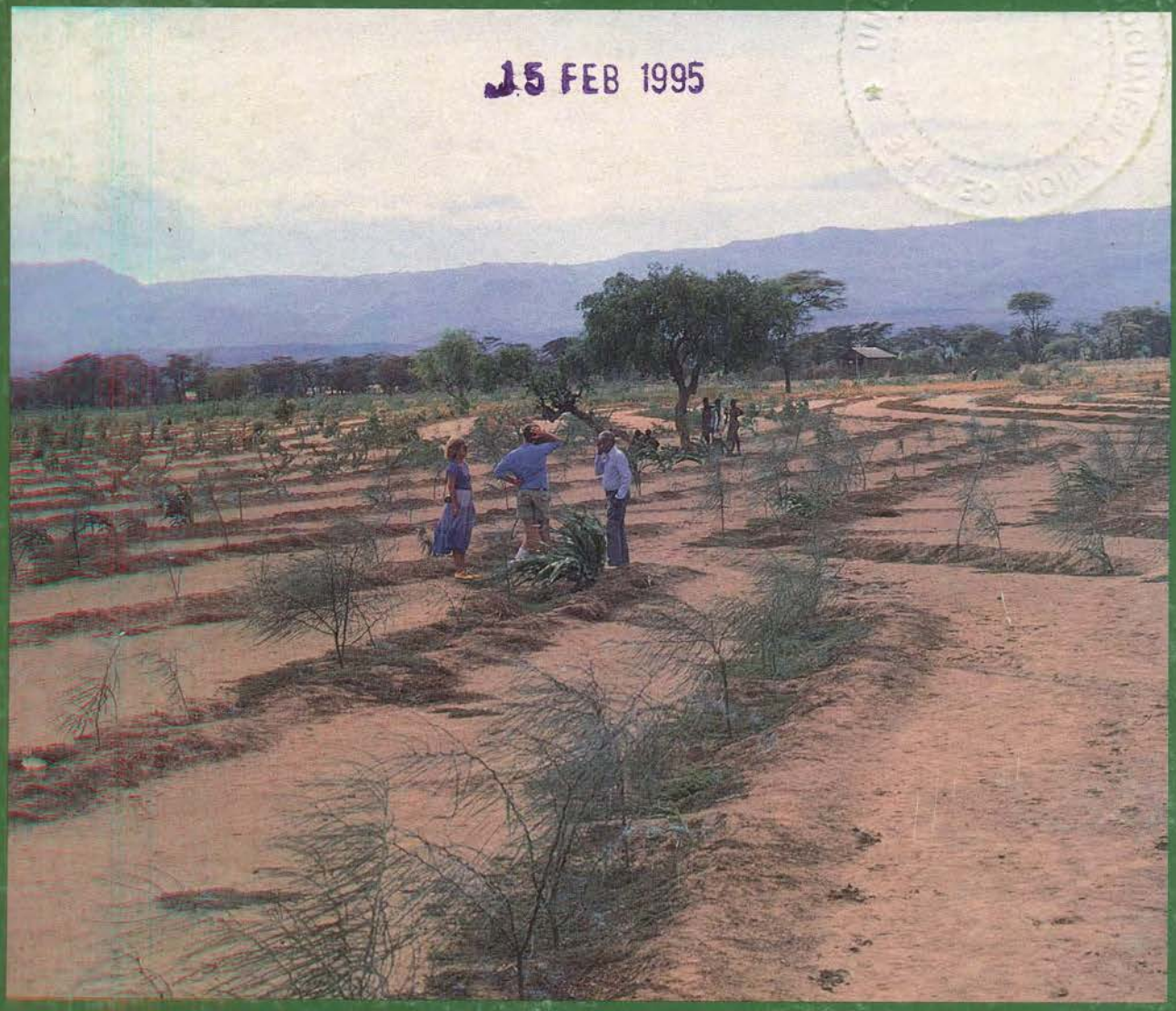
United Nations Environment Programme ISSN 0379-2455

Desertification Control Bulletin

A Bulletin of World Events in the Control of Desertification, Restoration of Degraded Lands and Reforestation

Number 25, 1994

UNEP



Desertification Control Bulletin

United Nations Environment Programme

Number 25, 1994

Fixation of sands in a desertified area by the planting of Eurotia ceratoides. *Kalmykia, the Russian Federation. (Photo: L. Kroumkatchev, UNEP)*

Cover: Land rehabilitation through the planting of tree seedlings and grasses on contour bunds, which are designed to harvest runoff rainwater in Baringo District, Kenya. (Photo: Daniel Stiles)

The United Nations Conference on Desertification (UNCOD) was held in Nairobi from 29 August to 9 September 1977. This was the first worldwide effort initiated to consider the global problem and responsibilities posed by the spreading menace of desertification. Ninety-five States, 50 United Nations offices and bodies, 8 intergovernmental organisations and 65 non-governmental organisations participated. The United Nations Conference on Desertification prepared and adopted a worldwide Plan of Action to Combat Desertification (PACD) with 28 specific recommendations. The PACD was approved by the United Nations General Assembly at its 27th session on 19 December 1977.

Recommendation 23 of the PACD invited all relevant United Nations bodies to support, in their respective fields, international action to combat desertification and to make appropriate provisions and allocations in their programmes. Recommendation 27 gave the responsibility for following up and coordinating the implementation of the PACD to the United Nations Environment Programme (UNEP) with its Governing Council (GC) and Administrative Committee on Coordination (ACC).

Immediately after approval of the PACD, the Desertification Unit was established within UNEP to assist the Executive Director and ACC in carrying out their tasks to implement it.

In 1985 the Desertification Control Programme Activity Centre (DC/PAC) was created on the basis of the Desertification Unit by UNEP's Executive Director with approval from the Governing Council. DC/PAC is a semi-autonomous office with increased flexibility to respond to the demands of following up and implementing the PACD.

One of the main functions required by the PACD from the Desertification Unit is to prepare, compile, edit and publish at six-monthly intervals a bulletin to disseminate information on, and knowledge of, desertification problems and to present news on the programmes, activities and achievements in the implementation of the PACD around the world. Articles published in *Desertification Control Bulletin* do not imply 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
PO 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.

Copyright

It is assumed that all submissions are the original of the photographer and all the rights are owned by the photographer. *Desertification Control Bulletin* gives full credit to photographers for the covers selected but does not provide remuneration.

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. 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. Dia-positive 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:
Naomi Poulton, IPA/UNEP

Technical advisor:
Leonid Kroumkatchev,
DC-PAC/UNEP

Layout
Enid Ngaira, IPA/UNEP

Summary of the 5th Substantive Session of the Intergovernmental Negotiating Committee for the Elaboration of an International Convention to Combat Desertification*

Paris, 6-17 June 1994

When weary delegates to the fifth session of the Intergovernmental Negotiating Committee for the Elaboration of an International Convention to Combat Desertification in those countries experiencing serious drought and/or desertification, particularly in Africa, left UNESCO headquarters at 8:00 am on Saturday, 18 June 1994, many were too exhausted to realize their accomplishment. After thirteen months of work and five two-week negotiating sessions the international community had just adopted the Convention.

During the two-week session, which took place in Paris from 6-17 June 1994, delegates negotiated the remaining bracketed text in the Convention, finalized the four regional annexes (Africa, Latin America and the Caribbean, Asia, and the Northern Mediterranean) and adopted resolutions that recommend urgent action for Africa and interim arrangements for the period between adoption and entry into force, which could take at least two years. There were times during this session that delegates thought they would never reach agreement on the financial provisions of the Convention. After three all-night sessions capped by a closing Plenary that did not even begin until 4:00 am, the Convention was finally adopted. Few delegates were totally pleased with the outcome, yet most were hopeful that this Convention could have some impact on the 900 million people around the world at risk from desertification.

A Brief History of the INCD

While the idea of a convention to combat desertification was discussed during the UNCED preparatory process, it was only in Rio that language was adopted requesting the General Assembly to establish an intergovernmental negotiating committee for the purpose of negotiating a convention. The General Assembly, during its 47th session in 1992, adopted resolution 47/188 calling for the establishment of the Intergovernmental Negotiating Committee for the Elaboration of an International Convention to Combat Desertification (INCD) in those countries experiencing serious drought and/or

* This Report was compiled from the Special Issue of Earth Negotiations Bulletin published by the International Insitiute for Sustainable Development (IISD), with the support of UNEP. This Report is reprinted without prejudice and in the understanding that any views expressed herein are not necessarily those of UNEP.

desertification, particularly in Africa and the convening of five sessions in order to finalize the Convention by June 1994. The organizational session of the INCD was held in January 1993. At that meeting, delegates elected Bo Kjellen (Sweden) Chair of the Committee, elected the remaining members of the Bureau, adopted the rules of procedure, set the schedule of meetings and established two working groups.

First Session

The first session of the INCD was held in Nairobi, Kenya, from 24 May to 3 June 1993. The first week of the session focused on the sharing of technical information and assessments on various aspects of drought and desertification. Divided into seven sections, the information-sharing segment provided an opportunity for scientists, technical experts, delegates and NGOs to share relevant experiences and learn more about the scourge of desertification and its global dimensions. The second week focused on the structure and elements to be contained in the Convention. Delegates also exchanged ideas about the Convention and its objectives.

Negotiations stalled in Nairobi over the issue of related regional instruments, while still giving priority action to Africa. Kjellen proposed that an instrument on Africa, such as an annex, be negotiated once the main structure of the Convention had been defined, and that similar instruments for other regions be negotiated subsequently. This proposal met with resistance from several countries in regions other than Africa. They felt that their own problems with desertification deserved attention and that similar instruments for their regions should be negotiated simultaneously with the instrument for Africa. The decision on this matter was deferred.

Second Session

The second session of the INCD met in Geneva from 13-24 September 1993. The Committee considered the compilation text of the Convention prepared by the Secretariat and agreed on the future programme of work of the Committee, including the elaboration of regional instruments for Africa, Asia and Latin America. As in Nairobi, the most difficult issue to resolve was the negotiation of regional instruments. At the conclusion of the second session, the two working groups completed their discussion of the Secretariat's compilation text, identifying areas of convergence and divergence. There appeared to be consensus on a number of areas, including the need for: a clear and concise preamble that refers to the history of desertification in the UN system; clear and concise objectives; and implementable commitments that are central to the Convention and articulated at different levels (national, regional and international). Delegates stressed the need for a public awareness strategy, improved education, and increased cooperation and coordination between North and South, South and South, and among donors.

48th UN General Assembly

The 48th session of the UN General Assembly adopted a resolution submitted by the INCD that urged the Committee to successfully complete the negotiations by June 1994. The General Assembly also decided that the INCD should hold one session after the adoption of the Convention during the interim period. The objective of this session, to be held in January 1995, will be to review the situation before the Convention enters into force, in particular with regard to the implementation of provisions that are to be adapted to the specific needs of each region.

Third Session

The third session of the INCD was held at UN Headquarters in New York from 17-28 January 1994. At this session, the two working groups focused on the draft negotiating text of the Convention that was prepared by the Secretariat and contained in document A/AC.241/15. By the end of the two-week session, the working groups were able to complete at least one and sometimes two readings of each draft article. Progress was made in shaping the Convention and in identifying the areas of convergence and divergence. The INCD also discussed the regional instrument for Africa for the first time. After an initial discussion of the nature of this instrument and its relationship to the Convention as a whole, delegates requested the Secretariat to prepare a draft text for consideration at the fourth session.

Fourth Session

The fourth session of the INCD was held in Geneva from 21-31 March 1994. The two working groups continued negotiating the draft text of the Convention, as contained in document A/AC.241/15/Rev.1. By the conclusion of the session, the substantive problems that remained included: the need for an article on principles in the text; all matters related to financial resources and mechanisms; categories of countries; subsidiary bodies; reservations or exceptions open to the Parties; and the obligations of a withdrawing Party. In order to have a more productive dialogue on the issues of financial resources and mechanisms, the Chair invited Pierre-Marc Johnson (Canada) and Bolong Sonko (The Gambia) to undertake informal consultations among delegations on the provisions of the Convention related to finance. The objective of these consultations was to develop a new negotiating text on finance for the fifth session.

The fourth session was also the first time that delegates formally considered the Regional Implementation Annex for Africa. In general, developed countries thought that the annex was too long and contained a number of articles that were better suited to or already contained in the main Convention. The Africans felt that the level of detail was absolutely essential, otherwise the instrument would not achieve its objective of providing priority treatment for Africa. After a series of informal sessions, the unresolved issues in this heavily bracketed text included:

the mandatory nature of the commitments to be taken by Parties; timetable for preparing action programmes; the necessity of regional action programmes; the role of the UN and other international institutions; financial arrangements; and follow-up and coordination.

The Asian and Latin American regional groups also produced their own draft regional implementation instruments. Although these annexes were not negotiated or even discussed in detail, initial reaction was positive. Delegates praised both annexes for their brevity and clarity and supported them as a good basis for further discussion.

Report of the Fifth Session

The fifth session of the INCD opened on Monday, 6 June 1994 at UNESCO headquarters in Paris. The Committee first dealt with certain procedural matters, including the adoption of the agenda (A/AC.241/22) and the accreditation of seven more NGOs to the negotiating process (A/AC.241/9/Add.7). The Committee also heard opening statements from UNESCO Director-General Federico Mayor and Alain Lammassoure, France's Ministre Delegue for European Affairs, who both welcomed delegates to Paris. President Mascarenhas Montero of Cape Verde, and ministers from Benin, Mongolia and Senegal also addressed the opening Plenary session.

INCD Chair Bo Kjellen emphasized the importance of negotiating an effective Convention and announced the flexible work schedule for the session. The Plenary was scheduled to meet informally to consider the main body of the Convention, while at the same time a negotiating group under the chairmanship of Anne de Lattre (France) was going to examine the regional annexes. Pierre-Marc Johnson and Bolong Sonko would continue consultations on financial issues. Kjellen made it clear, however, that delegates would have to be flexible and prepared for constant changes in the work programme, depending on the Committee's progress.

The Main Convention

While the majority of the Convention had been negotiated by the two working groups at the second, third and fourth sessions, there were still a number of words, paragraphs and articles that remained in brackets. The Plenary met in an informal session beginning on Monday, 6 June, to address the bracketed text. There were four categories of problems that remained in the text of the Convention: issues related to financial resources and mechanisms; issues related to categories of countries; points related to institutional and legal issues; and the inclusion of an article on principles. There were also a number of other sets of brackets that did not relate to these four issues and the Committee tackled these first. Issues that were not easily resolved were assigned to small contact groups. Financial issues were dealt with in an informal working group chaired by Johnson and Sonko. Kjellen held his own consultations on principles and categories of countries. A small legal committee also met throughout the session, under the chairmanship of Fred Mallya (Tanzania), to review the entire Convention to ensure that it is legally and grammatically consistent.

To facilitate greater understanding of the Convention, the following is a summary of each article in the final text, A/AC.241/15/Rev.7.

PART I: INTRODUCTION

Preamble

The 26-paragraph Preamble addresses a wide range of topics related to desertification and drought. The most contentious paragraphs addressed: the international community's commitment to attain the UN target of 0.7% of GNP for Official Development Assistance (ODA); the contribution that combating desertification can make to achieve the objectives of the Climate Change and Biodiversity Conventions; special attention to problems of combating desertification and mitigating the effects of drought in countries with economies in transition; and special provisions to meet the needs of developing countries, including new and additional financial resources and appropriate access to relevant technologies.

Of these four paragraphs, the one addressing the relationship between the conventions on desertification, climate change and biodiversity was the easiest to resolve, when the US agreed to accept it on the first day of the session. The other three paragraphs proved to be more troublesome.

