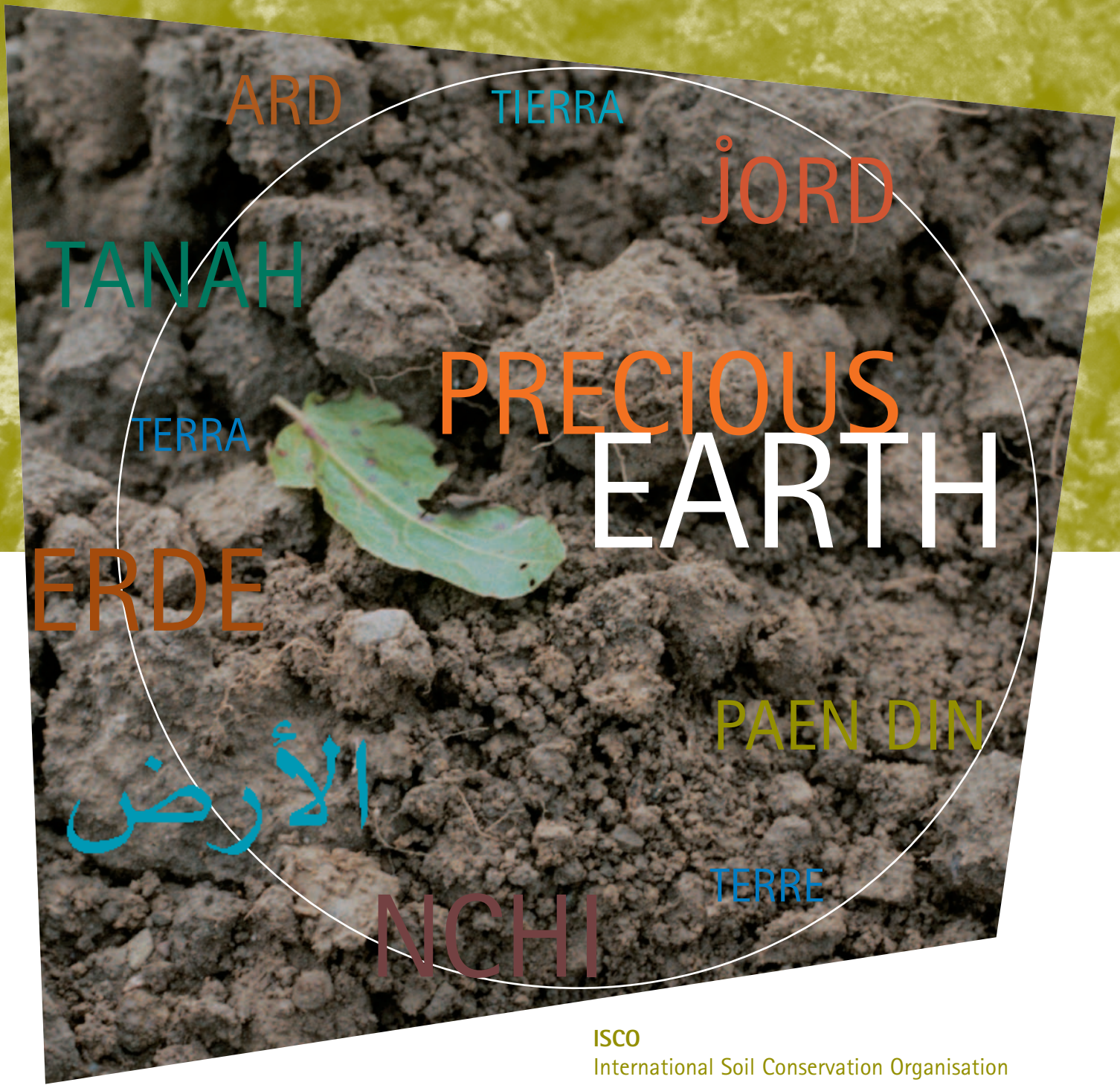

ISCO
International Soil Conservation Organisation

PRECIOUS EARTH

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FROM SOIL AND WATER CONSERVATION TO SUSTAINABLE LAND MANAGEMENT

Published by **ISCO**
International Soil Conservation Organisation

PRECIOUS EARTH:
From Soil and Water Conservation
to Sustainable Land Management was prepared by an international group of contributors working in the field of soil and water conservation, who are listed in the annex. It was designed primarily as a pre-conference issue paper in preparation for workshop discussions during the 9th International Conference of the International Soil Conservation Organisation (ISCO), from 26-30 August 1996, in Bonn, Germany.

The conference was organised under the auspices of ISCO by:
- The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
- The German Federal Ministry for Economic Cooperation and Development
- The German «Gesellschaft für technische Zusammenarbeit GmbH» (GTZ)
- The German Society of Soil Science (DBG)

in collaboration with
- The World Association of Soil and Water Conservation (WASWC)
- The International Society of Soil Science (ISSS)
- The European Society for Soil Conservation (ESSC)

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CONTENTS

This report was prepared by a group of contributors co-ordinated by Hans Hurni, president of the World Association of Soil and Water Conservation (WASWC). Principal contributors were Helmut Eger (Germany), Samir A. El-Swaify (USA), Eckehard Fleischhauer (Germany), Willie Östberg (Sweden), Eric Roose (France), T. Francis Shaxson (England), Samran Sombatpanit (Thailand), Hans W. Scharpenseel (Germany), Michael Stocking (U.K.), Anneke Trux (France), and Helen Zweifel (Switzerland). Their addresses are given in the annex. The group met in a special workshop held from 11-14 December 1995 in the wintry hamlet of Appenberg, Switzerland, in order to formulate the first draft of the paper. They were supported by staff members Eva Ludi and Lukas Frey of the Centre for Development and Environment (CDE), University of Berne. During the process of developing the final draft, all contributors actively provided additional support whenever requested. The project was carried out under the general direction of Eckehard Fleischhauer of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, and Helmut Eger of GTZ, the German Gesellschaft für technische Zusammenarbeit. Both provided inspiration and concrete suggestions, and also participated actively in the workshop. Further support came from the commissioning agency, the Federal Environmental Agency, Berlin, through A. Troge, A. Klein, and R. Drews.

A first draft of the paper was mailed to a number of additional contributors in order to obtain feedback from all continents, including S. K. Choi (FAO/Myanmar), Eric Craswell (Australia and Thailand), Alemneh Dejene (USA), Malcolm Douglas (U.K.), Rodney Gallacher (FAO/Rome), Jean-Claude Griesbach (FAO/Rome), Rolf Kappel (Switzerland), Hanspeter Liniger (Switzerland), Eva Ludi (Switzerland), Estefan Rist (Bolivia), Arie Shahar (Israel), Denis Sims (FAO/Rome), Donald Thomas (Kenya), and Jeff Tschirley (FAO/Rome). Their addresses are also given in the annex. These feedback contributors all made key suggestions for improving the text.

CDE staff members in Berne made particular in-house contributions during the formulation period. Markus Giger, Andreas Kläy, Karl Herweg, Hanspeter Liniger and Helen Zweifel helped to develop the conceptual grid in September 1995. Lukas Frey and Eva Ludi made invaluable contributions in the search for literature, compiled over 200 books and papers for reference, critically proof-read the manuscript, and provided administrative support throughout the project. CDE's editor, Ted Wachs, did the final English language editing in June 1996.

Graphic design and layout was done by Agnès Laube, Zürich, in June 1996. She also designed the cover, produced the illustrations, and supervised the printing. The book was printed in Germany by Clausen & Bosse, on chlorine-free paper, in July 1996.

ACKNOWLEDGEMENTS

AGRUCO	Agroecologia Universidad Cochabamba
ARO	Advanced Research Organisation
ASEAN	Association of South-East Asian Nations
ASOCON	Asia Soil Conservation Network
BMU	German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety
CARICOM	Caribbean Economic Community
CCD	Convention to Combat Desertification
CDCS	Centre for Development Cooperation Services
CDE	Centre for Development and Environment
CGIAR	Consultative Group for International Agricultural Research
CILSS	Comité Inter-Etats de Lutte contre la Sécheresse au Sahel
CIS	Commonwealth of Independent States
CSD	Commission on Sustainable Development
DITSL	Deutsches Institut für Tropische und Subtropische Landwirtschaft
ECOWAS	Economic Community of West African States
EEA	European Economic Area
ESSC	European Society of Soil Conservation
EU	European Union
FAO	Food and Agriculture Organisation
FFW	Food For Work
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information System
GLASOD	Global Assessment of Human-induced Soil Degradation
GNP	Gross National Product
GRID	Global Resource Information Database
GTOS	Global Terrestrial Observation System
GTZ	Gesellschaft für technische Zusammenarbeit
IBSRAM	International Board for Soil Research and Management
ICRAF	International Centre for Research in Agroforestry
IDRC	International Development Research Centre
IGBP	International Geosphere-Biosphere Programme
IIED	International Institute for Environment and Development
ILEIA	Information Centre for Low-External-Input and Sustainable Agriculture
ISCO	International Soil Conservation Organisation
ISRIC	International Soil Reference and Information Centre
ISSS	International Soil Science Society
IUCN	World Conservation Union
MERCOSUR	Southern Common Market
MODSS	Multi-Objective Decision Support Systems
NAFTA	North American Free Trade Agreement
NCS	National Conservation Strategy
NEAP	National Environmental Action Plan
NGO	Non-Governmental Organisation
NSDS	National Sustainable Development Strategy
NZZ	Neue Zürcher Zeitung
OAU	Organisation of African Unity
OECD	Organisation for Economic Cooperation and Development
ORSTOM	Institut Français de Recherche Scientifique pour le Développement en Coopération
OSS	Observatoire du Sahara et du Sahel
PLA	Participatory Learning and Action
PTD	Participatory Technology Development
RSCU	Regional Soil Conservation Unit
SAP	Structural Adjustment Programme
SADCC	Southern African Development Coordination Conference
SCRP	Soil Conservation Research Programme
SDC	Swiss Agency for Development and Cooperation
SIDA	Swedish International Development Authority
SLU	Sustainable Land Use
SOTER	Soils and Terrain Digital Database
SSSA	Soil Science Society of America
SUAS	Swedish University of Agricultural Sciences
SWC	Soil and Water Conservation
SWCS	Soil and Water Conservation Society
SWNM	Soil-Water-Nutrient-Management
UEA	University of East Anglia
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organisation
USDA	United States Department of Agriculture
WASWC	World Association of Soil and Water Conservation
WB	World Bank
WFP	World Food Programme
WOCAT	World Overview of Conservation Approaches and Technologies
WRI	World Resources Institute
WTO	World Trade Organisation
WWF	World Wide Fund for Nature
WWW	World Wide Web

ABBREVIATIONS

The scientific and administrative community working in soil and water conservation has been shaken over the past decades by the fact that only some successes have occurred among many memorable failures in sustainable use of the land and the soils. Since its inception, the International Soil Conservation Organisation (ISCO) has been very concerned that too little was being done to improve the situation in ways that would respond to land users' problems and opportunities. At the same time, it was realised that combating soil erosion is not a very appealing activity for land users because it is not their first priority, and rarely brings short-term economic benefits at the farm level. Moreover, subsidy systems often used as «incentives» did not yield the expected long-lasting results, but contributed rather significantly to the list of failures. In addition, other forms of soil degradation, besides soil erosion by water and wind, emerged in many parts of the world, notably in rapidly changing economies where industries and infrastructure spread over agricultural lands without proper guidance and control.

In view of these developments, the Organising Committee (OC) of the 9th ISCO conference in Bonn, Germany, from 26-30 August 1996, decided to commission a pre-conference issue paper by a group of knowledgeable people working on sustainable soil management, in order to present new perspectives on soil and water conservation, land management technologies, and multi-stakeholder approaches to decision-making. The OC considered it important that conference participants, and the concerned community at large, be inspired by new thinking and conceptual development.

It is clear that this publication, prepared by about two dozen key specialists from around the globe, is but a first step in the search for useful technologies and approaches to sustainable land management.

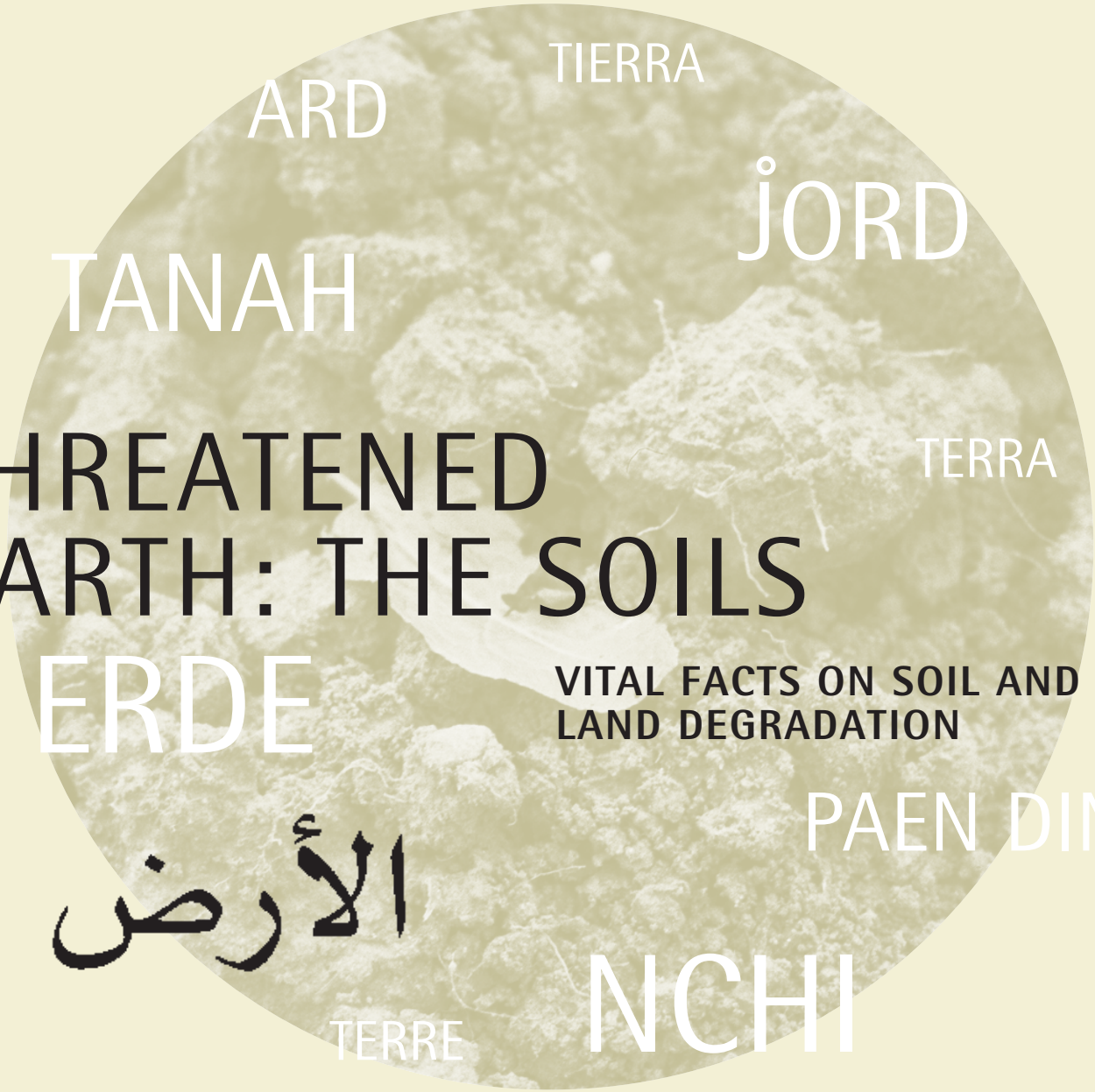
Because approximately 85% of the world's people live in countries where agriculture is the predominant occupational sector, **PRECIOUS EARTH** gives special attention to their situation. However, problems and possible solutions in all societies are addressed.

Hopefully, this book will stimulate public concern and raise the level of political discussion about better care of the soils and the land. All societies, highly developed as well as less developed, face the problem of degrading soils. But the former have a particular responsibility to foster global solidarity and set a positive example at home. Highly developed societies are in the best position to help promote and shape sustainable institutions at all levels, and to contribute to good governance and sustainable land management through policy development as well as through concerted international co-operation and financing. In this light, the following theme was chosen for the 9th ISCO Conference: **Towards sustainable land use: furthering co-operation between people and institutions.**

Bonn, 15 June 1996

FOR THE ISCO ORGANISING COMMITTEE:
Eckehard Fleischhauer and Helmut Eger

FOREWORD



1 THREATENED EARTH: THE SOILS

VITAL FACTS ON SOIL AND LAND DEGRADATION

In many languages, the words for «world» and «soil» are identical or closely linked. The English EARTH, the Swahili NCHI, the Thai PAEN DIN, the German ERDE, the Arabic ARD, the Swedish JORD, the Indonesian TANAH, and the words TERRA, TERRE and TIERRA in the Romance languages all reflect this, giving evidence of an impressive respect and appreciation for soil and land resources in these cultures. Today more than ever, soil, like water and air, is of central importance to human society and to the life-support functions of ecosystems. Soils have developed concurrently with plants and animals over millennia. These components of nature have become mutually dependent as well as mutually beneficial.

When humankind first began to cultivate the soil, the natural evolution of soils was altered and good soil qualities such as adequate rooting depth, high organic content and appropriate soil structure were made available for cultivated plants. Many farming systems through the ages were either adapted to their respective ecological settings through well-matched crop rotations and fallowing cycles, or were modified into sustainable systems through terracing, which conserved water or facilitated irrigation. In other instances, however, the beginning of sedentary agriculture and other developments which disturbed natural vegetation also led to soil degradation. Soil erosion by water and wind, and other forms of soil degradation, have adversely affected soil qualities that were once beneficial for human use, and have produced significant off-site damage as well. Fortunately, with the help of additional labour inputs, many traditional farming systems were made viable, and degradation, when it did occur, was usually at an imperceptible rate.

Present-day threats to the earth at both the local and the global level are much more serious and complex. Some of the ancient forms of labour-intensive care for the soil have been replaced by mechanisation, fertilisers, chemicals, and introduced crops. Demands on natural systems are now much heavier and are only partly accommodated by technology. Due to human population pressure world-wide, reinforced by excessive consumption in richer countries, land use has been intensified, expanded into unsuitable and unprotected lands, and fallow cycles have been shortened, thus accelerating the rate of degradation. New types of soil degradation resulting from inappropriate forms of agriculture, industrial development and urbanisation have been added to and superimposed on ancient types. Many forms of small-scale damage to soils, once perceived as local, have now accumulated to constitute a global threat to the survival of humankind.

On the other hand, agricultural research and modern inputs have helped to ensure a global increase in crop yields of about 3% annually over the last 40 years – a rate which has so far kept pace with population growth. However, this «success story» may be nearing its limits today. Although the rate of population growth is declining, production increases can no longer keep pace. Hence natural resource management has become a crucial issue, because sustainable management of water and soil, combined with sustainable agricultural development, is the only hope for providing food, feed, fuel and fibre for the present generation, while guaranteeing that future generations have equal access to the same resources in order to ensure their own survival.

1.1 SOIL EROSION – A PERSISTENT CRISIS

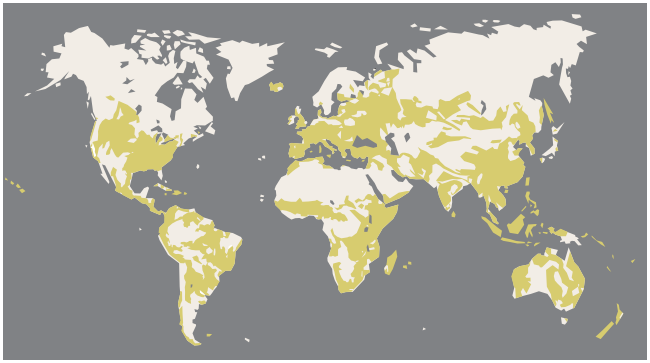
Soil, like air and water, is essential to support life on earth. Over 90% of all human food and livestock feed is produced on the land, on soils which vary in quality and extent. Of the earth's 13,000 million hectares of ice-free land surface, only 3% is covered with highly productive soils, 6% with moderately productive, and 13% with slightly productive soils.[1] The remaining 78% of the land has limitations which normally prevent its soils from being used for cultivation; even grazing is limited. It is here, however, that most land and soil degradation occurs.

A distinction should be made between land degradation and soil degradation, as these terms are often incorrectly used interchangeably. Land degradation includes the degradation of soil, fauna and flora, water, (micro-)climate, and losses due to urban/industrial development, and is likely to have impacts in entire ecoregions, such as the areas of the world affected by desertification (see 1.3). This is a much broader concept than soil degradation, which includes erosion by water and wind, as well as chemical (i.e. accumulation of persistent substances such as heavy metals), physical (i.e. trampling and mechanical compaction) and biological degradation (i.e. organic matter decline).

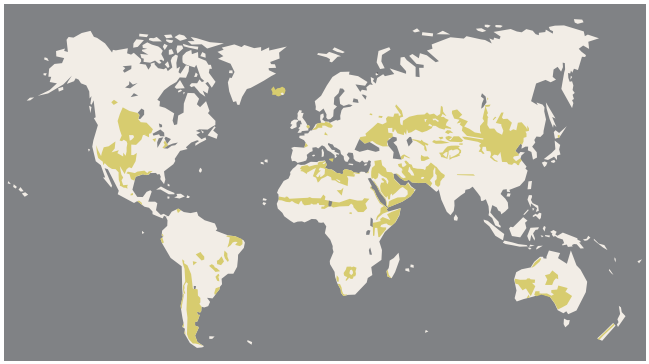
Processes of soil degradation have affected about one-third of the world's agricultural soils, particularly soils less suitable for cultivation which are nevertheless used for agriculture as well as for grazing and other purposes. The first global overview of the current status of soil degradation in all its forms, known as GLASOD, was produced in the late 1980s, and incorporated the opinions of many experts.[2] This study showed that the dominant processes are erosion by water and wind, which together account for more than 83% of the damaged areas, thereby justifying the special focus on erosion in this section. Two highly simplified excerpts from the published GLASOD maps are reproduced here (see figures). They demonstrate that land use systems are affected in all ecoregions and in most countries, although the impacts differ depending on the type, the severity and the areal coverage. This appears to be a threatening scenario in view of population increase and economic growth. Soil erosion has consequently been called a quiet crisis in the world economy,[3] which demands action at all levels.

Water erosion in mountainous areas of the world is of particular relevance. Due to adverse climatic conditions and steep slopes, rates of soil loss on agricultural land can be of an order of magnitude greater than soil loss rates on gentler slopes and

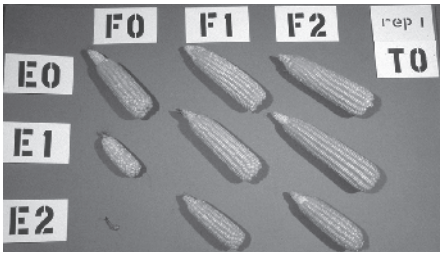
Short-term economic losses in soil productivity due to soil erosion are usually masked by additional inputs of fertiliser.



Occurrence of human-induced water erosion damage. Source: GLASOD, 1990



Occurrence of human-induced wind erosion damage. Source: GLASOD, 1990



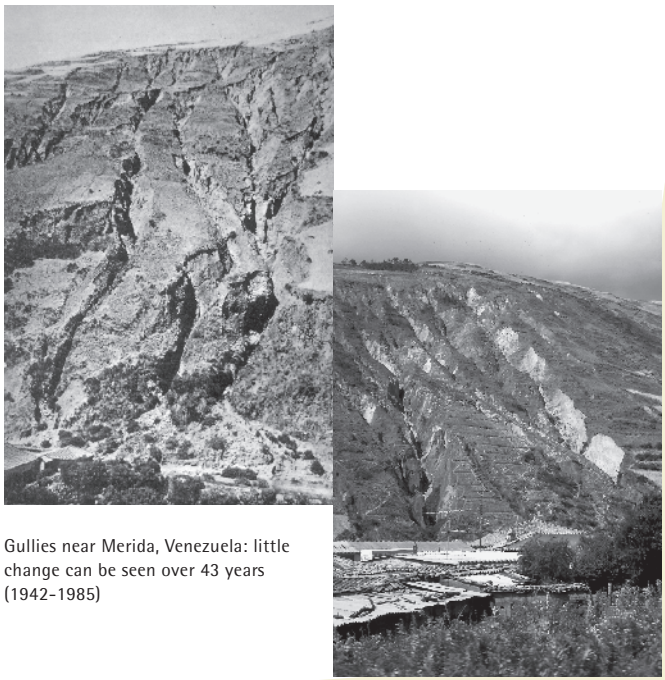
Effects of erosion on yields of corn grown on a highly weathered tropical soil at different erosion (E0, E1, E2) and restoration fertilisation levels (F0, F1, F2)[7]

LAND DEGRADATION is the reduction in the capability of the land to produce benefits from a particular land use under a specific form of land management.[8]

SOIL DEGRADATION is a process which lowers the current and/or the potential capability of the soil to produce goods or services. Six specific processes contribute to soil degradation: water erosion, wind erosion, waterlogging and excess salts, chemical degradation, physical degradation, and biological degradation.[9]

SOIL PRODUCTIVITY is an intrinsic value of the soil, expressed by such factors as soil quality and health, or physical, chemical and biological properties as a potential for biomass production. Long-term soil productivity is an indicator of soil sustainability.

