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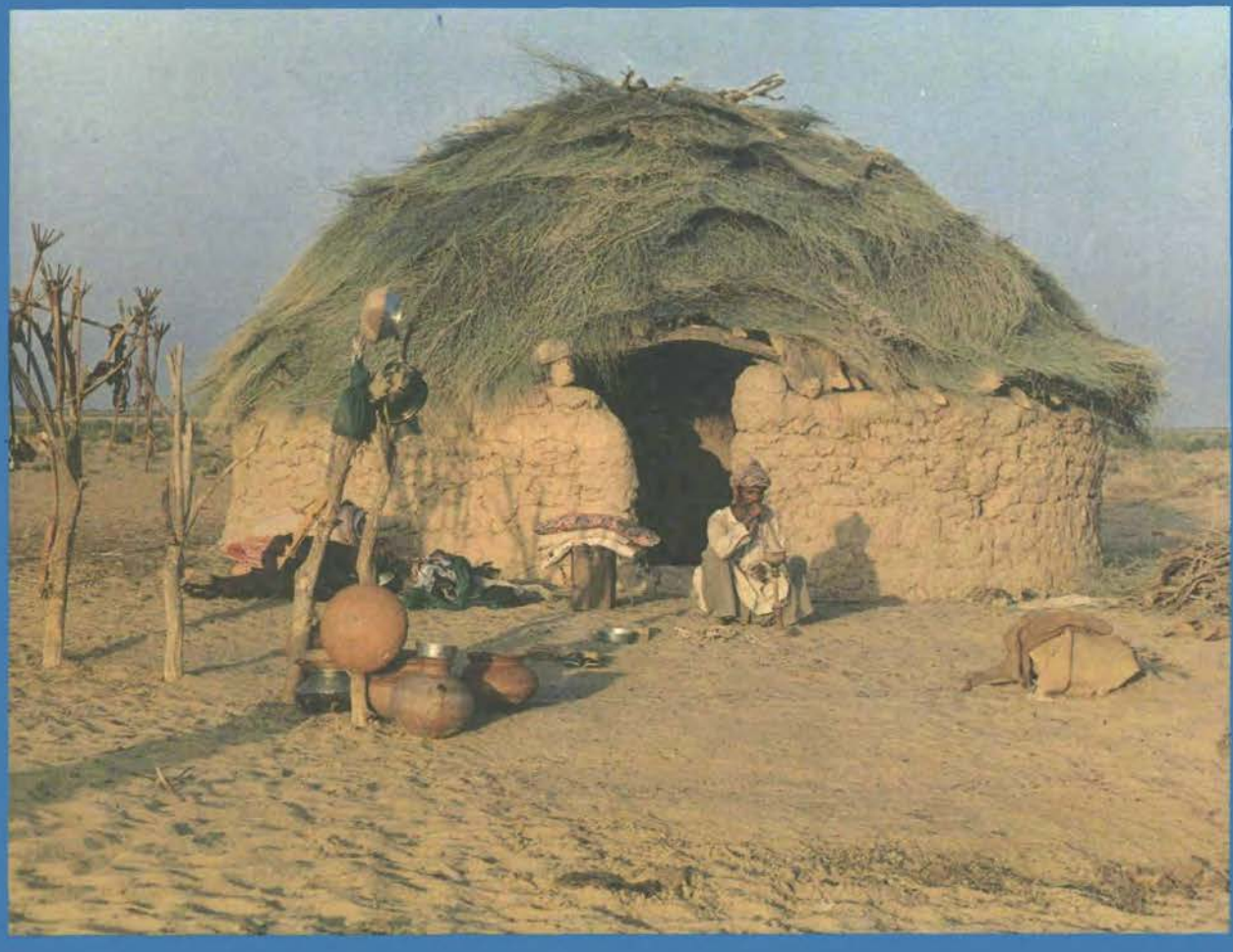

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Photo: Monique Mainguet, France

In Mauritania the formation of large, flattened barchan dunes, with ripple marks, is a result of wind erosion. The finest sand has been blown away, leaving behind a coarse sterile landscape.

Cover: Traditional thatched-roof huts belonging to nomad pastoralists in the Cholistan desert, Pakistan. Photo: Mohammad Arshad.

The United Nations Convention to Combat Desertification (CCD) which came into force on 26 December 1996, lays out new measures to be undertaken by governments of affected countries and by those in a position to help. It is a comprehensive treaty, with an innovative participatory approach aimed at involving all stakeholders.

The core of the Convention is the development of national, sub-regional and regional action programmes to combat desertification. National action programmes are to be developed by governments in close cooperation with donors, local populations and non-governmental organizations (NGOs). In contrast to many past efforts, these action programmes must be fully integrated with other national policies for sustainable development. They should be flexible, able to be modified as circumstances change.

For this approach to work it is essential that people at all levels are aware of the strengths of the drylands, as well as the causes and mechanisms of desertification and of possible solutions to the problems. Accordingly the UN-CCD emphasizes the increasing need to raise awareness and knowledge of dryland issues globally, particularly among government decision makers, affected and non-affected community groups, donors, international partners and the general public.

The UNEP Governing Council (GC. 19/17) requested that the function of UNEP/DEDC-PAC be maintained as a global centre of excellence on desertification control, promoting cooperation and the coordination of worldwide efforts to combat desertification, and advised UNEP to concentrate its efforts on the following:

(a) The development, jointly with partners, of appropriate indicators on land use and quality as part of an updated assessment methodology for drylands and desertification control;

(b) Increasing awareness of desertification and drought issues, and disseminating targeted information materials to a broad range of media and the public;

(c) Continuing to contribute to the implementation of the Convention and intensifying support for activities in Africa, Asia, Latin America and the Caribbean, at all levels, particularly in the preparation of national, sub-regional and regional action programmes.

One of the main aims of the bi-annual Desertification Control Bulletin is to disseminate information on, knowledge of, desertification problems and to present news about the programmes, activities and achievements in the implementation of the CCD around the world. Articles published in the *Desertification Control Bulletin* do not imply the expression of any opinion on the part of UNEP concerning the legal status of any country, territory, city or area, or its authorities, or concerning the delimitation of its frontiers or boundaries.

 Enquiries should be addressed to:

The Technical Advisor
Desertification Control Bulletin
UNEP
P.O. Box 30552,
Nairobi, Kenya

Cover Photographs

The Editor of *Desertification Control Bulletin* is seeking photographs for consideration as bulletin covers. All submissions should be addressed to the editor at the above address.

Technical requirements

Photographs must be colour transparencies of subjects related directly to desertification, land, animals, human beings, structures affected by desertification, control of desertification, reclamation of desertified lands, etc. Submissions must be of high quality to be enlarged to accommodate a square 18 cm x 18 cm (8 in x 8 in).

Captions

A brief caption must accompany each photograph giving a description of the subject, place and country, date of photograph and name and address of photographer.

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Articles

Desertification Control Bulletin invites articles from the world's scientists and specialists interested in the problems arising from or associated with the spread of desertification.

Audience

The bulletin addresses a large audience which includes decision makers, planners, administrators, specialists and technicians of countries facing desertification problems, as well as all others interested in arresting the spread of desertification.

Language

The bulletin is published in English and Spanish. All manuscripts for publication must be in English.

Manuscript preparation

Manuscripts should be clearly typewritten with double spacing and wide margins, on one side of the page only. The title of the manuscript, with the author's name and address, should be given in the upper half of the first page and the number of words in the main text should appear in the upper right corner. Subsequent pages should have only the author's name in the upper right hand corner. Users of word-processors are welcome to submit their articles on diskette in MS-DOS format, indicating the programme used.

Metric system

All measurements should be in the metric system.

Tables

Each table should be typed on a separate page, should have a title and should be numbered to correspond to its point in the text. Only essential tables should be included and all should be identified as to source.

Illustrations and photographs

Line drawings of any kind should each be on a separate page drawn in black china ink and double or larger than the size to appear in the bulletin. They should never be pasted in the text. They should be as clear and as simple as possible.

Photographs in the bulletin are printed black and white. For satisfactory results, high quality black and white prints 18 cm x 24 cm (8 in x 10 in) on glossy paper are essential. Diapositive slides of high quality may be accepted; however, their quality when printed black and white in the bulletin cannot be guaranteed.

All line drawings and photographs should be numbered in one sequence to correspond to their point of reference in the text, and their descriptions should be listed on a separate page.

Footnotes and references

Footnotes and references should be listed on separate pages at the end of the manuscript. Footnotes should be kept to an absolute minimum. References should be strictly relevant to the article and should also be kept to a minimum. The style of references should follow the format common for scientific and technical publications; the last name(s) of the author(s) (each), followed by his/her initials, year of publication, title, publisher (or journal), serial number and number of pages.

Other requirements

Desertification Control Bulletin publishes original articles which have not appeared in other publications. However, reprints providing the possibility of exchange of views and developments of basic importance in desertification control among the developing regions of the world, or translations from languages of limited audiences, are not ruled out. Short reviews introducing recently published books in the subjects relevant to desertification and of interest to the readers of the bulletin are also accepted. Medium-length articles of about 3,000 words are preferred.

Editor:
David Round-Turner,
Consultant,
DEDC/PAC, UNEP

Technical advisor:
Leonid Kroumkatchev,
DEDC/PAC, UNEP

Layout:
J. Odallo, RDS, UNON

Summary of the Second Conference of the Parties to the Convention to Combat Desertification

(abstract)[1]

30 November to 11 December 1998

Delegates to the second session of the Conference of the Parties to the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa met in Dakar, Senegal, between 30 November and 11 December 1998. The Committee on Science and Technology (CST) met in parallel to the COP from 1 to 4 December. Delegates approved arrangements for the institutional linkage between the Convention and the United Nations Secretariat and the headquarters agreement with the Government of Germany, where the Secretariat is scheduled to move in early 1999. The Conference of the Parties approved adjustments to its budget and adopted the outstanding rules of procedure concerning bureau members, but retained bracketed language regarding majority voting absent consensus. Eastern and Central European countries were invited to submit to Conference of the Parties-3 a draft regional implementation annex.

A brief history of the Convention

The Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa was adopted on 17 June 1994 and was opened for signature in October 1994 in Paris. Three months following the receipt of its fiftieth ratification, the Convention entered into force on 26 December 1996. As of 22 October 1998, 144 countries had ratified or acceded to the Convention to Combat Desertification.

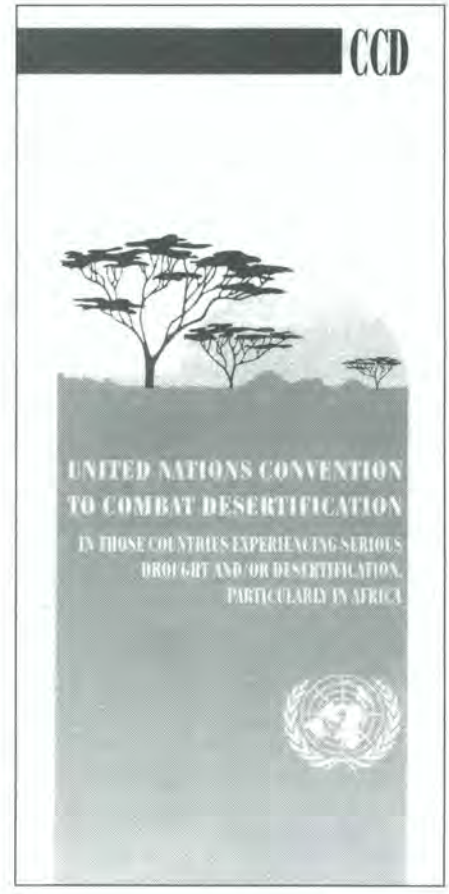
The Convention recognizes:

- The physical, biological and socio-economic aspects of desertification;
- The importance of redirecting technology transfer so that it is demand-driven;
- The involvement of local populations.

The core of the Convention is the development of national and subregional-regional action programmes by national governments in cooperation with donors, local populations and non-governmental organizations. The purpose of using an innovative 'bottom-up' approach, by involving people who are affected by desertification in decision-making, is to facilitate effective implementation of the Convention.

Report of COP-2

The second session of the Conference of the Parties to the Convention to Combat Desertification began with an opening ceremony on Monday morning, 30 November 1998. Abdou Diouf, President



[1] *This report was compiled from the special issue of Earth Negotiations Bulletin published by the International Institute for Sustainable Development (IISD). This report is printed without prejudice and in the understanding that any views expressed herein are not necessarily those of UNEP.*

of the Republic of Senegal, welcomed participants and thanked them for convening Conference of the Parties-2 in Senegal, on Sahelian soil. He highlighted the problems posed by desertification in Africa and Senegal, in particular, as well as actions taken to combat this phenomenon at all levels. He suggested that the Conference of the Parties, in moving toward its operational phase, consider how to coordinate activities under the Convention, the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (FCCC), and arrive at the precise definition of the role and operational procedures of the Global Mechanism.

During the opening Plenary on Monday afternoon, delegates elected Souty Touré, Senegal's Minister of Environment and Protection of Nature, as Conference of the Parties-2 President. He said the meeting should enable an in-depth exchange of views by participants on implementation and institutional arrangements. United Nations Under-Secretary-General for Economic and Social Affairs Nitin Desai, on behalf of United Nations Secretary-General Kofi Annan, highlighted three ways in which the Convention exemplifies and follows up on Rio: it shows how environmental and development objectives can be served in the same framework; it reflects the Rio partnership between developed and developing countries and it recognizes the interaction between sectoral and among cross-sectoral themes.

The Convention Executive Secretary Hama Arba Diallo introduced the documents prepared for Conference of the Parties- 2 and reported on recent meetings and workshops, including an interregional forum. He stressed the importance of focal points and national coordinating bodies, noting that recent reports indicate that the weakness of focal points is a reason for delay in implementation. He emphasized that the Secretariat would continue to work with Parties during the implementation phase.

A brief analysis of COP-2

Partnerships between a variety of actors propel the Convention's implementation and dominated the scene at Conference of the Parties-2 in Dakar.

Delegates discussed the importance of bottom-up approaches and involvement at all levels and by all relevant actors, but their deliberations revealed different perspectives on how the Convention should actually facilitate the translation of the theory of partnerships into action. The Convention to Combat Desertification Conference of the Parties faces a balancing act of communicating with, fostering and learning from, actors on the ground while remaining an international coordinating body. To accomplish its goals, it relies on horizontal partnerships ranging from arrangements between the regional implementation annex countries and relationships with related conventions, for example, to reach vertical partnerships between the Conference of the Parties, national governments and local level actors. The difference of opinion as to how this balance should be struck slowed some work at Conference of the Parties-2 but related discussions may serve as a foundation for building effective partnerships under the Convention. This analysis highlights ways in which some of these partnerships took form and shaped Conference of the Parties-2.

Intergovernmental partnerships

Intergovernmental cooperation at the Conference of the Parties level is a prime area where partnerships must be operational if the Convention to Combat Desertification is to be effectively implemented. In this regard, the continuing debate between the Convention's particularity to Africa, while at the same time being a global convention, remains a shaping force. The African Group's decision to emphasize this particularity held up the start of Conference of the Parties-1 by two days, but delegates did not delay their deliberations at Conference of the Parties-2 on this point. Their decision was indicative of the recognition by Conference of the Parties-2 participants of the need to focus on implementation and avoid situations that might deter their ability to cooperate. On the first day of Conference of the Parties-2, the African Group repeated its Conference of the Parties-1 request for three Bureau seats, which would have created the same problem Conference of the Parties-1 faced. However, in Dakar there was no option of temporarily filling the empty East European seat with an extra representative from Africa, given that three Parties from Eastern Europe participated in Conference of the Parties-2. The African Group's Presidency of the Conference of the Parties and desire to host a successful session offered a solution to the issue. Two African delegates were elected to the Bureau, although the Group indicated the decision did not imply a renunciation of their intention to hold three Bureau seats at future Conferences of the Parties.

From the bottom up

While intergovernmental partnerships did not feature as prominently as they did at COP-1, a number of issues regarding other partnerships did emerge. The need to engage all interested actors at all levels is standard rhetoric for those engaged in the CCD process. However, different approaches to how the Conference of the Parties can facilitate action on the ground, under the auspices of an international coordinating body for action on desertification, were evident in the Conference of the Parties-2 deliberations. Many Organisation for Economic Cooperation and Development (OECD) countries found the COP's modus operandi to be out of accord with its objectives. As an example of this divergence, they pointed to delegates' discussions about bottom-up approaches that resulted in recommendations for panels or studies, which they believed to be top-down solutions. Their emphasis on National Action Programmes (NAPs) was intended to surmount this trap and focus on specific actions and mainstream the issue in development processes through partnership arrangements. Some believed the European Union-proposed draft decision on implementation and NAPs was directed to this end. The Group of 77 and China, by contrast, stressed the need to take a holistic approach to implementation and thus did not support

some of the OECD countries' singular focus on local level implementation or its draft decision on implementation and NAPs.

Advancing vertical partnerships

This difference in approach also underlay the European Union (EU) and the Group of 77 and China positions regarding Secretariat support for activities at the regional level. Most participants do not envision the Secretariat as an implementing body. The OECD countries particularly desire to keep the Secretariat's activities focused on horizontal partnerships rather than vertical ones, as the Secretariat's regional and national level activities might imply. The Group of 77 and China, however, support a role for the Secretariat as a sponsor of regional and national meetings and regional coordinating units. Such meetings or units reach below the top international level of actors, but may not result immediately in the concrete actions that some OECD countries emphasized. Supporters see these meetings and units as useful ways to engage actors closer to the local level, while others do not think the action will trickle down that far. The efforts of Conference of the Parties- 2 to involve parliamentarians and non-governmental organizations, particularly through their network, RIOD, provide positive examples of how the Convention to Combat Desertification Conference of the Parties and Secretariat can advance vertical partnerships while remaining an international facilitative body.

The COP-2 experience saw non-governmental organizations presentations on activities and concerns at the local level. Unlike the NGO forum at COP-1, whose tone some found to be more provocative, these forums embodied the spirit of dialogue with a focus on possible ways to enhance collaboration with governments. This could be attributed to non-governmental organizations feeling more secure with their involvement in the Conference of the Parties and the recognition of their important role and the input they can have in shaping the process. However, some participants felt the presentations fell short of providing concrete insights into how the partnerships can be enacted within the framework of the ongoing Conference of the Parties negotiations and subsequent implementation of the Convention to Combat Desertification. Nonetheless, this was an essential step in charting a process of local level involvement and assisting the Conference of the Parties to visualize Convention implementation and the necessary framework to facilitate it. To this end, the Conference of the Parties will have to engage itself in elaborating an enabling environment for effective involvement of all stakeholders and interest groups.

Partnerships between the Rio conventions

Coordination across the board will be necessary to accomplish this task. This need to identify an enabling environment at the international level fits well with the repeated calls at Conference of the Parties-2 for synergies between the Rio conventions and coordination of their activities. Such coordination would not only result in resource efficiency but also, hopefully, stimulate tangible action. Conference of the Parties-2 participants recognized that the Convention to Combat Desertification has a lot to offer the other conventions, especially if it is able to find how to balance international, national and local action as well as environmental and development objectives. The goal of such coordination should be to provide an overarching framework under which partnerships can be strengthened and pursued at all levels. The modalities for such coordination promise to be the topic of further discussions as the Conference of the Parties charts Convention implementation in the years to come.

Toward effective implementation

While the decisions of COP-2 were not earth-shattering, its deliberations served to highlight areas and partnerships that need reinforcement and further opened opportunities for more representation in the process. Whether Conference of the Parties- 3 delegates will be able to steer away from sensitive issues that emerged in COP-1, and continued at COP-2, remains to be seen. Delegates' high regard for the informal dialogue on implementation of NAPs and dialogues with NGOs show a way forward as they consider the ways and means to accomplish their goals. The deadlocks and deferred decisions from Conference of the Parties-2 resulted more from differences in emphasis on partnership- building strategies rather than from differences in objectives. To this end, intersessional activities, active nurturing of partnerships and continuation of a dialogue between all actors is essential to the success of the Convention to Combat Desertification.

Third session of the Conference of the Parties to the United Nations Convention to Combat Desertification

COP-3 is scheduled to be held in Recife, Brazil, from 15 to 26 November 1999. Preparatory meetings for COP-3 include: Bureau meetings, the intersessional meeting of the Bureau of the Committee on Science and Technology, and the meeting of the ad hoc panel on traditional knowledge.

For dates, venue or any other information, contact the CCD Secretariat at: Geneva Executive Centre, 11/13 Chemin des Anemones, 1219 Chatelaine, Geneva, Switzerland; tel: +41-22-979- 9111; fax:+41-22-979-9030/31; e-mail: secretariat@unccd.ch; Internet: http://www.unccd.ch.

Effective in early 1999, the Secretariat can be reached at: PO Box 260129, Haus Carstanjen, D-53153 Bonn, Germany; tel: +49- 228-8152800; fax: +49-228-8152899; e-mail: secretariat@unccd.de; Internet:http://www.unccd.de.

UNEP Governing Council 20th Session 1 to 5 February 1999

Decision 20/10 - Land Degradation

The Governing Council is the governing body of United Nations Environment Programme (UNEP). It is composed of 58 members of the United Nations General Assembly, with due regard to the geographical representation of its membership, who direct and monitor UNEP's work. Membership of the Governing Council rotates every four years to allow all Member States to play an active role. The Governing Council meets at UNEP headquarters in Nairobi at least every two years in order to approve the programme of work for the forthcoming biennium. Special sessions of the Governing Council may also be called with the agreement of the Governing Council Member States. The Governing Council is an integral part of the United Nations Secretariat and reports back to the United Nations General Assembly through the United Nations Economic and Social Council.

At its twentieth session, the Governing Council devoted considerable time to negotiation of the decision on desertification/land degradation indicating the raised level of political interest in the issue. At the high level segment, the countries affected by desertification made many favourable references to the work UNEP has been doing in supporting them and in assisting the progress of the Convention to Combat Desertification.

The Governing Council, having considered the report of the Executive Director on the effort of the United Nations Environment Programme towards the implementation of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa: 1997-1998 (decision 19/17):

Recalling its decisions 19/17 of 7 February 1997 and SS.V/7 of 22 May 1998,

Having considered the report of the executive Director on the implementation of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa: 1997-1998 (hereinafter 'the Convention') UNEP/GC. 20/11),

Recognizing that land degradation is a major problem for many countries, particularly those in Africa,

Recalling that support for Africa is a priority for the United Nations Environment Programme in its work programme for 2000-2001,

Recalling the experience of the United Nations Environment Programme in developing desertification assessments and databases and its two editions of the World Atlas of Desertification; its research initiatives and cooperative studies with the Scientific Committee on Problems of the Environment of the International Council of Scientific Unions, its co-sponsorship of the Consultative Group for International Agricultural Research and the numerous joint programmes and studies on desertification with various centres within the Consultative Group and with other United Nations bodies,

Considering the concerns regarding the vulnerability of African soils to the impacts of climate change due to land degradation and desertification as expressed by the Special Consultation of African Ministerial Conference on the Environment on the United Nations Framework Convention on Climate Change and its Kyoto Protocol and Multilateral Environmental Agreements, held in Nairobi from 19 to 23 October 1998 (UNEP/AMCEN/CONSULT.1/5, para. 3 (a)),

Welcoming the efforts of the United Nations Environment Programme in assisting countries affected by land degradation, in strengthening cooperation and collaboration with other relevant United Nations bodies and agencies and other organizations in the field of land degradation, in developing land-degradation projects as they relate to the focal areas of the Global Environment Facility and the signing of a Memorandum of Understanding with the United Nations Development Programme in the context of these activities, and in assisting Governments in the implementation of the Convention

1. Requests the Executive Director to maintain the capability of the United Nations Environment Programme to respond to global land-degradation issues so as to serve its role as Task Manager for chapter 12 of Agenda 21, and in supporting the Conference of Parties of the Convention, in particular its Committee on Science and Technology in the assessment and monitoring of desertification and the enhancement of the scientific and

technological knowledge base on land degradation;

2. Requests the Executive Director to give the appropriate priority to promoting support action to combat desertification within the framework of the implementation of the work programme of the United Nations Environment Programme in accordance with Governing Council decision SS.V/7;
3. Requests the Executive Director to assist, upon their request, African countries in the preparation, development and strengthening of action plans made in accordance with articles 9 and 11 of the Convention;
4. Requests the Executive Director to continue efforts to secure and enhance support from the Global Environment Facility for providing assistance to countries to carry out activities related to land degradation in view of the interlinkages between land degradation and the focal areas of the Global Environment Facility;
5. Also requests the Executive Director to strengthen the coordination and collaboration with relevant United Nations bodies and agencies and other organizations concerned in providing assistance to countries in mitigating land degradation and the implementation of the Convention;
6. Requests the Executive Director to pursue his efforts to strengthen inter-agency collaboration in the field of combating desertification;
7. Further requests the Executive Director, in cooperation with other bodies, particularly the Secretariat of the Convention, the Global Mechanism under the Convention and the other implementing agencies of the Global Environment Facility, as well as relevant regional and subregional organizations, to assist countries affected by land degradation in the preparation of land-degradation projects consistent with their national action programmes for financing by the Global Environment Facility and other multilateral and bilateral agencies;
8. Requests the Executive Director to take appropriate initiatives to involve the United Nations Environment Programme in the activities of the Global Mechanism of the Convention and in particular its Facilitation Committee;
9. Requests the Executive Director to submit a report on this matter to the Governing Council at its twenty-first session.

Environmental Security in the Drylands of Africa: The Role of Science and Technology

M. B. K. Darkoh

Professor, Environmental Science Department University of Botswana Private Bag 0022 Gaborone, Botswana

Introduction

Throughout the African drylands there is clear evidence that the environment is not secure; it is failing to offer opportunities for sustainable livelihoods to rural and urban populations dependent upon it for their survival. For example, long spells of drought, desertification and floods are a few examples of the serious environmental problems that make it impossible for rural people to co-exist in harmony with nature or, at times, with each other. The famines and food shortages that hit people severely in the 1970s and 1980s, resulting in mass starvation, death, disease and the exodus of millions of environmental refugees who moved to urban areas or to more humid lands in a desperate search for survival, are the clearest manifestations of the unfolding environmental insecurity in the drylands of Africa. This article reviews the extent and significance of environmental insecurity in the drylands of Africa and the role that science and technology can play in any effort to find solutions.

Environmental security is viewed from two related perspectives: first, in terms of those environmental conditions that enable individuals and groups to satisfy their basic needs, and those that offer opportunities for sustainable livelihoods and, second, as a precondition for peace and conflict resolution. In societies where the reproduction of resource endowments (farms, herds, trees etc.) depends, to a large extent, on nature's bounty, environmental and people security are intertwined and cannot be treated in isolation from each other (Mohamed Salih, 1992). This line of thought has been forthcoming in recent literature (Frankie and Chaisen, 1980; Redclift, 1984; Spooner and Mann, 1982; Hjort, 1982, 1989; Hjort and Mohamed Salih, 1989, 1992). The linkage between people and environmental security has also reached a new high in the social science agenda, particularly when an association between political conflicts and environmental stress is evident in many parts of African drylands (Hjort and Mohamed Salih, ibid.). In essence, this means that environmental security implies the elimination of the factors which may threaten peoples' survival, such as soil erosion, depletion of natural resources and accompanying food shortages. In other words, to enjoy environmental security is to satisfy the basic needs of human existence and to overcome those environmental conditions that threaten the safety, health and well-being of human populations.

The second perspective, which sees security as a precondition for peace, assumes that peace cannot be attained if the physical, social and political environments are in a situation of imbalance (Buzan, 1983; Mohamed Salih, ibid.). Thus, the depletion of natural resources, or their appropriation by a few wealthy and powerful individuals or groups, jeopardises peace and undermines security. The security of one group of actors in their respective relationship to natural resources, or the harsh conditions of the drylands, will automatically affect the security of other groups of actors in the same environment.

Considering the above salient features of what we term 'environmental security', it seems that the whole logic of the concept is skewed when applied to the drylands (Mohamed Salih, 1992). It appears as if we mean 'insecurity' when we refer to environmental security in the drylands of Africa.

Major Environmental Security Issues

Climate

Dryland environments in Africa are undergoing rapid environmental change. Major environmental security problems stem from the effects of drought, desiccation, climatic variability, climate change, population and human activities. Drought denotes a regional deficiency in soil moisture which may be caused by a combination of lower than normal precipitation and higher than average evapotranspiration. Desiccation is a process of aridification resulting from a dry period lasting, perhaps, decades. Climatic variability denotes shorter-term climatic variability, including interannual variations, and climate change refers to

secular trends or shifts in climate resulting from natural processes or human activity.

Every year, drought occurs in some part or other of the arid and semi-arid lands (ASAL) of Africa. In fact, major droughts regularly affect large portions of these drylands. Examples include the most severe drought in recorded history between 1968 and 1973 and others between 1982 and 1985 and 1990 and 1992. In the Sahel, during the three decades from 1961 to 1991, annual rainfall had been between 20 and 40 per cent less than it was during the three previous decades (Kelly and Hulme, 1993). Over the last quarter of a century, the Sahel has undergone severe desiccation and increasing deterioration of the soil quality and vegetative cover. Some studies have pointed out that, within contiguous Africa, there has been a net shift of land area towards aridity, especially toward hyper-aridity and a consequent net loss of semi-arid and dry sub-humid areas (Hulme and Kelly, 1993; Kelly and Hulme, 1993; Hulme, et. al., 1992).

Drought, desiccation, climatic variability and other dryland climate characteristics greatly influence human use of drylands. These factors influence vegetation productivity; carrying capacity of the land; susceptibility of the land to erosion; surface water availability and aquifer recharge (Williams and Balling Jr., 1994). As such, they impose considerable constraints on the human use of drylands. They tend also to complicate the management of drylands and to impose limitations on food security and the quality of life for people. For example, drought, when it occurs, creates a shortage of available moisture for plant growth and limits total rangeland productivity. Since the use of supplementary feeds is limited, lack of nutritious forage results in high rates of livestock mortality. As a result of livestock loss and the total impoverishment of nomadic families, dependence on famine relief food by a population which has traditionally been self-reliant has increased (Oba, 1992). Recovery of livestock herds during post-drought periods is low. Following the severe weakening of the traditional security system of reciprocity and opportunistic lifestyles, a majority of former pastoral families has become economically marginalized and lives outside the pastoral system. According to the Office to Combat Desertification and Drought (UNSO) [formerly the United Nations Sudano-Sahelian Office] (1992), the effects of desiccation on pastoral communities have been even more serious than droughts. In the Sahel, many peasant and pastoral communities have 'simply ceased to exist after the desiccation of the last 20 years' (UNSO, ibid.).

Water

Closely related to climate is the issue of water. All life forms on earth depend upon water and water issues pose many challenges to environmental security in Africa. These challenges relate to water availability, shortages and quality. Because of aridity, water is a scarce resource in arid and semi-arid lands and, in many areas, it is not possible to obtain a ready source of sufficiently pure drinking water. Rapid population growth and urbanisation pose threats to water utilization and depletion. Surface water that is used for food production and other domestic purposes is often a medium of pollution and transmission of disease. Groundwater is not easily accessible and technologies for underground water detection, acquisition and monitoring are often lacking or underdeveloped, and generally have to be imported.

Because of its scarcity, water may be a source of strategic local and regional conflicts in the drylands of Africa. In Southern Africa, for example, the members of the Southern African Development Community (SADC) have responded to the issue of limited water resources in the region with a protocol on shared river basins like the Zambezi. However, this creates conflict in the region. As I shall discuss elsewhere in this article, areas such as river basins and wetlands in African drylands, which are naturally endowed with water, have become the seed-beds of land use conflicts and even international conflicts.

Population growth

A matter closely related to the problem of environmental security in Africa is the issue of scarcity of natural resources *vis-à-vis* human carrying capacity. For instance, Africa's population growth rate of 2.8 per cent per annum puts pressure on an already scarce supply of water and other natural resources. As *Our Common Future* (World Commission on Environment and Development (WCED), 1987:1) reminds us: 'The issue is not just numbers but how those numbers relate to available resources'. The ever growing demand for natural resources for human use or application, against the background of an ever growing population, not only intensifies competition over these resources, but has a number of other important consequences. First, there are problems created by the rapid depletion of non-renewable resources, which may be associated with the extraction of more diffuse and inaccessible deposits. Second, the exploitation of renewable resources exceeds their natural ability to renew themselves. This threatens their availability. Third, the possibilities of expansion into remaining natural areas and resources are limited and could lead to growing competition for natural resources.

Human activities

Agriculture and pastoralism are the predominant human activities in the drylands of Africa. Both have had more direct negative impacts on the biophysical environment. Soil erosion, soil and water pollution, water supply and species extinction have all become important environmental issues. While impacts were initially small-scale and local, they increased in extent and severity as agricultural systems became more industrialized and less in tune with natural ecosystems, processes and cycles.

Modern agriculture of the type common in high income nations is characterized by high levels of investment in technology, machinery, chemicals and genetics, a very extensive scale of operation, and constant change (Applin et. al., 1995). Indeed, change is so much a part of modern farming that it is difficult to describe a typical farming enterprise. Animal and human labour have been replaced by machines and fossil fuels; natural cycles of soil fertility have been

replaced by the use of chemical fertilisers; monocultures have been replaced by complex polycultures and weed and pest control are dominated by commercial chemicals. The geography of modern agriculture reflects climate and soil quality modified by human ingenuity and technology. Among the most intense application of modern science and technology are biotechnology, genetic engineering and information technology (Mannion, 1995). These innovations have been developed as scientific and technological responses to management problems.

In Africa, on the other hand, attempts at agricultural transformation have concentrated mainly on the export sector, on which most African countries depend primarily for employment, income, foreign exchange and government revenue while the traditional sector has been largely neglected. The technological content of African agriculture is among the lowest in the world, which means that agricultural production is largely dependent on the exploitation of the natural resource base without much replacement (Photo 1).

Land degradation

Unprecedented population increase and the problem of feeding people with the use of technologies in farming that have shown little change, and agricultural policies that are encouraging farmers to grow higher priced non-food cash crops, have led to excessive pressures in arable lands, rangelands, forests and other landed resources, leading to accelerated land degradation.

Land degradation is not just soil erosion; the term includes any change in the condition of the land which reduces its productive potential. In the drylands of Africa, the primary agents of land degradation are overcultivation, overgrazing, deforestation and poor irrigation practices (UNEP, 1992). Of the four main threats, three (deforestation, overcultivation and overgrazing) pose the principal threat to the livelihood of the peoples of the drylands.

In the woodland savannas and forests of Africa, rapid population growth has shortened the fallow periods, and the high demand for agricultural land has caused an extension of cultivation into water catchment areas with serious ecological consequences, as the soils of these lands degrade rapidly and become depleted of major plant nutrients. In a natural forest ecosystem, the nutrients released by plant litter are rapidly used by living plant tissues and become locked up in the biomass for most of the forest's life. When a forest canopy is cleared and burnt, the nutrients are released, but the soil fertility is short-lived. Loss of vegetation cover, therefore, accelerates soil loss. Furthermore, the removal of forest cover from a water catchment increases flood risks.

The present trend of overexploitation and mismanagement of forest resources can be reversed if the remaining forest lands are protected and the forest cover replaced where possible. Although afforestation programmes have been attempted in several countries, the introduction of exotic species has not restored the ecological stability that existed when there was natural forest cover. The rate of deforestation in Africa is 30 times greater than the pace of reforestation; in the early 1980s an estimated 3.7 million hectares were being lost every year through farming activities and cutting down of trees to meet energy and other needs, including lumbering by an increasing population. Partly as a result of tree cropping, wildlife resources are being depleted. A fuelwood crisis is manifested by severe fuelwood deficits in the savanna regions of West, Central and East Africa and in the arid areas of the Sahel, South-Eastern and South-Western Africa.

Most of the fragile arid and semi-arid lands do not have the capability to support large scale arable farming for non- food cash crops. Their real potential lies in livestock production and wildlife management. However, with rapid population growth and use of increasing amounts of land for cash cropping rather than subsistence agriculture, rangelands in eastern and southern Africa are fast disappearing.

Many large-scale mechanized schemes, irrigation projects, resettlement schemes and big dam projects have taken away lands used by pastoralists during droughts to alleviate pressure on the fragile drylands environment. The food security policies of African nations, which see the expansion of large scale projects as the key to agricultural development, rather than the improvement of production conditions for mobile animal husbandry and smallholder farmers, contribute to the insecurity of herders and small farming communities (Darkoh, 1994). The rights or needs of the indigenous populations and of small-scale producers and mobile livestock keepers in African drylands and river basins are often not given sufficient attention in development planning, a fact

Photo 1. *Soil degradation in ARSI Zone, Ethiopia.*

which often aggravates conflicts.

Because of their role as key production areas in drylands, African river basins and wetlands have become seed-beds for land use conflicts. As elsewhere, conflicts arise between the various production sectors or stakeholders, the major of which are agriculture, livestock, wildlife and urban development. Other conflicts are caused by polarized population interests (for example, pastoralists versus peasants) over river basin and wetland resources. In broader terms, land use conflicts reflect a lack of land reforms and coordinated national land use policies for drylands. Each sector views the key production areas as optimal for their particular activity. What ensues is intense competition for the same land.

Without a mechanism to prioritize competing demands, the resultant land use is not necessarily the most appropriate in ecological terms. For example, in many countries, large chunks of riverine forests and other wetlands, normally used by herders in the drylands as fall- back areas for dry season grazing, have been designated as national parks or forest reserves, which has marginalized the weakest sector, namely, pastoralism.

As a result of the endemic marginalization, the pastoralists have had little alternative but to utilize more intensively and, at times, overexploit the range and water resources available to them. The decrease in available pasturage, with a simultaneous increase in livestock, results in overgrazing. The consequent overgrazing causes the destruction of vegetation, soil erosion, desertification etc., and thus destabilization of the ecological balance in the river valleys and their adjoining upland areas.

Commercialization of the pastoral economy and land resources and sedentarization policies of African countries have also increased pressure on natural resources in many areas. The main causes are the reduced distances which livestock now roam and the heavy concentration of men and animals around new high-capacity watering places. Also, sedentarization or villagization without improved lifestyles and management practices have done little to prevent land degradation in the region.

Africa has 57 out of the 200 major river basins in the world. Twelve of these river basins are shared by four or more countries. African river basins have an international character and, as such, many countries cannot embark on large- scale river basin projects without affecting the interest of other countries. The construction of dams for irrigation and hydropower upstream usually impedes similar developments downstream. Some cases have shown that such projects may precipitate inter-state conflict, as has happened between Niger and Nigeria over the two dams on the Lamido and River Maggiya, and between Nigeria and Cameroon over the Ladoo Dam on the Benue River. Because of their international character and the polarized national interests over river basin resources, river basins are good examples of areas in African drylands where national political and economic interests can transcend ecological considerations to trigger off major social and political disasters. Witness, for example, the conflict between Senegal and Mauritania in the 1980s over the utilization of resources in the Senegal basin, and the potential conflict between Botswana and Namibia over the Okavango Swamps.

Indeed, natural resources and environmental issues underlie most forms of conflict in the drylands of Africa. Military conflicts between states and between groups within a state frequently occur over access to, and control of, natural resources. Military conflicts may occur within and between states when environmental degradation and natural resource scarcities undermine social, political and economic viability of societies and lead to political instability, a breakdown of law and order and increased flows of refugees. The refugee flows across international borders have further aggravated the political and environmental security situation in several African countries.

Improper irrigation practices are also turning large areas of precious irrigated farmlands into wet, salty wasteland, causing declining yields and often loss of productivity. The problem is usually inadequate drainage. Where excessive volumes of water are used, groundwater levels rise, creating the twin problems of waterlogging and salinization. Salinization and alkalinization are serious problems in some irrigated areas in North Africa, the Sahel, Eastern and Southern Africa.

All causes of land degradation discussed so far lead to soil erosion, in one form or another, and desertification – two major environmental problems in the drylands. The rates of soil erosion in the drylands of Africa are among the highest in the world. The continent's precious topsoil is being lost at an incredible rate. Data provided by the Global Assessment of Soil Degradation (GLASOD) (UNEP, 1992) shows that some 332.3 million hectares, or 27.6 per cent, of the susceptible drylands in Africa, are already affected by different degrees of soil degradation. Studies by Food and Agriculture Organization of the United Nations (FAO) indicate that more than 35 per cent of land north of the Equator is affected by either erosion or salinity. Zimbabwe alone could be losing, on average, 1.6 million tonnes of nitrogen and 240,000 tonnes of phosphorus each year through erosion. FAO's findings show that sediment in many African rivers is increasing drastically: thus, sediment levels are increasing at approximately 5 per cent in Nigeria, Tanzania and Zimbabwe, 4.3 per cent in the Sudan and 3.2 per cent in Tunisia (FAO, 1990, p. 10).