After lengthy discussion in the contact group on finance, that met during the final three days of the session, delegates agreed to remove reference to 0.7% of GNP for ODA and state instead state, "Reaffirming in this light the commitments of developed countries as contained in paragraph 13 of chapter 33 of Agenda 21." Paragraph 33.13 refers to this ODA target. Reference to the problems with desertification in the territory of the former Soviet Union continued to give problems until the final hours of the Plenary. The G-77, which did not want special reference to these countries, was finally able to accept the wording, "Expressing concern over the impact of desertification and drought on affected countries in Central Asia and southern Caucasus." At the final Plenary, however, the Russian Federation expressed its displeasure with this formulation since it did not include any Russian territory. The language was modified and now reads "trans-Caucasus."

The final outstanding issue — the provision of effective means to developing countries to combat desertification — was resolved by the contact group on finance. It now reads: "Recognizing the importance of the provision to affected developing countries, particularly in Africa, of effective means, inter alia, substantial financial resources, including new and additional funding, and access to technology, without which it will be difficult for them to implement fully their commitments under this Convention." This text was apparently the result of a compromise between the original text proposed in the Preamble and a G-77

proposal for Article 20, which was deleted from the body of the Convention and incorporated into this paragraph of the Preamble.

ARTICLE 1 — Use of Terms:

This Article contains definitions for desertification, combating desertification, drought, mitigating the effects of drought, land, land degradation, arid, semi-arid and dry sub-humid areas, affected areas, affected countries, regional economic integration organization, and developed country Parties. These latter two definitions, as well as the overall problem with categories of countries, were the subject of discussion at INCD-5.

Paragraph 2 (establishment of a glossary) was deleted after the Secretariat explained that UNEP had already commissioned a dictionary of terms related to desertification, making this paragraph unnecessary. Definition of "other Parties in a position to provide assistance" was deleted and replaced with a definition of developed country Parties. It reads: "'developed country Parties' means developed country Parties and regional economic integration organizations constituted by developed countries." Reference to affected country Parties eligible for assistance under this Convention was also deleted. Thus, the categories of countries are now affected countries, developed country Parties and developing country Parties. There is no longer reference to Parties needing assistance, Parties in a position to provide assistance or Parties providing assistance.

ARTICLE 2 — Objective:

Delegates agreed to the two paragraphs in this Article at INCD-4. The first states that the objective of the Convention is to combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification, particularly in Africa, through effective actions at all levels, supported by international cooperation and partnership arrangements, consistent with Agenda 21. The second paragraph stresses the importance of long-term integrated strategies.

ARTICLE 3 — Principles:

By the conclusion of INCD-4, delegates reached agreement on the contents of this Article. The US insisted on retaining the brackets around the entire article, since it was opposed to including principles in the Convention. On the final day of INCD-5, delegates agreed to delete the brackets and retain the Article. The sub- paragraph on the sovereign right of nations to exploit their own resources was deleted since similar language is contained in the Preamble.

The Article now lists four principles to guide the Parties in implementing the Convention: the participation of local communities in the design and implementation of programmes to combat desertification; cooperation and coordination at the subregional, regional and international levels; cooperation among all levels of government, communities, NGOs and landholders; and the special needs of affected developing countries.

PART II: General Provisions

ARTICLE 4 — General Obligations:

This Article lists the obligations of all Parties under the Convention, emphasizing the need to coordinate efforts and develop a coherent long-term strategy at all levels. These obligations include: adopting an integrated approach in addressing desertification and drought; giving due attention to the situation of affected developing country Parties with regard to trade, marketing arrangements and debt; integrating strategies for poverty eradication into efforts to combat desertification and mitigate the effects of drought; promoting cooperation among affected country Parties; strengthening subregional, regional and international cooperation; and cooperating within relevant intergovernmental organizations.

Delegates agreed to delete reference to the development of financial mechanisms that provide for new and additional resources. This sub-paragraph was replaced by the following: "promote the use of existing bilateral and multilateral financial mechanisms and arrangements that mobilize and channel substantial financial resources to affected developing country Parties in combating desertification and mitigating the effects of drought."

ARTICLE 5 —Obligations of Affected Country Parties:

This Article sets out the obligations of affected country Parties as follows: give due priority to combating desertification and mitigating the effects of drought, including the allocation of adequate resources; establish strategies and priorities; address the underlying causes of desertification; promote awareness and facilitate participation of local populations; provide an enabling environment by strengthening relevant existing legislation or by enacting new laws and establishing long-term policies.

ARTICLE 6 — Obligations of Developed Country Parties:

This paragraph proved to be one of the most contentious paragraphs in the entire Convention. Agreement was not reached until early Saturday morning, 18 June 1994, and, at times, it appeared as if the negotiations would end in deadlock.

When financial resources and mechanisms (Articles 20 and 21) were first discussed in the informal working group on finance, Algeria, on behalf of the Group of 77 and China, insisted on linking Article 6 with Articles 20 and 21, since financial resources and mechanisms should not be discussed separately from developed country obligations. After a procedural debate that lasted all afternoon, Johnson and Sonko reported back the next day that they would open discussions with Article 6.

This Article was also linked to the ongoing discussions on categories of countries. During the discussion, the G-77 insisted that the title read "Obligations of developed country Parties," while other options included "Obligations to provide

assistance in implementation" and "Obligations of country Parties able to provide assistance". Other issues that emerged during the discussions during the subsequent week were: the use of the phrase "as mutually agreed," which was strongly supported by the OECD countries and opposed by the G-77; the reference to the mobilization of new and additional financial resources; the reference to the target of 0.7% of GNP for ODA; and reference to the countries in the former Soviet Union.

The final Article, which was adopted with reservations by Ethiopia, Uganda, Sudan, India and Djibouti, states that developed country Parties undertake to: "(a) actively support, as agreed, individually or jointly, the efforts of affected developing country Parties, particularly those in Africa, and the least developed countries, to combat desertification and mitigate the effects of drought; (b) provide substantial financial resources and other forms of support to assist developing country Parties, particularly those in Africa, effectively to develop and implement their own long-term plans and strategies to combat desertification and mitigate the effects of drought; (c) promote the mobilization of new and additional funding in accordance with Article 20, paragraph 2(b); (d) encourage the mobilization of funding from the private sector and other non-governmental sources; and (e) promote and facilitate access by affected country Parties, particularly affected developing country Parties, to appropriate knowledge, know-how and technology."

ARTICLE 7 — Priority for Africa:

This Article calls on Parties, in implementing this Convention, to give priority to affected African country Parties, while not neglecting affected developing country Parties in other regions.

ARTICLE 8 — Relationship with other Conventions:

The first paragraph encourages coordination of activities carried out under this Convention and other relevant international agreements. The second paragraph, which was retained after consultations with the UN Legal Office, says that the provisions of this Convention shall not affect the rights or obligations of any Party under agreements that it has entered into prior to the entry into force of this Convention.

PART III: Action Programmes, Scientific and Technical Cooperation and Supporting Measures

SECTION 1: Action Programmes

ARTICLE 9 — Basic Approach:

This Article states that existing successful plans and programmes, as well as relevant subregional and regional programmes, will be the basis for the preparation of national action programmes. Parties shall notify the Permanent Secretariat in writing of their intention to prepare a national action programme. Such programmes will be updated through a participatory process and will be interlinked with other efforts to formulate national sustainable development policies.

The second paragraph states that in the provision of assistance, priority shall be given to supporting, as agreed, national, subregional and regional action programmes of affected developing country Parties, particularly those in Africa. The third paragraph says that the Parties shall encourage organs, funds and programmes of the UN system and other relevant intergovernmental organizations, academic institutions and the scientific community and NGOs in a position to cooperate, to support the elaboration, implementation and follow-up of action programmes.

ARTICLE 10 — National Action Programmes:

This article states that the purpose of national action programmes is to identify the factors contributing to desertification and practical measures necessary to combat desertification and mitigate the effects of drought. These action programmes shall: incorporate long-term strategies to combat desertification and mitigate the effects of drought; allow for modifications to be made in response to changing circumstances; give particular attention to the implementation of preventive measures; enhance national climatological, meteorological and hydrological capabilities; promote policies and strengthen institutional frameworks; provide for effective popular participation; and require regular review of implementation.

The Article also lists measures to prepare for and mitigate the effects of drought and measures in the following priority fields as they relate to combating desertification and mitigating the effects of drought: promotion of alternative livelihoods; improvement of national economic environments with a view to strengthening programmes aimed at the eradication of poverty and at ensuring food security; sustainable management of natural resources; sustainable agriculture practices; development and efficient use of various energy sources; institutional and legal frameworks; strengthening of capabilities for assessment and monitoring, including hydrological and meteorological services; and capacity building, education and public awareness.

ARTICLE 11 — Subregional and Regional Action Programmes:

This Article reads: "Affected country Parties shall consult and cooperate to prepare, as appropriate, in accordance with relevant Regional Implementation Annexes, subregional and/or regional action programmes to harmonize, complement and increase the efficiency of national programmes. The provisions of Article 10 shall apply *mutatis mutandis* to subregional and regional programmes.

Such cooperation may include agreed joint programmes for the sustainable management of transboundary natural resources, scientific and technical cooperation, and strengthening of relevant institutions."

ARTICLE 12 — International Cooperation:

This Article states that the international community should cooperate in the implementation of the Convention, especially in fields of technology transfer, scientific research and development, information collection and dissemination and financial resources.

ARTICLE 13 — Support for the Elaboraton and Implementation of Action Programmes:

Once the categories of countries and financial provisions were resolved, agreement was reached on this Article. It states that measures to support action programmes include: financial cooperation; cooperation mechanisms at the local level; flexibility in project design, funding and implementation; and more efficient administrative and budgetary procedures.

ARTICLE 14 — Coordination in the Elaboration and Implementation of Action Programmes:

This Article was also agreed to after the categories of countries were resolved. The first paragraph states that the Parties shall work closely together in the elaboration and implementation of action programmes. The second paragraph stresses the need for coordination to avoid duplication, harmonization of interventions and approaches, and maximization of the impact of assistance.

ARTICLE 15 — Regional Implementation Annexes:

This Article had been bracketed pending the elaboration of the regional annexes. Once the regional annexes had taken shape, delegates agreed to delete the three sub-paragraphs that listed obligations to be set out in the annexes. The chapeau was retained and it states: "Elements for incorporation in action programmes shall be selected and adapted to the socio-economic, geographical and climatic factors applicable to affected country Parties or regions, as well as to their level of development. Guidelines for the preparation of action programmes and their exact focus and content for particular subregions and regions are set out in the regional implementation annexes."

SECTION 2: Scientific and Technical Cooperation

ARTICLE 16 — Information Collection, Analysis and Exchange:

The most contentious issue in this paragraph was compensation for the use of traditional and local sources of knowledge. The Chair asked Ethiopia to hold consultations on this issue, which is also mentioned in Article 22. These consultations proved to be quite difficult since certain developing countries supported its inclusion in the Convention and certain developed countries with indigenous populations had trouble with reference to local and traditional knowledge, which is not the focus of this Convention. Agreement was not reached until the final day of the negotiations. The sub-paragraph now reads: "subject to their respective national legislation and/or policies, exchange information on local and traditional knowledge, ensuring adequate protection for it and providing appropriate return from the benefits derived from it, on an equitable basis and on mutually agreed terms, to the local populations concerned."

ARTICLE 17 — Research and Development:

This Article states that Parties will support research activities that: contribute to increased knowledge of the processes leading to desertification and drought; address the specific needs of local populations; protect, integrate, enhance and validate traditional and local knowledge, know-how and practices; develop and strengthen national, subregional and regional research capabilities in affected developing country Parties; take into account the relationship between poverty, migration and desertification; promote the conduct of joint research programmes; and enhance the availability of water resources in affected areas.

ARTICLE 18 — Transfer, Acquisition, Adaptation and Development of Technology:

This Article, which was the result of intensive consultations at INCD-4, did not cause any problems in Paris. It states that Parties shall: fully utilize relevant existing information systems and clearing-houses for the dissemination of information on available technologies; facilitate access to technologies most suitable to practical application for specific needs of local populations; facilitate technology cooperation among affected country Parties; and take appropriate measures to create domestic market conditions and incentives conducive to the development, transfer, acquisition and adaptation of suitable technology, knowledge, know-how and practices. The Parties shall also: make inventories of technology, knowledge, know-how and practices and their potential uses; ensure that such technology, knowledge, know-how and practices are adequately protected; encourage and support the improvement and dissemination of such technology; and facilitate the adaptation of such technology.

SECTION 3: SUPPORTING MEASURES

ARTICLE 19 — Capacity Building, Education and Public Awareness:

Most of this lengthy Article had been agreed upon at INCD-4. The first paragraph lists eleven capacity building activities. Only sub-paragraph 1(f) — the provision of appropriate training and technology in the use of alternative energy sources, particularly renewable energy resources — remained bracketed at the insistence of Saudi Arabia. After consultations, the Saudis agreed to retain the sub-paragraph in the text.

The second paragraph addresses an interdisciplinary review of available capacity and facilities at the local and national levels. Paragraph 3 lists six types of public awareness and educational programmes. Paragraph 4, the result of a fragile compromise between developed and developing countries, addresses the establishment and/or strengthening of regional education and training centres.

ARTICLE 20 — Financial Resources:

This Article was the subject of intensive consultations throughout INCD-5. Both Articles 20 and 21 were first addressed in an informal working group co-chaired by Pierre-Marc Johnson and Bolong Sonko. This group first met on Wednesday, 8 June 1994, and continued on Thursday and Friday. The initial basis for discussion was a draft text prepared by Johnson and Sonko (A/AC.241/L.19), based on consultations held in Geneva and during the intersessional period. After consultations in the extended bureau over the weekend, it was decided that after one more meeting in the large working group, a smaller contact group, consisting of approximately eight developed countries and eight developing countries would begin negotiating the text Monday evening. This group met late into the night throughout the second week and did not reach agreement on all of the financial provisions in the text until early Saturday morning.

With regard to Article 20, most delegations were in agreement early in the session that the Article should be developed based on three main principles: partnership; differentiated responsibilities; and flexibility. Many developing countries expressed concern about the use of the phrase "as mutually agreed." Others noted that while the text outlined how available resources would be spent, there was no indication of how to mobilize new and additional resources. Furthermore, there was concern that no provision was made for concessional loans, although it was clear that grants would not resolve current desertification problems. Since much of the negotiation of this Article took place behind closed doors, it is not certain how the final agreement was reached.

The first paragraph of the final text states that Parties shall make every effort to ensure that adequate financial resources are available for programmes to combat desertification and mitigate the effects of drought. Paragraph 2 says that developed country Parties undertake to: mobilize substantial financial resources, including grants and concessional loans; promote the mobilization of adequate, timely and predictable financial resources, including new and additional funding from the Global Environment Facility; facilitate the transfer of knowledge, know-how and technologies; and explore innovative methods and incentives for mobilizing and channelling resources.

Paragraph 3 states that affected developing country Parties, taking into account their capabilities, undertake to mobilize adequate financial resources for the implementation of the Convention. Paragraph 4 says that the Parties shall seek full use and continued qualitative improvement of all national, bilateral and multilateral funding sources and mechanisms. In paragraph 5, the Parties shall: rationalize and strengthen the management of resources already allocated for combating desertification and mitigating the effects of drought; give due priority and attention within the governing bodies of multilateral financial institutions, facilities and funds, to supporting affected developing country Parties in activities to implement the Convention; and examine ways in which regional and subregional cooperation can be strengthened. Paragraph 6 says that other country Parties are encouraged to provide, on a voluntary basis, knowledge, know-how and techniques related to desertification and/or financial resources to affected developing country Parties.

At the final Plenary meeting, Saudi Arabia, supported by India, Ethiopia, Brazil, Malaysia, Sudan and Bolivia, said they had problems with paragraph 3, since it would, in effect, turn developing country Parties into donors. Saudi Arabia proposed that instead of "for the implementation of this Convention," it should read "for their national action programmes." This was accepted and the Article was adopted.

