as part of NRM it should be possible to develop a generic hierarchy of intended outcomes and some generic strategies or operating principles that will provide a basis for evaluation. The development of such generic hierarchies of intended outcomes could:

— contribute to the consistency of approaches used to evaluate similar types of programmes thereby facilitating the accumulation of knowledge about what makes particular types of NRM activities more (or less) effective

— provide a useful tool for practitioners who are wondering where to start their evaluation. The tool would be a source of advice about what outcomes should be measured and evaluated

For illustrative purposes, the development and application of a generic hierarchy of outcomes for research programmes has been included in this report and it is envisaged that similar generic outcomes hierarchies could be developed for all of the activities at level 4. For example, generic hierarchies of intended outcomes could be developed for codes of practice, for networks

and so on. The development of these hierarchies would draw on research literature to identify the mechanisms through which of those tools are designed to achieve impacts. The development process would also draw on practitioner experience with the various types of tools and what makes them work or not work so well.

There would be great value in developing a research programme, starting with literature reviews, to identify the evaluation methodologies that are typically used to evaluate the various types of tools. From this research it should then be possible to provide further advice to practitioners about how to evaluate particular policy, programme and project tools and activities

— A database of who is monitoring what, to encourage efficiencies between levels of government and agencies. Some agencies and tiers of government rely on the monitoring work of other agencies, sometimes in other tiers, because of a lack of resources or lack of expertise. It may be useful to construct a system that guides agencies to the best available information, and it could also be used to limit duplication of effort

— A review and development of the planning 'models', both explicit and implicit, used in NRM and other 'benchmark' departments, in order to:

Communication Strategy

Efforts towards improving the effectiveness of NRM policies and programmes over time will require, among other things, a targeted and sustained focus on ensuring that the results of research and development efforts are made available to the relevant interest groups. Moreover, it is necessary to engage with these groups early into the life of the SIRP so as to ensure that preliminary findings are robust, relevant to their needs, easy to understand and use and cost-effective to implement should they wish to.

Here we outline the elements of a communication strategy that starts to address these matters. However, we are mindful that as the SIRP initiative is new and there are at least seven other complimentary projects running in parallel, it is likely that a broader communication plan will be needed to draw together the issues relevant to the entire initiative at this stage of its evolution.

This report has developed the argument that NRM, and its attendant policy and programme agendas, can be considered a complex system with a number of distinct features. These include the inherent complexity of the natural and productive ecosystems, the multiobjective nature of many NRM initiatives and the jurisdictional and institutional complexity within which its activities are embedded.

This complexity sets up some clear challenges for communication because most approaches tend to favour simple, clear messages neatly packaged and easy lessons and guidance for consequent actions.

Here we will focus on the elements of a communication plan that meets some specific and immediate needs of this project.

There are at least three distinct client groups for this report. Each group will have several different perspectives on the issues raised and frameworks proposed in this report. These mix of perspectives and interests will need to be better understood if efforts at communication are to be effective.

First are the NRM practitioners. We have deliberately not tried to dissect the composition of this diverse group, but it includes at least:

— public sector decision-makers across all government agencies (Ministers, Cabinets, Ministerial Councils, political advisers, senior bureaucrats)

— public sector resource managers across all government agencies (from strategic to operational)

— corporate (private sector) decision makers (Industry Boards and CEOs)

— non-corporate (private sector) resource managers (from landowners to small firms)

The second client group is the research and development community. There are several, sometimes overlapping groups here including:

— natural and social scientists who are working in multidisciplinary teams with a focus around the broad policy goal of sustainability

— mixtures of public policy, political and sociological theorists and lawyers with an interest in systems of governance

— management and evaluation theorists and practitioners with a focus on accountability and planning

There are clear examples of various forms of these groupings and interests across universities, the CSIRO and within Commonwealth and State government portfolios. There are also likely to be equivalent groups in the private sector, but these are less obvious so it would require further work to identify them though professional associations and the like.

The third client group for this project are the evaluation practitioners. There is a well-established professional organisational structure both in Australia and in the US. They are potentially both a client and a service provider, in the sense of the likely ongoing need for NRM evaluations. Evaluation theorists and practitioners are scattered across universities, government departments and the private sector.

13

Rio Declaration on Environment and Development

The United Nations Conference on Environment and Development,

Having met at Rio de Janeiro from 3 to 14 June 1992,

Reaffirming the Declaration of the United Nations Conference on the Human Environment, adopted at Stockholm on 16 June 1972, a/ and seeking to build upon it,

With the goal of establishing a new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of societies and people,

Working towards international agreements which respect the interests of all and protect the integrity of the global environmental and developmental system,

Recognizing the integral and interdependent nature of the Earth, our home,

Proclaims that:

Principle 1

Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 2

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Principle 3

The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.

Principle 4

In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 5

All States and all people shall cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development, in order to decrease the disparities in standards of living and better meet the needs of the majority of the people of the world.

Principle 6

The special situation and needs of developing countries, particularly the least developed and those most environmentally vulnerable, shall be given special priority. International actions in the field of environment and development should also address the interests and needs of all countries.

Principle 7

States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

Principle 8

To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.

Principle 9

States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.

Principle 10

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public

awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle 11

States shall enact effective environmental legislation. Environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply. Standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries.