Desertification, defined simply as dryland degradation (UNEP, 1992; Darkoh, 1996a, 1998) affects millions of hectares of arable land and grazing land as pressure from humans and animals increases, thereby removing the vegetative cover through farming, overgrazing and bush fires as the net shift of land area towards aridity in the ASAL environments continues to gain momentum. The exposure of soil to wind erosion leads to an extension of desert-like areas outside the climatic desert. As much as 34 per cent of Africa's land area is under threat of desertification. The extent of desertification revealed by UNEP's 1991 assessment is alarming. About 61 per cent of the continent's rain-fed croplands, 18 per cent of its irrigated lands and 74 per cent of its rangelands are affected by desertification of moderate or high degree (UNEP, 1992). Nearly three-quarters of the total agriculturally used drylands in

Africa have lost at least 25 per cent or more of their productivity during the last few decades. And the process still goes on.

Urbanization and environmental security

The growth of human settlements in Africa today is marked by an unprecedented urban explosion, reversing the rural trends which had characterized the continent until recently and compounding the problems of land degradation and environmental security. There are certain common characteristics in the general geography of human settlements and pattern of urbanization. At the macrolevel, there tends to be an imbalance in the relationship between people, resources, environment and development which has led to a geography of disparities, including sharp disparities between the urban and the rural areas and between the towns and the villages, reflected in the sharp drop in environmental quality and services (Saha, 1992). Over-concentration of wealth in the big cities contributes to the abandonment of the rural areas and the small towns. Attempts to redress the situation are beset with difficulties caused by the low level of investment available to inject into the rural areas and lift them from their existing level of deprivation or resource degradation, and also structural issues such as institutional capacity and the absence of meaningful intersectoral linkages. This has led to a depletion of human resources and an inability to maintain infrastructure and provide services.

In most African human settlements, large masses of people live in environments that are neither life-sustaining nor conducive to positive development. Areas are poorly serviced and the inhabitants are susceptible to both man-made and natural hazards. These can be identified at different spatial scales of the settlement hierarchy.

At the very local level, the neighbourhood or village, millions of Africans are exposed to pathogens, with serious impacts on human health; for example, pathogens from human excreta in water supplies and smoke fumes from stoves which cause respiratory problems. There is also the problem of unsafe housing sites subject to flooding and exposed to other risks of natural disasters. These problems are compounded at the next level, the small or medium town, where there are are added risks from toxic chemicals used in the workplace without adequate safeguards; household, occasionally industrial, solid wastes which are dumped around houses, attracting disease-causing agents like rats and flies, which feed on the uncontrolled garbage dumps and dirty water pools caused by inadequate sewage disposal facilities and drainage.

At the third level, the city or conurbation, problems centre on inadequate and overcrowded housing; unplanned peri- urban development; proliferation of squatters and shanties; high levels of air pollution caused by poorly maintained vehicles on congested streets and high levels of lead additive in petrol; high levels of water pollution because of inadequate and strained systems, absence of drains and sewage treatment plants, inappropriate dumping practices and inadequate environmental control on industry (UNCHS, HABITAT, 1990; Saha, 1992).

In the context of the potential impacts of industrialization, it is worth noting that the contribution of cities in developing African countries to global environmental problems remains relatively small – it is mainly the cities of the developed world that emit greenhouse gases. Thus, the main threat from industry located in African cities is to the local population. Even so, African cities are threatened by global warming which may lead to more severe storms as well as rising sea levels.

Finally, at the sub-national level, problems arise from the interaction between cities and their rural hinterlands. Urban-based decisions have a powerful influence on rural resource exploitation and rural areas suffer from the impact of city-based activities or city-generated wastes. Among the most common examples are the degradation of coastal and estuarine fisheries as a result of water pollution from city- based enterprises, and air pollution from city-based industries which damages vegetation through acid rain and by disrupting natural systems. Other resource degradation would occur from over-intensified demand, say, for fuelwood; dumping solid wastes from city enterprises; poorly prepared and maintained landfill sites which often contaminate water used by rural households because of the high incidence of run- off and seepage during periods of heavy rain.

Some way forward: science and technology

Most of the rural and urban environmental problems outlined above are linked to the failure or inability of African countries to provide appropriate scientific and technical knowledge, effective regulations and planning frameworks to address the problems of poor citizens and to protect rural and urban environments from contamination or degradation. Rapid population increase; urban explosion; recurrent droughts; increasing scarcity of land and increasing pressure of exploitation of the limited resources of soil, water and vegetation are some of the major factors behind the repeated famines and food shortages which occur on the continent. The cures for the problems of land degradation, low biological productivity and food security in the drylands of Africa can generally be formulated as 'planned and improved land use on a sound ecological basis' (Rapp and Hellden, 1979). This is true both for small-scale traditional farming or herding as well as for large-scale mechanized projects (Photo 2).

Understanding and knowledge

To be successful, planning for better land use in African drylands must be based on a sound knowledge of both biophysical and social sciences; neither the biophysical nor the social sciences alone will suffice, but neither will a reliance on technology while neglecting basic science. We desperately need greater depth and breadth in our collective knowledge of dryland environments. We need, above all, to understand the processes operating within the dryland ecosystems and the complex web of interconnections between these component parts. Much of the background data for planning better land

Photo 2. *School children attending a video show on environmental awareness organized by the environmental protection and land-use planning team or ARSI Zone, Ethiopia.*

use can be provided by natural and social scientists.

Combating land degradation requires scientific knowledge of available natural resources, their conditions and ecologically viable management methods. This, in turn, requires inventories of natural as well as human resources, appropriate counter measures (cures) and environmental monitoring (repeated, comparative surveys or registrations). Repeated famines and food shortages show that traditional knowledge of land use in drylands, though highly useful (Darkoh, 1996b), is not sufficient to meet the challenge and the changing situations of pressure from growing populations and annually fluctuating rainfall. Research is needed on improved land use and alternative land management in drylands.

We need to gain so much knowledge so rapidly that we cannot afford to work in competition and unnecessarily replicate the work of others, though that is not to say that a high degree of specialization is the answer. African developing countries are marginal producers of new scientific knowledge and technology. Their share of world research and development is less than 0.5 per cent and the research work being done does not produce much scientific and technological innovation (Economic Commission for Africa (ECA), 1995). Indeed, the research and development effort in Africa has made little contribution to technological and economic development during the last thirty years and is not expected to make much contribution, either, in the years ahead (ECA ibid.; Jugessur and Hamel, 1995). Under these circumstances, what is needed is international cooperation in research and an easy and unselfish exchange of ideas, data banks and other information. This has become increasingly simple with the advent of international computer-based networks.

Technology

There is no universally accepted definition of technology or technology transfer. Technology can be defined simply as practical knowledge applied to satisfy human needs; technological transfer can be defined as the process of assimilation and exploitation of technological resources (ECA, 1995). Technology has a crucial role to play in any attempt to find solutions, but we should note that technology by itself will not fix anything. Technology is a social construct responding to social, cultural, political and economic demands and priorities. These factors determine not only whether technology is used positively or negatively, but which forms of technology are developed in the first place. Technology, then, must be seen in a social, economic and political context.

There are at least five separate but closely related ways in which changes in technology can assist in avoiding environmental crises in drylands (Aplin et. al., 1995):

- By reducing our dependence on diminishing resources;
- By helping develop more effective ways of managing resources, such as soil and water;
- By avoiding or reducing pollution of the environment;
- By giving us better data on our activities, the environment, and the interactions between the two;
- By providing more powerful means of analysing that data.

In the long run, the last two of these may turn out to be the most important, as one very real barrier to managing environmental issues in Africa has been inadequate data and the inability to analyse it, build models and develop management plans.

Many types of instrumentation will help increase the amount of information available. Satellites provide the capacity to record enormous amounts of information for every point on the earth's surface. Information can also be updated at very frequent intervals, providing a unique opportunity to analyse processes and to heed early warning signals of impending problems. However, we have to be extremely careful in interpreting the data. Pretty maps on a screen are one thing; making practical use of them another. We still need to supplement information gathered from satellite data with information collected from the ground or ocean surface. Environmental monitoring should utilize information from three levels: ground, air and space. Ground checks of sample areas should be combined with analysis of air photographs and satellite images of Landsat or other available types.

Geographic Information Systems (GIS) is a young science, related to remote sensing, surveying, geodesy and photogrammetry, all of which deal with spatial data handling. We see GIS as essentially a tool for urban and regional

research, policy analysis, policy simulation and planning. In addition to GIS, which holds a variety of applications for planning arid land development, two other Spatial Information Systems need to be mentioned: Land Use Information System (LIS) and Computer-aided Design (CAD). LIS is primarily a tool for the legal, administrative and economic management of land resources. It consists of two main components: a database containing spatially referenced land-related data and a suite of procedures and techniques for systematic collection, updating and querying of data. The differences between GIS and LIS, from the hardware and software perspective, are the fact that LIS is used primarily for storage and retrieval of spatial data while GIS is used essentially for more complex spatial analysis (Scholten and Vlugt, 1990). CAD refers to graphical systems which support the work of architectural or industrial designers. It provides facilities to perform calculations and to produce technical drawings and three-dimensional displays of designs.

In order to utilize and share existing knowledge on drylands, using some of the powerful and sophisticated computer-based tools such as those described above, we recommend that the high-income countries (Australia, the countries of the European Union, United States of America, etc.) should support research and development of methods in environmental monitoring and control, particularly of desertification in the drylands of Africa. They should identify and work closely with local African research institutes, universities and other research organizations.

Transfer of information and technology

Sound technological transfer and acquisition will have to play a greater role in African development than they have up to now and they must receive greater attention from policy makers than they have so far. In particular, human, institutional and legal capacity in technology transfer must be enhanced.

Chapter 34 of Agenda 21 deals at length with the international transfer of basic data, scientific knowledge and environmentally sound technology. It states that the basic goal is to place all nations in a position where they can make informed choices as to which technology is most appropriate in their particular circumstances. This will then strengthen each nation's own technological capabilities, especially in the case of low-income nations. Both information and technology are vital if global environmental catastrophe is to be avoided. As Aplin et. al., (1995) have noted, both information and technology are vital if such a catastrophe is to be avoided. However, information and technology transfer from high-income to low-income nations raises questions on what terms such transfers will occur and the kind of information and technology that should be transferred.

Transfers of technology and information frequently involve questions of ownership, patent rights and commercial advantage. Much of the technology needed by developing countries or low-income nations to ameliorate or overcome serious environmental problems is too expensive to acquire at market rates. Some is certainly in the public domain and therefore freely or relatively cheaply available, but what of emerging state-of-the-art technology being developed commercially? Their owners have definite rights to profit from its sale, so ways must be found to subsidize costs to poorer nations. There is an obvious role for aid in this area, as both parties can benefit; the low-income nations obtain subsidized access to desired technology, and the commercial developers are appropriately rewarded.

Equally important is the question of the suitability of technology transferred to low-income countries. The high-income world is not the citadel of all technological wisdom, nor are excellent technological solutions to environmental problems in the high-income nations necessarily appropriate for similar problems in poorer countries. The belief that they are could only be maintained if one believed that all other circumstances were also the same, including levels of education, technological expertise, ability to pay, social and cultural traditions, and so on. But the context clearly differs. High-income nations and their transnational corporations may well try to impose their solutions because they see profit in doing so, but such attempts must be resisted and more appropriate local solutions sought wherever possible.

Agenda 21 stresses the need for cooperative research and the sharing of information on an international scale. Again, national and commercial interests can be at odds with the need to assist poorer nations. But it is also essential that as much relevant information as possible is available so that each nation can make its own informed decisions on environmental issues.

The challenges

There are many challenges facing African countries in acquiring and gaining access to appropriate and cost-effective information systems and technologies in support of the proper management of physical environmental resources. For example, in the field of information science, in Botswana, where this author is working, we have ERDAS IMAGING 8.2-UNIX running on a SUNSPAC10 + Digital Workstations (DECS). We have equipment to do much fundamental work using Remote Sensing-GIS and a great deal of work is already in progress in the development of a digital map base which could be used with ARC/INFO GIS package (Ringrose et. al., 1997). What we need for rangeland and crop monitoring is to acquire software for georectification of standard aerial photographs to develop better base maps and facilitate 3-0 modelling (digital elevation) for soil erosion studies, for example. We always need more hard disk space. We need a mechanism for taking our own low level digital (still) or video photography, e.g. from a blimp (a small airship or captive balloon). Automated meteorological stations and soil moisture plus groundwater monitoring equipment is required at about 10 to 15 different locations around the country, and a database developed in Gaborone where conditions on the ground can be monitored on an ongoing basis. This could be linked to the National Oceanic and Atmospheric Administration, US (NOAA) receiving station already in place (Ringrose, 1997,

pers. comm.). Some of the broad areas for scientific and technological cooperation with the developing nations of the drylands of Africa include:

- Sustainable management of renewable natural resources;
- Sustainable improvement of agriculture and rangeland productivity;
- Health and disease.

Additional sectors of mutual interest include information technologies, biotechnologies; materials and production technologies. The European Union has recently identified areas of scientific and technological co-operation in developing countries which include the areas outlined above, and specific areas related to these broad areas (Official Journal of European Communities, No. C117/29, 1997).

Some of the specific areas posing the greatest challenge for scientific and technical cooperation in arid lands development in the developing countries of Africa are:

- Climate change and global warming in arid and semi-arid lands;
- Synoptic meteorological observations of dust storms and other conditions of high dustiness;
- Changes occurring in chemical cycling during a disturbance of arid ecosystems;
- Physical and social indicators of desertification and land degradation;
- Drylands management systems, avoiding the risk of desertification;
- Land use conflicts in river basins and wetlands;
- Land use changes, sand dune fixation and sediment control;
- Conservation of biodiversity;
- Coastal zones and wetlands management systems for enhanced long-term aggregate economic productivity;
- Revegetation of eroded and saline soils in rain-fed and irrigated areas;
- Dynamics of the contamination of soils and underground aquifers by agro-chemicals;
- Waste reduction and pollution abatement;
- The use of solid and liquid urban wastes in soil improvement in peri-urban agriculture;
- Integrated water management, focusing on water treatment and recycling, water conservation, particularly in agriculture and industry, water pollution risk assessment and prevention, improved water supply systems enhancement, and water harvesting technologies;
- Groundwater monitoring;
- Management systems of mountain environments;
- Improved food systems in marginal lands and fragile environments;
- Biotechnology and genetic engineering for agriculture, medicine and pollution control;
- Irrigation and water resource potential;
- Conservation and technologies targeted at reduction of post-harvest losses or quality deterioration;
- Technologies for reducing post-harvest damages and spoilage;
- Improved rangeland management for multi-purpose livestock and wildlife production;
- Endangered species and habitat monitoring;
- Rangeland rehabilitation;
- Animal health systems and resistance to infectious diseases;
- Animal feeding strategies based on the use of food crops products and by-products, specialised forages or pastures;
- Aquaculture.

Conclusion

Finding solutions to environmental problems in the drylands of Africa involves more than simply gathering facts but understanding scientific issues of particular problems and finding types of actions to be taken. This calls for research and technology development and transfer. Cooperation with developed countries and international organizations would appear to us to be a foremost priority if success is to be achieved. Also, solutions of our environmental problems have much to do with our systems of values and issues of social justice (Botkin and Keller, 1995). To solve our environmental problems, we must understand what are our values and which potential solutions are socially just. Then, we can apply scientific knowledge about specific problems and environmentally sound technology to find acceptable solutions.

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Ecology, People and the Environment: a Challenge to the Educators of Managers of Drylands Restoration

V.R. Squires

Dryland Management Consultant
497 Kensington Rd
Wattle Park, South Australia
Australia 5066

Introduction

Drylands cover 43 per cent of the earth's land surface and are the home to millions of people. Many are degraded to a greater or lesser extent. Drylands are extremely diverse in their topography, ecology and productivity, ranging from desert margins to subhumid regions. They are used in a wide variety of ways – as rangelands, conservation areas, urban areas, croplands and so on. All need management by people who are well acquainted with the complexities of integrating ecology, people and environmental concerns.

Drylands in many countries, especially in the industrialized nations, are in public ownership and are managed with multiple use objectives in mind. Ranching, watershed management, forestry, wildlife management, conservation and tourism are often practised together on the one tract of land. In Africa, parts of Asia and countries of the Middle East the drylands are communal grazing lands. There are large areas of arid and semi-arid rangeland on almost every continent and these are used to support millions of livestock and the human communities who depend on them (Thomas and Middleton, 1997).

Many of these grazing lands are the residual lands – the peripheral lands (figure 1). In most situations they are the lands for which no 'higher' purpose could be found (Squires and Sidahmed, 1997). As residual lands they hold a special place because they are the repository (refuge) for wild things (animals and plants). Consequently, they are often rich in biodiversity (Stiles, 1998). In the coming decades the pressure on these rangelands will increase in response to population growth. There will be pressure

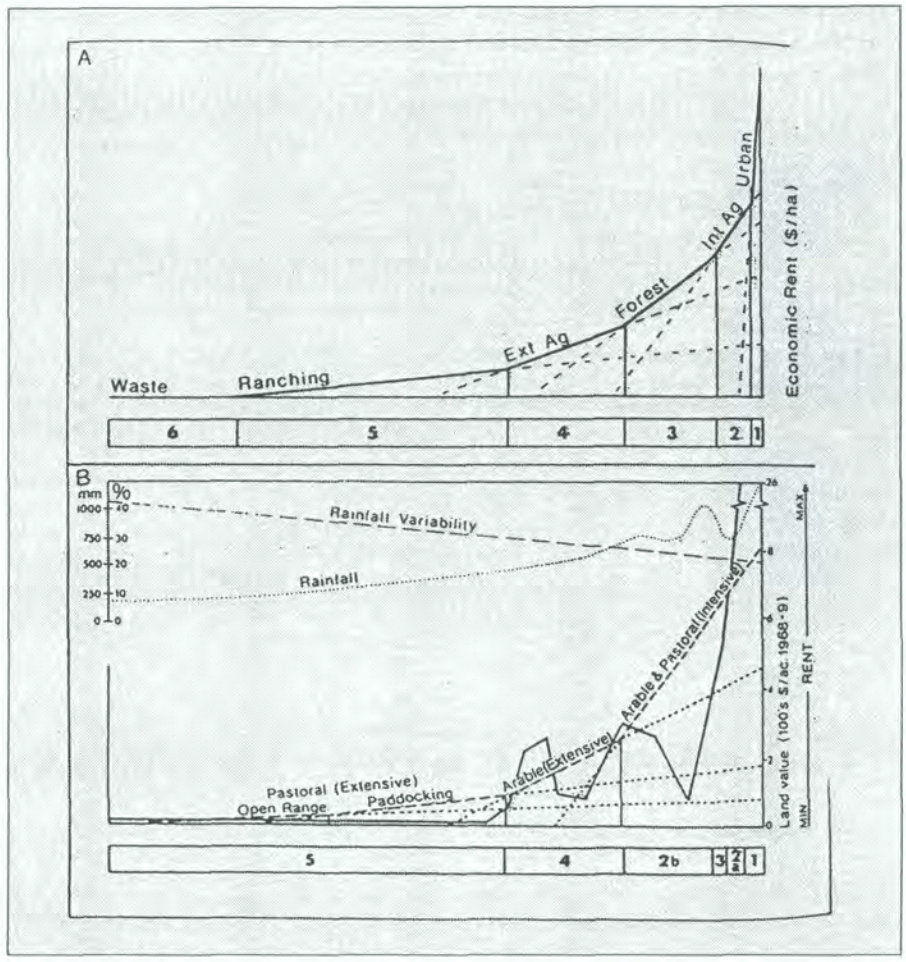

Figure 1. Rangelands are the last lands. The peripheral lands — according to the theories of economic rent. Source: Heathcote (1988).

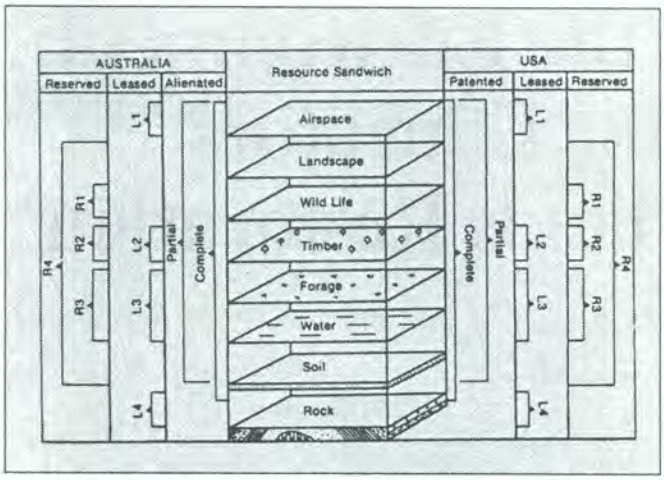

Figure 2. Rangeland resources can be thought of as a "sandwich". Different users have access to different slices in this example from two developed countries. Conflicts arise over confusion as to which users have rights of access to which slice. Source: Heathcote (1988).

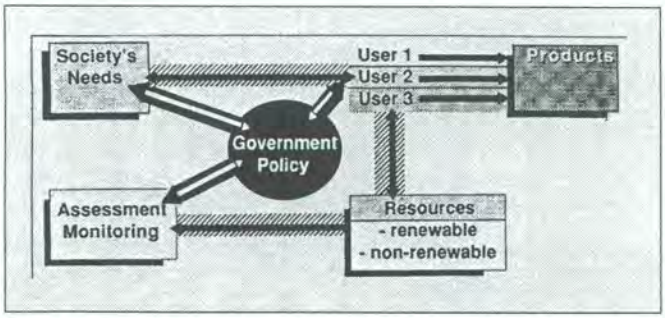

Figure 3. Land management is a juggling of the demands (and expectations) of various groups within society. It recognised that there are several users and several products or outputs. Source: Squires (1990a).

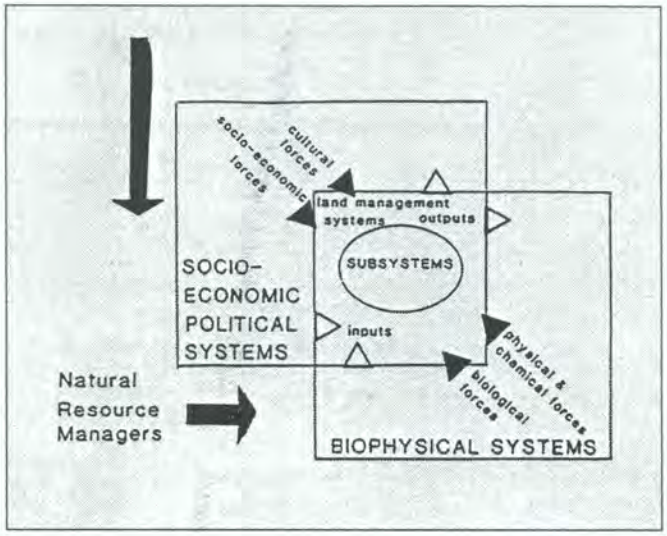

Figure 4. Natural resource managers work at the interface between people and the environment. Source: Squires (unpublished).

to convert them to other purposes such as irrigated cropping, as has already occurred in many countries (Squires and Sidahmed, 1998).

Much of the current controversy about the use of the rangelands, especially the public lands in the industrialized nations, stems from a failure to understand the 'resource sandwich' concept put forward by Heathcote (1988). Those people who use the forage and the water fail to recognize that other slices of the sandwich exist or that others may have a legitimate right to them (figure 2). It is clear that there are different users, or potential users, for almost any piece of rangeland. The role of government has been to try and reconcile the conflicts (figure 3).

It is not surprising, therefore, that we can easily buy into an argument when setting out ideas about range science and management as a profession and the appropriateness of training to service the profession. An important trend over the past few years is to recognise that the role of the natural resource manager is as a mediator between the people who use the resource and society at large. Natural resource managers operate at the interface of these two systems (figure 4). Clearly, an understanding of the forces at play from both the socio-economic/political system and the biophysical system is a prerequisite to any successful intervention. The emphasis should be on problem-solving skills and on methods for retrieving information rather than on knowledge acquisition and storage. In some cases decision support systems, including expert systems, can be extremely useful ways to capture and distil the accumulated knowledge about a particular region or problem (Squires, 1998).

The challenge for educators

Teaching rangeland management is as much about people, ideas and issues (this is called soft data) as it is about hard data like scientific facts, new assessment methodology and new production technology. However, despite the fact that many major rangeland problems involve the people in the system, rangeland management is rarely studied and taught as a soft system.

Rangeland production is a subset of the broader category of agriculture. The terms agriculture and ecosystem (of which ecology is the study) are neatly linked by Conway (1985). In this line of thinking, ecological knowledge is essential for a stable relationship between agriculture and ecosystems ever since farming and ranching began to replace hunting and gathering. Agriculture has evolved both stable and unstable systems. Evidence of this instability is to be seen in the widespread land degradation which is a feature of many drylands.

The education of renewable resource managers (including those who will work in the drylands) is vital. The role of resource managers is a tough one. They must be trained to understand the many interactions of the various ecosystems in order to make balanced judgements as to how these systems can be used and, just as importantly, how much use they can stand and still be productive (table 1). Figure 5 is a flow chart

Table 1. Expected competencies in natural resource management graduates

Competencies related to acquisition of knowledge

- Understand the scientific principles underlying renewable resource management;
- Understand the socio-economic principles underlying renewable resource management;
- Comprehend how the various disciplines involved in renewable resource management interact with one another.

Competencies related to attitude development

- develop a positive attitude towards the need for continuing personal study and research;
- be sensitive to the implications of changes to the total environment;
- be sensitive to the impact of technological change;
- be sensitive to the impact of sociological change.

Competencies related to the acquisition of skills

- be able to communicate effectively;
- be skilled in collecting, processing and interpreting data associated with resource inventory, baseline studies and survey (including sociological studies;
- be able to carry out field operations associated with monitoring soils, water, air, flora and fauna;
- be able to carry out routine laboratory operations associated with resource inventory, baseline studies and survey.

People trained in natural resource management require a programme of education which includes the study of biological, physical and social sciences relevant to renewable resources management. The integration of biological, physical and social sciences is most effectively achieved in the context of a systems approach.

setting out some processes by which education and training in land resource management can achieve better land management.

The job of educators is to alert students to the fact that agricultural and pastoral pursuits themselves disturb ecosystems. Teaching should not be alarmist but as a first step in the task of bringing understanding to what are complex and delicate systems. We should begin educating students to understand the relationship between rangeland use and the environment and the difference between a production-orientation and holistic rangeland development (Squires and Andrew, 1998). Rangeland development is a people-oriented activity which seeks to promote benefit to the whole community, whereas livestock production seeks to maximise returns. Often the objectives of commercially-oriented livestock producers (and their advisers) are not compatible with rangeland development and may even contribute to accelerated land degradation. Many of the professionally trained/ educated rangeland researchers and

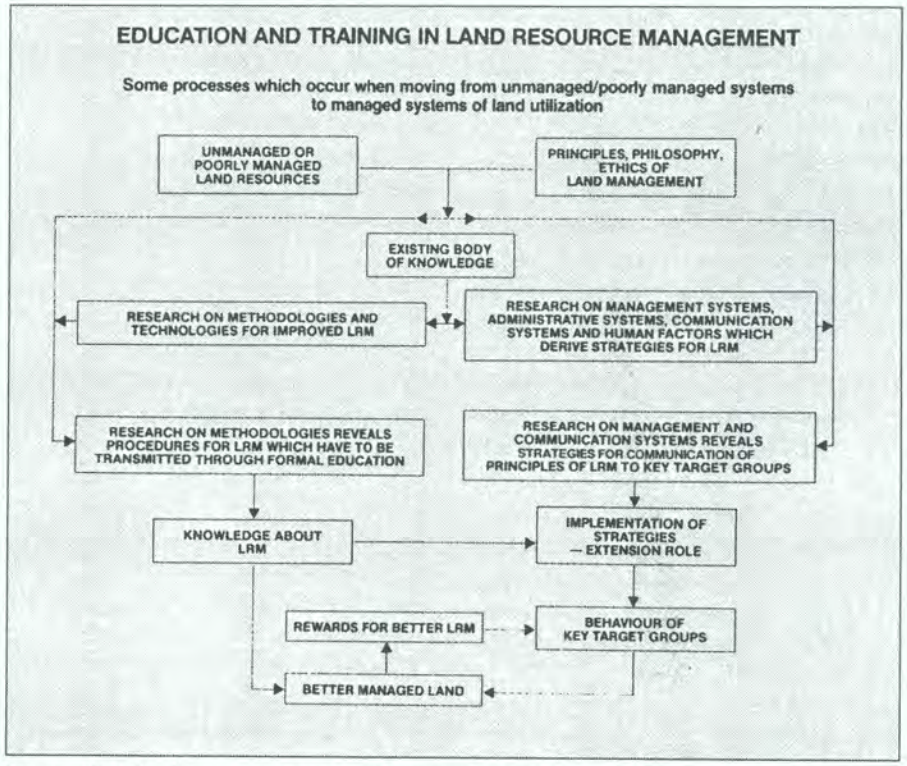

Figure 5. A badly managed system is one where it is used in such a way that the capital stocks of the resource are being consumed. The managed system represents a more desirable state and should ensure that the natural resources are being used in a sustainable way. Source: Squires (1990b)

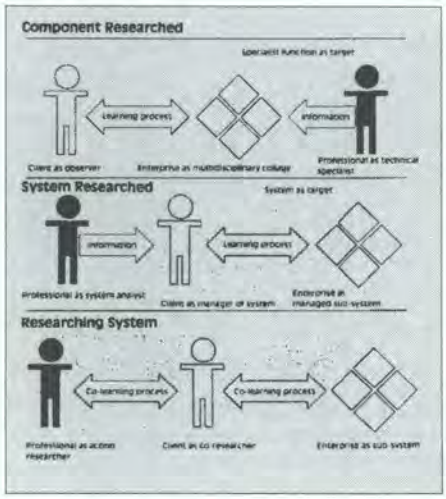

Figure 6. The roles of extension workers, researchers and the client (principally ranchers) can be viewed in different ways. The recognition that the client is a co-researcher is growing. Indigenous knowledge can be combined with other information and research findings to help improve a situation. Source: Squires, Tow and Boast (1991).

extension personnel hold the view that more efficient or profitable livestock production is their key objective (Behnke, Scoones and Kerven, 1993). Often, they are poorly equipped to cope with the complexities of systems where socio-economic, political or cultural aspects may dominate.

Conway (1986) has developed the concept of an agroecosystem to study the relationship between natural systems (ecological) and managed systems (agriculture). It should be obvious that people are the key element in this agroecosystem and that we should, therefore, involve them in the study of rangeland systems and how to improve them. Figure 6 is a series of diagrams to show how our perceptions of the role of the end-user have changed. The shift from passive observer (receiver) of new technologies to an active role as a co-researcher is quite evident (Squires, Tow and Boast, 1991).

The systems approach

Spedding (1982) argues that agriculture is a system. Clearly then, the study of agriculture (including rangeland production) should not be confined to biological sciences. Humanities are an essential part of it. The relevance of a systems approach lies less in its methodology than in its philosophy. There is recognition that systems need to be studied as entireties and not broken down too quickly into the component parts – the so- called reductionist approach. The danger of a reductionist approach is that the people factors (culture, tradition, religious beliefs) are often ignored.

Of several systems principles which are important only one will be discussed here: the concept of emergent properties. This concept is based on the belief that any change to the system (made by the manager) must be tested on a model of the whole to predict its outcome. Thus the soft systems (those which contain people) are said to be purposeful. It is assumed that a rangeland system is more than the sum of its parts. Thus certain additional properties 'emerge' when a holistic approach is used (Bawden and Packham, 1991).

The first step in learning the systems approach is to embrace the concept and to understand the principles, including the concept of emergent properties. The second step is to learn to construct models. According to Spedding (1976), it is virtually impossible to communicate about production systems without models.

In this context picture-type models are not inferior to mathematical models. The models should be as simple as possible and highlight parts and processes. They must have a boundary and defined goals. The latter gives the systems its purpose and drive (Rickert and McKeon, 1991).

Rangelands and the environment

I wish now to return to the thesis that studying renewable resource management is as much about issues and ideas as it is about science and economics. We must get away from the notion that everything is knowable. Furthermore, not all problems are solvable – often the best we can hope for is to improve the situation (Squires, 1991). A lot of work, therefore, in rangeland management involves dealing with imperfect knowledge and helping people make changes that will improve their situation.

Conventional science approaches in resource management involve 'experts' solving problems with specialist knowledge and perspectives. This can result in confusion, frustration and further problems. Methods which show appreciation of human elements and communication skills are more realistic approaches for many of the complex problems found in rangeland management. The curricula of the past did not reflect this need very well (Squires, Andrew and Biggins, 1991).

Facing up to complex problems comes as a shock to students schooled in the facts of chemistry, soils, biology, genetics and the methodologies of rangeland management. To find that there are no clear answers to systemic rangeland problems is often viewed as heresy. But alternative ways of seeing rangeland management must be established to improve many complex production and conservation problems (Behnke, Scoones and Kerven, 1993).

Conway (1981) developed an approach based on the idea that rural development is beset by problems such as the inevitable conflict between production goals and environmental protection. When ecosystems are transformed into agroecosystems they become simpler and more definable on one hand, but more complex on the other, because of human management activity. The complexity of a diverse ecological system is replaced by a complex management/control process (figure 7).

The agroecosystem concept can be used to analyse the production system at various levels of complexity and at different areal scales – a paddock (pasture), ranch, district, watershed or region for example.

The twin crises

Sustainability is much talked about and now generally understood as a measure of the capacity of the system to cope with, and recover from, constant stress or sudden crisis. The effect on long-term productivity is the common yardstick. The ability to take a long-term view of an agroecosytem is the key to understanding sustainability (Squires 1992, 1998).

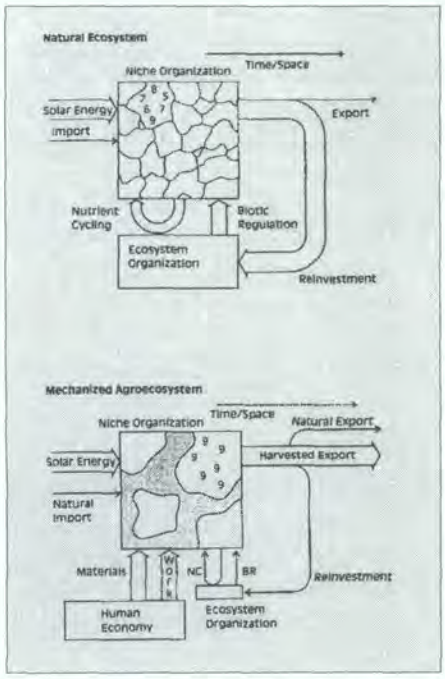

Figure 7. Natural ecosystems differ from modern human-managed production systems in several ways. The biotic community of the undisturbed system is more diverse (indicated by the number of cells in the niche space box) than that of the human-dominated system and exploits more fully the available niche space. The characteristics of individuals (genetics, age, health) within a species (indicated by numbers within one species' cell) tends to be varied in natural ecosystems but more uniform in human- managed systems. Natural ecosystems are more continuous in space and time, and they reinvest the bulk of their production in their own ecosystem organisation. The export of food and fibre from human-managed systems limits such reinvestment, and makes these systems dependent on materials inputs and work from the human economy. Source: Squires (1991).

Short-term concerns for productivity must be contrasted with long-term, often community-wide, concerns about sustainability and equitability (including intergenerational equity). Equitability is a measure of the extent to which the use of natural resources and the distribution of their production among the population is fair or balanced. The concept is based on the assumption that all people in the system should receive a fair share of the benefits generated from the resources. Most forms of economic protection (subsidies, price support schemes) are examples of low equitability. This is because they unfairly benefit some people but are paid for by the whole economy.

Exclusive use of public land by one sector is another example, especially if there are additional costs incurred by people outside the production system which are not borne by those who create those costs. These are what are referred to by economists as negative externalities.

It is clear that the environmental lobby sees a crisis in the current system of rangeland-based production. Their proposed solutions to the perceived problems are not always compatible with the goal of producing ample quantities of a quality product at low cost. It has always been relatively easy to identify ways of improving productivity but it is not so easy to describe ways of ensuring sustainability and equitability.

This calls for a rethink of research priorities.

Currently, the whole rural social and economic structure is in jeopardy because of international trade wars, threats to subsidies and support schemes and the broad-based opposition in many industrialised countries to the continuation of rangeland operations on public land. At worst, many ranchers will be forced out of business. Even more, the conservation- minded ones will be forced to cut short- term costs by deferring conservation programmes, or by taking short cuts which may deplete biological and economic resources.

What is the danger that existing range management practices are affecting the sustainability of our productive land base? Many commentators are quite pessimistic: they argue that the present systems are not sustainable unless our land management practices change fundamentally. Production targets must be lowered to match the ecological reality of diminished biological capacity. Dregne, Kassas and Rosanov (1991) argue that the world's rangelands are continuing to deteriorate at an alarming rate. This is a very grim view of the relationship between rangeland use and the environment but it may be the correct one. Either way, there is a serious challenge to educators to ensure that the new generation of resource managers have the education and training to address the issues and ensure situation betterment.

Conclusions

The revision of curricula to encompass environmental issues and the systems approach to their reconciliation is necessary. This is a difficult and sometimes lonely task, but it is intellectually stimulating. From my position as a former academic and a one-time farmer I urge everyone involved in range management education to pursue this revision. But beware: there is danger that an open-minded approach will be rejected in favour of reductionist 'hard science' approach because the latter are more academically respectable and because national policy wants us to be in the technology and development race. The race is judged in terms of productivity; it has yet to be assessed in terms of sustainability and equitability. Perhaps to date we have been too much influenced by Marx (Groucho not Karl) who said 'Why should I worry about future generations? What will they ever do for me?'

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Baseline and Growth Indicators for Desertification in the Saharo-Sahelian Area of Mauritania and their Monitoring from 1953 to 1998.

Monique Mainguet

Institut Universitaire de France, Zonal Geography Laboratory for Development, Université de Reims Champagne-Ardenne, Reims. France

Frédéric Dumay

Zonal Geography Laboratory for Development, Université de Reims Champagne-Ardenne, Reims. France

Mohamed Lemine Ould El Hacen

Faculty of Arts and Human Sciences, Université de Nouakchott, Mauritania.

Ahmedou Ould Mahfoud

Faculty of Science and Techniques, Université de Nouakchott, Mauritania.

Introduction

The onset and pace of the increase of environmental degradation in the last four decades in the countries of the Sahel in general, and more particularly in Mauritania (figure 1), give rise to environmental changes that demand constant efforts on the part of the local people to adapt to new constraints. That is why it is of interest, with the help of objective tools such as land surveys using aerial photographs and satellite imaging, to arrive at indisputable indicators of the

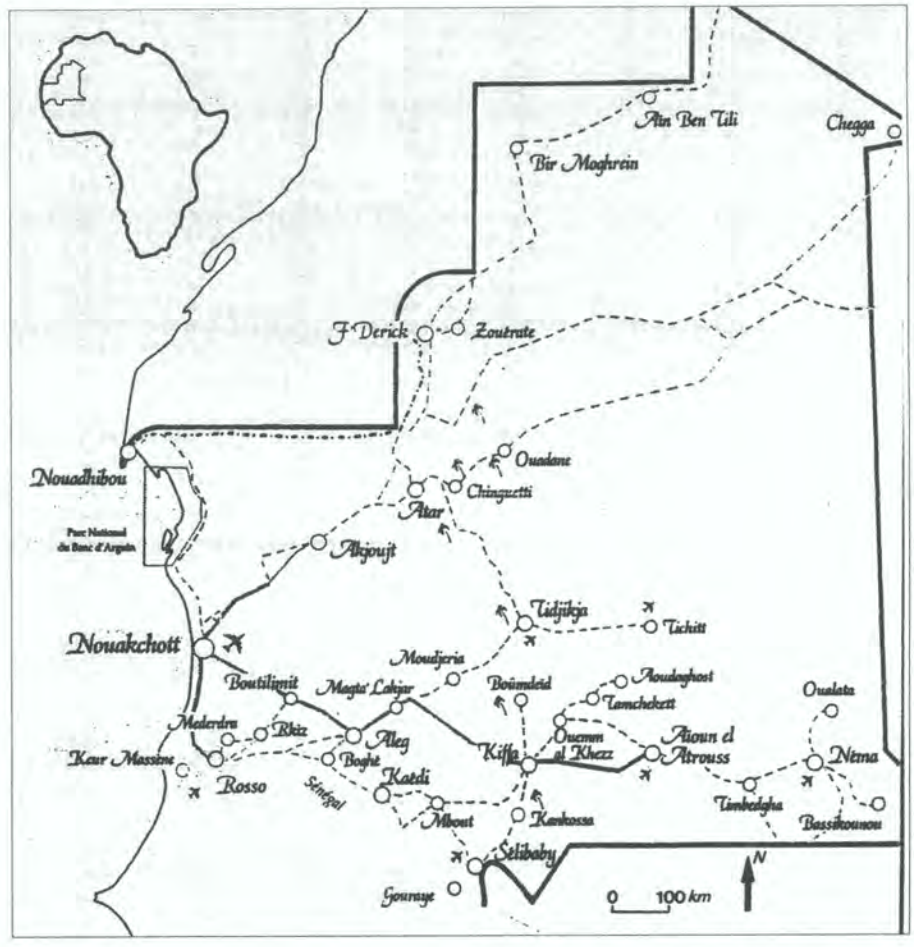

Figure 1. General location of Mauritania, West Africa. Principal cities and road network.

onset of the desertification process in time and space, and monitor them so as to understand the dynamics of desertification in and around the urban fabric of Nouakchott, along the 'Route de l'Espoir' and, more generally, in the Hodh.