ARTICLE 21 — Financial Mechanisms:

This Article was initially viewed as the most contentious article in the entire Convention. The key issue to resolve was the establishment of a global fund for combating desertification. While the G-77 strongly supported the idea of a fund, the EU and the US were opposed to the establishment of a new institution. Instead, they stressed the need for improved management, mobilization and coordination of existing funds. Sweden pointed out that a global institution would have high administrative costs, which would result in few funds getting to the local level. Some of the Africans were also concerned that the establishment of a global fund would strip the Convention of the priority to Africa.

There appeared to be no way out of this deadlock until the small contact group met Monday night, 13 June, and Canada suggested the establishment of a coordinating mechanism. The US then took the lead and circulated a proposal to identify an existing organization to serve as a "Global Mechanism" to monitor and evaluate the activities of financial mechanisms and facilitate the mobilization of adequate and timely assistance. After lengthy discussions within the OECD and

the G-77, delegates agreed to use the US proposal as the basis for further negotiation. Thus, a breakthrough was achieved and the door was opened for productive negotiations.

Paragraph 1 of the final text states that the Conference of the Parties (COP) shall promote the availability of financial mechanisms and consider approaches and policies that: facilitate the provision of necessary funding at national, subregional, regional and global levels; promote multiple-source funding approaches, mechanisms and arrangements; provide information on available sources of funds; facilitate the establishment of mechanisms, such as national desertification funds; and strengthen existing funds and financial mechanisms at the subregional and regional levels. In paragraph 2, the COP shall encourage the provision of support at the national, subregional and regional levels through the UN system and multilateral financial institutions. Paragraph 3 states that affected developing country Parties, when necessary, shall establish and/or strengthen national coordinating mechanisms to ensure the efficient use of all available financial resources.

Paragraphs 4 and 5 establish a Global Mechanism to promote actions leading to the mobilization and channeling of substantial financial resources, including for the transfer of technology, on a grant basis, and/or on concessional or other terms, to affected developing country Parties. This Mechanism shall function under the authority and guidance of the COP. At its first ordinary session, the COP shall identify an organization to house this Global Mechanism and ensure that the Mechanism: identifies and inventories relevant bilateral and multilateral cooperation programmes; provides advice, upon request, to Parties on innovative methods of financing; provides interested Parties and relevant intergovernmental and non-governmental organizations with information on available sources of funds and funding patterns; and reports to the COP. Paragraphs 6 and 7 address the administrative operations of the Mechanism and call for a review of the Mechanism's operations at the third session of the COP.

PART IV: Institutions

ARTICLE 22 — Conference of the Parties

The issues that proved to be the most difficult included the COP's budget and the COP's role in establishing criteria for compensation for the use of traditional and local sources of knowledge. The first issue was resolved by the contact group on finance. Rather than going into the specifics on the source of budget funds, the sub-paragraph reads "approve a programme and budget for its activities, including those of its subsidiary bodies, and undertake necessary arrangements for their financing." The issue of traditional and local sources of knowledge was resolved as part of a package deal with Article 16 and the paragraph now states that the Conference of the Parties may request competent national and international organizations, which have relevant expertise, to provide it with information relevant to Articles 16(g), 17.1(c) and 18.2(b). This, in effect, removes the responsibility for substantive deliberations on this issue from the mandate of the COP.

The rest of the Article sets forth the role of the COP in: reviewing implementation of the Convention; promoting exchange of information; establishing subsidiary bodies; adopting rules of procedure; adopting amendments to the Convention; electing its Bureau; holding extraordinary sessions; and exercising other functions deemed appropriate. The first session of the COP shall be convened by the interim secretariat and shall take place not later than one year after the date of entry into force of the Convention. Unless decided otherwise, the second, third and fourth ordinary sessions shall be held yearly and, thereafter, ordinary sessions shall be held every two years.

ARTICLE 23 — Permanent Secretariat:

A key problem in this Article had been the title of the institution. The African Group has requested the use of the word "permanent." The developed countries argued that this expression did not agree with the wording in similar international agreements. In Paris, the Secretariat announced that, according to the UN Legal Office, it does not matter if the secretariat is referred to as "permanent." After consultations, the EU, Japan and Norway agreed to remove the brackets and retain the word "permanent".

The Article states that the functions of the Permanent Secretariat shall be to: make arrangements for sessions of the COP and its subsidiary bodies; compile and transmit reports; facilitate assistance to affected developing country Parties on request; coordinate its activities with the secretariats of other relevant international bodies and conventions; and perform other secretariat functions as determined by the COP. The COP at its first session shall designate the Permanent Secretariat and make arrangements for its functioning.

ARTICLE 24 — Committee on Science and Technology:

There were initially two versions of Article 24 in the text. The first created a panel of experts in fields relevant to desertification and drought selected by the COP. The latter created a council open to all Parties. Australia, the US, the EU and Canada supported the first option. Brazil argued that all countries interested in participating should be allowed to do so. The Chair asked Egypt to hold consultations. No progress was made in these consultations and the issue was referred to the extended Bureau. On Wednesday, 15 June, Kjellen circulated a non-paper, which proposed the establishment of a committee on scientific and technological matters along the lines of Article 9 in the Climate Change Convention. The non-paper also proposed the establishment of a roster of independent experts to be nominated by Governments. Some members of the G-77 supported this proposal, since it would give them influence on the choice of scientists. Some OECD countries continued to express concern that such a roster of "experts" would tend to contain more policy makers and diplomats than scientists. After further discussions in the extended Bu-

reau, a drafting group met and considered the text.

The final text establishes a Committee on Science and Technology and states that the COP will establish and maintain a roster of independent experts. The COP may, as necessary, appoint ad hoc panels to provide information and advice through the Committee on specific issues regarding science and technology.

ARTICLE 25 — Networking and Existing Institutions, Agencies and Bodies:

This Article calls for the Committee on Science and Technology to "survey and evaluate the relevant existing networks, institutions, agencies and bodies willing to be networked." Pursuant to this process, the Article outlines the steps that the COP shall undertake to identify units most appropriate for networking.

PART V: PROCEDURES

ARTICLE 26 — Communication and Information:

This Article provides for a reporting mechanism by the Parties to the Convention on the activities they have undertaken to meet their obligations. Affected country Parties shall provide: a description of the strategies established pursuant to Article 5 and detailed descriptions of the programmes and their implementation. Developed country Parties shall report on measures taken to assist in the preparation and implementation of action programmes, including information on financial resources provided. The COP shall facilitate the provision to affected developing countries, on request, of technical and financial support in compiling and communicating information.

ARTICLE 27 — Measures to Resolve Questions on Implementation:

This Article stipulates that the COP shall consider and adopt procedures and institutional mechanisms for the resolution of questions arising from the implementation of the Convention.

ARTICLE 28 — Settlement of Disputes:

This Article sets out the dispute settlement mechanisms under the Convention. Parties shall settle any dispute between them concerning the implementation of the Convention through negotiation. Other mechanisms include arbitration, in accordance with a procedure adopted by the COP in an annex, as soon as practicable, and submission of the dispute to the International Court of Justice.

ARTICLE 29 — Status of Annexes:

This Article states that the regional implementation annexes and other annexes form an integral part of the Convention.

ARTICLE 30 — Amendments to the Convention:

Since there were still outstanding questions with regard to Articles 30 and 31 at the outset of this session, the Chair asked Patrick Szell (UK) to hold consultations on these articles. The final text states that the Convention can be amended at ordinary sessions of the COP. The text of any proposed amendment shall be communicated to the Parties by the Permanent Secretariat at least six months before the meeting at which it is proposed for adoption. If consensus cannot be achieved, the amendment shall, as a last resort, be adopted by a two-thirds majority vote of the Parties present and voting.

ARTICLE 31 — Adoption and Amendment of Annexes:

After consultations, this Article now states that any additional annex to the Convention and any amendment to an annex shall be proposed and adopted in accordance with the procedure set forth in Article 30. Annexes or amendments to annexes shall enter into force for all Parties to the Convention six months after the date of communication of the adoption of such an annex or amendment. The annex or amendment shall not enter into force for Parties that have notified the Depositary in writing within that six-month period of their non-acceptance of such annex or amendment.

ARTICLE 32 — Right to Vote:

This Article stipulates that each Party shall have one vote. Regional economic integration organizations, in matters within their competence, shall exercise their right to vote with a number of votes equal to the number of their member States that are Parties to the Convention.

ARTICLE 33 — Signature:

The Convention shall be opened for signature in Paris this autumn. The exact dates were left blank, pending a decision by the French.

ARTICLE 34 — Ratification, Acceptance, Approval and Accession:

This Article states that the Convention and any additional regional implementation annexes or amendments to regional implementation annexes will be subject to the ratification, acceptance, approval or accession by States and regional economic integration organizations.

ARTICLE 35 — Interim Arrangements:

This Article states that during the interim period, the Secretariat functions, referred to in Article 23, will be carried out by the interim secretariat, as established by UN Resolution 47/188.

ARTICLE 36 — Entry into Force:

After consultations by the Chair, delegates agreed that 50 ratifications are necessary for the Convention to enter into force. The Convention shall enter into force 90 days after the date of deposit of the 50th instrument of ratification.

ARTICLE 37 — Reservations:

No reservations may be made to this Convention. The US stated for the record that it is reluctantly accepting this Article.

ARTICLE 38 — Withdrawal:

It was agreed that at any time after three years from the date on which the Convention has entered into force for a Party, that Party may withdraw from the Convention by giving written notification to the Depositary. Any such withdrawal shall take effect upon expiry of one year from the date of receipt of the notification of withdrawal.

ARTICLE 39 — Depositary:

The UN Secretary-General is the depositary of the Convention.

ARTICLE 40 — Authentic Texts:

This Article states that the texts in the six official UN languages are all equally authentic.

Regional Implementation Annexes

The Convention contains regional implementation annexes for Africa, Asia, Latin America and the Caribbean, and the Northern Mediterranean. The idea of regional annexes emerged during the first meeting of the INCD in Nairobi, where options were still being explored on how to express the particularity for Africa stipulated in resolution 47/188. This was interpreted by developing countries in other regions as a blatant attempt to provide an option for the developed countries to provide financial assistance in favor of Africa through an annex or instrument. Consequently, the Latin American and Caribbean Group and the Asian Group emphasized that they also wanted their own annexes, a demand that was reluctantly approved, with a decision taken that any region could have an annex and the priority for Africa would be demonstrated through the urgent action to be undertaken before the entry into force of the Convention.

Initially, it was not clear how multiple annexes could be finalized simultaneously by 17 June 1994. However, due to regional-level initiatives taken by the Asians, Latin Americans and the southern Europeans, draft annexes were tabled at INCD-4 and negotiated in Paris. The four annexes differ quite substantially in their content in order to reflect the different regional realities. Despite the fact that all the annexes cover the same range of issues, it is the African Annex that is the most elaborate in form and content.

Regional Implementation Annex for Africa:

This Annex comprises 19 articles and addresses a broad range of issues including: scope; commitment and obligations of both African and developed country Parties; strategic planning, framework and content of the national, subregion and regional programmes; technical assistance and cooperation, as well as the transfer, acquisition, adaptation and access to environmentally sound technology; financial mechanisms and resources; and coordination, partnership and follow-up arrangements.

The Annex highlights the particular conditions of the region, which include its topography, the number of affected land-locked countries, political instability of the region, and the difficult socio-economic factors, including poverty and debt. The Annex is unique in that it is the only regional instrument to articulate concrete commitments for financial contributions. In addition, it provides for the execution of the action programmes before the Convention's entry into force. This is to serve as an indication of the priority to be accorded to Africa under the main Convention.

The action programmes highlight the areas that need attention such as: improvement of the economic environment; natural resource conservation; and existing institutional organizations. The Annex also provides the detailed actions to be undertaken under the national action programmes.

However, it is only within the last three articles of the Annex that a new approach is actually articulated. Explicit reference is made with regard to technical assistance and cooperation to ensure that preference is given to the utilization of the less-costly local experts. This important reference is in response to the sentiment among African Governments that the current disbursement of funds tends to be subsumed by foreign technical assistance and high overhead costs.

On the other hand, emphasis is placed on the need for increased coordination among the key players involved in desertification activities, including donors, national governments, NGOs and local populations. Hence, consultative groups and processes are recommended at three different levels: national, subregional and regional. And finally, the Annex sets out procedures for the follow-up arrangements of the Convention.

One of the most difficult issues to resolve in this Annex, besides the financial resources question, was the role of the Secretariat in the implementation of

the Annex. Indeed, this was a contentious issue for all the other annexes as well. The Africans favored an enlarged role for the Secretariat, along the lines of an executing or implementing agency. By contrast, OECD countries did not feel that the Secretariat is equipped to exercise these functions and that its primary role should be to provide administrative support to the Convention and the Conference of the Parties.

Regional Implementation Annex for Asia:

This Annex is much shorter and more general in scope than the African Annex. The Asian countries felt that the level of detail that characterizes the African Annex would not be appropriate here, given the vast and varied geographical expanse of the region. Hence, it only contains eight articles: purpose; conditions of the region; framework and content of national action programmes; subregional and joint action programmes; regional activities; financial resources and mechanisms; and coordination and cooperation mechanisms. The Asian Governments decided not to articulate concrete commitments in their Annex since they did not want to be legally-bound to financial obligations. On the other hand, the financial resources and mechanisms provisions were not as elaborate as those in the African Annex. This was due in large part to the sentiment of the donor countries that the Asian countries are better able to mobilize local resources to deal with drought and desertification, especially since the impact in Asia has not been as severe as in the African region.

Regional Implementation Annex for Latin America and the Caribbean:

This Annex is similar in content and scope to the Asian Annex. It is equally general and concise, containing only seven articles: purpose; particular conditions of the region; content of the national action programmes; technical, scientific and technological cooperation; financial resources and mechanisms; and institutional framework. Despite the similarities with the Asian Annex, this instrument aims at identifying the important links between the desertification and biodiversity loss, as well as debt issues, unfavorable international economic trade practices and other socio-economic factors. In technical cooperation, it emphasizes the issue of traditional knowledge, know-how and practices.

Regional Implementation Annex for the Northern Mediterranean:

This Annex mainly covers Greece, Portugal and Spain. It differs from the other annexes in its orientation. While the other three tend to link desertification and drought-related problems to socio-economic factors, this Annex addresses the issue from a more scientific approach. Only two economic issues are emphasized as causal factors: urbanization and agricultural practices. Another important distinguishing factor is the provision that clearly disqualifies the region for eligibility for funds raised through the main Convention. The Northern Mediterranean Annex is the only annex that provides for coordinated activity with other regions, particularly with North Africa, in the preparation and implementation of action programmes. Even the African Annex does not acknowledge this collaboration. It is noteworthy, however, that while this Annex was the least contentious within the main negotiations, it appeared that Spain, who had lobbied for it, initially met with resistance from OECD countries.

Interim Arrangements:

The next item on the Agenda was the adoption of a resolution on interim arrangements. This resolution, which had been circulated during the first week as document A/AC.241/L.20, was adopted without amendment. It calls upon States and regional economic integration organizations to sign the Convention in Paris. It also requests the Secretary-General to: make appropriate arrangements for the continuation of the signing period in New York during and after the 49th session of the General Assembly; make the necessary arrangements to convene a session of the Committee from 9-20 January 1995 in New York; make recommendations to the 49th General Assembly regarding arrangements for further sessions of the Committee until the first meeting of the COP; and make proposals so that the Secretariat can continue its activities on an interim basis until the Permanent Secretariat is designated by the COP.