Principle 12

States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problems of environmental degradation.

Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade. Unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing transboundary or global environmental problems should, as far as possible, be based on an international consensus.

Principle 13

States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage.

States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental

damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.

Principle 14

States should effectively cooperate to discourage or prevent the relocation and transfer to other States of any activities and substances that cause severe environmental degradation or are found to be harmful to human health.

Principle 15

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Principle 16

National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

Principle 17

Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

Principle 18

States shall immediately notify other States of any natural

disasters or other emergencies that are likely to produce sudden harmful effects on the environment of those States. Every effort shall be made by the international community to help States so afflicted.

Principle 19

States shall provide prior and timely notification and relevant information to potentially affected States on activities that may have a significant adverse transboundary environmental effect and shall consult with those States at an early stage and in good faith.

Principle 20

Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development.

Principle 21

The creativity, ideals and courage of the youth of the world should be mobilized to forge a global partnership in order to achieve sustainable development and ensure a better future for all.

Principle 22

Indigenous people and their communities and other local communities have a vital role in environmental management and development because of their knowledge and traditional practices. States should recognize and duly support their identity, culture and interests and enable their effective participation in the achievement of sustainable development.

Principle 23

The environment and natural resources of people under oppression, domination and occupation shall be protected.

Principle 24

Warfare is inherently destructive of sustainable development. States shall therefore respect international law providing protection for the environment in times of armed conflict and cooperate in its further development, as necessary.

Principle 25

Peace, development and environmental protection are interdependent and indivisible.

Principle 26

States shall resolve all their environmental disputes peacefully and by appropriate means in accordance with the Charter of the United Nations.

Principle 27

States and people shall cooperate in good faith and in a spirit of partnership in the fulfilment of the principles embodied in this Declaration and in the further development of international law in the field of sustainable development.

14

Report of the United Nations Conference on Environment and Development

Preamble

(a) The subject of forests is related to the entire range of environmental and development issues and opportunities, including the right to socio-economic development on a sustainable basis.

(b) The guiding objective of these principles is to contribute to the management, conservation and sustainable development of forests and to provide for their multiple and complementary functions and uses.

(c) Forestry issues and opportunities should be examined in a holistic and balanced manner within the overall context of environment and development, taking into consideration the multiple functions and uses of forests, including traditional uses, and the likely economic and social stress when these uses are constrained or restricted, as well as the potential for development that sustainable forest management can offer.

(d) These principles reflect a first global consensus on forests. In committing themselves to the prompt implementation of

these principles, countries also decide to keep them under assessment for their adequacy with regard to further international cooperation on forest issues.

(e) These principles should apply to all types of forests, both natural and planted, in all geographical regions and climatic zones, including austral, boreal, subtemperate, temperate, subtropical and tropical.

(f) All types of forests embody complex and unique ecological processes which are the basis for their present and potential capacity to provide resources to satisfy human needs as well as environmental values, and as such their sound management and conservation is of concern to the Governments of the countries to which they belong and are of value to local communities and to the environment as a whole.

(g) Forests are essential to economic development and the maintenance of all forms of life.

(h) Recognizing that the responsibility for forest management, conservation and sustainable development is in many States allocated among federal/national, state/provincial and local levels of government, each State, in accordance with its constitution and/or national legislation, should pursue these principles at the appropriate level of government.

Principles/Elements

1. (a) States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies and have the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

(b) The agreed full incremental cost of achieving benefits associated with forest conservation and sustainable development requires increased international cooperation and should be equitably shared by the international community.

2. (a) States have the sovereign and inalienable right to utilize, manage and develop their forests in accordance with their development needs and level of socio-economic development and on the basis of national policies consistent with sustainable development and legislation, including the conversion of such areas for other uses within the overall socio-economic development plan and based on rational land-use policies.

(b) Forest resources and forest lands should be sustainably managed to meet the social, economic, ecological, cultural and spiritual needs of present and future generations. These needs are for forest products and services, such as wood and wood products, water, food, fodder, medicine, fuel, shelter, employment, recreation, habitats for wildlife, landscape diversity, carbon sinks and reservoirs, and for other forest products. Appropriate measures should be taken to protect forests against harmful effects of pollution, including air-borne pollution, fires, pests and diseases, in order to maintain their full multiple value.

(c) The provision of timely, reliable and accurate information on forests and forest ecosystems is essential for public understanding and informed decision-making and should be ensured.

(d) Governments should promote and provide opportunities for the participation of interested parties, including local communities and indigenous people, industries, labour, non-governmental organizations and individuals, forest dwellers and women, in the development, implementation and planning of national forest policies.

3.(a) National policies and strategies should provide a framework for increased efforts, including the development and strengthening of institutions and programmes for the management, conservation and sustainable development of forests and forest lands.

(b) International institutional arrangements, building on those organizations and mechanisms already in existence, as appropriate, should facilitate international cooperation in the field of forests.

(c) All aspects of environmental protection and social and economic development as they relate to forests and forest lands should be integrated and comprehensive.

4. The vital role of all types of forests in maintaining the ecological processes and balance at the local, national, regional and global levels through, inter alia, their role in protecting fragile ecosystems, watersheds and freshwater resources and as rich storehouses of biodiversity and biological resources and sources of genetic material for biotechnology products, as well as photosynthesis, should be recognized.