With a knowledge of how to evaluate natural and man-made mechanisms that are indicators of environmental degradation and generators of desertification, and avoiding the formulation of strictly quantitative estimates, we are putting forward an inventory of the tools used, particularly aerial photographs and satellite imaging and the sequence of events, later expanded, using field data that enables an accurate estimate of the geomorphological processes to be made.

Analytic tools for the study of the symptoms and development of the early stages of desertification

Photographs and satellite imaging used (table 1):

Six photographic coverages at various dates and scales (National Geographic Institute (IGN) France);

Spot satellite images at a scale of 1:100,000, from between 1987 and 1995 for the monitoring of sand encroachment on the Zouérate-Nouadhibou railway and in Nouakchott;

A 1973 Landsat mosaic of Mauritania at a scale of 1:1000,000, supplied to us by the United States Geological Survey, Flagstaff, Arizona.

Time-frame of the onset and development of desertification in the Nouakchott sector

The Nouakchott site in 1954, the year our study first deals with, consisted of a group of longitudinal sand ridges, oriented NNE-SSW 30°, ending south of

Amoukrouz, beginning at Latitude 18° 37'N at the junction of the Areich l'Abara and Tin Yourgat ergs (figure 2, map of Nouakchott to a scale of 1:200,000).

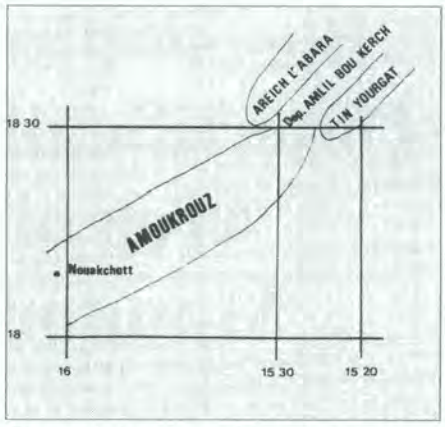

Figure 2. Location of Nouakchott downwind of the Amoukrouz erg; junction of Areich l'Abara erg and Tin Yourgat erg.

The first mission evaluation 1954 AOF 096

The oldest photographs on record are those of 1954, taken while Mauritania was still a colony, just after the establishment of the town of Nouakchott as the new capital in 1953.

Table 1. Documents used IGN France Aerial Photographs

Mission evaluated	Date	Scale
1 AOF 096	1954	1:50,000
2 AO 628/60	1963-1964	1:6,000
3 AO 628/125	1963-1964	1:12,500
4 AO 692/10é0	1965	1:10,000
5 MAU 4/125	1980	1:12,500
6 MAU 12/150	1991	1:15,000

Satellite Images Mosaic Landsat	Path and Row	Date 1972-1974	Scale 1:1,000,000
Spot Images Spot HRV 1 P	023-307	10-03-88	1:100,000
Spot HRV 2 P	026-307	13-01-88	1:100,000
Spot HRV 2 P	026-306	13-01-88	1:100,000
Spot HRV 1 P	025-307	13-01-88	1:100,000
Spot HRV 2 XS	050-316	17-10-88	1:100,000
Spot HRV 2 P	018-307	12-12-87	1:100,000
Spot HRV 2 P	024-307	10-03-88	1:100,000
Spot HRV 1 P	025-306	13-01-88	1:100,000
Spot HRV 1 P	019-307	02—1-88	1:100,000
Spot P + XS	021-314	04-02-95	1:200,000

Photographs 073-074-075-076 from the 1954 AOF 096 mission to the scale of 1:50,000 cover the initial Nouakchott site, five kilometres from the Atlantic coast, at the northern edge of the Aftout depression (18° 7N, 15° 5W). Situated on the longitudinal dunes already fixed in 1954, which were called 'ogoliens' by geologists and geographers, the city is swept by the Regional Wind Action System (SRAE). This system consists of two wind currents:

- The harmattan, a continental trade wind blowing NNE-SSW in Mauritania, which gives rise to the longitudinal sand ridges of Amoukrouz;
- The N-S to NNW-SSE wind that originates in Morocco, around the latitude of Essaouira (32°N) and sweeps the Mauritanian coast across a 60 km belt to the latitude of Cap Mirik (18° N) and beyond, probably as far as the latitude of the Senegal river.

The stereopair 073-074 to a scale of 1:50,000 enabled us to determine that the town was still small in 1954, with about 75 houses and approximately 500 inhabitants, and was divided into three units, as shown in figure 3, a stereoscopic view of the Nouakchott section 4: the first of these (1) is to the south-west of that on the summit of the sand ridge and is the richest in vegetation; the second (2), in the interdunal depression to the west of the previous unit, is made up of gardens; the third (3), to the north-east of the whole area, is the dense housing core of the town. In these photographs, the initial urban site was established on the west edge of a complex interdunal corridor which at times became a channel with flowing water that threatens parts 2 and 3 of the town.

In 1954, the longitudinal dunes were fixed by desert vegetation. Water erosion has scoured out a dense maze of gullies, the bottoms of which have been colonized by lines of concentrated plant cover (photographs 075-076). These gullies are generally on the sides of the dunes; some reach the top by regressive erosion. Runoff water fills temporary ponds of the 'sebkha' type, which leaves salinization rings on evaporation.

The main facts emerging from an analysis of the 1954 photographs are:

- The absence of any wind reactivation up to that date;
- The existence of water erosion on the sand ridge slopes, with signs of laminar and sheet erosion, mostly on SW-facing slopes.

It can be deduced from the 1954 aerial photographs that the early 1950s was a period of calm wind, without any sand mobilization but with relatively intense water action.

Figure 3. Stereoscopic montage of 1954 aerial photographs to a scale of 1:50,000 of the situation of Nouakchott, showing a landscape of longitudinal vegetated sand ridges with little degradation.

Photo 1. *Nouakchott, the capital of Mauritania, suffers from severe sand encroachment, as is evident from the wind-blown sand around and within all manmade infrastructures.*

The second mission evaluation

The second mission evaluation was in 1963 and 1964 AO 628/60 to a scale of 1:6,000, immediately after Mauritanian independence in 1960. In photographs 009-010-011, the first signs of man-made degradation could be detected, in connection with the opening of quarries to mine marine-shelly building material and the proliferation of paths used by livestock, mainly on the sand ridge covered by the centre of the stereopair 009-010. In 1963 to 1964 the density of the desert vegetation compared to 1954 had regressed, an observation corroborated by the disappearance of plant cover in the beds of gullies that was already present in 1954 – ten years earlier.

In photographs 050-051 from the same mission, the first geomorphological change had taken place in the sand ridge structure. The topographical surface had become more complex, more uneven, the sand ridge less well defined, the first signs or beginnings of reactivation sifs were forming at the top of the sand ridges,

which still had a convex profile, but the desert vegetation cover was becoming more and more open.

On the outskirts of Nouakchott, an intrusive influx of sand can be deduced from the protective walls erected around buildings, not to be confused with the traditional fences in use in Islamic countries (photographs 056-057-058 of the same mission AO 628/60). In these same three photographs, nomadic camps were noted, already set up at the edge of the town in 1963 and 1964, long before the onset of the 1968 Great Sahelian Drought.

In photographs 059-060 AO 628/60 of the same second mission, the proliferation of tracks and the many animal enclosures demonstrate the primordial part human activities played in the degradation of the outskirts of the town.

Third mission evaluation

The foregoing observations made regarding the 1963 to 1964 AO 628/60 mission were substantiated by the analysis of the 1963 to 1964 AO 628/125 third mission to a scale of 1:12,500, basically covering the town of Nouakchott, for which we have forty photographs. The plant cover, degraded by overgrazing, had in fact disappeared all along the livestock trails, which were clearly to be seen. As for the AO 628/60 mission, the beginning of reactivation of the sand ridge summits was confirmed. Following the opening of the plant cover, the sand at the tops of compact dunes was set in motion by a mechanism which it was possible to diagnose as deflation/corrasion. The term deflation defines wind scavenging of loose sandy or silty material, while corrasion means this same erosion of coherent rock, and we propose the expression deflation-corrasion in the case of compact sand.

In the stereopair 024-025 of the same 1963 to 1964 AO 628/60 mission, it was quite clear that the opening of large-scale quarrying of building material in the north, namely upwind of the town, was a mistake because of the scale of the mechanisms set in motion. Leftover material subject to movement by wind indicated that problems of sand encroachment in Nouakchott have their origin right there, since the first sifs penetrated the northern part of town in 1965, as is shown by the 1965 AO 692/100 fourth mission evaluation.

The fourth mission evaluation

This mission evaluation gives the answer to a question we asked several years ago: what the meeting of two major air currents would be like at the soil-air interface in a sandy environment? The three photographs 049-050-051 of the 1965 mission AO 692/100 to a scale of 1:10,000 cover the meeting location of two wind flows, the harmattan and the coastal wind, previously referred to. The genesis of the longitudinal sand ridges oriented WNW-ESE could be attributed to the coastal wind; the ridges are 100 metres wide, the interdunal depressions 50 m wide. The sand ridge occupying the most westerly location due to the harmattan, oriented ENE-WSW, go up to 450 m in width, while the interdunal corridor between ridges reaches a width of 150 m.

The meeting of the harmattan and the coastal current gives rise to a longitudinal ridge caused by the harmattan, which cleanly intersects the longitudinal ridges caused by the coastal current. The profile of this contact range is asymmetrical since the influence of the coastal current makes itself more felt: the western side, where the runoff is more active, is steeper than the eastern side, giving greater asymmetry, which disappears on other ridges caused by the harmattan situated further inland, as in photographs 073-074 of the 1965 AO 692/100 mission, that is about 10 kilometres to the east of the area where the two wind currents meet.

In the aerial photographs Nos. 052-053 of the 1965 AO 692/100 mission, somewhat further east, the longitudinal ridges are different from those described above: they are more narrow, not more than 50 to 80 m wide, while the interdunal depressions only reach a width of 300 to 400 m. Their summits are active (moving sand) and the first signs of sifs without any specific orientation seems to indicate a change towards sifs. Sand in transit in a WNW-ESE direction detected in aerial photographs by the nebkhas or ridge summits, intersect the ridge at an angle of 20°. In the interdunal corridors, nomads have installed numerous livestock pounds surrounded by brushwood fences, also a cause of degradation. It is alarming to count up to ten pounds per square

Figure 4. Stereogramme of aerial photographs to a scale of 1:10,000 of the west part of the town as it was in 1965. The significant feature of these photographs is the development of the first sif (S) appearing to the north of Nouakchott airport. Also to be seen is the degradation of the steppe vegetation on the airport periphery.

kilometre.

In photographs 027-028-029 of the 1965 AO 692/100 mission, the signs of wind action were hardly noticeable in the urban area, except for some shelter effects and a reflection dune. In the stereopair 030-031, the expansion of what was part 3 of the town in 1954 was not yet in danger from sand encroachment in 1963 and 1964, contrary to the findings of the following mission in 1980.

The most westerly photograph, still in reference to the 1965 mission, is located over Nouakchott, since the flight path followed the old outline of the Route de l'Espoir. In the stereopair 001-002, a well-developed sif south of the airport was, to that date, the first active built-up dune found in the analysis (figure 4); some 250 m in length, it had a N-S orientation. We noted that it starts off in contact with the Route de l'Espoir. Further east, along this road (photographs 015-016-017-018-019 of the 1965 AO 692/100 mission) no new built- up dune was to be seen by this date, but there were deep multi-branched gullies still well colonized by vegetation on both sides of the sand ridges, although, on the whole, the plant cover was quite degraded and the livestock paths more and more frequent.

On figure 5, obtained from the stereopair 030-031, from the 1965 AO 692/100 mission, we measured 700 to 800 m of those paths per hectare, that is seven to eight well-defined trails per 100 m of terrain, trails that cut across the summits of the sand ridges so that they became troughed paths and converged in the interdunal depressions in some sectors as isolated patches, where the vegetation had completely disappeared in 1965. In the trail convergence area, in fact, degraded areas of 100 m in diameter had been created.

Starting from the photograph 049 of the 1965 AO 692/100 mission, namely some 30 km east of Nouakchott, the landscape changed: the sand ridges were intersected by gullies, the floors of which were still covered by a vegetation cover consisting of a bushy steppe.

To conclude this analysis, the outstanding feature in 1965 was, near the Nouakchott airport, the emergence of the first true sif, oblique in relation to the sand ridge (C) (figure 4), which was accompanied in the whole landscape by true active sifs, with sharp summits oblique in relation to the ridges, a possible reactivation of earlier sifs that had been fixed until then.

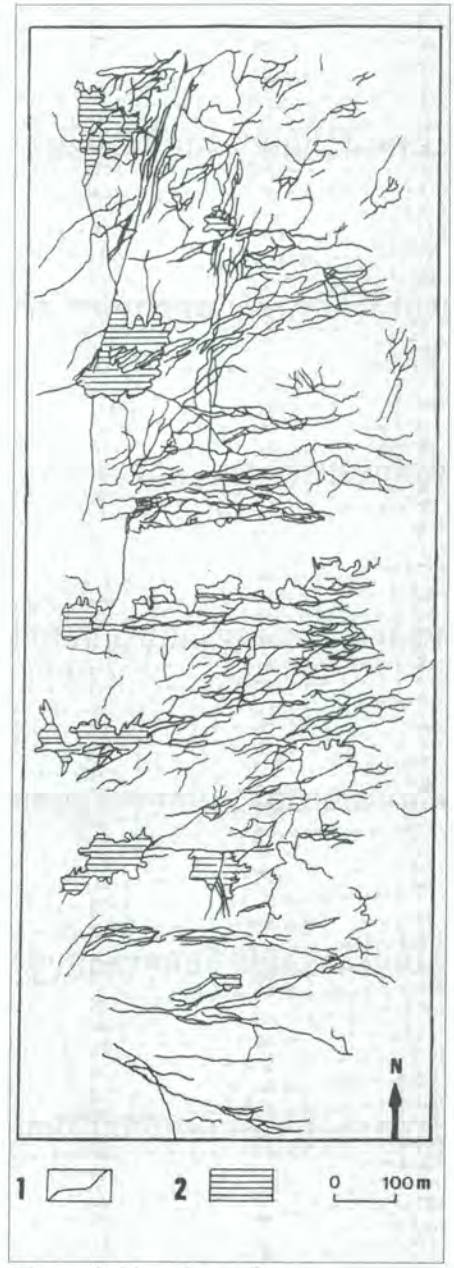

Figure 5. Map drawn from a stereoscopic montage of photographs 030-031 from the 1965 AO 692/100 mission. Also to be seen is the density of trails and the areas of concentration of livestock herds forming patches of degradation.
1. Trails,
2. Patches of degradation.

The fifth mission evaluation

The evaluation was of the mission carried out in 1980, 15 years after the 1965 mission, and was reported under the reference 80 MAU 4/125. This time, the signs of wind reactivation were to be seen everywhere and showed up, throughout, an increased reflectance. Only the major gullies could still be seen; all the other runoff indicators had been covered over by sand, probably wind-borne. Everywhere, sharp profile sifs topped the pre-existing sand ridges, and intersected these at the same angle of 20° previously

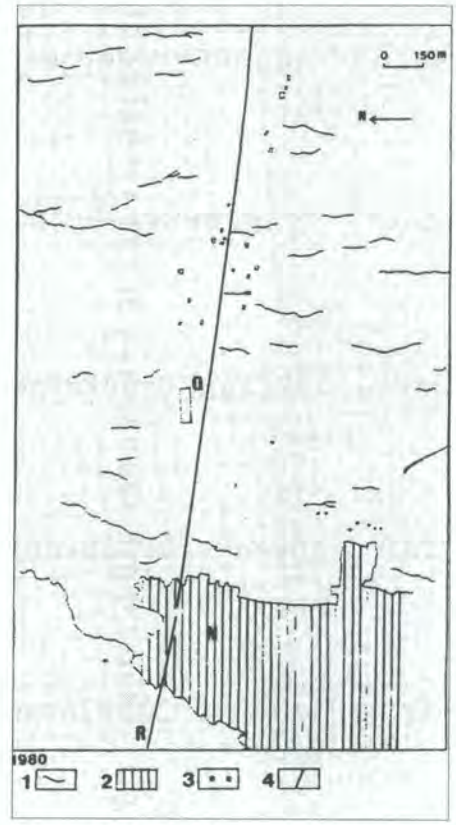

Figure 6(a). Multi- time analysis of sand encroachment and reactivation in the sector of Toujinine along the Route de l'Espoir, 7-8 km from Nouakchott in 1980 and 1991. The IGN aerial photograph missions used were: MAU 1980 4/12
5 Nos.195-196 and Mau 1991 12/150 No. 100-10: there is analysed MAU 1980 4/125 No 195-196. 1. Sifs.2. First buildings.3. Isolated buildings.4. Route de l'Espoir.

mentioned for the nebkhas. This 20° angle between the sifs and the longitudinal ridges is a permanently recurring datum for eastern Mauritania, as is verified by the 1995 Spot P + XS 021-314 satellite image.

The sixth mission evaluation

Comparison of the 80 MAU 4/125 mission (fifth mission evaluation) with that referenced 1991 MAU 12/150 (sixth mission evaluation) enabled us to make a time-span analysis of the Toujinine locality 18 km east of Nouakchott, from photographs 195 and 196 of the 1980 MAU 12/125 mission and photographs 123- 123 (figure 6 (a) and 6 (b) of the 1991 MAU 12/150. The key findings of this analysis are as follows:

- Densification of the population along the Route de l'Espoir, with a heavy build up of this trend over the past ten years. The concentration of population in this sector is higher than anywhere else, since these aerial photographs cover the Moughataa de Toujinine, the eastern suburbs of Nouakchott. This population densification is accompanied by uncontrolled urban growth which is indiscriminately spread over interdunal corridors and longitudinal sand ridges;
- Sifs are endangering buildings everywhere.

Figures 6 (a) and 6 (b) were based on the aerial photographs 197 of the 1980 MAU 4/125 mission and 124 of the 1991 MAU 12/150 mission, and show exactly the same location as can be seen from the quadrilateral urban structure (Q). They reveal the explosive expansion of the town of Nouakchott (N), and even more the devastation of the steppe (S) south of the town and the proliferation of sifs, now developed into real fields of sifs, endangering all man-made infra-structures: for example, a road engulfed in sand (R). These two photographs reveal an alarming situation for anyone concerned by environmental degradation, and this concern is confirmed by field observations made in 1997 and 1998.

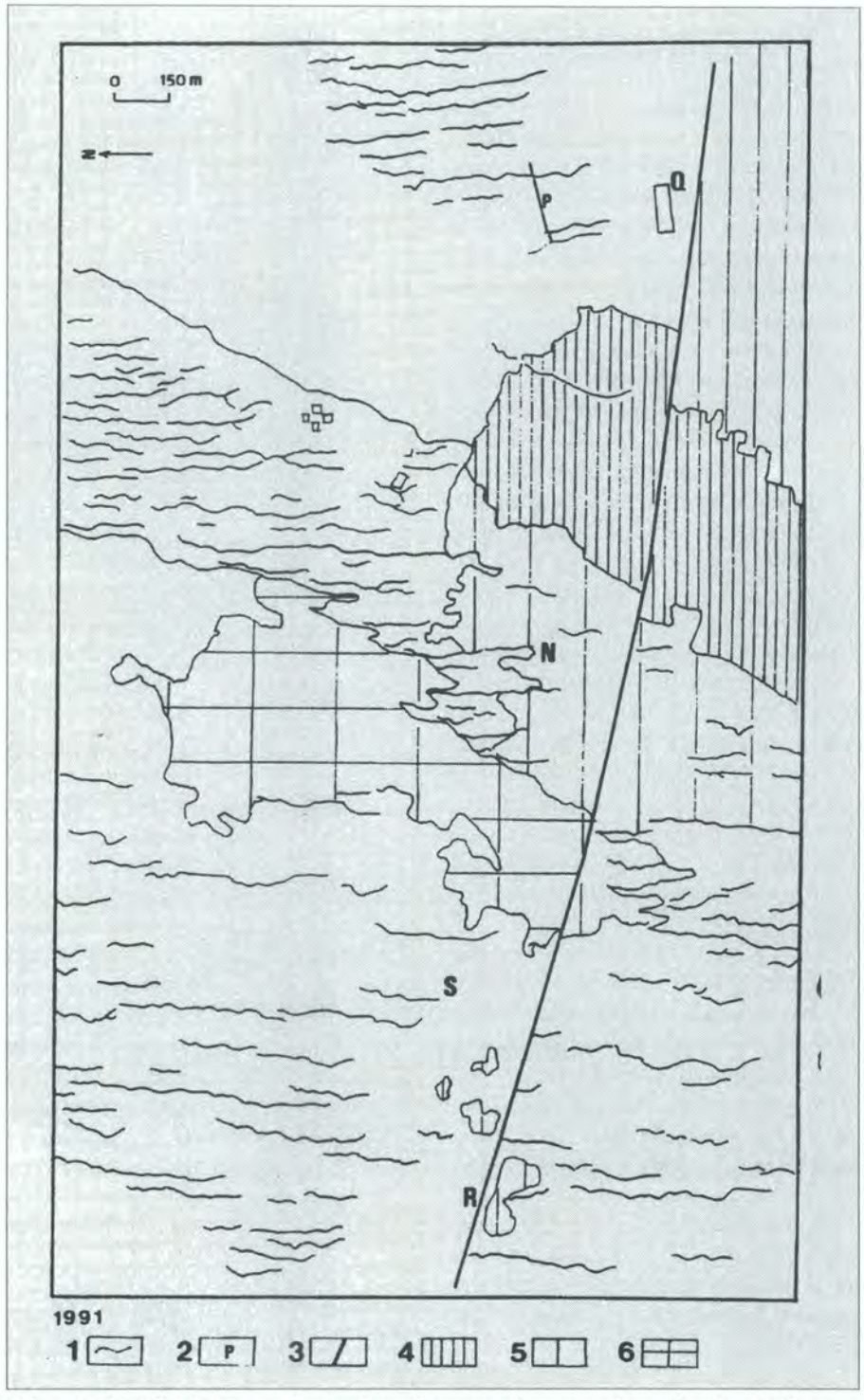

Figure 6(b). Multi-time analysis of sand encroachment and reactivation in the sector of Toujinine along the Route de l'Espoir, 7-8 km from Nouakchott in 1980 and 1991. The IGN aerial photograph missions used were: MAU 1980 4/12 5 Nos.195-196 and Mau 1991 12/150 No. 100-101: there is analysed MAU 1991. 12/150 No. 100-101.

1. Sifs.2. Fence. 3. Route de l'Espoir. 4. Residential sector. 5. Habitat sector developed on the longitudinal ridge. 6. Habitat sector developed in the interdunal corridor.It is clear that in the decade 1980 to 1991, real desertification has taken place starting with some sifs. Desertification is shown by a field of active dunes difficult to master in an urban setting.

Scaling up of the observations carried out locally to apply to the whole of Mauritania

The multi-level wind damage (figure 7) consists of:

- The setting in motion of ferrimorphic material compacted during ancient soil-forming processes, which yields sand with the definite orange-red colour of the new generation of red barkan-type sif dunes;
- The deflation of white sandy material from wadis or whitened by hydromorphy into the interdunal corridors; this yields the new generation of white barkan-type or sif dunes;
- At times, a mixture of the two previously mentioned sands, constituting new light orange-coloured dunes;
- A tendency for ergs (areas of shifting sand dunes) to extend at the edge downwind, while the upwind side loses body, an inverse situation to that observed in the north of the Sahara in the Great Western Erg and the Great Eastern Erg, in which the upwind part gains ground, while the downwind part loses ground;
- Progressive wind deflation that removes the sand veils and the upper part of the sand sheets. The IGN map of Moudjeira to a scale of 1:200,000 shows in 1969 a lean sand deposit which has now disappeared;
- A new generation of active dunes, both barkan and sif types, in which loose material replaces ancient fixed and vegetated material organized in a continuous sand sheet; this is the real definition of desertification in Mauritania.

The action of wind mechanisms is, above all, one of thinning out the ancient ergs and the intersection of hollows, depressions and the interdunal corridors by new active dune structures.

Proposal for an observable definition of desertification

A term such as desertification deserves an analysis of its causes, its mechanisms and the time and spatial scale encompassing it.

The definition we previously proposed (Mainguet, 1993), namely irreversible environmental degradation in a human time- span, since the generation

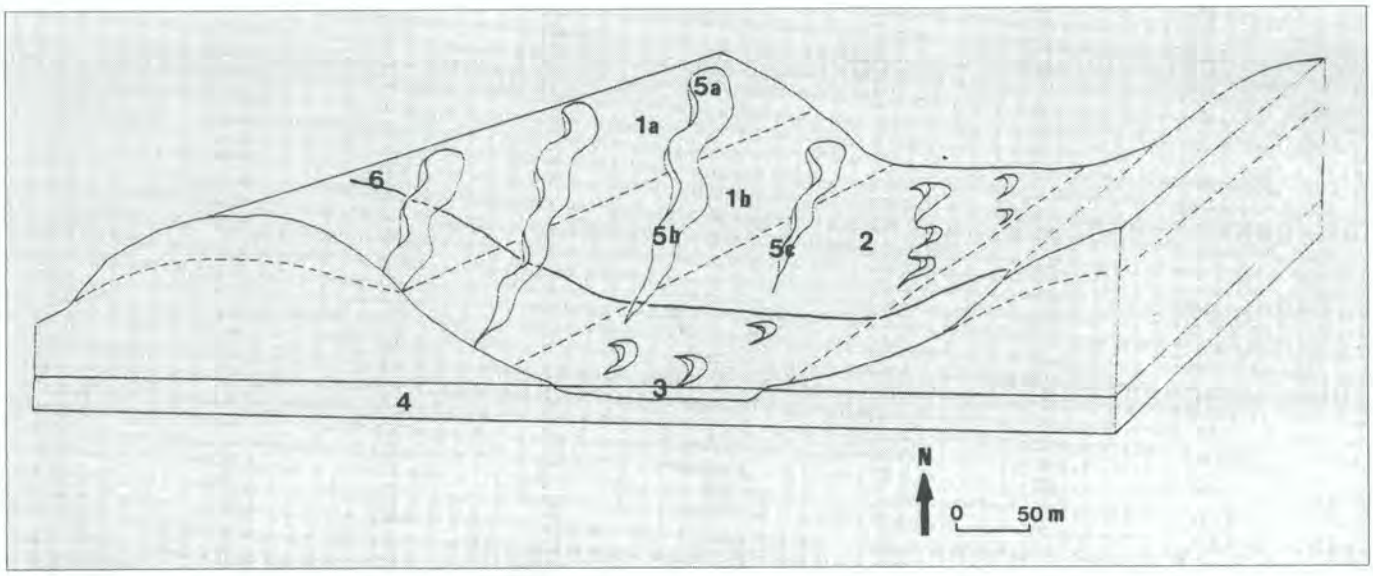

Figure 7. Overlapping of a system of open sifs (i.e. that are not joined) on a closed erg (i.e continuous) made up of longitudinal dunes. K(The design was partially borrowed from Raunet 1985, but the caption was completely ch anged.) This figure shows quite well how, along the Route de l'Espoir, sifs develop in roughly a N-S direction. 1. Longitudinal sand ridge with a convex top. 1a. Wind-borne sand with a true reddish colour and compacted, from the Amoukrouz and Trarza ergs. 1b. Wind-borne sand with a beige to white colour (called 'paradise sand'), discoloured by hydromorphy, probably from contact with perched groundwater. 2. Interdunal corridor or Goude, at times with a sequence of quaternary water deposits. 3. Blackish sand-limestone aggradation of underlying water ('Tarouss') called 'Chadian'. 4. Erg floor. This constitutes a continuous sheet. 5. Reactivation sif. 5a The head of the sif on the top of the longitudinal ridges is composebd of reddish sand.5b The mid- structure of the soil is of clear beige to orange sand from reactivation of sandy material discoloured by hydromorphy, which gradually merges with the red sand transported from the summit. 5c The sif end is always of clear white-beige to orange sand and has still-isolated white bachan-type structures which get caught up and are incorporated into the sifs when these extend. 6. Route de l'Espoir.This figure clearly shows the differentiation to be made between winds that here form part of the wind flows on a synoptic scale (the harmattan and the coastal wind flow) and aeolian sand transport. The different sand colours reveal the local deflation along a regional or synoptic wind current, but it also indicates a rapid mixing of sand particles taking place in the space of a few dozen metres.

responsible for it is unable to reverse the situation, owing to a lack of technical and financial resources, in Mauritania takes on a new sense because of the change in the spatial and time scales. This is because the deflation phenomenon, normally harmless enough, here becomes a genuine geological mechanism country-wide, progressive in time, resulting within a few decades in a total flight of soil cover and the loss of a wide slice of arable land.

While irreversible degradation, or desertification, is due to salinization in all the dry ecosystems that practise large-scale irrigation: the Aral Basin States, Pakistan, Uzbekistan, at very different latitudes, and in Egypt at similar latitudes, the desertification mechanisms in Mauritania are not chemical ones, but natural wind processes magnified.

It is a well-known fact that to arrive at irreversible degradation, that is desertification, in a human time-span of one generation, the cause has to be a combination of natural and man-made mechanisms. Natural causes include:

- The inherent vulnerability of dry semi-arid environments (Saharo-Sahelian and Sahelian) with an open plant cover due to low rainfall and, above all, to the thinness of the soil and its lack of cohesion that makes it fragile, especially if it is sandy, because loose sand is easily set in movement by wind, and sand with plant cover and fixed by ancient soil-forming processes is susceptible to degradation by wind corrasion;
- Drought crises, which, given the basis of vulnerability, can be accelerators of degradation.

Man-made causes add to natural causes when the plant cover and soils are degraded by normally harmless peasant practices which become harmful under increasing demography; often noted are overgrazing and the uprooting of plants and, perhaps even more, the trampling of herds of livestock.

The thinning out of ancient soils happens in various ways that have been studied, mainly for the top of the Akchar erg, the many alluvial stony deserts and in the Hodh:

(a)The head of the Akchar erg, adjacent to Adrar as we saw in 1997, consists of sifs which, downwind, are replaced on the pediment (rocky surface) when the wind dies down, by mega-barchans sustained by a wind current more or less from NE 70°. Oumm Ghreid, a structure with a height of 30 m, is an example of these mega-barchans. East of these structures, Adrar constitutes a transit area and is perhaps a source area of sand. The sandy material, set in motion by the dhar (escarpment), forms large fall-out deposits as it comes down from the plateau. The local nomads say that, during the rainy period, the sand from wind-driven fallout is transported by water from the wadis and accumulates on the slopes, from where the wind then carries it off, resulting in a mixture of local fluvial sand and wind- driven sand from further away. On the pediment, the transported sand is thus mixed with the weathering material to form a complex wind-driven material.

Part of the sand transported from Adrar is transported on the pediment by forming nebkhas, sheets of sand covered by a desert pavement; these lie mostly in areas of confluence and where the wadis are dense.

The sifs and the mega-barchans at the head of Akchar are thinning out, which is, in this sector, the major process of desertification; this loss of material is because of an increase in deflation and winnowing, shown by the mega-ripplemarks made up of granules and coarse residual sand;

(b) Stony deserts (regs), whether alluvial or from dissociation, which are particularly large and numerous in Mauritania, are areas favourable for wind transport, especially saltation, because of the size of the ground material. These are also deflation areas, where thin veils and sand sheets still existing in the 1950s were carried off by the wind, substituting sub-sterile stony areas in place of sandy areas suitable for grass cover; all the more so because the matrix between the pebbles and the angular blocks of these regs has a cavity structure that impedes the infiltration of rainwater. To make such areas cultivable requires the very special strategy used effectively by the Russians in the semi-arid areas in Central Asia;

(c) The Hodh belongs to the third type of desertification area. It is a flat fixed sandy area, whose heads, at the upwind ends, are situated between 20 and 30 km west of Dahr Néma and Dahr Oualata, while the opposite end◊ is anchored at the eastern slope of the Massif of Assaba. This large sandy area made into dunes may be termed an erg. The originality of its eastern side is the transverse orientation to the NE wind of its highest built-up dunes: this was an erg with a positive sediment balance (SB +), not surprisingly, given its location south of the Aouker erg.

Photo 2. *In Akjout, Mauritania, sand encroachment in a suburb of the town.*

Up to a few decades ago, this erg was fine grazing land; its rapid deterioration in the last two decades poses serious problems of redeployment of the nomads.

The analysis of the erg will be made by proceeding in an east to west direction, in line with the wind dynamics and the sense of the wind actions responsible for the deposit of the Hodh erg.

On its eastern side, east of 9° West, the Hodh erg is a continuous sand cover. On the western side, it is subdivided by the range of typically flat hills of Avolé (Affolé). These typical hills are not only bypassed by the wind-borne sand, but the falling and rising of wind-driven sand, probably one of the most beautiful sights in the world, indicates a saltation capable of passing over the top of them, in spite of their relatively large height of over 100 m. This group of hills, moreover, gives rise to 'venturi', corridors between obstacles that cause the wind to accelerate. It is mainly because of the venturi that the large numbers of sifs appear, although the sif phenomenon already existed in the early 1950s, north of the degraded desert river Tayaret Oumm Seboua, between 10°45' and 7°55' West.

The Chergui Hodh, a southern fixed prolongment of the active transverse erg of Aouker, was strongly reactivated by numbers of sifs existing long before the drought and quite well mapped on the IGN map to a scale of 1:200,000 at the end of the 1970s.

The Hodh erg with transverse dunes has undergone a change and is levelling out. Originally composed of chains of active barchans the dunes have been smoothed out into flattened mounds with vegetation.

The remarkable and complete obliteration of a fluvial relief by sand encroachment causing, in a second step, the transverse Hodh sand sea explains the many closed depressions, where a fluvial feature is intersected by one caused by wind, depressions that combine with the other family of depressions located at the foot of transverse barchan dunes, wedged between two transverse chains.

The Hodh Chergui, in short, is an ancient fixed and vegetated sand sea as is shown by:

- Its reddish colour;
- Its light compaction that allows it to be cut up like coherent rock, giving corrasion shapes and near- vertical sides in gullies, particularly in the Devara area, which was carefully studied and sampled (N16°26'03 5 - W10° 27'03 5) next to the bridge built in 1974 and the result given in another paper.

The colour of the surface material changes depending on the depth reached by earlier and current corrasion-deflation of the erg; in sectors where the erg is particularly thin, sandstones with an iron crust at their surface with some ferruginous gravel mixed with the material at the base of the erg – for example, between 20 and 25 km to the east of Kiffa.

Up to the great drought of 1968, this Hodh erg was millet- growing land in certain sectors near towns, and, in other sectors, was land suitable for livestock grazing.

Nowadays, it is undergoing a phase of reactivation and intense degradation, with sifs developing and extending. Over lengthy sections, this moving sand is the source of sand encroachment on the Route de l'Espoir, by the enlargement of sifs or by the appearance of sand strikes.

The ancient erg of Hodh, under the effects of desertification, is in the process of suffering from the twofold danger of:

Loss of soil and a major loss of land suitable for growing millet; Sand encroachment on communication routes, including the Route de l'Espoir between Kiffa and Aioun El Atrous. Therefore, it is the Hodh Chergui that needs πto be protected and rehabilitated in order to achieve the protection of the Route de l'Espoir in the section east of Tagant.

Results obtained and chronology

Photo 3. *Mauritania, between Choum and Atar, depicting uprooted balanities at the SW foot of the* ***Guelb Zarget.***

Based on the patterns of the dunes, their value as indicators of degradation, changes in dynamics and the impact of man-made effects on the physical environment, especially in the outskirts of Nouakchott and along the Route de l'Espoir, Mauritania's major communication route, the present analysis has facilitated the dating of the combination of several mechanisms leading to desertification and the determination of the pace of its establishment and its build-up.

In 1954, a group of fixed longitudinal ridges NNE-SSW 30°, all covered with a Sahelian steppic vegetation. The inventory of their surface condition showed a fairly rough surface with:

- In relief, vegetated sandy alignments, generally oriented obliquely to the longitudinal ridges and corridors, mostly at an angle of 20°;

- Alignments of small depressions towards which the runoff lines converged. The depressions were lined with organic material carried along the gullies by the runoff.

By 1963 and 1964, there was a steady increase of the complexity of the topography:

- The longitudinal ridges still had a vegetation cover, but their reflectance was increased, various early signs of sifs with convex tops and more open vegetative cover began to be detected;
- Fields of nebkhas showed deflation and saltation. On the increasingly rough longitudinal ridges, 'blow-outs' (wind depressions) proliferated. They were separated by converse ridges, perhaps the first signs of sifs which were becoming more and more individually distinguishable.
- In 1965 the observations were: Near the Nouakchott airport, the development of the first sif, obliquely orientated with respect to the sand ridges. Overall appearance, in the whole landscape, of genuine active sifs, obliquely orientated in relation to the ridges. These could have been –the result of the reactivation of sifs of a previous generation fixed until then;
- Growing deflation resulting in light sand re-deposition deriving from the livestock trails, the main paths and areas where the degradation of the vegetation cover was almost total;
- Obliteration of the lines of water erosion by wind-driven sand: the gullies were being filled in;
- Disappearance by deflation of the organic matter that was lining the depressions in 1954.

From 1980 to 1991:

- Proliferation (to say the least) of active sifs dating from the 1980 observations. The embryonic sifs with curved convex peaks and irregular patterns had disappeared. The sifs had become more defined, their peaks had matured into sharp crests, their overall orientation had become straighter, their pat tern more sinuous since the increasing range of what caused them is more accentuated;
- Development of nebkhas, which have become widespread since the 1980s and indicate a massive sand movement and more÷ efficient saltation;
- Intersection of interdunal corridors by sifs in the course of extension: this indicator is the most striking and the most alarming.

The man-made causes of degradation that we could detect were:

- The establishment and mining of quarries, especially those upwind of the urban site;
- Overgrazing, the proliferation of animal trails, and trampling;
- The numerous livestock pounds; Earth roads upwind of the Route de l'Espoir;
- The population concentration and its settlement;
- Housing construction up to the top of the sand ridges.

Conclusion

With ongoing desertification Mauritania today appears like an emaciated body. In the Saharo-Sahelian environment of Mauritania, desertification is the degradation of sand fixed by the soil-forming of an old dune system, continuous in space, ferromorphitic and compacted, which is disturbed by wind to form mobile non-contiguous mobile dunes in which deflation-corrasion plays a major role. There is, therefore, a substitution of structure – fixed material becomes loose – to which should be added a different organization of dunes: fixed joined dunes become isolated mobile dunes.

The main consequence of desertification is, therefore, the loss of soil, by the conversion of wind-built cultivable structures into loose uncultivable dunes, as in the case of the Hodh and, above all, through loss of the matrix due to dust winds.

In Mauritania, to avoid the serious damage engendered by major hydraulic works, including salinization, the recognized special precautions must be taken in connection with large projects.

Unless precautions are taken to avoid adding salinization to the wind processes, resulting in an even more serious form of desertification, since it would be even more difficult to reverse it, Mauritania would, in a very *shor*t space of time, become a desert-like area.

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India's Approach to Combat Drought and Desertification

An Analysis

R.N. Kaul,

Forestry Consultant. F-8, South Extension, New Delhi

Ajai Kumar

Assistant Inspector General of Forests, Ministry of Environment and Forests, New Delhi

S.K. Puri

Director, NAEB, Ministry of Environment and Forests, New Delhi

Introduction

The arid (19.6 per cent), semi-arid (37 per cent) and sub-humid (21 per cent) areas of India (figure 1) occupy 77.6 per cent of the total land area of 328.73 million hectares (Government of India, 1994). These comprise a large belt of country running from the Pakistan border in the north-west through Peninsular India to the southern tip of the country. Aridity is most severely developed in Western Rajasthan, which is an eastern extension of the much larger arid areas of the Middle East. This part of Rajasthan, together with the adjacent portions of Haryana and Gujarat States may be regarded as truly arid or in transition to semi-arid, but not as natural desert. The dry areas of the peninsula are better described as semi-arid, although portions of them have a combination of partly induced unfavourable factors, which now create conditions approaching the arid. These lands comprise what are called 'drylands' and where desertification is occurring.