PRODUCTION is a measure of the economic yield of a soil under given input systems. Production can be maintained by technological inputs – at least to a certain degree – even while the soil degrades, but at an economic cost, and with much uncertainty and future risk.



Gullies near Merida, Venezuela: little change can be seen over 43 years (1942-1985)

in areas outside the mountains. Geological erosion adds to these processes. Local technologies for preventing erosion exist, but are often inadequate, particularly in situations where social, environmental and agricultural changes have taken place. In view of the fact that 10% of the earth's population lives in mountainous areas, while an additional 40% lives in nearby areas and uses mountain resources such as water, an entire chapter of UNCED's Agenda 21 was dedicated to sustainable mountain development.

Soil erosion is as old as human history. In the 1930s, distinctions were made between natural, or «geological» erosion, and «human-induced», «anthropogenic», or «accelerated» erosion.[4] Geological erosion has been credited with benefiting «food cradles» in flood plains enriched by sediments received from eroding uplands, e.g. the Nile and Mekong valleys. But the real question is: To what extent can soil erosion be tolerated before it poses a threat to life on earth? Even when soil erosion is beneficial – for example, to farmers in lowland plains – it may be at someone else's expense.

Science faces the challenge of assessing the impact of soil erosion by water and wind. How much is agricultural production affected by soil erosion? Or more importantly, to what extent is soil productivity affected?[5] Economic estimates focusing on production may be misleading because they underestimate the problem, its long-term irreversible consequences on soil productivity, and the urgent need for action. Despite these uncertainties, there are clear indications of the impact of various degrees of soil erosion on crops, depending on the level of soil fertility and the efficiency of fertiliser use (see illustration). Soil erosion usually appears to have a negative impact on the functions of soils in the ecosystem, the environment in general, and the economy of the affected human populations.

Uncertainty about impacts may arise because some authors quote annual reductions in yields due to soil loss, while others calculate the total productivity loss since the inception of agriculture on a particular site. Economists sometimes refer to the gross annual immediate loss, the gross discounted future loss, or the gross discounted cumulative loss to a country.[6] Predictive models and tools have focused on quantifying soil erosion, but the resulting long-term consequences of erosion on soil productivity are often not (yet) used in economic calculations.

1.2 DESERTIFICATION – A PARTICULAR THREAT TO DRYLANDS

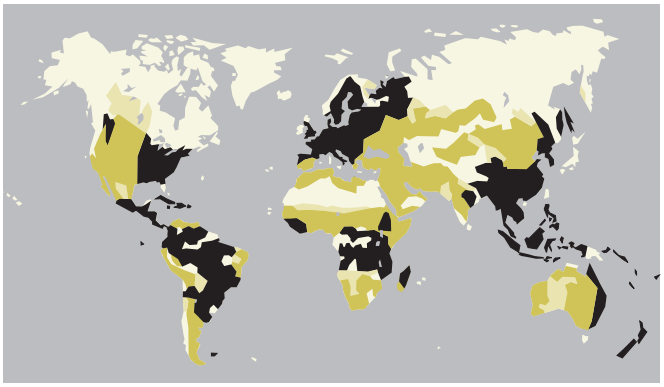
Nearly five billion hectares of the earth's surface are arid, semi-arid, or dry sub-humid areas which are fragile lands by nature. These areas support nearly one quarter of the world's population.[10] A fraction of this population, about 250 million people who are engaged primarily in subsistence nomadic and/or agricultural activities, is directly affected by low food security in such environments.

Reports of desert expansion and encroachment onto the fringes of productive regions on several continents, particularly Africa, aroused concern in the late 1960s and early 1970s.[11] After the UN conference of 1977 in Nairobi, the term «desertification» came to be widely used to refer to the catastrophic droughts which had plagued the Sahel region of Africa in the previous decade. In the years after the UN Conference on Environment and Development (UNCED) in 1992, desertification was defined by general agreement as «degradation of land resources in arid, semi-arid and dry sub-humid areas, caused by different factors including climatic variations and human activities». It was at this time that organisations and states in the Sahel region activated a global strategy to develop a Convention to Combat Desertification (CCD).

Three factors are usually cited as causes of desertification: overgrazing, inappropriate agricultural practices, and overuse of woody biomass. Desertification has often been associated with wind erosion in some areas and with accumulation in others. The off-site effects of wind erosion are mobile sand dunes and dust storms that damage cropland, grazing lands, water resources, settlements and infrastructure. Wind erosion, however, is only part of the desertification process in arid to sub-humid areas. The removal of soil particles means a loss of soil nutrients, and at high wind velocities damage to plants results from sand shearing. On rangelands, the loss of permanent vegetation cover is a serious problem. Due to the human-induced impacts of animal grazing, in combination with cycles of drought, and reinforced in some places by a long-term decline in rainfall, the permanent grass cover and the quality of the grasses has been reduced. This results in compaction of the topsoils, decreased water infiltration into the soil, increased surface runoff, and direct evaporation of water from the soil surface. Consequently, there is a decline in the growth of vegetation and soil erosion increases. Both these developments continue to reduce the productivity of the land, thereby

Soil degradation in «desertification areas» accounts for little more than 50% of all land affected, the rest being soil degradation in humid areas.

Soil degradation inside and outside desertification areas.[17] Source: UNEP[18]



- Desertification area: slight to severe soil degradation
- Desertification area: little or no soil degradation
- Soil degradation in subhumid to humid areas

Gully formation in Burkina Faso is a consequence of reduced vegetative cover and increased peak runoff

Sheet flooding is one likely result of advanced desertification, as seen here in Kenya

further increasing grazing pressure, with possible impacts on the surrounding land.

In dryland cropping areas, on the other hand, the main processes that trigger desertification are inappropriate management of water resources and loss of soil fertility. With regard to water management, problems are caused by too much surface runoff leading to erosion in some areas, and inappropriate drainage on irrigated land causing salinisation in other areas.[12] The annual loss of productive irrigated land due to excess salinisation has been estimated at 1 to 1.5 million hectares.[13] Many semi-arid to sub-humid croplands have rather low fertility levels or have been mined without replacing the removed nutrients. The result is a vicious circle of poor crop development, reduced soil cover, increased surface runoff, soil erosion, and poor yields. The most tragic process in areas affected by desertification is that water (and soil) is being lost in places where there is already a severe water shortage.

Identifying human-induced desertification is still a problem due to natural short-term droughts (below average rainfall) and long-term declines in rainfall due to climate change. Estimations of irreversible damage to land resources resulting from desertification processes are difficult to make, and separating human-induced and natural causes has been almost impossible. Earlier estimations reported that around 3,100 million hectares of rangelands were at least moderately desertified, and 1,300 million hectares severely desertified. Corresponding figures for rainfed cropland are 335 and 170 million hectares, and 40 and 13 million hectares for irrigated land.[14]

Very often, soil and land degradation has been exclusively associated with dryland areas.[15] It would be captious to conclude that desertification is synonymous with degradation, be it soil or land degradation, since many areas in humid ecozones would be neglected by this assumption. Soil and water conservationists are concerned that the areas of the world affected by desertification, as commonly defined, «only» account for little more than 50% of all land affected by soil degradation.[16] Although it is important to acknowledge that the Convention to Combat Desertification is a significant step towards reducing soil and land degradation in dry zones of the world, it should not be forgotten that little has been done to formulate a global convention on soils as part of the UNCED follow-up process.

1.3 OTHER FORMS OF SOIL DEGRADATION – THE PEDOLOGICAL DIMENSION

Industrialisation, urbanisation and intensive agriculture over the past 100 years have played an enormous role in meeting growing human needs. Intensive, high-external-input agriculture has initiated, and sometimes accelerated, other forms of soil degradation apart from the dominant processes of soil erosion due to water and wind. These can be classified as chemical, physical, and biological soil degradation.

Global chemical degradation mechanisms account for 12.2% of total global degradation according to GLASOD (see note 2). Nutrient losses and salinisation, including alkalinisation due to sodic and high pH conditions, play a major role. The former are prevalent in humid climates which promote leaching and acidification. The latter prevails in arid climates where irrigation is required for cropping. Acidification occurs mostly on soils with low buffering capacity, e.g. tropical soils enriched by low activity clays. It results from excessive leaching of the soil's basic cations, and may be promoted by a natural abundance of organic acids released as by-products of organic decomposition. Other causes are the use of specific sources of N fertilisers such as ammonium sulphates, application of overloads of stable organic waste, other fertilisers, and/or acid deposition from atmospheric sources.

Excessive accumulation of organic or inorganic chemicals in soils is a further mechanism of chemical degradation. These accumulations, some of which occur naturally, lead to salinity, sodicity, alkalinity, pollution by persistent toxic agrochemicals or specific ionic species, radioactivity, and acidity, including the formation of acid-sulphate soils and so-called cat-clays. Nutrient deficiencies may be due to natural losses, e.g. organic matter oxidation, chemical weathering and excessive leaching, or be accelerated by «soil exploitation or mining» or by non-protective land management leading to accelerated runoff and erosion.

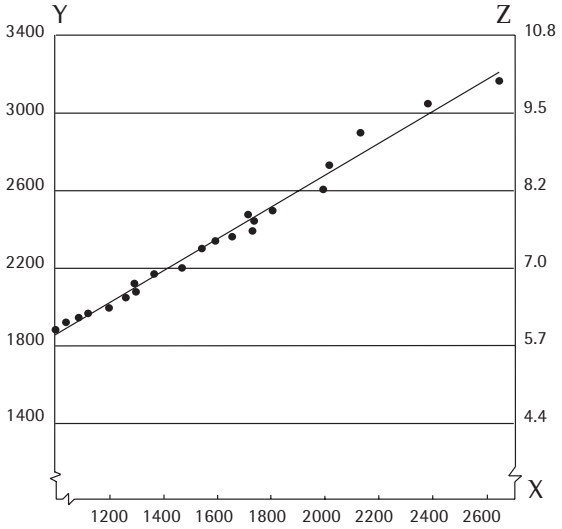
Industrial and urban sewage, air pollution caused by traffic and production processes, and by-products generated by the burning of fossil fuels contribute to soil contamination by persistent organic and inorganic substances (e.g. dioxins, heavy metals). This contamination, and that arising from radioactive disposal or fallout, are the most difficult to remedy. Formation of acid-sulphate soils can result from draining and a subsequent prevalence of oxidised conditions in the soils of coastal areas. Sulphides are transformed into oxidised forms, i.e. sulphates and jarosites, a condition that leads to the formation of free sulphuric

There is a wealth of knowledge about soil salinity, sodicity, acidity, and nutrient deficiency, but it has been difficult to take timely remedial action.

The amount of liquid manure applied often exceeds the absorptive capacity of soils in highly intensive systems.

The impact of agrochemicals on soil life and quality can be considerable.

Correlation between economic growth and consumption of land in West Germany from 1960-1989.
Source: E. Fleischhauer, based on data from German Federal Statistical Office.



X = GDP (billions of DM, 1985 prices)
Y = Built-up areas in 1000 ha
Z = Percentage of total land area

acid if insufficient calcium is present in the soil. This can produce severely acidic conditions with soil pH values of 3 or even lower. Draining land and lowering the water-table, which causes subsequent accelerated oxidation and loss of organic matter, may also result in land subsidence in organic-rich soils such as former peat. It is fair to state that our technical ability to assess and interpret chemical degradation and to restore most soil chemical qualities is more advanced than our ability to assess and rectify other forms of soil degradation.

Physical degradation, including soil erosion, leads to loss of soil depth and water retention capacity, structural breakdown, loss of macro-porosity, surface sealing and crusting, hard-setting, compaction, water-logging, and poor aeration.

Biological components that contribute to soil quality are threatened by degradation processes which affect enzymes, bacteria, fungi, algae, worms, insects, and vertebrates, thereby reducing their interaction with plants and the soil, and overall biological activity in the soil.

Industrialisation, urbanisation, transport infrastructure, and mining, which consume vast areas of land and generally highly valuable soils, are important causes of land degradation in highly developed countries. Areas with sealed surfaces cannot be expanded infinitely since they exert a negative influence on the balance of flows in the ecosystem. Economic and social progress should not always lead to growth in energy consumption, increased pollution, and expansion of built-up areas (see graph). People who live in cities must be aware that they are living on credit from an ecological point of view. Urban and rural development must therefore be considered simultaneously. Costs accrued due to losses of ecological functions have to be included in planning and calculations of social prosperity.

Industrialisation and the mechanisation of agriculture may induce or reinforce different forms of soil degradation. Timely assessment of and remedial action against these emerging and rapidly spreading impacts has been difficult, especially in highly developed and newly industrialised countries. The close relationship between soil quality and environmental quality, and particularly water quality, is a strong argument for a holistic approach to combating overall ecosystem degradation. Multiple objective decision making tools[19] allow holistic planning as a first step toward overall environmental improvement.

1.4 SOIL DEGRADATION AND SOCIETY

Degradation in one form or another has been indiscriminately experienced in every region of the world. The main question is whether distinctions can be made between countries to explain the phenomenon. Certain types of degradation and certain trends are caused, intensified or deterred by socio-economic and natural factors.[20] There may be a temptation, however, to oversimplify existing differences between «categories» of nations on the basis of cultural and economic systems.

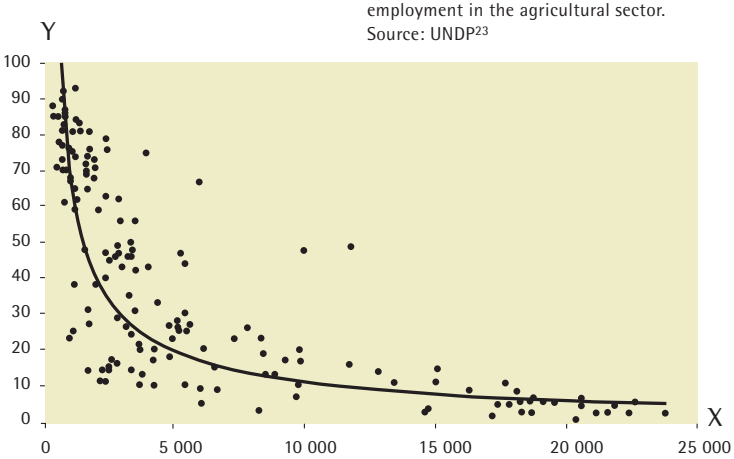
While soil degradation occurs in every country, distinctions must be made when assessing the national ability to cope, which is determined by economic status, public awareness, educational levels, and other factors. A global breakdown of countries according to the percentage of people employed in the primary sector is quite revealing in this regard (see figure and map).[21]

Countries where less than 10% of the people are employed in the agricultural sector can be classified as «highly developed». About 14% of the world's population lives in such countries, transmits land degradation problems to other parts of the world, and is responsible for many external negative impacts on the environment and the global climate. Agenda 21 of UNCED has called for environmental and resource accounting in national statistics. So-called «ecological footprints» have been elaborated for some industrialised countries by relating the use of natural resources to the area needed to regenerate those resources. Switzerland, for example, would need an area 3-8 times its size to regenerate the resources it uses, mainly because demands on energy, forestry, agriculture, and infrastructure are so high.[22] Agriculture in these «highly» developed countries is industrialised, farmers are subsidised, and agricultural land is threatened not only by many types of soil degradation, but also by loss of space due to urbanisation. More labour-intensive forms of biological agriculture are difficult to implement owing to a loss in the labour force, which partly reflects a declining interest in agriculture. Nonetheless, industrialised countries have the greatest financial, educational, scientific and service resources available to cope with degradation, provided that there is public willingness to do something about it.

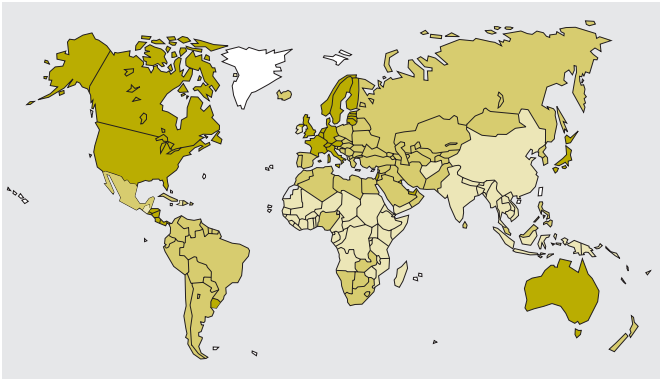
On the other hand, there is a large group of countries (57% of the world's population, see note 21) in which agriculture has remained the dominant sector of the economy, employing more than 50% of the population. These are generally classified as «developing» countries. This group of countries is characterised

While soil degradation does not discriminate between different countries, distinctions must be made between nations when assessing their capabilities to cope with degradation.

World distribution of per capita GDP and employment in the agricultural sector. Source: UNDP[23]



X = Gross domestic product in US$ per capita per year (1992)
Y = Percentage of population employed in the primary sector (agriculture, mining; 1992)



0 - 9 %
10 - 49 %
≥ 50 %
no data

World map showing percentage of population employed in the agricultural sector. Source: UNDP[24]

Simple farm mechanisation is a sign of labour substitution in countries in the intermediate group, such as Thailand

Sophisticated machinery is needed in a highly developed country where there has been a great decline in the use of manual labour in agriculture

Subsistence agriculture in a marginal mountainous zone of Ethiopia

by low per capita income, high population growth rates, accelerated soil degradation due to abbreviated fallow cycles, continuous reductions in farm size, and the need for rapid agricultural development regardless of potential long-term damage to natural resources. Here, there is a surplus of labour in the agricultural sector, mechanisation is not widespread, productivity is low, indigenous knowledge is being lost, and most farming families are subsistence-oriented and are generally forced to farm marginal lands, owing to poverty and lack of opportunity. There is usually no enabling framework of conditions for sustainable use of soils and for sustainable economic and social development, extension services and infrastructure barely exist, and the potential for improvement supported by other sectors of society is extremely low.

A third, intermediate group of countries, where between 10 and 50% of the population is employed in the primary sector, appears to have a labour force sufficient to guarantee the needed labour inputs for potentially sustainable agriculture, and sufficient economic potential to provide enabling conditions. The situation seems to be ideal. However, it is also in this group of countries that poverty-driven forms of soil degradation most heavily overlap with «new» forms of degradation accelerated by industrialisation and urbanisation. This group includes most Latin American, North African, and East Asian countries, as well as some successor states of the former Soviet Union. These countries may have the greatest overall problems despite their relative potential.

The crisis affecting the world's soils will remain hidden until it reaches its final stages. Short-term economic perspectives are responsible for masking losses in soil productivity with additional inputs of fertiliser. The problem can be postponed – until other soil functions like rooting depth or organic matter become limiting factors. Even when soil erosion is observed, the damage appears to be of little importance to immediate agricultural production, probably because the planning horizons of both commercial and subsistence farmers are too short. The result is myopic behaviour, which is based primarily on the time preferences of land users. Future costs and benefits are discounted, i.e. the later they occur, the less important they seem.

1.5 SOIL DEGRADATION AND GLOBAL ENVIRONMENTAL CHANGE

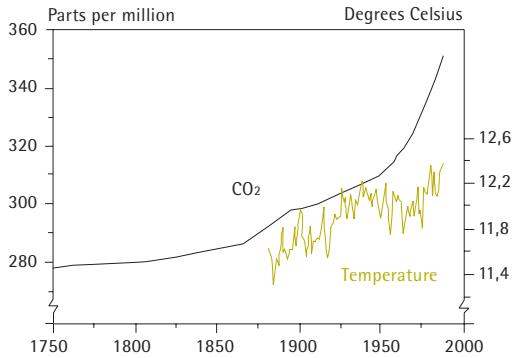
Global change, in the broad sense, encompasses not only changes in climate or atmospheric/stratospheric composition, but also other changes in global life-support systems and human societies, for example in demography and agriculture, and also in industrialisation and infrastructure. Much international debate and research funding have focused on global climate change, although other dynamic social and environmental changes may be equally important, if not more so. Degradation of land and soil is the poor cousin of global climate change, but has potentially far more harmful impacts.

It is true, however, that changes in climatic patterns – particularly rainfall, temperature, and wind – in atmospheric composition, and in other ecosystem attributes do influence soil stability, productivity, quality, and overall function in ecosystems. For example, models and data bases on global climate change confirm the observed steady increase in the levels of atmospheric CO_2 and certain other greenhouse and trace gases. In these situations soils behave both as a source of greenhouse gases and as a sink, or sequestering medium, for these gases. However, substantial uncertainties about the likelihood, extent, distribution, effect and magnitude of global climate change remain. For example, the rise in average global temperature during the past two decades has been estimated at 0.6°C. Although future trends are hotly debated, there is a general consensus in the scientific community that a global warming of about 2°C is very likely over the next 100 years.

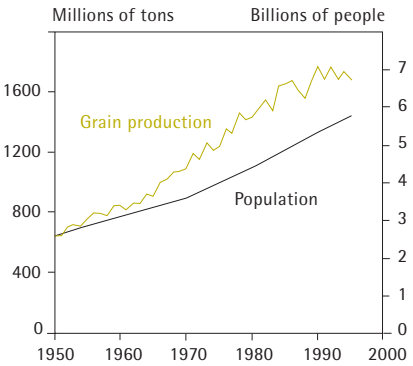
The above uncertainties, and related controversy in the scientific community, are the primary obstacles to evaluating the impacts of change in atmospheric composition and climate on land and soil quality, performance, and degradation. If and when these obstacles are removed, then existing databases, and available or evolving models for plant growth and land degradation – particularly soil erosion – will be capable of predicting such impacts with considerable reliability. For example, CO_2 enrichment – a form of «fertilisation» – will likely invigorate biomass growth and production, and may promote soil biological activity, thereby enhancing soil protection.

On the other hand, increased total or seasonal rainfall may have multiple and conflicting effects, e.g. promoting vegetation performance, increasing rainfall erosivity and erosion-sedimentation hazards, and exacerbating nutrient losses and acidification. Reduced rainfall and extension of seasonal dry spells increase

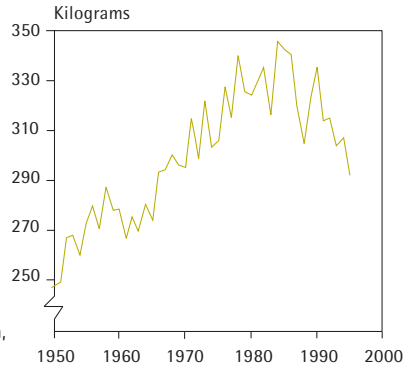
Global change in environment and climate is the result of a myriad of small changes at the local level which add up to a global threat.



Atmospheric concentration of CO_2, 1750-1988, and average global temperatures, 1880-1988. Source: Worldwatch[26]



World grain production, 1950-1995, and world population, 1950-1995. Source: Worldwatch[27]



World grain production per person, 1950-1995. Source: Worldwatch[28]

LAND DEGRADATION AND CLIMATE CHANGE

Computer models suggest that there are three ways in which deforestation and soil degradation may reduce rainfall:[29]

1 Overcultivation, overgrazing and deforestation can all strip soil of vegetation. Bare soil and rock reflect more solar radiation back into the atmosphere than do crops, grass, shrubs and trees. Increased reflectivity (albedo) keeps the atmosphere warmer, disperses clouds, and reduces rain.