5. (a) National forest policies should recognize and duly support the identity, culture and the rights of indigenous people, their communities and other communities and forest dwellers. Appropriate conditions should be promoted for these groups to enable them to have an economic stake in forest use, perform economic activities, and achieve and maintain cultural identity and social organization, as well as adequate levels of livelihood and well-being, through, inter alia, those land tenure arrangements which serve as incentives for the sustainable management of forests.

(b) The full participation of women in all aspects of the management, conservation and sustainable development of forests should be actively promoted.

6. (a) All types of forests play an important role in meeting energy requirements through the provision of a renewable source of bio-energy, particularly in developing countries, and the demands for fuelwood for household and industrial needs should be met through sustainable forest management, afforestation and reforestation. To this end, the potential contribution of plantations of both indigenous and introduced species for the provision of both fuel and industrial wood should be recognized.

(b) National policies and programmes should take into account the relationship, where it exists, between the conservation, management and sustainable development of forests and all aspects related to the production, consumption, recycling and/or final disposal of forest products.

(c) Decisions taken on the management, conservation and sustainable development of forest resources should benefit, to the extent practicable, from a comprehensive assessment of economic and non-economic values of forest goods and services and of the environmental costs and benefits. The development and improvement of methodologies for such evaluations should be promoted.

(d) The role of planted forests and permanent agricultural crops as sustainable and environmentally sound sources of renewable energy and industrial raw material should be recognized, enhanced and promoted. Their contribution to the maintenance of ecological processes, to offsetting pressure on primary/old-growth forest and to providing regional employment and development with the adequate involvement of local inhabitants should be recognized and enhanced.

(e) Natural forests also constitute a source of goods and services, and their conservation, sustainable management and use should be promoted.

7. (a) Efforts should be made to promote a supportive international economic climate conducive to sustained and environmentally sound development of forests in all countries, which include, inter alia, the promotion of sustainable patterns of production and consumption, the eradication of poverty and the promotion of food security.

(b) Specific financial resources should be provided to developing countries with significant forest areas which establish programmes for the conservation of forests including protected natural forest areas. These resources should be directed notably to economic sectors which would stimulate economic and social substitution activities.

8. (a) Efforts should be undertaken towards the greening of the world. All countries, notably developed countries, should take positive and transparent action towards reforestation, afforestation and forest conservation, as appropriate.

(b) Efforts to maintain and increase forest cover and forest productivity should be undertaken in ecologically, economically and socially sound ways through the rehabilitation, reforestation and re-establishment of trees and forests on unproductive, degraded and deforested lands, as well as through the management of existing forest resources.

(c) The implementation of national policies and programmes aimed at forest management, conservation and sustainable development, particularly in developing countries, should be supported by international financial and technical cooperation, including through the private sector, where appropriate.

(d) Sustainable forest management and use should be carried out in accordance with national development policies and priorities and on the basis of

environmentally sound national guidelines. In the formulation of such guidelines, account should be taken, as appropriate and if applicable, of relevant internationally agreed methodologies and criteria.

(e) Forest management should be integrated with management of adjacent areas so as to maintain ecological balance and sustainable productivity.

(f) National policies and/or legislation aimed at management, conservation and sustainable development of forests should include the protection of ecologically viable representative or unique examples of forests, including primary/old-growth forests, cultural, spiritual, historical, religious and other unique and valued forests of national importance.

(g) Access to biological resources, including genetic material, shall be with due regard to the sovereign rights of the countries where the forests are located and to the sharing on mutually agreed terms of technology and profits from biotechnology products that are derived from these resources.

(h) National policies should ensure that environmental impact assessments should be carried out where actions are likely to have significant adverse impacts on important forest resources, and where such actions are subject to a decision of a competent national authority.

9. (a) The efforts of developing countries to strengthen the management, conservation and sustainable development of their forest resources should be supported by the international community, taking into account the importance of redressing external indebtedness, particularly where aggravated by the net transfer of resources to developed countries, as well as the problem of achieving at least the replacement value of forests through improved market access for forest products, especially processed products. In this respect,

special attention should also be given to the countries undergoing the process of transition to market economies.

(b) The problems that hinder efforts to attain the conservation and sustainable use of forest resources and that stem from the lack of alternative options available to local communities, in particular the urban poor and poor rural populations who are economically and socially dependent on forests and forest resources, should be addressed by Governments and the international community.

(c) National policy formulation with respect to all types of forests should take account of the pressures and demands imposed on forest ecosystems and resources from influencing factors outside the forest sector, and intersectoral means of dealing with these pressures and demands should be sought.

10. New and additional financial resources should be provided to developing countries to enable them to sustainably manage, conserve and develop their forest resources, including through afforestation, reforestation and combating deforestation and forest and land degradation.

11. In order to enable, in particular, developing countries to enhance their endogenous capacity and to better manage, conserve and develop their forest resources, the access to and transfer of environmentally sound technologies and corresponding know-how on favourable terms, including on concessional and preferential terms, as mutually agreed, in accordance with the relevant provisions of Agenda 21, should be promoted, facilitated and financed, as appropriate.

12. (a) Scientific research, forest inventories and assessments carried out by national institutions which take into account, where relevant, biological, physical, social and economic variables, as well as technological development and its application in the field of

sustainable forest management, conservation and development, should be strengthened through effective modalities, including international cooperation. In this context, attention should also be given to research and development of sustainably harvested non-wood products.