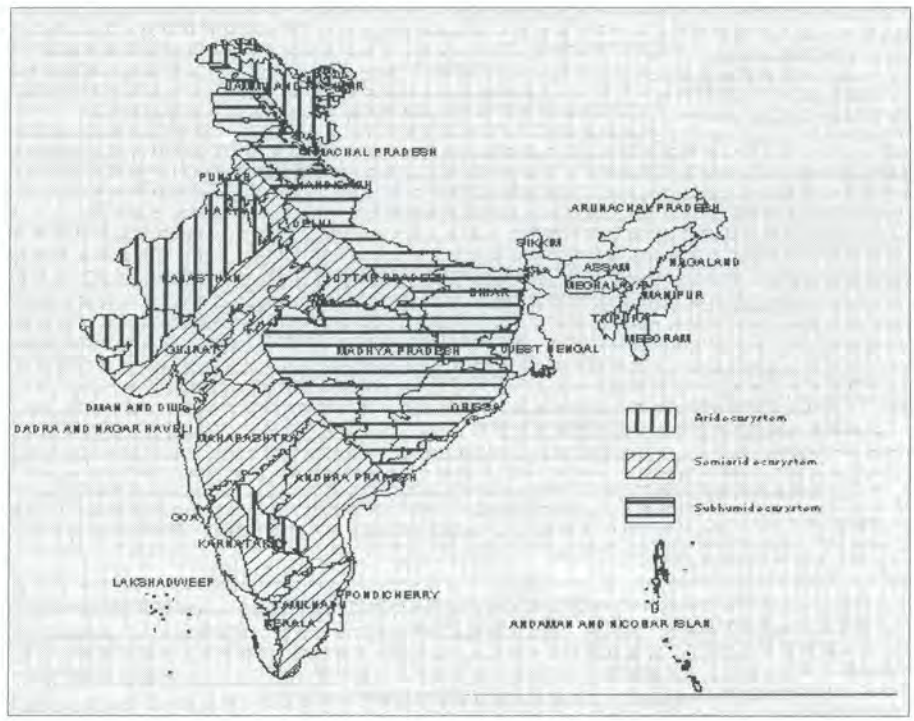

Figure 1. Arid, semi-arid and sub-humid, ecosystems of India.
Source: adapted from from agro-ecological regions map prepared by the National Bureau of Soil Survey and Landuse Planning, ICAR, 1992.

These drylands have long been occupied by man and his livestock. By general arid zone standards, there is a high population density, ranging from 264 persons per km^2 in Jhunjhunu to 9 persons per km^2 in Jaisalmer (Kaul, 1993). The population growth rate during the decade 1981 to 1991 in this region has been 29 per cent as against 23 per cent for the country as a whole (Government of India, 1991). The livestock population increased from 9.4 million in 1951 to 14.4

million in 1961 (53 per cent increase) and 15.52 million in 1971 (8 per cent increase). The density of livestock per 100 ha of grazing lands increased from 72 in 1951 to 175 in 1971 (293 per cent increase) with an especially high increase in the numbers of bovines (cattle and buffalo) and camels. The percentage of net area sown in the truly arid Thar Desert area has been steadily increasing, leading to intensive use of land and other natural resources, contributing to their degradation.

Impact of desertification

The general problem of arid areas with large populations is essentially one of human ecology. Where large-scale water resources from outside the arid and semi-arid regions cannot be tapped, the inherently limited water resources within these regions set the ultimate limit of production of plant material, on which both human and animal populations finally depend. Furthermore, erratic rainfall results in widely fluctuating production and this, in turn, leads to famines which impose stress on these populations. As the population increases, these stresses become greater and the demand on natural resources is magnified. In consequence there is an imbalance between the human and animal population on the one hand, and plant, water and land resources on the other. As the demand by the first persists and increases, the resources tend to become depleted and, as depletion progresses, the stress upon them becomes even greater. Thus, a process of progressive degradation of resources is set in motion, which intensifies in every famine and the period following it. If unchecked, it leads to permanent damage in the form of loss of valuable plant species through excessive grazing or cutting for fuel, and vegetal cover is replaced by bare land or, at best, less useful plant communities (figures 2 to 4). Although the total precipitation may be low, rainfall is often in the form of sudden heavy storms which may lead to flooding. The loss of surface soil by water or wind erosion leads to lower soil fertility and the conversion of large areas into wasteland cut up by erosion channels, or the formation of unproductive barren sand dunes.

Figure 2. Pressure of population on vegetation for meeting their firewood needs.

Figure 3. Loss of vegetation due to excessive grazing.

However, the recovery of such land depends upon its resilience, which may be completely lost if the land is not treated carefully and in good time. Drought, through its short-lived but recurrent stress, can advance the process of desertification, especially when man fails to respond properly, accentuating its effects and interfering with the land's natural powers of recovery. Thus desertification causes:

Figure 4. Desertified landscape bereft of vegetation.

- A diminishing food security base;
- A deterioration of the rural environment, which affects adversely the socio-economic conditions and livelihood systems of the inhabitants;
- A reduction of irrigation potential;
- A loss of biodiversity.

Urgency of the problem

Although the drylands of the country have low productivity per unit area, their total production, especially of milk, meat, pulses, millets, fibres and hides, is substantial, and they support 68.7 per cent of the country's population. It is, therefore, necessary to realize the full agricultural and other biomass

production potential of these lands. Moreover, as ecotypal reserves with a variety of interesting and useful natural settings, these constitute a precious human heritage and, in recent years, they have also become areas of tourist interest.

The process of desertification is dynamic and self- accelerating, so some fundamental preventive measures need to be introduced without delay. This intervention should be in the form of land-use practices which are both socio-economically and environmentally appropriate; ameliorate micro-climates and soils and which prevent desertification from encroaching further.

Any delay not only makes rehabilitation time-consuming and expensive, and the degradation may even reach a threshold beyond which it is irreversible in practical and economic terms. The magnitude of the problem is reflected in the occurrence of frequent drought and floods.

Drought and Flood Hazards

Drought

The country experiences drought in one part or another every year (e.g., in Rajasthan, 18 drought years of different intensities have been observed in the past 32 years). About three million people with their livestock migrate annually in search of new pastures (Das, 1977). This migration has often resulted in excessive grazing along the migration route and in neighbouring areas. The consequent destruction of the protective vegetal cover leaves the soil bare to the erosive action of both wind and water.

The role of drought in conservation land-use management in India is very great. About 70 per cent of the net cropped area of the country is rainfed and produces 40 per cent of the country's food grains (Government of India, 1988). It is estimated that, even after all irrigation potential is achieved, at least 55 per cent of the cultivated land will remain rainfed (Das, 1977). Vast stretches of non-agricultural land in these tracts have scanty rainfall and are suited only to grassland development and livestock farming. The drought-prone areas of the country have been divided into four classes, as shown in figure 5 (Das and Pandey, 1989).

Flood

Like drought, floods occur every year and cause untold misery over an average area of 8 mha out of which 3.7 mha are cropped. The total affected area is estimated to be 40 mha Annual estimated damages due to floods has been put at Rs. 6,268.5 million (US $1 = Rs. 40). Areas affected by flood are shown in figure 5.

Land Use Distribution

Erosion problems vary according to the land-use practices which play a significant role in the process of degradation and desertification. The distribution of areas under various land uses is given in table 1. Out of the total geographical area of 328.73 mha, about 43 per cent is cultivated and 22.3 per cent is legally recorded forest area. However, according to the Forest Survey of India, 1995, only 19.47 per cent of the total geographical area is covered by forests. The vast stretch of the Indo-Gangetic Plain, Deccan Plateau and the Thar Desert has few forests. Barren and uncultivable wasteland constitute 6.4 per cent, cultivable wastes 4.9 per cent, fallow land 7.9 per cent and permanent grassland 3.8 per cent of the whole area (Government of India, 1994). The net area sown has increased by 19.08 per cent during the period 1950/1951 to 1991/1992, whereas

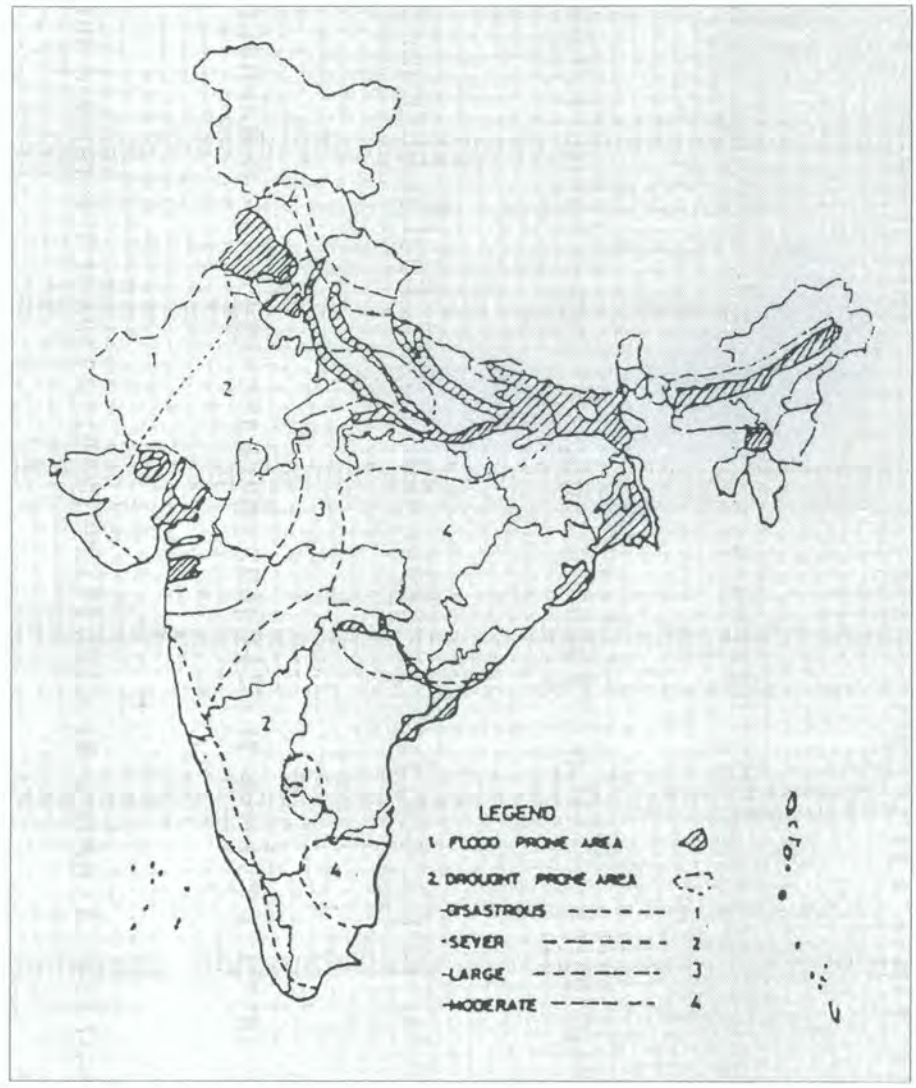

Figure 5. Drought and flood-prone areas in India.
Source: D.C. Das, 1997.

Table 1. Land use distribution (in million hectares)

	Heading	1950-51	1991-92	% of Reporting Area (1991-92)	% change between 1950-51 and 1991-92
I.	Geographical area	<———— 328.73	————>		
II.	Reporting area for Land Utilization statistics (1-5)	284.32	305.06	100.00	7.29
1.	Forests	40.48	68.02	22.30	68.03
2.	Not Available for cultivation (a + b)	47.52	41.02	13.50	-13.68
	(a) Area under non-agricultural uses	9.36	21.53	7.10	130.02
	(b) Barren and unculturable land	38.16	19.49	6.40	-48.93
3.	Other uncultivated land excluding fallow land (a + b + c)	49.45	30.39	9.90	-38.54
	(a) Permanent pastures and other grazing lands	6.68	11.68	3.80	74.85
	(b) Land under miscellaneous tree crops and groves not included in net area sown	19.83	3.64	1.20	-81.64
	(c) Culturable waste	22.94	15.07	4.90	-34.31
4.	Fallow Lands (a + b)	28.12	24.22	7.90	13.87
	(a) Fallow lands other than current fallows	17.44	9.85	3.20	-43.52
	(b) Current fallows	10.68	14.37	4.70	34.55
5.	Net area sown (6-7)	118.75	141.41	46.40	19.08
6.	Total cropped area (gross cropped area)	131.89	182.73	–	38.55
7.	Area sown more than once	13.14	41.32	–	214.46

Source: Government of India, 1995

the areas under pasture and other grazing lands, cultivable waste and fallows decreased by 16.39 per cent*, 34.31 and 13.87 per cent respectively. (*However, from 1950-51 to 1960-61, this increased from 6.68 to 13.97 mha Thereafter, it has steadily come down to 11.68 mha.)

It is, therefore, seen that there is a move towards greater intensity of land use and increase in the amount of cultivation on what were formerly reserve or common grazing lands. The grasslands, by and large, are poor and overgrazed and so are the wastelands. Both suffer from a high degree of degradation and desertification. and wind occurs over large areas. This results in the loss of top soil and reduced productivity, the most serious land degradation problem.

Measures taken to combat or mitigate desertification

Structures

Under India's federal structure land is a State subject and there is no national legislation. However, there are two apex bodies: the National Landuse and Wastelands Development Council (NLWDC), chaired by the Prime Minister, and the National Landuse and Conservation Board (NLCB), chaired by the Deputy Chairman, Planning Commission for Policy, Planning and Coordination. The National Afforestation and Eco-Development Board (NAEB) in the Ministry of Environment and Forests, and the National Wastelands Development Board (NWDB) in the Ministry of Rural Areas and Employment, are responsible for the development of forest and non-forest wastelands respectively. In addition, the Ministry of Agriculture and Cooperation and the Ministry of Water Resources Development also implement various schemes for afforestation and soil and water conservation, which have a bearing on combating desertification and drought.

At the State level, the State Land Use Boards are chaired by the respective Chief Ministers. Various line departments such as Forests, Agriculture, Soil and Water Conservation, Rural Development, Animal Husbandry, etc. are responsible for the implementation of related Central

Table 2. Current assessment of the extent of various types of land degradation in India.

Type of Land Degradation	Area mha	Percent of total geographical area
Water erosion	57.15	17.42
Wind erosion	10.46	3.18
Ravine formation	2.67	0.81
Salt affliction	6.32	1.92
Water logging	3.19	0.97
Mining and Industrial wastes	0.25	0.08
Shifting cultivation	2.37	0.72
Degraded Forest	24.89	7.58
Special Problems	0.11	0.30

Source: Government of India, 1994

and State schemes and programmes.

Policies and policy instruments

National land use policy outlines have been prepared which take into account the environmental, social, demographic, economic and legal issues. The policy has been circulated to all concerned for adoption and implementation through the enactment of suitable legislation. The National Conservation Strategy and Policy Statement on Environment and Development also addresses the issues of natural resource management and development.

The National Forest Policy (NFP) of 1988 states: 'the principal aim must be to ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium which are vital for sustenance of all life forms, human, animal and plant. The derivation of direct economic benefit must be subordinated to this principal aim'. NFP states further that one of the essentials of forest management is to increase forest cover on semi-arid, arid and desert tracts. The Forest (Conservation) Act, 1980 is a major milestone and has initiated a process by which India's forests are treated as an environmental and social resource rather than as a revenue or commercial resource. The Act provides strict controls on the diversion of forest land to other uses and, in rare cases when this is permitted for developmental purposes, compensatory afforestation is a prior requirement. The guidelines issued by the Government of India on 1 June 1990 formalized the process of the people's participation in forest resource management. It envisages active involvement of village communities and voluntary agencies/non-governmental organizations (NGOs) in the regeneration of degraded forest areas, on the basis of their taking a share of the usufruct from the forest areas that they protect and rehabilitate (Society for Promotion of Wastelands Development (SPWD), 1993).

The policy of empowerment of village communities and their involvement in developmental activities, including natural resource management, has been further strengthened through the Constitution (Seventy-third Amendment) Act, 1992. This gives constitutional status to Panchayati Raj Institutions (village, block and district levels). A host of subjects, such as agriculture; land improvement; implementation of land reforms; land consolidation and soil conservation; water management and watershed development; animal husbandry; fuelwood and fodder; social forestry, etc. were handed over to the Panchayati Raj Institutions. This was a significant step towards creating an institutional mechanism, which would help in the proper formulation and effective implementation of Local Area Development Programme (LADPs).

Major development programmes and strategy

Afforestation programmes

Targets for afforestation or tree-planting activities are fixed annually by the Ministry of Environment and Forests in consultation with the State Governments. These afforestation activities are taken up under various schemes and programmes of the different Central Ministries or Departments and of State Governments. From 1985 to 1997, a total of 22.61 mha were covered under afforestation and/or tree planting activities.

Drought Prone Areas Programme (DPAP)

The Rural Works Programme (RWP), initiated in 1970/1971 with the objectives of creating durable assets which could contribute towards reducing the severity of drought wherever it occurred, and to provide wage-earning employment to the affected population, was the first major and conscious effort in this direction. The RWP was redesignated as Drought Prone Areas Programme (DPAP) in 1973/1974 and focused on problems of the drought-prone areas only. At present, the DPAP is being implemented in 946 Blocks of 149 Districts in 13 States. The total area covered under different components of the programme since its inception to 1995 is about 5.7 mha.

Desert Development Programme (DDP)

With the realization of the fragility of the arid land ecosystem, the Desert Development Programme (DDP) was initiated in 1977 and is now being implemented in 227 Blocks of 36 Districts in nine States. Since the programme's inception, by 1995 552,669 ha have been covered under different components of the programme.

Sectoral activities under DPAP and DDP are:

a. Land resources development;
b. Water resources development;
c. Afforestation and pasture development.

Since 1996 these two programmes, DPAP and DDP, are being implemented on a watershed basis only. However, in hot sandy arid areas where it is not possible to delineate a watershed, the programmes are taken up on the basis of a cluster of villages/index catchment. To ensure people's participation in planning and implementation, there is provision to create watershed associations, comprising the adult population of the watershed; 80 per cent of the project funds are placed at the disposal of the committees elected by the associations.

National Watershed Development Project for Rainfed Areas (NWDPRA)

NWDPRA, initiated in 1990, envisaged treatment only of arable lands and consisted mostly of crop production components. The programme was redesigned in 1993 with a focus on development of micro-watersheds as models of comprehensive and integrated development in different agro-climatic regions of the country. The new programme contains measures to conserve rainwater in micro-watersheds, to promote in situ moisture conservation on arable lands and to develop three-tier appropriate vegetation, consisting of grasses, shrubs and trees for fuel, fodder, timber and fruit species on non-arable lands. At present work is being undertaken in 2,500 watersheds spread over different agro-climatic zones of the country (Government of India, 1995).

Indira Gandhi Nahar (Canal) Project (IGNP)

The Indira Gandhi Canal, in north-western Rajasthan, covers part of the Thar Desert. It provides irrigation facilities to over 2.5 mha of the Desert, of which 1.2 mha is cultivable command area. Under an externally aided OECF project, a total area of 33,725 ha., which includes sand dune stabilisation (16,114 ha.); canalside plantation (11,522 ha.); roadside plantation (603 ha,); block plantation (2,279 ha) and pasture development (3,207 ha.) has been covered since 1991 to protect IGNP against sand deposition and to develop adjoining arid lands.

Other initiatives

Other measures and/or schemes, such as Jawahar Rozgar Yojana (JRY), for poverty alleviation and rural employment with a focus on horticulture and watershed development; Integrated Wasteland Development Projects scheme (IWDP); Integrated Afforestation and Ecodevelopment Project Scheme (IAEPS); soil conservation in the catchments of river valley projects; integrated watershed management in the catchments of flood-prone rivers; reclamation of special problem areas and improvement of productivity, to mention a few, are relevant in this context. In addition, the National Remote Sensing Agency (NRSA) is preparing land and water resource management maps and plans in 174 chronically drought-affected districts (Dutt, pers. comm.).

Research and Development Efforts

Besides creating an institutional framework and through the formulation of policies and policy instruments, the Government of India has substantially augmented research efforts by strengthening relevant National Research Institutions and by adopting development programmes which focus on combating desertification and drought.

Research

Over the years the research institutes, in collaboration with State agricultural universities, have been engaged in research into the problems of desertification and drought. The emphasis is on the development of appropriate and cost-effective technologies to combat desertification and drought processes and to increase the productivity of affected areas. In addition, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) at Hyderabad is intensively studying the resource conservation and management aspects in its farming systems research. It serves as a world centre to improve the genetic potential, yield and nutritional quality of sorghum, pearl millet, pigeon pea, chickpea and groundnut. ICRISAT has mainly used soil loss as an index for desertification progress. The thrust areas of the most important institutes are given in table 3:

In addition, three All India Coordinated Projects of the Indian Council of Agricultural Research (ICAR) have been established; one on forage crops at Jhansi, the second on dryland farming at Hyderabad and the third on agro-forestry at Delhi. These projects, with a network of subcentres in the arid and semi-arid regions of the country, have been established to conduct location-specific research on problems related to mitigating the effects of drought.

Problems related to the development of suitable technologies for afforestation and improving forest productivity are being addressed by a network of research institutes under the Indian Council of Forestry Research and Education (ICFRE), Dehradun. These include the Arid Forest Research Institute, Jodhpur; the Tropical Forest Research Institute, Jabalpur and the Institute of Forest Genetics and Tree Breeding, Coimbatore.

Constraints in combating desertification

Human and livestock pressures exceeding sustainability levels

India has pursued an active population policy. Educated people, especially in the urban areas, consciously restrict family numbers in order to give their children

Table 3. Research institutes of the Indian Council for Agricultural Research (ICAR) dealing with problems related to desertification and drought and their thrust areas of research.

Research Institutes	Thrust Areas (Basic and applied Research)
Central Arid Zone Research Institute (CAZRI), Jodhpur.	Repository of information on the State of natural resources and desertification process and its control. Development of sustainable farming systems.
Central Research Institute for Dryland (CRIDA), Hyderabad.	Development of strategies for sustainable Agriculture farming systems in the rainfed areas.
Central Soil and Water Conservation Research and Training Institute, Dehradun.	Controlling degradation of soil through erosion and rehabilitation of degraded lands.
National Research Centre on Agroforestry (NRCAF), Jhansi.	Evaluation and improvement of multi-purpose tree species (MPTS) suitable for agroforestry; basic and applied research on all aspects of agroforestry.
Central Soil Salinity Research Institute Karnal.	Development of strategies for salinity control (CSSRI), and management of salt-affected soil and use of poor quality water.
Indian Grassland and Fodder Research (IGFRI), Jhansi.	Forage crops and grassland management; Institute sustain, enrich and enhance germplasm of these crops.
Central Sheep and Wool Research Institute Awikanagar .	All disciplines relating to sheep and rabbit (CSWRI), production; developed update and standardised meat, fibre pelt technology.
The National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Nagpur.	Inventorise and upgrade scientific information on the nature, extent and distribution of soils and associated climatic features.

Note: These institutes serve as repositories of information in their respective fields and have excellent training facilities.

improved facilities and a better education. In rural areas tradition still favours a large number of children whom it is anticipated will work on the farm and later look after their parents when they become old.

As pastoralism is, by necessity, a major land use in arid areas a larger human population is reflected in a larger livestock population. This overpopulation makes it impossible to sustain the resources of India's arid zone regions. It is a major problem which has so far proved insoluble.

Inadequate coordination between implementing agencies

Many agencies are involved in land use and in combating desertification. Although different States have attempted to coordinate their land management efforts in various ways, it is not surprising that coordination is often inadequate. At national level the various bodies mentioned above have contributed significantly but there is still room for improved coordination at the State level.

Inadequate financial provision

At all levels, India is conscious of the need to allocate financial resources fairly, but it is never possible to satisfy so many conflicting needs. Combating desertification involves so many aspects of human and natural resource ecology that many of them are invariably left underfunded.

Inadequate expertise and trained manpower

This constraint could be partly resolved by increasing training facilities. However, for benefits at the grass-roots level a much more effective and well-funded extension service is needed. This would require improvements in rural health services in addition to the more obvious aspects of livestock and crop husbandry. Much greater financial resources would be needed, together with considerable

institutional change and reallocation of priorities.

Lax enforcement of proper land and water use

The frequent condoning improper land use is a common problem in rural areas throughout the tropics, even though there may be State and local regulations which attempt to ensure sound land-use practice. Sometimes there are political reasons why regulations are broken, or officials turn a blind eye to misdemeanours. Although such difficulties are by no means restricted to India, they are serious restraints which are not easy to resolve.

Changes in Strategy

Analysis and review of different programmes and/or schemes related to natural resource management reveal three major weaknesses: the absence of an integrated approach, lack of participation by the people and the neglect of traditional practices in various natural resource development programmes. This realization has led to shifts in the focus and strategy of these programmes. The two major shifts have been:

- Sectoral to integrated approach. In order to maximize production in good rainfall years and to minimize losses when the monsoon fails, all the major programmes related to natural resources management and development are now implemented on an integrated watershed management basis;
- From governmental programmes to people-oriented programmes. Involvement of people at all stages from planning to implementation is at the core of all the schemes and programmes. In pursuance of the Government of India guidelines issued on 1 June 1990, 16 State Governments have so far issued their guidelines to involve the village communities and voluntary agencies to protect and regenerate degraded forest areas, on the basis of their taking a share of the usufructs from the forest areas that they protect and develop. More than 10,000 forest protection committees (FPCs) are protecting about 1.5 mha under this arrangement. Some successful joint forest management models which have been documented are Arabari, Orissa, Phulbani, West Bengal (Chandra and Poffenberger, 1989, Kant et. al., 1991); Jammu in Jammu and Kashmir (Chatterji and Gulati, 1991); Harda, Madhya Pradesh (Bahuguna, 1992); common lands in the Aravallis of Haryana (Srivastava and Kaul, 1995); Khariya nala watershed, Jhansi (Hazra et. al., 1996), etc. However, the success of these arrangements have thrown up certain second generation issues which need to be resolved to strengthen the movement (Kumar and Kaul, 1996).

  Similar arrangements in the form of watershed associations have been made to implement the Ministry of Rural Areas and Employment's DPAP and DDP programmes. Panchayati Raj Institutions have a pivotal role in this arrangement.

Traditional practices for natural resources conservation and management

While these changes in strategy would result in better implementation of the programmes, there is a need to incorporate traditional best practices of water harvesting, natural resource management and land use. Though the participation of local communities in the programmes may lead to greater acceptance of traditional practices, a conscious effort is required to document and include them in the programmes. Some of these traditional practices are :

- **Water harvesting**. Traditional systems of land use met environmental challenges in various ways. The limited crop growing season in the Thar Desert led early inhabitants to rely on animal grazing, or scattered rainy season (summer) farming of hardy millets. However, one group of indigenous cultivators (Paliwals) devised a rain-harvesting technique fully capable of growing winter season crops. The cultivators followed a unique practice of water harvesting and moisture conservation in suitable deep-soil plots, surrounded by some sort of natural catchment zone. These plots were rigorously built and managed to make the entire system a self-contained unit for winter cultivation. Under conditions of intense evaporation, the moisture threshold and soil fertility were maintained. The total energy input, rainwater, sand/silt/clay accumulation and the cultivators' own activities were interwoven into a complete production system of winter crops. There was a progressive increase of yields every year as more and more fresh silt and clays accumulated and widened the vertical and horizontal dimension of such plots (figure 6). The ratio of farm land and catchment area was regulated to be 1:11 so that a critical supply of moisture was maintained (Tewari, 1988). This is known as the Khadin system of cultivation. The nearby uplands and rocky grounds have also been used as local catchments for collecting rainwater. Similarly, village ponds ('nadis') and 'tankas' were common for meeting the drinking water needs of the inhabitants;
- **Conservation of forage resources**. The pastoralists (nomadic cattle breeders) have developed a unique method of water harvesting, based on centuries of experience, for the most effective utilization of their grazing lands and also for ensuring their revival and growth during successive years. With the start of the rains, the population divided into different caste groups and dispersed to their 'tobas' (small dug-out ponds) along with their livestock. The tobas were situated within the confines of the village boundaries but outside the settlement proper. As the water in one toba became exhausted its users were not allowed to come back to the village, but had to make use of another toba, where water and fodder might still be available and, by convention, they had to be allowed the facility of using the water and grazing resources there. It was only when the water in all the tobas were exhausted that the entire population, along with their stock, returned to the village proper and

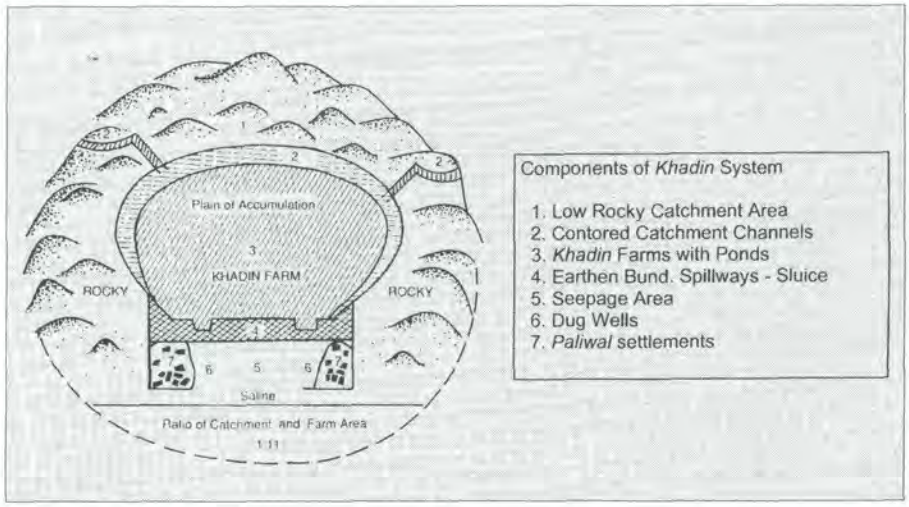

Figure 6. Different components of Khadin system of cultivation.

were allowed to use the water in the village tank and the lush growth of grasses around the village (Malhotra, 1988);

- **Combined production system.** The practice of agro-forestry, namely cultivation in spaces between rows of trees and shrubs, has been traditionally practised by the desert dwellers. For example, *Prosopis cineraria* in cultivated fields and *Ziziphus mauritiana* in rangelands are common in arid and semi-arid parts of Rajasthan. There is a strong belief that trees and shrubs not only provide livestock feed but also increase crop growth under their canopy. Moreover, as cultivation of crops alone is a big gamble in arid areas, most desert dwellers follow mixed farming to minimise risk against total crop failure;
- **Preservation of vegetation**. There were inbuilt customs for the preservation of vegetation on certain types of lands and also for raising certain trees for religious reasons; for example it was religiously prohibited to cut any vegetation from the lands in the immediate vicinity of temples and religious places, known as 'oran' (protected forest) lands. Serious punishment was prescribed for using an axe in orans, and only dry wood was allowed to be collected for fuel. Some customs observed by the Bishnoi community helped to conserve vegetation. An incident that occurred over 25 decades ago in Khejadala village in Jodhpur district is an excellent example, where Bishnoi women zealously sacrificed their lives by embracing their 'khejri' (*Prosopis cineraria*) trees rather than allow them to be cut down (Malhotra, 1986).

These technologies were designed for a certain carrying capacity of human and animal populations. However, they could not withstand the increasing population pressure, change in lifestyle and value systems and over time have fallen into disuse.

Conclusion

The growth in demand for produce from land and livestock is directly linked to human and livestock numbers. The current pressures are due both to ignorance and the need for survival. The demands of human and livestock populations on the environment need to be regulated through developing alternative sources of livelihood and the means to meet the subsistence needs of the population. Unless a holistic view is taken of ecological sustainability, the environment will continue to be vulnerable. The short- and long-term objectives of combating desertification and sustainable development are not attainable if we look at the problem only from the technological perspective. The human and behavioural dimensions are equally important as they provide a framework within which change and development take place.

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Gender Dimension in Relation to Desertification Control Initiatives in the Southern African Development Community

William Rugumamu

Professor of Geography University of Dar-es-Salaam, Tanzania

Introduction

Statement of the problem

Within the member countries of the Southern African Development Community (SADC), the major environmental problems include the spread of the Kalahari-Namib desert and the surrounding semi- arid zone; drought and soil erosion hazards; the depletion of forests, rangelands and wetlands; overcultivation and declining food and energy yields. These features are simply symptoms of an underlying set of complex physical and anthropogenic factors that are a cause and effect of poverty (Darkoh, 1989; Rugumamu, 1989).

Furthermore, these inter-related hazards tend to vary in severity across the subregion, nationally and locally, causing a serious reduction in the quality of life of the people and their natural resource base (Caring for the Future, 1996). In fact, the impact on society varies between race, religion and gender.

In view of the severity of the desertification hazard, there has been a proliferation of terms among SADC states to describe the problem. For instance, in Botswana the catch- phrase is 'desertification', in Tanzania it is 'accelerated soil erosion', in Lesotho it is 'watershed management' while in Swaziland it is simply referred to as 'environmental degradation' (Rugumamu, 1989). It may be speculated that the different terms used are aimed at winning sympathy and international support from the international (donor) community.

Because of the magnitude of the agricultural and livestock sector and its contribution to the national economies in SADC, the fact that both men and women are predominantly engaged in agricultural, and agriculture-related, activities and also because the impacts of desertification and drought are more directly felt by this sector and the population engaged within it (Wade 1974; Wiggins, 1985; Timberlake, 1985; Tarrant, 1990), SADC scholars and policy makers are duty-bound to search for strategies to combat these hazards.

There is, therefore, an urgent need to transform the contemporary resource use systems into environmentally sustainable ones in order to prevent the depletion of the natural resource base and widespread rural poverty. This calls for application of appropriate 'people-centred' natural resources management systems which will only come about when problems and solutions are defined in conjunction with the local population and their development partners (Tukahirwa and Veit, 1990; PRA Handbook, 1991; Doorn-Adzobu et. al., 1991; Ford et. al., 1992).

Noting that, at production level, women are more involved in agriculture and related activities than men they, therefore, play a more crucial role in the utilization and management of land resources in arid and semi-arid areas (Rugumamu, 1997). They (women) are thus referred to as land managers. It is against this background that the United Nations Convention to Combat Desertification (CCD) and to mitigate the effects of drought, as postulated by the Intergovernmental Negotiating Committee on Desertification (INCD) set up by the United Nations General Assembly, underscores the need to promote awareness and to facilitate the effective participation of local people, especially women and youths in this initiative (INCD, 1994).

Conceptual framework

According to the 1992 United Nations Conference on Environment and Development (UNCED), desertification refers to land degradation in arid, semi-arid and dry subhumid areas resulting from various factors, including climatic variations and human activities (Agenda 21; Cardy, 1993). The Convention to Combat Desertification, based on the INCD of Paris 1994, notes that the desertification disaster is caused by the complex interactions among physical,

biological, political, social, cultural and economic factors (INCD, 1994).

Drought means different things to different people in different disciplines, either conceptually or operationally (hydrological drought, meteorological drought, agricultural drought and so on). To a farmer, however, a drought hazard is an extended period of dryness; usually any period of moisture deficiency below normal for a specific area to support crop growth, leading to crop failure and hence famine. The vulnerability of a community to drought is in part dependent upon its capacity to mitigate the disaster. In 1996 and 1997, for example, Tanzania, one of the poorest countries, faced a period of drought and had to import relief food worth millions of US dollars which reversed her development inertia.

The concept of a household, according to Nindi (1992), has been conceived as 'socially produced and culturally constructed'. In essence, a household is a basic unit of operation in society whose labour, resources, roles and benefits are shared for the perpetuation of life. It constitutes a husband, wife and children interacting for survival. Rugumamu (1997) notes, however, that the unit is heterogeneous with respect to roles and responsibilities resulting in asymmetrical gender relationships in society.

Gender is a socially constructed concept referring to defined rules, roles and responsibilities between men and women and boys and girls in a society through a process of socialization (Rugumamu, 1997). Basically, all societies organise their lives and activities on the basis of a division of labour between males and females which is reinforced by other factors such as culture, race and religious beliefs. The gender analysis approach seeks effectively to involve men and women as individuals, interacting with the environment within a society in the CCD programmes and policies beyond their biological sexual identities.

The fact that desertification control aims particularly to improve the quality of life of the rural poor, it calls for the integration of the gender factor in the development equation. It is in this context that one is able to analyse the multiplicities and overlappings of women's and men's activities, access to and control of resources as well as benefits which are judged, by all standards, to be discriminatory and unprogressive (Mahmoud, 1991; Wilson, 1993).

Past efforts to combat desertification

In SADC member countries, concern for the environment has been used as a justification for unpopular government interventions in land developments (Berry and Townshend, 1973; Rugumamu and Kishimba, 1992). Western scientists perceived the African environment as threatened or in need of control and/or protection. Further, solutions to these perceived problems were generally imported from abroad' and, while they may have worked in temperate environments were often not beneficial to the drier and more fragile environment of Southern Africa and hence the protracted resistance by local people (Fierman, 1990).

It was not until 1977 that the United Nations Conference on Desertification (UNCOD) was convened in Nairobi, in response to a problem of ecological degradation causing serious threats in many parts of the world (UNCOD, 1977; Westcoat, 1991). It was commonly agreed that desertification is a kind of land degradation resulting primarily from adverse human impact. To this end a Plan of Action to Combat Desertification (PACD) was first drawn up. The key issues addressed included overcultivation, overgrazing, deforestation and wood cutting, among others. On the basis of PACD, the solution to the problem is 'an improved and ecologically adapted management of soil, water and vegetation'.

In a review of the United Nations Environment Programme (UNEP) progress in implementing PACD, Wangari (1997) notes that the population threatened by desertification in 1984 had increased approximately threefold (from 80 to 230 million). It was also revealed that some six million hectares of land continued to be lost annually. All this meant that the implementation of PACD fell way below expectations.

At regional level, Rugumamu (1996) reports that the African Ministerial Conference on the Environment (AMCEN) meeting in Cairo in 1985 established four environmental committees. These committees were charged with the responsibility to strengthen regional cooperation, particularly as it affects essential natural resources, namely water, forests, rangelands, energy and seas through a gradual reorientation of economic development strategies towards a more productive and less destructive approach.

The committee dealing with drought and desertification, referred to as the African Deserts and Arid Lands Committee (ADALCO), set out to establish pilot villages and stock-raising zones in 30 countries. So far there has been no progress report on these projects, which were under the umbrella of the Organization of African Unity (OAU), UNEP and the United Nations Economic Commission for Africa (ECA) and especially on their impacts on the ecology and economy at subnational, national, subregional and regional levels. No wonder this initiative has ended in thin air!

It may be stated that, although in the above-cited efforts it was recognised that destructive human activities were the core of the desertification disaster, and that the solution to the problem was to be based on improved and ecologically adapted management of soil, water and vegetation cover, the gender- environment interrelation was not underscored.

The gender dimension in desertification control initiatives

As the problem of desertification escalated, it was not until Agenda 21 was launched in Rio in 1992 that the issue was placed high on the global agenda. As a follow-up to this global conference, INCD was set up to formulate an international convention to combat desertification.

It is noted that the major output of the Convention to Combat Desertification, which came into force in 1996, is the development of national environment action plans (NEAPs) through which to identify causes of desertification and

develop action programmes to combat it, mitigate drought effects and promote sustainable development (INCD, 1994). The strategic focus is placed on popular participation and assisting local communities, particularly women and the youth, in design, implementation and monitoring and evaluation of programmes and policies.

The United Nations Educational, Scientific and Cultural Organisation (UNESCO), Dakar office, unlike other agencies, boasts of having appreciated the need to integrate gender issues in its Man and the Biosphere (MAB) activities in Africa (UNESCO- Dakar, NST, 1997). Women's participation is reported to be well articulated in such projects as the Cooperative Integrated Project on Savanna Ecosystems in Ghana (CIPSEG) and Mananara North Project in Madagascar, etc..

At national level, the Government of Tanzania report to UNCED also devotes a whole chapter on gender and the environment (Government of Tanzania, 1992). It underscores the fact that the role played by women in society makes them daily managers of the environment and acknowledges that their knowledge and awareness are key factors to achieving the goal of sustainable development.

By and large, there is no consensus as to how the gender relations-environment nexus should be pursued despite a growing focus on development research, policies and programmes.

Following on from the above observations, two main objectives form the core of this article: the first is to underscore the fact that for a programme and policy formulation, implementation and evaluation for combating desertification and promoting environmentally sustainable development to be viable, it has to be gendered and participatory. It is hence hypothesized that at household level the key decisions on land use made by men and implemented by women are rarely successful. The second objective is to understand better the importance of gender as a tool in this initiative and so form the basis for the next research agenda on desertification control policies and programmes from local level upwards (a bottom-up approach). It is hypothesized that the capacity of the stakeholders to carry the initiative forward is dependent upon the available resources at household level (men's, women's and children's access to and control over resources) on the one hand, and upon the effective collaboration with and support by other development partners (non-governmental organizations, subnational level authorities, central government, donors) on the other.

Analytical framework

In view of the foregoing observations, the process of combating desertification and drought hazards should take a gender and participatory approach using Participatory Rural Appraisal (PRA Handbook, 1991) tools, whereby all stakeholders, both men and women, including their development partners, from household through sub-national and national to international levels get involved in decision-making regarding arid and semi-arid resource utilization and management.