2 A general lowering of soil moisture could itself suppress rainfall. Much of the rain in tropical moist forests comes from water that evaporates from vegetation, and not from outside the region. Wholesale clearing of rain forests breaks this hydrological cycle and may well produce a drier local climate.

3 Deforestation and loss of topsoil structure allows the wind to throw more dust into the air. This dust reduces the amount of sunshine reaching the earth's surface, which would have the same rain-reducing effect as bouncing more solar radiation back off the earth's surface.
Source: Various authors

the risks of declining land productivity and desertification. Reported losses in mean annual rainfall during the period 1960-90, as compared to the period 1930-60, are presumed to be one of the reasons for desertification in some zones of western Africa. But desertification may also have been intensified by land degradation caused by the spreading of deforestation and agricultural activities in the sub-humid zones north of the equator.

With reference to climate change, the soil resource base plays three different roles. First, it is a force which drives global climate change. For example, deforestation and subsequent soil degradation may reduce rainfall in three ways (see box). Second, it is influenced by the impacts and consequences of global climate change. Third, it could retard the process of global climate change. There is consensus that, theoretically, rangelands in semi-arid zones of the earth have the potential to be an economically viable sink for significant amounts of carbon, i.e. between 15-35% of the carbon remaining in the atmosphere, provided that these lands could be closed to human use and restored to their full ecological potential, and that they are not affected by increased drought.[25] There are, however, conflicting views about the feasibility of this vision.

Analysing the interactions among global forces of change and the resulting impacts, including benefits to and degradation of agroecosystems, is a monumental interdisciplinary challenge. It is believed that a number of factors will continue to have a much stronger influence as determinants of agroecosystem productivity, degradation trends, and sustainability than global climate change. Among these factors are normal climatic fluctuations and cycles at a specific site, land use systems and dynamic changes therein, human-induced environmental stress, and applied management practices at the site.

Research funding institutions and the scientific community have not given adequate attention to assessing the above-mentioned processes of global environmental change which are not directly linked to climate change. The reason may be that they are of local origin and have primarily local consequences. Yet overall changes in vegetative cover and in other living organisms, soils, and water due to land use in connection with economic development may have much more dramatic consequences than the impacts of climate change, even on a global scale.

1.6 EVOLUTION OF APPROACHES IN SOIL CONSERVATION

An evolution of philosophies has taken place in the field of soil and water conservation over the past 75 years. Historically, conservation researchers and practitioners have been among the leaders in pioneering concepts of sustainability and amassing a wealth of quantitative data on soil degradation, its causative factors, and technical solutions. In a broad sense, soil conservation has now come to mean the non-exploitive use and wise overall stewardship of natural resources. It thus lies at the heart of ecosystem sustainability.

Nevertheless, the track record of soil conservation efforts, particularly in tropical regions, has been a mixture of some successes and many memorable failures.[30] This led to considerable critical analysis and re-evaluation of conservation strategies. Reviewers of projects felt that the effective implementation of preventive or corrective conservation measures was impeded less by lack of knowledge about natural constraints than by societal factors.

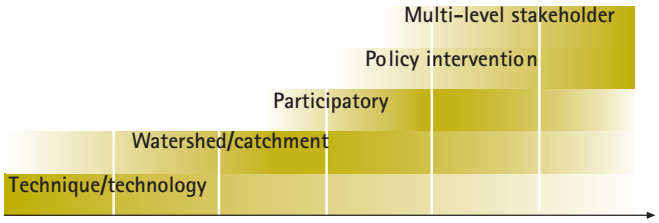
The reasons given for the lack of sustained success have repeatedly included the same arguments. An international symposium on conservation adoption concluded with a long list of cultural, social, economic, institutional and political barriers to effective implementation (see box). The concept of soil and water management, or land husbandry, emerged out of these concerns.[31] It is distinguished from «conventional» soil and water conservation by a positive outlook, emphasising improvement of soil productivity as an objective to be accomplished through land care, education, and empowerment of the risk-taking land user, i.e. the bottom-up approach. This positive outlook is somewhat similar to the more recent emphasis on soil quality.[32] Our own view, however, represents a further step forward. It is a merger between top-down and bottom-up approaches, because it involves all levels of interaction on the land. We call it the multi-level stakeholder approach. This approach will be described in more detail in Chapters 2 and 5.

The first fundamental requirement for designing soil conservation strategies is to understand the merits of existing land management practices and technologies, including «indigenous», or local technologies.[33] In combating soil erosion, these are generally called «best management practices» and are broadly classified as structural or engineering measures – involving major modification of the land surface and drainage patterns –

The track record of soil conservation efforts, particularly in tropical regions, has been a mixture of some successes and many memorable failures.

General assembly at UNCED

Farmers meeting in Tanzania



Evolution of approaches in soil and water conservation

BARRIERS TO EFFECTIVE IMPLEMENTATION OF SOIL CONSERVATION

An international symposium held in 1994 identified the following factors:

Lack of suitable, productive land for expanding populations to practice cultivation and meet essential needs

Failure of land users and community leaders to recognise, be aware of or be educated about the causes, urgency, seriousness, and full consequences of degradation

Lack of land users' will to accept «improved» farming technologies, often because they seldom recognise or incorporate valuable indigenous knowledge

Lack of secure land access and tenure systems

Lack of extension services to assist land users in selecting appropriate conservation measures. Shortage of trained personnel is a major obstacle, particularly in countries with agricultural economies

Lack of resources or surplus to acquire necessary inputs for improving land husbandry and/or labour to install conservation measures

Lack of national land use policy and institutions to oversee such policy and fulfil society's role in providing needed incentives to support land use policy and to promote conservation of natural resources

Non-involvement of grassroots levels of society (e.g. farmers) in the development of conservation policies, programmes, and projects

Lack of monitoring and early detection of accelerated degradation

Lack of systematic land resource inventory at the national level, a prerequisite for matching site characteristics with best uses, and designation of lands which most need conservation protection

Lack of policy guidelines for addressing erosion problems at a meaningful scale. Assessing such problems, and planning and implementing effective counter-measures, often requires the institution of regional and international policies and strategies.
Source: S.A. El-Swaify[38]

and biological measures, involving the use of vegetation components, products, and other organisms, such as earthworms, to achieve effective conservation.

There is another fundamental issue which must also be considered. The continuing shrinkage of global water supplies available for irrigation, a major ingredient of the Green Revolution, points up the need to balance soil conservation with water conservation.[34] Water losses in the form of runoff can be more detrimental than soil losses in rainfed agricultural systems, particularly where annual or seasonal rainfall is marginal. It is an advantage, particularly in rainfed farming, if water and soil conservation can be planned and practised in an ecosystem context,[35] e.g. watershed or hydrologic unit area.[36] This makes it possible to address issues of water quality as well as water quantity. «Participatory watershed development» is a catchword currently used to emphasise this approach.[37] However, an area that is ecologically suitable for planning may not necessarily be the best social unit for obtaining successful results. In conservation planning, considerations of communal processes and social and economic justice are just as important as good land husbandry.

Early long-term concern with environmental degradation, and increasing recognition of the importance of obtaining firm commitments from governments and relevant institutions to adopt wise environmental management policies, have led to many international declarations, agreements, and treaties. However, because considerable funding is often required for implementation, only a few notable treaties and agreements have led to substantive action. Among these was the development and adoption of a World Soils Charter and a World Soils Policy by the Food and Agriculture Organisation (FAO) of the United Nations. Both charters set forth principles for wise, productive and protective land use to assure the welfare of future generations, although they still await individual country implementation in the form of national policies. Additional concerns were articulated at the UN Conference on Environment and Development (UNCED, 1992) in its Agenda 21, particularly in the chapters on desertification, sustainable agricultural and rural development, and sustainable mountain development. However, implementation of the action plan agreed at UNCED has been very slow up to now due to lack of funding.

1.7 CONTROVERSIAL ISSUES IN SOIL DEGRADATION

Arguments about the severity of global land and soil degradation, and the crises which humans are facing as a result of the shrinking productive natural resource base, are convincing. Unfortunately, there is still a certain amount of scepticism, expressed in the view that «too much should not be made of the land resource problems».[39] Such arguments are heard mostly in connection with soil erosion impacts, and they have caused considerable damage to the cause of, and research support for, sustainable use of natural resources. Overall, our ability to meet the demand for food on most continents, or to relieve regional food shortages by trade with or donations from surplus areas, will be limited by new realities.[40] However, the negative impacts of soil degradation (including erosion) on ecosystem productivity and soil functions will continue, regardless of our ability to meet the demand for food.

Much has already been accomplished in terms of understanding, assessing, and designing planning tools and taking action against land degradation. Available information, technical manuals, supporting literature, concepts, and theoretical approaches to preventing or reversing degradation are impressive in both amount and diversity. On the technical level we already know more than we use, so there is no excuse for lack of action. Amazingly, soil and land degradation problems not only persist, but continue to escalate. The main problem is to identify appropriate technologies and approaches suitable for both the ecological and the socio-economic environment. Another problem is to find scientists and technicians willing and ready to live and work with land users for an extended period of time.

Despite these common concerns, some issues relating to the status and causes of soil degradation remain controversial. Opinions and counter-opinions relating to four of these issues are presented here.

ISSUE 1 THE SEVERITY OF SOIL DEGRADATION

OPINION: The doomsday scenario says that soil degradation is an ecological disaster which will threaten at least one-third of humankind in the next 20 years. The extent of erosion and its impacts is massive. Billions of tons of soil are lost from agricultural lands each year, and suspended sediments contaminate water courses downstream and lead to flooding. Soil is a non-renewable resource, so it may take centuries to restore soil depth which is readily lost to erosion within just a few cropping seasons. In many areas where soils are irreversibly damaged the final result is the formation of badlands.

ISSUE 2 SOIL DEGRADATION AND GLOBAL CHANGE

OPINION: Caring for soil and land is a fundamental part of caring for the earth. Not only land users, but also product consumers, nations, and the global community have a stake in combating degradation. Thus, conducive policies and economic systems should be adopted to enable land users to conserve their land. If degradation continues, local disasters will eventually add up to a global disaster because people are being deprived of the benefits of agriculture, while their numbers and consumption requirements are increasing, the climate is changing, and global sinks for CO_2 are being lost. Regeneration cannot be achieved in the short term. Sustainable use of soils is the foundation of sustainable development.

ISSUE 3 POPULATION GROWTH AND DEGRADATION

OPINION: Population growth is the primary culprit in global degradation. Since there is a growing global shortage of productive lands, exponentially expanding populations must encroach on marginal lands for their livelihood. These are the very lands where degradation hazards are high, particularly when the land user or society cannot afford soil protection measures. Food shortages and famines are a consequence of expecting too much from marginal lands.

ISSUE 4 ALTERNATIVES TO SOIL CONSERVATION

OPINION: Soil conservation is a matter of matching the right technology to the appropriate local economic, social, cultural and environmental setting. Enforcement will be unnecessary; technologies will ensure economic viability and support rural livelihoods. Access to technologies can be encouraged by extension services and by projects or programmes, possibly with some modest initial incentives.

COUNTER-OPINION: The optimistic scenario sees soil degradation as an intrinsic natural process which may have been accelerated by humans as a result of misuse. Data from erosion plots exaggerate the problem by not addressing actual global scales, ignoring baseline degradation, not quantifying actual sediment delivery, and not recognising the vast capacity of modern science and technology for restoring soil productivity and developing stress-tolerant organisms.

COUNTER-OPINION: Soil degradation has not become a major global issue because it is always a local phenomenon and can be treated at the site where it occurs. Technologies for preventing and curing soil degradation do exist, however; they are low-cost and can be applied by unskilled labour, provided that there is an economic incentive to do so. Moreover, global trading systems increasingly allow for rectifying localised food shortages.

COUNTER-OPINION: The human race in general, and the ingenuity of scientific communities in particular, have shown a remarkable ability throughout history to cope with population growth and enhance the well-being of the earth's occupants. Doomsday predictions of the impacts of land scarcity or degradation have repeatedly failed to materialise. Added population is an asset rather than an impediment in many societies. Under certain conditions of economic opportunity, increasing population density and reduced soil degradation have occurred simultaneously.[41]

COUNTER-OPINION: Soil conservation technologies will never pay, and they will never be accepted in their own right. True conservation will only be achieved by targeting land use and rural livelihoods directly. People will adopt and create their own enduring coping mechanisms that will, coincidentally, also address soil quality.

ENABLING
ECONOMIC AND POLICY
ENVIRONMENT

APPROPRIATE
TECHNOLOGIES

2
FINDING COMMON GROUND

DEVELOPING A FRAMEWORK FOR SUSTAINABLE LAND MANAGEMENT

PARTICIPATORY
DECISION-
MAKING

Soil degradation does not discriminate. In virtually all societies of the world soil degradation is a process which leads to the loss of a natural resource essential for survival. A sustainable society cannot be built on lost ground. Creating solid foundations for successful action against degradation is a key need, and it will be a major challenge in the coming decades.

Despite the evolution of philosophies that has already occurred in soil and water conservation, a substantial paradigm shift from technical «soil conservation» to a more holistic «sustainable management of soils» will still be necessary because soil conservation efforts over the past 75 years have not succeeded in adequately enhancing the sustainability of agricultural land uses. With solid theoretical and conceptual foundations, it will be possible to develop a common vision shared by land users, national societies, and the global community in a first step. Creating the necessary foundations for combating degradation will also mean identifying the real causes and consequences of soil degradation, incorporating a perspective on sustainable management of natural resources, and acknowledging elements of sustainable land use.

In a second step, principles for action can be designed to help stakeholders at different levels in making decisions. These principles will relate to technological considerations, the issue of participatory planning and realisation, and the enabling institutional settings which are indispensable for long-term success. If we are to remain alerted about the future health of the soil in all potentially dangerous situations, indicators of soil quality will have to be carefully monitored in a global web of reference points. Monitoring must be carried out by local institutions which co-operate in larger networks established in similar ecoregions.

The major challenge we face in achieving sustainable use of soils is a basic one. Degradation processes must be arrested and reversed, while individual and societal needs are fulfilled, economic viability is assured, and future generations are guaranteed that they will have soil resources which are not only adequate for fulfilling their own needs but at least as productive as the soils available to present-day societies. In addition to promoting local action, from the farm level to the community level, it will also be necessary to develop an enabling environment at the national and international levels. Controversial issues will have to be addressed in the negotiation process in an attempt to reach common agreement and understanding.

2.1 BUILDING ON HEALTHY SOIL FUNCTIONS

At the microscopic scale, the activities of soil-inhabiting organisms play a key role in soil health, particularly in transforming organic materials and mineral nutrients. This makes the soil a self-regenerating resource in which plants can continue to grow. Something similar happens at the global scale, where the earth can be conceived as a self-regulating super-organism (Gaia).[42] Soils have a multiplicity of characteristics, and they consist of sub-systems whose interconnections we, as inhabitants of the earth, must necessarily respect and maintain.

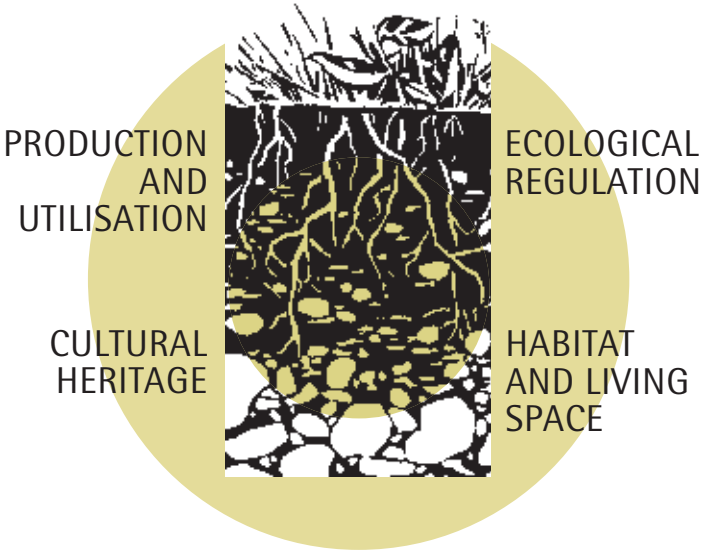
From a human perspective, soils have four broad interrelated functions. They have ecological functions, such as providing a living space for organisms and regulating flows of substance and energy. They also have a productive function geared to fulfil economic needs, whether through agriculture or other activities. And soils have a socio-cultural function within human society. Sustainable development requires that these functions be respected to the fullest extent possible.

Soil and water have ecological regulatory functions which sustain ecosystems. These functions include aspects such as humus formation in topsoils and nutrient mobilisation in subsoils; buffering of soil systems and maintenance of their resilience against sudden alterations, e.g. mediating water movements between rainfall and required regular stream flow; and retention of chemical ions in plant nutrients and/or chemical pollutants prior to slow release or removal. A related function is the provision of habitats for living organisms, either in the soil or on the soil, as a component of landscapes.

The productive functions of the soil are the basis of agricultural and economic production in their widest sense. Agricultural production is of primary importance, as soils provide the rooting conditions necessary to produce the biomass that supplies food, fibre, fuel, and feed. Human activities, such as forestry, mining, infrastructure development, and even tourism also have an important relation to the soil as a living space. Animals need soil and land as habitat areas.

Soil can also be said to have a socio-cultural function. Many human beings have a strong sense of belonging to a particular place, whether as sedentary agriculturalists, nomadic pastoralists, or city dwellers. Within certain landscapes, communities set aside «cultural space» to be used as graveyards, places of worship and celebration, and holy mountains. Even at the global level, natural and cultural «world heritage» sites and

The productive functions of the soil are the basis of agricultural production in its widest sense.



Soil functions[46]

EVERY SOCIETY HAS ITS OWN VIEW OF RESOURCES

In any given context, at least two different perspectives on natural resources are normally encountered. One is the perspective of local land users – a view which is based on the ways in which nature and soil have traditionally been perceived, and which varies from place to place and region to region. This view has been called the internal perspective on natural resources. The other perspective – which is found throughout the world and is represented by researchers and scientists, environment and development experts, politicians and administrators – usually reflects an economic world-view and is characterised by its scientific approach. It has been called the external perspective on natural resources.[47]

SOIL AND WATER CONSERVATION (SWC)

Soil and water conservation is a combination of appropriate technology and successful approach. Technologies promote the sustainable use of agricultural soils by minimising soil erosion, maintaining and/or enhancing soil properties, managing water, and controlling temperature. Approaches explain the ways and means which are used to realise SWC in a given ecological and socio-economic environment.

LAND HUSBANDRY

This refers to care, management and improvement of our land resources as a positive approach, where control of erosion follows as a result of good management.[48]

SUSTAINABLE LAND MANAGEMENT

This is a system of technologies and/or planning that aims to integrate ecological with socio-economic and political principles in the management of land for agricultural and other purposes to achieve intra- and intergenerational equity.[49]

SUSTAINABLE DEVELOPMENT

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.[50]

land-scapes have been designated worthy of appreciation and preservation.[43]

In most cases, local land users are the ultimate decision-makers when it comes to using land in rural areas. Exchanges between land users and other decision-makers in a particular society are an important prerequisite for action. Participatory strategies for promoting sustainable land use and rural development proceed on the assumption that men, women, and children have ideas, aims, technical insights, and organisational capabilities that are needed for development.[44] People have always had to develop and adjust their land use practices in order to cope with a changing environment. If they perceive that particular recommendations for improving the condition of their land actually provide universal benefits, in accordance with their own goals and aspirations, they are likely to adopt and follow such recommendations.

The careful management of land – good land husbandry[45] – implies that natural resources are managed according to principles of sustainable land use. Defining sustainable land use in a given situation must be a societal undertaking, in which the principles of sustainability and natural processes are evaluated using participatory, democratic procedures. Unless regenerative and resource-conserving technologies and practices bring both environmental and economic benefits to land users, to communities and to nations, they will not be socially and economically acceptable. There is evidence that sustainable intensification of agriculture – emphasising the use and recycling of internal or available resources, the involvement of people concerned, and the use of local knowledge and practices – can be accompanied by indirect social and economic benefits. These benefits include less pressure to expand into non-agricultural areas, reduced contamination and pollution, greater self-reliance among rural people, and less likelihood that local cultures will break down.

2.2 SHAPING CONVERGING PRINCIPLES

In a multi-level stakeholder approach, three principles must converge: good land husbandry, sustainable land use, and an enabling institutional environment.

The sustainability of biologically-based forms of land use fundamentally depends on the degree to which such forms of land use preserve the health and vitality of water and soil as the basic resources necessary for rainfed plant production.[51] Any principle of individual or social action will therefore have to be guided – and eventually evaluated – on the basis of its ability to maintain or improve various soil functions,[52] as determined by the land user or the society. There are different principles of action concerned with the soil, the land use system, and the overall enabling environment. These principles may be mutually beneficial, but they may also be divergent.

Both productive plant growth and balanced hydrology depend on maintaining the ability of the soil to absorb, retain and release water. Maintenance of this capability is a basic principle of soil improvement (see box). To avoid losing porosity, which is diminished in the uppermost soil layers by the vertical component of the force of high energy (compaction), it is necessary to ensure that adequate vegetative cover is provided, and that a stable granular structure, i.e. soil architecture, is maintained. These basic principles need to be considered at the same time as or even prior to the time that attention is given to the lateral component of moving rainwater (i.e. runoff). It is necessary to balance the equation between inflow of materials to the land (e.g. soil deposition, soil formation processes, or artificial inputs) and outflow (e.g. runoff and erosion).

The more diverse and complex the variety of species within an agricultural system, the more resilient, stable and sustainable the system is likely to be in the face of the unpredictable vagaries of weather, pests, farming system conditions, and demographic and economic pressures. Soils affect the organisms that can live in and on them. Conversely, the organisms themselves affect and modify soils. Examples include the tunnelling and mixing effects of earthworms and the topsoil-formation effects of microbial processes that affect root residues. This leads to a series of principles concerning management of organic matter to improve soils. Because less and less land is available for naturally-regenerative fallow periods to restore both architectural conditions and plant nutrients, it is necessary to simulate the beneficial effects of such fallow periods, but much more quickly. The principal techniques here are ground cover and reduced tillage, manure, composts, planting crop combinations that leave bulky residues, rotations – including

PRINCIPLES OF ACTION FOR GOOD LAND HUSBANDRY

- ensure vegetative cover
- maintain favourable soil structure
- enable appropriate water flows
- optimise organic matter
- support active fallowing

PRINCIPLES OF ACTION FOR SUSTAINABLE LAND USE

- ensure good land husbandry
- increase productive quality
- ensure compatible soil functions
- control soil erosion
- adapt cropping systems
- ensure appropriate tillage management
- activate nutrient cycles

PRINCIPLES OF ACTION FOR AN ENABLING INSTITUTIONAL ENVIRONMENT

- promote viable social and economic institutions
- co-ordinate farming within same catchments
- share resource-protecting technologies and tools
- promote participatory decision-making
- foster an egalitarian society
- ensure enabling land titling and economic policies
- promote democratic decision-making in society
- apply developed principles of sustainability

continuous intercropping – N-fixation by legumes, and application of organic materials.

At the farm level, maintaining or improving soil health alone will no longer suffice (see box). As population and consumption levels continue to grow regardless of the decreasing availability of land, two interdependent productive improvements will become increasingly necessary. These are the need to intensify production, and the need to occasionally optimise soils, in conservation-effective ways, for particular plant-production uses. It is often advisable, again at the farm level, to co-ordinate action within the community or the catchment[53] in which the farm is situated, particularly when water is scarce. Co-operation with other land users in the design and application of appropriate, resource-protecting technologies is most often beneficial, both in terms of selecting the best options and in shielding the individual land user from external influences. For example, contamination by heavy metals, acid rain, or excess fertilisers harms the soil's biological components and functions. Political, institutional and social support must be forthcoming if the sources of such pollution are to be combated.

At the scale of the enabling institutional environment, there are considerable demands on social organisations such as families, clans, communities and the state with respect to healthy soils (see box). Issues of central concern are ownership versus user rights, or private versus communal ownership of land.[54] Participation is also a basic principle. In soil and water conservation programmes, there is ample scope for different types of participation, ranging from passive participation – when people are engaged to do what they are told, e.g. in constructing earth dams - to self-mobilisation, when people participate by taking initiatives independent of external organisations. Empowering politically and economically disadvantaged groups is a means of ensuring that all social groups affected by resource use can participate in public discourse. All user groups, irrespective of gender, age, class, status, ethnicity, religion, etc. should be given the means to define their own aims and participate in societal decision-making processes regarding sustainable land use.