Urgent Action for Africa:

The Committee then adopted a resolution on urgent action for Africa. This resolution, as contained in document A/AC.241/L.22/Rev.1, was the product of intense consultations held by Takao Shibata (Japan). This lengthy resolution: encourages all countries to disseminate information and promote education and public awareness about the objectives of the Convention; invites affected African countries to take urgent steps to prepare national and subregional action programmes; invites the developed countries to provide support to the affected African countries in such actions; invites the international and multilateral organizations, African subregional and regional organizations, and private sector organizations to provide support and mobilize necessary resources; and recommends that the affected African countries designate coordinating bodies at the national and subregional levels. The resolution also calls for the establishment, at national and subregional levels, of partnership arrangements with relevant developed countries, economic organizations, NGOs and representatives of local populations to facilitate the coordination of activities.

Concrete Gains

Global Awarness of the Problem:

Perhaps the most important accomplishment of the INCD process is the international attention that has been mobilized around the problem of desertification. Many have argued that regardless of the specificities in the final Convention, the process itself has been a success in providing a networking forum for those affected by desertification, with donors, affected developing countries, UN agencies, intergovernmental organizations and NGOs. These numerous contacts have already laid the groundwork for future partnership arrangements to combat desertification.

Legitimization of Public Participation:

Another critical gain is the acceptance by many governments of the importance of the participatory approach in the development of national action programmes and, indeed, the recognition that this element is a pre-condition to successful results. Many African countries have come to accept that their national and regional action programmes will not meet with real success unless affected local populations are involved in the design, development and implementation of these programmes. Twenty years ago, few countries would have even considered the usefulness, yet alone the political importance and good sense, of NGO involvement. Now there is an awareness that donors may very well steer money away from those programmes planned in capital cities. This awareness may well lead to an attitudinal shift regarding the need to plan action programmes in a fundamentally different way, with the full involvement of NGOs and affected communities as an absolute prerequisite to the true achievement of sustainable development.

NGO impact :

Likewise, NGOs were extremely positive about the openness of the negotiating process and the extent to which they were able to influence decision-making, especially around such issues as national desertification trust funds and NGO participation in the development of national action programmes. The whole process translated into an important capacity-building exercise for the NGOs, many of whom had never attended an international negotiation before, let alone had the opportunity to play an advocacy role in such a forum. At the first INCD session in Nairobi, there were only 15 NGOs represented. By INCD-5 there were over 50 NGOs actively participating, with over 230 accredited. The impact these NGOs had on the Convention and the role they are preparing to play in its implementation have set an important precedent.

Change in Donor Activities:

This process has also stimulated key changes in the attitudes within the donor community. First, there has been an important change in the attitude of policy-makers regarding the socio-economic dimensions of the desertification problem and the need for incorporating these factors into action programmes.

Second, this process has stimulated a new awareness on the need to coordinate action and aid programmes. There has been a heightened awareness of the problems in national and regional resource management and the need to build on the very concrete successes and to avoid replication of the failures of the 1977 Plan of Action. This process not only addressed the issue of the orientation of development aid, but has prompted the need for pointed efficiency in aid spending through the increased coordination and cooperation that will be catalyzed by the new Global Mechanism. Through the Mechanism aid flows should be better monitored and assessed, and efforts should be stimulated to increase aid coordination on the ground, ensuring that good pilot programmes are developed and replicated. The Mechanism should also help stimulate increased awareness within the international financial institutions, such as the World Bank, the IMF and the regional development banks, regarding the new approach that must be taken in combating desertification.

Short Comings and Setbacks

No New Financial Resources:

Perhaps the most concrete shortcoming of the Convention, according to many developing countries, was the lack of commitment for new and additional resources. During the finance negotiations, the G-77 stressed the need for a desertification fund as well as new and additional financial resources. On the other hand, donors were only prepared to discuss such matters as increasing the efficiency of current aid flows. Even with the increased coordination and efficiency that may result from the operation of the Global Mechanism, some felt that the monies freed up would not fully meet the large-scale costs needed to combat desertification and mitigate the effects of drought. Given the realities of national sovereignty and international law, the most that could be achieved was the articulation of a framework for action to be taken at the national, subregional or regional levels. Even the regional annexes were not able to set out specifics.

Dissatisfaction with the Global Mechanism:

There is also concern about the Global Mechanism itself. OECD countries did not support the G-77's call for a desertification fund, citing the failure of

the fund to implement the 1977 Plan of Action, and commenting that the overhead and administrative costs associated with such a fund would markedly reduce the amount of funds available in the field. The compromise — the establishment of a Global Mechanism — met the concerns of the donors, however, many Africans were dissatisfied, arguing that such a mechanism would not catalyze new and additional resource and would divert limited resources to other regions. This led some to remark that "the thieves had got the banquet". Furthermore, the current language also provides a hazy picture of the functions of the Global Mechanism, with no indication as to how it will be set up, administered, or implemented.

Insufficient Scientific Input:

Many lamented the fact that the immense body of technical and scientific expertise on the problem of desertification did not fully infuse the Convention as much as had been hoped. This may have resulted from the fact that the objective of most African delegates was to create a convention that would focus on development assistance and catalyze the provision of new and additional resources, not one that would focus on science.

As the negotiations shifted from the scientific to the political realm, many of the technical aspects of the causes and results of desertification got buried in a graveyard of brackets. As a result, delegates continually lost sight of the larger picture and the urgency of the problem despite the Chair's constant reminder of the 900 million people whose survival depends on the Convention. Some delegates thought that a greater infusion of scientific and technical expertise, along the lines of the IPCC in the climate change negotiations, would have maintained a better balance between science and politics. However, when the INCD was formed, many maintained that over 50 years of research had already been done on this subject, obviating the need for a new intergovernmental scientific body to support the negotiations. Nevertheless, INCD-1's information sharing segment raised the awareness of the international community of the scientific and technical aspects of desertification not only in Africa but in other parts of the world. This set the process in motion for the recognition and acceptance of the need for instruments for other regions other than Africa.

Lack of Linkages Between Environment and Development:

Another criticism of the process was that stronger links should have been drawn between the environment and development components of the problem. The Convention became a development convention negotiated largely by Northern aid specialists and Southern environmental experts and bureaucrats and diplomats, rather than an environmental convention. Although this may not be altogether negative in the context of combating desertification, it does illustrate the fact that the linkage between environment and development — sustainable development — is still more of a concept than reality.

Lack of High-level Involvement:

Finally, INCD-5 did not include the high-level participation that had been anticipated, largely due to the low profile from which the desertification problem suffers in the international arena. This was especially problematic where negotiations tended to slow or indeed break-down for lack of mandates on the part of negotiators, necessitating frequent consultation with national capitals, even around "misplaced modifiers" and other grammatical changes. Perhaps higher political profile and participation would have led to a stronger Convention. On the other hand, a Convention is only as strong as the commitment of national governments to implement it. It will take considerable political impetus at this point to ensure that focus remains on desertification and the Convention during the crucial months to come. Based on the lack of political impetus to date in some developed countries, this could prove to be a major challenge.

Critical Next Steps

Now that the negotiation of the Convention and its four regional annexes are complete, there are several crucial steps that must be taken to ensure that the Convention is ratified and that momentum is not lost before its entry into force.

Prompt Ratification:

The first step is to achieve prompt ratification of the Convention. While the process and difficult financial negotiations may be construed as an indication of the willingness to support the Convention, most delegations, both from developed and developing regions acknowledged that one of the biggest challenges now is the ratification of the Convention. It will be particularly important to sell the Convention in the North and to ensure that it receives support at the highest political levels.

Urgent Action for Africa:

In the meantime, OECD and African countries must work together to ensure that the resolution on urgent action for Africa is implemented. The OECD countries must work together more productively, perhaps even through the formation of partnerships where funding from one country could be matched with technical expertise from another. This, in turn, could be matched with the very real needs of affected regions in Africa. As the negotiating process has demonstrated, there is an urgent need to channel more coordinated assistance to Africa. There is also a need to: move from a traditional donor-recipient relationship to a true partnership association; generate a more productive ongoing dialogue with the Africans; and increase the percentage of financial assistance that actually reaches projects by reducing or eliminating such obstacles as tied aid and excessively high overhead costs.

Mobilizing Public Awareness:

Another important step is the necessity of mobilizing local and community interest in the Convention and the preparation of

national action programmes. The key challenge is that many governments do not have a tradition of popular participation. Access to information is very limited and bottom-up input is practically non-existent. NGOs and governments alike must embark on a major campaign to disseminate information to grassroots and community organizations to ensure that bottom-up input is received and incorporated into the action programmes. Unless the actual needs of communities are taken into account in the preparation of these action programmes, the Convention could be considered a failure.

The negotiation of this Convention was difficult, the implementation process will not be any easier. The concern that emerged from the negotiations on the financial provisions of the Convention will have to be overcome. Developed and developing countries alike, along with support from the NGO community, will have to work together to ensure that this Convention has an impact on the 900 million people throughout the world, particularly in Africa, who are the real foot soldiers in the battle against desertification.

INCD-6:

The sixth session of the INCD will meet in New York in January 1995. The provisional agenda for this session, as adopted in Paris, includes: adoption of the agenda and organization of work; work programme for the interim period; preparation for the Conference of the Parties; status of signature and ratification of the Convention; review of the situation as regards extra budgetary funds; and adoption of the report.

NGO Activities:

NGOs are now preparing for the implementation of the Convention. To facilitate their participation in the preparation of action plans, the NGOs in Paris established a network to be known as "Reseau International des ONG sur la Desertification" (RIOD). RIOD will operate at the community, national, subregional, regional and international levels. Each country, subregion and region will have a focal point. At the international level, the Environment Liaison Centre International (ELCI) in Nairobi will function as a member of an interregional committee constituted of other NGOs — one each from Latin America, Asia, Europe, Australia, North America and Africa. These focal points were to serve on an interim basis until a larger assembly of NGOs at a meeting held in Ouagadougou, Burkina Faso, in November. A planning committee has been established and more information will be circulated when available. For more information, contact Heinz Greijn, Environment Liaison Centre International, PO Box 72461, Nairobi, Kenya; phone: (254-2) 562015; fax: (254-2) 562175; e-mail: elci@gn.apc.org.

Note: *The International Convention to Combat Desertification* is available in English, French, Spanish, Russian, Arabic and Chinese from UNEP/DC-PAC, P O Box 30552, Nairobi, Kenya: Fax No (254) 2 215615 and from the INCD Secretariat in Geneva.

Draft Resolution on Urgent Action for Africa

The Intergovernmental Negotiating Committee for the Elaboration of an International Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa.

Having adopted the text of the United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa,

Considering the priority given to Africa in the Convention and the need for urgent measures to be taken during the period between the adoption of the Convention and the first meeting of the Conference of the Parties, consistent with the objectives of the Convention,

Considering the significant activities already being undertaken by affected African countries with the support of the international community, consistent with the objectives of the Convention,

Considering further the desirability of initiating without delay the implementation of further measures consistent with the objectives of the Convention in and with the affected African countries and of continuing to pursue or strengthen, where necessary, such measures where they are already in place,

Acknowledging with appreciation the preparatory and ongoing work carried out by affected African countries and the assistance provided by a number of countries, by multilateral organizations, including the United Nations Environment Programme (UNEP), the United Nations Development Programme/United Nations Sahelian Office (UNDP/UNSO), the African Development Bank (ADB), and intergovernmental organizations, including the Organization of African Unity (OAU), the Organization for Economic Cooperation and Development (OECD), the Economic Commission for Africa (ECA) and non-governmental organizations.

1. Encourages all countries to disseminate information and promote education and public awareness about the objectives of the Convention;
2. Invites the affected African countries to take urgent steps, in particular, to prepare national and subregional action programmes or, where action programmes exist, such as National Environmental Action Plans, to review and improve them, if necessary, and implement them, consistent with the objectives of the Convention;
3. Invites the developed countries to provide support to the affected African countries in such actions, including those in capacity-building;
4. Invites international and multilateral organizations, particularly UNDP, including UNSO, UNEP, the Food and Agriculture organization of the United Nations (FAO), the World Meteorological Organization (WMO), the International Fund for Agricultural Development (IFAD), the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the World Bank, to provide support and mobilize necessary for the implementation of the present resolution;
5. Invites African subregional and regional organizations, particularly the organization of African Unity (OAU), the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS), the Preferential Trade Area (PTA), the Intergovernmental Authority on Drought and Development (IGADD), the Southern African Development Community (SADC), the Arab Maghreb Union (UMA), the African Development Bank (ADB) and the Economic Commission for Africa (ECA), to provide support for the implementation of this resolution;
6. Invites private sector organizations, including relevant non-governmental organizations, to provide support and mobilize necessary resources for such actions by the affected African countries;

7. Recommends that the affected African countries designate coordinating bodies at the national and subregional levels, if necessary, and at the regional level for the implementation of this resolution;

8. Recommends, as priority, the establishment, at national and subregional levels, in the affected African countries, of partnership arrangements with the relevant developed countries, intergovernmental regional economic organizations, non-governmental organizations and representatives of the affected local populations to facilitate the coordination of activities, to be initiated by the individual African country concerned;

9. Recommends also that such partnership arrangement should inter alia:

(a) Provide support to proposals in the preparation of national, subregional and, to the extent possible, regional action programmes of the affected African countries;

(b) Where national action programmes exist, review them and consider action that may be needed to improve or reorientate them, as necessary;

(c) Improve coordination of effort at the national, subregional and regional levels, taking into account those programmes and projects to combat desertification that are in progress, including those supported by the international community;

(d) Provide support for the implementation of specific project proposals within the context of national, subregional and regional action programmes;

10. Invites the developed countries and the international and multilateral organizations, agencies and programmes to provide enabling funds to support the partnership arrangements referred to in paragraph 7 above;

11. Invites the affected African countries to provide information at the time of signing the Convention, on the actions that they have taken or propose to take, during the interim period, for the implementation of this resolution;

12. Invites the developed countries, subregional, regional, international multilateral organizations and United Nations agencies and programmes as well as those countries that may provide assistance on a voluntary basis, to provide information, at the time of signing the Convention, on the actions that they have taken or propose to take, including the provision of financial and other resources, during the interim period, for the implementation of the present resolution;

13. Invites also the affected African countries to propose, as appropriate, additional measures to be taken at the subregional and regional levels in support of national actions;

14. Requests the interim secretariat to the Convention to facilitate the implementation of the present resolution, consistent with the responsibilities allocated to it by the resolution of the Committee concerning interim arrangements;

15. Invites those countries that are members of relevant United Nations agencies and programmes and regional or multilateral financial institutions to bring to the attention of those institutions the content of the present resolution and promote their support for it.

UN General Assembly Highlights: Convention to Combat Desertification

The 49th United Nations General Assembly held its debate on Agenda Item 89 (d). "Elaboration of an international convention to combat desertification in those countries experiencing serious drought and/or desertification, particularly in Africa" on Friday, 21 October and Tuesday, 25 October 1994. Although the debate on this issue was held in the General Assembly plenary, action will be taken in the Second Committee. In connection with this item, the General Assembly had before it the report of the Secretary-General on UN Convention to Combat Desertification (document A/49/477) and a note by the Secretary-General transmitting the reports of the Intergovernmental Negotiating Committee for the Elaboration of an International Convention to Combat Desertification (INCD) on its third, fourth and fifth sessions (A/49/84 and Addenda 1 and 2).

During the course of the debate most Governments noted that this Convention was innovative in its recognition of the physical biological and socio-economic aspects of desertification. The Convention also recognizes the importance of redirecting technology transfer so that it is demand driven. The involvement of local populations in the development of national action programmes was also cited as an innovative provision. Most delegates stressed that political commitment is essential at this stage if the Convention is to be a success. Developing countries specifically mentioned the need for new and additional financial resources. While many were pleased with the fact that 87 nations signed the Convention in Paris at the ceremony on 14-15 October 1994, they urged more Governments to sign the Convention in New York and called for rapid ratification and entry into force.

Drylands, People and Desertification Control -UNEP Looks Ahead*

By Franklin Cardy,

Deputy Assistant Executive Director and Director, Desertification Control Programme Activity Centre, UNEP

UNEP's job is to draw attention to important environmental issues and help identify effective responses. We are gratified that after years of effort on desertification, there is now a Convention on Desertification which we hope will act as a magnet for worldwide political commitment.