There is, however, a heated debate on participatory methodologies and the concept has now become a catchword among development researchers and politicians (Carruthers and Chambers, 1981; Leighton, 1986; Conyers, 1986; Kalyalya, et. al., 1988). A consultative and participatory process (PRA Handbook, 1991) should form the basis for strategic design, implementation and monitoring and evaluation of programmes and policies. In this article it is advanced that PRA is capable of capturing the dynamic qualities of gender in particular and society in general, including their development agencies and resources which are essential inputs in formulating and implementing strategic plans and informed policies and legislation (Kalyalya et al., 1988; Rocheleau et. al., 1988; Agarwal and Narain, 1992; Slocum, et. al., 1995).

Based on the philosophy of potential community solidarity at all levels, development research should be directed at ensuring that the community formally undertakes more thorough work on what was and is being done by government for them (Kalyalya et. al., 1988). This is community empowerment, a prerequisite for democratic decision-making and community self- development (Seidman and Anang, 1992; Bandyopadhyay and Shiva, 1989).

Gender-centred development has, indeed, a socio-cultural dimension, one which is critical to success, particularly in traditional societies predominantly dependent on biodiversity for their livelihood. It has the potential to broaden the base of the role occupants and instil a sense of responsibility and accountability at respective levels (Seidman and Seidman, 1994). A generally valid lesson is that when change in behaviour is contemplated, it is advisable that human development policies and programmes take socio-cultural concerns into account, instead of ignoring them, as has been done in the past. This calls for a gender awareness initiative for all the key stakeholders.

In introducing new ideas and practices, (technology), it is important that people see these concepts as meeting their needs (Badyopadhay and Shiva, 1989; Cook, 1991). If perceived needs do not exist, they must first be generated by a consciously planned action. The deep-rooted beliefs in the infallibility of modern scientific knowledge prevents technical experts and decision makers from seeing the potential use of local knowledge which is possessed by men and women (Bowman, 1974; Peatti, 1968; Blaikie, 1989). It is against this background that post-modern technologies can be generated. Indeed, men and women are a source of much useful knowledge for combating desertification and the effects of drought for sustainable self-development (Baumer, 1990; Shiva, 1991).

Further, gender-based participatory methodologies are deemed capable of capturing the needs and aspirations of the community as individuals as well as national development priorities aimed at promoting equity and efficiency. This will subsequently lead to evaluating the requirements of the life- support systems based on ecological potential in the search for a sustainable development strategy (Bremer, 1984; Agarwal and Narain, 1992). The process constitutes gender participatory design, implementation, monitoring and evaluation of development programmes and policies at all levels

(Grindle, 1981; Conyers, 1986; Rocheleau et. al., 1988; Herrick and Green, 1993). The operation requires that national and international support be sought to strengthen local initiatives.

The proposed framework on gender analysis in programme and policy design, implementation and monitoring and evaluation, seeks to concretize the definition of general programme and/or policy objectives, assess how these relate to the involvement of men and women in the programme and finally anticipate the effects of the programme and/or policy on both sexes (Overholt et. al., 1986). The main thrust of the framework is an adequate data base which considers what women and men do and why (Slocum et. al., 1995; Rugumamu, 1997).

The data and information required in this model should revolve around four themes (Overholt et. al., 1986): first, activity profile; second, access and control profile; third, analysis of factors influencing activities, access and control and fourth project cycle analysis.

Overholt et. al. (1986) note that the activity profile should be based on a gender division of labour. The profile will be able to portray, firstly, gender and age desegregated economic activities in the programme. By asking the questions related to 'who' we start with female adults and male adults, but other categories may be equally important: female-headed households, female spouses, male-headed households. Secondly, it will indicate the amount of time spent by each category to accomplish these activities.

Further, by asking a series of questions related to 'what' we map the resources available and who has access to, or control of, them. Control of a resource or input implies decision-making about its use. Access to a resource implies conditionality about using it and how it is used; these inputs include labour, land, water, seed, implements. It is proposed that the access and control profile produced will show what resources individuals may command to conduct their activities and the benefits which they derive from them.

In order to capture fully the pattern of and constraints upon labour the calendar should be constructed with all gendered production activities. As for analysis of factors influencing activities, access and control, the focus should be directed on the underlying factors which determine the gender division of labour and the gender-related control over resources and benefits.

It is further noted that these analyses identify the factors which create differential opportunities or constraints for men and women in, and benefits from, the programmes and policies. In view of the fact that gender roles change over time with technological development, an understanding of the underlying trends within the broader economic and cultural environment should be incorporated in this analysis.

In analysing benefits there are three questions to be considered:

1. What are the products which are a source of income?
2. What are the uses and desirable characteristics of these products?
3. Who has access to or control of the products and the income they produce? Will this pattern be an incentive or hindrance to the allocation of any additional labour or resources required by a new technology?

For programme sustenance, gender criteria and indicators have to be developed and integrated in the implementation process. In the final analysis, disaggregation of costs and benefits by gender helps anticipate which technologies will be accepted and by whom. It is in the programme cycle analysis that we seek to predict the life-cycle of the programme in the light of the foregoing basic data and the trends that are likely to affect it and/or be generated by it.

Programme and policy monitoring and evaluation should be conducted through public meetings of all the stakeholders. The event should be carried out on completion of each scheduled phase. The above operation has to be promoted by a facilitator who acts as a catalyst – neither a funding agent nor an implementor.

By and large, this framework provides sufficient basis for designing, implementing, and evaluating programmes and policies which can best benefit both men and women through a gender-based participation (Overholt et. al., 1986; Slocum et. al., 1995). Principally, the good will and cooperation of men and women must be gained if development programmes and policies are to succeed. Since it is not possible that every member of the community be approached individually, the practical thing to do is to secure the support of individuals whose views command respect in the community, together with the views of the cross- section of the peoples, community and groups concerned.

It is important that full participation of the adult and youth population are invited in the consideration of problems that confront the community. It goes without saying, therefore, that there is need to involve and promote traditional organizations (community-based organizations, indigenous non-governmental organizations) serving wider interests of the community at all levels that have existed through centuries in all cultures (Kjekshus, 1977; Rodney, 1980; Fierman, 1990; United Republic of Tanzania, 1992; Koimowitz, 1997). This is where the involvement of state, private and popular sectors and groups holds strongly at all phases and levels of the programme and policy process (UNSO, 1986; DANIDA, 1989; Herrick and Green, 1993).

It is proposed that a multi-disciplinary team consisting of development scholars, committed policy makers, representatives of a vibrant community of peasants, pastoralists, members of the public and the private and popular sectors be formed to embark on a search for sustainable socio-economic ecological development through combating desertification at different spatial and institutional levels (Wade, 1974; Bremer, 1984; Conyers, 1986; Cooke, 1991).

Further, local level institutions, both public and private, are keys to generating programme and policy inputs that promote the quality of resources and the infinite character of human demands upon them (Caldwell, 1970; Fierman, 1990). Development initiatives should be directed towards empowering the community to make decisions and implement them. The process would

facilitate the integration of local development plans into district and national plans. Finally, conflicts between local and national level interests are likely to be minimized and the chances of local needs being met increased (Conyers, 1986).

At the subnational level, a district, an agroecological zone or a constituency may be an appropriate institutional and natural resources management unit for sustainable development planning (Luttlrel, 1973; Tukahirwa and Veit, 1992). At this level, government and non-governmental institutions and the private and popular sectors operate in the development process. These institutions should be coordinated in order to effect positive change and hence the need to effectively mobilize the apparently fixed scarce resources at this scale. The focus should be on four main issues: support for local initiatives; developing and linking up horizontal and vertical networking of existing institutions; coordinating training and representing local needs at national level.

Going up the scale, the strategy should, at the national level, strive to accomplish five goals: to win the commitment of government leaders and heads of private institutions regarding the plight of marginal communities and zones; to integrate conservation-based resource use with other socio-economic activities; to coordinate research and training; to delegate responsibility to subnational institutions; to obtain feedback through a monitoring and evaluation process and to invite, wherever necessary, international support.

At the international level, the strategy should seek to coordinate exchange of information and expertise; and to analyse and evaluate national and subregional or regional resources management projects and programmes with a view to assessing their sustainability.

It is within this framework that two complementary development paths, which seek to strike a balance between gendered socio-economic activities and sustenance of the life- support systems in desert-like conditions, are pegged. Whereas the first path centres on improving crop and livestock production and ecological management systems, the second focuses on sustainable utilization of the potential natural resources endowment, based on industrialization in the study area.

Conclusion

Now that national governments, the donor community and United Nations agencies have resolved to combat desertification and drought and promote the quality of life of the affected populations, a gender-based participatory design, implementation and evaluation of programmes and policies forms the basis for promoting sustainable self-development. The proposed framework, backed by education and training, is but a platform upon which to build development initiatives. It may be postulated that gender analysis will better specify research and action toward specific gendered groups in order to increase both efficiency and equity amongst stakeholders by making explicit the actual biases inherent in technologies.

It is proposed that the next research agenda would test the model outlined above in field situations using participatory methodologies in specific socio-cultural-economic-ecological settings. The research thrust would be on scaling up gender, household and community participation in local resources utilization and management in arid and semi-arid zones in SADC in the light of contemporary interactions between community based socio-cultural-economic activities, on the one hand, and the sustenance and promotion of the productivity of the natural resource base on the other, within the local, subnational, national and international socio-cultural-economic and political climate. It is anticipated that the research output will inform desertification control programmes and policies by capturing the forces that drive human behaviour to destroy their natural resource base unknowingly or otherwise.

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Integrating Gender Issues into NAP Process in Zimbabwe

Emmanuel Chinyamakobvu

NAP Programme Officer
Department of Natural Resources
P 0 Box Cy 385 Causeway Harare,
Zimbabwe

Summary

Recognizing the fundamental role played by women in the management of natural resources, the Parties to the United Nations Convention to Combat Desertification (CCD) committed themselves to promoting awareness and to facilitating the participation of all affected people, particularly women, in the decisions that affect them. It has become clear that the success of the Convention depends on the full participation of women at all levels of the implementation process. Over the last few years, since the United Nations Conference on Environment and Development in Rio de Janeiro in 1992, debates on how to achieve this has pointed to the realisation that gender-sensitive approaches are required during all phases and at all levels of implementation of the Convention to Combat Desertification, to build on existing and available resources to meet the needs of all stakeholders.

The National Action Programme (NAP) on desertification attempts to create opportunities and to address existing gaps and deficiencies related to the role of women in the CCD implementation. It aims to strengthen and promote the role of women in the decision-making process and in project implementation. The fundamental assumption at play is that women do not currently have equal opportunities to participate and contribute fully to these processes, hence, without commitment and concerted actions to involve them, the successful implementation of NAP process and, hence, the Convention to Combat Desertification, becomes uncertain and obscure.

Introduction

In Zimbabwe, it has since been recognized that problems related to land degradation and drought, such as fuelwood and water shortages, affect women more than men, thus women are identified as a key stakeholder group in NAP process. The goal of including gender issues in NAP process is the emancipation of women from their subordination and their achievement of equality, equity and empowerment. The process focuses on gender roles and needs, control over resources and decision- making in the civil society. The background to this focus is well known. The United Nations Decade for Women (1976 to 1985) highlighted the important but often invisible role of women in the social and economic development of Third World countries and communities. The Convention to Combat Desertification stressed the important role played by women in regions affected by desertification and or drought, particularly in rural areas of developing countries, and the importance of ensuring the full participation of both men and women at all levels in programmes to combat desertification and mitigate the effects of drought. In addition, the first national forum on the establishment of NAP process and the National Desertification Fund (NDF) in Zimbabwe identified women and women's groups as the major key stakeholders in NAP process and beneficiaries for NDF. The participation of women in all activities of NAP is viewed as critical, as these programmes and strategies are gender sensitive. The underlying rationale is that women are mostly an untapped resource who can contribute to development through sustainable environment management.

The concept of gender

The concept of gender is used as a tool to understand the relationship between men and women in a given society. It refers to specific rules, roles and responsibilities that society assigns to men and women. Almost each and every society organizes its activities on the basis of a division of labour between males and females, and this socially-based division of labour determines how men and women relate to each other. Gender roles and responsibilities are, therefore, socially constructed through the process of socialization, varying from one society to the other. Female and male sex roles are different from gender roles. Sex roles are inherently biological/physiological and cannot be exchanged or reversed. On the other hand, gender roles are socially constructed and may be performed by either male or female and can be reversed. Consequently, the gender notion excels biological reductionism through providing a framework for interpreting the relationships between women and men as cultural constructs which result from imposing social, cultural and physiological meanings upon biological sexual identities. Emphasis is placed on the complementarity of the roles of men

and women for the ultimate well-being of households, communities and societies.

The integration of gender issues into NAP process aims at making women's and men's concerns and interests and experiences an integral dimension of the design, implementation, monitoring and evaluation of projects and programmes in all social, economic and environmental spheres, such that women and men benefit equally from development, with the ultimate goal being the achievement of gender equality through equity-led growth. The strategy links with one of the key principles for the successful implementation of CCD that calls for an integrated approach based on development of solid partnership among all stakeholders.

Genuine gender participation in NAP process guarantees that decisions are taken by communities who will be affected by these decisions. The integration of gender therefore facilitates the desegregation and differentiation of the roles of men and women confronted with desertification (land degradation) and drought. Gender, poverty and environmental degradation are intertwined and reinforce each other, particularly in rural areas where the majority of the population live and interact very closely with the environment. Hence, NAP process gives attention to the configurations of gender, environment and development to influence the capacity of the affected populations to respond to challenges posed by drought and land degradation.

It is believed that, unless the people who are most affected by desertification and drought are completely involved in NAP process and are committed to its implementation, the Convention would not achieve its objectives. Both men and women must participate in NAP process and activities at all stages, ranging from needs assessment, problems identification, action planning and project implementation, management, monitoring and evaluation. Equal gender participation in NAP process is expected to increase ownership and control of the implementation process by the affected populations.

Definition of gender

'Gender' as opposed to 'sex' refers to relationships between men and women, and boys and girls and the different rules and roles and responsibilities assigned to them by society. Hence gender relationships, rules, roles and responsibilities are socially constructed through the socialization process, differing from one society to the next, and reinforced by factors such as religion, culture, individual inclinations, etc.. The particular society and culture one lives in constructs their attitudes, views, behaviours, customs and values. These are generally learnt or acquired from role models in a person's life who contribute greatly towards changing the particular person's gender identity, the way they see and carry themselves in society and the way they act and interact with others.

The meaning of gender at times is difficult to understand as it translates into concrete frameworks that are visible and obvious. It is difficult in that it deals with the daily interactions and relationships between men and women which everyone comes to take for granted and which some people may even come to assume as given and unchangeable. Occasionally, the term gender is used to refer to 'women' or to a person's sex, but usually, the word refers to the relationships between men and women and to the ways in which roles of women and men, girls and boys are socially construed and shaped. Understood in this way, the term gender transcends biological reductionism by interpreting the relationships between men and women as cultural constructs which result from imposing social, cultural and physiological meanings upon biological sexual identities.

Why gender and not women

NAP process has since recognized the limitations of focusing on women in isolation hence the focus on gender in the process. Focusing on women in isolation would result in their problems being perceived in terms of their sex, that is their biological difference from men, rather than in terms of their gender – the social relationship between men and women, in which women have been systematically subordinated.

It is perceived in NAP process that the focus on gender, rather than women, makes it critical to look not only on the category 'women', but at women in relation to men, and the way in which relations between these categories are socially constructed. Men and women play different roles in society, with their gender differences shaped by ideological, historical, religious, ethnic, economic and cultural determinants. These roles show similarities and differences between other social categories such as class, ethnicity, race, and so on. Social categories differentiate the experience of inequality and subornation within societies.

Women and the environment

It is a known fact that the breakdown in ecological equilibrium weighs more on women because of their daily intimate interaction with the living environment in their bid to satisfy basic survival needs. Women in many societies have the responsibility of providing the family with its basic needs such as diet, water, energy fuel and short-term economic needs. With vast expanses of land becoming rapidly infertile and unproductive, the livelihoods and lives of many women and their families as well as their economic prospects continue to be threatened by environmental degradation.

Although women feel the immediate effects of the degrading environment, its consequences affect their families, the communities they nurture and the resources they manage. The roles of women in environment and resources management is central to resource-base sustainability and development. As poverty is a most direct consequence of environmental degradation, an appreciation of the role of women in environmental management for sustainable development becomes more imperative than ever before.

Women, because of their dependence on, and daily contact with, natural

resources have acquired deep and extensive knowledge of the environment, thereby unavoidably becoming active environmental managers, caretakers, and repositories of knowledge relevant to sustainable living. Examples abound in Zimbabwe where, after a series of devastating droughts, women have realized the importance to maintain and to manage sustainably their environment and have embarked on tree planting projects. It is reality to such women, more than anyone else, that shorter term economic needs can only be met continuously if longer term measures for sustainability are not overlooked for short-term gains. For these women, environmental conservation and sustainable development are livelihood necessities.

Women are constantly engaged in a continuous exercise intended to maintain a healthy balance between short-term economic needs on the one hand and the longer term ecological imperatives on the other. This emanates from the realization that both these factors are crucial to their very survival and those of their families and the communities they nurture. Hence, women have become increasingly aware that what they do as producers and resource managers is central to the sustainability of the resource base and thus to development.

Women and the society

Despite immense contributions to survival, Zimbabwean women are more often confronted with rigid socio-cultural barriers and a lack of access to means of production, including land and capital. Traditionally they have been marginalized both in private and public life, as important decisions can only be taken by the heads of their households who happen to be males. Consequently, they are usually projected as passive recipients of project benefits, not being involved in the higher levels of decision-making which denote a more active role in the development process.

At the level of tradition and social practice, discrimination against women in Zimbabwe is prevalent. In some circumstances, this is further aggravated by discrimination against women in official and administrative government practice and, sometimes, by discriminatory legislation. It has been a practice for generations in Zimbabwe, as in other countries, that women cannot hold title to land which means they do not have access to credit as they are not able to provide the necessary collateral. In cases where loan capital could be provided without need of collateral, women, by law, would need the consent of their husbands to execute the necessary agreements. Considering women's contributions and the high incidence of female-headed households, such restrictions impose severe limits to effective and substantial management of natural resources and to development.

In recognition of the limits imposed on Zimbabwean women, it is fundamental to move away from largely unsustainable development towards development that is economically, socially, and environmentally sustainable by embarking on a transition to include gender-expanded rights and participation of women in the development process. The rationale of such an argument is that any national development which fails to reach, involve, and benefit the poor majority, being both men and women, cannot lead to sustainable development.

The issue of placing Zimbabwean women in the development mainstream process must attract increasing priority and must place gender firmly on community sustainable development initiatives and strengthen efforts to achieve gender equality. Thus an enabling environment for gender equality and equity must be established and promoted by addressing both practical and strategic gender needs in order to bring about an egalitarian society in which men and women can have equitable access to and control over decision making, resources and their benefits.

Gender and the environment in the NAP process

Gender, poverty and land degradation are interwoven and reinforce each other, especially in rural communities where the majority of the people live and interact on a daily basis with the environment for their survival. Unfortunately, the burdens of ecological decline and overexploitation of natural resources fall most heavily on women. Integrating gender, poverty, resource decline and land degradation is the fundamental challenge for NAP process to achieve sustainable environmental and economic development in rural areas among affected communities, as it is central to positioning the interests of both men and women in the process. Thus the equality between men and women, boys and girls is basic to the integration of gender in development through NAP process.

Consequently, a framework for linking gender and environment and natural resources management in Zimbabwe should involve some of the following components:

- Identification of interfaces and interactive processes between gender, resources, and environmental issues;
- Recognition of diversity of natural resources and social/cultural communities and the range of options available for particular resource users;
- Analysing the ways in which local communities and their environmental management/resource utilization approaches, strategies and activities are structured by gender;
- Building upon relevant and strong viable local institutions and organizations for effective and sustainable resource use, environmental management and sustainable development activities;
- Reformation of policies to give ownership, control and management of resources such as forests, grazing areas, water and wildlife to local communities.

NAP vision for gender empowerment

It is recognized that the success of the NAP process and hence the Convention to Combat Desertification in Zimbabwe will depend on the full participation of women at all levels of the implementation process. The consensus that gender-sensitive approaches are essential during all phases of NAP implementation has

been reached so as to realize the needs of all the major stakeholders. The guiding principle in the involvement of gender into NAP process is to build a receptive and enabling environment at the key decision-making points where policies are formulated, programmes designed and resources allocated resulting in increased chances of alleviating poverty and improving the lives of the affected populations.

Several areas of an action plan towards gender empowerment in Zimbabwe have therefore to be identified:

- Awareness creation: creation of continued awareness of NAP process among women and local communities, and the need for their participation in desertification programmes and projects as well as experience sharing of undertaken activities;
- Provision of resources: increase women's access to financial resources by providing seed funds for projects for income-generating activities linked to desertification control;
- Access to land: facilitation of easy access to land resources by women through reviewing laws and customs affecting women's access to land;
- Involvement of women in decision-making: encouraging women to participate fully in decision-making structures on issues pertaining to NAP process;
- Provision of skills to women: equipping women with the necessary skills to implement programmes and projects of NAP process.

Conclusion

The formulation and implementation of NAP process is designed in a manner that ensures that both women and men participate and benefit from the implementation of the CCD. However, in view of the disadvantages that women often start off with in Zimbabwe, there is need for a continued and concerted support for special inputs targeted at women wherever and whenever necessary.

In the process of NAP process formulation, it has become apparent that gender issues should be viewed and analysed in the broad Convention to Combat Desertification contextual framework. It has not been adequate simply to describe women as subordinate, vulnerable and disadvantaged. The underlying causes and consequences of this subordination and vulnerability has had to be clearly identified in NAP process, for sound and sustainable strategies for development, and the implementation of the CCD in particular, to be defined and articulated.

It is known and acknowledged that the problems of women are directly linked to the social relations between men and women in the society. If the NAP process in Zimbabwe fails to take into account these relations and view them in their proper perspective and manifestations, they can lead to the increased marginalization of women. The roles, responsibilities, access to and control over resources, decision-making powers, needs and constrains of both women and men should be analysed on the basis of target group identification, stakeholder analysis, and impact assessments.

Ultimately, cumulative positive changes in communities' lives, through NAP process, in both time and space, should lead to the improvements that enhance the quality of life of the affected people, which is one important outcome of any development process. Such an outcome is attained through mutually beneficial activities and undertakings by all members of society: women and men. Women and men have special interests and needs and these should be addressed and taken into account in any development process.

Extent, Severity and Causative Factors of Land Degradation in the Sudan[1]

Ali Taha Ayoub

United Nations Environment Programme, P. O. Box 47074, Nairobi, Kenya

Summary

This article examines the status of land resources in the Sudan after over half a century of unsustainable use. Several studies indicate that about 120 million hectares of land, including 64 mha of soils, are degraded to varying degrees. A remarkably high correlation seems to exist between human population densities and degraded soil in different aridity zones. The most degraded zones were the arid and semi-arid zones where 76 per cent of the human population of the Sudan live. Wind erosion was the most widespread soil degradation type in the arid zone, while water erosion was dominant in the semi-arid zone. Chemical deterioration through nutrient loss was affecting all climatic zones. The central clay plains and the ironstone soils of the south-west were the least degraded soil types. Overgrazing is the most widespread cause of soil degradation, particularly around permanent settlements and watering centres, affecting about 30 mha (47 per cent) of the total degraded areas. Clearance of forests and woodlands cover for firewood and charcoal making and overexploitation of vegetation is the second cause of soil degradation affecting 22 mha. Cropping without appropriate nutrient inputs have degraded about 12 mha, particularly in small-scale farming on sandy and loamy soils. When these processes of resource mismanagement coincided with the recent recurrent droughts, collapse of the economic base of fragile areas took place.

Keywords: desertification; land degradation; Sudan; assessment; erosion; nutrient depletion; severity; extent; overgrazing.

Introduction

The first serious sign of soil degradation in the Sudan was reported by Kennedy-Cooke (1944). It was reported that rapid deterioration of soil and vegetation was occurring in parts of the Red Sea Hills; this was considered as a warning that similar problems might be developing elsewhere, particularly around town peripheries and settlement areas in Kordofan and Darfur Provinces of western Sudan.

At present, in the flat clay plains and sandy areas of the Sudan Sahel, overgrazing, overcultivation and cutting of trees for domestic purposes are still continuing. After several years of bad rains grasses are unable to reproduce, creating a condition known locally as 'mahal,' synonymous with desertification. The Sudan derives more than 75 per cent of its energy requirements from fuelwood estimated at 22 million m^3 per year (WRI/UNEP/UNDP/PAVB, 1996). This is equivalent to about 400 million *Acacia* trees being uprooted annually for rainfed cropping. Rangelands cleared for mechanized rainfed agriculture and shifting cultivation increased from about 2.0 mha in 1954 to about 14 mha in 1994, a rate of 300,000 ha $year^1$ (Tothill, 1954; Ministry of Environment and Tourism, 1996). Range fires, set deliberately by herders to improve grazing, annually take out about 35 per cent of the natural range productivity, estimated to be about 300 million tonnes (Atta El Moula, 1985).

Being dry and hot most of the year, livestock in the Sudan concentrate around boreholes during dry periods, causing vegetation denudation and soil pulverization by trampling. About 5,500 wells and boreholes were opened during the period 1960 to 1990 in anti-thirst campaigns without proper land-use studies (Salih, 1996). The repercussions of the challenge to alleviate thirst went far beyond its intention.

Location and environment

The Sudan, Africa's largest country and with the biggest agricultural potential, is a microcosm of the continent. The country can be divided into five aridity zones which form a consecutive series from north to south (figure 1). Statistical areas

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of these zones are shown in table 1. The hyperarid and arid zones consist essentially of a plain of loose red sand with broad undulations. The hyperarid zone has little binding vegetation, particularly early in the summer season. In the arid zone the natural vegetation of short grass and sparse thorn scrub provides a period of good grazing for sheep, goats, cattle and camels. Opportunistic rain cropping of sorghum and pearl millet is practised in depressions and foothills. In this zone the strong winds associated with summer thunderstorms cause dust-storms. The semi-arid zone of tall grass plus *Acacia* woodland is cultivable by rain. The main granaries of the Sudan lie in this zone. To the south and south east, talh *(Acacia seyal)*, from which gum arabic of inferior quality is collected, attains its best development on heavy clay. On the sandy soils to the north and north-west open grassland is found with abundant hashab *(Acacia senegal)* which produces the best quality of gum arabic. This zone is also a cattle region. Thus, this semi-arid zone is distinguished as the zone of both animal and rainfed husbandry. The western part is traversed by the cattle-owning tribes moving south and north with their herds to seek new pastures. The more reliably watered rangeland of Bahr Al-Arab provides an important seasonal resource for grazers from the overgrazed pastures of Darfur and Kordofan. An area of about 24 mha of this semi-arid zone is swampy and seasonally inundated by the White Nile and its tributaries. The Sudd and Machar swamps act as a reservoir, absorbing the irregular stream flow from the south while discharging a regular flow, much reduced by evaporation, in the north. The seasonally inundated parts of the flood plain are vast meadows of almost pure grass which maintain the very important cattle industries of the Dinka and Nuer tribes. Soil on the surface is sandy with iron concretions and is underlain by a dark heavy clay which accounts for standing water.

The dry sub-humid and moist sub-humid zones are loamy leached lateritic catena soils in an area of 30 mha (12 per cent of the total area of the country). The most luxuriant vegetation occurs at the border with The Democratic Republic of Congo and the Central African Republic where the tallest grass in Africa, the elephant grass *(Pennisetum purpureum)*, abounds. The famous Sudan mahogany *(Khaya senegalensis* and *Khaya grandifoliola)*, Sudan teak *(Tectona grandis)* and the ebony *(Diospyros mespiliformis)* were abundant here. During the last 40 years of civil unrest in southern Sudan, uncontrolled tree felling for timber and bush fires have severely reduced the abundance of these trees.

The soil resources

The Sudan sits on the little-disturbed Basement rocks of the African continent. The Basement is overlain by the Nubian Sandstone formation in the centre and north-west, and by the Umm Ruwaba formation in the south. The Basement rocks protrude to the surface in the eastern part of the country forming the Red Sea Hills. Soils of the Sudan are products of these parent materials plus the alluvial

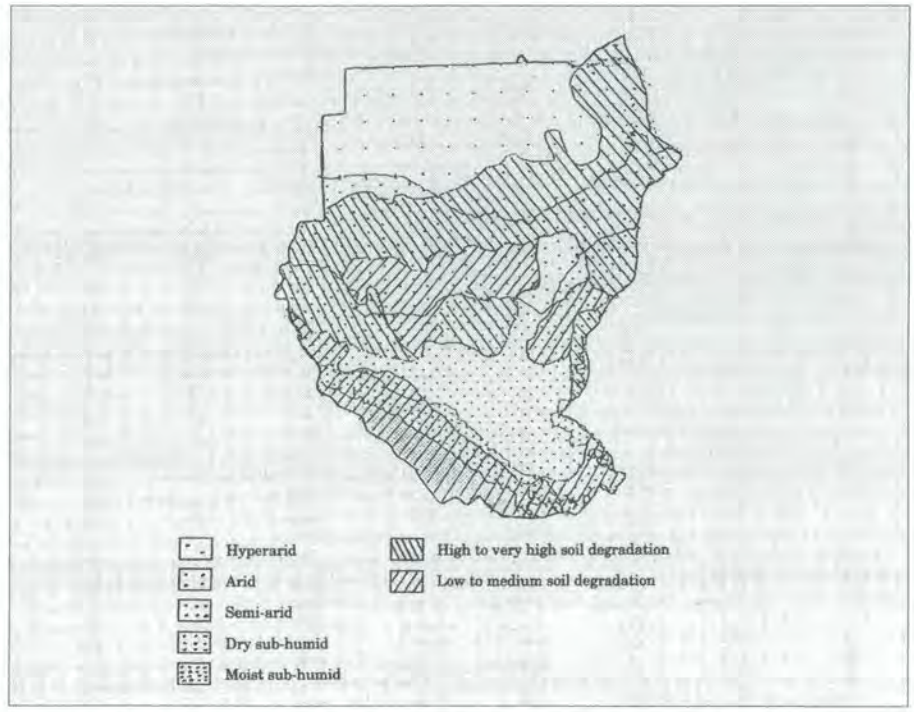

Figure 1. Aridity zones and severity of soil degradation in the Sudan (UNEP/ ISRIC (GLASOD), 1990; UNSo, 1997).

Table 1. Extent of aridity and population density per aridity zone (source UNSO, 1997)

Aridity zone	Hyperarid	Arid	Semi-arid	Dry sub-humid	Moist sub- humid
Area (mha)	77.6	63.0	77.6	16.2	14.4
Population (millions)	3.6	10.8	10.4	1.6	1.4
Population density (per person km^{-2})	4.6	17.1	13.3	10.1	9.2

deposits of its rivers and their tributaries. According to Food and Agriculture Organization of the United Nations (FAO) (1995), soil resources of the Sudan can be divided into seven broad regions.

Soils of the hyperarid area (about 78 mha) of Xerosols comprising part of the Sahara Desert are superficial deposits of sand with bare rock debris, shifting dunes, and consolidated dunes. Recent alluvium provides a basis for productive agriculture in the narrow Nile valley north of Khartoum. Elsewhere soils are sandy with little agricultural potential.

To the south of this region are the soils known locally as 'goz' and 'gardude', classified as Arenosols and about 28 mha in area. Further to the south are 12 mha of the more weathered Arenosols in the semi-arid climate of western and central Sudan. These soils are low in nutrients and organic matter and have a high sensitivity to erosion. The sands are free draining, with some clay or ferruginous clay as a bond near the surface, making them firm after the rains. Under high torrential rains their nutrients could be easily leached.

Vertisols (about 70 mha) have considerable agricultural potential in the semiarid zone of the Sudan. They form the central clay plains extending southwards to the eastern part of the flood plains. Special management practices are required to secure sustained production of these Vertisols. Their problems lie in the area of physical soil characteristics and water management, while their assets are a rather high chemical fertility and their location in extensive level plains where mechanical cultivation is possible. The irrigated Gezira/Managil, New Halfa and Rahad schemes and the extensive forms of rainfed mechanized cropping are classic examples of low- input agriculture increasingly confronted with soil physical deterioration, among other things.

Ferrasols (about 30 mha) are the soils of the dry sub-humid and the moist sub-humid zones embracing the tropical rain forest of the Sudan and the lush tall grasses. These soils have good physical properties but are chemically poor. Their low natural fertility and very low nutrient retention capacity are serious limitations. Their great depth, high permeability and stable microstructure make them less susceptible to erosion than many soils in the country, other than the Vertisols.

The rocky soils of the Red Sea Hills and parts of Mara mountains, classified as Leptosols, constitute about 18 mha The soils of the Red Sea Hills are shallow and poor in nutrients with high gravel contents. The Mara mountain soils are relatively rich volcanic soils. Because of the limited soil depth and sloping terrain these soils are liable to erosion by water. Cambisols are the smallest soil group in the Sudan (about 2 mha), but could be among the most productive soils in the country. These soils lie along the undulating Ethiopian Highlands under dry and moist sub-humid conditions, and thus are prone to water erosion.

Freshwater resources

Much of the present economic activity and most of the future activities envisaged in the Sudan will depend on the country's share of the 18.5 billion m^3 annual flow of the River Nile and its tributaries. However, 75 per cent of the population of the Sudan currently depend on groundwater and rainwater for their domestic water for most of the year. A total of about 1,100 billion m^3 of rain falls annually on Sudan's land surface with very high potential evapotranspiration rates. Underground water is very localized and is estimated at 9,000 billion m^3 (Ministry of Environment and Tourism, 1996).

The forest resources

According to the WRI/UNEP/UNDP/WB (1996), an area of about 44 mha, mostly in the moist sub-humid, dry sub-humid, and southern fringes of the semi-arid zones, is covered by natural forest and woodlands. Annual deforestation, which mostly takes place in all these zone, is 482,000 ha (rate of 1.1 per cent of the forest cover), 90 per cent of which is for fuel and charcoal making.

Land degradation

Several global or regional attempts of land degradation/desertification assessments have covered, among other countries, the Sudan (UNEP, 1977; FAO/UNEP, 1984; UNEP/ISRIC [International Soil Reference and Information Centre]; (GLASOD) [Global Assessment of Soil Degradation], 1990; Dregne, 1991). Figure 2 shows such attempts. From these studies one can conclude that of the land surface of the Sudan (excluding the hyperarid zone), of the agricultural land, pasture, and forest and woodland (170 mha in total), nearly 75 mha (45 per cent) have been degraded severely to very severely by human factors in recent history. The highest estimate was that of Dregne (1991), while the estimates of UNEP (1977) and FAO/UNEP (1984) were similar. GLASOD soil degradation assessment shows that severe and very severe degradations totalled 58 mha. The difference between GLASOD and other assessments could be vegetation degradation without significant soil degradation. This may indicate that desertification in the Sudan is more linked to soil degradation than to vegetation degradation. The GLASOD methodology of assessing human-induced soil degradation was considered a definite progress from those used in the other assessments (Thomas & Middleton, 1994). Moreover, GLASOD data are stored in a geographic information system (GIS) which allowed reasonable estimates of different aspects of soil degradation in a large country like the Sudan.

Extent and severity of soil degradation

Table 2 shows data calculated by overlaying the aridity map of the Sudan over the GLASOD portion of the Sudan. Though the GLASOD database came with warnings against extracting data on a country level, the huge size of the country (8.5 per cent of Africa) and the great expanse of well demarcated degraded areas made it possible to determine the following data.

About 64 mha of soils are degraded in the Sudan, 88 per cent of them highly to very highly. Of the total degraded area 81 per cent is in the susceptible drylands (arid, semi-arid and dry sub- humid). Most degradation (74 per cent of total degraded soils) is in the arid and semi-arid zones, but significant percentages of land are also degraded in the dry sub-humid and

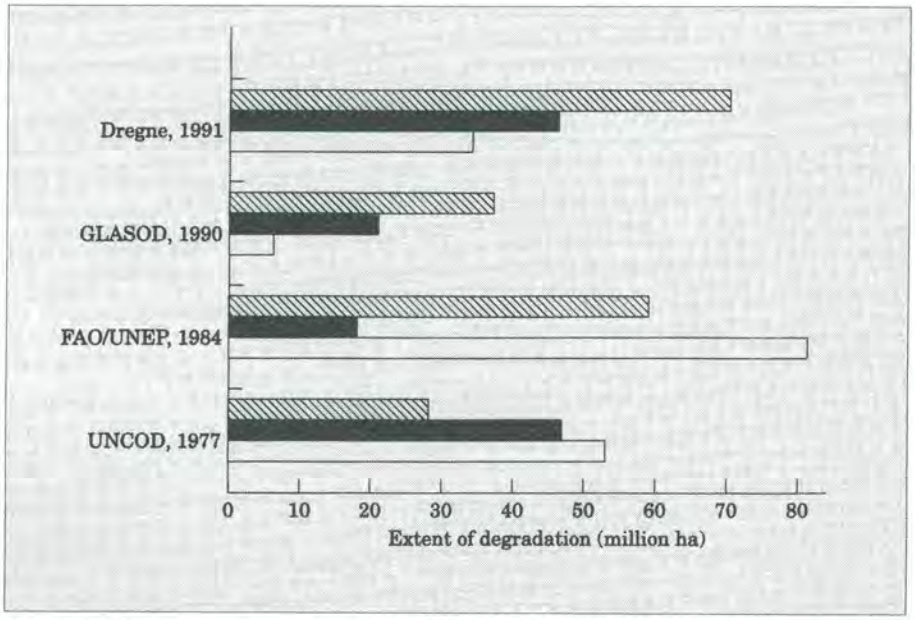

Figure 2. Various assessments of soil (UNEP/ISRIC (GLASOD), 1990) and land degradation (UNEP (UNCOD), 1977; FAO/UNEP, 1984; Dregne, 1991). (□) = moderate; (■) = severe; (▨) = very severe.

moist sub- humid zones. As per cent of total area per aridity zone, the dry sub-humid and moist sub-humid zones have figures higher than the semi-arid and hyperarid zones, 28 per cent and 29 per cent respectively.

Types of soil degradation

Erosion by wind affects 27 mha, most of it in the hyperarid and and zones of Kordofan and Darftir where vegetation is poor and soil particles are loose, and further accentuated by the strong winds characteristic of the region (table 3). The narrow fertile strips along the Nile River north of Khartoum are being encroached by sand dunes on both banks of the river, while very active overblow of sand, sometimes becoming thick dust ('habub'), are now frequent phenomena in most of northern Sudan, particularly along the Red Sea coast. The total area affected by wind erosion in the hyperarid zone is about 6 mha. Just over one mha is affected by wind erosion in the semi-arid zone, while the dry sub-humid and the moist sub-humid zones show no sign of wind erosion.

About 18 mha of soils are affected by water erosion (table 3). Topsoil loss through sheet erosion is a common type of water erosion, and formation of gullies is an extreme form. The arid loamy soils of the Butana area between the Nile and Atbara Rivers, with an area of about 8 mha, experiences high water erosion (Shepherd, 1985; Akhtar & Mensching, 1993). The Nuba Mountains in southern Kordofan, and the Jebel Mara volcanic soils in Darfur, are also experiencing high topsoil loss through water erosion. These are rich soils covering an area of about 10 mha vulnerable to erosion due to their sloppy terrain denuded of their vegetative cover. Water erosion occurs mostly in the semi-arid and and zones, but 2.4 mha along the River Nile banks in the hyperarid zone is also affected by water erosion.

About 16 mha of the ocean-like expanse of reddish yellow sandy soils of the and and semi-arid zones in central and southern Kordofan and Darfur, and the dry sub-humid and the moist sub-humid zones of western Equatoria and Bahr Al-Arab areas are experiencing high rates of nutrient depletion (table 3). These soils are inherently poor in nutrients. The situation is aggravated when all biomass has been cleared, and when agriculture is practised without sufficient application of manure or other fertilizers (Ibrahim, 1987). It is worth noting that all the zones, except the hyperarid zone, are experiencing soil degradation through loss of nutrients at almost equal levels. In the hyperarid zone agriculture is mainly practised in the narrow Nile valley, the fertility of which is replenished annually through alluvial deposits.

About 3 mha of the Sudan's central clay plains in the mechanized rainfed agriculture of the Gedaref area are experiencing high physical deterioration due to the use of heavy machinery and monocropping. Physical degradation is the least common of the four types of soil degradation, but it could spread if such inappropriate management practices continue.