2.3 MONITORING INDICATORS OF SOIL AND LAND QUALITY

In today's rapidly changing world it is increasingly difficult to agree on fixed reference points. A typical example relating to soil degradation is the fact that people very often confuse current conditions with the dynamics of the degradation process. Highly degraded areas, for example, are thought to have appeared in the recent past, while in reality they are almost always the result of processes that have occurred over much longer time spans. Although destruction appears to be widespread in Ethiopia's highlands, it must be kept in mind that this is the result of over one thousand years of agriculture. Again, it is rarely perceived that the overall rate of degradation in Ethiopia today is probably ten times greater than it was at the beginning of this century. How can a benchmark be established? Three categories of indicators should be distinguished: for soil quality, land quality, and sustainable development. While soil quality refers, as precisely as possible, to the most appropriate soil characteristics for specifically defined uses, and land quality refers to the most appropriate characteristics of the land unit, indicators of sustainable development have the broadest and most difficult scope in terms of describing ecological and socio-cultural needs in an economically viable system (see figure).

People very often confuse the current status of soil degradation with the dynamics of degradation processes.

Soil quality is assessed by a huge range of different indicators with widely varying scales. Generally, any indicator system should take account of a number of aspects, and careful selection is essential. Within a production system, the most useful soil quality indicators are those relating to fertility and productivity. Included here are indicators of physical condition (e.g. bulk density), moisture-holding capacity, soil aggregate stability, chemical condition (e.g. acidity), organic-matter content and quality, plant-nutrient contents, and biological condition (e.g. microbial biomass, distribution of microbial species, and biological activity). Each would be described by detailed analyses of the specific factors chosen as indicators. But is such a sophisticated monitoring system economically feasible, and would it serve its intended purpose?

Indicators of sustainable land use should cover a multitude of aspects. In addition to ecological and economic indicators, socio-cultural, institutional, and political features should also be taken into account. It will be necessary not only to look at the status of the soil resource and its human and ecological environment, but also to monitor indicators of change. For example, it is not sufficient to monitor organic matter content in a soil at

Catchment runoff and suspended sediment yield monitoring

PROXY INDICATORS OF SOIL AND LAND QUALITY

At least three important proxy indicators[57] can be of value in indicating the health of soils and of the landscapes in which they are found. One such indicator is the stability of plant production, in the form of crop and pasture yields, assessed from year to year. Visible signs of land degradation, as evidenced by such things as the symptoms of excessive erosion and runoff, and/or declining biodiversity in natural and agricultural ecosystems, are another indicator. A third indicator is the changes perceived by farm families themselves.

CHOOSING SPECIFIC INDICATORS BASED ON WHAT FARMERS SAY THEY HAVE OBSERVED

«Soils are darker in colour, spongy to the step, moist, and full of earthworms» as a result of farmers incorporating green manure and leguminous cover crops in Santa Catarina in southern Brazil (H.V. de Freitas, see note 53).

FARMERS' OBSERVATION	MEASURABLE INDICATOR
«Darker in colour»	Munsell colour chart
«Spongy to the step»	Organic matter %; bulk density; porosity
«Moist»	Pore-size distribution; water-holding capacity
«Full of earthworms»	Organic activity; species distribution

regular intervals; the inputs and outputs of farm management practice, the land use system, the crop cycle and production, and soil erosion rates must also be monitored at a particular site. Furthermore, when an intervention is planned, comparable locations with and without intervention should be selected for monitoring, so that it will be possible to analyse the impact of a particular activity on the sustainability of the soil and land use system in a long-term perspective.

Regular monitoring is most valuable when the results are used to obtain feedback which leads to adjustments in ongoing programmes[55] designed to improve the sustainability of land uses, in both rural and urban-industrial settings. Monitoring networks should be established to observe whole ecoregions, and even developments at the global scale. Undertaking monitoring in more than one place and at regular intervals makes it possible to assess trends with a comparative temporal and spatial perspective.

In assessing sustainability, it is also necessary to monitor changes in off-farm factors which are likely to affect land users' decisions about land use and management. This may include economic factors such as change in prices of outputs and costs of inputs.[56] While costs are often readily identified, benefits are frequently less clear. Once again, farm-families' own assessments of benefits may be among the most pragmatic indicators of sustainability. There may also be indirect costs (externalities) borne by the land user or passed along to others. Wherever possible, these costs should be evaluated and incorporated in the assessment. Institutional factors, such as laws and regulations which may favour or inhibit conservation-enhancing decisions by land users, should also be monitored, as should political factors, such as the effectiveness of off-farm institutions in providing adequate and appropriate information which land users can use to make informed judgements and decisions. Finally, socio-cultural factors such as landlessness, migration, minimal access to credit or necessary inputs and farm families' assessments of altered conditions should also be considered. An increase or a decline in satisfaction with the life they lead can affect decisions about whether a family stays on a farm or leaves it, assuming they have the option to do so.

2.4 INITIATING ACTION AT THE LOCAL LEVEL

Because soil degradation takes place at the local level within a specific land unit, sustainable land use must also be realised here. In reality, however, the causes of degradation are very often rooted in the economic, social and political environment in which farms are located, and are typically beyond the control of local land users. Every stakeholder, from the land user to the international market broker, has a certain potential to contribute to sustainable land use. Therefore, it is necessary to analyse the differences as well as the common interests and motivations found among all actor groups (i.e. stakeholders) involved (see box).

The potential for sustainable land management on a farm is greatest if organic materials are produced at an optimal level and also partially recycled. This will maximise the multiple benefits of high organic matter content in the soil. Second, adding needed nutrients from inorganic sources should make up for any deficit. Third, favourable soil architecture must be maintained at all levels of the profile by minimising direct raindrop impact and the negative effects of tillage. Fourth, rainwater entry and storage must be facilitated by rough-surface tillage and other activities on the contour, and by safe management of any unavoidable runoff and soil movements. Finally, improved rooting conditions and greater water infiltration will allow intensification per unit area and make it easier for land users to increase agro-diversity on their farms.

These are practical techniques for promoting sustainable land use. But how does a land user learn about such techniques and obtain the skills to apply them? How does he/she gain access to the required materials, tools, and financial resources needed to implement these techniques? Whereas farmers in developed countries concentrate primarily on generating cash income, the basic aims of most land users in developing countries are to provide the household with a reliable supply of preferred foods, to meet the household's additional primary needs for water, fuel, clothing, shelter and basic medical care, to generate cash to purchase items that cannot be produced on the land, and to meet social and cultural obligations to the community.[58] Advantages likely to be favoured by land users include greater stability and higher yields, leading to increased food security. This is indeed the main point: technologies designed to sustain the soils must be beneficial to the land user.

Sometimes spontaneous adoption of good ideas can be supported by social institutions at the local level. Certain existing

«Once groups, communities or localities have made serious efforts to solve priority problems by their own initiative and with their own resources, they are in a stronger position to get assistance from higher levels to deal with problems that cannot be redressed locally.»
(N. Uphoff[61])

PARTICIPATORY TECHNOLOGY DEVELOPMENT (PTD)

External support for land users requires mutual support in decision-making processes at the farm, community, research, and policy levels. The following steps must be taken:

1. **Participatory analysis of local farming system (status and dynamics), and of the social, economic and policy environments**
2. **Collection and selection of technology options that address felt needs/constraints, and meet sustainability requirements at the same time**
3. **Testing these techniques with continuous evaluation and monitoring of their performance**
4. **Disseminating promising techniques by finding out under which conditions they can be used, and enhancing the process of PTD.**

Source: ILEIA[64]

STAKEHOLDERS

A stakeholder approach analyses issues from the perspective of different actor categories. Stakeholders may be distinguished according to their activity, tenure (terms of access, use, and ownership), social unit of organisation, or level of action. Stakeholders may be classified as follows:

1 STAKEHOLDERS BY ACTIVITY

Producers such as farmers (large and small), farm workers, herders. Hunters, gatherers. Processors, market vendors. Consumers.

2 STAKEHOLDERS BY RIGHTS OF ACCESS, USE AND OWNERSHIP

Owners (state, group, individual, de jure or de facto). Tenants (rent paid). Users by permission or exchange agreement (continuous, regular, occasional). Squatters, «poachers» (illegal users).

3 STAKEHOLDERS BY UNIT OF ORGANISATION/LEVEL OF ACTION

Individual or household subgroups: men, women, children; age groups. Households managed by men/women; small/large; young/old; rich/poor. Communities and community groups: families, clans, self-help groups, extension workers, researchers, local NGOs or representatives of international NGOs, businessmen. National level/districts: national governments, administrators, planners, researchers and technical experts. International level: governments of industrialised countries, development organisations, international organisations, international agricultural or environmental research organisations, multinational enterprises, consumers.

Source: Adapted from D.E. Rocheleau[62]

NGOS AS TRIGGERS FOR DEVELOPMENT?

During the 1980s and 1990s the debate about development and changing aid strategies emphasised the role of non-governmental organisations (NGOs) as facilitators of development in poor countries. A study on NGOs, their efficiency, and their contribution to development revealed that they rarely realise the comparative advantages claimed for them. The study concluded with the suggestion that rather than placing too much hope in one «cure-all» organisation, a greater effort should be made to provide incentives for the emergence of environments conducive to organisational prosperity.

Source: H. Holmen and M. Jirström[63]

community organisations, such as land users clubs, credit management groups, marketing co-operatives, irrigation or range management associations, women's and development groups, land-user-to-land-user extension groups, and consumer groups are directly relevant and may have the potential to enhance action at the local level. Some local stakeholders play an important role in spreading new ideas. Often, such people belong to the uppermost wealth categories. For example, agroforestry extension trials in Uganda were always carried out on the land of the richest farmers in a community, simply because rather large plots were needed for replication, uniformity, and controlled monitoring. Extension to the majority of land users was thus prevented at the very beginning of the action.[59] One major problem in this regard is that certain groups and sectors of the population may be excluded from decision-making processes.

Finally, land use planning for communal or common property land is particularly important in many communities where communal lands are the most seriously degraded. Often, tensions exist between local traditions and national law, making it necessary to find sensible and effective rules and regulations for sustainable use of these communal lands. In Somalia, for example, a state leasehold programme introduced in 1975 allowed people to obtain land titles and claim access to large areas of high-potential agricultural land without regard for the customary smallholder system already in place, thereby provoking conflict and insecurity at the local level.[60] In countries with diverse land tenure systems, it may be more relevant to use social units such as villages or family clans, or geographical units, such as watersheds or land use types, as planning units for communal land, rather than trying to regulate communal lands through national policy. Village planning is most successful if an iterative process is used in planning, based on dialogue involving all the actors affected, with the objective of defining communally binding rules for sustainable land use. Enabling external institutions, such as NGOs, may play a supportive role in stimulating processes of open discussion and conflict resolution, although many second thoughts have recently been voiced about NGOs as triggers for development (see box).

2.5 CREATING AN ENABLING ENVIRONMENT

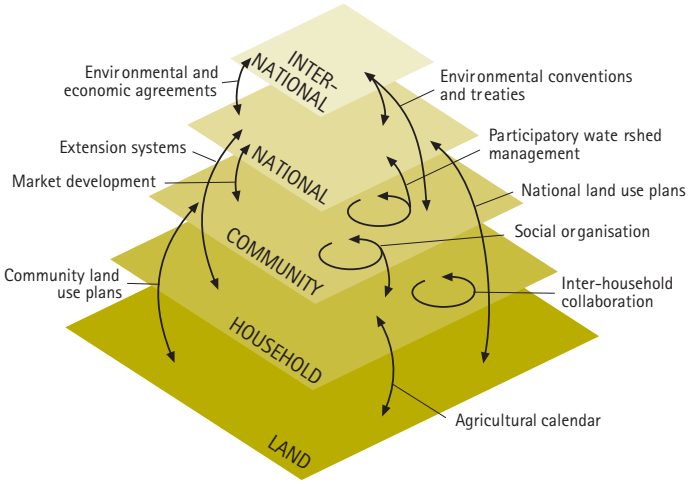
A positive, «enabling» institutional environment at the national and the international level offers the potential for substantial support of sustainable land use by creating favourable conditions in which land users and communities can benefit by improving existing shortcomings. In this regard, distinctions must be made among a number of incentive systems at the national scale (see box).

As opposed to incentives, farm subsidies – particularly in «highly developed» countries – seriously distort markets and discriminate against non-subsidised farms in most poorer countries.

National policies directly affect land users, whether in agriculture, forestry, livestock production, or industrial and urban land use. Many national governments are increasingly attempting to integrate environmental, economic and social concerns into national planning processes. Declaration of a national policy on sustainable land use is an important measure that can help bring about necessary political, institutional and economic changes. National economic policy is an additional means of improving sustainable land use. Revisions of price policy should aim at the internalisation of ecological costs, as external costs like soil degradation and loss of biodiversity and groundwater quality have not been accounted for in the past. Access to credit can also be used to help land users invest in sustainable land use, provided that goals are clearly set. Subsidies are a more critical element of a national economic policy. Farm subsidies have become common, particularly in «highly» developed countries, although they seriously distort national and international prices and discriminate against farm products from non-subsidised farms, which includes the farms in most of the poorer economies.

Land titling policy is another user-enabling incentive at the national level. Clear property rights or tenure security, developed in participation with the local land users, can be an important incentive for them to make long-term investments in technologies and systems necessary for sustainable land use. In many countries, national land reform programmes may be necessary to promote more equal distribution of land and natural resources. In countries undergoing rapid demographic change, however, land titling policies alone will not be sufficient to make land use sustainable.

Soil and water conservation programmes have traditionally been organised at the national level, usually employing top-down approaches that are associated with particular problems. Direct incentives such as food-for-work have been heavily used in these programmes. Their effectiveness, however, has been strongly



Intervention levels and activities in sustainable land management

INCENTIVES FOR ENHANCING THE SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES

The emergence of enabling incentives marks a paradigm shift away from command and control approaches, which force land users to adopt or abandon a particular course of action, towards the creation of an environment which allows them to choose their own course of action.

1 ENABLING INCENTIVES ARE INCENTIVES WHICH EITHER ENABLE LOCAL LAND USERS TO TAKE ACTION OR PROVIDE A FAVOURABLE POLICY FRAMEWORK.

– USER-ENABLING INCENTIVES...
...may secure access to land, clarify land tenure issues and provide access to means of production (water, credits, tools, extension, labour)

– POLICY-ENABLING INCENTIVES...
...acknowledge the need for a coherent natural resource policy in all policy aspects, co-ordinate economic and financial policies with environmental policy, co-ordinate strategies of agrarian and development policies with natural resource policy, create an institutional framework which supports natural resource policy, co-ordinate between different government institutions, guarantee regional autonomy and delegation of responsibility for natural resources to the communal and local levels, and enforce sustainable use of natural resources in local communities.

2 VARIABLE INCENTIVES...
...are price incentives used to steer economic processes in ecological directions, such as revision of price policies which give the «wrong» ecological signals, removal of price distortions resulting from subsidies for energy or agricultural inputs, increases in producer and consumer prices and ecological reform of the tax system.

3 DIRECT INCENTIVES...
...are commonly defined as materials, food, tools, or cash provided to land users for pursuing projects such as soil conservation, afforestation, irrigation and other rural construction work.
Source: I. Perich,[68] D. Pearce,[69] and FAO[70]

contested in recent years, for several reasons. One reason is their potentially negative impact on the attitude of land users towards the introduced conservation technologies. A second reason is the distortive effect of direct incentives on the agricultural market. A third is that the technologies introduced in these programmes did not increase productivity for the farmers.[65] An important new approach in soil and water conservation is the focus on empowerment of local and community groups by delegating authority, accountability and resources to the most appropriate level,[66] and focusing on local technologies.[67]

Education, training, research, and technology development can also be «user-enabling incentives». Priorities should be set with these incentives, and they should focus on analysing and adapting framework conditions and principles for sustainable land use as well as resource-conserving technologies and practices. Research institutions should also look for ways of working closely with land users and rural communities.

Policies and programmes at the international level might include international conventions and agreements, and international research. Activities designed to reduce the impact of human-induced climate change, to preserve natural forests, and to maintain the biodiversity of living organisms can help promote sustainable land use in indirect ways. International agreements on terms of trade represent the best potential to provide enabling conditions to land users in agricultural economies, particularly if they have provisions aimed at internalising so-called «external costs». One example is fossil fuels, which are responsible for lower world market prices, owing to the cheap production and transportation costs of mechanised agriculture when compared with labour-intensive practices. International research – particularly strategic research, co-operation among advanced research organisations (ARO), and global monitoring and databases – carried out through networks, consortia, or joint initiatives, could also play an important role. This type of research also serves as a means of communication on research methodologies, as a stimulus to research in areas not yet sufficiently covered, and as a way of presenting crucial issues to policy institutions and decision-makers at the national and the international level.

2.6 **CONTROVERSIAL** CONCEPTUAL ISSUES

There is a multitude of controversial issues connected with the fundamentals of sustainable soil and land use. Some, like soil quality and land quality, are relatively clear, and there is also consensus on what land use systems are appropriate for certain agro-ecological environments. But there is much debate over incentives, approaches to soil conservation, land use planning, economic development at the national scale, and the catchword «sustainability». These issues remain controversial and will be subject to further debate and evolution, as illustrated by the following arguments.

ISSUE 1 THE COSTS AND BENEFITS OF TECHNOLOGIES

OPINION: Technologies for sustainable soil management are a means of caring for the soil resource. In most cases these technologies are not profitable in economic terms. On the contrary, cultivated land may be «lost» when the technologies are installed on the ground, and beneficial effects will only become apparent after many years - far beyond the planning horizon of a land user. However, soil degradation is a major concern for entire nations. Societies should be worried about long-term irreversible damage which will affect coming generations. This justifies external support for initial investment and extension services, going beyond land use systems, communities, townspeople, and governments. An improved system can be more easily maintained by the local land user.

COUNTER-OPINION: Technologies to mitigate or prevent soil degradation must be productive in the short term. Only then will land users adopt them as a first priority. We should thus invest in the development of inherently resource-conserving technologies. Increases in productivity will be guaranteed from the first year onwards, and maintenance will be in the immediate interest of the producer. This way, governments will not have to bear the costs of extension and subsidies.

ISSUE 2 DIRECT INCENTIVES

OPINION: Providing direct incentives to farm families is dangerous because people undertake the work expected of them primarily to enjoy the benefit of the incentive, not to produce the intended results. Furthermore, such programmes mask other deficits at the policy level, such as the lack of land ownership. Specifically, food-for-work programmes distort local markets, leading land users to expect donations instead of promoting their empowerment. Direct incentives should be applied with utmost prudence, and only in situations where other measures are less appropriate.

COUNTER-OPINION: Improved management of the soils requires inputs that are beyond the means of land users. In highly developed societies it is common to subsidise farmers to compensate for all the disadvantages they have. Direct incentives like food-for-work are fully justified in poor nations, all the more so if a large number of people are suffering from hunger or are already starving as the result of famine. Furthermore, re-allocation of food from surplus countries to deficit countries is beneficial to farmers on both sides.

ISSUE 3 NATIONAL ECONOMIC DEVELOPMENT

OPINION: Economic development by itself does not imply that wealthier nations care more for land and soils than poorer nations. In highly developed economies soil degradation is even further accelerated by the additional environmental impacts of industrialisation, urbanisation, and the growth of the tertiary sector. When degradation processes are perceived and the public becomes aware of them, a nation must react, within the limits of its possibilities. If it is unable to react, external support must be sought. Caring for the land is a prerequisite for alleviating poverty.

COUNTER-OPINION: Economic development by itself will make land use more sustainable. As soon as there is adequate social welfare and a high level of education, more investments and subsidies will be earmarked for the agricultural sector as well as other sectors. The problem of sustainability will solve itself. Alleviating poverty is a prerequisite for additional care of the land. Wealthier land users are in a position to develop longer planning horizons, which enables them to make investments, e.g. in SWC.

ISSUE 4 WHAT CONSTITUTES THE GREATEST THREAT TO THE RESOURCE BASE?

OPINION: Poor economies usually employ a high proportion of their populations in the primary sector. Rapid population growth threatens their natural resources and renders appropriate action impossible because people are preoccupied with their own survival and the burdens of poverty in subsistence agricultural systems. Slowing population growth rates is a crucial prerequisite for economic growth and sectoral transition, industrialisation, and controlled urbanisation in these economies. Unless the problems of accelerated growth and poverty are solved, steps towards sustainable development will be little more than drops in the ocean.

COUNTER-OPINION: It is the «highly» developed countries which consume most resources and threaten survival at the global scale. Eighty percent of the global gross domestic product is concentrated in the hands of 20 % of the world's population. Agricultural products, fossil fuels, and minerals are imported from less developed countries, which bear the burden of degradation and pollution. Highly developed countries and countries with emerging economies are also most responsible for global climate change, which will have impacts at the global scale.

ISSUE 5 SUSTAINABILITY AS A CONCEPT

OPINION: Sustainability establishes the right principles because it assigns ethical value to natural resources, to all life on earth, and also to future generations. It calls for a more modest position for humankind within the earth's life systems, and a humbler vision of future possibilities and potentials. In order to reach agreement on common values, questions of sustainability must be negotiated in participatory processes that involve individuals, communities and nations. There must also be an effort to seek agreement on technical solutions.

COUNTER-OPINION: Sustainability only survives as a concept because it means all things to all people. It is not a practical concept that can be defined in technical terms, and it has no rational foundations. It cannot be used as an indicator because nobody knows what is meant by the general principles associated with it. Rather than losing time discussing issues linked with sustainability and holding conferences which involve tens of thousands of people and great expenditures of money, we would be better advised to invest in alleviating poverty and promoting economic development. Even if resources are being exhausted today, as in the case of fossil fuels, present and future generations will be innovative enough to develop substitute technologies, as humankind has always done in the past.

3 GAINING MOMENTUM

CONFLICT RESOLUTION

PARTICIPATORY PLANNING

POVERTY ALLEVIATION

PROMOTING SUSTAINABLE LAND MANAGEMENT

LAND USE SECURITY

ETHICS OF NATURE

NATURAL RESOURCE MANAGEMENT

It would be presumptuous to believe that momentum towards sustainable land use will grow everywhere, irrespective of the local context. In ecological terms, for instance, natural resource management has the least potential to become more sustainable in areas where there is little chance for natural restoration of soils (resilience[71]). The socio-economic context will be different for communal lands, farms, private enterprises, or pastoralist areas, and will depend greatly on the national economic situation.

For example, small-scale farmers in an agricultural economy depend almost exclusively on their own financial, material, and intellectual resources, and most of all on labour and time. Poverty and lack of economic opportunity are probably the most pronounced obstacles for such farmers when it comes to adopting more sustainable forms of land use. In Latin America, for instance, farmers often face land tenure problems and high inflation rates and are consequently unable to make investments in land or agricultural inputs. Therefore, external programmes to improve natural resource management must often go hand in hand with poverty alleviation to have a chance of success.

On the other hand, land use in non-agricultural economies is influenced by many external factors and impacts. The overwhelming majority of the population in these economies, which is not engaged in land use but is responsible for most of the impacts which indirectly affect the sustainability of land use, pays little attention to the implications of its activities.

The best way to gain momentum towards more sustainable management of natural resources may be to critically analyse existing momentum and then examine the processes of communication and participation that are in place, the legal framework which supports the principles mentioned in the previous chapter, and the economic setting which governs land use mechanisms.

Initiatives ranging from the local to the national level will probably be more important than those ranging from the regional to the international level. The relative importance of these initiatives must be weighed, and activities which have the greatest potential to support land users must be identified, while those activities which cause the greatest indirect degradation of the soil must be reduced. Finally, it will be easier to expand social responsibility if priority is given to local monitoring of processes of degradation and local experimentation with possible solutions. There will be a much better basis for gaining momentum when land users, politicians and administrators, and professionals and scientists have an equal appreciation of the need for sustainable land use.