(b) National and, where appropriate, regional and international institutional capabilities in education, training, science, technology, economics, anthropology and social aspects of forests and forest management are essential to the conservation and sustainable development of forests and should be strengthened.

(c) International exchange of information on the results of forest and forest management research and development should be enhanced and broadened, as appropriate, making full use of education and training institutions, including those in the private sector.

(d) Appropriate indigenous capacity and local knowledge regarding the conservation and sustainable development of forests should, through institutional and financial support and in collaboration with the people in the local communities concerned, be recognized, respected, recorded, developed and, as appropriate, introduced in the implementation of programmes. Benefits arising from the utilization of indigenous knowledge should therefore be equitably shared with such people.

13. (a) Trade in forest products should be based on non-discriminatory and multilaterally agreed rules and procedures consistent with international trade law and practices. In this context, open and free international trade in forest products should be facilitated.

(b) Reduction or removal of tariff barriers and impediments to the provision of better market access and better prices for higher value-added forest products and their local processing should be encouraged to enable producer

countries to better conserve and manage their renewable forest resources.

(c) Incorporation of environmental costs and benefits into market forces and mechanisms, in order to achieve forest conservation and sustainable development, should be encouraged both domestically and internationally.

(d) Forest conservation and sustainable development policies should be integrated with economic, trade and other relevant policies.

(e) Fiscal, trade, industrial, transportation and other policies and practices that may lead to forest degradation should be avoided. Adequate policies, aimed at management, conservation and sustainable development of forests, including, where appropriate, incentives, should be encouraged.

14. Unilateral measures, incompatible with international obligations or agreements, to restrict and/or ban international trade in timber or other forest products should be removed or avoided, in order to attain long-term sustainable forest management.

15. Pollutants, particularly air-borne pollutants, including those responsible for acidic deposition, that are harmful to the health of forest ecosystems at the local, national, regional and global levels should be controlled.

15

INDIA – ENVIRONMENTAL (PROTECTION) ACT, 1986

An Act to provide for the protection and improvement of environment and for matters connected there with:

WHEREAS the decisions were taken at the United Nations Conference on the Human Environment held at Stockholm in June, 1972, in which India participated, to take appropriate steps for the protection and improvement of human environment;

AND WHEREAS it is considered necessary further to implement the decisions aforesaid in so far as they relate to the protection and improvement of environment and the prevention of hazards to human beings, other living creatures, plants and property;

BE it enacted by Parliament in the Thirty-seventh Year of the Republic of India as follows:-

CHAPTER I
PRELIMINARY

1. Short Title, Extend and Commencement

(1) This Act may be called the Environment (Protection) Act, 1986.

(2) It extends to the whole of India.

(3) It shall come into force on such date as the Central Government may, by notification in the Official Gazette, appoint and different dates may be appointed for different provisions of this Act and for different areas.[1]

2. Definitions

In this Act, unless the context otherwise requires,—

(a) "environment" includes water, air and land and the inter-relationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro-organism and property;

(b) "environmental pollutant" means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, injurious to environment;

(c) "environmental pollution" means the presence in the environment of any environmental pollutant;

(d) "handling", in relation to any substance, means the manufacture, processing, treatment, package, storage, transportation, use, collection, destruction, conversion, offering for sale, transfer or the like of such substance;

(e) "hazardous substance" means any substance or preparation which, by reason of its chemical or physico-chemical properties or handling, is liable to cause harm to human beings, other living creatures, plant, micro-organism, property or the environment;

(f) "occupier", in relation to any factory or premises, means a person who has, control over the affairs of the factory or the premises and includes in relation to any substance, the person in possession of the substance;

(g) "prescribed" means prescribed by rules made under this Act.

Chapter II
General Powers of the Central Government

3. Power of Central Government to take Measures to Protect and Improve Environment

(1) Subject to the provisions of this Act, the Central Government, shall have the power to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing controlling and abating environmental pollution.

(2) In particular, and without prejudice to the generality of the provisions of sub-section (1), such measures may include measures with respect to all or any of the following matters, namely:—

(i) co-ordination of actions by the State Governments, officers and other authorities—

(a) under this Act, or the rules made thereunder, or

(b) under any other law for the time being in force which is relatable to the objects of this Act;

(ii) planning and execution of a nation-wide programme for the prevention, control and abatement of environmental pollution;

(iii) laying down standards for the quality of environment in its various aspects;

(iv) laying down standards for emission or discharge of environmental pollutants from various sources whatsoever:

Provided that different standards for emission or discharge may be laid down under this clause from different sources having regard to the quality or composition of the emission or discharge of environmental pollutants from such sources;

(v) restriction of areas in which any industries, operations or processes or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards;

(vi) laying down procedures and safeguards for the prevention of accidents which may cause environmental pollution and remedial measures for such accidents;

(vii) laying down procedures and safeguards for the handling of hazardous substances;

(viii) examination of such manufacturing processes, materials and substances as are likely to cause environmental pollution;

(ix) carrying out and sponsoring investigations and research relating to problems of environmental pollution;

(x) inspection of any premises, plant, equipment, machinery, manufacturing or other processes, materials or substances and giving, by order, of such directions to such authorities, officers or persons as it may consider necessary to take steps for the prevention, control and abatement of environmental pollution;

(xi) establishment or recognition of environmental laboratories and institutes to carry out the functions entrusted to such environmental laboratories and institutes under this Act;

(xii) collection and dissemination of information in respect of matters relating to environmental pollution;

(xiii) preparation of manuals, codes or guides relating to the prevention, control and abatement of environmental pollution;

(xiv) such other matters as the Central Government deems necessary or expedient for the purpose of securing the effective implementation of the provisions of this Act.