About 30 mha of the Sudan's soils are stable under natural conditions. These are lands under forest, swamp or marsh,

Table 2. The extent and severity of soil degradation in different aridity zones (mha) (UNEP/ISRIC (GIASOD),1990; UNSO, 1997)

Degradation severity	Hyperarid	Arid	Semi-arid	Dry sub-humid	Moist sub-humid	Total
Very high	8.0	24.7	8.8	2.1	2.3	45.9
High	0	4.7	5.4	0	0	10.1
Medium	0.2	0.5	2.1	2.2	1.7	6.7
Low	0	0	0.9	0.2	0.2	1.3
Total	8.2	29.9	17.2	4.5	4.2	64.0

mostly in southern Sudan. Another 4 mha are stable under sustainable agriculture. These mostly include the large irrigated schemes such as the Gezira, Managel, New Halfa. etc., and some parts of the rainfed mechanized agriculture.

Causes of soil degradation

Major causes of soil degradation are overgrazing (47 per cent), improper agricultural practices and mechanized rainfed agriculture (22 per cent), deforestation for firewood and urban demand for charcoal (19 per cent), and overexploitation of vegetation for domestic use (13 per cent) (table 4). Overgrazing of rangelands by livestock affects 30 mha, mostly in the arid zone, causing widespread wind erosion. The combination of overgrazing, overexploitation of vegetation and deforestation resulted in some sheet and gully erosion in the semi-arid zone. In the dry sub-humid and moist sub-humid zones soil, mining through low input agriculture and deforestation are causes of soil degradation. There is a very high population imbalance in the Sudan (table 1). The majority of the population live in the arid and semi-arid zones.

Figure 3 shows per cent soil degraded versus soil types.

Per cent degradation varies from 16 to 73 per cent for different soils types. The most extensively degraded soils are the Arenosols and Leptosols; 71per cent of the Arenosols and 58 per cent of the Leptosols are severely degraded. Arenosols are mostly depleted of their nutrients and partially affected by wind erosion. The Leptosols are rocky soils of the Red Sea Hills and part of Mara mountains. These soils are severely eroded because of overuse. About 31 per cent of the Ferrasols are degraded, mainly through nutrients loss. The least degraded are the extensive level clay plains of Vertisols. Only 16 per cent of the total area is degraded. Dry Vertisols have a very hard consistency, and become very plastic and sticky when wet. These characteristics add to their resilience to erosion by wind and water. However, the irrigated schemes and extensive rainfed mechanized cropping are increasingly confronted with soil physical deterioration, nutrient depletion and loss of soil organic matter.

Table 3. Soil degradation types by aridity zone (mha) (UNEP/ISRIC (GLASOD), 1990; UNSO, 1997)

Aridity zone	Wind erosion	Water erosion	Chemical deterioration	Physical deterioration	Total degraded
Hyperarid	5.8	2.4	0	0	8.2
Arid	20.0	6.9	3.0	0	29.9
Semi-arid	1.2	7.7	5.3	3.0	17.2
Dry sub-humid	0	0.7	3.8	0	4.5
Moist sub-humid	0	0.5	3.7	0	4.2
Total	27.0	18.2	15.8	3.0	64.0

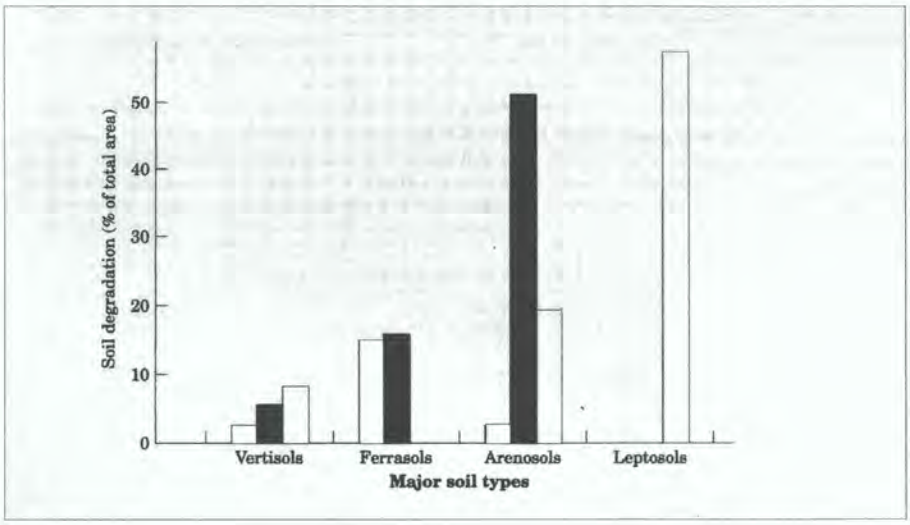

Figure 3. Severity of degradation of major soil types. (□) = *moderate;* (■) = *severe;* (□) = *very severe.*

Discussion

The Sudan is the one most arid county in Africa. Of the entire territory, 31 per cent is hyperarid, and 63 per cent is drylands susceptible to desertification and where 82 per cent of the population live (table 1). About 64 mha of the Sudan's soils are affected by degradation, 81 per cent of which is inside the drylands susceptible to desertification, thus contributing to the desertification of 33 per cent of such susceptible drylands.

Over 65 per cent of the causes of the extensive wind erosion on the sandy soils of western Sudan is attributed to overgrazing by all types of domestic animals (tables 3 and 4). These continental sands of Kordofan and Darfur, which support bushes and grasses for grazing and the production of the lucrative cash crop gum arabic, are experiencing the most severe soil degradation in the country. In this area hashab *(Acacia senegal)*, which produces the best quality of gum arabic, is under threat. Hashab is losing its dominance because it is the most favoured tree for building, fuelwood and charcoal making (Al-Awad et. al., 1985). Areas around the permanent settlements and watering centres (deep bores and shallow wells) were the first to

Table 4. Causes of soil degradation in different aridity zones (mha) (UNEP/ISRIC (GLASOD), 1990; UNSO, 1997)

Aridity zone	Overgrazing	Inappropriate agricultural activities	Deforestation	Over exploitation vegetation
Hyperarid	5.3	1.6	1.3	0
Arid	20.2	4.2	2.5	3.0
Semi-arid	4.5	4.3	3.3	5.1
Dry sub-humid	0	2.0	2.5	0
Moist sub-humid	0	1.8	2.4	0
Total	30.0	13.9	12.0	8.1

be denuded at large scales. Nomadic grazing in the arid and semi-arid areas is an environmentally compatible system, but collapses of such systems are being noted with increasing frequency in the arid zone where about 68 per cent of soil degradation is due to overgrazing (table 4).

An increase in grazing intensity can be induced by many factors (figure 4). Fire incidents have effects equal to overgrazing. Infestation of the area with grasshoppers, rats and locusts also produces a situation similar to overgrazing. Overgrazing around settlements is often related to the sedentarization of nomadic herders. Settlement of these former nomads has meant that their herds have been concentrated on grazing around their new homes. Drought conditions have also forced herders to concentrate their animals in areas where drinking water was available causing the complete disappearance of herbaceous cover in many places, particularly around boreholes which provide drinking water for humans and animals all year round, with consequent sheet erosion and windblown loss of topsoil and reactivation of ancient sand dune deposits. Al- Awad et. al., (1 985) reported the impacts of sedentarization of nomads and animal concentration around boreholes on soil and vegetation degradations in the arid zone of Kordofan. They showed steady increase of bare soil around boreholes with time, increasing from 20 to 55 per cent in 30 years and the livestock carrying capacity of the area decreasing from 44 to 20 LSU per 1,000 ha. during the same period. However, Hellden (1984) reported that the 'sacrifice zones' around watering centres do not necessarily expand significantly over time in the manner found by Al-Awad et. al., (1985). As a matter of fact, Thomas & Middleton (1994), citing several authors, reported that the 'sacrifice zones' soils may have enhanced levels of nutrients because of the high input of dung and urine around the watering centres.

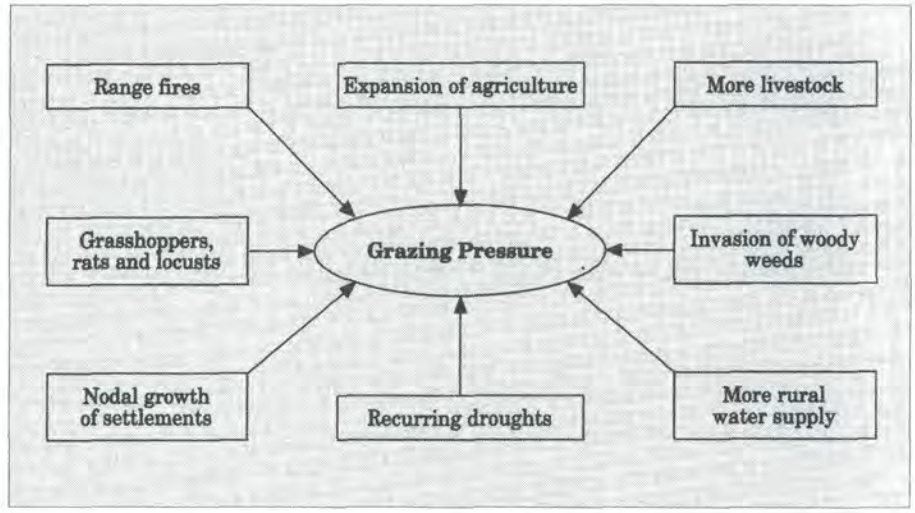

Figure 4. Factors contributing to grazing pressure.

Roughly a quarter (24 per cent) of the Sudan's livestock is raised in Kordofan alone and this region has been subjected to severe rangeland degradation. A FAO report (1988) indicates that 26 per cent of the nation's rangeland is degraded, 10 per cent irreversibly. Until recently, pastoralism in the Sudan was based on the system of common property administered by community leaders. Abolition of the native administration system in 1970 adversely affected rangelands, among other things. Overgrazing has also caused decline in plant species diversity as well as vegetation coverage (Ibrahim, 1978; Ingrouille et. al., 1991). Ingrouille et. al., (1991) reported that the droughts of the late 1960s to mid-1970s have destroyed the whole of the*Acacia tortilis* belt of north Kordofan, while frequent fires in the semi-arid zones has destroyed *Acacia mellifera* and replaced them by fire-resistant species such as *Acacia seyal* and *Acacia nubica*. Suliman (1988) also reported a substantial and steady decrease in the number of plant species in the Sudan's rangelands.

The severe wind erosion experienced in the Sudan results in dust-storms which occur throughout the year, but are most intense in summer. Middleton (1985) reported that the number of dust-storms (visibility less than 1,000 m) per year in

El Fashier, capital of northern Darfur state, had increased more than five-fold during 1970 to 1980. Dust-storms were almost negligible before 1970, but increased dramatically to over 45 incidents per year during the period 1970 and 1980. Dust-storms peaks seemed to coincide with low rainfall.

Water resources are meagre in most of the Sudan. The problem of water supply in rural areas is a growing one. Surface water is available in only about 16 per cent of the country (Allan, 1996). During the last 30 years, groundwater extraction for irrigation and human and livestock consumption increased steadily and has currently reached about 2 billion m^3 $year^{-1}$ (Ministry of Government and Tourism, 1996), and this is believed to have contributed to the desertification of wide tracts in the central and western Sudan. During the period between 1960 to 1991, over 5,500 wells and boreholes were opened in central Sudan without adequate land-use studies. While increased water supplies are necessary for a proper use of the natural resources and to alleviate adverse living conditions, the almost inevitable result was concentration of the population and their livestock around watering centres thus disturbing the fragile ecological equilibrium. Using data from Ingrouille et. al., (1991) the degraded area around these watering points would be in the vicinity of 25 mha, about 39 per cent of the total degraded soils. In parts of the Sudan annual rainfall in 1965 to 1984 was 40 per cent below 1920 to 1939 levels, and the wet season length had contracted by 39 to 51 per cent. Hydrological consequences were reduced frequencies of wadi flows, major decline in shallow aquifers recharge, and earlier exhaustion in the dry season of shallow wells, surface pools and reservoirs (Walsh et. al., 1988). Actually, water points did not help in population and livestock distribution; instead, they led to their concentration (Al-Awad et.al., 1985). About 42 per cent of the arid and semi-arid zones of the Sudan are underlain by water- bearing aquifers, mostly in the western and southern parts of the country. The rest is underlain by Basement complex offering little possibility of underground water availability. The Basement complex areas are overlain by heavy clays (Vertisols), wherein varying capacity 'hafirs' (water hollows) may be excavated to collect rainwater for part of the year. This shows that in the more fragile sandy soils of the arid and semi-arid zones of the Sudan, watering centres are mostly boreholes providing water all year round while in the more resilient clayey soils watering centres are hafirs which provide watering for part of the year. The controversy arising from these situations is that fragile areas are under more stress than less fragile areas resulting in more and more imbalance in human and livestock distribution in different parts of grazing areas as drought and dry seasons progress.

Soil degradation due to nutrient depletion is found all over the Sudan but is largely critical in the arid and semi-arid parts in southern Kordofan and Darfur, and the dry sub-humid and moist sub-humid zones of south-western Sudan. Such degradation is clearly related to agricultural activities and deforestation at ratios of 45 and 55 per cent respectively, particularly in the dry sub-humid and moist sub-humid zones. UNEP/ISRIC (1990) data show that soil deterioration by nutrient depletion is very high in the Sudan. Percentagewise, it is about three times as high as the average of the world and over twice that of Africa. This is due to the very low fertilizer inputs in the Sudan, currently less than 5 kg of nutrients per ha of cropland. This is a quarter of Africa's average fertilizer use, and less than one-fifth of the world average (WRI/UNEP/UNDP/WB, 1996). Inappropriate agricultural practices and deforestation combined account for 35 per cent of wind erosion. None of the causative factors are clearly related to water erosion. This may indicate that water erosion is caused by a combination of all of the above-mentioned factors.

The heavy clays of central and eastern Sudan are experiencing physical deterioration due to an inappropriate mechanized farming system. Atta El Moula (1985) cited literature that showed there was a direct positive correlation between discing frequency and development of compaction layer. The Vertisols of the Sudan's central clay plains, though resilient to degradation by erosion and nutrient depletion, are very vulnerable to physical deterioration and would need careful management practices.

Table 1 shows the population distribution in the Sudan's different zones. The majority of the population lives in the arid and semi-arid zones. This has resulted in uneven human pressures on the available land resources. Figure 5, calculated from tables 1 and 2, shows the fragility index of different aridity zones in the Sudan. The fragility index was calculated by dividing area degraded (mha) in each zone by its population density (person km^2). Fragility index values were highest in hyperarid and arid zones, moderate in the semi-arid zone, and lowest in the dry sub-humid and the moist sub-humid zones. The hyperarid and arid zones are particularly fragile due to the nature of their easily erodible soils (see figure 3), recurring droughts and the erosivity of the prevailing winds. The semi- arid zone is less degraded because of the dominance of the extensive erosivity resilient Vertisols. Fragility indices were low in the dry and moist sub-humid zones because of the low grazing pressures and because of the less intensive agriculture in these zones. Currently much of the dry and moist sub-humid zones are without livestock, particularly cattle, due to the presence of tsetse fly *(Glossina moritans)*.

Data available from Nachtergaele (1996) of FAO on the 32 Sudan GLASOD

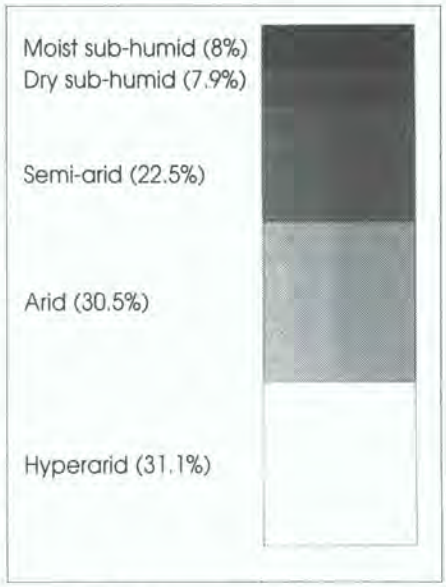

Figure 5. Relative fragility index of different aridity zones in the Sudan.

units show no relation between the severity of soil degradation and the density of the human population, either collectively or by land-use type. In the FAO data, population densities varied from 4 to 120 persons km^2 as compared to population densities ranging from 4.6 to 17.1 reported by UNSO (1997) shown in table 1. Several GLASOD units with population densities less than 10 persons per km^2 had severely and very severely degraded soils, while several other GLASOD units with population densities between 25 to 66 persons km^2 show light and moderate degradations. These data from FAO show that human population density had little relationship with the degree or severity of soil degradation. However, the impact of the presence of some 650,000 refugees from Eritrea and Ethiopia around Kassala area of eastern Sudan for some 20 years (from 1973 to 1993) is evident. Thousands of square kilometres are denuded of their vegetation, leaving the soil vulnerable to wind and water erosion. It is not clear whether these refugees are included in the population data provided by FAO.

Conclusions

Soil resources in the Sudan are inherently poor and their utilization is based on extensive land use with minimum inputs and, therefore, the extent of land degradation and the impacts of disasters such as drought, locusts, pests, etc. are quite substantial. Rainfed crop production and grazing enterprises in the arid and semi-arid areas are based on unsustained management and are subject to variable climates. Inappropriate grazing management strategies have caused changes in pasture composition, invasion of woody weeds, a reduction in total vegetative cover and increased soil erosion. This degradation has reduced productivity, increased variability in production, and threatened the long-term sustainability of the land resource base. It is highly recommended that authorities in the Sudan urgently identify, map and assess the potentials and constraints of the land resources in different aridity zones, map current land use, accurately assess the present conditions of land resources, predict foreseeable hazards and develop methods for their sustainable use.

A new comprehensive approach in research and development with a major focus on rehabilitation of degraded land and prevention of further degradation is required. Such an approach is outlined, among others, in the relevant chapters of Agenda 21 (United Nations Conference on Environment and Development, 1992), and in the Convention to Combat Desertification.

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Indicators of Desertification in Kuwait and their Possible Management

Shabbir A. Shahid

Samira A. S. Omar

Samir Al-Ghawas

Aridland Agriculture Department
Food Resources Division
Kuwait Institute for Scientific Research,
P.O. Box 24885 Safat 13109
State of Kuwait

Abstract

Desertification is a world-wide problem, but intensified in arid zones as in the case of Kuwait. This article identifies some of the major factors and processes causing desertification specific to Kuwait, with possible management strategies to combat it. It identifies aridity, overexploitation of land resources and inappropriate land use, insufficient water resources and pollution as the main causes of degradation. The major degradation processes occurring in Kuwait are erosion (wind and water); salinity and waterlogging; loss of vegetative cover; soil disturbance (mining); soil sealing/crusting and hardsetting; depletion of organic matter and soil fertility, and oil pollution. The article also addresses management strategies to either reduce or moderate the extent of land degradation in Kuwait.

Introduction

Kuwait is situated in the north-eastern corner of the Arabian Peninsula; it covers approximately 17,818 square kilometres extending between latitude 28° 30' and 30° 05' N, and between longitude 46° 33' and 48° 30' E. Similar to other parts of the Arabian Peninsula, Kuwait is characterized by a desert type environment with scanty rainfall, and a hot, dry climate. Summer is very hot, especially in July and August, with a mean temperature of 37.4°C and a maximum mean temperature of 45°C (Al- Kulaib, 1984). The mean total precipitation is approximately 100 mm yr^{-1}, the rate of evaporation which exceeds precipitation is approximately 16.6 mm day^{-1}. The winds usually blow from the north-west and, to a lesser extent, from the south-east. Dust and dust-storms, locally known as 'toze', are common throughout the year, but more frequent during the spring and summer months, March to August.

The United Nations Convention to Combat Desertification (CCD) defines desertification as land degradation in arid, semi- arid and subhumid areas resulting from various factors, including climatic variations and human activities. It is a world phenomenon of the degradation of the world's ecosystem (Lanly, 1995), which can be assessed by looking at the soil resilience, which is a qualitative category to capture the ability of land to regenerate its capability after sustaining a shock (Bie, 1989). Kuwait signed and ratified the Convention in 1995. The Convention adopts an integrated approach to ensure that all aspects of the problems are addressed. It also suggests that a national action programme (NAP) should be set up to overcome, or at least to reduce or moderate, the problem, with the purpose of identifying factors which contribute to desertification and practical measures to combat desertification and mitigate the effects of drought (Sourang and Ahmad, 1995) for natural resource management. These NAPs would then serve as an operational framework for the implementation of the CCD in affected regions and countries, such as Kuwait. The present article presents a framework to identify the key processes of natural resource degradation in Kuwait and future management options to moderate the environmental effects.

Land degradation in Kuwait

An overall view of land degradation in Kuwait revealed water and wind erosion; disappearance of vegetation; soil salinity and sodicity; sand encroachment; dust-storms; oil pollution; disturbance of rangeland productivity and soil crusting as the main components of land degradation. Types and processes of land degradation and possible improvement strategies with special reference to Kuwait are described below.

Erosion

Wind erosion causes serious problems. This is due to loose, dry, sandy soils, poor vegetation protection and periods of strong winds (Skidmore, 1988). Erosion, caused either by wind or water, induces scoring of unprotected land. Runoff, in particular, causes rills and gullies. The erosion is enhanced due to vegetation loss as a result of salinity, loss of fertility, grazing, and human-induced factors such as military activities. Water erosion is divided into sheet, rill, gully, tunnel erosion and land slips. The majority of these erosion forms are observable at Jal Az Zour watershed

(±145 metres above sea level).

One of the most dramatic events in Kuwait is the dust- storms. Not only is the soil lost in the erosion process but also a proportionally higher percentage of plant nutrients, organic matter, pesticides and fine soil particles in the removed material are lost. The surface is usually overlain by several types of recent sediments that include aeolian, residual, playa, desert plain, slope, and coastal deposits. Of these, the aeolian deposits are the most predominant and account for 50 per cent of the surface deposits (Khalaf, 1989). Khalaf et. al., (1984) estimated that mean monthly fallout of soil deposition is 191.3 t km^2, while the mean monthly maxima and minima were recorded in July 1002.7 t km^2 and November 9.8 t km^2 respectively.

Table 1. Particle size distribution at three locations in Kuwait

	Size Class µm	Mass %
Location 1	**Grid Reference: 788894 E 3282827 N**	
	< 63	6.1
	63-500	77.6
	> 500	16.3
Location 2	**Grid Reference: 214268 E 3162931 N**	
	< 63	7.6
	63-500	55.9
	> 500	36.5
Location 3	**Grid Reference: 741847 E 3240681 N**	
	< 63	10.4
	63-500	67.7
	> 500	21.9

Mechanism of soil particles movement

On the basis of sizes of soil particles three different modes (Bagnold, 1973) of transport can be distinguished, they are:

a. creep (> 500µm);
b. saltation (63-500µm)
c. suspension (<63µm).

There are three distinct phases (Schwab et al., 1993) of wind erosion:

a. Movement ;
b. Transportation;
c. Deposition.

Table 1 reports the distribution of soil particles in various size fractions, collected at three different locations from the soil surfaces. The soil profiles of all the three sites have been classified as typic torripsamments at the subgroup level of the Keys to Soil Taxonomy (USDA, 1994). Table 1 illustrates that the surface soil material from the deserts of Kuwait are dominant in the size range which is predominantly susceptible to saltation movement, and, therefore, saltation moves the main mass of windblown particles (Chepil, 1945). In Kuwait, this is followed by creep to a lesser extent and the least as suspension movement. The loss of plant nutrients from agricultural soils is usually attributed to losses by suspension (Leys and McTainsh, 1994). As the suspension movement is caused by saltating particles when hit at the surface, so that if saltation movement is initially controlled suspension movement would automatically be reduced.

Future strategies for wind erosion control

Efficient stabilization of Kuwait's very fragile soil is required to enhance the environmental quality. A number of approaches have been evolved and tested on desert soils, including heavy loads of farmyard manures, green manuring, mulching, shelter belts, etc. The practice which maintains soil structure and conserves moisture should be followed. The conservation of soil water, particularly in arid regions, is of utmost importance to control wind erosion. In an arid environment, such as Kuwait, plants with low water requirements should be planted, particularly before high intensity winds. The vegetation used should have the ability to grow on sandy soils and to grow in the open, firmness against the wind, and be long-lived and should provide an obstruction to reduce wind velocity. Under Kuwaiti dry conditions, the combination of shrubs and trees may be successful to minimize the effects of wind erosion. The filtering brush matting, debris, rock and gravel may also be suitable in stabilizing sandy areas.

A variety of mulches are available in the market, both organic or inorganic. The best way of mulching is to incorporate the material with the soil so it reacts with the soil; this usually enhances the soil binding forces and therefore soil absorption of moisture; it also increases organic matter and nutrients in the soil if the mulches are organic based. Recently, a new technology, synthetic hydrophylic polymers, is emerging. They effectively increase soil stabilization, decrease both wind and water erosion of soil, increase infiltration rate, and act as a soil conditioner (Agassi and Ben-Hur, 1992; Ben-Hur and Keren, 1997). The polymers induce flocculation of dispersed clay particles, bridge soil particles and therefore develop soil structure. These polymers may also be used in turfgrass landscaped areas under Kuwait Municipality and are a very attractive new technology.

Water erosion

Water erosion in Kuwait is active only during the October to March wet season, when intensive rainfall (more than 20 mm in 8 to 10 hours) causes severe water erosion by runoff flows. Misak and Dousari (1997) reported water erosion to take place at the slopes of watersheds in Jal Az Zour (+145 m), Al-Ahmadi-Adan (+100m) and Wadi Al-Batin (+265 m). Moreover, accelerated erosion prevails in grazing and camping areas, for example Mesherif (Kuwait city), Ras Al-Sabiyah

(north-eastern portion of Kuwait Bay) and north-west Al-Jahra city. Runoff scouring and deposition are the most significant indicators.

Soil salinity, sodicity, waterlogging and their management

The difference between rainfall and evaporation is invariably negative, imposing severe restrictions on the development of agriculture in Kuwait. The groundwater is mostly saline with some limited fresh and brackish water (Al-Sulaimi et. al., 1996). The total available groundwater in Kuwait is 247 million imperial gallons per day (MIGD) with total dissolved solids (TDS) ranging between 2,000 and 5,000 mg l1 and even higher in some places. The groundwater is pumped from the regional aquifer systems found in the Kuwait Group and Dammam Formation. The TDS of ground water of the Kuwait Group varies from about 4,000 mg l1 along the Saudi Arabia border to about 12,000 mg l1 along the north-eastern corner. Municipal and industrial wastewater are the two sources of recycled waters. The concentration of TDS in the municipalμ water is reported as 2,500 mg l1 (Akbar and Puskas, 1992). The high salt content in the soil and the shallow water-table causes salinity. Irrigation with brackish water can further compound the problem. Proper management measures may be adopted, and salt-loving plants, halophytes, may be grown with potential for grazing (Photo 1).

Development of soil salinity

The arid region of Kuwait receives inadequate and irregular precipitation to effectively leach the salts originally present in the soil profile. Normally when the precipitation is more than 1,000 mm per annum, salinity should not develop (Chhabra, 1996). This is not the case in any arid zone, and in Kuwait salinity occurs in most of the areas which are classified under the order Aridisols (USDA, 1996). The soils of Kuwait belonging to the order Entisols and the suborder psamments do not present salinity, with the exception of the Wafra area in the south of Kuwait where the high water-table causes soil salinity in entisols. In the coastal areas saline water seeps laterally from the sea and through capillary action reaches the surface (Photo 2). The loss of vegetation in this area is an early-warning indicator of the effect of soil salinization as a land degradation process.

Photo 2. *Saline wastelands in Kuwait (extreme north-eastern corner of Kuwait.*

Photo 1. *Grazing on growing halophytes in the saline lands of Kuwait (Doha, north-east of Kuwait).*

The presence of salinity in the fields of Kuwait can be observed by these indicators:

a. Presence of white salt efflorescence (crust);
b. Reduced plant vigour or stunting in crops;
c. Salt stains visible on dry soil surface;
d. Small to large bare areas can be seen;
e. Affected area may worsen after high seasonal rainfall;
f. Some species show marked changes in leaf colour and shape due to salt stress;
g. Only salt-tolerant species are present;
h. Trees are dead or drying;

i. High water-table, usually less than 2 metres;
j. Collapse of green belts, buildings and roads due to the corrosive effects of salinity.

Research on salt-affected soils in Kuwait

Very limited research has been done on the salt-affected soils of Kuwait, and so the current extent is unknown, but some of the most productive lands are threatened. Salinity control options have not been tried on a large scale. Research needs to determine the best practices for soil reclamation and management, such as the best mix of plants and possibly subsurface drainage to achieve salinity control. The following are suggested as the pre-requisites to initiate research on salt-affected soils:

a. A detailed soil survey of Kuwait;
b. Identification and characterization of salt-affected soils;
c. Identification of causes and sources of salts;
d. Analysis of the soils for ECE, ESP, texture, lime and gypsum.

It is hoped that the project 'Soil Survey and Associated Activities for the State of Kuwait' (Omar and Ghawas, 1995) will fill the above gaps and form the basis for future research. The soil survey of the whole of Kuwait (reconnaissance 1:100,000) and detailed (1:25,000) of 200,000 ha is due to be completed in June 1999 according to USDA (1993 a & b; 1994) specifications.

Salinity control strategy

The strategy should aim to reduce significantly the future effects of salinity. This may be achieved by revegetating the high water-table areas. The main emphasis should be to provide further encouragement, assistance and technical support to the scientists to identify the areas where most effort should be directed. These areas, once identified, should be considered as 'hot spots'. To achieve success on salinity two targets need to be met: first, revegetation of saline lands with salt-tolerant species and second, installation of subsurface drainage and proper disposal of saline water, or blending drainage and fresh water in suitable ratios prior to irrigating crops, and conjunctive use of brackish and fresh water. If these targets are met, the benefits will be felt by the whole community.

Crusting, hardsetting and soil structure impairment

In Kuwait, off-route trafficking of heavy machinery, holiday camping and raindrop impact have introduced compaction and structural problems resulting in surface sealing and crusting. This hinders plant growth, infiltration rate and enhances erosion hazard. Crusting and hardsetting (15-40 cm) is a significant land degradation process. The impact is evident in severely degraded rangelands at Sulaibiya, Umm El-Eish and Meshrif. The problem was manifested by the movement of heavy military machinery and equipment during the armed conflict between 1990 and 1991. The use of synthetic polymers effectively increases final infiltration rate and reduces runoff and erosion on soils subjected to raindrop impact (Agassi and Ben-Hur, 1992; Ben-Hur and Keren, 1997). Shallow ploughing (10-15 cm depth) is recommended to overcome the soil crusting problem.

Mining construction material

Local activities produce gravels for roads, landscaping and concrete from the Quaternary Dibdibba Formation (Kwarteng and Al-Ajmi, 1997). The Dibdibba occurs only in the northern desert of Kuwait, and consists of north-east- south-west, subparallel, elongated ridges parallel to Wadi Al- Batin (Khalaf et. al., 1982) which introduces dust into the atmosphere, covers buildings and households through wind transport, creates surface crusting when brought to the soil surface. The tailings from the gravel mines appear as north- east-south-west trending artificial sand dunes (Kwarteng and Al- Ajmi, 1997). Although gravel quarrying was abandoned in 1997, this activity has disturbed the natural soils, formed deep depressions and may develop into anthropogenic soils (human activity) in future. However, such activity usually improves the physical properties of the mined refilled area without stones and gravels.

Loss of vegetation and organic matter

The Kuwait terrestrial ecosystem is being subjected to various stresses, for example low rainfall; high temperature; insufficient good quality water; salinity; sodicity and waterlogging and oil pollution, which collectively reduce vegetation. Loss of vegetation cover, and particularly the soil organic matter, presents a formidable and unique research challenge. The vegetation types in Kuwait are controlled by four major ecosystems, i.e. sandy desert plains, desert plateau, salt marshes and saline depressions (Halwagy and Halwagy, *1974)*. The major plant communities are *Cyperus conglomeratus, Rhanteriume papposum and Haloxylon salicornicum.*

The rangelands of Kuwait are in poor condition due to the armed conflict crisis and subsequent activities. Plant cover was destroyed due to mechanical activities and plant communities were altered and subjected to pollution following the explosion and ignition of over 700 oil wells (Omar and Zaman, 1995). In agricultural areas, vegetation is lost through salinity and waterlogging while open overgrazing has devastating effects on land degradation. Soil organic matter is an important component of soil, being a major natural resource and constitutes a carbon pool three times larger than the atmospheric pool, and organic matter also changes soil properties such as nutrients, pH and structure (Tisdale, et. al., 1990; Brady, 1990). The strategy should be to maintain soil cover and soil organic matter levels, which in turn improve soil structure and aggregate stability. An overall view of the vegetation cover in Kuwait revealed that there are some controlled fenced sites where open grazing cannot be practised; in these sites there is a significant build up of vegetation cover and an increase in the soil organic matter level, therefore, controlled grazing is suggested to tackle this issue of great environmental concern.

Oil pollution

Kuwait is a major oil exporting country, where the land resources are also subjected to oil pollution, particularly during the armed conflict in 1991 (Al-Awadhi et. al., 1996). The Greater Burgan oilfield, consisting of Burgan, Ahmadi and Magwa fields, is the second largest oilfield in the world after Saudi Arabia's Ghawar oilfield. During the conflict more than 732 oil wells and some oil refineries were set on fire to create one of the world's worst environmental disasters. At the Burgan oil field, 365 oil wells were set ablaze (Kwarteng and Bader, 1993). Since then the surface of the oilfields and the surrounding productive soils turned into pools of oil lakes, tar mats and soot which eventually turned into black soil, degraded for further uses (Al-Awadhi, 1996; Shahid et. al., 1998).

The crude oil spills have accumulated in shallow depressions resulting in about 70 oil lakes of 50 billion barrels of oil covering about 3,500 ha or 0.2 per cent of the State of Kuwait; the soil contaminated by soot is estimated to be in the order of 6 per cent of Kuwait (Fitzpatrick, 1996). These areas are in the north (20 km x 20 km) and in the south (100 km x 50 km). Remote sensing data (1992 to 1995) show that the aerial extent is progressively decreasing (Kwarteng, 1998). The hostilities in the region have greatly modified the chemical, physical and biological characteristics of Kuwait's soil environment.

Landcare - management of degraded lands

Landcare is a partnership between production and conservation; it is about a whole community caring for their land – government agencies, the farming community, awareness in schools and interested individuals. Working together to tackle land degradation problems is sensible, especially when the cause may not necessarily be confined to one property. The Government of Kuwait should take appropriate steps in forming landcare groups in collaboration with government agencies and the farming community. This will help in improving long-term productivity and the amenity value of the area. Grants and incentives should be made available to conduct research, educate the community, to enhance awareness on land degradation problems and to protect farmers' livelihoods.

Conclusions

The state of Kuwait faces a number of desertification interventions of varying degrees such as erosion; salinization and waterlogging; crusting and hardsetting; loss of vegetation and soil organic matter; mining construction material and oil pollution. A national action programme is required to reduce or moderate desertification in the first instance, and urgent attention by the Government is needed. Possible management strategies to enhance the environment quality are suggested.

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The Social Work Research Centre Barefoot College

A Success Story in Desertification/Land Degradation Control [*1]

Mutsa Chasi and Edith Mussukuya**

*The project received UNEP's 1998 'Saving the Drylands' award**
*The authors were consultants hired by UNEP, with funds from IFAD, to evaluate the success of the Project***

Introduction

Barefoot College, also known as the Social Work and Research Centre (SWRC), is a voluntary organization founded in 1972, and provides services to the rural poor in Silora Block. The College is located in the rural area it serves, Tilonia village, situated 55 kilometres from Ajmer, the district headquarters in the state of Rajasthan, India. The area extends over 82,349 square kilometres with 110 villages and a population of 100,000. Silora falls under the arid region and experiences frequent droughts.

The College has relied on building and using local capacity. The eight programmes run by the college include water, education, health, social forestry, agriculture, animal husbandry, women's programme, communications and rural industries. Of the 178 staff up to 95 per cent are local staff members who have received training from the college. The institution is decentralized to eight field centres with resident local staff across the project area. These function as training and resource outreach centres for communities. SWRC considers environmental conservation and development as one and this is achieved through human resource development within communities.

Background

Early resource base surveys

SWRC's environmental work began in 1973 when it carried out a water survey for mapping of the existing, potential and quality of water resources. At the time, the provision of drinking water in the arid environment constituted one of the main programmes. Socio-economic surveys were carried out to identify viable solutions for the alleviation of drought, particularly for the rural poor, in Silora Block.

In 1976, the College worked directly with the community in planning and implementing land-use plans for the environmental improvement of villages. SWRC and Panchayats focused on community land leases, grazing land, deforestation, afforestation and the inadequate access to infrastructure and services, especially water and sanitation. It was found that the technical interventions based on surveys were not achieving the expected improvement and discernible impact in the existing livelihood and management of the land resource base by the poor.

The SWRC experience of the 1970s led to a change in its policy and strategies, from technical interventions delivered by graduates of external institutions to a community-based development approach where attitude-change processes featured. They had to learn from the people in order to reach out for their effective participation. Consequently, SWRC changed its philosophy and thrust. They would assist communities to improve on the capacity to handle problems with locally available resources, while meeting basic needs and improving their livelihoods. Human resource development of local residents would contribute towards this initiative. The strategy was to combat desertification through an integrated approach with short, medium- and long-term goals which respond to the written project request and priorities of the people.

Financial sustainability of Barefoot College and programmes

Barefoot College programmes are financed by its own core funds which

[1] *This article was reviewed and technically edited by Elizabeth Migongo Bake, Programme Officer, UNEP.*

amount to 30 per cent of project budget, the Government of India contributes 30 per cent and 40 per cent comes from international agencies such as Hivos, USAID and Save the Children Fund. Barefoot's own core funds are generated from professional services and goods.

Government grants are allocated towards eight programmes where the College has a comparative advantage over Government for programme implementation. The devolution of power and of funds to Panchayats implies that communities will now have access to public financial resources for development programmes of their choice, including services of SWRC.

Land use constraints in Silora block

The Silora block was facing land use constraints arising from:

- Increase in human and animal population;
- Encroachment on open-access grazing land or village commons;
- A breakdown of the effective village level institutions for land management, which contributed to overgrazing and deforestation, especially of the village commons;
- Cows and buffaloes being replaced by small ruminants, in consequence the extensive grazing land-use system was replaced by intensive grazing;
- Increase in land-use pressure, as a result of the above, leading to land degradation with productivity and carrying capacity of the pastures falling below the natural potential of the ecosystem. This retrogression gave rise to the formation of 'wastelands' (photo 1);
- Communities being faced with inadequate fodder and grazing, giving rise to low livestock productivity. The Wasteland Development and Goat Programme were initiated to redress these constraints.

The Barefoot approach

The Barefoot approach to reclamation and prevention of dryland degradation is focused on people. It is estimated that up to 80 per cent of the investment in the programme is in people and processes, while 20 per cent is in tangible strategies such as wasteland reclamation; water conservation; rooftop rainwater harvesting and non-conventional energy alternatives. This has given rise to an integrated and intersectoral development approach where livelihoods and short-term basic community needs (food, energy, water, health, literacy, employment) are central requisites, together with important basic components, and inputs into long-term and sustainable environmental programmes. It is anticipated that the human resources that are developed bring about the desired change from within the community.

There is an intricate interface of the degraded or reclaimed resource base with the people and communities. SWRC's success is on the community and human element interface with the natural resource base conservation and preservation so that the environment is in harmony with the sustainable development of people.

Photo 1. *Tilonia wasteland, adjacent to the SWRC Campus. Land degradation as a result of intensive grazing with high stocking rate of small ruminants.*

Achievements/successes in the implementation of SWRC community- based programmes

Wasteland development and goat programme

Approximately 2.4 km^2 of wasteland have been successfully reclaimed and regenerated with trees over a total area of 1,295 km^2. Out of the eight wasteland development projects reviewed there was a failure rate of 25 per cent due to community land- use conflicts at Gundli and Singla, where reclamation was not effected. The successes in the implementation of this programme include:

Vegetation and the ecosystem have been revitalised on reclaimed wastelands. There has been an increase in wildlife species, soils have improved, with reduced soil erosion rates. There has been a notable rise in the water- table in the watershed resulting in increased areas under irrigation due to the improved water yield of wells;

Rehabilitation of vegetation incorporates biological diversity with three vegetation strata, including indigenous species with a mixture of trees, legumes and grass planted. The economic value of species, palatability and preferred livestock feed is important in species selection (photo 2);

The programme has successfully decentralized nurseries for communities outside wasteland development areas.

Photo 2. *Afforestation and land reclamation activities in Tilonia.*

Night schools and village communities participate in this reforestation programme where seedling survival rate is up to 80 per cent;

There has been increased productivity of wastelands through vegetation regeneration with financial returns from the sale of fodder. Other benefits include direct grazing and fuel;

Wasteland development incorporated the management of the indigenous Sirohi goat by the expansion of a phenotypically and genotypically superior animal through selected buck servicing at field centres. The centres also maintained pure breeds and quality Sirohi does. Goat stall feeding was not adopted due to labour, economic and production constraints.

It was envisaged that participating communities would demonstrate that planned and systematic management of village commons was beneficial and this would lead to a demand for the development of remaining areas. However, this process has been slow.