3.1 NATURAL RESOURCE MANAGEMENT IN CONTEXT

Today there are still extensionists who merely disseminate their technical knowledge to land users. But this situation is changing slowly. Farmers, specialists, politicians, entrepreneurs and others debate acceptable land use. New patterns of interaction are now emerging. Better communication and access to information certainly helps actors who have a stake in a certain type of land use in a particular area. Communication allows them to base their decision-making on knowledge rather than on assumptions and rumours. The slogan «information is power» is often heard in this context. There is hope that weak actors can be empowered by opening up communications systems. This is often not desired by influential people, however, since it affects the established power structure and social system. When powerful actors prevent others from having equal access to information, this can have negative impacts on decisions that affect land use, and it frequently reduces the sustainability of existing management systems.

In negotiated settlements it is most important to include all categories of actors with an interest in the land uses under discussion, regardless of the political power they possess.

Legal frameworks are essential in promoting sustainable resource management if they are attuned to the goals of sustainability. The example of long-term land use security is a generally accepted principle in this regard. This may consist of formal entitlement or communal regulations and norms which allow flexible, ethically adapted regulation of access to land. In Bolivia, a multiplicity of communal norms has been substituted for individual property rights. This allows social and cultural interaction among land users, which fosters land security at village level.[72]

In poor economies there is very often no legal framework to safeguard sustainable land use. Instead, land use plans are drawn up by national institutions, and it is expected that they will be enforced at the local level. Such planning approaches, however, which were vigorously pursued in many countries in the 1970s and 1980s, were seldom implemented due to weak institutional capacity. This failure could well be seen as something fortunate, however, since the national plans did not take account of the many local variations in land use and their corresponding alternative economic options for land users. Similar shortcomings can be found in numerous development projects and programmes. There has been a considerable paradigm shift in approaches used in development co-operation (see box), from single-institution, top-down land use planning to integrated, multi-actor-oriented, participatory approaches.

PARADIGM SHIFTS IN DEVELOPMENT CO-OPERATION

In the 1970s, projects in soil and water conservation, as well as agricultural projects, were characterised by «top-down» methods of planning and implementation. Typically, the conservation «expert» from outside identified the «problem» in the field and came up with a technical «solution», developed at the research station. This technical approach concentrated on building physical structures (conservation banks, storm drains, artificial waterways, etc. to control runoff) with heavy machinery or with local labour, often supported by incentives (food-for-work or cash) which did not address the underlying causes.

Sustainable use of agricultural soils requires a change in development approaches, away from conservation per se to land husbandry. Land husbandry is understood as a positive approach in which care and improvement of the soil resource come first, and control of erosion follows as a result of good land husbandry.

Gradually, it was recognised that local land users would only implement conservation measures if they perceive and accept them as beneficial. The need for people's participation became widely acknowledged and featured in strategy papers produced by international development organisations. This means that interventions must be local and context-specific, and must respect and value local knowledge and technologies.

The «farmer first» approach was developed to counter the shortcomings and limitations of the old top-down development and extension approach. The main objective of this bottom-up approach is to empower farmers to learn to adapt and do better. Analysis is done by farmers themselves, assisted by outsiders.

A new approach is emerging, focusing on the different, often conflicting perspectives and interests of the stakeholders involved. It implies that strategies and approaches for sustainable soil use and conservation measures can only be effective if they involve the perspectives of the different actors, insiders as well as outsiders, at the local, national and international levels. For this, the programmes concerned will need to develop mechanisms through which the various interests of the different stakeholders can be negotiated and addressed.

The challenge ahead is to change institutional and structural mechanisms for development co-operation in the direction of long-term programmes that encourage processes of negotiation, mutual learning and local participation.

Source: A. Dahlberg,[74] M. Douglas,[75] L. Lundgren and G. Taylor[76]

Tanzanian farmers in discussion

KNOWLEDGE INTEGRATION – AN EXAMPLE FROM AUSTRALIA

The Landcare movement originated relatively recently in the State of Victoria, Australia. The basic principle of the movement is that people living on the land in any one locality can form a group among themselves and can freely initiate any kind of activity which will preserve their land resources from their perspective. The responsible government agencies have an obligation to assist by helping to provide financial and technical advice. It is argued that in this way technical knowledge from scientific sources can be integrated with indigenous knowledge and the skills of local people. Thus, with limited government funding, Landcare group action will facilitate the process of community development, produce more aware, informed, skilled and adaptive resource managers, and result in adoption of more sustainable natural resource management practices.

The Landcare approach puts land degradation in a socio-economic context and «empowers» local communities to find solutions by making them responsible for managing natural resources in their area. Land users themselves assess the health of their lands, «reading the land» as it were, making use of both scientific tests and environmental indicators developed from local experience. Landcare kits have names like Saltwatch, Watertable Watch, Drain Watch, Wormwatch, Grass and Pasture Watch. When landowners themselves have been involved in fact finding on their own land, they also act on the basis of the information recorded. Thus it is knowledge that determines if rehabilitation work actually takes place. Several unresolved contradictions are built into the Landcare approach: who has the final word if national conservation interests and local opinions clash?
By their very nature Landcare groups have a local perspective. But not all issues are local. A related dilemma arises from the fact that public funds are allocated to the Landcare groups. These groups will only remain viable if they retain a certain independence from government departments. A problem of a different order, but still vital, is the varying degrees of enthusiasm within communities. Paradoxically, greater local involvement can also result in greater social stratification, and some environmental problems may be obscured.

Evidence from Australia suggests that Landcare has promoted a huge wave of informed action amongst land users, and support for it is widespread. The number of Landcare groups has increased rapidly to more than 3,000 within less than a decade.

Source: A. Curtis and T. DeLacey, 1995[77]

Landcare in Australia

Conflict management and conflict resolution is an important recent approach which reflects global circumstances.[73] Environmental constraints, aggravated by land and soil degradation, often contribute to the outbreak of political conflicts. Many recent conflicts, including those in Somalia and Eritrea, and to some extent in former Yugoslavia and Rwanda, have been partly intensified by these problems. The social, economic, political and ecological impacts of armed conflicts on natural resource use are often underestimated.

It should not be forgotten that access to markets, education, health care and cash income are basic needs, and that the satisfaction of these needs is as important as pursuing goals of less immediate importance to survival, such as sustainability and environmental improvement. Poverty alleviation is an indispensable prerequisite in «poorer» economies, although second thoughts have been voiced about the long-term impacts of these «standard» development options.

Emotional attachment to the land and the value of land have proven to be important factors in creating movements to preserve land from unsustainable forms of use. One good example is the Australian Landcare movement, in which both land users and other people living in the same communities make joint efforts to achieve better land management (see box). Articulated needs become guiding principles for policy-making, and the possibilities for sustainable use of natural resources vastly increase. Such developments are now beginning to emerge in many places. Here too, financial requirements will be governed by economic options and the availability of credit systems which allow for investments in more sustainable land uses and needed technological inputs.

Finally, the principle of ethics as applied to nature also influences efforts to achieve sustainable land use. Plants and animals do not have a voice to participate in land use decisions. Their potential inputs must therefore be made by actors who agree to act on their behalf. Although such representation is only possible to a limited extent, it can nevertheless be a guiding principle which should not be neglected.

3.2 INITIATIVES AT THE NATIONAL SCALE

The economic capacity of a nation is decisive in creating a feasible enabling environment for sustainable land use. In non-agricultural societies, a complete network of subsidy systems has been developed. As early as the 1930s, farms in the US were subsidised by the government in an effort to reduce cropland areas where these were unsuitable. As a result of this policy, about 10-15 million hectares of agricultural land was converted to other, more sustainable uses each year between 1933 and 1976.[78] Production-related subsidy systems, however, have become a major concern, particularly since the Uruguay round of GATT and the founding of WTO in the 1990s, because they depress commodity prices on the world market. Newer forms of subsidies, based on land size or consisting of direct payments to farms, are becoming more frequent. They do not directly affect commodity prices or distort the market. Besides a variety of subsidies in industrialised countries, many different institutions, technological options and tools exist to provide an enabling or enforcing environment for land users. Despite this momentum, sustainable land management has not become widespread because of a probable drop in farm income and external impacts such as industrial pollution.

Policies, subsidies and incentives as a means to achieve sustainable land management need to be carefully monitored and examined during their implementation.

In «poor» countries, on the other hand, it has been the practice to use direct incentives to implement conservation programmes, such as payment of cash, or food, for the conservation work to be done by land users on threatened or degraded land. Ethiopia is one of the many developing countries where this approach has been applied. Here, direct incentives have been used since 1974 where food security was at stake, and where the aim was to use external food aid in a productive way instead of simply distributing it for humanitarian reasons alone. However, set-backs soon occurred because conservation technologies were introduced on the land although land users had no clear perception of their validity. Hence maintenance was not guaranteed in many cases and conservation structures collapsed (see box on page 46).

Instead of subsidies and direct incentive systems, enabling incentives are now being introduced. These incentives are either directed towards land users – for example, in the form of improved extension services – or they are used in policy formulation. They consist of a whole range of institutional forms of support for sustainable land use at the national scale (see box in 2.5). These policy incentives have not yet been fully applied to land sers

Shifting cultivation on the forest fringes in Eastern Madagascar

LAND CADASTRES IN AREAS OF SHIFTING CULTIVATION IN MADAGASCAR

The eastern Malagasy escarpment is characterised by shifting cultivation along a dwindling strip with natural primary forest and much secondary fallow vegetation. Land use is communal, and clans decide on swidden areas in their territories on an annual basis. Immigrants buy individual holdings which can be titled.

The National Environmental Action Programme, which was launched in 1989 under the auspices of the World Bank to protect the last remaining primary forest zones of Madagascar, pursues a strategy of formalising land ownership in the buffer zone around these forests with individual titles. Near the Andasibe Reserve, however, local communities successfully forced titling authorities not to register individual land, but to assign land to whole villages, introducing group property rights. Some villages with greater numbers of immigrants preferred the individual titling approach. Early warning about the titling process led to accelerated forest clearing by the land users trying to increase their land holdings along the forest line.

Whether this flexible government policy will succeed remains an open question. Control of land titles in remote areas is almost impossible, and intensification of agriculture on fixed parcels of land has so far remained insignificant despite population pressure. It appears that titling as a single approach will not succeed if it is not supplemented by other measures at the local level.
Source: J. Brand, 1996[83]

Swidden agriculture in secondary vegetation successions in Eastern Madagascar

FOOD-FOR-WORK IN ETHIOPIA

Probably the largest-scale physical reclamation of eroded land in Africa took place in Ethiopia during the 1970s and 1980s. Following the drought of the early 1970s, the country's central highland mountains were badly hit. With assistance from the World Food Programme, the Ethiopian government initiated a massive programme of afforestation and soil conservation. Altogether, the volume of the programme reached an estimated input of US$ 50 million per year by 1987. Between 1976 and 1988, conservation involved some 800,000 km of soil and stone bunds for terrace formation on cropland, about 600,000 km of hillside terracing for afforestation of steep slopes, some 100,000 ha of closed areas for natural regeneration, and many other land rehabilitation activities.

The overall impact of these activities, however, was greatly reduced when political instability swept over the country between 1989 and 1992. Maintenance problems affecting the implemented measures, the perceptions and attitudes of farmers, and the negative impact of food-for-work led to a massive neglect of work and brought the programme to a virtual standstill. It is estimated that less than 30% of all structures were maintained over the years, while the rest simply disappeared. After 1992, more participatory planning approaches were introduced, and negotiations with farmers have now become common. However, in view of the threatening current degradation rates, the overall situation in Ethiopia is still deteriorating, despite some recently observed successes. Source: FAO, 1990,[84] and H. Hurni, 1993[85]

Food-for-work in Ethiopia's soil conservation campaign

in nations with predominantly agricultural economies, although they appear to have great potential. One important but controversial issue is land titling. African case studies report a wealth of local land ownership regulations.[79] Such regulations may be distorted by the uniform application of national titling policies. Another issue is economic policy. Governments in countries with agricultural economies do not have sufficient means to implement costly structures and organisations in their land user-dominated societies, partly because they have to live with commodity prices dictated by the world market, and partly because of the relatively cheap prices of fossil energy vis-à-vis manual labour. This distortion of prices and government income will persist for the most part, and land users in poor nations will continue to have to live without government support.

Another issue at the national scale is the institutional set-up and institutional strategies. Governments and development agencies often direct their efforts towards so-called specialised institutions, «soil conservation services», and provide support for them in order to implement soil conservation programmes with land users. But new land use planning approaches in recent years point to the possibilities of overcoming some of the constraints observed earlier, particularly when all interest groups (stakeholders) are included in the planning process (see box). A whole set of national planning initiatives has been introduced in many nations since the 1980s. One of the first of these was the National Conservation Strategy,[80] the basic aim of which was to improve management of protected areas at the national scale. More comprehensive in scope is the recently launched National Environmental Action Plan,[81] which focuses particularly on improved management of natural resources. An example is the Environmental Action Plan launched under the auspices of the World Bank in Madagascar in 1989, with an input of US$ 85 million to date (see note 75). A major focus of the programme was land titling operations, where considerable experience was gained with a complicated measure (see box). A third major initiative recently launched is the National Sustainable Development Strategy,[82] which includes measures to promote social and economic sustainability. Whether these national strategies and plans will lead to improved sustainability can only be determined in future. They have, however, done much to raise public awareness in all the countries where they have been initiated.

3.3 REGIONAL INITIATIVES

Bridging activities, whether in the form of economic, legislative, or cultural networks, involving several nations in a region, are a means of transcending national boundaries. They permit comparisons of various national institutional settings under somewhat different conditions. Neighbouring countries, however, often have comparable land use systems, cultural linkages, and sometimes even similar languages. Regional initiatives on sustainable management of natural resources can thus provide encouragement and stimulation, allow comparative analyses of why certain approaches work in one country but not in another, and introduce new ways of thinking and acting, while also stimulating sound neighbourly competition.

Existing regional institutions and movements have a variety of orientations which must be evaluated in terms of fostering sustainability. For example, some development-oriented regional economic associations aim to promote easier exchange of capital and goods. They may stimulate regional co-operation, increase food production, and promote trade and economic stability. Politically and economically motivated associations between nations, which often strive towards a common goal, are another example of such movements. These include regional organisations like the OAU for Africa, the ASEAN countries, the CARICOM in the Caribbean, and the MERCOSUR in Latin America. Research associations and institutions, on the other hand, may focus on agriculture, forestry and the environment, and stimulate improvements in productivity, or reduce environmental degradation (see box). Regional collaboration can also be guided by common goals, such as water resource development for energy and irrigation in a shared river basin. Examples include the Nile treaty of 1959, the Zambesi, Orinoco, and Amazon basin development schemes, and more recently, joint undertakings to develop the Mekong River basin. Unfortunately, these collaborations have been mainly concerned with the most efficient use of water as a resource for irrigation and hydropower, and have almost fully neglected problems of sustainable development.[86] Finally, NGOs have been growing in importance and have now become powerful in the regional context, particularly with regard to environmental issues (see box).

While regional institutions certainly do improve regional economic exchange and also have the potential to overcome language and other barriers, several important questions must still be asked, e.g.: For what purpose were they created? What are their target

Serious consideration of the principles of sustainable use of natural resources would require reassessment and possibly also reform of most regional institutions.

Water conservation between tied ridges in semi-arid Zimbabwe

NGOS AND INTER-STATE ORGANISATIONS DOING ENVIRONMENTAL WORK IN REGIONAL CONTEXTS

GREENPEACE is an NGO active in many environmental hot spots and other areas. It has 3.5 million supporters in 143 countries, offices in 32 countries, and consultative status with the UN Economic and Social Committee.

ENDA is a Sahelian NGO located in Dakhar (Senegal), active in the fields of environment, development, and participatory action.

CHURCH-SPONSORED NGOS have basically evolved from missionary work. Today they have long-term development programmes operating in their original target areas.

ECOFARMING is now characterised by numerous movements in Europe for biological farming. One example is DEMETER, which operates in Germany and Switzerland.

OSS: Observatory for the Sahara and the Sahel
CILSS: Permanent Inter-State Committee for Drought Control in the Sahel
SADCC: Southern African Development Coordination Conference
UNSO: United Nations Sudano-Sahelian Office[88]

REGIONAL ASSOCIATIONS FOR ENVIRONMENTAL RESEARCH, TRAINING, AND COMMUNICATION

RSCU: Regional Soil Conservation Unit, Nairobi, Kenya (see box on page 51)
ASOCON: Asia Soil Conservation Network. A member state organisation including 8 Asian countries, centred in Jakarta, Indonesia. Newsletter, regional meetings, and training.[87]
ESSC: European Society of Soil Conservation. A membership organisation in Europe. Newsletter and meetings.
SWCS: Soil and Water Conservation Society, Ankeny, Iowa, USA. A membership organisation with professional staff, a journal, and many other services.
Réseau érosion: List of 700 members in a dominantly francophone network in France and parts of Africa. One annual meeting in France.

Half-moon structures for water conservation in Niger

RSCU's support of soil and water conservation in East Africa

THE REGIONAL SOIL CONSERVATION UNIT (RSCU) IN EASTERN AFRICA

By the early 1980s the Kenyan national soil conservation project had established a rather good record. But could its experiences also be transferred to neighbouring countries? Sweden, which had been supporting the Kenyan soil conservation effort for about a decade, now agreed to finance a new programme, the Regional Soil Conservation Unit (RSCU). The emphasis from the start was on training and exchange of know-how throughout the region.

The main techniques were physical soil conservation structures and support for tree planting and fodder grass grown along the structures. The programme thus had something quite tangible to teach, and the impacts could be easily seen by the land users. Gradually this approach to soil conservation widened. Today, agroforestry and livestock issues are integral parts of RSCU activities and training events, and improved water conservation for agricultural production is becoming more and more important. While RSCU now supports a number of land husbandry projects throughout East Africa, and contributes to policy formulation as well as methodological development, the overall aim of the programme has remained unchanged: to bring together technical staff and others on a regional basis to exchange information and receive training.

It does not take long before someone with an interest in natural resource management in Ethiopia, Kenya, Tanzania, Uganda or Zambia meets with field officers or administrators or researchers who have participated in RSCU courses and study tours. They are usually enthusiastic about their experiences. Learning from neighbours seems to be a most fruitful and relevant way of picking up new ideas and also observing one's own activities at home in a new light.

For a number of years the RSCU was part of the Swedish Embassy in Nairobi. Since mid-1994 it has been attached to ICRAF, the International Centre for Research in Agroforestry, based in Nairobi. Source: W. Östberg and L. Lundgren[89]

groups? What is their financial basis? Serious consideration of the principles of sustainable use of natural resources being presented here would require reassessment and possibly also reform of most regional institutions. There are potential concerns relating to the unintended impacts of their activities and the question of how much they actually enhance sustainability.

Some particular recommendations for generating greater momentum can be made here. Regional economic associations should be geared towards finding ways to internalise those external costs which may do irreversible harm to the environment. Among other things, they should give consideration to taxing the use of fossil energy and favouring renewable sources of energy, and they should promote ecofarming movements within their region. Regional political organisations should also emphasise the maintenance of peace in their region, mitigate conflicts, and guarantee the free movement of people between the countries involved. And regional research associations should restructure their research approaches to move away from commodity-oriented research rooted in specific disciplines towards more integrated, interdisciplinary and holistic approaches which are guided and controlled by public evaluation and directives. Regional river basin programmes have so far neglected most of the environmental and socio-cultural issues associated with their development plans.

Finally, regional NGO activities, although they might need co-ordination and restructuring, should be enhanced because of their potential to assure local participation in decision-making and adoption of local solutions. They may also need considerable upgrading in professional terms, as well as technical and administrative support.

3.4 GLOBAL INITIATIVES

«Think globally – act locally» has long been considered a guiding principle for detecting environmental impacts and promoting local action. While this is certainly still the case for issues like climate change or depletion of the ozone layer, the proverb will have to be reversed if it is to apply to almost all other environmental concerns, including soil and land use problems. Global threats demand global action. Local threats, on the other hand, rapidly accumulate if they occur everywhere, and finally become global threats too. Soil degradation is an example of an environmental threat whose impacts can accumulate. Along with global threats, however, there are also global opportunities. Both the economic system and UN organisations have become global during this century. Communication has undergone a revolution in recent decades, too, and is truly global today. For example, the Internet which now spans the globe consisted of four computers in 1969. Today, nearly 1 percent of the world's population has access to the net,[90] although 95% of these are male. This has greatly facilitated and expanded the possibility for discussions surrounding international conferences, such as those on population (Cairo, 1994) and women (Beijing, 1995). At the same time, the issue of unequal access to communications systems has come to light as a problem at the global level.

The international community, represented by the greatest number of governments and NGOs ever assembled at the UNCED conference in Rio de Janeiro in 1992,[91] gave support to such global activities as conventions on climate, biodiversity, and desertification. It also initiated the forestry action plan, and outlined a large-scale programme for sustainable development in the 21st century, known as Agenda 21, to be subsequently financed and implemented (see box). At UNCED it was agreed that the world community should strive for global partnership, taking into account both national and global responsibility for policies and action on development and environmental issues. Prior to UNCED, a number of international institutions had already initiated numerous activities. These include FAO, created in 1945 to advance agriculture and forestry,[92] and UNEP, created in 1977 to promote environmental programmes. Together, these institutions developed the World Soils Charter in 1982. After UNCED, the Global Environment Facility (GEF), administered by the World Bank, was created to finance environmental programmes, and the Commission on Sustainable Development, (CSD) was opened in New York to co-ordinate follow-up to the

The real potential of the international economic system lies in the concerted restructuring of tax policies, price policies, and financial markets, which can be geared to improve social and ecological sustainability with a well-functioning economy at the same time.

Highly degraded grazing lands need more attention at all levels of intervention

Finding alternatives to slash-and-burn agriculture demands concerted action at the global scale

AGENDA 21

Agenda 21 is the action programme that resulted from numerous pre-conference consultations prior to the UNCED Conference in 1992. Agenda 21 explains that population, consumption patterns and technologies are primarily responsible for environmental change. It demonstrates paths that lead away from waste-producing and inefficient consumption patterns to systems which are more intensive but more sustainable. Policy measures and programmes for finding a new balance and harmony on earth are described in 37 chapters. By adopting Agenda 21, the industrialised countries acknowledged a major responsibility to facilitate environmental improvements and to finance parts of the programme budget of over US$ 100 billion, a process which has got under way only very slowly in the years since 1992.

Irrigation terraces requiring high manual inputs have been functioning well for centuries in Bali, Indonesia

SOIL INSTITUTIONS WITH A GLOBAL MANDATE

ISRIC: **International Soil Reference and Information Centre, Wageningen, The Netherlands. Founded in 1966, ISRIC is a centre for documentation, research, and training focusing on the world's soils, with emphasis on the resources of developing countries. ISRIC collects, generates and transfers information on soils, and participates in global programmes like SOTER and WOCAT.**

IBSRAM: **International Board for Soil Research and Management, Bangkok, Thailand. IBSRAM was founded in 1983 to promote and assist research on soils and land. Collaborative networks on sloping lands and acid soils are being monitored separately from global initiatives to cope with soil erosion.[95]**

WASWC: **World Association of Soil and Water Conservation, Ankeny, USA. Founded in 1983, WASWC is a membership organisation with about 700 members. It sponsors workshops, publishes a quarterly newsletter, edits proceedings,[96] and implements the global programme WOCAT.**

ISCO: **International Soil Conservation Organisation. Founded in 1983, ISCO organises international conferences of scientists, environmentalists from NGOs and governmental organisations, development experts, and others to promote conservation, management, and sustainable use of natural resources.[97] ISCO is based wherever the next conference will be held, i.e. in Bonn for the 9th ISCO conference.**

WOCAT specialists evaluating SWC in Kenya

WOCAT database management and expert system for SWC

WOCAT: WORLD OVERVIEW OF CONSERVATION APPROACHES AND TECHNOLOGIES

WOCAT is a global programme launched in 1992 by the World Association of Soil and Water Conservation (WASWC).

WOCAT aims to contribute to the sustainable management of soil and water world-wide by compiling and evaluating existing soil and water conservation (SWC) technologies and approaches, mapping SWC, and making experiences available in the form of handbooks, reports, maps, databases and expert systems.

The WOCAT methodology is to develop a standardised framework for evaluating and collecting data on SWC experiences through questionnaires, to collect information through regional and national workshops (so far in Eastern and Southern Africa), to develop a database and simple data management system, and to analyse and present information in the different outputs described above.

WOCAT aims to finalise its task in Africa by 1998, while continuing to launch other regional initiatives on other continents. Completion will depend upon full funding. The main donors so far are The Swiss Agency for Development and Cooperation (SDC), FAO, UNEP, and IDRC.