(3) The Central Government may, if it considers it necessary or expedient so to do for the purpose of this Act, by order,

published in the Official Gazette, constitute an authority or authorities by such name or names as may be specified in the order for the purpose of exercising and performing such of the powers and functions (including the power to issue directions under section 5) of the Central Government under this Act and for taking measures with respect to such of the matters referred to in sub-section (2) as may be mentioned in the order and subject to the supervision and control of the Central Government and the provisions of such order, such authority or authorities may exercise and powers or perform the functions or take the measures so mentioned in the order as if such authority or authorities had been empowered by this Act to exercise those powers or perform those functions or take such measures.

4. Appointment of Officers and their Powers and Functions

(1) Without prejudice to the provisions of sub-section (3) of section 3, the Central Government may appoint officers with such designation as it thinks fit for the purposes of this Act and may entrust to them such of the powers and functions under this Act as it may deem fit.

(2) The officers appointed under sub-section (1) shall be subject to the general control and direction of the Central Government or, if so directed by that Government, also of the authority or authorities, if any, constituted under sub-section (3) of section 3 or of any other authority or officer.

5. Power to Give Directions

Notwithstanding anything contained in any other law but subject to the provisions of this Act, the Central Government may, in the exercise of its powers and performance of its functions under this Act, issue directions in writing to any person, officer or any authority and such person, officer or authority shall be bound to comply with such directions.[3]

Explanation—For the avoidance of doubts, it is hereby declared that the power to issue directions under this section includes the power to direct—

(a) the closure, prohibition or regulation of any industry, operation or process; or

(b) stoppage or regulation of the supply of electricity or water or any other service.

6. Rules to Regulate Environmental Pollution

(1) The Central Government may, by notification in the Official Gazette, make rules in respect of all or any of the matters referred to in section 3.

(2) In particular, and without prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters, namely:—

(a) the standards of quality of air, water or soil for various areas and purposes;[4]

(b) the maximum allowable limits of concentration of various environmental pollutants (including noise) for different areas;

(c) the procedures and safeguards for the handling of hazardous substances;[5]

(d) the prohibition and restrictions on the handling of hazardous substances in different areas;[6]

(e) the prohibition and restriction on the location of industries and the carrying on process and operations in different areas;[7]

(f) the procedures and safeguards for the prevention of accidents which may cause environmental pollution and for providing for remedial measures for such accidents.[8]

Chapter III
Prevention, Control, And Abatement Of Environmental Pollution

7. Persons Carrying On Industry Operation, Etc., Not To Allow Emission Or Discharge Of Environmental Pollutants In Excess Of The Standards

No person carrying on any industry, operation or process shall discharge or emit or permit to be discharged or emitted any environmental pollutants in excess of such standards as may be prescribed.[9]

8. Persons Handling Hazardous Substances To Comply With Procedural Safeguards

No person shall handle or cause to be handled any hazardous substance except in accordance with such procedure and after complying with such safeguards as may be prescribed.[10]

9. Furnishing Of Information To Authorities And Agencies In Certain Cases

(1) Where the discharge of any environmental pollutant in excess of the prescribed standards occurs or is apprehended to occur due to any accident or other unforeseen act or event, the person responsible for such discharge and the person in charge of the place at which such discharge occurs or is apprehended to occur shall be bound to prevent or mitigate the environmental pollution caused as a result of such discharge and shall also forthwith-

(a) intimate the fact of such occurrence or apprehension of such occurrence; and

(b) be bound, if called upon, to render all assistance, to such authorities or agencies as may be prescribed.[11]

(2) On receipt of information with respect to the fact or apprehension on any occurrence of the nature referred to in sub-section (1), whether through intimation under that sub-section or otherwise, the authorities or agencies referred to in sub-section (1) shall, as early as practicable, cause such remedial measures to be taken as necessary to prevent or mitigate the environmental pollution.

(3) The expenses, if any, incurred by any authority or agency with respect to the remedial measures referred to in sub-section (2), together with interest (at such reasonable rate as the Government may, by order, fix) from the date when a demand for the expenses is made until it is paid, may be recovered by such authority or agency from the person concerned as arrears of land revenue or of public demand.

10. Powers Of Entry And Inspection

(1) Subject to the provisions of this section, any person empowered by the Central Government in this ehalf12 shall have a right to enter, at all reasonable times with such assistance as he considers necessary, any place-

(a) for the purpose of performing any of the functions of the Central Government entrusted to him;

(b) for the purpose of determining whether and if so in what manner, any such functions are to be performed or whether any provisions of this Act or the rules made thereunder orany notice, order, direction or authorisation served, made, given or granted under this Act is being or has been complied with;

(c) for the purpose of examining and testing any equipment, industrial plant, record, register, document or any other material object or for conducting a search of any building in which he has reason to believe that an offence under this Act or the rules made thereunder has been or is being or is about to be committed and

for seizing any such equipment, industrial plant, record, register, document or other material object if he has reason to believe that it may furnish evidence of the commission of an offence punishable under this Act or the rules made thereunder or that such seizure is necessary to prevent or mitigate environmental pollution.