Rural water programme

The rural drinking water supply programme has benefited 1.9 million people in the following areas:

- Well drilling and successfully installing 1,300 hand pumps (photo 3);
- Construction of a pipeline for sweet water supply in cases of areas with brackish water. A pipeline water supply is installed where lower caste households cannot have access to water pumps due to caste discrimination. Piped water has benefited 14,000 families in six districts;
- Nine million litres of water were conserved through the SWRC improvement and application of local knowledge in harvesting rooftop rain water and redirecting it to concrete underground storage tanks. This is a low cost effective solution in areas of brackish water where the community has direct control over the water resource;
- Digging man-made depressions for monsoon rain collection for livestock watering and recharging ground-water. This has had positive impacts in desalinization, environmental protection and raising the water-table level;
- 600 jobs have been created through training local people (the youth, women and the illiterate) in water pump management and technical operation within their communities (photo 4);
- The water programme generates income for staff salaries.

Education, training and employment programme

Communities operate 85 night schools with a total of 3,000 pupils who cannot attend day school as they help their families in agricultural and other economic activities. In this programme 114 local teachers have been trained and acquired employment. The programme instils environmental awareness and protection in the 3,000 children. A children's parliament is an innovation under the education programme. The

Photo 3. *Community-built sustainable water pumps provide water for livestock and household use.*

Photo 4. *Buharu Village Water Committee and Women Group Committee members.*

Government of India has established 275 more such schools in other remote areas.

Up to 50 per cent of project budgets is channelled towards alternative employment creation benefiting the poor to break the vicious 'poverty and land degradation cycle'. There are 2,500 artisans employed through the rural industry programme while projects employ up to 2,600 people in the Silora community. Impressive achievements have been made with respect to SWRC training and employment of the youth as Barefoot doctors, engineers, etc.

The women's programme

The women's programme consisting of 58 groups with a membership of 2,000 is instrumental in the initiation of wasteland reclamation, water schemes and construction of mechanical conservation works. Through their collective action and lobbying, the women's groups have gained a minimum wage status and equal opportunities for relief work. This is one sector of the community which believe they have been empowered through the activities with SWRC. The programme is sustainable as it is issues-based and does not receive external funding.

Achievements of SWRC in other programmes

In its portfolio, SWRC includes other successful programmes which contribute towards the well-being of the people, their livelihoods, environmental protection and preservation. These include a successful rural communication system, a community health programme and the solar programme. SWRC research, trials and demonstrations which seek to explore options and alternatives of environmentally friendly farming systems and livelihoods incorporate biogas, organic farming, and vermiculture.

The development programmes directly contribute to infrastructure improvements for the communities in terms of access to water through storage tanks, piped water and pumps; sanitation, solar lighting (photo 6), day and night schools, crèche, clinics and the eight field centres. The main campus hosts the post office. a telephone exchange which operates on solar power, a clinic, school and training facility for the community and the State. The Tilonia craft shop and export company which is a member of the Alternative Trading Organisation is housed at the SWRC campus.

Photo 5. *Fetching, carrying and tending: just a few of the activities in an ordinary day for the women of Tilonia.*

Social capital

Institutions and sustainability in project operations and maintenance

The Barefoot approach develops sustainable local institutions through broadly based participatory processes resulting in elections of committees who administer projects. Committees collect service fees and operate their own bank accounts. The impact of institutional building was reflected in the 1995 Panchayat elections when 40 per cent of the elected leadership had SWRC linkages as staff or committee members, giving SWRC philosophies an upper hand in community politics and priorities.

Photo 6. *Barefoot solar engineer on solar-powered telephone exchange with 200 lines. Next to him are fabricated solar lanterns.*

Sustainability of essential services

Communities sustain their own basic service needs, such as education, water and developed wasteland. It is evident that the culture of financial contributions and Shramadan (community voluntary labour) is now acceptable where communities require services. Consequently, programmes that matter to the community are economically sustainable and their maintenance is institutionalized, so ensuring reliable infrastructure and service provision once the project has been implemented. Villages select their representatives who are trained at Barefoot College. The trained manpower return to their community to operate and maintain project infrastructure under the supervision of committees.

Preservation of local culture, skills and knowledge systems

The Barefoot approach respects, builds upon and gives legitimacy to local culture, skills and knowledge systems. The rooftop water harvesting and rural communication programmes are examples of improvements of indigenous practices. The college has five non-negotiable principles: equality, decentralisation, collective decision making, self reliance and austerity. These principles imply that the institution is accessible, approachable and flexible in its approaches. This provides the ability to reach the poor, disabled and disadvantaged who participate in all programmes. Consequently, SWRC service delivery systems have remained relevant and sustainable while achieving notable achievements across socio-economic classes and castes, especially the poor, throughout its 24 years of existence.

Socio-economic constraints: attitudes, conflict and social problems

Problems remain, despite the massive input and efforts by SWRC into attitude change processes, social cohesion and organisational structures. The desired impact through human development is a slow process. Some of the projects have failed to make the expected impact due to problems at community level:

- Land-use conflict between communities and individuals;
- Social problems of resource sharing;
- Attitude problems prohibit adoption of innovations;
- Management of common property remains problematic.

While SWRC has made remarkable achievements in the services sectors, there is a conflict of interest, ideas, practices and standards with formal institutions. That graduates and technical reports are not always the prerequisite to development has been demonstrated by the approach. Nonetheless, technical problems still require systematic attention of specialists and researchers. There is a need for benchmark surveys for monitoring and evaluation since SWRC is experienced in application and dissemination of local knowledge systems. This could be shared with a wider community. From this perspective, documentation and collaboration with formal institutions remains valid, perhaps in the context of Barefoot practices of participatory approaches.

Replication and the impact of Barefoot programmes on policies

Barefoot has had an impact on policy at all levels. At local institutional levels communities now submit written requests for development proposals. Proposals include community financial contributions, labour, implementation and project management arrangements. SWRC receives more requests than its capacity to implement projects in Silora Block.

The State Government now runs various education programmes based on Barefoot principles, such as the Lok Jumbish and the Shiksha Karmi programmes. A community-based water pump maintenance system has replaced the three-tier system which was controlled by the district level. Barefoot College is the official State training centre for mechanics in water pump programmes.

At national level, SWRC's Director has influenced a shift from the charity or welfare approach for the rural poor to technology-oriented and sustainable participatory development programmes. To this extent 0.02 per cent of the national budget is now allocated to voluntary organization work with the rural poor at village and grass-roots levels.

Up to 23 voluntary organizations (VOs), which share similar aspirations with the SWRC, are affiliated to Barefoot College through a network. The majority of these VOs were founded by former

SWRC graduates and staff members who went back to their home areas and began similar work

Conclusion

The project evaluation team concluded that the Barefoot programme was a success story in the socio-economic and cultural dimension, especially in the areas of a holistic approach to environmental conservation and alleviation of poverty. It was difficult to measure the effect of human resource development on the environment, this has a long-term impact. The programme was also successful in improving the livelihoods of whole communities in an integrated approach by providing basic services and alternative employment in an arid environment.

The Zabré Women Agro-Ecological Project Burkina Faso

A Success Story in Desertification/Land Degradation Control *[1]

Racine Kane

*Henri M. Lo***

*The project received UNEP's 1998 'Saving the Drylands' award. * The authors were consultants hired by UNEP, with funds from IFAD, to evaluate the success of the project.***

Photo 2. *Good quality compost ready for use in Zoaga.*

Introduction

Established in 1987 through the will of the Association of Zabré Women, better known as PLY Women's Association, to work for the improvement of agricultural productivity through better management of soils, this project involved the preparation and intensive utilization of compost and manure, composted in pits (photos 1 and 2) in peanut, millet and soybean fields and in vegetable gardens. It also included a training programme. The other component of the project consisted of water erosion control through training and the construction of bunds and stone cordons.

Photo 1. *Compost pit and anti-erosion dikes in Pakoungou.*

Among the significant results obtained with organic fertilizers is the improvement in soil structure and fertility, which resulted in a significant increase in agricultural productivity. These results were met with so much enthusiasm that many women joined the association, along with other new actors such as men and

1This article was reviewed amd technically edited by Elizabeth Migongo Bake, Programme Officer, UNEP.

herdsmen who contributed input in the making of compost. The income drawn from these crops has consequently increased, thus allowing farmers, women in particular, to achieve better living and working conditions.

Having started with this agro-ecological project, PLY's activities are today diversified to include socio-economic units oriented towards mother and child health, the conservation and processing of fruit and vegetables, cereal banks, a savings and loan scheme, and even the management of a filling station, with education and training as the backbone of all these activities. These new activities may appear as competing with the agro-ecological project, but they are in fact complementary and indispensable to the improvement of working conditions and to a greater financial autonomy of the association.

Location and general background

PLY carries out activities in three provinces of Burkina Faso: Boulgou, Yatenga and Zoundwéogo. Agro-ecological activities (preparation and utilization of organic fertilizers and green manure) initiated by this association are carried out in the various administrative units (Départements) in these three provinces. This report deals, however, with the Département de Zabré only, located 185 kilometres north of Ouagadougou, in the Sudanian Sahel part of the country.

From a physical standpoint, this zone corresponds to the central plateau. The climate is of a Sudanian type and is characterized by the alternation between a long dry season (November to May) and a rainy season from June to October and linked to the incursion of the monsoon. Rainfall varies between 5.8 millimetres in March and 204.4 mm in September; the annual average for the period 1993 to 1997 is 883 mm.

According to the latest census in 1985, there were 84,274 inhabitants in the Département de Zabré (PQD, September 1997). With an annual population growth rate of approximately 2.8 per cent, this population is presently estimated at 100,000 residents. The population in PLY's zones of intervention is also very young (60 per cent are under 20). The average density is relatively high (56/ km^2).

The main ethnic groups in the Département are Bissas, Koussassis and Mossis. There are also Fulanis, but these are hitherto generally in transhumance. Four religious groups are present: Animists, Muslims, Catholics and Protestants.

The economic activities are dominated primarily by agriculture, especially food crops, and cattle rearing under its two main forms, traditional sedentary and transhumant. There are many constraints to efficient agricultural production, among them are: the concentration of farmers on exhausted lands (no fallow), lack of organic manure and difficulty in accessing credit for inputs such as chemical fertilizers. As for pastoralists, they are faced with the lack of zones for animal husbandry, rustling and animal health problems.

Commercial activities are rather embryonic; the bulk of trade takes place during markets organized every three days. One notes the presence of some economic units (millet mills, cereals banks, maintenance units, etc.) as well as a number of village groupings, development support services (governmental and non-governmental) and projects.

The agro-ecological project was initiated in 1987 through the will of PLY women to work for the improvement of agricultural productivity through better management of soil fertility. To achieve this objective, the association requested and obtained formative training sessions in agro-ecology at Pierre Rhabi Centre in Gorom-Gorom, northern Burkina Faso. The training initially involved 25 women from various villages of the zone, and focused on techniques for making and utilizing compost (compost and manure pits).

Long-term overall objective of the project

The long-term objective of the project is the control of land degradation resulting from drought and poverty, and to improve the living conditions of communities, especially women. This purpose is, in a way, a sine qua non for achieving the basic objective of self-promotion in rural areas occupied by the PLY Women's Association.

Specific objectives:

- To restore the fertility of soils through organic improvement techniques, since chemical fertilizers are inaccessible to farmers, especially women;
- To control land erosion through simple techniques than can easily be mastered by the communities;
- To promote income-generating activities so as to improve the living conditions of the communities in general, but especially the economic status of women.

Evaluation methodology

Evaluation was carried out with PRA tools such as the use of secondary data, group interviews and key informants and focus groups. These different tools of inquiry were combined with direct observations during field visits and visits to the various socio-economic units.

Evaluation findings

The evaluation of composting activities initiated by PLY women reveals many positive aspects that ought to be highlighted. These results, noticeable in several areas, include the following:

Environmental protection and improvement

In this sector, mention must be made of the following:

- Soil fertility improvement. There is evidence that the uninterrupted use of soils that have lost their fertility not only has adverse effects on yields but also provokes, in the medium and long term, destructuring and, therefore, accelerated degradation of lands that thus become prone to erosion (wind as well as water). Composting has thus contributed not only to increasing soil fertility and yields (twofold increase in most

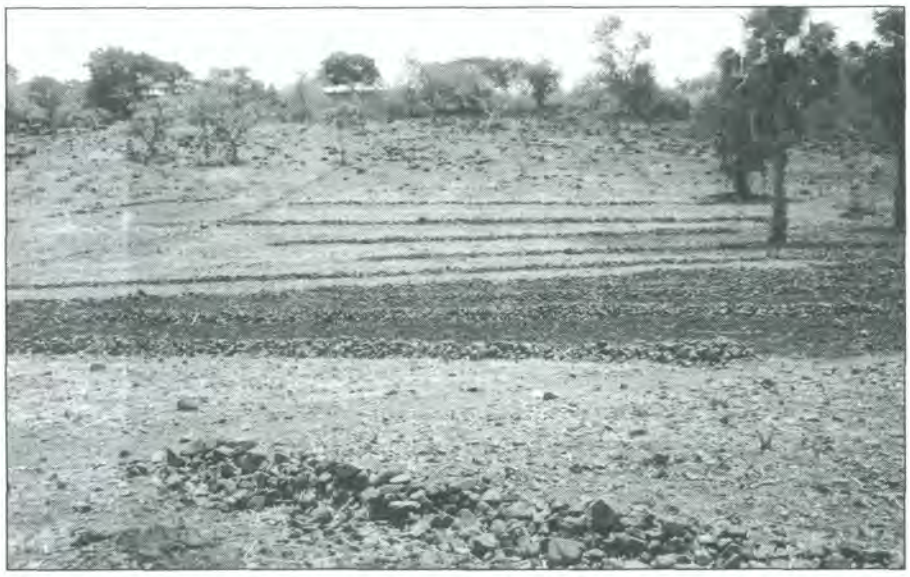


Photo 3. *Anti-erosion techniques are mastered in hilly landscapes of Bingo area.*

cases), but also to the opening to agriculture of lands hitherto deemed sterile and exposed to desertification (photos 1 and 2);

- Measures for the protection and restoration of soils and significant reduction of water erosion. Excessive deforestation and mismanagement of soils have exposed these to erosion, especially water erosion. Addition of compost to the soil to improve fertility cannot, therefore, have the expected benefits if it is not accompanied by measures aimed at preventing water from washing off the top layers of the soil and the organic fertilizers applied;
- In the framework of its support to training and to the popularization of composting techniques, CEAS also initiated the training of trainers in water and soil conservation and, more specifically, in the construction of bunds and stone cordons. This technique, now mastered by populations (both men and women), enabled the recovery of a wealth of degraded lands and the practice of strip cropping on hillsides (photos 3 and 4);
- Production of seedlings and reforestation activities so as to allow an artificial regeneration of the vegetation. These activities are easily noticeable in vegetable gardens, where (association of fruits and vegetables) is a clear option. Apart from vegetable gardens (photos 5 and 6), however, achievements are less remarkable;
- Significant improvement of agricultural yields has therefore been made possible by the application of organic fertilizers (compost, manure) and green manure (nitrogen-fixing plants also used in reforestation, such as *Acacia albida*).

Raising the level of participation through education and training

Five women are responsible for the establishment of PLY in 1975. Today, the association brings together 11,000 members (women and men), through 703 grass-root groups in 200 villages.

Composting activities started with a group of 25 women who received initial training. Today, thanks to the popularity of the training, there are more than 8,000 farmers who have mastered the technique of composting and the preparation of manure pits. Composting with organic matter is the only source of fertilizer used in communal and individual peanut and cereal fields, as well as in vegetable gardening.

In the framework of the other activities (socio-economic units, savings and credit, child and mother health) which support agriculture, the main activity, training and education (literacy and learning of basic French) are essential and enable populations to fully participate in the project. Furthermore, these have become conditions for being entrusted with management responsibilities.

Diversification of activities

Having started with initiatives aimed at improving agricultural productivity and food security, activities carried out by PLY are now much diversified with the main objective of removing constraints to a more active participation of women in the local development process. Activities have been initiated involving mother and child health (family planning, fight against malnutrition, etc.), primary

Photo 4. *A PLY member standing in front of her field in Pakoungou; note the stone anti- erosion bunds.*

Photo 5. *A fenced vegetable garden in Zoaga equipped with a compost pit; note 2 compost fits in the fore ground.*

health care and village pharmacies, etc. In general, however, the activities carried out are far more lucrative and are designed to support traditional subsistence ones. They include the conservation and processing of agricultural products, the production of shea butter, natural insecticide (from neem trees) and soap, weaving, the sale of drinks, the management of a filling station, etc.

All these activities may appear to have no connection with the agro-ecological activities of the project; members of PLY are nevertheless unanimous in recognizing that this diversification, this orientation towards financially profitable activities is indispensable and, after all, they do have complementarity with agriculture, the main activity. Two examples can be cited in this regard:

- Misola flour intended for children suffering from malnutrition is made from peanut, soy and millet cultivated in individual or community fields;
- Income drawn from the refreshment stall and the filling station also contribute to support agricultural activities. These economic units are also perceived as investments that could contribute to greater financial autonomy.

Sustainability of activities

This aspect was evaluated in relation to activities undertaken in the framework of the compost-utilizing (agro-ecological) project and, in general, to all the activities carried out by the association and which bear enough complementarity for the most part or generate income likely to supplant external funding in the long term.

Lessons learnt from this experience and which constitute indicators of sustainability are the following:

- Women's awareness of the role they have to play in the social and economic life of the region and their capacity to fulfil this role;
- Improvement in the living conditions of women and, in general, of all populations, thanks to the economic impact of certain activities carried out by the association. This is part and parcel of the struggle against poverty, an important factor contributing to the degradation of natural resources and to desertification;
- Literacy classes and training in management techniques, agricultural techniques (composting, manure pits, stone cordons, etc.), learning of basic French, etc. with a special focus on training of trainers for the replication and sustainability of actions. This training creates much more awareness and effective participation;
- Awareness of excessive dependence on external funding and a quest for financial autonomy in the medium to long term through the development of income-generating activities (economic units) such as the conservation and processing of agricultural products and vegetables, the management of the only filling station in Zabré, the refreshment stall, etc.;
- Education in savings and credit issues;
- Good interaction with the local administration;
- Further decentralization of decision-making centres within the association;
- Development of mechanisms for the management of social conflicts;

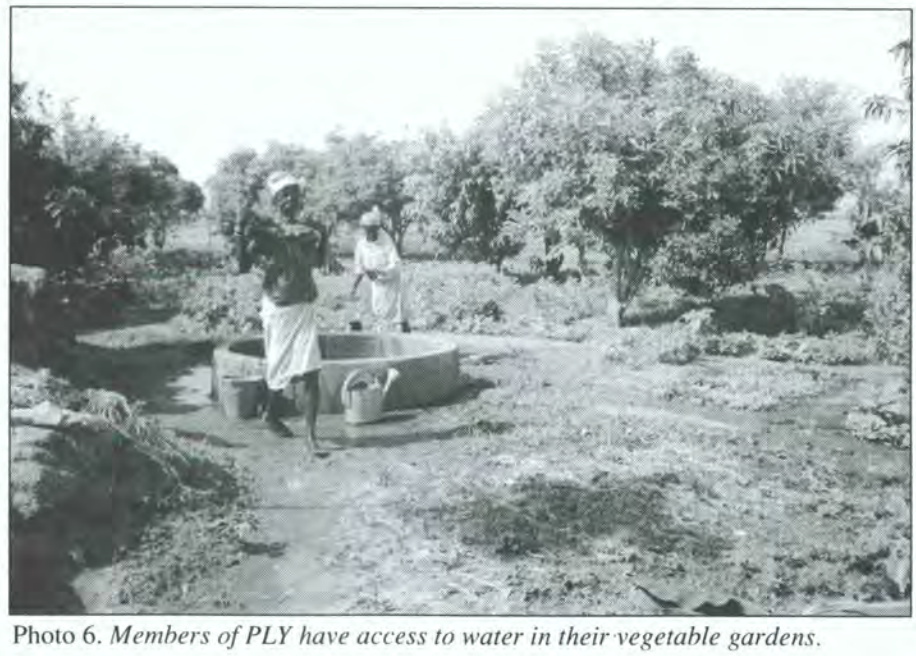


Photo 6. *Members of PLY have access to water in their vegetable gardens.*

- Development of mechanisms for the management.

Achievements of the agro-ecological project are judged excellent by many observers. The significant increase in yields and in the quality of production resulted, however, in the arrival of new actors, i. e. men and herdsmen who refuse to let women collect dung. Despite the income they could generate from the sale of dung, the price for a cart having increased from CFA 250 to CFA 500, they refuse to sell it, preferring to maintain their compost and manure pits and to spread the manure preferably in their own fields;

Replicability of activities

The rate at which membership to the association increased, bringing together as many as 11,000 active members in the agro- ecological project is solid evidence of the replicability of actions; the Savings and Credit Co-operative (COOPEC) launched in 1990 with 23 members, today boasts 390 members.

Agriculture remains the main land-use/income-earning activity, either in vegetable gardens or in individual and community cereal and peanut fields. The diversification of activities takes into account not only the complementarity between activities, but also their financial profitability;

- Replication has been made possible by the following:
- Use of simple techniques, methods and forms of organization;
- Training of trainers, basic literacy and post-literacy classes, learning of basic French;
- Utilization of locally available and inexpensive inputs;
- Sound organization and sense of responsibility;
- Invitation by PLY of non members to various activities, including training sessions;
- Exchange of experiences with organizations in other regions.

Social Capital

Before the establishment of PLY, interventions in rural areas were mainly under the responsibility of the Government, through decentralized technical structures (regional agro-pastoral promotion centres, regional department of the environment and forestry, etc .).

The launching of PLY's endeavours in 1975 triggered the setting up of many associations, all of which are striving for self-promotion in the rural areas.

The impact of the agro-ecological project as the first activity of PLY cannot be dissociated from that of the association itself, especially as regards the status of women. To better understand the qualitative changes that have occurred, it would be necessary perhaps to recall that 'the condition of rural women depends to a large extent on their status in their own society'. In the PLY zone of intervention, 'they have a status of wives, mothers and workers. They are encouraged to have as many children as possible' (PQD, September 1997).'Tedious and multiple domestic chores leave no time for women to participate in literacy, education and training activities intended for them' (PQD, op. cit.). In general, women have no say when it comes to making decisions concerning family life or to managing crop production from family fields, even though they have to bear the brunt of most expenses (education and child support, school fees, etc.).

The following conclusions emerge from the reports consulted, interviews with resource persons and field observations:

- Female members of the association are more open-minded than non members and they have a higher economic and educational standing. They are more confident, they can express themselves in public and they have therefore a more positive image of themselves. Today, in the zone of intervention of PLY, especially in Zabré, it is impossible to make important decisions without women's participation;
- The impact of PLY is remarkable at different levels, including food security (with the creation of cereal and vegetable banks) in a zone where there was a critical production gap, sometimes resulting in food shortages and malnutrition; literacy in national languages; agricultural equipment; the struggle against environmental degradation; the improvement of soils cultivated using newly popularized organic fertilizer production techniques, etc.
- With 11,000 members, PLY is today the most important women's organization in Burkina Faso; it is a powerful means of lobbying in the struggle for more equity and social justice;
- The elevation of women's aspirations also constitutes an important element determining their capacity to take up challenges; this is a major factor contributing to development;
- Lastly, thanks to PLY, many women have access to knowledge (literacy, practical training), which frees them from ignorance, poverty and men's domination.

In many respects, the experience of PLY has generated substantial direct or indirect benefits. Among the direct benefits, one notes:

- Actions undertaken in the framework of PLY activities that started with the agro-ecological project (awareness-raising, literacy, education and training) have allowed women in this region of Burkina Faso to have more power from political, financial and socio-cultural standpoints;
- Regular income for women who were busy previously only for part of the year with rainfed crops from which they drew little profit, because of the critical decline in soil fertility and a rainfall deficit. This income is generated through the sale of vegetable and cereal production (individual fields) which have notably improved with compost and manure pits (where they hardly obtained five millet bags from previously exhausted lands, they now obtain up to nine bags and a better quality of ears); (with the diversification of activities, income is also generated through the sale of beverages and gasoline by the Association);
- Savings made possible with this income give them access to small loans for the acquisition of agricultural equipment or for commercial operations; PLY has set up a modern and flexible enough

savings and credit system for which the membership fee is CFA 500, with an annual contribution of CFA 600. A membership share in the Savings and Credit Co-operative (COOPEC) is CFA 2, 500 and all members can obtain a loan up to CFA 50,000. Established in 1990 with 23 members, the cooperative today has 390 members and ready cash worth CFA 11 million;

- Jobs generated. Socio-economic units are generally managed by women (this is the case with the village pharmacy in Zabré); all the activities closely connected to agro- ecology, such as the processing and conservation of fruits and vegetables, the preparation of natural insecticide (from neem trees and tobacco) or of flour for children suffering from malnutrition (misola), are the responsibility of persons paid by the association. Literacy and training in management and basic French have become conditions for access to these jobs. One also notes the participation of female organizers in the agro-ecological project (12 such organizers recruited directly by the association). In addition, there are female trainers in literacy and in basic French, a secretary, a communication officer, a driver, a guard, nursery attendants and a coordinator in Ouagadougou with limited support personnel;
- Setting up of infrastructures. PLY has built a school for girls, the objective of which is not only to fill the gap in girls' schooling but also to propagate the basic tenet of PLY;
- Marked improvement in living conditions and of child and mother health;
- Improvement in the status of women and better understanding by men of the complementary role played by women and, consequently, better relationships within families;
- Better management of funds for the public school. Indeed, misappropriation of funds contributed by parents was previously the rule; since the establishment of the Savings and Credit Co-operative (COOPEC), the school has its own savings account.

Apart from the utilization of compost for the regeneration of lands and erosion control, the commitment of PLY women to natural resource and environmental protection is perceptible through reforestation programmes and the production of seedlings, the popularization of improved stoves to offset deforestation (the association uses solar ovens for the production of dried fruits and vegetables) as well as education and sensitization on environmental issues in the region in general, and within the association in particular.

Conclusions

The main objective of the Zabré women agro-ecological project was to enhance soil fertility so as to increase agricultural productivity and improve food security. In this process, needs assessment led to the organization of a number other activities with a view to diversifying and generating income likely to improve populations' conditions of living and, in particular, to securing future opportunities for financial autonomy.

These activities have not overshadowed imperatives of environmental preservation, which still have a proud place in the association's programmes, through intensified use of compost to abate land degradation, soil protection and restoration through anti-erosion control (construction of bunds and stone cordons), agro-forestry (production of seedlings and reforestation), environmental education. Although some achievements remain to be strengthened, especially those relating to the regeneration of vegetation and bush fire control, the project is nonetheless a real success in the struggle against land degradation and desertification through poverty alleviation and literacy.

Collective and Family Woodlands Project in Tiogo Forest Reserve, Burkina Faso

A Success Story in Desertification/Land Degradation Control*[1]

Racine Kane and Henri M. Lo**

*The project received UNEP's 1998 'Saving the Drylands' award**
*The authors were consultants hired by UNEP, with funds from IFAD, to evaluate the success of the project***

Introduction

Over the last two decades, Burkina Faso, like other Sahelian countries, as a result of drought and desertification experienced an accelerated degradation of its natural resources, especially forests. Faced with the threat of human population pressure on increasingly fragile resources, the Government of Burkina Faso and its development partners launched programmes to combat the degradation of ecosystems. The project was launched by the Office to Combat Desertification and Drought (UNSO) [formerly the United Nations Sudano-Sahelian Office], in 1984 and taken over in 1994 by the communities, the self-reliance phase, in the Sanguié and Bulkiemdé provinces, located in the central part of the country, on the Mossi plateau.

The objective of the project was to preserve natural resources, while ensuring access of populations organized in Forest Management Groupings (Groupements de Gestion Forestières (GGFs)) to reserved forests of the zone and the rational exploitation of wood, the main source of energy in Burkina Faso. The project covers four locations, including Tiogo forest reserve, the case-study being reported here.

In evaluating the self-reliance phase of the project, the evaluation team confirmed the effective involvement of village GGFs around the Tiogo reserved forest in the preservation of forest resources, under the supervision of regional forestry technical services. Indeed, measures for the preservation and development of natural resources have been carried on in a stable organizational framework and through management in partnership, which facilitate self-reliance of wood producers without threatening the natural resource base.

Location and physical background

The Tiogo reserved forest is located south-west of Ténado District, Province of the Sanguié, on the Kodougou-Dédougou axis, approximately 15 kilometres from Tenado and 40 km from Koudougou. Reserved by Decree No. 114 of 17 January 1940, it was established as a reserved area that covered initially approximately 46,000 hectares, now reduced to 30,000 ha. The co- ordinates of Tiogo reserved forest are approximately 2°39' and 2° 52'W, 12°11' and 12°24' N.

The vegetation of Tiogo forest reserve is characterized by two main physiognomic types:

- A predominant tree savannah occasionally alternating with a shrub savannah;
- A riparian layer consisting of *Pterocarpus santalinoides, M ytrangyna inermis, Vetivera nigritana, Sporobolus pyramidalis* and *Oryza longistaminata*, along the Mahoun River and its tributaries.

Also present are various groves of *Tamarindus indica, Capparis corymbosa and Cissus quadrangularis.*

Tiogo forest reserve has a Sudanian type of climate within average annual rainfall of 700-850 millimetres. The dry season is from November to April and the rainy season from May to October.

The self reliance phase and objectives

This phase corresponds to the withdrawal of the donor and to the management of the project by populations themselves within forest management groupings, with the support of national technical structures.

[1]*This article was reviewed and technically edited by Elizabeth Migongo Bake, Programme Officer, UNEP.*

Thus, the Tiogo forest reserve project was placed under the responsibility of the Office of the Forestry Commission for the Central West Region.

General long-term objective

The long-term objective of the project was to protect and regenerate the natural resources, especially forests, with a view to improving living conditions in rural areas through, among others, an increase in vegetal productivity.

Specific objectives

The first specific objective is to contribute to meeting the needs of populations in terms of fuelwood, building poles and in forest products in general, through better management and development of wood resources.

The second specific objective is to support the reconstitution of a favourable environment for agro-pastoral activities and thus the reconstitution of soil fertility and increased productivity, through the quest for farmers' self- promotion.

To achieve these objectives activities were carried out with populations organized in GGFs under the supervision of regional structures.

Evaluation findings

Natural resources

In Tiogo forest reserve, the self-reliance phase pursued the objectives of conservation and sustainable management of resources by carrying out activities for the protection and rehabilitation of the vegetation cover. These activities allowed the preservation of the forest ecosystem, especially important when the decline of rainfall throughout the Sahel over the last decade is taken into consideration.

Protection

The Government of Burkina Faso reaffirmed the status of reserved forests, in force since 1940, through the new Forest Code and the Land Reform Programme (RAF). This took place in an exceptionally political context, marked by the will to embark on the 'three struggles' with the communities, namely, against stray animals, bush fires and excessive logging in reserved forests. Once the post-project period was underway, populations in villages bordering the reserved forest took over the enforcement of regulations on pastoral activities in forests and the move against illegal grazing of domestic animals. Unlike other Sahelian regions, herdsmen and farmers arrived at a consensus, which made it possible to avoid the often violent conflicts. In Négarpoulou, Fulani herdsmen entered into an agreement that restricts the presence of animals in the forest to the daytime only, these having to imperatively return to the village at night. According to them, this arrangement is justified by the will to create conditions for a good regeneration of vegetal resources, even though they do not participate directly in the activities of the GGF, due to their adoption of a different way of life.

In the same village, populations are against clandestine cropping in the forest. This attitude is no doubt enhanced by the shortage of land for farming because the village is surrounded by the forest.

Activities have been carried out to set up fire-breaks and to apply early controlled fires. These measures are deemed necessary for a good protection of the reserved forest. Despite these efforts, bush fires are still to be entirely controlled.

Lastly, stone cordons or small anti-erosion dikes around fields in the main villages visited are among the most noticeable protection measures. These stone cordons are erected by the population, with the assistance of non-governmental organisations, such as Projet de Développement Intégré dans les Provinces du Bulkiemdé et du Sanguié (PDISAB). These were not introduced by the UNSO project; instead, they were adopted by the communities because of their great efficiency in erosion control.

Photo 1. ***Detarium microcarpum*** *offshoots three years after harvest in Tiogo forest reserve.*

Rehabilitation of the vegetation cover

Protection activities are concomitantly carried out with the rehabilitation of the trees. The involved communities continue to put into practice the lessons learnt during the UNSO phase, concerning the production of planting materials, direct planting of forest species seedlings and direct seeding. To this must be added a good mastery of harvesting techniques at the level of GGFs, thus enabling the production of offshoots and inducing good regeneration (photo 1). In the three villages visited, thousands of seedlings are produced in pots. These include species such as eucalyptus and some fruit varieties.

On the other hand, direct planting, which consists of placing the seedling in a hole in the shape of a half-moon and filled with manure, poses problems mainly because these areas are prone to drought and open to bush fires. This is compounded by the lack of mastery of planting techniques among the population. As a rule, results obtained through direct planting in the Tiogo reserved forest are low and call for a critical reassessment of techniques and an implementation of alternative methods

Sustainability

Sustainability was assessed through the above conservation measures and is expressed by the following indicators of success:

- Populations accept the status of the reserved forest and relevant restrictions. Sustainability is therefore linked to the fact that regular provisions exist and guarantee lasting relationships of complementarity between populations and forests;
- Wood resources are available in sufficient quantity to justify harvests. Farmers have mastered efficient and adoptable harvesting techniques, which contribute to the regeneration of forest resources. However, the completion and implementation of a management plan that would ensure more sustainability in the exploitation of resources re mains to be« done;
- A reorganization of the pastoral mode of exploitation has been adopted by herdsmen, i.e. the return of herds to the villages every night, to avoid uncontrolled wandering and grazing in forests at night. The concern to manage potential conflicts is taken into account.

Photo 2. *Harvested wood at a retailer's stand in Koudougou.*

In short, the evaluation mission noted an active involvement of populations in protection and rehabilitation activities. As a result of the self-reliance phase, recognition of the status of the reserved forest, with its constraints and restrictions, has been reaffirmed. The exploitation of wood (photo 2) and other resources is rational, in that it has been done according to generally well-mastered methods and techniques, without a negative impact on the forest resources.

The sustainability of this experience, however, could be jeopardized in the long term by the low level of control of bush fires, whose adverse effects ‹on the regeneration process are acknowledged by all those concerned. On the other hand, a better mastery of direct planting techniques would constitute a valuable advantage in reforestation.

Replicability

The management of natural resources has provided evidence of its usefulness in the three villages visited during the evaluation mission. Replicability of this experience is facilitated by the fact that costs are low and it can be transferred without difficulty through training. Furthermore, villagers have noted a clear difference between the period before and after this experience, which resulted in an improvement of their standard of living. Harvesting of wood resources constitutes a source of income as yet unknown. Similarly, women have seen the time devoted to fetching wood reduced with the adoption of improved stoves (photo 3). A return to the old days is excluded because 'once you taste something good, you just do not stop wanting it' (a quotation from a villager in Ténado).

This experience gained ground since two villages interested in Tiogo forest, Tielivele and Poa, joined the programme because populations were directly influenced by achievements in the village of Negarpoulou.

Social capital

The 'village woodlots' programme ushered in profound changes as to the interplay between populations and resources in the Tiogo reserved forest, through the impetus given by various actors concerned to put an end to the continuous degradation of the natural heritage while ensuring its rational

Photo 3. *Fuel-efficient stoves at Negarpoulou village*

exploitation. Among these actors, mention must be made of development partners whose financial and technical contribution in the first phase of the programme made it possible to create conditions for preservation: conservation activities, training and use of wood resources in a specific framework. The Government's role in the regulation and the organization of forest areas, as well as in the regulation of resource management, resulted, among others, in stabilizing the field of intervention, despite an apparent bias in favour of contractors, at the expense of foresters. These two categories of actors can be singled out from all the other beneficiaries (dolo brewers, retailers, rural and urban households) for their complementarity-conflict relationships which determine the availability of wood resources. One can thus speak, on the phase of self-reliance of the programme, of a stabilized management of forest resources, despite the constraints that need to be taken into account.

- Overall, the experience gained in the framework of this programme in the Tiogo reserved forest can be summarized through some features regarding social achievements which include:
- Changes in the perception and attitudes with respect to the forest: the communities are aware of the need to preserve forest resources which are viewed as having an economic value, in so far as they generate income. Apart from income generation, by-products of wood harvesting often have other uses, especially those related pharmaceutically;
- Capacity-building through training in new methods for harvesting, production of seedlings and reforestation, methods unknown before the launching of the programme but that are now frequently used by the communities after withdrawal of donor support. Besides these methods for the rehabilitation of the tree cover, linear erosion control, through the establishment of small anti-erosion dikes (stone cordons) has been implemented through new training sessions. The most significant aspect lies in the fact that these training sessions took place during the self-reliance phase, which suggests that there is awareness of an interplay in the various factors influencing the degradation of resources (linear erosion, degradation of the canopy, for example);
- Impact of improved stoves: it is clear that the introduction of improved stoves has had a positive impact on women's daily chores. The use of improved stoves reduces the consumption of fuelwood, hence a substantial saving of time spent by housewives fetching it. The time saved can be dedicated to other activities. The impact of improved stoves is also appreciated by contractors who speak of a 'falling-off of hassle,' that is, less pressure from clients. Similarly, dolo brewers view this situation as a means of substantially reducing their energy bill. On the other hand, manufacture of improved stoves is an employment-generating activity for both men and women;
- Capacity-building in organization and negotiation was brought to the forefront with the conflict around the price of wood. Reports on activities concerning the management site in Tiogo area point out a persistent claim of GGFs for an increase in the price of the cubic metre of wood set by the Government in 1985. To put an end to this claim, negotiations were initiated during the general assemblies of groupings and with central authorities at the national and regional levels. Unable to find a satisfactory solution, GGFs decided to stop selling wood to contractors in April 1998. In the light of this situation, central authorities requested direct negotiations between foresters and contractors. For lack of agreement on the price of the cubic metre at CFA 2,500 as demanded by foresters, the Government set the new price at CFA 2,200. Thus, it appears that the idea of pursuing and defending their own interests has taken root among foresters, even if their claims have been met in part only. This means that they are aware of their strength, which may contribute to changing relationships with the Government and contractors;
- Intra-community relationships have benefited from a better organization of forest areas and activities. The typical case is the reorganization of pastoral practices in the framework of an agreement between herdsmen and farmers. On the other hand, a sentiment of accountability *vis-à-vis* resources of the Tiogo reserved forest encourages the local communities to fight illegal exploitation and the destruction of the forest resources by

outsiders;
- Community investments facilitated by revolving funds (Fonds de roulement (FDR)) constitute assets resulting from endogenous financial efforts. Achievements are important. These include: rehabilitation of schools and earth roads, construction of inverts, village maternity centres, etc. These achievements give a tangible dimension to the efforts put in the management of forest resources by populations and encourage them to strive for proper management these.

Conclusions

The management of Tiogo reserved forest is an experience that reveals several positive points:

- Income is generated by populations through the sale of green wood and fuelwood, following a well-organized programme and a clearly defined allocation of resources;
- This situation is directly profitable to GGF members and indirectly to non-members who enjoy infrastructures financed with income accruing from forest resource management;
- Harvesting and sale of wood have generated jobs among the different categories of population and put a brake on rural exodus;
- The adoption of improved stoves by rural households, especially women, allows considerable savings in terms of energy and time;
- Foresters have learnt to negotiate with the Government and other partners to better defend their interests as a group;
- Harvesting methods are mastered an d they facilitate the regeneration of wood species;
- Villages have joined the programme because of its overall positive results.

Certain aspects likely to jeopardize the outstanding outcomes of this experience, such as the lack of a management plan that would enable better planning in the utilization of forest resources, and that would offset discouragement resulting in some villages from problems connected to the producer price policy have, however, been noted. Despite these considerations, the management programme of Tiogo reserved forest is considered as a success in desertification control.

News From UNEP

UNEP's Effort Towards the Implementation of the United Nations Convention to Combat Desertification 1997-1998

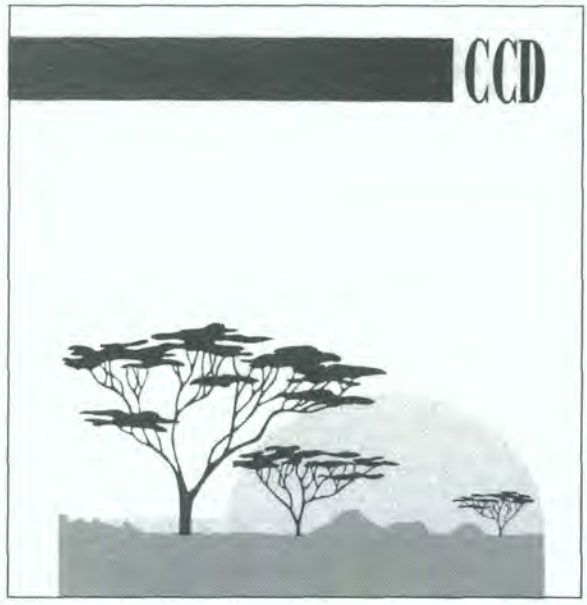
Summary

The present report, prepared in accordance with Governing Council decisions 19/17 of 7 February 1997 and SS/V/7 of 22 May 1998, covers assistance provided by the United Nations Environment Programme (UNEP) to countries affected by desertification and drought, especially those in Africa, in the context of the implementation of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa. Such assistance is seen as being provided through direct support of countries, regions and subregions, especially in the context of formulating and implementing action programmes. It is also detailed under support to project development and implementation through the Global Environment Facility (GEF) and in direct and indirect support to the Convention to Combat Desertification, especially through UNEP's work on behalf of the Committee on Science and Technology of the Convention.