Negotiation of the convention text was completed within two years of the Rio conference - a singular achievement, and one of the most significant results from Agenda 21. At an October ceremony in Paris, 87 countries signed the Convention, including the major donor countries, and there were more signatures later at the United Nations General Assembly in New York. This strong response augurs well for the degree of political commitment necessary if the convention is to be ratified quickly and implemented effectively.

In spite of this successful conclusion to two years of intense international collaboration, desertification continues to demand UNEP's attention. There are reasons for this. One is that much remains to be done to persuade the world's nations that this convention addresses issues which are critical, not only to the future stability of the drylands and their populations, but also to the global community.

Another is that we still have to overcome the effects of the confusion caused by changing definitions, inadequate data-bases and professional skeptics. There is no question that the scientific basis for determining the extent of desertification is too subjective. The Atlas of Desertification published by UNEP in 1992, is based on the best available assessments from national experts around the world but there are clear inadequacies in this sort of data-base. More detailed information of better quality is urgently needed, but the information that is already available shows convincingly that land degradation has worldwide impact and is increasing in scope and severity.

In addition, it remains necessary to demonstrate that desertification control is not a narrow sectoral activity. Successful action against land degradation, requires effective management of the environment as a whole, to support sustainable levels of production.

There has to be a more integrated approach by Governments to managing their overall dryland environments. This requires moving from sectoral action plans which are implemented independently and may even conflict, to a more comprehensive sustainable environmental management approach. This will take time and will not be easy. The physical and economic interlinkages between different sectors are only beginning to be appreciated fully and the more complex social interlinkages have yet to be understood adequately.

And yet the social issues are fundamental. The approaches of the past have been less than successful because they overlooked the people, the hundreds of millions of people who face the issue every day and are the best hope for resolving it.

As Ambassador Arba Diallo Executive Secretary of the INCD has ex-

*This article is reprinted from the November Special Edition of *Our Planet* on Desertification. *Our Planet* is UNEP's house journal which is published bi-monthly covering a wide range of environmental topics. *Our Planet* is available free of charge from UNEP/DC-PAC and UNEP/ IPA

plained so eloquently, the reason why desertification is so critical is because, through the loss of productivity of the land, people are being forced to leave their land and migrate in search of sustenance, or die.

The Almeria Statement, prepared by an international workshop in Spain on Desertification and Migrations in February 1994, suggested that there should be a "Right to Remain" for those who wish to do so. There are many, especially women, who wish to remain on their land but no longer can, because the land productivity and the available support from the local community or government can no longer sustain them. Ways must be found to help these people help themselves.

At UNEP, the desertification programme has been reviewed in depth. We now anticipate that there will be more attention given by our partners to implementing desertification control, so we plan to focus on certain key areas. These include the assessment, evaluation and dissemination of better information especially for the wider public. We shall work on emerging issues and on linkages with others such as migration and trade; and we will promote innovative and people-oriented approaches. We also plan to work with affected countries to develop practical measures to create the "enabling environment" at the field level for people to sustain themselves. The administrative challenges of implementing a truly "bottom up approach" are formidable; how it will be done is not yet clear, but we shall be actively encouraging important initiatives in this direction.

Where outside help is required to support village initiatives, ways have to be found to ensure that this is appropriate support, not based on external ideas of what the people need. This will require development of greater skills in listening to the people and hearing what their needs and interests really are. Once these are identified, it is often possible to find ways to help them meet their objectives, within the framework of assisting the wider community or ecosystem.

Controlling desertification involves all aspects of environmental management. The role of water management in desertification control is fundamental and much rainfall still goes to waste. More effective water harvesting is possible in many places. Other global issues such as biodiversity conservation, climate change and north-south economic linkages have to be tackled with land and water management in an integrated manner. At UNEP we plan to demonstrate that the drylands of the world and the people and ecosystems they include, are a large, integral and crucial part of the social, economic and physical structure of the global community.

Work now has to be done to publicise the Convention and encourage its early ratification and coming into force. We will support and facilitate the implementation process and continue to raise public awareness about the seriousness of the issue and the need for concerted and effective, sustainable action in the field. Once it becomes clear that a coordinated and effective approach to the sustainable development of dryland ecosystems is being implemented, at the local level and with the support of the global community, then we shall feel our task has been accomplished.

In the meantime, we shall continue to press for a broader understanding and awareness of the problem and encourage, through whatever means available, the more effective implementation of sustainable environmental management activities in the drylands of the world.

Population, Environment and Sustainable Development: Desertification in Africa*

Paper presented at the Round Table Confrence on Population, Environment and Sustainable Development at the International Academy of the Environment, Geneva, Switzerland, 24 - 26 November 1993

M.B.K. Darkoh,

Ph.D.
Professor and Chair of Geography,
University of Papua New Guinea

Concept and definition

Despite the different definitions and contentions about what is desertification as reflected in the works of individuals and international organisations in the past, I think the world development community has now reached a consensus on what is a much more composite or comprehensive definition, which can provide an adequate basis for analysis of the problem and possibly the development of appropriate and effective mitigating policies. I dare, therefore, suggest that the forum accept for operational purposes the latest internationally negotiated definition of desertification adopted by the UN Conference on Environment and Development (UNCED) which says that:

"Desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variations and human activities."

The inescapable fact is that desertification is caused by the interactions of climate and human abuse or misuse of the environment. Thus, while focusing our attention at this round table on population or the human side of the problem, it is important that we do not lose sight of the other (the physical). The more so, because the purpose of our meeting is to respond to the many calls in *Agenda 21* for more policy relevant knowledge about the relationship between environment and sustainable development, of which the demographic factor of course, constitutes only one, albeit a very important variable in the equation. It is surprising that the Report before us overlooks this consensual definition.

Emerging from our accepting this definition of desertification as land degradation in drylands for whatever reason, I would like, for operational purposes, to point out that the drylands in Africa face three major environmental predicaments: (1) unpredictable and at times severe drought. I use the term drought here to refer to short-term (1-2 years) deficits in rainfall which can generally be accommodated by existing ecological, technical and social strategies. (2) desiccation or aridification due to chronic drought. I use the term desiccation here to refer to longer-term (i.e. decadal order) deficits in rainfall which seriously disrupt ecological and social patterns and which require national and global responses. I would like to stress that it does not, however, necessarily follow that drought and desiccation, by themselves, will give rise to desertification in dry-land areas. Much depends on the nature of the resource management in these areas. When human misuse (mismanagement) of land weakens the natural system, drought and desiccation often lead to desertification. (3) dry-land degradation brought about mainly by inappropriate land use. Dry-land degradation manifests itself in the slow secular decline in productivity of the land through such human mismanagement as overcultivation, overgrazing, deforestation and poor irrigation practices.

*This article is this author's commentary on "Issues in Sustainable Development : Population, Poverty, and the Environment" Publication No. R11 of the International Academy of the Environment, Geneva, Switzerland a report prepared by Mary Barberis in October 1993 for the Round table discussion on Population, Environment and Sustainable Development.

Although the three problems overlap on the ground, their discrimination is important for the development of appropriate and effective policies. In assessing the linkages between population, poverty, environment and sustainable development, however, I presume, it is the third aspect of these three environmental predicaments that will be our principal focus.

Extent of the problem of desertification

Even more surprising is the lack of information in the Report before us on the latest data sets on the extent of desertification in Africa. Perhaps, it may not be out of place (and this is only a minor criticism) to point out that the Report limits its documentation to only one principal source i.e. World Bank Reports - occasionally and randomly making mention also of others such as IIED and FAO reports, and almost completely ignoring the tremendous and generally useful work done by UNEP and UNSO on desertification.

However, thanks to the resolute efforts of these two international organisations, we now have what can be regarded as more precise data not only on the extent of the drylands in Africa (and the rest of the world) but also on the status and trends of desertification. In 1990-91, in accordance with the provisions of the UN General Assembly resolution 44/172 of December 1989, UNEP carried out a new assessment of the status of desertification and a new world map of drylands was prepared by the GEMS/GRID Programme Activity Centre of UNEP in 1991. The new data is regarded as more precise because they are based on time-dependent climate data selected by rigorous criteria.

According to these new data, drylands in Africa comprise 1959 million ha or 65 per cent of the continent and 32 per cent of the world's drylands. One third of this area is hyper-arid (762 million ha) and uninhabited (except at oases), where by definition, desertification is ruled out since the area is already a desert. The remaining two thirds or 1,287 million ha comprise the arid (504 million ha) semi-arid (514 million ha) and dry sub-humid (269 million ha) areas. These latter three sub-areas are commonly referred to by the acronym ASAL (Arid and Semi-Arid Lands). Nearly 400 million people (two thirds of all Africans) live in this ASAL, currently the most densely peopled part of the continent.

Again, from the 1991 assessment of the status of desertification, we now know that the total area of agriculturally used drylands in Africa is 1432.59 million ha of which 1045.84 million ha or 73 per cent is presently degraded at a moderate or high degree.

The extent of desertification in Africa on the basis of the three principal land use categories of irrigated lands, rainfed croplands and rangelands, according to UNEP, is as follows:

Irrigated Lands			Rainfed Croplands			Rangelands		
Total	Degraded		Total	Degraded		Total	Degraded	
m.ha	m.ha	%	m.ha	m.ha	%	m.ha	m.ha	%
10.42	1.90	18	79.82	48.86	61	1342.35	995.08	74

Source: UNEP (1992) Status of Desertification and Implementations of United Nations Plan of Action to Combat Desertification, Report of the Executive Director, Nairobi, UNEP, p.81.

Human population

The Report also does quite a good job of analysing the relationship between population growth and land degradation, and it quite correctly says that there is a general consensus among development experts that rapidly growing poor rural populations are being increasingly forced by circumstances to degrade the environment. It does not, however, sufficiently bring out the fact, which some have found in the field, that population growth is not itself directly related to degradation, but is an important (albeit very important) component in a mix of factors that include drought, desiccation, poverty, powerlessness, inappropriate agricultural policies and ineffective land laws (UNSO 1992). The same applies to the connection between land degradation and population density. It is seldom direct or clear cut. And as it correctly documents from studies by Mortimore, there are certain large concentrations of people in the Sudano-Sahelian area, notably around cities like Kano where degradation is not acute. In such instances, perhaps, more people means more labour to till and protect the land. While population density may be one cause of land degradation, it is rarely the primary one and like rapid population growth, is never the only one.

Migration

People in the ASAL lands of Africa have strong traditions of migrations stretching back centuries. Migration often tends to reinforce the effects of natural population growth and population density. These have important environmental implications.

Migration generally takes three forms:

1. rural-urban migration i.e. migration caused by the urban pull.
2. rural-to-rural flows.
3. emigration - or the steady loss of labour especially of able bodied males, which is keenly felt in rural areas.

All three types are common in the ASAL. They are particularly pronounced in the Sudano-Sahelian countries.

In Kenya, my own work in 1990 in relation to the preparation of the Draft Environmental Action Plan for Sustainable Development in the ASAL for the World Bank and Kenya's Ministry of Land Reclamation and Regional and Water Development reveals three migratory trends in the ASAL: permanent immigration, temporary or seasonal emi-

gration and return migration. The first two are of particular importance to environmental issues in ASAL. Several factors influence these migration trends, including climate, security, tradition, availability of central services, famine relief, gainful employment in towns, irrigation schemes and seasonal labour in high potential districts.

Permanent immigration in the ASAL

With high population densities in the high potential areas, more and more people are moving from these areas into the marginal zones in search of farming land and employment opportunities. Environmentally this is the most important form of migration as it is these immigrants who often cause land pressure and import inappropriate technologies that lead to land degradation. They also disrupt the indigenous management systems which are based on appropriate and locally adapted technologies.

Sometimes, this permanent movement of population into the ASAL is part of a deliberate government policy of solving the population-resource problem by encouraging planned settlement and cultivation in the wetter margins of the arid and semi-arid lands, or irrigation schemes.

Seasonal emigration out of the ASAL

Another important migratory phenomenon in the ASAL is temporary out-migration of men in search of work. The reason for this migration is that most dryland farming and pastoralists households are unable to earn enough cash from herding and farming alone. This type of migration rate is higher in the mixed farming belt than it is in the areas where pastoralism prevails. In the ASAL, temporary out-migration increases sharply during drought years and falls in years of good rainfall. In years of adequate rainfall, many stay away for short periods of time while in drought years they may stay away for up to six months or possibly more. Such migration is essentially a traditional drought-coping strategy and has positive implications for the environment.

Return migration

This mainly occurs when people return from the city to rural areas, for instance on retirement or when there are better opportunities for jobs or farming in the home district.

Land use conflicts

Permanent and seasonal migrations of populations within the ASAL, especially movement of farmers from the over populated adjacent high potential areas (where arable land is in short supply) to the arid and semi-arid lands seems, on the basis of the evidence I have gathered from fieldwork all over Kenya and Tanzania, the main threat to the environment in the ASAL. It is giving rise to land use conflicts. These conflicts arise as a result of intrusion of agriculture into lands traditionally used for domestic stock. Partly because of a lack of coordinated national land use policies for ASALs, there is competition for resource use between the various production sectors. The major contenders are agriculture, livestock, wildlife and settlements. Often the weakest sector - pastoralism bears the brunt of this fierce competition for resource use, consequently becoming increasingly marginalised.

The conflicts are especially intense in the key production areas within the ASAL. These are the riverine forests along the main water courses, the natural forests, swamps and hilly areas. The dynamics of the conflict in these key production areas which are currently some of the most threatened marginal productive lands within the ASAL need to be investigated thoroughly in order to devise policies and strategies for their rehabilitation.

Other conflicts relate to the seasonal movement of wildlife or what has been called wildlife dispersal corridor conflicts. In Kenya, for instance, between 65 and 80 per cent of wildlife live outside the parks. Many wild animals migrate during the wet season out of the parks and tend to concentrate within them in the dry season, using them as dry season water and range reserves. The major conflict outside the park boundaries by free roaming animals is with agriculture. Major problems relate to the destruction of crops by the trampling of elephants, buffalo and wildebeest. Conflicts also arise because of predations of livestock by wild animals such as hyenas, leopards, lions and jackals as well as the transmission of diseases.

Refugees:

Another special kind of population movement has recently emerged : the large movement of refugees has been triggered by war, drought, desiccation and dryland degradation in the last two decades. The heaviest burdens are felt near the international borders with countries in which there are civil wars - Sudan, Djibouti, Ethiopia, Guinea, Somalia, Kenya, Tanzania, Rwanda, Burundi and Cameroon are particularly heavily burdened. Refugees have had considerable negative impacts on the environment as in parts of the Sudan and Tanzania. In Africa we are still not clear whether the "refugee problem" is simply a manifestation of otherwise underlying conflicts over resource access and use. One of the priority areas for policy relevant research is the refugee-environmental degradation nexus.

Population and degradation

Is the understanding of the interlinkages among population, poverty, environment and sustainable development sufficient for purposes of policy formulation and implementation?

In my view, from the background document and from my own research findings, the following seem pertinent (1) The first and most striking feature of the ASAL's social structure is continued rapid population growth. There is wide agreement, despite the inadequacy of the data

base that the high rates of growth are real and arise principally as a result of the huge gulfs between crude birth rates and death rates and the effects of migration and other factors. It also appears that these high growth rates will continue for some time. Increases in population size have been projected to rise for at least another two decades.

The rapid population growth is a development problem for several reasons. First, it exacerbates the difficult choice between higher standards of living now and the investment needed to bring higher standards of living in the future (Clausen 1984). Second, in many countries, increases in population threaten what is already a precarious balance between natural resources and people. Continuing large increases in population can contribute to overuse of limited natural resources such as land for agriculture, and fuel wood, mortgaging the welfare of future generations.