(2) Every person carrying on any industry, operation or process of handling any hazardous substance shall be bound to render all assistance to the person empowered by the Central Government under sub-section (1) for carrying out the functions under that sub-section and if he fails to do so without any reasonable cause or excuse, he shall be guilty of an offence under this Act.

(3) If any person wilfully delays or obstructs any persons empowered by the Central Government under sub-section (1) in the performance of his functions, he shall be guilty of an offence under this Act.

(4) The provisions of the Code of Criminal Procedure, 1973, or, in relation to the State of Jammu and Kashmir, or an area in which that Code is not in force, the provisions of any corresponding law in force in that State or area shall, so far as may be, apply to any search or seizures under this section as they apply to any search or seizure made under the authority of a warrant issued under section 94 of the said Code or as the case may be, under the corresponding provision of the said law.

11. Power To Take Sample And Procedure To Be Followed In Connection Therewith

(1) The Central Government or any officer empowered by it in this behalf,[13] shall have power to take, for the purpose of analysis, samples of air, water, soil or other substance from any factory, premises or other place in such manner as may be prescribed.[14]

(2) The result of any analysis of a sample taken under sub-section (1) shall not be admissible in evidence in any legal proceeding unless the provisions of sub-sections (3) and (4) are complied with.

(3) Subject to the provisions of sub-section (4), the person taking the sample under sub-section (1) shall-

(a) serve on the occupier or his agent or person in charge of the place, a notice, then and there, in such form as may be prescribed, of his intention to have it so analysed;

(b) in the presence of the occupier of his agent or person, collect a sample for analysis;

(c) cause the sample to be placed in a container or containers which shall be marked and sealed and shall also be signed both by the person taking the sample and the occupier or his agent or person;

(d) send without delay, the container or the containers to the laboratory established or recognised by the Central Government under section 12.

(4) When a sample is taken for analysis under sub-section (1) and the person taking the sample serves on the occupier or his agent or person, a notice under clause (a) of sub-section (3), then,-

(a) in a case where the occupier, his agent or person wilfully absents himself, the person taking the sample shall collect the sample for analysis to be placed in a container or containers which shall be marked and sealed and shall also be signed by the person taking the sample, and

(b) in a case where the occupier or his agent or person present at the time of taking the sample refuses to sign the marked and sealed container or containers of the sample as required under clause (c) of sub-section (3), the marked and sealed container or containers shall be

signed by the person taking the samples, and the container or containers shall be sent without delay by the person taking the sample for analysis to the laboratory established or recognised under section 12 and such person shall inform the Government Analyst appointed or recognised under section 12 in writing, about the wilfull absence of the occupier or his agent or person, or, as the case may be, his refusal to sign the container or containers.

12. Environmental Laboratories

(1) The Central Government15 may, by notification in the Official Gazette,-

(a) establish one or more environmental laboratories;

(b) recognise one or more laboratories or institutes as environmental laboratories to carry out the functions entrusted to an environmental laboratory under this Act.[16]

(2) The Central Government may, by notification in the Official Gazette, make rules specifying-

(a) the functions of the environmental laboratory;[17]

(b) the procedure for the submission to the said laboratory of samples of air, water, soil or other substance for analysis or tests, the form of the laboratory report thereon and the fees payable for such report;18

(c) such other matters as may be necessary or expedient to enable that laboratory to carry out its functions.

13. Government Analysts

The Central Government may by notification in the Official Gazette, appoint or recognise such persons as it thinks fit and having the prescribed qualifications19 to be Government Analysts for the purpose of analysis of samples of air, water,

soil or other substance sent for analysis to any environmental laboratory established or recognised under sub-section (1) of section 12.

14. Reports Of Government Analysts

Any document purporting to be a report signed by a Government analyst may be used as evidence of the facts stated therein in any proceeding under this Act.

15. Penalty For Contravention Of The Provisions Of The Act And The Rules, Orders And Directions

(1) Whoever fails to comply with or contravenes any of the provisions of this Act, or the rules made or orders or directions issued thereunder, shall, in respect of each such failure or contravention, be punishable with imprisonment for a term which may extend to five years with fine which may extend to one lakh rupees, or with both, and in case the failure or contravention continues, with additional fine which may extend to five thousand rupees for every day during which such failure or contravention continues after the conviction for the first such failure or contravention.

(2) If the failure or contravention referred to in sub-section (1) continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to seven years.

16. Offences By Companies

(1) Where any offence under this Act has been committed by a company, every person who, at the time the offence was committed, was directly in charge of, and was responsible to, the company for the conduct of the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:

Provided that nothing contained in this sub-section shall render any such person liable to any punishment provided in this Act, if he proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (1), where an offence under this Act has been committed by a company and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of, any director, manager, secretary or other officer of the company, such director, manager, secretary or other officer shall also deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

Explanation-For the purpose of this section,-

(a) "company" means any body corporate and includes a firm or other association of individuals;

(b) "director", in relation to a firm, means a partner in the firm.