Collaborating institutions include international (UNEP, FAO), regional and national organisations and research bodies.
Source: WOCAT, 1994[98]

UNCED process. Action on the various chapters of Agenda 21 is currently taking place at three main levels – the inter-governmental level, the national level, and the level of NGO programmes.

Parallel to these international activities at the policy level, several international institutions concerned with research, training and communication have been created with a view to promoting conservation and sustainable development. Mention should be made of the World Conservation Union (IUCN) and the World Wide Fund for Nature (WWF), which developed the World Conservation Strategy together with UNEP in 1980. International programmes which have a focus on natural resources, including soils, include the International Geosphere-Biosphere Programme (IGBP), the Global Terrestrial Observation System (GTOS), the Global Resource Information Database (GRID), and, to a limited extent, the ecoregional approach of the Consultative Group for International Agricultural Research, (CGIAR), including the recently launched initiative on research in soil-water-nutrient-management (SWNM).[93] A number of other institutions give specific support to the sustainable use of soils at the global level (see box on page 53), such as the World Association of Soil and Water Conservation (WASWC) and its global network for the evaluation of soil and water conservation, known as WOCAT (see box).

One major criticism at the global level is the relative lack of economic considerations among the current movements for sustainable development. Nor do global agreements like the Uruguay round of GATT, signed in 1994, include ecological considerations. Economic aspects need to be taken up in order to finance proposed environmental programmes and to provide an enabling framework of economic conditions. The real potential of the economic system lies in the restructuring of tax policies, price policies, and financial markets. The exclusion of these two dimensions of sustainability is a controversial issue of global dimensions, and the subject of much current debate.[94]

Another issue of great concern is the question whether a specific global convention, equivalent to those on climate, biodiversity, and desertification, should be devoted to soils or land use in general. There are well-founded arguments both for and against such a convention, relating to effectiveness, cost, and practicability, which need further discussion (see page 82).

3.5 INNOVATION, EXPERIMENTATION AND MONITORING

From Sierra Leone it is reported that Mende rice farmers isolate 2-3 new rice varieties with useful properties per generation. Farm trials are a well-established part of Mende language and culture. It is interesting to see that farmers deliberately test in «'marginal» soil conditions, rather than looking for «uniform» conditions. This reflects their concern to keep open as many options as possible in the face of environmental uncertainty.[99] In most regions of the world, land users – both men and women – continuously experiment and conduct trials with new seeds and plants, as well as new practices and technologies, in order to cope with changing environments and new problems. The need for learning and innovation is accelerated during times of rapid and dramatic change such as land tenure reform, large-scale migration, or the introduction of new technology.

As agricultural researchers, as well as conservationists and extension workers, open their eyes and minds to learn more from land users on all continents, reports about successful local conservation practices are starting to proliferate. Basic assumptions have been shaken: local people are knowledgeable about their land use system and the effects of degradation, and they are also capable of conducting trials and experiments.[100]

As the focus on people rather than on soils or crops becomes more pronounced, research problems and methodologies are being redefined. Researchers are increasingly taking into account that land users operate under constraints which have largely been overlooked, both on test plots and in the laboratory. Land users' and researchers' preferences for different research designs and methodologies may differ substantially.[101] New approaches, based on collaboration between people with local knowledge and the «scientific establishment», are now being developed and put into practice. Hence it is important to be aware of some of the misuses of the participatory approach that have now become obvious (see boxes on page 58/59).

Another important development within the scientific community is that researchers from a very wide range of disciplines are involved nowadays in research concerned with soil and water management. This research is not restricted to soils and crops; it also focuses on new types of co-operation, interactive planning modes, and forms of communication not tried before in conservation work. Meanwhile, of course, there is an ongoing need for laboratory and on-farm work carried out by researchers, such as measurement of erosion and sedimentation under long-term

Researchers are increasingly taking into account that land users operate under constraints which have largely been overlooked, both on test plots and in the laboratory.

Test plots for measuring soil loss under continuous fallow conditions have been used in monitoring and modelling for many decades

Twin catchments are used to compare ecological improvements resulting from soil conservation measures in one catchment with so-called «unimproved» conditions in the other

FIELD TRIAL CATEGORIES: CHALLENGES TO MAINSTREAM RESEARCH IN ASCENDING ORDER OF LAND USER EMPOWERMENT

1. **On-site researcher-designed and managed trials, at local production sites**
2. **On-site researcher-designed and user-managed trials**
3. **Joint design and management of on-site trials by researchers and land users**
4. **Trials designed and managed by land users, in consultation with outside researcher(s)**
5. **Trials designed and managed by land users**

Source: D.E. Rocheleau[103]

Participatory planning approaches are a promising tool for knowledge integration – an example from Ethiopia

DANGERS IN PARTICIPATORY LEARNING AND ACTION (PLA) WORK

Participatory planning processes demand time from local land users. Many land users are involved in a daily struggle for survival and simply cannot afford to participate. This is one of many reasons why the poor are often left out of development planning. But people involved in participatory planning exercises frequently find lengthy co-operative procedures with outsiders a waste of time. «Why can we not just solve the issue in an hour or two with a local extensionist who is already familiar with the situation?»

Many people do not want to participate in collective processes. But should they simply be left out in countries where more conventional extension services are being replaced by participatory learning and action processes?

Those who initiate participatory processes often have a superficial understanding of how power is distributed locally. Consequently, they may expose vulnerable groups in ways that are harmful. It is a well-known fact that elites commonly monopolise public gatherings. Participatory planning may therefore strengthen the position of such elites rather than provide opportunities for less privileged groups to improve their lot. Experience has shown that even development projects directly targeted at the poor often fail to include the most marginal groups.

The initiative for «participation» usually comes from outside donors and may be a condition for support rather than an open, non-binding offer. This is because its ultimate rationale is to serve the needs of current debate in the West just as much as perceived needs in local communities, although this is not openly acknowledged. By giving farmers freedom of choice, policy-makers and project staff in the field transfer the responsibility for success or failure to the land users themselves. Participatory exercises are usually performed unprofessionally and do not correctly reflect local conditions and aspirations. They may in fact be a form of coercion in the guise of democracy. Too many cases have already been reported in which «consultants» describe quick, sloppy work using the rhetoric of participatory learning and action.
Source: After J.N. Pretty et al., 1995[104]

controlled and field conditions. There is a need to validate both existing local experience and development experience in various settings and make it accessible to scientists, as well as to people concerned with technology and development, all over the world. This is also the primary aim of the WOCAT programme (see box on page 55).

Because soil and water conservation now encompasses a wider range of disciplines than before, the need to monitor what actually happens on the land is even more urgent. In particular, it should be emphasised that whoever finances external interventions also has a responsibility to provide funds for analysing the dynamics of man-environment systems and for monitoring the impacts of such interventions on local societies and natural resources.

Apart from keeping track of environmental changes, monitoring should also cover the whole range of variables now considered vital in soil and water conservation. These include social and economic conditions, changes in policy at different levels, institutional and legal capacities at all levels, and the framework of economic conditions. Above all, the conditions that affect local land users are particularly important. Monitoring should be designed to address their concerns.

There is a need for changes in approach that reflect the above concerns. Monitoring has traditionally been much too restricted in scope and time, and has usually been restricted to registering ways of fulfilling specific project targets, such as the number of seedlings produced, or the number of farmers trained. Projects should assume responsibility for undertaking comprehensive studies of environmental and socio-economic changes in the areas where they are active. In order for monitoring to be effective, it is important to develop land degradation indicators. The recent initiative on land quality indicators led by the World Bank could be useful in this regard.[102]

Furthermore, local land users should be involved in both the design and the execution of monitoring. Experience shows that when people study their own environments they are far more interested in the results, and they also put greater trust in what they learn. Their opinions and experiences carry great weight. Involving them directly is probably the best guarantee that interventions will lead to more sustainable forms of resource use.

3.6 CONTROVERSY OVER MOMENTUM

Current debate suggests that the best momentum in soil and water conservation work can be generated if the needs, the knowledge and the objectives of local land users are taken as the starting point. However, local land users, especially in developing countries, are primarily concerned with the daily struggle for survival and therefore do not perceive soil and water conservation as an immediate need. Nevertheless, local land users can be supported, and should be assisted, through research and through the many agencies, institutions and networks that exist to promote soil and water conservation, all of which can serve as enabling structures.

Local efforts by land users could be even more valuable if greater effort were put into monitoring the impacts of natural resource management and projects, and if these impacts were measured with a long-term perspective. Maintaining soil quality – i.e. land husbandry – is now being emphasised as a means of obtaining higher yields and promoting better management. The other current emphasis is on participatory learning and action processes. Often, however, participation does not take account of wider implications that go beyond the immediate environment of groups of land users. One example is the downstream impacts of soil erosion and soil conservation, which point up the need to protect other land users from floods, sediment accumulation, or drought. Questions of compensation for disadvantaged users are highly complex and have political implications. One famous example is the Nile basin, where Egypt and Sudan have signed a treaty stipulating that they will share the waters of the Nile. The area upstream which is the source of the river was not included in negotiations, however, even though there is great fear that Ethiopia may be withholding water for its own purposes.[105]

Participatory planning often expands the number of local groups who get a chance to influence both their own lives and conditions in their communities. The examples of «negotiated settlements» provided above illustrate success in this context. Participatory planning can also expand the horizons of extensionists and researchers. Processes of negotiation automatically reveal how the staffs of ministries and aid agencies perceive their obligations and their roles, and how politicians and other leaders as well as farmers, entrepreneurs and other local actors perceive their roles. This is another important benefit of participatory approaches.

ISSUE 1 THE USE OF ENVIRONMENTAL ACTION PLANS

OPINION: Global agreements like the Convention to Combat Desertification, or Agenda 21, which was produced by the UN Conference on Environment and Development, are important steps towards ensuring sustainable livelihoods and environmental protection. They have drawn the world's attention to environmental threats. Governments, municipalities and NGOs are now formulating local environmental action plans. A total reorientation is underway.

ISSUE 2 THE ROLE OF REGIONAL ENVIRONMENTAL INSTITUTIONS

OPINION: Regional networks can compensate for the monopoly on information and knowledge enjoyed by the major world powers. Good methods of resource management can be documented and disseminated at the regional level, which is a tremendous boost to environmental work. At the same time, scarce resources can be preserved. These networks can also provide a breathing space and new outlooks for people living under authoritarian regimes.

ISSUE 3 STAKEHOLDERS IN RESEARCH

OPINION: Local people who have experience with natural resource systems are easily overlooked by the scientific community. But everyone stands to gain if the experiences of those who live on the soil are taken as the basis of research. New areas of research will open up. Moreover, natural resource management can be improved and poverty alleviated much more rapidly if enabling policy-making and economic structures and incentives are developed for land managers than if further investments are made in research.

COUNTER-OPINION: Single-minded solutions to the complex interactions of people and environments never work. There is every reason to be sceptical about environmental action plans imposed by global institutions, aid agencies, or national governments. Basically, these plans reflect the interests of external institutions, both in the way that problems are described and in terms of suggestions for action. To make things worse, environmental action plans are often forced on impoverished nations as a condition for loans and aid. When this happens, they become vehicles for top-down planning.

COUNTER-OPINION: Many regional environmental institutions have developed their own agendas and products which they then try to shop out to «target groups». This is nothing but development turned upside down. Institutions should get to know the needs of land managers and allow them to guide their activities. It is time to reassess the role of regional institutions.

COUNTER-OPINION: Technologies will emerge to mitigate the problems of land degradation, provided that enough money is made available for basic and applied research. Science has already solved many crucial problems. Therefore, research institutions should be given a totally open mandate to generate the new knowledge that may best serve both human societies and the environment.

Economic factors can be a key to generating momentum in conservation work. Land users improve their land when it pays for them to do so. This is a significant development to which we can all contribute by trying to influence public opinion and encouraging decision-makers at the national and international levels to use economic tools to promote sustainable forms of natural resource management. Several questions must be addressed in this regard: Are we using resources efficiently? What role do taxes and subsidies play? Are we sharing the burden of reducing soil degradation risks? Are we saving enough for the future? What is the source of the wealth of nations, and how have the poor fared?[106] The importance of economic factors is painfully visible in the difficulties poor land managers face in taking good care of their land. For this reason, conservation and efforts to alleviate poverty must be combined in developing countries. Without such a combined commitment, conservation may even constitute an offence against the poor. This is true in a local context as well as in relations between poor and rich countries.

Many of the issues touched on in this chapter are controversial, and the authors themselves are not in agreement on all the details about which types of momentum are to be reinforced and which are not.

PROFESSIONAL KNOW-LEDGE

GRASSROOTS EDUCATION

EXTENSION AND TECHNOLOGY

4 GENERATING AND DISSEMINATING KNOWLEDGE

THE ROLE OF SCIENCE, LOCAL KNOWLEDGE AND EDUCATION

ENABLING ENVI-RONMENT FOR LEARNING

When land users decide on management practices, they usually base their activities on their own experience and knowledge. This local knowledge, accumulated over generations, has come under pressure in today's rapidly changing world.

Many parts of the world experiencing rapid population growth are being forced to cope with a growing demand for food. Local knowledge systems sometimes no longer function under present circumstances. This is the case in Ethiopia, where local knowledge in many places has become irrelevant, given the accelerating rates of soil erosion due to population pressure, the political context, and the lost resilience of some soils, which were originally barely susceptible to erosion and thus did not require immediate action until it was too late. In other cases, care of the land has intensified, as in Bolivia, where similar pressures forced accelerated adaptation of the farming systems in some places. This has also occurred in the Machakos District of Kenya, where a combination of factors - including the nearby market in Nairobi, extension services, and innovative farmer communities - has been responsible for successful adaptation to a marginal environment, which was subsequently transformed into a high-potential agricultural area. Due to rapid change in economic, ecological and structural conditions, local knowledge systems are often inadequate to cope with contemporary problems. Creation, improvement, testing and integration of different knowledge systems is therefore a major challenge in the process of developing sustainable forms of land use.

Enabling people to acquire, disseminate and make the best use of knowledge about sustainable land use practices means empowering them to cope with their own problems. But what means are available to do this? The process of acquiring and refining knowledge must start with basic education, training and experimentation at the grass-roots level through participatory land use research, and rapid or participatory rural appraisals which draw attention to local skills and knowledge. Second, additional skills are badly needed at higher levels. These can be attained by capacity-building to benefit planners, politicians, and scientists, including provision of better inventories and databases for planning and for devising scenarios. Third, knowledge will be disseminated through extension and technology transfer, but also through primary education, the media, and training at all levels, thereby enabling people to make use of the information they receive. Fourth, an enabling environment should be created for learning. Its elements would include a legal framework that permits free distribution of information, and the decentralisation of decision-making power.

4.1 CREATING A POSITIVE LEARNING ENVIRONMENT

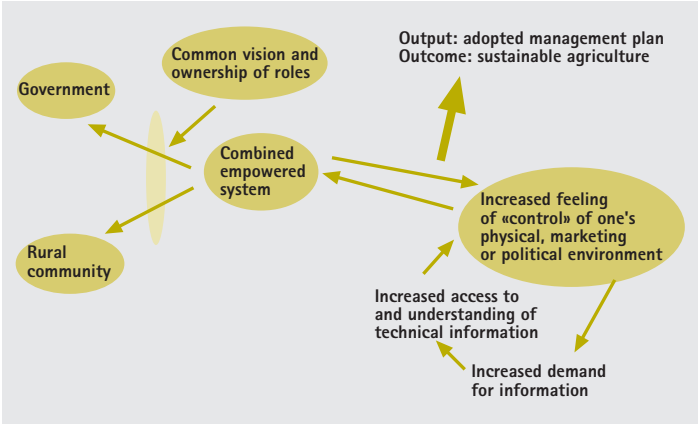
There are solid reasons why land users, field workers, professionals or politicians might not want to share their knowledge or be open to knowledge possessed by other people. It is often safer to erect a barrier around one's own knowledge system, create a jargon so that others do not understand it, and restrict access to one's friends – or to those who pay! However, if we really want to reach people – to enlist their support in protecting the physical environment and engage them so completely that our concerns become theirs, and theirs ours – then barriers are inappropriate. We must therefore consider how to create the right environment for learning and how to foster openness to knowledge characterised by respect and understanding for different views rather than conflict and rejection of what is not part of one's own knowledge system. Put another way, people must have good reasons why they should share their know-how, their understanding of the physical world, and their concepts of a sustainable society.

Formal basic education develops our ways of thinking and reinforces stereotypes in science and myth. Because sustainable agriculture is partly concerned with accessing and implementing many types of knowledge shared by different people for different reasons, we must rethink the structure, orientation and style of basic education and educational institutions (schools, colleges and educational publications). For many authors,[107] the main obstacle to promoting sustainability is rejection of human intuition, cultural development, and community awareness (local «myths») in favour of Western-based paradigms of scientific methodology («hard facts») as the basic means of exchange of knowledge. In what follows, several criteria for fostering a positive learning environment will be proposed.

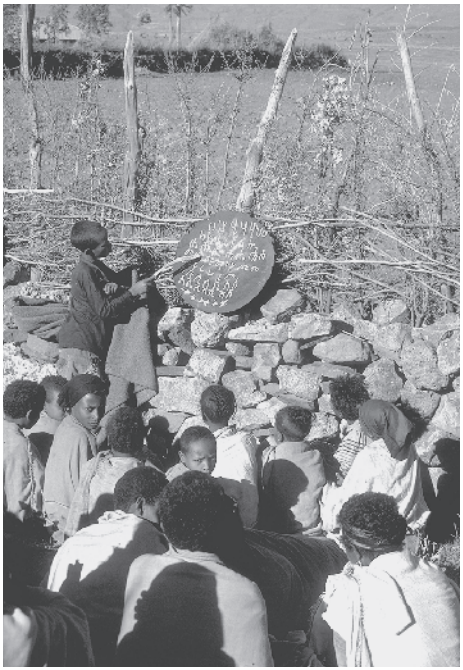
First, people would learn from others and by direct experience, through «participant observation», accepting non-standard sources of information, data and observations such as oral history, folk wisdom, intuition, emotions and feelings. Second, science would be seen as a set of provisional hypotheses, to be constructed, reconstructed and reformulated as additional knowledge becomes available. Third, in place of separate disciplines, multi- and inter-disciplinary institutions would be created under one roof to provide an institutional setting in which different forms of knowledge are equally acceptable. Fourth, the reward structures in education for both student and teacher would be changed, affecting exams, career development,

Professional education is a forum for embracing all sections of society.

Empowerment and information in Australia's landcare movement. Source: Gibbon et al.[109]



Learning with chalk and roasting iron as a substitute for a black board in Ethiopia



SUSTAINABLE CONVERSATIONS

The Australian Hawkesbury model of educational development, pioneered by Richard Bawden, structures professional agricultural education around what Bawden calls «sustainable conversations»; i.e. open discussion between and within all groups in society, especially to address conflict and subjects of mutual interest:

rural people	**x**	**city dwellers**
young	**x**	**old**
women	**x**	**men**
students	**x**	**lecturer**
theoretician	**x**	**field worker**
industrialist	**x**	**agriculturalist**

Nobody is external to the learning experience. The Landcare movement (see box on page 42) is, at least partly, based on revised notions of how to learn. Source: R. Bawden, 1990[110]

A SUSTAINABILITY NETWORK IN ACTION

INFORUM, an e-mail network to support sustainable agriculture, was in operation for part of 1994. It was an international electronic conference on sustainability indicators involving 500 participants. It was moderated, but not controlled, from UNDP. Everyone, provided they had e-mail (admittedly a problem for some countries), had equal access and absolute freedom. The main positive learning environment features were:

- **all members participated voluntarily**
- **joint activities were encouraged, especially amongst unlikely partners and between locations where such activities had previously been impossible**
- **individual autonomy was sacrosanct**
- **structure was informal and participation was easy to encourage**
- **little or no cost to the individual.**

It is perhaps no coincidence that many of these attributes are also prerequisites for soil and water conservation! Source: M.A. Stocking[111]

prestige and pay. Some personal attributes and skills which are also desirable for promoting sustainability might also be added here, such as modesty, patience, tolerance, open-mindedness and support for as well as acceptance of others.

There have been some revolutionary paradigm shifts in methods of communicating knowledge, such as participatory learning, but in general the academic community has remained resistant to change. A FAO study in 1994,[108] which reviewed 20 national case studies of agricultural education and agricultural extension found only cosmetic attempts to integrate environmental and sustainability issues into curricula and educational practice. However, some innovations have taken place (see box). If sustainability is to be more than a concept to which we merely pay lip-service, professional education must incorporate all sectors of society that interact with land use, i.e. everyone!

The ultimate goal is to make education and training a shared experience among equals. But this is difficult in societies which do not promote equity, freedom of expression or independent thought – a problem to a greater or lesser degree in all countries, whether they are rich or poor, temperate or tropical, agricultural or non-agricultural. Training is therefore needed in facilitation techniques, management and leadership skills, literacy and numeracy, public speaking and listening, and other skills related to learning and communication. A simplified relationship between empowerment and the demand for information on sustainable agriculture is shown in the diagram.

The revolution in information technology has failed to keep pace in agriculture and related fields. In terms of creating positive learning environments, technology can be both a blessing and a curse. It spawns «experts» and jargon, and it excludes certain groups; it can be a very divisive force in society and can constitute a threat to learning. But it also creates opportunities for sharing and gaining access to information when wisely managed. National and international networking groups are flourishing in many fields, while the Internet and the World-Wide-Web have only very recently begun to demonstrate the electronic potential for interactive bulletins and exchanges of information.

4.2 TAKING ACCOUNT OF LOCAL KNOWLEDGE

Basing technological improvement on local or indigenous knowledge has become a new paradigm in soil and water conservation.[112] It is preferable to refer to «local knowledge», however, since this implies not only the historical character of knowledge gained by land users in a certain locality or culture but also indicates that adaptive learning has taken place.[113] Local knowledge systems may be characterised as the sum of all experience and knowledge shared by a given group which forms the basis for decision-making related to familiar and unfamiliar problems and challenges.[114]

In many local knowledge systems farmers and pastoralists, men and women, the young and the elderly, all have different roles. Women generally have distinct socio-economic positions, linked to the gender division of labour, and therefore they also have distinct knowledge and experience. In many cases women have been found to possess greater knowledge about food production and the quality of food, and they attach greater value to maintaining agricultural productivity and a healthy environment. Men, on the other hand, tend to focus more on short-term benefits and production for the market.

Local technical knowledge reflects natural and societal factors, and is embedded in social organisations as well as in cultural traditions and preferences. Land users' knowledge systems are dynamic; land users themselves continuously interact with the environment and make changes as they encounter new problems. Among the characteristics of local technical knowledge are low external input in materials, the low risk usually associated with the technologies at hand, and the fact that it is based on the preferences and skills of local society. An analysis of the social and cultural context is necessary to understand and decode the significance of «local knowledge» in scientific terms.[115]

Among the well-known examples of local technical knowledge are the irrigated rice terrace systems of South-East Asia, such as those on the island of Bali, where land users have developed a perfect irrigation system on terraces in steep mountainous areas over the centuries. Rainfed terraces, generally sloping outwards, are traditional in many countries such as Nepal, where they exist side by side with irrigated terraces. Sloping terraces are essential to prevent too much water from being retained, and their construction does not involve a great deal of labour. Highly developed terrace systems for water conservation and water harvesting are found in the highlands of Yemen on the Arabian peninsula, where they were constructed thousands of years ago. Semi-arid conditions forced land users here to level the ground in order to retain all rainwater as well as run-on from adjacent rocky hillsides and fields. In the Andes Mountains, perhaps the best known terraces are those in the pre-Columbian settlement of Machu Picchu, although it is possible that they were constructed primarily for military defence. In Africa[116] impressive systems of soil improvement have been developed in the Sahel zone (see box on pages 68/69). Even in Ethiopia, where high rates of degradation have produced extreme conditions known to the whole world, there are as many as 38 different traditional soil and water conservation technologies.[117] But these technologies have not been sufficient to keep soil erosion below tolerable limits. Nowadays other local systems are failing as well, owing to external pressures which they were not designed to resist. For example, the terraces in Yemen, which have sustained land use for centuries, started to degrade at an alarming rate in the 1970s when young Yemeni males emigrated to work in the oil fields of Saudi Arabia. Maintenance work on the huge dry masonry stone walls that retain the terraces was neglected. The walls subsequently began to collapse at an unprecedented rate because there was no longer an adequate labour force available in the villages to repair them.[118]

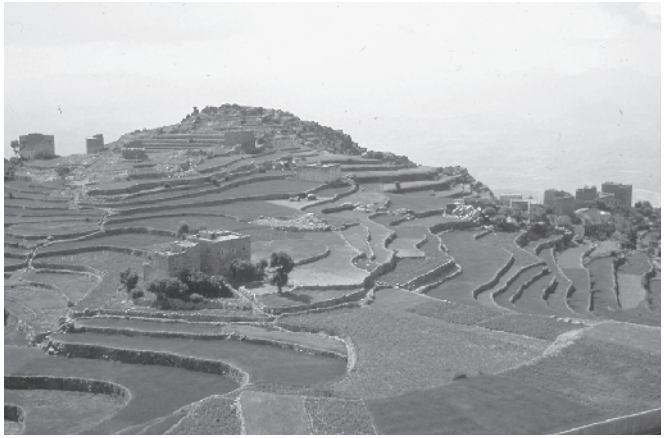
The local knowledge and practices of land users are key inputs in the continuing development of resource management systems. Established forms of land use and conservation have sustained people over time in fragile environments and must be supported. Recognition of the value of local knowledge does not imply a wholesale rejection of modern technologies. Recognition of local techniques can help to identify practices suitable for adoption or adaptation, with a view to improving or reinforcing accepted methods and processes without destroying local societies and environments.