Third, rapid population growth is creating urban economic and social problems that risk becoming wholly unmanageable. Fourth, with rapid increases in population growth, more and more people are swelling the ranks of the poor in both rural and urban areas. The number of people below the poverty line in sub-Saharan Africa in 1985 was 184 million. This is projected by the World Bank to increase to 304 million in the year 2000, an inexorable expansion of the number of human beings condemned to lives of deprivation and desperation.

The World Bank has further estimated that by the end of the decade about one quarter of the world's poor will live in sub-Saharan Africa. Fifth, growing population means shortening of fallow cycles and the need to deal with more destitution during droughts. More mouths to feed especially after drought and desiccation, and more people to consult, can only bring problems to those who are responsible for welfare (UNSO 1992). Finally, population growth increases the demand for goods and services and if practices remain unchanged, implies increased environmental damage.

The relationship between population density and land degradation as we have already indicated is not that straight forward, and perhaps more research work is needed to establish the precise relationship. Similarly, although increasingly much is now known about population movement and resulting population pressures on natural resources, further research work is needed in these two areas as well. Research is needed to assess the dynamics and impact of population movement and resettlement on the carrying capacity of arid lands.

An intriguing question related to this issue of population movement and resettlement is why migrants in ASAL cling to imported habits and practices that they themselves know are sometimes harmful and not suited to ASAL environments. Only social science research can provide the answer to this question.

Impact on agriculture (Crop Production)

The relationship between population growth and productivity increase in agriculture has been adequately brought out in the Report. The slow growth in agricultural production in relation to population growth would seem to suggest some Malthusian and Von Thunian scenarios in play : population expanding beyond the capacity of the land to support it; and expanding onto the poorer land, giving lower returns per hectare for labour and other investments and probably more degradation and susceptibility to drought.

An important factor not discussed in the Report is the relationship between cash cropping and food cropping. It would be interesting to note how cash crops combine with population growth to encourage farmers to overcultivate the declining areas reserved for food or to cultivate them poorly and at the wrong time or to neglect them and how these relate to land degradation and hunger. It will also be interesting to see how the land squeeze works on an individual's plot and at national levels.

Rangeland degradation

The Report partially portrays the state of our present knowledge on animal population and rangeland degradation. However, in recent years some significant paradigmatic changes have occurred in the discipline of range science with regard to overgrazing and the carrying capacity of rangeland in arid and semi-arid areas, which have not been sufficiently portrayed.

The new paradigm in range science suggests that the problem is not just one of too many animals relative to available grazing areas but that the state of the rangeland ecosystems in arid and semi-arid areas has more to do with the highly irregular supply of rainfall than anything else.

The new paradigm suggests that "overgrazing" or extensive grazing systems have been greatly overestimated as an environmental problem. Seven reasons are given according to UNSO (1992). First, herds seldom reach carrying capacity between droughts. Second, rarely can enough stock be kept over the dry season to damage wet-season pastures. Third, it is hard to measure "carrying capacity" where pastoralists are constantly moving between many different types of rangeland. Fourth, herds usually recover quickly after droughts, suggesting that there has been little long-term damage to the range. Fifth, herds have continued to increase over many decades despite repeated claims of overgrazing. Sixth, where earlier range scientists saw extreme damage to the grazing lands around watering points, recent studies show that pressure can be improved in these areas as nutrients are brought in by cattle from surrounding rangeland. Seventh, many pastoral communities have been shown to have developed methods for managing the range.

The new paradigm would seem to point towards policy makers looking in other directions such as drought preparedness, early warning systems, insurance schemes and other measures of contingency planning rather than to destocking as a solution to the desertification problem in rangelands.

Fuelwood supply

Fuelwood cutting can have some of the most serious, though localised, effects on dry-land degradation in certain areas, es-

pecially in urban centres where considerable amounts of charcoal is used. Fuelwood and charcoal are a critical resource for the poor. They are the cheapest available fuels per ton and per unit of heat and they are used extensively if not exclusively to provide energy for cooking, heating and light. The poor compete for fuelwood with richer urban users who demand charcoal-grilled meat, baked bread, beer and the like, all dependent on wood. UNSO (1992) has noted that in purely rural macrocosm, with dispersed settlements, fuelwood seldom has been a great problem. My own research in East Africa has revealed that except in some highly localised or highly populated rural areas like the Ethiopian Highlands and some parts of central Tanzania, little evidence exists to suggest that rural household energy consumption is responsible for large scale deforestation. Mounting evidence from all over the ASAL seem to point out that it is rather the urban demand, usually for charcoal, that leads to the wholesale cutting down of forests. The commodity status of charcoal makes it an attractive choice for entrepreneurs who can derive incomes from its production and distribution.

Intense wood cutting causes the severest form of land degradation near urban areas. The effects of wood cutting around cities include fuelwood scarcity and ever longer journeys made and man-hours spent on the quest for wood supplies, often by women and children. The need for woodfuel and land for cultivation, however, poses a real threat to the remaining areas of forest lands, especially the riverine forests within the ASAL.

Need for policy-oriented research and development options

It is quite clear that population is a critical factor in desertification in Africa. While we must concede that a lot is now known about population trends and dynamics and how these relate to land use pressures, there are still definite gaps in our knowledge of how population interacts with other variables to have a detrimental impact on the environment and natural resources.

The other variables can be classified as both internal and external. Among the internal factors are absence of political stability, civil wars, illiteracy, failure to work out priorities, national policies, growing poverty, landlessness, lack of appropriate technology, natural and man-made disasters such as drought, dessication, disease, and famine; poor rural infrastructure, subsides and pricing policies; inadequate and ineffective agricultural support services, lack of managerial and financial skills.

Among the external factors are the lack of new credit, mounting national debts, and debt servicing burdens, adverse terms of trade; falling commodity prices; the IMF's conditionalities and the World Bank's structural adjustment policies, depression of prices and quota systems of purchase of primary produce; and the unequal economic relations that the North imposes on these ASAL countries of Africa.

To a certain degree desertification is associated with human population and human activity. Indeed one could argue that one force behind desertification is the social transformation produced by development. Modernisation and population growth in Africa have been putting increasing pressure on available land and other natural resources. The result has been a major transition from traditional to modern patterns of livelihood. We are still not very clear on how change causes deviation from normal mechanisms of resource utilisation and the resulting impacts such changes have on the environment.

An example of needed research initiatives : community management of natural resources [1]

After decades of abortive efforts to develop the ASAL it is being realised today that sustainable natural resource management and utilisation are critically dependent upon the ability of local communities to control the resources from which they derive their livelihood. The local people do not only have the useful local knowledge of their environment but have sound management strategies that enable them to survive in a region with extreme climatic and, at times erratic water supply; they also have a vested interest in conserving their local resources for sustainable use. The recognition of these facts has supported the idea of decentralising authority over natural resource management.

At the same time, some African governments seem to have entered a phase in which their political penchant for highly centralised authority and often autocratic rule, is being eroded. As perceived stability and security needs are diminishing, with independence being consolidated and national identity forming, and as political conditionality (the linking of development assistance to political liberalisation) is taking hold, these countries are moving towards more democractic systems. The building of representative local government, a prerequisite for more decentralised approaches to natural resource management is becoming a priority in this context.

Efforts to devolve authority on natural resources management to local level institutions requires changes and adaptations in policy and practice on national and local levels. There must be in place research programmes that continually monitor and evaluate the new experi-

1 This section is based on Krugmann (1992)

ments. We need answers to a host of questions in this connection.

For example, how best can local representative institutions be built to encourage effective participation of the local population? How can these institutions' capacity to manage natural resources be strengthened? What are the decision making processes that govern local use and management of natural resources, and how are they changing as a result of decentralisation? What are the roles of customary and statutory laws in regulating access and rights over resources at the local level and what resource tenure regimes are most suitable for facilitating equitable and sustainable resource management? How are they affected by markets and the cash economy? How can local resource management enhance the livelihood and development of communities and contribute to their empowerment (ability to articulate their needs and to influence the ways to satisfy them)?

These and related questions must be addressed in a variety of experiments, across different ecosystems as well as within socio-economic and political contexts.

Towards sustainable development : a personal perspective

Drought and land degradation/ desertification have inflicted and continue to inflict tremendous loss of life and livelihoods on the people of Africa's drylands. The nature and scale of the problem facing the populations in these drylands are well known. In some countries oppression and armed conflicts make any efforts towards sustainable development an impossibility; in others the problems are not given priority by international and bilateral agencies because the countries concerned are strategically unimportant.

Climate change is now expected to make things worse for the people in the coming decades. There is probably little that can be done, by governments or anyone else to avert this climatic threat to our ecological and social fabric. With the essential support of the international community, however, the people of the drylands in Africa must find ways to deal with the problems, as they have done for many centuries with only their own resources.

Local communities cannot undertake the enormous task of resource rehabilitation and conservation without support from their governments and the international development community. External assistance is required to supplement local efforts and initiatives. It is important that such assistance should reinforce local efforts, enhance local capabilities, build upon local knowledge and skills and respect community priorities. Local people possess assets in the form of empirical knowledge of the individual elements of the ecosystem, of their inter-linkages, and of the way in which these relations change through time. The outsiders could do well first to identify and prioritize this local knowledge. Such knowledge can then be applied via farmer's participation in the design, testing and adaptation of appropriate technologies. Finally such knowledge can be efficiently shared via farmer-to-farmer or herder-to-herder technology transfer.

Local agricultural and pastoral production systems are the backbone of African food security. They are best adapted to local soils, resources and ecosystems. Contrary to common belief, many of these production systems have the potential to produce surpluses for market and can under appropriate stimuli feed the ever increasing population and also serve as the basis for environmentally sound development. If they are ignored, it is likely that food security will decrease and environmental degradation will continue. They can best be improved by building upon existing systems rather than trying to replace them and by merging the best aspects of traditional systems with the contributions of modern science. This presents a great challenge for development assistance.

Development assistance to enhance local agricultural and pastoral systems will need to:

- place a high priority on environmental, economic, social and institutional sustainability.
- it will need to accommodate the diverse and flexible approaches typical of resource-poor agriculturalists and enhance their ability to handle risks.
- local participation, especially of women, would be an integral part of such a strategy and be one way to tap important local resources.
- it would need to account for the interacting ecological, social and economic components of low resource agriculture and improve the links between farms and external systems such as markets, extension systems and transportation networks (Horwith, 1989).

In any effort at improved land use and conservation of natural resources at the community level, one problem area would seem to be land tenure and property rights. The present situation in most ASAL countries in Africa in this respect is unsatisfactory and it is necessary to establish clear rules on the access, ownership and use of resources. Recent studies have shown that in marginally productive ecological zones such as the ASALs, common property regimes have intrinsic social, environmental and hence long-term economic advantages over private property arrangements. What is needed is understanding of all aspects of land use management within a group's territory. In some cases, it may require the formalisation or legislation and enforcement of traditional systems of land tenure and use. In other cases, individual title deeds may be necessary. Under some circumstances, it may even be necessary to evolve new property regimes and build new institutions to ensure their use.

Many environmental problems can easily be solved by adapting and applying existing traditional and customary laws and property rights to environmental protection and sustainable community resource management. Governments with support of international organisations and non-governmental organisations should look into the possibility of modernising, articulating and adapting traditional customary laws and property rights to sustainable resource management in the arid and semi-arid lands.

In conclusion, I personally hold the strong view that the knowledge and technology necessary for self-reliant liveli-

hoods, growth and sustainable development exists in the poverty-ridden rural communities in Africa. Non-utilisation of this potential results from a development bias created by the interaction between Africa and Europe through political, cultural and technological colonisation of the former. A reversal of attitudes by African elites and leaders to enable recognition of the values and potentials of their people and to use these as a focus for sustained development planning is urgently necessary.

References

Barberis, Mary 1993 *Issues in Sustainable Development : Population, Poverty and the Environment*, Final Report and Executive Summary, International Academy of the Environment, Geneva, Publication No. R. 11s

Clausen, A.W. 1984 *Population Growth and Economic and Social Development*, The World Bank, Washington D.C.

Darkoh, Michael B.K. 1993 *Desertification : the Scourge of Africa*, TIEMPO, Issue 8, pp.1-6.

Darkoh, Michael B.K. 1993 *Desertification : Its Human Cost in Africa*, Forum for Applied Research and Public Policy, (in press).

Darkoh, Michael B.K. 1993 *Towards Sustainable Development and Environmental Protection in African Drylands*, WHYDAH, African Academy of Sciences Newsletter, vol. 3, No. 3, pp 1-7.

Darkoh, Michael B.K. 1993 *Towards a Community Management of Natural Resources in the Drylands of Sub-Saharan Africa*, Paper presented at the International Conference on "Human Livelihoods in Drylands-Constraints and Possibilities", Organised by EPOS Environmental Policy and Society, Uppsala University Uppsala, Sweden, November 23-35, 1993.

Darkoh , Michael B.K. 1993 *Land degradation and Soil Conservation in Eastern and Southern Africa Sub-Region : A Research Agenda*, Desertification Control Bulletin, UNEP, No. 22, pp. 60-68.

Darkoh , Michael B.K. 1992 *Land Degradation and Resource Management in Kenya*, Desertification Control Bulletin, UNEP, No. 19, pp. 61-72.

Darkoh , Michael B.K. edited 1992 *African River Basins and Dryland Crises*, Uppsala University, Sweden.

Darkoh , Michael B.K. 1992 *Planning Arid Lands Development in Africa : Some Reflections from the Ringside*, in Security in African Drylands edited by Anders Hjort af Ornas, Uppsala University, Sweden, Chapter 3.

Darkoh , Michael B.K. 1991 *The Fuelwood Crisis in Kenya's Asal Resources*, A Journal of Sustainable Development in Africa, Vol.2, No. 2, pp.7-14.

Darkoh , Michael B.K. 1990 *Trends in Natural Resource Use and Prospects for Sustainable Resource Management in Kenya's Arid and Semi-Arid Lands*, Land Degradation and Rehabilitiation, Vol. 2, pp. 177-190.

Darkoh , Michael B.K. 1989 *Combating Desertification in the Southern Africa Region*, UNEP, Nairobi and Moscow.

Darkoh , Michael B.K. 1987 *Population Expansion and Desertification in Tanzania*, Desertification Control Bulletin, UNEP, No.6, pp.26-63.

Finkel, Moshe and Darkoh , Michael B.K. 1991 *Sustaining the Arid and Semi-Arid (ASAL) Environment of Kenya Through Improved Pastoralism and Agriculture.* Journal of Eastern African Research and Development, Vol 21, pp.1-20.

Finkel, Moshe and Darkoh , Michael B.K. 1990 *Draft Environmental Action Plan for Sustainable Development of Kenya's Arid and Semi Arid Lands.* (Consultancy Report), The World Bank and Kenya's Ministry of Reclamation and Regional Development (formerly MRDASW).

Horwith et al, B.J. 1989 *The Role of Technology in Enhancing Low-Resource Agriculture in Africa*, Agriculture and Human Values, Vol. VI, No. 3, pp 68-84.

Hartmut Krugmann, 1992 *Regional Research Initiatives : IDRC's contribution*, Resources Vol.3, No.1, pp31-37.

UNSO, 1992 *Assessment of Desertification and Drought in the Sudano-Sahelian Region*, The United Nations Sudano-Sahelian Office, New York.

UNEP, 1992 *Status of Desertification and Implementation of the United Nations Plan of Action to Combat Desertification*, Report of the Executive Director, United Nations Envrionment Programme, UNEP/GCSS.111/3, Nairobi, Kenya.

World Bank , 1992 World Development Report 1992 : *Development and Environment*. Oxford University Press.