17. Offences By Government Departments

(1) Where an offence under this Act has been committed by any Department of Government, the Head of the Department shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly.

Provided that nothing contained in this section shall render such Head of the Department liable to any punishment if he proves that the offence was committed without his knowledge or that he exercise all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (1), where an offence under this Act has been committed by a Department of Government and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of, any officer, other than the Head of the Department, such officer shall

also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

CHAPTER IV
MISCELLANEOUS

18. Protection of Action Taken in Good Faith

No suit, prosecution or other legal proceeding shall lie against the Government or any officer or other employee of the Government or any authority constituted under this Act or any member, officer or other employee of such authority in respect of anything which is done or intended to be done in good faith in pursuance of this Act or the rules made or orders or directions issued thereunder.

19. Cognizance of Offences

No court shall take cognizance of any offence under this Act except on a complaint made by-

(a) the Central Government or any authority or officer authorised in this behalf by that Government,[20] or

(b) any person who has given notice of not less than sixty days, in the manner prescribed, of the alleged offence and of his intention to make a complaint, to the Central Government or the authority or officer authorised as aforesaid.

20. Information, Reports or Returns

The Central Government may, in relation to its function under this Act, from time to time, require any person, officer, State Government or other authority to furnish to it or any prescribed authority or officer any reports, returns, statistics, accounts and other information and such person, officer, State Government or other authority shall be bound to do so.

21. Members, Officers and Employees of the Authority Constituted Under Section 3 To Be Public Servants

All the members of the authority, constituted, if any, under section 3 and all officers and other employees of such authority when acting or purporting to act in pursuance of any provisions of this Act or the rules made or orders or directions issued thereunder shall be deemed to be public servants within the meaning of section 21 of the Indian Penal Code (45 of 1860).

22. Bar Of Jurisdiction

No civil court shall have jurisdiction to entertain any suit or proceeding in respect of anything done, action taken or order or direction issued by the Central Government or any other authority or officer in pursuance of any power conferred by or in relation to its or his functions under this Act.

23. Powers To Delegate

Without prejudice to the provisions of sub-section (3) of section 3, the Central Government may, by notification in the Official Gazette, delegate, subject to such conditions and limitations as may be specified in the notifications, such of its powers and functions under this Act [except the powers to constitute an authority under sub-section (3) of section 3 and to make rules under section 25] as it may deem necessary or expedient, to any officer, State Government or other authority.

24. Effect Of Other Laws

(1) Subject to the provisions of sub-section (2), the provisions of this Act and the rules or orders made therein shall have effect notwithstanding anything inconsistent therewith contained in any enactment other than this Act.

(2) Where any act or omission constitutes an offence punishable under this Act and also under any other Act then the

offender found guilty of such offence shall be liable to be punished under the other Act and not under this Act.

25. Power To Make Rules

(1) The Central Government may, by notification in the Official Gazette, make rules for carrying out the purposes of this Act.

(2) In particular, and without prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters, namely-

(a) the standards in excess of which environmental pollutants shall not be discharged or emitted under section 7;[21]

(b) the procedure in accordance with and the safeguards in compliance with which hazardous substances shall be handled or caused to be handled under section 8;[22]

(c) the authorities or agencies to which intimation of the fact of occurrence or apprehension of occurrence of the discharge of any environmental pollutant in excess of the prescribed standards shall be given and to whom all assistance shall be bound to be rendered under sub-section (1) of section 9;[23]

(d) the manner in which samples of air, water, soil or other substance for the purpose of analysis shall be taken under sub-section (1) of section 11;[24]

(e) the form in which notice of intention to have a sample analysed shall be served under clause (a) of sub section (3) of section 11;[25]

(f) the functions of the environmental laboratories,[26] the procedure for the submission to such laboratories of samples of air, water, soil and other substances for analysis or test;[27] the form of laboratory report; the fees payable for such report and other matters to enable such

laboratories to carry out their functions under sub-section (2) of section 12;

(g) the qualifications of Government Analyst appointed or recognised for the purpose of analysis of samples of air, water, soil or other substances under section 13;[28]

(h) the manner in which notice of the offence and of the intention to make a complaint to the Central Government shall be given under clause (b) of section 19;[29]

(i) the authority of officer to whom any reports, returns, statistics, accounts and other information shall be furnished under section 20;

(j) any other matter which is required to be, or may be, prescribed.

26. Rules Made Under This Act To Be Laid Before Parliament

Every rule made under this Act shall be laid, as soon as may be after it is made, before each Hose of Parliament, while it is in session, for a total period of thirty days which may be comprised in one session or in two or more successive sessions, and if, before the expiry of the session immediately following the session or the successive sessions aforesaid, both Houses agree in making any modification in the rule or both Houses agree that the rule should not be made, the rule shall thereafter have effect only in such modified form or be of no effect, as the case may be; so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule.

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[1]It came into force in the whole of India on 19th November, 1986 vide Notification No. G.S.R. 1198(E) dated 12-11-86 published in the Gazette of India No. 525 dated 12-11-86.