One of the principal objectives of research at the local level is empowerment of the land users. It is therefore necessary to accept land users as partners and collaborators in defining and analysing problems, setting priorities, and testing and evaluating technologies. Enhancing the local capacity for research means allowing for some local control over the content and direction of research in addition to generating and adapting technologies for sustainable land use and soil conservation.

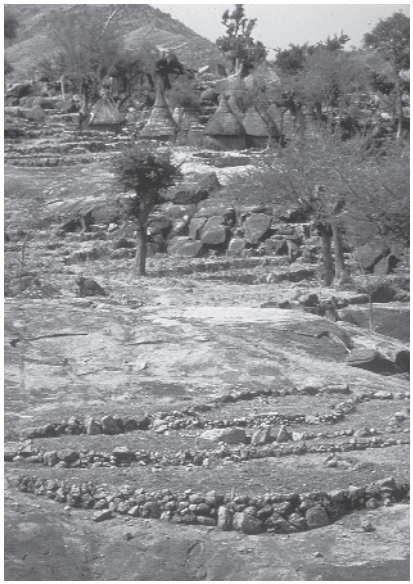
At the same time, the scientific community must become more

«We need to understand not only what people do but why they do it and how they understand what they know and do» (C. Longley and P. Richards)[119]

Rainfed terrace systems in Yemen



Marginal terraces in North Cameroon



ORGANIC FARMING IN GERMANY AND SWITZERLAND

In Germany ecological farming has developed considerably during the past 20 years. Whereas in 1975 only 250 farms practised ecological farming, by 1995 3,800 farms declared that they were practising organic or ecological farming. Ten different trademarks for ecological farm products (among them, DEMETER, BIOLAND, and NATURKOST) are now recognised by the «Association for ecological farming». Members have to make several commitments:

- renouncement of chemical herbicides and inorganic fertiliser
- protection of soil fertility
- livestock husbandry based on on-farm forage cultivation (not more than 20% of the fodder required may be bought elsewhere)

Members of the association take advantage of a well-known registered trademark and marketing services when marketing their products. Farm products with this «green» label are not only sold on farms but are widely available in supermarkets, thus ensuring the competitiveness of ecological production.

In Switzerland as of 1995, there were 157 farms producing according to the DEMETER principles, while as many as 2,300 farms practised «ordinary» biological farming techniques. Despite these opportunities, however, one should not forget that all ecological farms in Switzerland together cultivate less than 3% of the country's usable land.
In Germany it is very likely that the proportion is even much smaller.
Source: A. Trux[121]

THE IOWA LESSON

In the mid-1980s more than 200,000 farms in the USA went bankrupt as a consequence of falling crop and land prices. As a major wheat producer, Iowa paid a high price in this crisis. Shops and banks were also forced to close as part of a chain reaction effect, and 80,000 people left the region. Some islands of stability remained, however, including the old order Amish community. Amish farms, which use organic farming methods, seemed better able to withstand the crisis. They are much less dependent on external inputs like synthetic chemicals, and produce much of their own food as well as a greater variety of crops than conventional Iowa farming systems. These features are linked with a management approach that considers protection of land for future generations as important as yield or profit. Amish farms in Iowa proved to be profitable enough to survive this crisis.

As a result of the lessons learnt from this experience, among others, the Centre for Indigenous Knowledge in Agriculture and Rural Development was founded at Iowa State University. The purpose of the centre is to preserve, record and disseminate local knowledge.
Source: D.M. Warren, 1994[122]

Farming in Iowa

A TRADITIONAL TECHNIQUE IN THE WEST AFRICAN SAHEL: ZAÏ AND TASSA

Hand-dug planting pits called «zaï» or «tassa» are a traditional practice in parts of Mali, Burkina Faso and Niger. During the early dry season, pits are dug with a diameter of 20 to 40 cm, a depth of 10 to 15 cm, and a distance of 80 to 100 cm from each other. The earth removed is used to build a micro-dam, so that the pit acts as a micro-catchment, collecting the rainfall from the crusted surface between the pits. Soil fertility is improved by adding manure, which also attracts termites that improve the soil.

Zaï system in the Sahel

This labour-intensive practice was apparently abandoned and superseded by the plough during the decades from 1950 to 1970, when there was sufficient rainfall in the Sahel. Other reasons for abandonment include the cultivation of valley floors, and the lack of a labour force when people left rural areas to earn cash income in the cities or in coastal countries. In recent years this practice has been successfully revived in projects in Burkina Faso, Niger and Mali, and has also spread without any project support. In the north of Niger, the surface area regenerated by «tassa» in the past two or three years has been estimated at several thousand hectares. Increasing problems of crusting and compaction, as well as pressure on the land, are apparent reasons why farmers have come to appreciate this technique once again. Women in Mali and Niger occasionally mentioned the advantages of being able to integrate the construction of some of these pits into their daily work schedule more easily. They can spread their land care work over a longer period if necessary, using those hours or periods during the course of the year when there is less work. Opportunity costs for labour are therefore lower for «zaï» compared to practices that require mobilisation for several days at a time.

One side effect of this practice even promotes agroforestry. Manure contains tree seeds that will germinate in the pits. Most of them are removed, but in every fifth pit farmers let leguminous trees grow for fodder. In order to protect them during the first year, millet stalks are cut one meter above the ground, so that they form a fence against goats.
Source: V. Kabore, E. Roose and C. Guenat, 1995[120]

aware of the cultural and social context in which land use activities take place, and attempts must be made to work in accordance with the beliefs of local populations. So far, formal research institutions have largely failed to incorporate an understanding of local knowledge and the local context into policy frameworks, with the result that the planning and implementation of projects often has negative impacts. New understanding implies the need for new institutional and organisational forms, as well as new research approaches and methodologies, which will strengthen the ability of land users – women and men, young and old – to place their needs on the development agenda while simultaneously strengthening their own autonomous traditions of innovation and production.

In the industrialised countries, modern production systems have not only caused a loss of biodiversity but have also been responsible for pesticide and antibiotic residues in food as well as polluted soils and surface waters. This has resulted in the formation of movements to restore and safeguard local knowledge, which was on the verge of being lost. Many people have become interested in healthier and more environmentally friendly and sometimes traditional agricultural practices and methods of food production. Food that is organically or «ecologically» produced is eligible for labels which testify to its high quality, for which a growing number of consumers are willing to pay higher prices. Organic farming is characterised by mixed cropping, crop rotation, recycling of farm residues such as animal manure and green manure to fertilise the soil, minimum inputs of mineral fertilisers and pesticides, no herbicides, integration of livestock and agriculture, and avoidance of heavy machinery in order to minimise soil compaction. Mixed cropping technologies are often based on traditional practices that have been abandoned due to accelerated mechanisation and modernisation of agriculture. This shift to organic farming involves sacrifices – at least for a certain period – which can be seen in decreased income and productivity at the farm level. In order to cope with these economic difficulties, and to guarantee reliable production standards for the consumer, organic farmers have organised themselves into associations (see box on page 67). Another example from Iowa (see box) illustrates how organic farming can even enjoy competitive advantages over conventional, high-input farming.

4.3 ADVANCING THE SCIENCE OF SUSTAINABILITY

A combination of science and economic interests provided the primary impetus for agricultural modernisation. Today, three distinct types of agriculture can be distinguished[123]: industrialised agriculture, the green revolution, and low external-input, so-called traditional agriculture. The first two have benefited from technological packages to become high-input systems, whereas the latter has been described as the «forgotten agriculture» – forgotten because it is often practised in marginal and inaccesible places, e.g. drylands, wetlands, mountains, and forests – and because it is perceived as having low productivity and low potential. However, nearly 35% of the world's population is directly supported by this type of agriculture, and it has been held accountable for causing an even larger proportion of the world's land degradation.

Yet the fact remains that technology-based progress has been responsible for most advances in agricultural production, without which it would not be possible to feed the world's population (see box). There is a question of the extent to which sustainable agriculture can translate scientific principles into technological practices that will benefit the degraded and «forgotten» third of the world's agriculture by raising its productivity in sustainable ways. And there is a further question of the extent to which the same scientific principles are responsible for current degradation affecting the other two-thirds of the world's agriculture. Answers to these questions depend upon social, cultural, economic, educational and political conditions. In highly developed societies fundamental changes in life-style, involving such things as dietary habits, mobility and infrastructure, will have to take place in order to allow the majority of the world's population to enjoy a greater share of overall production. Ethical principles for sustainable development will have to be adopted at a global scale first, and goals and priorities will have to be set by society.

These questions will have to be resolved partially by technologies that can fulfil multiple objectives such as supporting safe and ecologically viable land use, enhancing rural livelihoods, reversing social inequities, and meeting people's cultural and social preferences. These are the real challenges for science, and are ambitious demands. Science cannot just concern itself with technological development; it must adopt selection criteria which allow for the integration of non-technological factors. Some scientific methods will have to be modified to make them more responsive to societal demands. At the same time, science must

Science-based knowledge achieves some advantages – but at a cost.

OUR DEPENDENCE ON SCIENCE-BASED AGRICULTURE

Half of all rice, wheat and maize areas in the developing world are planted with modern (Green Revolution) varieties. 70-90% of recent increases in production have arisen from improved yields rather than from expansion of the land area under agriculture.

In Asia, per capita food production has increased 40% since 1965, largely because of modern farming methods and inputs.
Source: World Bank, 1994[124]

SCIENCE IN SOIL CONSERVATION IN SMALL-SCALE AGRICULTURE

The Instituto Agronómico do Paraná and its counterpart agricultural research organisation in Santa Catarina, both in southern Brazil, started intercropping experiments in the 1970s with the main cereal (maize) and legumes in order to enhance yields. It was shortly discovered that maize combined with Velvetbean (Mucuna pruriens) made an ideal combination cropping system which:

- **increased grain yield by two to three times**
- **decreased fertiliser inputs**
- **combined easily with small-farm minimum tillage and «plantio direito» (direct drilling, often by hand)**
- **gave excellent weed control because of the thick Mucuna mulch**
- **considerably relieved the main farming constraint - lack of labour.**

In addition, it was often unnecessary to replant the Mucuna because it set seed naturally in favourable years and germinated after the main growth period of the maize - thus offering almost perfect temporal complementarity.

As a product of the state's agricultural research systems, Maize-Mucuna was a resounding success. However, some of the key ingredients that went into this success were distinctly local – the good soils necessary to grow good legumes; cold in winter to kill the leguminous cover crop and give good mulch; farmers with specific labour demands and constraints; severe land pressure; and few alternative employment opportunities, which necessitated intensification.
Source: M.A. Stocking[126]

CONSERVATION TILLAGE

Probably the single most significant advance in soil and water conservation in the last twenty years, «conservation tillage», consists of a package of techniques designed to maximise surface residues and minimise soil disturbance on arable lands. Surface residue cover is known to greatly reduce soil erosion. As residue cover approaches 100%, soil erosion approaches 0%; with 50% residue cover erosion reduction is about 83%; when residue cover is 10%, erosion reduction is still about 30%.

Partly out of concern for the construction and maintenance costs of broad-base terraces (the then-recommended conservation approach), the US Agricultural Research Service devised an alternative system using the properties of surface crop residues to reduce water, soil and nutrient losses. Under some conditions, this is a completely no-till system, involving direct drilling and herbicide treatment for weeds in addition to high inputs of nitrogenous fertiliser to counteract biological nitrogen fixation. On other soils, it involves reduced tillage with disc or chisel plough.

Between 1980 and 1993, the area devoted to conservation tillage grew to 40 million hectares in the USA. For many (but not all) farmers, this approach constitutes an attractive package that reduces cultivation costs considerably. On some soils it is said to increase yields substantially through better nutrient retention and soil humidity. The costs come in the form of greater use of herbicides, investments in expensive machinery for direct drilling and reduced tillage, and somewhat greater risks of disease with organic mulch. On balance, the take-up rate for conservation tillage in the US suggests that the benefits outweigh the costs under most conditions.
Source: W.C. Moldenhauer et al, 1994-95[125]

retain its considerable strengths in experimentation, analysis, data processing and innovation in order to continue offering the choices that society wants.

What does science have to offer? And what adaptations in traditional forms of agricultural and land use science are suggested by current trends? Scientific methodology consists of a well-developed set of procedures involving the formulation of hypotheses, significance testing, and basing conclusions on observable and measurable phenomena which are normally credible (see box). Experimental techniques include sampling and experimental designs which allow comparisons to be made between single variables and groups of variables, an approach that is particularly useful for comparing the potential advantages of new technologies such as conservation tillage (see box). Laboratory and statistical analyses provide quantitative information upon which to base decisions. Finally, model-building and simulations allow simplified constructions of real world systems which can be used to predict possible changes and to extrapolate the results of experiments to unmeasured conditions. Current trends in science are moderating some of the shortcomings in research and making scientifically-based recommendations more applicable and appropriate. On-farm experiments potentially encourage, but do not guarantee, land user participation. Participatory Learning and Action (PLA) is gaining acceptance as a tool useful in generating socio-economic criteria for the design and analysis of experiments. There is a greater willingness to research alternative land use strategies, such as low-input systems, intercropping and agroforestry (see box). On a more basic level, the relationship between local and scientific knowledge systems can be improved by clarifying the ethical differences that are present among people from different backgrounds. Here, qualitative empirical methods of social science research, particularly actor-oriented «stakeholder» approaches, have evolved as the tools for bridging ethical gaps.

4.4 **INTEGRATING** KNOWLEDGE SYSTEMS

There is abundant evidence that most soil and water conservation projects make use of only one knowledge system – the technical-scientific – and as a consequence they usually fail. The reason is that each knowledge system has different goals and different means of achieving them. Thus, for example, an engineering approach to soil and water conservation controls soil and water already in motion; a biological approach tries to prevent the soil and water from moving in the first place; and an approach based on small-farm livelihoods will focus on the reliability of the people. Consequently, all forms of knowledge, i.e. those existing in a particular locality, those transported from adjacent areas, those in the minds of scientists, those originating in women's groups, and so on, must be integrated and presented in a coherent fashion. This can be done by developing mutual respect, listening to others, and working out plans acceptable to everyone concerned for activities that will promote conservation.

Co-operation and communication are the essential primary ingredients needed by individuals, organisations, and groups in society. Land users' groups, commodity associations, NGOs, government agencies, and research institutes, each of which have different roles and goals in natural resource management, have to share group responsibilities and work together towards common goals. This way, knowledge becomes multi-disciplinary and more attuned to supporting livelihoods than just conserving soil and water. Co-operation and communication between and within organisations and groups must not be forgotten. Feuds between professionals within one organisation are extremely harmful. Instead of sharing data and making them widely available, individuals have been known to keep their information under lock and key. Scientists can be particularly jealous of their data. But it is not only professionals who have problems. Local conflicts between land users can dominate local concerns to the detriment of mutual co-operation. Tribal antagonism is rife in some places. We have already noted that some of the worst environmental degradation occurs in war-torn countries.

It is not just necessary to talk; it is also vital to communicate in the right place. As the land user is the eventual risk-taker, the best place is in the field - not at the research station director's desk, or at the extension assistant's office. In a way, this is using the main forum – the field – to promote positive discrimination

As the land user is the eventual risk-taker, the best place for communication is in the field - not at the research station director's desk, or at the extension assistant's office.

HOW TO IMPROVE CO-OPERATION AND COMMUNICATION: SOME SUGGESTIONS WHICH HAVE WORKED

In Tanzania, groups of villagers have been helped to travel to other villages with the specific mandate of comparing, contrasting and sharing experiences with natural resource management practices. All participants usually have fun on such occasions.

In northern Thailand, farmers (usually hill tribe people) are routinely invited to professional workshops. Not only do they articulate their own views, but it has been observed that the professionals present display a more open-minded attitude and become more responsive to their clients!

In Rajasthan, India, field researchers often join villagers in digging contour bunds and sediment traps, and in carrying out routine farm operations. They not only learn the techniques, but also how hard it is to implement some of the recommendations!

In Chile, one prosperous farmer has built an education centre specifically to bring townspeople, land users, extensionists and researchers together - well away from telephones, fax machines and the road. Local people work with professionals in pegging terraces and carrying out simple soil analyses of organic matter content and the like. This farmer also has runoff plots for demonstration purposes and for measuring yield decline due to erosion.
Source: M.A. Stocking[128]

AN EXAMPLE OF KNOWLEDGE INTEGRATION FROM INDIA

Considerable benefits may be achieved by integration of knowledge systems. This was proven in a case study from the Shivalik Hills of the Indian Himalaya. Erosion was very severe; large areas were rendered «badlands» as a result of cultivation on steep slopes and overgrazing. The authorities, however, only really became concerned when the local reservoir, built at considerable cost with government funds, was threatened with siltation. The local people were also concerned, but for different reasons. At least there was a common concern, although perceptions of the problem varied considerably.

There was a combined use of local knowledge – adjusting land use to fodder-based systems and keeping improved buffaloes for better milk – and introduced knowledge – mechanical and vegetative erosion control practices. Great increases were recorded in biomass production in agriculture (120%), fodder (600%) and fuelwood/timber (50%). Sediment transport to the reservoir is also calculated to have decreased by 92%.
Source: C.A. Scott and M.F. Walter, 1993[129]

CHARACTERISATION OF SOIL TYPES BY ANDEAN FARMERS:

Quechua denomination norms	m.a.s.l.	Management and conservation
«Pata Jallpas» (soils in the higher zone)	3800-4000	Crop rotation: 2-3 years, without leguminoseae Fallow period: 8-9 years Construction of contour bunds or drainage ditches
«Chaupi Jallpas» (soils in the intermediate zone)	3600-3800	Crop rotation: 3-4 years, with leguminoseae Fallow period: 1-5 years Construction of contour bunds
«Ura Jallpas» (soils in the lower zones)	3500-3650	Crop rotation: 4-5 years, with legumioseae Fallow period: 1-3 years Construction of terraces or contour bunds

Source: AGRUCO, 1995 [130]

in favour of the land user's own knowledge (see box). Even more important, the field is the only place where most of the immediate relevant aspects come together and where their potentials and their constraints can be exposed – broadly seen in terms of land, labour and capital.

Very often, local and scientific knowledge systems must be seen as complementary. Communication can take place between them in a framework of intercultural dialogue. Positive examples exist to illustrate this. In Ethiopia, traditional drainage ditches, which farmers ploughed on their land after seeding in order to drain surplus rainfall at the onset of the rainy season, were integrated into graded grass strips or graded bunds, which served the same purpose but were more efficient and more permanent and still effective in draining excess water while holding back much more sediment.[127]

One of the greatest barriers to integrated knowledge is the language we use – the jargon of our disciplines, the data from our analyses, and ways of classifying natural resources. Take, for example, Soil Taxonomy – a term that even baffles non-soil professionals. The bottom line is that everyone, local people and professionals alike, needs to have a common language and means of communication. For example, Andean farmers classify soils according to their suitability for local farming systems rather than in absolute terms. Other examples of such relative forms of classification are categories relating to the requirements for fertiliser, the risk of frost, the need for fallow, and altitudinal zonation (see box).

4.5 CONTROVERSY OVER PRIORITIES

Creating, disseminating and managing knowledge for sustainable land use requires the patience of Job, the wisdom of Solomon and the skills of a juggler. What has been outlined in this chapter calls for a huge commitment on the part of all sectors of society to be much more responsive to people in other societies and to competing knowledge systems. The most controversial question to ask, then, is whether this can be accomplished with imperfect human beings, societies and institutions. Or are we just being naive? Let us conclude by considering several difficult issues related to agricultural knowledge and sustainable development.

ISSUE 1 REFORMING EDUCATIONAL SYSTEMS

OPINION: Creating a positive learning environment for sustainability will require a radical restructuring of education and training, and society and political institutions will have to be supported in accelerating and guiding the process. Tinkering with the curricula, or adding one or two extra courses, or putting a video screen in the lecture theatre, or letting some professors retire early will not suffice to fulfil societal needs for maintaining healthy soils, land, and the environment. New ways of learning demand new ways of teaching.

COUNTER-OPINION: Scientific education systems have always enjoyed the freedom of self-determination because only the members of institutions concerned with science have the competence to know what is best for them. Public knowledge is not sufficient to tackle the contemporary need for scientific restructuring.

ISSUE 2 THE IMPACT OF SCIENTIFIC KNOWLEDGE

OPINION: We do not have the time to wait until science can accomplish all the tasks that society needs and expects. We already know enough to take social and economic action now. We could engage in participatory negotiations with concerned stakeholders, and induce change without waiting for technological innovations. Assuming that the peasant has all the answers, however, is probably as wrong as assuming that science can solve the problems of humanity. Each assumption is part of the problem, and each part of the solution. The trick is to strike a balance.

COUNTER-OPINION: Science could solve mankind's problems if only scientific models were more comprehensive and better calibrated. We are limited by the amount of scientific knowledge we possess; one day we will be able to model the real world, including its social, economic and cultural systems, and be able to come up with technological packages exactly tailored to the complexity of diverse environments and complex societies. We should redouble our investments in science, bigger computers, more sophisticated models, and greater expertise in the natural and social sciences. If we do, we are bound to find the answers to our environmental problems.

ISSUE 3 THE DISTRIBUTION OF RESEARCH FUNDS

OPINION: There is a need for more accurate research, particularly in agricultural economies, where less than 3 percent of global research funds are invested.[131] Present estimates of soil degradation, for example, are highly uncertain, and the published rates show a disconcerting variance. What we need is greater effort and additional resources, so that the skills of the world's scientists can be focused on the problems of sustainable agriculture in fragile, sensitive, tropical and subtropical environments, where most of the world's poor people live. Scientists should be doing all they can to create a sustainable, equitable society, while doing good science at the same time. But they will need adequate resources – money, time and manpower – to accomplish this immense and challenging task.

COUNTER-OPINION: Consider the land user: he or she has been managing resources for decades. Land users represent generations of on-farm «experiments» right before our eyes. Why look further? Let us use research funds and make them available to support local action. Of course, there are things that land users cannot know. Outside experts may suggest one or two modifications. But the land user is the main expert. The most appropriate body of knowledge is contained in the minds of local people and is put into practice in local fields. And the most appropriate analytical and decision-making functions are those that involve the mental processes of the land user. To understand the contention that local is best, we must ask who takes the risks. The answer is local land users - if they get it wrong, then they bear the burden. If we get it wrong, they still bear the burden.

ISSUE 4 EXTENSION FOR RURAL SUSTAINABLE DEVELOPMENT

OPINION: Extension services are usually charged with disseminating knowledge. Yet extension services are notoriously inefficient, biased and overburdened. We cannot just add more knowledge systems to be disseminated by severely-limited extension services whose scope has been reduced in many countries. Furthermore, most extension is top-down transfer of technology - the antithesis of what is needed for a sustainable society. Possible alternatives include using intermediate technology directly with clients; using villagers to train villagers; and working with NGOs and local institutions. Facilitation is the key to sustainable land use in the new paradigm.