Soil Erosion and Desertification as a Consequence of Farmland Abandonment in Mountain Areas

José M. García-Ruiz (1), Teodoro Lasanta (1), Purificación Ruiz-Flano (2), Carlos Martí (1), Luis Ortigosa (3) & Constanza González (1)

Abstract

Farmland abandonment is probably the most important geoecological process affecting soil and water conservation in mountain areas of Central and Western Europe in the 20th century. Experimental field studies show that the evolution of abandoned fields depends on the interaction between plant succession, land-uses after abandonment (including grazing and the use of fire) and the physico-chemical characteristics of the soils. The authors conclude that farmland abandonment introduces many changes in runoff and sediment yield.

Photo 1. Sloping abandoned fields can support high erosion rates, sometimes developing deep gullies such as those in this view of the Canary Islands. These fields were cultivated up to 1960 with tomato. (Author: J.M. García-Ruiz. Date: February, 1992).

(1) Instituto Pirenaico de Ecología. Campus de Aula Dei, Apartado 202, 50080-Zaragoza, Spain.
(2) Department of Geography, University of Las Palmas de Gran Canaria, Spain.
(3) Department of Geography, University of La Rioja, Logrono, Spain.

Introduction

Desertification is a concept generally used to explain land degradation in arid and semi-arid areas, due to human activities and climatic change. However, soil erosion and degradation in sub-humid and humid areas have almost similar effects, leading to an impoverishment of ecological diversity and to a decrease in productivity. In the past, sheet erosion, rilling and gullying yielded large quantities of sediments to the fluvial networks, encouraging the sedimentation in alluvial plains, alluvial fans and deltas. For example, during the 17th century, the Ebro delta, on the Mediterranean coast of Spain, advanced up to 60 metres per year. Many areas of Europe, included in the sub-humid or humid temperate zone, show the results of forest wasting, overgrazing and cropping, with dramatic consequences for sustainable development. Such a process is clearly a process of desertification, perhaps not so spectacular and generalized as that of semi-arid areas, but the final effects can be very similar.

Most of Europe's mountains have supported high demographic pressure since the 10-11th centuries, with a peak during the middle of the 19th century (Lasanta, 1988). Human activities included the cultivation of steep slopes with cereals, surely causing high erosion rates. In many cases the hillslopes were terraced in order to avoid soil erosion, but in others the fields had scarce structures of conservation.

Throughout the 20th century most of the fields have been abandoned as a consequence of rural depopulation, in such a manner that, nowadays, only the valley bottoms remain cultivated (García-Ruiz & Lasanta, 1990 and 1993). After several years of abandonment many fields show evidence of degradation: most of the soil has been eroded; stones almost completely cover the soil surface; and vegetation scarcely protects the soil against raindrop impact and overland flow; finally, plant colonization progresses very slowly and even shows evidences of degradation, with plants belonging to drier environments and supporting heavy thermic and hydric stresses.

Such a problem poses several basic questions: is soil degradation a natural or a man-induced evolution of sloping fields in temperate mountain areas? What is the role of land-uses? How is the interrelation between plant colonization and erosion expressed? The answers to these questions must help to control soil erosion and desertification as a consequence of hypothetical farmland abandonment in many other mountains of developing countries, now supporting high population densities (for example, in the Himalayas, some Andean regions and African mountains).

The sampled area is located in the domaine of the southern Pyrenean flysch, which is extremely homogeneous from a topographical and lithological point of view (Fig. 1). The area's relief is characterized by smooth divides and regularized versants affected by debris-flows and ravines, which are caused to a great extent by deforestation. This region enjoys a Mediterranean mountain climate, somewhat continentalized, with annual rainfalls around 800-1000 mm, mainly concentrated in spring and winter, although the most intense rainstorms fall in autumn.

Shallow brown, loamy soils prevail, with surface stones. They are poor in organic matter and in nutrients, rich in carbonates and with a pH between 8 and 8.5. The high content of carbonates plays an important role because, on the one hand, it tends to prevent clay dispersion and, on the other hand, it contributes to the structural stability of soils. The stability of aggregates, tested by the drop test, produced satisfactory results (Pardini et al., 1991).

Methods included geomorphic transects, experimental plots of different sizes, chemical and physical soil analysis, and rainfall simulation, among others.

The complex evolution of abandoned fields

In abandoned fields, several geomorphic environments can be distinguished: severe sheet erosion areas, mild sheet erosion areas, no-erosion areas and severely degraded environments (including rills and stone pavement). Fig. 2 shows the evolution of each geomorphic environment as the years pass after the abandon-

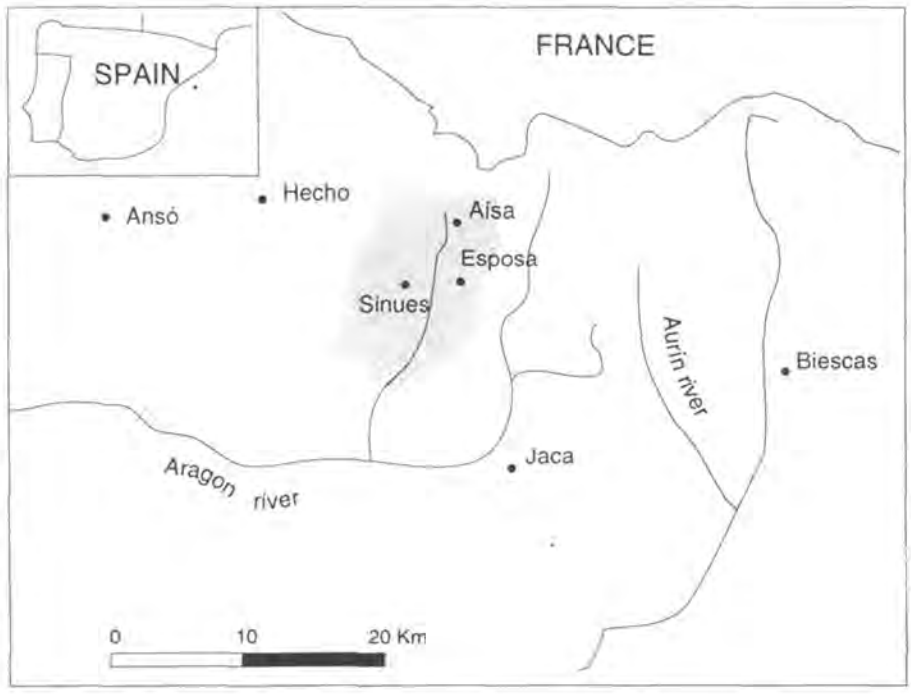


Fig. 1. The study area.

Photo 2. After 20 or 25 years of abandonment a dense shrub cover may prevail on the field, protecting the soil and controlling both erosion and overland flow. Farmland abandoned hillslope in the Aísa Valley, Central Pyrenees, Spain. (Author: J.M. García-Ruiz. Date: March, 1991).

ment. A quick overview leads us to conclude that the different erosion processes are progressively substituted in time: severe sheet erosion prevails during the first years, mild sheet erosion reaches a peak 10-25 years after abandonment, after which, a stable situation is reached (after 25-50 years) therefore more degraded environments progressively increase as the fields get older.

Such an evolution can be considered normal up to 50 years, owing to the characteristics of plant succession (see Fig. 3). Once abandoned, the fields have a sparse herbaceous cover, favouring the predominance of severe sheet erosion processes, but as the density of plant cover increases, the activity of geomorphic processes diminishes, thus mild sheet erosion prevails.

As shrub cover is established - twenty-five years later - sheet erosion decreases and no-erosion areas cover almost all the surface, blocking overland flow and erosion. The normal evolution of abandoned fields reflects the typical pattern of secondary plant succession, with important and positive consequences for the hydrological and geomorphological behaviour of the hillslopes. The problem is to understand what happens after the abandoned fields reach a dense shrub cover, just at the moment when an evolution to more mature and complex stages of plant colonization might be expected. The fact is that rills, small mass movements and stoniness become ever more present in abandoned fields, resulting in soil erosion and degradation as well as in a loss of productivity, reducing the possibilities of grazing (Ruiz-Flano et al., 1992).

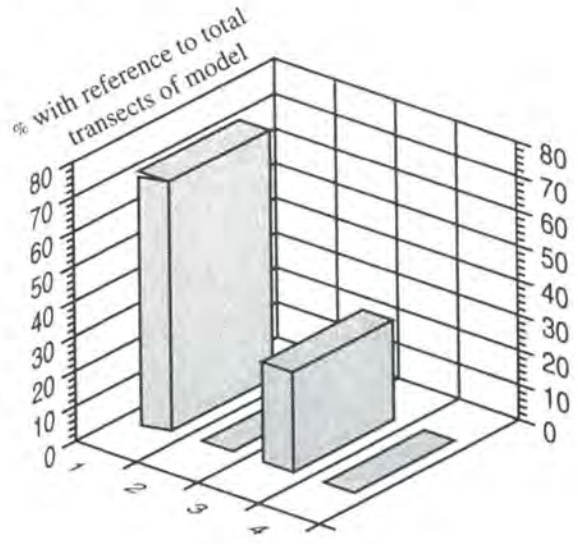
Photo 3. Many abandoned fields show, after decades of abandonment, a high degree of stoniness on the soil surface, showing the effects of sheet erosion processes, caused by a rupture in the plant succession. Farmland abandoned hillslope in the Aísa Valley, Central Pyrenees, Spain. (Author: J.M. García-Ruiz. Date: July, 1988).

The role of plant cover

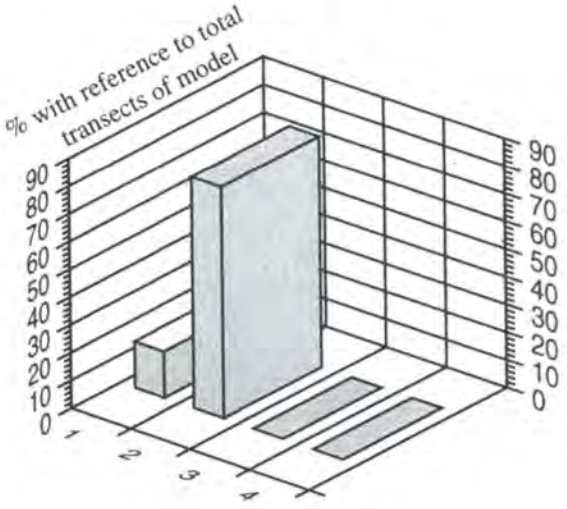
The only explanation for soil deterioration and intensive soil erosion is a break in plant succession, due to human activities (burning of the shrub cover in order to improve the grazing systems) or to natural factors (i.e. senescency of the shrub cover, unable to advance to more mature stages of plant succession owing to the poverty of soil nutrients). In fact, the presence of ashes in the soil is frequent and the use of fire has been a customary practice in the past when spiny shrubs densely covered the old fields.

The evolution of organic matter, total capacity of exchange, calcium and nitrogen varies significantly with the age of abandonment (Ruiz-Flano, 1993). Or-

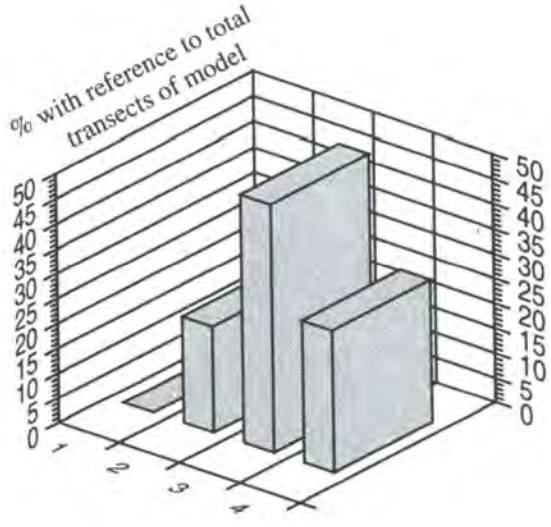
SEVERE SHEET EROSION ENVIRONMENTS



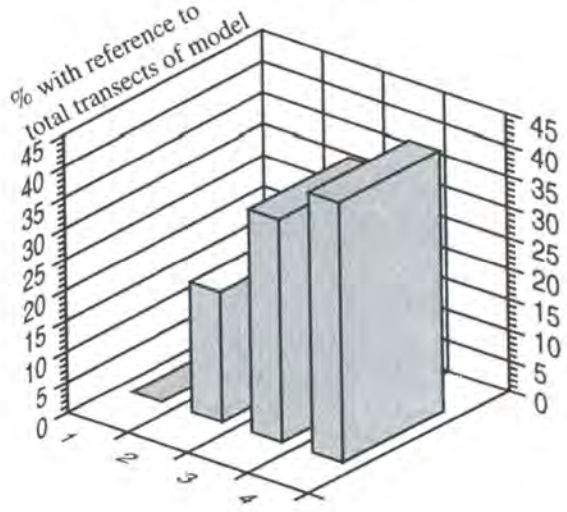
MILD SHEET EROSION ENVIRONMENTS



NO-EROSION AREAS



VERY DEGRADED ENVIRONMENTS
(rills and stone pavements)



1.- <10 years after abandonment
2.- 10-25 years after abandonment
3.- 25-50 years after abandonment
4.- >50 years after abandonment

Fig. 2. Evolution of different geomorphic environments after farmland abandonment.

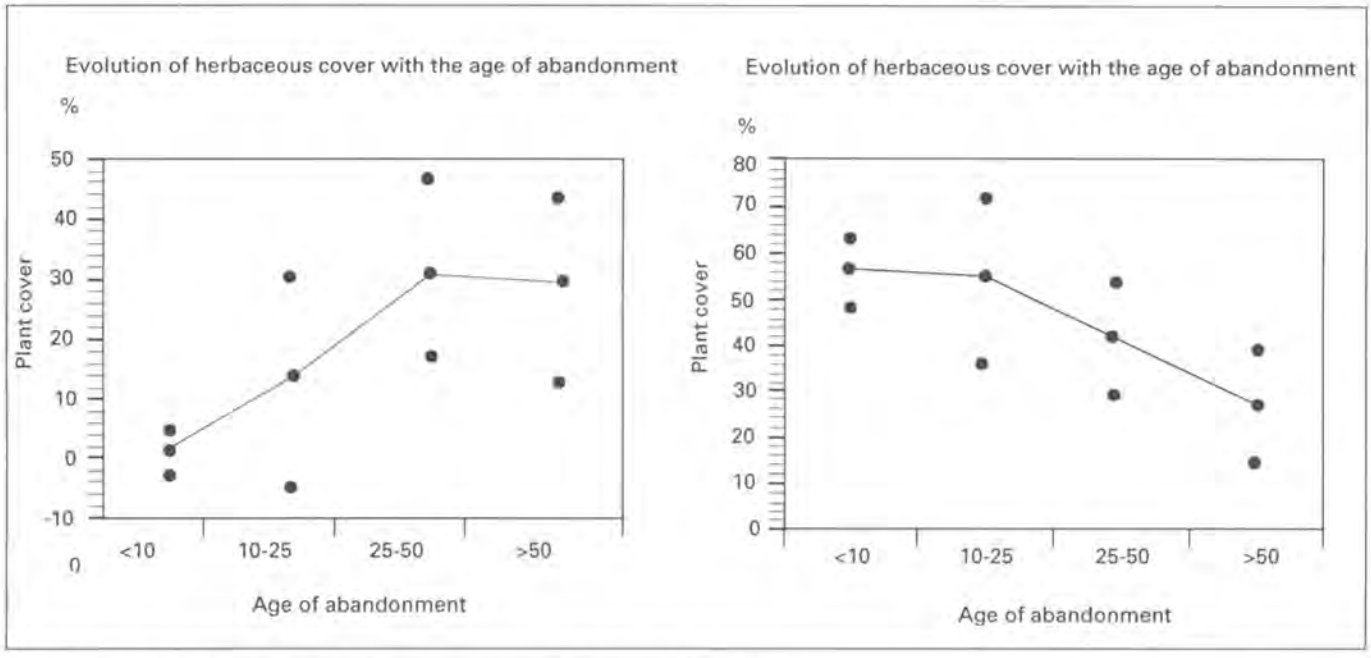


Fig. 3. Evolution of bush and herbaceous cover with the age of abandou

ganic matter and nitrogen increase up to 25-50 years after abandonment, as a result of the increasing density of plant cover and of the predominance of *Genista scorpius*, a leguminous able to fix nitrogen into the soil; but they undergo a decrease in the oldest abandoned fields. The greater density of herbaceous and shrub cover during the first 50 years can explain the positive evolution of the organic matter and nitrogen content, as well as the diminution of the total capacity of exchange and calcium (taken by the plants and incorporated to biomass). Afterwards, a degradation of plant cover - and an increase of erosion- explain the opposite process; the burning of the shrub cover may be the reason for a soil nutrient restoration.