Implementation of the United Nations Convention to Combat Desertification

Pursuant to Governing Council decisions 19/17 and SS V/7, UNEP has continued to support countries in the implementation of the Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa, but because of reduced allocations the programme of work could not be implemented as envisaged.

In terms of activities at national level, UNEP supported the implementation of the Convention in the countries members of the Commonwealth of Independent States (CIS), using resources from the Russian Fund, in line with the decisions of the Almaty and Tashkent conferences of 1995 and 1997, respectively. The US$ 4 million worth of contributions to UNEP from the former Union of Soviet Socialist Republics, held in the Russian Fund, were unfrozen in 1995 for use specifically on UNEP projects in the Russian Federation.



Following the development of the national action programme for the Kalmyk Republic in the Russian Federation, UNEP is now supporting the implementation of a project on the reclamation and management of the Black Lands and the stabilization of moving sands in Kalmykia. The completion of the national action programme for Kazakhstan in 1997 was followed by awareness- raising campaigns on the issue in 1998. The programme for Uzbekistan is still under preparation. UNEP also supported a training course in desertification control for 28 participants from CIS countries, held in Volgograd in the Russian Federation, in October 1997.

In a drive to promote the ratification of the Convention to Combat Desertification by the Russian Federation and to catalyse action, UNEP assisted with awareness-raising activities in the region, by supporting the locally produced newsletter on desertification. In addition, the Kalmyk sequences of a film made for UNEP by Television Trust for the Environment (TVE) and financed by the Government of Norway, have been repackaged into Russian. Accompanied by a booklet and posters, the film is being disseminated to schools throughout the steppe region. A film in Russian on the problem of shifting sands invading south-eastern Europe was completed and an English version has been produced to ensure wider circulation.

UNEP, with counterpart funds from the Government of Norway, is assisting in the awareness-raising component of

the national- action-programme formulation process in South Africa, as a pilot project for outreach in the southern African region. A strategy meeting in December 1997 resulted in an action programme of activities to be undertaken for the launch of the awareness- raising campaign in June 1998. The launch took place on 17 June in Pretoria at the end of the National Environmental Film Festival.

UNEP has been particularly involved in the regional and subregional action programme process, through participating in and supporting subregional meetings on the Convention. In 1997, such meetings were held in Burkina Faso, China, Cuba, Spain and the Syrian Arab Republic. In 1998, UNEP supported meetings for West Asia in Oman, for Asia and the Pacific in Japan and Thailand, and for Latin America and the Caribbean in Antigua, Barbuda and Brazil. UNEP offered to assist in coordinating the thematic programme networks which are to be established under the regional action programme for Asia and the Pacific. UNEP further offered to host a regional coordination unit within the UNEP Regional Office for Latin America and the Caribbean, and the associated memorandum of understanding between the Government of Mexico, the Secretariat of the Convention to Combat Desertification and UNEP was signed in July 1998.

Assistance was also provided for the development of subregional action programmes for the southern European (Dagestan, Kalmykia and Tatarstan republics, Astrakhan, Samara, Saratov and Volgograd regions) and Asian (the republics of Buriatia, Khakass and Tuva) parts of the Russian Federation.

As part of a special focus on Africa, UNEP promoted the development of subregional action programmes for the members of the Southern African Development Community (SADC) and the Inter- Governmental Authority on Development (IGAD), by supporting workshops to establish multidisciplinary scientific and technical consultative committees in Namibia in June, and in Nairobi in July, 1998. At the request of the Permanent Inter- State Committee on Drought Control in the Sahel (CILSS), UNEP supported a workshop on women and decision-making, held in Dakar.

UNEP also hosted and supported the Special Consultation of the African Ministerial Conference on the Environment on the United Nations Framework Convention on Climate Change and its Kyoto Protocol and Related Multilateral Environmental Agreements, held in Nairobi in October 1998, for which the UNEP Land Unit gave substantive inputs. In addition, UNEP supported a workshop on a network for the integration and management of international river, lake and hydrogeological basins in Africa, held in Abidjan in September 1998. The latter was one of the seven workshops called for in the context of the regional action programme to combat desertification for Africa by the Panafrican Conference on the Implementation of the United Nations Convention to Combat Desertification and Follow-up in Africa of the Results of the United Nations Conference on Environment and Development, held in Burkina Faso in March 1997. The report of the proceedings formed an input to the second session of the Conference of the Parties to the Convention. UNEP has expressed its willingness to host the network through the African Ministerial Conference on the Environment.

Cooperation continued with other United Nations organizations and leading science and technology institutions and non-governmental organizations, such as the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), the United Nations Development Programme (UNDP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations University (UNU), IUCN – The World Conservation Union – the members of the Consultative Group on International Agricultural Research (CGIAR), the Scientific Committee on Problems of the Environment (SCOPE) of the International Council of Scientific Unions (ICSU) and others, contributing to a better understanding of the factors leading to land degradation and assisting countries to take action to control desertification. In this context, case- studies on population dynamics in the drylands of central Asia and the affected areas of eastern Europe, and on land tenure and environmental degradation in the Asia and Pacific region were undertaken. Further, UNEP, in cooperation with the World Meteorological Organization (WMO), the International Centre for Agricultural Research in Dry Areas (ICARDA) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), organized an expert workshop for 19 participants entitled 'Wind erosion in Africa and West Asia: problems and control strategies', held in Cairo in April 1997. Jointly with the International Fund for Agricultural Development (IFAD), UNEP evaluated several potential success stories in desertification control, with 'Saving the Drylands' awards being presented to worthy projects at the twentieth-anniversary meeting of IFAD and at the second meeting of the Conference of the Parties to the Convention to Combat Desertification.

As a co-sponsor of CGIAR and partner of many of its centres, such as ICARDA, ICRISAT and the International Centre for Research in Agroforestry (ICRAF), UNEP actively contributed to many projects and programmes which add to the body of knowledge related to land degradation; one example being the Desert Margins Programme (DMP) in nine sub-Saharan African countries, another multi-focus, multidisciplinary project which is being prepared partially for GEF funding. DMP implementation was facilitated by ICRISAT which has established a coordination office in Sadore, Niger. UNEP serves as a member of the Steering Committee on behalf of United Nations organizations and agencies.

Preliminary discussions were held in June 1998 between the Executive Director of UNEP and the Chief Executive Officer of GEF on UNEP's role in land degradation projects and UNEP-UNDP collaboration. UNEP initiatives in land degradation, as it relates to the four other focal areas of GEF, focused on assessments, regional, subregional and transboundary projects; demonstration, pilot and experimental approaches; targeted research and methodological frameworks; capacity-building and technical assistance and environmental information and reporting.

UNEP has started to implement a

project largely financed by GEF and entitled 'People Land Management and Environmental Change' (PLEC), executed by the United Nations University (UNU), which is a multidisciplinary project on the conservation of agrodiversity in Africa, Asia and the Pacific, and South and Central America that was initiated in February 1998. Activities began in March 1998. A meeting of the Steering Committee (of which UNEP is a member) was held in Tokyo in July 1998, and the first meeting of the Advisory Group was held in Paris in September 1998. National and subnational activities under the project continued in all project clusters: East Africa, West Africa, Amazonia, China and Papua New Guinea.

Two other projects, on conserving biological diversity in the arid and semi-arid transboundary areas of Mauritania and Senegal and on managing indigenous vegetation to rehabilitate degraded rangelands in Botswana, Kenya and Mali, have both been developed by UNEP and UNDP and approved for GEF funding. Several others covering different countries of Africa are at earlier stages of development under GEF funding.

As an overall contribution to the implementation of the Convention to Combat Desertification, UNEP has provided assistance to enable government representatives and non- governmental organizations to attend Convention related meetings, and for government and non-governmental organization experts to participate in topical workshops and training courses related to desertification.

At the request of the Committee of Science and Technology of the Convention, during the first meeting of the Conference of the Parties to the Convention, and with funds provided by the Convention Secretariat, UNEP is leading a consortium to undertake a preliminary survey of organizations able to form part of a global network to support implementation of the Convention. UNEP also contributed to the consultative process on benchmarks and indicators of desertification held in Geneva in September 1998.

In line with the request for greater awareness-raising contained in the Convention, UNEP also produced and disseminated targeted information on desertification control to a broad range of media and public at both national and global levels. Four issues of the Desertification Control Bulletin (Nos. 30, 31, 32 and 33) were produced, and new publications included National Land Degradation Assessment and Mapping in Kenya and Wind Erosion in Africa and West Asia: Problems and Control Strategies. The second edition of the World Atlas of Desertification was published in 1997. It summarizes the latest scientific knowledge on the drylands of the globe and was launched at the first meeting of the Conference of the Parties to the Convention. Several films have also been developed to raise global awareness of the drylands in accordance with the articles of the Convention. One film, on migration and social problems and set in Ethiopia, was completed in November 1997. Another film for the World Service of the British Broadcasting Cooperation (BBC), on desertification as the legacy of past politics, featured Kalmykia and South Africa, while several short features were compiled for youth audiences, more information dissemination.

In the context of the second session of the Conference of the Parties to the Convention to Combat Desertification, UNEP organized a workshop for 15 participants from non-governmental organizations, on synergies and the role of civil society and non-governmental organizations in the implementation of the Convention, which was held in Nairobi from 4 to 6 November 1998. The results of this workshop, stressing the need for better coordination between various environmental conventions, formed an input to the Conference of the Parties, and especially to the forum organized by IUCN on linking the biodiversity and desertification agendas, which was supported by UNEP and held in Dakar from 4 to 6 December 1998, in conjunction with the meeting of the Conference of the Parties.

UNEP and UNDP Join Forces in the GEF Land Degradation Cross-Cutting Area

The Executive Director of the United Nations Environment Programme (UNEP), Dr. Klaus Topfer and the Administrator of the United Nations Development Programme (UNDP), Mr. Gustave Speth have signed in New York an agreement between their two agencies to collaborate in land degradation activities as they relate to biodiversity, climate change and international waters in the context of the Global Environment Facility (GEF). The memorandum of understanding is the result of joint initiatives to respond to the recommendation of the GEF Council's call for the implementing agencies and the GEF Secretariat 'to take appropriate steps, consistent with the GEF guidelines and in full consultation with interested recipient countries, to identify, prepare and implement GEF-financed land degradation activities as they relate to biodiversity, climate change and international waters'.

The memorandum of understanding builds upon a long and successful collaboration between UNEP and UNDP in the area of desertification. These include: UNEP/UNDP Joint Venture Mechanism through the Office to Combat Desertification and Drought (UNSO) for the implementation of the Nairobi Plan of Action to Combat Desertification, adopted by the United Nations Conference on Desertification held in 1977; the Joint Statement on UNEP and UNDP partnership for collaboration in the implementation of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa, signed by the heads of the two organizations on 26 April 1995, and the Framework Agreement for Cooperation in Capacity- building between UNEP and UNDP of 28 November 1995.

According to the memorandum of understanding UNEP will focus on the following issues:

- Strategic scientific and technical analyses, such as assessment, monitoring and remote sensing, methodology development and testing, and programme leadership;
- Implementing inter-country protocols, environmental agreements and regional conventions;
- Development of policy, legal and institutional responses which more fully integrate land degradation with biodiversity/climate change/ international waters activities;
- Development and management of global, regional and/or transboundary activities which advance cooperation, increase technical and scientific knowledge and information exchange, and associated catalytic support.

This agreement establishes an institutional framework for upstream consultation through bi-annual reviews of the pipeline of the two agencies. It is expected that the adoption of the memorandum of understanding will foster the promotion of a meaningful pipeline in the GEF cross-cutting area of land degradation, in particular in Africa.

It must be noted that this is the first time that such a contractual agreement has been signed in the context of GEF with a view to strengthening the GEF inter-agency collaboration and partnership.

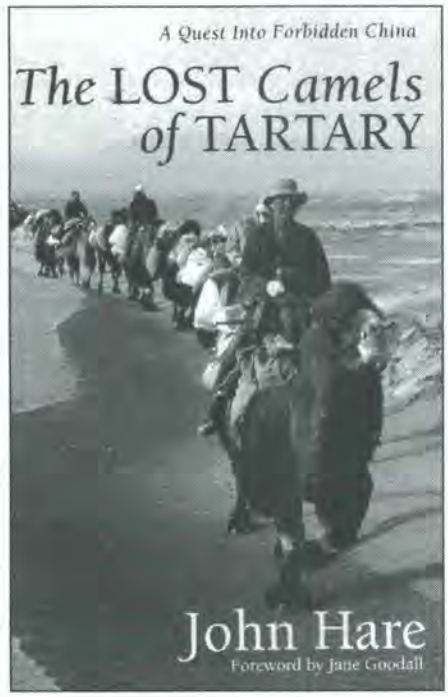
For more information, please contact:
UNEP/GEF Coordination Office
P.O. Box 30552
Tel: (254) 2-624166
Fax: (254) 2-624041
Nairobi, Kenya

Book Review

The Lost Camels of Tartary

A quest into forbidden China

by John Hare



As a child I loved to read books about eighteenth-century explorers. How courageous they were: trekking off into the absolute unknown where, inevitably, they were beset by all manner of dangers – hostile tribes, disloyal partners, wild animals and sickness. But when they returned, what amazing tales they had to tell. I felt sad that those days had gone – but, 50 years later, I met a modern version of those old adventurers: John Hare. Accompanied by a small team of Chinese colleagues, John set out to explore one of the most hostile and desolate regions on earth, the Gashun Gobi desert in the Xinjiang Province of China, where there is no fresh water at all in an area three-quarters the size of Germany. This is the home of the mysterious, shy and fast-vanishing wild Bactrian camels.

This is a book rich in adventure, filled with fascinating historical facts and legends, shrewd observations about the people encountered and their way of life, and vivid descriptions of landscapes as alien to most of us as the surface of the moon. Each expedition brought its share of excitement, hardship and danger; indeed, the adventures of John Hare and his companions were every bit as amazing as those I had read about with such awe as a child.

John's expeditions were not financed by some wealthy society; he struggled for funding, and for permission from the Chinese, on his own. He was successful partly because of his ability to establish such an excellent relationship with the Chinese. He gained high-level support and became the first foreigner to receive permission to enter that portion of the Gashun Gobi which had been closed for nuclear testing in the early 1950s. John became involved with the plight of the Bactrian camels because of his love for adventure, not because he was passionate about camels. But as the team learned more and more about these magnificent beasts, with their aloof faces and twin humps, he became increasingly concerned about their survival. The wild Bactrian is one of the most endangered species in the world – more so than the giant panda. There are, of course, many domestic Bactrians, but new research indicates that they are genetically different from their wild forebears. There are no more than 1,200 wild Bactrian camels in the world today; probably less than 800. Of these, 650 are to be found in China, divided into three separate groups each of which is severely threatened by hunting, mining, and despoiling of their habitat. Water is continually scarce. To save these camels is a race against time.

John Hare's expeditions furnished compelling evidence of the need for swift action if the camels were to be protected. So well was this evidence presented, and so compelling the arguments, that the Chinese Government has agreed in writing to create the Lop Nur Nature Sanctuary. This huge refuge for the wild Bactrians will cover 107,768 square kilometres in remote north-west China. It will protect a unique and quite unspoilt desert ecosystem, with its diversity of life-forms, as well as saving the wild Bactrian camels living there. And this decision comes only just in time, because since the suspension of nuclear tests the area is under increasing threat from hunters and miners. The Government will maintain the sanctuary for a minimum of ten years; John must find the money for the infrastructure.

And so this sanctuary will exist because of one dedicated and utterly determined individual. How wonderful to know that people like John Hare still exist in the materialistic and greedy western world. The Bactrian camels and their desert environment are fortunate in their champion. And I feel honoured to know John, and that he asked me to write an introduction to his book. When you have read it, you will understand why I feel this way. I hope you will recommend it to friends, too, not only because raising awareness will help John help the camels, but because it reaffirms one's faith in human nature, and the fact that, with imagination, courage, diplomacy, dogged tenacity, self-confidence – and a wonderful sense of humour – it is still possible to accomplish the impossible.

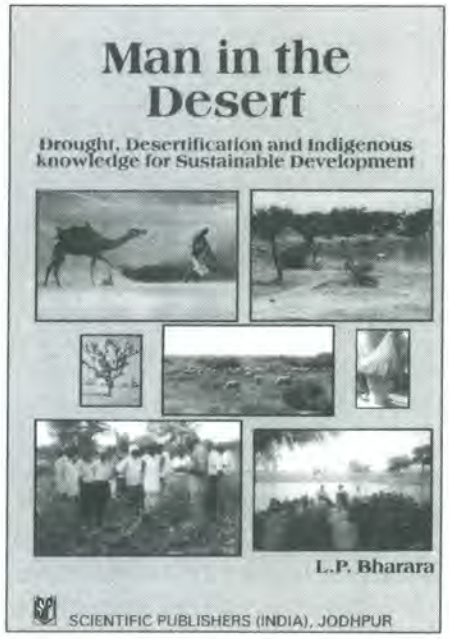
Jane Goodall

Man in the Desert

Drought, Desertification and Indigenous Knowledge for Sustainable Development

by L.P. Bharara

Recently, world concern has been expressed over the social aspects of the problem of drought and desertification in the desert ecosystem. Though the desert environment is harsh and rainfall is unreliable, rural people based on traditional knowledge have been living in balance with the natural environment for ages. The people depend on an agro-pastoral economy which operates in the



context of great uncertainty about rainfall and subsistence. They have evolved traditional knowledge, skills and practices for dryland agriculture, soil, water and vegetation conservation, livestock rearing and management. The techniques of natural resource conservation, the role of physio-cultural institutions and biotechnological capacities to sustain a variety of life forms, form the basis of their sustenance living.

But enormous increases in human and animal populations have disturbed the fragile ecosystem. Overgrazed lands, shrinking forests, eroded agricultural fields and overcultivation, deforestation and cutting of vegetation show the imprints of man''s activities on his environment. The way of life of the people and their sources of livelihood have chiefly been conditioned by disturbances in ecological balance due to the severity of the arid climate, which has led to the degradation of vegetation and the diminution of crop potential through decreasing productivity per unit area. This poses a potential threat to the resources and, ultimatel the lives and livelihood of the inhabitants. Thus, to protect these resources from conversion to a desert-like situation to desertification, there is a need to study indigenous technical knowledge for sustained production and conservation of resources. An appropriate mix of new technologies and traditional wisdom is extremely important.

This book synthesizes the problem of drought and desertification from a social angle and encompasses indigenous technical knowledge for sustained production and survival. Applying a socio-ecological approach, the author shows how different socio- economic and caste groups adopt different adaptive strategies for survival. The book focuses on new dimensions of the problem of drought and desertification and the use of indigenous technical knowledge to overcome them.

Reclamation and Management of Eroded Soils Proceedings of UNEP/CIP/VNIALMI International Training Course, 15 September 5 October 1997

Edited by Pavlovsky Ye. S. Volgograd. VNIALMI, 1998 -380p

The collection contains materials of the UNEP/CIP/VNIALMI international training course. There are theoretical problems of soil erosion and deflation, evolution, classification and monitoring of eroded lands, projecting and fulfilling the systems of anti-erosion and anti-deflation measures, medical- social and legal aspects of soil degradation consequences, items of using foreign experience and organizing international collaboration on the struggle against erosion and deflation.

The collection is intended for scientists and nature conservation and environment monitoring, agriculture and forestry, agroforestry and erosion specialists, university and college teachers and students.

The use of the materials is permitted if a source reference is given.

Available from:

The Centre for International Projects (CIP)
P O Box 165, CIP 117292,
Moscow, Russia
Tel: (095) 165 0562/165 0890
Fax: (095) 165 0890
E-mail: cip@mepnt.msk.ru

News of Interest

Request for Articles and Photographs

The editorial board of the *Desertification Control Bulletin* is always looking for photographs and articles for publication in the magazine. In particular, the editorial board is interested in receiving articles which describe success stories in controlling dryland degradation and desertification, follow-up to the implementation of the United Nations Convention to Combat Desertification and also NGO activities in the field of desertification control in all regions of the world, particularly in Africa.

The technical advisor also seeks photographic submissions for use on the cover of the *Bulletin*. Photographs should be colour transparencies of subjects related to desertification, land degradation, humans, animals, structures affected by desertification, reclamation of degraded lands, etc.. Please include a brief caption giving a description of the subject, place and country name, date of photograph and name of the photographer.

All contributions should be sent to:
Mr. Leonid Kroumkatchev
Technical Advisor
Desertification Control Bulletin
UNEP, Land
PO Box 30552
Nairobi, Kenya
Tel: 254-2-623266
E-mail:
Leonid.Kroumkatchev@unep.org.

For information regarding manuscript preparation, please see page ii of this issue of the *Bulletin*.

Submitting Success Stories to UNEP

UNEP is seeking projects or community-based activities that satisfy the preceding criteria or indicators of success as much as possible and which have been sustaining themselves without donor support for at least two years.

To submit a project or community-based activity for the 'Saving the Drylands' award please send a 1 to 2 page summary of the project or activity you are proposing with the following information in the given order: 1. Name of Project; 2. Country; 3. Location in country including biophysical descriptions; 4. Number of people involved; 5. Area (sq km) covered by the project; 6. Cost of project (US $ equivalent); 7. Source of funds; 8. Project period (years); 9. Problems; 10. Solutions; 12. Results/ Impact; 12. Why the project is a success; 13. Names and addresses of three referees outside the project; 14. Contact person.

The contact

For more information on success stories or request for reports please contact:
The Coordinator,
Success Stories Initiative,
Social Dimensions & Sustainable Practices,
Land
United Nations Environment Programme (UNEP)
P O Box 30552,
Nairobi, Kenya
Tel: (254-2) 623261; Fax: (254-2) 623284;
E-mail: elizabeth.migongo-bake@unep.org

Agroenviron -98 Statement

The international symposium on Agroenvironmental Issues and Future Strategies: Towards 21st Century, held at the University of Agriculture, Faisalabad, Pakistan between 25 and 30 May 1998 with 350 participants from all over the world, having considered the importance and urgency of addressing agroenvironmental issues (agro-chemicals, acid rains, soil erosion, deforestation, sewage water use implications, environmental legislation, farm waste management and recycling) urges international organizations, governmental organizations, non-governmental authorities, farmers' groups and citizens to adopt the guidelines, measures and recommendations set out below:

General recommendations

1. Establishment of the International Agroenvironment Foundation (IAF) was conceived as a catalytic agent for explicit handling of environmental issues generated by present day agriculture. Structure, operation and promotion of the foundation would be developed by a group of scientists from the international community.
2. In view of the serious dimensions of agroenvironmental issues, public motivation necessitates celebrating 25 May every year as the international 'Ageoenviron Day'.
3. International symposia on agroenviron issues be held at appropriate venues and intervals to pool and share internationally available information and knowledge.
4. Centres of Excellence in Agroenvironmental Studies (CEAES) be established at appropriate places all over the world in order to investigate and delineate environmental issues in agriculture.
5. All countries should develop a National Agroenviron Policy (NAEP) to streamline the management of agricultural systems for sustainable environment, especially in developing countries.

Specific recommendations

1. Waste disposal with resource recovery offers a valuable approach to waste management. Soil waste can be utilized in food and feed industries and also for energy generation.
2. Increasing nitrate-nitrogen concentrations in shallow groundwater of irrigated areas with intensive agriculture indicate a potential danger, especially when the water is pumped for human consumption. Regular programmes be developed for monitoring groundwater qualities in the intensively cultivated areas. Nature farming and chemical free agriculture be promoted at all levels through farmers' organizations.
3. Since considerable quantities of sewage and/or industrial waste waters are used for crop irrigation, minimum standards for bacterial, viral pathogens, suspended loads be followed, especially in the developing world. Nevertheless, treatment of waste water at source is strongly recommended.
4. Rural Community Health Centres at town level be staffed with an environmental specialist to create awareness as to agroenvironmental control programmes.
5. Partnerships between agricultural services institutions and producers' organizations should be established for sustainable agriculture. Incentives like rebates in land revenues or taxes be introduced for adopting sustainable technologies.
6. Indiscriminate use of pesticidal sprays on vegetables, especially before marketing, present a great health hazard. Strict legislation and control is urged.
7. System of Environmental Impact Assessment (EIA) for all agro-projects, similar to industrial ones, should be strictly followed for the sustainability of the system.

Copies of the proceedings are available at a reduced rate. For further information and copies of the proceeding contact:

Dr Jehangir Khan Sial (Symposium Director) or
Engr Sajid Mahmood (Symposium Secretary)
Department of Structures & Environmental Engineering,
University of Agriculture, Faisalabad, Pakistan. Fax: 0092-41-647846.

Pollution can be controlled, says Pakistan scholar

"The pollution imp can be bottled", Khwaja Shamsuddin Azeem said during a special lecture held at the University of Agriculture, Faisalabad, Pakistan, on World Environment Day 1998. Since environmental pollution is a result of the misdoings of man, so man himself has to curb this menace. This was stated by renowned spiritual scholar Al-Sheikh Khwaja Shamsuddin Azeemi. He was addressing a large crowd of students and teachers in Old Senate Hall on World Environmental Day as a guest speaker.

Angels predicted that man would create trouble on the earth. "Pollution is a form of creating trouble," he said. Major manifestations of this deterioration are greed, selfishness and lack of understanding on the part of man. And, man being a cardinal child of nature blessed with knowledge, has the power to eliminate pollution of every kind.

When one resolves to do something, he succeeds. "We have to do something practical to resolve this problem, mere words won't take us anywhere". he opined. After describing various forms of environmental pollution, he explained the importance of plantations, which on one hand are oxygen-producing factories and on the other consume poisonous gases and maintain the CO_2 balance. Students should form committees to ensure plantations of trees. One tree per person would reduce the problem by up to 75 per cent. Moreover, they should ensure personal hygiene besides keeping the environment clean, he suggested.

Sheikh Muhammad Akram, Registrar of the University of Agriculture, after expressing his gratitude for the kind words of advice said that it was an honoured privilege for the University to have had such a thought-provoking lecture which should go a long way in concentrating the faculties of the students and enlightening their souls. Dr Jehangir Khan Sial, Chairman, Department of Environmental Engineering, in his welcome address emphasized the need for informal education of students on environmental issues in the light of Quran, Sunnah- and Spiritual Sciences.

For more information about the special lecture contact:

Dr. Sajid M. Azeemi, Lecturer,
Department of Structures &
Environmental Engineering, University of Agriculture Faisalabad, Pakistan.

About the Guest Speaker: Khwaja Shams-ud-din Azeem the Chief Editor of the monthly *Roohani Digest,* is a Pakistani scholar of international eminence and has authored a number of books besides many pamphlets and articles covering almost every aspect of metaphysical sciences. His appearance in a number of international TV channels in USA, participation in various BBC programmes, private radio channels in England and special lectures at universities in European countries, Japan and the United Arab Emirates, to answer questions and queries about the most complicated and enigmatic phenomena of nature, is his incredible success in promoting the art of spiritual thought in a scientific manner to others without any distinction of caste, creed or colour.

Culture and the Environment: The Case of Cameroon

Rose Ateng Mbah

General Coordinator of Rural Women Environmental Protection Association (RWEPA)
B.P. 2186 Sonac Street,
Bamenda NWP Cameroun

Introduction

The aim of this article is to identify and review various cultural practices and beliefs, and their corresponding effects and linkages to environmental management in general, and the conservation of forest and vegetation cover in particular, in parts of Cameroon. The challenge involved in blending indigenous practices with formalized science and conservation of forest and vegetation is very formidable.

In Cameroon, more than 60 per cent of its approximately 14 million people depend directly or indirectly on natural resources for survival. In this part of the world, conservation of forest, vegetation cover and natural resources is influenced by anthropogenic factors, such as the livestock stocking rate and the intensity of resource use by humans. Land-use planners need to consider the impact of land-use policies on the environment at the alpha, beta, and gamma levels. At the alpha level, within communities, species richness is influenced by the intensity of disturbance in relation to land use. At the beta level, turnovers in plant and animal communities across boundaries are influenced by differences in land use. At the gamma level, regional biodiversity is related to the mosaic of land-use types in an area. In this article, emphasis is laid on what happens at the alpha level in Cameroon by using a few examples to

show the link between cultural beliefs and practices and conservation of the environment.

This relationship between culture and conservation has, in some instances, negative impacts and, in others, positive effects.

Cultural beliefs and practices that have a negative impact on the environment

Reliance on certain plant species

A general reliance on some plant species by the population, because of the belief that they have a medicinal value, can have a positive impact on the environment. In the coastal zone of Cameroon, and even in parts of south-eastern Nigeria and neighbouring Gabon, there is an edible weed called 'eru', scientifically known as *Ginetum afticanum*.. In the East, South, and Centre Provinces of Cameroon, it is called 'okok'. The 'eru' dish delights palates in many Cameroonian households today because it is said to contain a very high nutritive and even medicinal value.

The plant's natural environment is the wild, damp and dark undergrowth of the rain forest found in the southern part of Cameroon. The liana does not grow, nor can it be cultivated, other than in the natural tropical rain forest. It extends for 15 metres and more into the tree canopy. Once the forest is cut down, for instance to open up a farm, the vine shoots up again but dies shortly after. The demand for 'eru' for local consumption among all Cameroonians and some of their neighbouring Nigerian and Gabon tribes has become extremely high. As a consequence, it has become a powerful economic weapon for the indigenous people of these zones. Because of this, there has been massive destruction and unsuitable harvesting of the 'eru' liana to sell. It is even exported to Europe and the United States of America, where descendants of these tribes reside, since they believe in it as a staple food. It is obvious that these people have to open up and try to adopt other foodstuffs as their staple food, otherwise with the massive exploitation of timber from the tropical rain forest without reafforestation, the massive demand for 'eru' might lead to the extinction of this very highly nutritive plant species.

Bush burning

In some parts of Cameroon, notably in the North-West and Western Provinces, bush burning is still considered to be the best method to prepare a piece of farmland for cultivation. This leads directly to the destruction of vegetation cover and of micro-organisms in the soil, leaving the landscape bare, leading to soil erosion and land degradation (physical component of the environment). Soil fertility is greatly reduced since the organic manure that would have added fertility (through decomposition of the grasses and other plants) is no longer available once the vegetation has been burned off. Sometimes, the village women construct their ridges and burn them to produce 'Ankara'. This they do in the belief that the fertility of the farmland would be improved, in complete ignorance of how much damage they are causing to the piece of land. This particular practice is like a cancer that has already developed right into a person's bone marrow and the chances of clearing it all out are seemingly very slim. It is really an uphill task for those of us who happen to be aware of the after-effects and whose duty, it would seem, is to preach against this habit or belief. A reasonable number of them have begun to realize the reality of our gospel because, after the first year of farming, the crop yield is generally very poor because of leaching of the soils.

Gender-biased belief

This is the belief that women should not own landed property. This gender-biased tradition leads to a negative consequence on women, who happen to have been the main users of the land. It prevents them from carrying out any long-term investment or commitment to the welfare of the land, because the male landlords always turn them off their land when they realize that the crop yield is encouraging.

Belief about trees on farms

In some remote areas in the Adamawa Province of Cameroon there is a belief that trees on the farm attract animals, like monkeys, to the farm. This belief or wrong conception is also shared by farmers who live in the forest zone. According to them, trees and forest cover provide a habitat for wild animals that would destroy their farm crops. They then make sure that all the trees on the farmland are either burnt or cut down before they can cultivate the land, thus destroying the environment. This may account partly for the lack of trees and vegetation cover in most parts of the Northern Provinces of Cameroon. All this is because they are unaware of how long it takes for trees to mature, and also because it has been their cultural belief over the years.

Traditional hunting habits

There is a traditional hunting habit in some areas of Cameroon in which a target area during the dry season is encircled and the vegetation cover burnt. This practice destroys the vegetation cover and the beauty of the area. Thus, the area which served as habitat for other living species of organisms is also destroyed, with most of them killed in the process. The soil remains bare and subject to physical degradation.

The Moghamo area (from where the writer comes) in Batibo, North-West Province of Cameroon, has a total surface area of about 873 square kilometres with a population of about 67,000 people. Traditional rulers (chiefs) in this area attach great importance to elephant tusks. It is what distinguishes the 'Fon' (chief) from any other person in their community. There is also the leopard skin which is used as the Fons' carpets, on which they are supposed to sit in their palaces. The demand for these parts of the elephant and the leopard is so high that these two species of animals are almost becoming extinct in this area.

Cultural practices with a positive impact on the environment

The practice of creating and keeping sacred areas

Almost every village and every clan in Cameroon consider the particular area where their ancestors first settled to be a sacred area. Every year certain traditional rituals are performed in these areas. An example is the Tadkon area in the Moghamo clan, regarded by all Moghamo men as the home of their ancestors. It is also believed that every son or daughter of Moghamo dies and goes to live in Tadkon, in any form (life after death is a real belief in this area). Because of the belief in the area's sacred nature all the components have always been well protected from time immemorial. In these sacred areas no burning, no farming, no hunting, not even fetching of fuelwood takes place. There are no guards but all members of the society are acutely aware of this traditional belief and individually and collectively act as guards to the sacred area. At the beginning of every farming season, the Fon of each village, in collaboration with other notables, performs traditional rituals, believing that the ancestors of their village would help increase the crop yield for that farming season.

The general belief is that if this is not done, crop yield would be very low leading to starvation. The salient result of this cultural belief is that these sacred areas, including their natural resources and the various species of living things found there, are well protected. It is a practice worth encouraging.

The belief in non-consumption or killing of some animal species

In the Babungo Area of the North-West Province there is a cultural belief that some animals and certain organisms of their society are of the utmost significance to their clan. When a pregnant woman sees the two-headed earthworm it is a sign of twins and as such it is never killed. To see the greenish frog on a leaf, when harvesting vegetables behind the house in the morning, is a sign of fertility for the woman or young girl in the future. The green fat caterpillar often found on the kola nut tree is also a sign of fertility. When it drops in front of elderly women, they pick it up with a leaf and take it home to a childless couple to put under their matrimonial bed. The belief is that it would draw children to the couple. In the end most of the species of organisms of these environments are protected and conserved because of the cultural importance attached to their existence.

The 'Queen of the Night' plant produces a nice and refreshing scent at night.

Cameroonians believe that the scent from this plant helps to send away devils or evil spirits from their homes. Consequently this plant species is well propagated everywhere and well cared for; the plant is protected and sustained

Traditionally, the rural woman believes that after cultivating a piece of farmland for three or four years, it should be allowed to fallow. This is very important because, during this period, the vegetation cover and the fertility of the land is re-established.

Mixed farming method

In the rural areas, indigenous farmers practise mixed farming where a variety of crops are planted on the same piece of farmland during each planting season. In this way, and without any conscious effort by the farmers, leguminous plants (like groundnuts) help to increase the nitrogen content of the soil through the nitrogen found in their root nodules. This nitrogen helps improve the fertility of the soil.

Planting of medicinal plants by traditional healers

This is a very common practice and needs to be expanded because many plant species have a medicinal value. By creating awareness among even non-traditional practitioners of each community, trees which are of the utmost importance to our environment would equally be propagated. Apart from their medicinal value, trees generally provide water to the environment which is equally indispensable to human life and serve as homes for other living organisms (completing the ecosystem). This protects the soil surface from the effects of desertification, etc.

Agroforestry practice

In the villages of the grasslands of Cameroon the people plant fruit trees on their farmlands. The trees help to draw the water-table nearer to the surface for the plant roots to absorb easily. Some of the trees planted help to increase the fertility of the farmland. The traditional practice is that these trees are never destroyed whether they are fruit-bearing or not. In Cameroon, trees play an important role from a social and cultural point of view. They provide food for people and animals. For example, the mango trees, in addition to providing fruit, also provide essential soil fertility, protection of soils from erosion, and also moderate climate, etc. The disappearance of trees threatens the stability of both rural and urban societies. In this light, efforts are made in favour of reafforestation and the prevention of deforestation. The Cameroonian community has realized that there can be no development without lasting reafforestation. As a consequence of this realization, the Rural Women Environmental Protection Association (RWEPA), a non-governmental organization for which the writer is the general coordinator, lays emphasis on activities that would enhance sustainable development and encourage the protection of the environment in general.

Conclusion

In all, cultural practices and beliefs have always been thought of as having only negative impacts on the environment. The above, however, illustrates that these beliefs and practices can have both positive and negative effects. It is possible that the relationship between these cultural practices, beliefs and the management of the environment can be expressed as a function whose variables would be: A=People; B=Nature of their Activities and C=Cultural beliefs and practices. If $f(x) = f(A+f(B)+ f(C)$, where $f(x)$ is the

relationship between cultural practices, beliefs, and the management of the environment.

Recommendations

1. Cultural beliefs and practices should be supported and protected since they would give more meaning to the management of the environment;
2. It will be useful that organisations working at the grass roots carry out research and document in detail cultural beliefs and practices which relate to the environment. This well-researched and documented information could reveal the importance of understanding cultural diversity as a way of trying to set up the link between it and the protection of the environment.

International Conference on Desertification and Soil Degradation Moscow, Russian Federation, 11-15 November 1999

Russian Academy of Sciences
Moscow Lomonosov State University
Russian Academy of Agricultural Sciences

First Announcement

Topics of the Conference

1. Desertification assessment methodology and concepts;
2. Definition, criteria and indicators;
3. Desertification mapping;
4. Desertification control, monitoring and prognosis;
5. Soils and lands restoration and reforestation;
6. Social and economic problems of desertification and land degradation;
7. Desertification and sustainable development;
8. Russian experience in desertification assessment and combating.

General structure and schedule of the Conference

11 Nov	Arrival at Moscow, welcome and registration.
12 Nov	Opening session. Plenary lectures.
13-14 Nov	Round tables, seminars, discussions.
15 Nov	Departure.

Conference languages

The languages for the conference will be English and Russian.

Proceedings of the Conference

Each participant will be provided with the proceedings of the Conference, comprising:

- a printed volume of texts of the plenary lectures and summaries of posters;
- a detailed programme of the conference;
- list of participants with contact addresses.

The Organizing Committee also plans to publish all conference materials on: http:/www.soilinst.msu.ru

This http address will also be used for new information of the conference after 1 May 1999. The full text of plenary lectures and summaries of posters must be sent to the organizing committee by e-mail in Microsoft Word, 2.0, 5.0, 6.0, 7.0 or RTF format not later than 1 July 1999. The printed size of plenary lectures must not exceed 20 pages printed by Times New Roman, 12 single spaced.

Presentations

Except ordered key lectures the Organizing Committee also welcomes poster presentations devoted to general topics.

Costs

There is no registration fee for those Conference participants who present key lectures and for the citizens of the former USSR Republics. For others the registration fee is US$ 150. All participants will pay for themselves for hotel, meals and transportation.

The closing day for registration fee is 11 November.

Information

The notice of intent form for participation in the Conference must be sent to the

Secretariat before 15 April 1999 by mail, fax or e-mail.

Conference will be held in Moscow University.

Participants will stay in the hotel, 15 minutes walk from Moscow University. There are only single rooms at US$ 30 per day (including registration and breakfast).

Organizing Committee:

Chairman:	Prof. G. V. Dobrovolskiy
Deputy Chairman:	Prof. G. S. Kust
Senior Secretary:	O. V. Andreeva
Secretaries:	I. A. Martynenko
	T. I. Malysheva

Address of the Secretariat:

Institute of Soil Science, Vorobiovy Gory, Moscow State University, Moscow, 119899, Russia.

Tel/Fax:	(7-095- 939-37-74)
E-mail:	main@soil.msu.ru geo@soil.msu.ru kust@soil.msu.ru
Tel:	(7-095-939-35-23)
Fax:	(7-095-939-09-89)

Desertification is land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities. This latest, internationally negotiated definition of **desertification** was adopted by the United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, Brazil, in June 1992.

The United Nations Convention to Combat Desertification was formally adopted on 17 June 1994 and opened for signature in Paris on 14 October 1994. This Convention is notable for its innovative approach in recognizing the physical, biological and socio-economic aspects of desertification; the importance of redirecting technology transfer so that it is demand driven; and the involvement of local populations in the development of national action programmes. The Convention came into force on 26 December 1996.

Desertification Control Bulletin
United Nations Environment Programme