COUNTER-OPINION: Extension should retain its place in agricultural institutions. It is a form of government subsidy for improving agriculture, and the best answer to widely dispersed user groups which cannot be informed and supported otherwise. Extension systems need to be enhanced and multiplied to achieve favourable ratios between extensionists and farmers.

PEOPLE AND INSTITUTIONS

LAND MANAGEMENT POLICIES

5 TAKING ACTION

FROM SOIL AND WATER CONSERVATION TO SUSTAINABLE LAND MANAGEMENT

MONITORING AND RESEARCH

STAKEHOLDER PARTICIPATION

APPROPRIATE LAND USE

Many books, reviews, inventories, and contrasting perspectives dealing with the extent and the seriousness of human-induced land and soil degradation have been published in recent years. Numerous conferences have also taken place, and action plans and conventions have been formulated. The previous chapters of this book have explored and provided syntheses of certain alarming problems and indicated what priorities must be established in order to solve them. The emergence of «sustainable land management» as a follow-up concept and a general policy to complement technological approaches in «soil and water conservation» has been described. Its validity as a method of combating accelerated degradation of natural resources in a more holistic manner now remains to be proven. The overall goal is to preserve and enhance the quality and productivity of global natural and environmental resources, with a view to the dynamic and constantly changing needs of all the earth's inhabitants.

Disparities exist between the abilities of highly developed and less developed societies and regions to combat land degradation. In the former, the basic human needs of most people are generally satisfied, although individual behaviour, political processes, and various forms of institutional collaboration sometimes act as barriers to sustainable development. In less developed societies, the basic human needs of the majority are often not fulfilled; therefore, they must be a top priority for governments and land users, coming well ahead of attempts to combat degradation processes. In addition, these societies face structural and financial problems, and the range of action open to individuals and institutions is much more restricted, even when the political will for sustainable development is present.

Despite the presence of these constraints in all social systems, it is important to try to overcome them by setting clear priorities and determining activities at the outset. For example, when severe degradation is widespread, priority must be given to areas where the land is still productive and prevention is still possible. Second, the principle of subsidiarity in decision-making should be followed, i.e. decisions should be delegated to the lowest possible level. All members of a society are «decision makers», although their individual ranges of action will vary greatly. A multi-level stakeholder approach to decision-making will thus be needed (see 5.1).

Soil conservation specialists are prominent stakeholders in sustainable land management, whether as researchers, extensionists, planners, or practitioners. They are well equipped to act as mediators between different stakeholders, and enter into partnership with other actors to realise sustainable and productive land use by virtue of their knowledge and experience. One important effect of this relationship is to empower disadvantaged stakeholders by providing them with the knowledge they need for well-informed participation in decision-making, based on the principle of subsidiarity. If specialists and policy-makers are serious about achieving sustainable land management, they must incorporate the perspectives and the knowledge of local land users.

5.1 PRECIOUS EARTH: TAKING ACTION THAT MATTERS

DESIGNING IMPROVEMENTS IN PRESENT LAND USE

Three principles have been put forward for improving present land use: 1| increase vegetative ground cover and biomass production; 2| enhance productivity in a sustainable manner, while minimising the negative effects on soils and ecosystems; and 3| use regenerative agricultural technologies for sustainable land management.[132] If these principles are applied, land users might be willing to change their present land use practices. However, this goal has been achieved only in very few cases.

In the process of developing economically viable practices, it is sometimes difficult to apply all three principles, so that compromises or alternatives must be sought.

At the local level, technological solutions to make present land use systems sustainable in a productive way are often lacking or not feasible.

IDENTIFYING ALTERNATIVES TO INAPPROPRIATE LAND USE

Technological, environmental, social, economic and political constraints can sometimes prevent sustainability in present forms of land use. In this case, the only solution may be to live with degradation and declining productivity, particularly when food security is at stake. This situation may affect as many as several hundred million people today.

In other cases, productivity goals may have to be set lower than at present and stabilised there, using technologies which are not profitable in the short run, but which will compensate for degradation losses in the foreseeable future. Again, this is a very common phenomenon whose disadvantages have been overcome in some places with various types of subsidies or direct incentives. Or, land users may be able to increase productivity on some farm plots or earn income in other sectors, thus compensating for the losses accepted due to the application of a sustainable but unprofitable technology on part of their land. A final possibility is to abandon current land use and seek alternative income outside the agricultural sector.

New technologies in harmony with traditions

APPLYING A MULTI-LEVEL STAKEHOLDER APPROACH IN SUSTAINABLE LAND MANAGEMENT

Often improvements cannot be realised because conditions are unfavourable or because other actors erect barriers against certain types of action which do not reflect their interests. In this case, the multi-level stakeholder approach will be most appropriate. All stakeholders in a problem setting must be

Land use systems in harmony with nature

SOME STAKEHOLDER CATEGORIES IN SUSTAINABLE LAND MANAGEMENT

Primary sector land users and households:	**Farmers, pastoralists, miners, land owners**
Secondary sector land users:	**Planners, entrepreneurs, builders**
Tertiary sector land users:	**Consumers, recreationists, tourists, conservationists, planners**
Administrative staff:	**Extensionists, teachers, trainers and administrators**
Researchers:	**All research staff working in fields related to sustainable land use**
Policy-makers:	**Communal, national, international decision-makers**

identified and invited to take part in a broad participatory process to analyse problems, and express and evaluate their needs, interests and aims. Stakeholders must then negotiate options and priorities for action. This is a way of ensuring that action at the local level can be co-ordinated, and that alternative scenarios can be compared with a view to their potential for long-term improvement.

Programmes using this approach may be longer-lasting than conventional projects, if stakeholders are able to find solutions in a democratic process, to co-ordinate implementation, and to review development trends and the impacts of new measures, ex-ante as well as during the process of implementation. A number of positive experiences have been reported with this approach, both in developing and developed societies.

INTEGRATING LOCAL COMMUNITIES AND NATIONAL ADMINISTRATIONS IN ALL ACTIONS

Collaboration between people and institutions means fostering vertical integration, from the land user to the Prime Minister, and horizontal integration between households, communities, regions and ministries. Activities and policy implementation must be harmonised among various groups of actors and decision-makers at different levels who must play a role in promoting sustainable land management.

This type of integration could have been applied long ago to soil conservation extension. However, it has only recently been realised how much this seemingly simple activity needs to be integrated, both vertically and horizontally,[133] with other activities at the local level.

INCORPORATING THE RESULTS OF MONITORING LOCAL EXPERIENCE

Longevity, which includes the flexibility to cope with a changing environment, has been identified as a key indicator of success in sustainable land management practices. The goal is better care of the soil and the land, not conservation of the soil alone. Here again, lasting solutions which foster sustainable land management can only be initiated and maintained through democratic processes. Continuous observation and participation by stakeholders will be necessary in monitoring and evaluation of such processes.

5.2 ENHANCING ACTION-ORIENTED RESEARCH

INTRODUCING ECONOMIC THINKING AND INSTRUMENTS IN NATURAL RESOURCE MANAGEMENT

The basic hypothesis put forward by economists is that soil and water conservation and sustainable land management must not only be ecologically effective but also (economically) profitable.[134] Otherwise farmers will not make changes in their agricultural practices. Tests of profitability require three analytical steps (see box).

Comprehensive economic analyses can increase the chances of success in promoting new technologies if they clearly identify constraints which have been neglected in the past and which can be overcome by appropriate policy interventions.

FURTHERING THE DEVELOPMENT OF INTEGRATED TECHNOLOGIES

The basic principle of sustainable land management is to increase biomass production with technologies which make maximum use of solar energy, water, and soil nutrients, and which do not have negative impacts on the environment. This principle will guide research on adaptation of existing technologies as well as on the development of new integrated technologies, which may include genetic engineering. Given rapid scientific progress in the latter case, however, mechanisms must be introduced to prevent hasty implementation of results which could be hazardous.

When assessing land use techniques suitable for the local context, five broad issues should be considered:[135] productivity, security, continuity, identity, and adaptability (see box). A framework for the evaluation of sustainable land management now exists and is available for application.[136]

DEVELOPING SUITABLE IMPLEMENTATION APPROACHES

Any research on implementation approaches will have to consider the specific land use systems in place (pastoralist, agrarian, forestry, integrated), as well as the relationship between land use and settlement, infrastructure, industry, and mining. It must also include the impacts of agricultural mechanisation, industrialisation (pollution, construction) and climate change on soils and land, because these processes are likely to modify local conditions and land use systems.

According to the framework for evaluation of soil and water conservation developed by WOCAT, approaches for intro-

In order to fulfil basic needs in natural resource management research, local research organisations should be enhanced and supported by a new international network of strategic environmental research and global observation systems.

ANALYSIS OF ECOLOGICAL SUSTAINABILITY

1. **ANALYSIS OF SOIL FUNCTIONS** will show whether these functions (production, regulation, cultural heritage, living space) are being maintained.
2. **ANALYSIS OF THE FUNCTIONALITY OF ECOSYSTEMS** will help determine whether such ecosystem components as the water cycle, soil nutrient balance and microclimate will remain intact after the introduction of new land management technologies.
3. **ANALYSIS OF BIODIVERSITY** will show whether new land management technologies have negative impacts on fauna and flora.
4. **ANALYSIS OF ECOLOGICAL RESILIENCE** will indicate the extent to which an ecosystem can tolerate depletion and/or accumulation of material without exceeding the capacity for natural regeneration and/or human activities which reverse damaging processes.

Source: H.P. Liniger[142]

ANALYSIS OF TECHNICAL FEASIBILITY

1. **ANALYSIS OF PRODUCTIVITY** will show whether a given measure meets land user/household needs, does not take up too much space, and is adapted to available inputs.
2. **ANALYSIS OF SECURITY** will show whether the measure minimises risks, leaves sufficient management flexibility, uses local resources, and reduces dependency.
3. **ANALYSIS OF CONTINUITY** will give indication of soil quality, recycling of nutrients, prevention of soil degradation, maintenance of biomass and biodiversity, efficient use of water, and neutral off-site effects.
4. **ANALYSIS OF IDENTITY** will be shown by integration into the land use systems and infrastructure, by strengthening of cultural systems, by consistency with policies, and by benefiting underprivileged groups.
5. **ANALYSIS OF ADAPTABILITY** will be demonstrated by spontaneous adoption, rapid success, flexibility in adaptation, and easy communication to other land users.

Source: ILEIA, 1991 (see note 135)

NETWORKS FOR MONITORING INDICATORS OF SUSTAINABILITY

Level	Area	Observation parameter	Use of indicator for:
international	ecoregion	biophysical	global observation
national	agro-ecological zone	biophysical, socio-cultural, economic, political	policy guidance
local	test area/ catchment	comprehensive assessment of land use systems in context	impact assessment and initiation of change

ANALYSIS OF ECONOMIC VIABILITY

1. SITE-SPECIFIC FINANCIAL COST-BENEFIT ANALYSES (CBA), from the land user's point of view, will provide insights into the profitability of a specific land management technology.
2. ANALYSIS OF THE ECONOMIC ENVIRONMENT will reveal impediments to changes in agricultural practices which are not reflected in CBA.
3. ANALYSIS OF INSTITUTIONAL CONSTRAINTS and imperfections will provide insights into other variables which influence farmers' investment and production decisions.
4. A POLICY ANALYSIS must be carried out based on the results of the previous three analytical steps. Appropriate policy instruments ranging from the macro-economic to the micro-economic level can then be selected.

Source: R. Kappel[140]

ANALYSIS OF SOCIAL ACCEPTABILITY

1. ANALYSIS OF SOCIAL HETEROGENEITY will provide insights into different social groups as well as social conditions, e.g. poverty, equality, access to resources, including information, etc.
2. ANALYSIS OF DEMOGRAPHIC CONDITIONS will examine such phenomena as migration, population growth, and ratios between people and resources (land, capital, etc.).
3. ANALYSIS OF SOCIAL INFRASTRUCTURE will shed light on the availability and the quality of various types of infrastructure such as schools, health care facilities, etc.
4. ANALYSIS OF NORMS AND VALUES will indicate possible reasons for acceptance or rejection of new approaches in land management.

Source: C. Ott, E. Ludi[141]

ducing sustainable land management technologies should take account of issues addressed by WOCAT, including ecological factors, production, participation, policy-making, local economic conditions, and area applicability.[137]

ESTABLISHING NETWORKS OF OBSERVATION SYSTEMS

Present-day problems arising from rapid change call for new methods which provide better reference points for assessing change. Environmental monitoring can only be carried out if suitable indicators are developed.[138] Different types of indicators will be needed at the scientific, political and community levels. The goal will be to compare and appraise 1| different technologies in different areas, and 2| temporal change in socio-economic and biophysical conditions within an area.

From the institutional point of view, such reference points will require different monitoring networks (see box). International networks should have observation systems in all major ecoregions of the world and focus on biophysical parameters as indicators of global change (see box). National networks will have more refined systems which also take account of socio-cultural, economic and political parameters (see box). At the local level, test areas will be programme-specific and make long-term comprehensive assessments of both land use systems and natural and societal dynamics, including the impact of local measures (see all boxes). Research and experimentation with different approaches, methodologies, and communication and training systems is best carried out in local test areas because of the variety of knowledge available there.

INTERACTION BETWEEN NATIONAL AND INTERNATIONAL RESEARCH ON SUSTAINABLE LAND USE

International research should complement national research efforts rather than competing with or acting as a substitute for such efforts. Strategic research, methodological development, and global networks are best co-ordinated by international research institutions, together with AROs. The CGIAR international agricultural research centres are a good example of international co-ordination.[139]

In view of the global threat posed by natural resource degradation and the tasks listed above, a network of environmental research institutes should be created at the global level.

5.3 FURTHERING INTERNATIONAL AND INSTITUTIONAL CO-OPERATION

CO-ORDINATING GLOBAL AGREEMENTS AND CONVENTIONS

Global conventions dealing with sustainable land management include the Convention to Combat Desertification,[143] the Convention on Biological Diversity,[144] and the Framework Convention on Climate Change.[145] All three emphasise global solidarity in their ratification procedures, and they all initiate action programmes through a variety of means (see box). In addition, Agenda 21, the Tropical Forestry Action Plan, and other international action programmes or regional frameworks for action[146] are also concerned with promoting sustainable land management.

However, all these global initiatives and programmes display three chronic deficiencies: 1| they are very far from the world of local land users; 2| they have been poorly financed to date; and 3| there is little co-ordination between their action plans at the local level.

Policy-makers continue to discuss the creation of a convention on sustainable land management. Justification for such a convention can be found in accelerating degradation of the world's land resources, and slow progress in promoting better management. Specific points such as nature reserves, natural world heritage sites, and wildlife preservation in natural habitats could also be included. Ecoregional approaches and basin-wide watershed development could be better co-ordinated under the auspices of such a convention. New and existing programmes could emphasise soil and water management and combine this with land use planning. However, there are a number of serious obstacles and arguments which could block such a convention, including the need for context-specific approaches, decentralisation, and financing. As the same problems apply to the Convention to Combat Desertification, it might be advisable to first evaluate experience with that convention before further pursuing the idea of a convention on sustainable land management.

HARMONISING INTERNATIONAL ACTION PLANS WITH NATIONAL POLICIES AND LAND USERS' PRIORITIES

National frameworks and policies do not always take account of the local context. This holds true to an even greater extent in the case of international action plans. The enormous disparities that exist among countries in terms of economic

International co-operation agencies should be encouraged to critically review their present activities in view of the growing need for long-term increases in land productivity and other needs which should be satisfied through sustainable land use.

ELEMENTS OF AN INTERNATIONAL CONVENTION

International conventions generally consist of national action programmes which are coordinated with regional action programmes and supported through international co-operation. Technical and scientific co-operation consists largely of collecting information, monitoring, analysis, and exchange of knowledge. Research and development are also a part of such conventions. Access to technology and transfer of conservation measures can also be important means of making both scientific and local knowledge available to other member states. Direct support consists of capacity building and creation of awareness. The most important aspects, obviously, are the financial resources and the financing mechanisms for implementing a convention. A considerable bureaucratic structure is needed to achieve co-ordination among government representatives, a secretariat of the convention, committees, and networks.

Source: Various conventions

On the long road to sustainable land management

status, natural resources, educational level, etc., should be reflected in the design of action plans.

Policy issues in sustainable land management include co-ordination of land titling, economic policy, nature conservation policy, and population policy.[147] Therefore, national strategies for sustainable use of natural resources need to thoroughly harmonise, adapt, and integrate the different strategies and policies of governments and their ministries.

DEVELOPING CLEAR POLICIES OF SUSTAINABLE LAND MANAGEMENT IN INTERNATIONAL CO-OPERATION

International co-operation offices in highly developed countries have made major efforts to harmonise their own development programmes and projects in order to achieve better land management. To date, however, technical and economic co-operation has often been poorly co-ordinated, and has sometimes even produced conflicts. Secondment of technical staff to assist partner institutions during implementation is a way of implementing a new approach which involves direct linkage of funding and technical support.

One interesting example in the area of technical co-operation is the German GTZ policy paper on support for sustainable use of soils in development co-operation.[148] GTZ advocates specific allocation of financial resources to support projects for sustainable land management within a particular agency.[149] Emphasis is to be given to participatory watershed development.[150]

FURTHERING CO-OPERATION BETWEEN PEOPLE AND INSTITUTIONS

Informal and formal institutions and organisations – from farmer groups, local NGOs and communities to ministries, government policies, and legislation – can only be sustained if they are accepted and supported by their respective populations. This means that local knowledge systems, norms and values must be respected. Distant organisations will always have difficulties finding acceptance if their mandates are not based on democratic decision-making processes. Negotiation processes among all stakeholders, which must be a part of good governance and administrative management, can be enhanced by better information and knowledge about land users' visions, options, and needs with respect to sustainable land management.

NOTES

Notes to Chapter 1

1 According to Buringh (see Buringh, P. 1982. «Potentials of world soils for agricultural production.» In Trans. 12th ICSS. Vol. 1. **Managing soil resources**. New Delhi: Indian Society of Soil Science), about 10% of the soils on the earth's land surface are covered with ice, a further 15% are too cold, 17% too dry, 18% too steep, 9% too shallow, 4% too wet, and 5% too poor. Only the remaining 22% can be considered slightly, moderately or highly productive.

2 All quantitative information in this section has been taken from GLASOD, the **G**Lobal **A**ssessment of human-induced **SO**il **D**egradation. This project was carried out by ISRIC on behalf of UNEP between 1987 and 1990. Following consultation with experts, GLASOD determined that 1,964.4 million hectares of the earth was affected by all forms of soil degradation: specifically, 55.6% by water erosion; 27.9% by wind erosion; 12.2% by chemical and 4.2% by physical degradation. While 38.1% of the land surface was considered to have been only slightly damaged during the past 50 years, 46.4% was moderately damaged and 15.5% heavily damaged (Oldeman, L.R., van Engelen, V.W.P., and Pulles, J.H.M. 1990: **The extent of human-induced soil degradation**. Annex 5. Wageningen: ISRIC).

3 Brown, L. and Wolf, E.C. 1985. **Soil erosion: Quiet crisis in the world economy**. Worldwatch Paper No. 60. Washington D.C.: Worldwatch Institute.

4 H.H. Bennet, in his book **Soil conservation** (1939), defined soil erosion as «The vastly accelerated process of soil removal brought about by human interference with the normal equilibrium between soil building and soil removal...».

5 Stocking, M. «The impact of erosion on soil productivity.» In Haskins, P.G. and Murphy, B.M. (eds), 1992. **People protecting their land**. ISCO 1992, Volume 1. Sydney: International Soil Conservation Organisation, Department of Conservation and Land Management.

6 For example, these indicators are used by Bojö and Cassels (see Bojö, J. and Cassels, D. 1995. **Land degradation and rehabilitation in Ethiopia: A reassessment**. AFTES Working Paper No. 17. Washington D.C.: The World Bank), and re-assessed in Kappel, R. 1996. **Economic analysis of soil conservation in Ethiopia: Issues and research perspectives**. Soil Conservation Research Programme. Addis Abeba, Ethiopia and Berne, Switzerland.

7 El-Swaify, S.A. 1991. Land-based limitations and threats to world food production. **Outlook on Agriculture**. Vol. 20, No. 4. 235-242.

8 Definition by Malcolm Douglas. See Douglas, M. 1994. **Sustainable use of agricultural soils**. Group for Development and Environment. Development and Environment Reports. No. 11. Berne: Institute of Geography, University of Berne, referring to Blaikie, P. and Brookfield, H. 1987. **Land degradation and society**. London and New York: Methuen.

9 Ibid., quoting FAO, 1979. **A provisional methodology for soil degradation assessment**. Rome.

10 See **World atlas of desertification**. UNEP 1992.

11 E. Eckholm and L. Brown reported on «Spreading deserts - the hand of man» in Worldwatch Paper 13, Worldwatch Institute, Washington in 1977.

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CONTRIBUTORS

Hans Hurni, Centre for Development and Environment (CDE), Institute of Geography, University of Berne, Hallerstrasse 12, 3012 Berne, Switzerland (coordinator)

Helmut Eger, Gesellschaft für technische Zusammenarbeit (GTZ), Postfach 5180, 65760 Eschborn, Germany (steering committee member)

Eckehard Fleischhauer, German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Postfach 120629, 53048 Bonn, Germany (steering committee member)

Samir A. El-Swaify, University of Hawaii, College of Tropical Agriculture and Human Resources, Department of Agronomy and Soil Science, 1910 East-West-Road, Honolulu, Hawaii 96822, USA

Wilhelm Östberg, Environment and Development Studies Unit, Department of Human Geography, University of Stockholm, 106 91 Stockholm, Sweden

Eric Roose, Centre de Montpellier, ORSTOM, B.P. 5045, 34032 Montpellier cdx 1, France

Hans W. Scharpenseel, Department of Soil Science, University of Hamburg, Allende-Platz 2, 20146 Hamburg, Germany

T. Francis Shaxson, 8 Springdale Grove, Corfe Mullen, Dorset BH 21 3QT, England

Samran Sombatpanit, Department of Land Development, Phaholyothin Road, Bangkok 10900, Thailand

Michael A. Stocking, School of Development Studies, University of East Anglia, Norwich NR4 7TJ, United Kingdom

Anneke Trux, Observatoire du Sahara et du Sahel (OSS), 1, rue Miollis, 75015 Paris, France

Helen Zweifel, Centre for Development and Environment (CDE), Institute of Geography, University of Berne, Hallerstrasse 12, 3012 Berne, Switzerland

FEEDBACK CONTRIBUTORS

S.K. Choi, P.O. Box 101, c/o FAOR, Yangon, Myanmar

Eric T. Craswell, IBSRAM, P.O. Box 9-109, Bangkhen, Bangkok 10900, Thailand

Alemneh Dejene, AFTES, The World Bank Group, Washington, D.C. 20433, USA

Malcolm Douglas, Langenfeld, Easingwold Road, Huby Y06 1HN, United Kingdom

Rodney Gallacher, Jean-Claude Griesbach, Denis Sims, and **Jeff Tschirley,** FAO, Via delle Terme di Caracalla, 00100 Roma, Italy

Rolf Kappel, NADEL – Postgraduate Course on Developing Countries, Swiss Federal Institute of Technology, ETH-Zentrum, Voltastrasse 24, 8092 Zürich, Switzerland

Hanspeter Liniger, Eva Ludi, Centre for Development and Environment (CDE), Institute of Geography, University of Berne, Hallerstrasse 12, 3012 Berne, Switzerland

Estefan Rist, AGRUCO, KM. 5, Carretera a Santa Cruz, Casilia postal 3392, Cochabamba, Bolivia

Arie Shahar, 7 Nitzana St., Giv'ataim, 53-364 Israel

Donald Thomas, P.O. Box 14893, Nairobi, Kenya

PRECIOUS EARTH: From Soil and Water Conservation to Sustainable Land Management presents new perspectives on caring for the precarious soil resource, which provides us with over 90% of all human food, livestock feed, fibre and fuel. Soils, however, have more than just productive functions. The key challenge in coming years will be to address the diverse and potentially conflicting demands now being made by human societies and other forms of life on Earth, while ensuring that future generations have the same potential to use soils and land of comparable quality. **PRECIOUS EARTH,** which was produced by a group of international specialists in soil and water conservation, provides a global overview of current thinking and action, and includes ideas on how to initiate and build positive momentum towards sustainable land management.

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