[2] The Central Government has delegated the powers vested m it under section 5 of the -Act to the State Governments of Andhra Pradesh, Assam, Bihar,

Gujarat, Haryana, Himachal Pradesh, Karnatalca, Kerala, Madhya Predesh, Mizoram, Orissa, Rajasthan, Sikkim and Tamil Nadu subject to the condition that the Central Government may revoke such delegation of Powers in respect of all or any one or more of the State Governments or may itself invoke the provisions of section 5 of the Act, if in the opinion of the Central Government such a course of action is necessary in public interest, (Notification No, S.O. 152 (E) dated 10-2-88 published in Gazette No. 54 of the same date). These Powers have been delegated to the following State Governments also on the same terms:

Meghalaya, Punjab and Uttar Pradesh vide Notification No. S.0.389 (E) dated 14-4-88 published in the Gazette No. 205 dated 144-88;

Maharashtra vide Notification No. S.O. 488(E) dated 17-5-88 published in the Gazette No. 255 dated 17-5-88;

Goa and Jammu & Kashmir vide Notification No. S.O. 881 (E~ dated 22-9-88; published in the Gazette No. 749 dated 2.9.88.

West Bengal Manipur vide Notificadon N. S.O. 408 (E) dated 6-6-89; published in the Gazette No. 319 dated 6-6-89;

Tripura vide Notification No. S.O. 479 (E) dated 25-7-91 published in thc Gazene No. 414 dated 25-7-91.

[3] For issuing directions see r.4 of Enviromnent (Protection) Rules, 1986.

[4] See r. 3 of Environment (Protection) Rules, 1986 and Schedules thereto.

i. Schedule I lists the standards for emission or discharge of environmental pollutants from the industries, processes or operations and their maximum allowable limits of concentration;

ii. Schedule II lists general standards for discharge of effluents and their maximum limits of concentration allowable;

iii. Schedule III lists ambient air quality standards in respect of noise and its maximum allowable limits; and

iv. Schedule IV lists standards for emission of smoke, vapour etc. from motor vehicles and maximum allowable limits of their emission.

[5] See r. 13 of Environment (Protection) Rules, 1986, and

i. Hazardous Wastes (Management and Handling) Rules, 1989;

ii. Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989; and

iii. Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Micro organisms, Genetically-engineered organisms or Cells.

[6] Rule 13 SUPRA.

[7] See r. 5 of Environment (Protection) Rules, 1986.

[8] See r. 12 of Environment (Protection) Rules and Schedule 11, and relevant

provisions of Hazardous Wastes (Management and Handling) Rules, Manufacture, Storage and Import of Hazardous Chemicals Rules and Rules for the Manufacture, Use, Import Export and Storage of hazardous Micro-organisms, Genetically Engineered Organisms or Cells.

[9] See r. 3 of Environment (Protection) Rules, 1486 and Schedule I.

[10] See r. 13 of Environment (Protection) Rules, 1986 and

i. Hazardous Wastes (Management and Handling) Rules, 1989;

ii. Manufacture, Storage and h7lporl of Hazardous Chemicals Rules, 1989; and

iii. Rules for the Manufacture, Use Import, Export and Storage of Hazardous Micro organisms, Genetically Engineered organisms or Cells.

[11] For authorities or agencies see r. 12 of Environment (Protection) Rules, 1986 and Schedule

[12] The Central Govt. has empowered 60 persons listed in the Table (p. 251) vide S.O. 83 (E) published in the Gazette of India No. 66 dated 16-2-87 and S.O. 63 (E) published in the Gazette of India No. 42 dated 18-1-88.

[13] In excercise of powers conferred under sub-section (i) of section 11 the Central Government has empowered 60 officers listed in the Table (p. 254) vide S.O. 84. (E) published in the Gazette No. 66 dated 16-2-87 and S.O. 62(E) published in the Gazette No. 42 dated 18-l-88.

[14] For procedure for taking samples see r. 6 of Environment (Protection) Rules, 1986, also.

[15] The Central Government has delegated its powers under clause (b) of sub-section (i) of section 12 and section 13 of the Act to the Central Pollution Control Board vide Notification No. S.O. 145 (E) dated 21-2-91 published in the Gazette No. 128 dated 27-2-91.

[16] The list of laboratories/institutes recognised as environmental laboratories: and the persons recognised as Govt. Analysts is given in the table (p. 223).

[17] See r. 9 of Environment (Protection) Rules, 1986.

[18] See r. 8 of Environment (Protection) Rules, 1986.

[19] For qualifications of Govt. Analyst see r. 10 of Environment (Protection) Rules, 1986.

[20] In exercise of powers conferred under clause (a)of section 19, the Central-Government has authorised the officers and authorities listed in the Table (p. 238) vide S.O. 394 (E) published in the Gazette No. 185 dated 164-87, S.O. 237(E) published in the Gazette No. 171 dated 29-3-89 and S.O. 656(E) dated 21-8-89 published in the Gazette No. 519 dated 21-8-89.

[21] See footnote 2 on Page 213.

[22] See footnote 3 on Page 213.

[23] See footnote I on Page 214.

[24] See r.6 of Environment (Protection) Rules, 1986.

[25] See r. 7 of Environment (Protection) Rules, 1986.

[26] See r. 9 of Environment (Protection) Rules, 1986.

[27] For the procedure for submission of samples to laboratories and the form of laboratory report see r. 8 of Environment (Protection) Rules, 1986.

[28] See r. 10 of Environment (Protection) Rules, 1986.

[29] See r. 11 of Environment (protection) Rules, 1986.

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