Plant cover plays a key role in controlling soil erosion in sloping abandoned fields, explaining to a great extent the location of sediment sources (Ruiz-Flano et al., 1991). Using small experimental plots, the influence of the structure and density of plant cover on runoff and sediment yield is well known. Fig. 4 shows the results obtained after a record of 18 months. It proves the importance of a dense shrub cover for soil conservation, because runoff and erosion are almost completely controlled, thus demonstrating that the disappearance or degradation of such a plant cover is the reason for an intensification of erosion processes. These results confirm that shrub cover can be an excellent plant formation for soil protection (see also Francis & Thornes, 1990). On the other hand, the areas where shrub cover only represents 40-60 per cent of the surface are the most important sediment sources in the slopes, much more than the areas where shrub cover only represents 10-15 per cent, because in such cases soil has been extensively eroded. The behaviour of pasture lands, yielding much water but few sediments, can be considered as normal, and reflects the possible trends of runoff and sediment yields as a consequence of a generalized change in land-use.

The role of land-uses

In the Aisa Valley Experimental Station the hydromorphological effects of different land-uses were estimated. In eight

	Elec. Conduct	Suspended sediments (mg.l^{-1})	Ca	Mg	Na	K	P	C1
					p.p.m			
Shifting agriculture	225	172	1.3	0.5	0.4	0.9	0.01	2.5
Cereal	375	43	7.0	2.0	1.2	6.1	0.32	12.7
Stubble	223	61	4.4	2.0	1.0	2.6	0.03	2.1
Burnt plot (1991)	203	44	3.5	2.0	1.1	3.0	0.03	1.8
Dense shrub cover	121	30	1.7	0.7	0.5	2.0	0.01	1.8
Meadow	284	76	5.2	1.9	0.7	5.3	0.11	10.5
Fallow land	147	1064	2.3	2.0	1.7	3.3	0.05	3.6
Burnt plot (1993)	335	1027	6.3	3.3	1.0	6.4	0.14	14.8

Sediment concentration under different land-uses Storm event: May 5, 1993

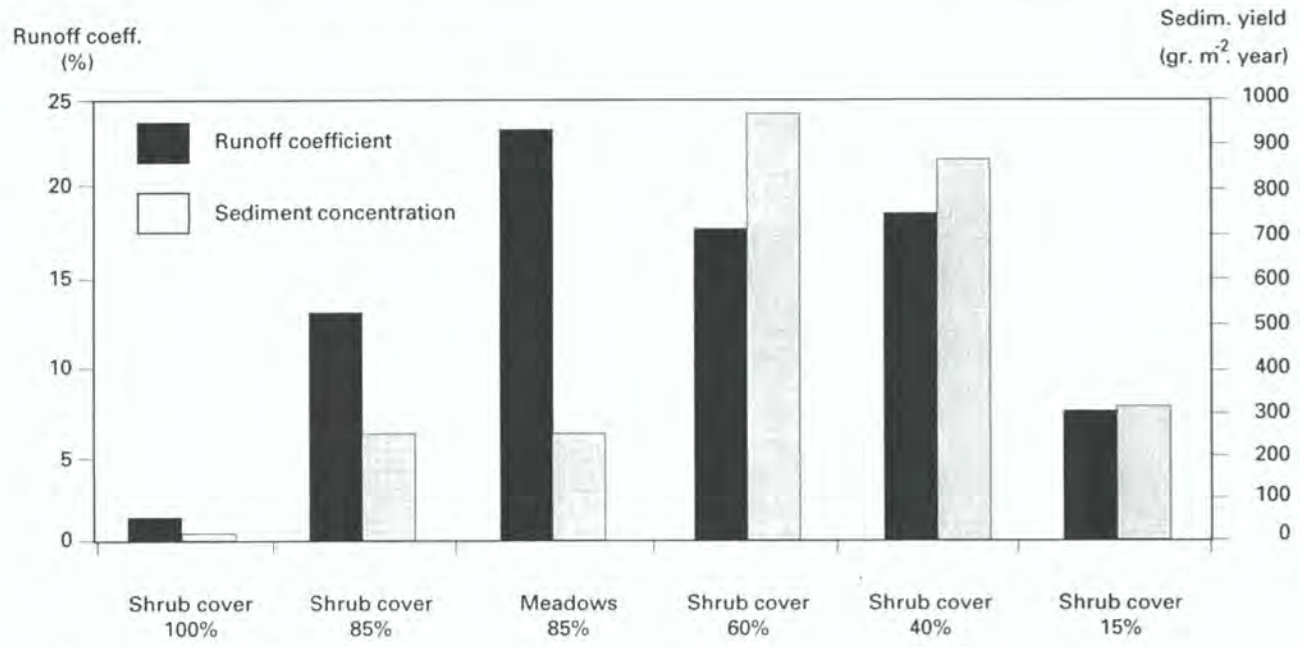


Fig. 4. Runoff coefficients and sediment yield under different plant cover in abandoned fields.

plots, each measuring 30 square metres, runoff and sediment yield were controlled in cereals, dense shrub cover, grazing meadows, "articas" (a type of shifting agriculture fertilized with ashes and without structures for soil conservation), fallow, recently abandoned field and two burnt plots (one in June, 1991 and the other in May, 1993). Fig. 5 and Table 1 show the results obtained during one rainy period. Articas, cultivated in the worst topographic conditions, undergo the most important water and sediment losses, confirming the erosive character of such land-use. Cereals show a moderate behaviour, although nutrient losses are very important, owing to the addition of chemical fertilizers. Farmland abandonment repre-

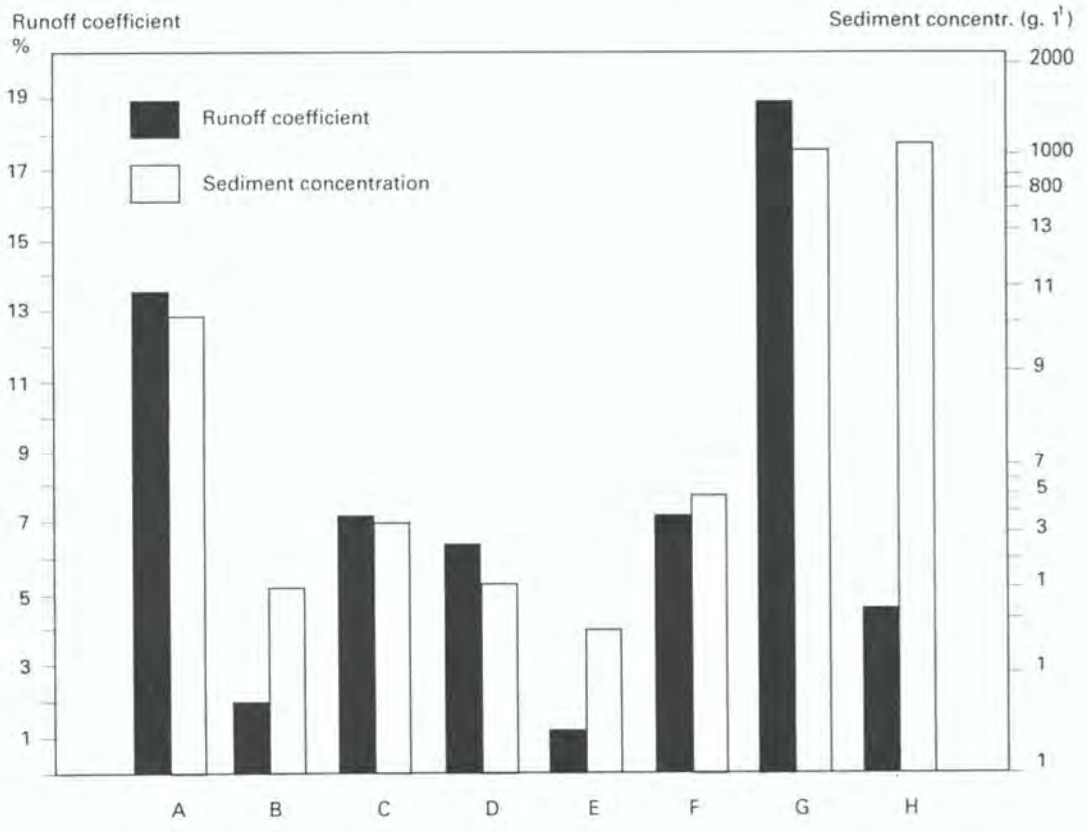


Fig. 5. Runoff coefficients and sediment concentration during one rainstorm event (May 5, 1993). A: Shifting agriculture. B: Cereal field. C: Stubble. D: Burnt plot (1991). E: Dense shrub cover. F: Pasture land. G: Burnt plot (1993). H: Fallow land

sents a sudden increase in runoff and sediment as a consequence of the high proportion of bare soil immediately after cropping and during the first years. Pasture land yields much water but few sediments and a dense shrub cover protects the soil very well as demonstrated above. Finally, the burnt plots show very different behaviour according to the time passed since the wildfire. The plot burnt in 1991 acts in a similar way to the dense shrub cover, showing the effects of a quick plant recovering; but the runoff coming from the plot burnt in 1993 has a very high suspended sediment concentration and high losses of calcium, potassium, nitrogen and phosphorous, confirming the negative effects of the wildfire during the first months.

Conclusions

Cereal crops on steep slopes caused much erosion in the past, above all when shifting agriculture was practised. The erosive effects of farmland abandonment depend on:

i) The characteristics of soil after centuries of cultivation, in many cases very impoverished in nutrients. In such cases, plant succession advances very slowly, encouraging soil erosion during the first years of abandonment.

ii) The characteristics of land management after abandonment, which partially control the features of plant succession. A recurrent use of fire to remove the spiny shrub cover causes important losses of nutrients, making a quick plant recovering increasingly more difficult and finally provoking an increase in stoniness and soil degradation, with decreasing productivity (Ruiz-Flano et al., 1992). If fire is not used, the field is claimed by a dense shrub cover which protects the soil very well against overland flow and erosion. An intermediate solution is to substitute - in the best topographic conditions, i.e. in the concave hillslopes - the shrub cover by meadows, thus increasing the possibilities of grazing for the local livestock, without risk of erosion, and leaving the convex hillslopes and the steepest areas to evolve towards complex stages of plant colonization (Ruiz-Flano et al., 1992).

Land management after abandonment is the most important factor in order to prevent any undesirable effects from a geomorphological and hydrological point of view. A dense shrub cover and, afterwards, a forest cover will cause a decrease in the volume of surface water resources, a problem in arid and semiarid areas. The substitution of shrubs for meadows will yield much clean water but the fluvial channels will probably betray a degradation owing to the increase of energy, eroding their own bed (Martínez-Castroviejo et al., 1992). As the consequences of farmland abandonment can affect extensive areas - even far away from the affected country - land management is not only a private matter but a public decision.

References

Francis, C.F. & Thornes, J.B., 1990, Matorral: Erosion and reclamation, in *Soil degradation and rehabilitationin Mediterranean environmental conditions*, C.S.I.C., Murcia, Spain.

Garcia-Ruiz, J.M. and Lasanta, T., 1993. Land-use conflicts as a result of Land-use changes in the Central Spanish Pyrenees, *in Mountain Research, and Development*, Vol. 13 (3), pp. 295-304

Lasanta, T, 1988, The process of desertion of cultivated areas in the CentralSpanish Pyrenees, in *Pirineos*, vol. 12, pp. 15-36.

Matínez-Castroviejo, R., Gómez-Villar, A. & García-Ruiz, J.M., 1991, Ajustes fluviales derivados de cambios de usos del suelo en el Pirineo aragonés, in *Cuaternario y Geomorfología*, vol. 5, pp. 91-106.

Pardini, G., Aringhieri, R., Plana, F. & Gallart, F., 1991, Soil properties relevant to land degradation in abandoned sloping fields in Aísa Valley, Central Pyrenees (Spain), in *Pirineos*, vol. 137, pp. 79-93.

Ruiz-Flano, P., 1993, *Procesos de erosión en campos abandonados del Pirineo*, Geoforma Ediciones, Logrono, Spain.

Ruiz-Flano, P., Lasanta, T., García-Ruiz, J.M. & Ortigosa, L., 1991, The diversity of sediment yield from abandoned fields of the Central Spanish Pyrenees, in *IAHS Publ.*, vol. 203, pp. 103-110.

Ruiz-Flano, P., García-Ruiz, J.M. & Ortigosa, L., 1992, Geomorphological evolution of abandoned fields. A case study in the Central Pyrenees, in *Catena*, vol. 19 (3-4), pp. 301-308.

Ruiz-Flano, P., Lasanta, T. & García-Ruiz, J.M., 1992, La erosión del suelo en campos abandonados en relación con las características y manejo de la vegetación, in *ITEA*, vol. 12, pp. 180-190.

Acknowledgements

This work has been supported by the research projects "Erosion and desertification induced by farmland abandonment in mountain areas" (NAT 89-09039) and "Soil erosion after farmland abandonment in middle mountains: interactions with plant colonization strategies, land-uses and nutrient availability" (AMB 93-0806), which were funded by the CICYT, Spain.

Multitemporal Satellite Image Analysis for Monitoring Human Encroachment on Forest Reserves

By Patrick Mushove

Forest Research Centre
Forestry Commission
P. O. Box H. G. 595
Highlands, Harare, Zimbabwe

Introduction

Most ecosystems in arid and semi-arid regions of the world are going through various processes that lead to desertification. Since the definition of the term 'desertification' has been refined on a number of occasions, it is useful to point out that, for the purposes of this article, the 1992 UN Conference on Environment and Development (UNCED) definition is assumed to apply. That definition takes desertification to be land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities.

Tropical deforestation features prominently as an important cause of land degradation (Barbier *et al.*, 1991; Katerere, 1993; Oppong, 1993). However, the causes of natural resource degradation in general are so complex that popular slogans about the problem being one of "poverty or population or multinationals or debt are unhelpful other than to point proper research towards testing the relationships between these issues and the environment" (Pearce and Maler, 1991). More specifically, sustainable environmental resource management is only possible if the biophysical environmental characteristics are considered together with relationships between land-use, land tenure, institutions and the culture of the people drawing a livelihood from the environmental resources in question. It is mainly due to disharmony among these factors that the world's environmental refugee population, which Cardy (1993) put at 10 million in 1988, is on the increase.

Tolba (1982) refers to "forest farmers" as rural inhabitants of the traditional and/or shifting cultivator type as well as the squatter type peasantry who eke out livings by scratching at the soil in their habitats. These people were believed to number about 300 million in 1979 and were ranked as the number one factor behind deforestation in tropical lands.

Encroachment on forest reserves or, indeed, other land categories set aside for uses other than human settlement and agriculture, emerges as a solution for some of the above mentioned environmental refugees. After all, is it not true that forest reserves and national parks around the world are often places where local people try to exercise usufructuary rights despite the state's statutory claim to the land, trees and animals? Is it not true that while forest reserves may serve important ecological functions to villagers, these latter may consider the same forests as a land bank, i.e. "spare" land, or potential source of arable land? While encroachment is such a common phenomenon, there is little quantitative information available on the extent and rate of such encroachment, let alone on suggestions to monitor and mitigate the effects of encroachment on the environment.

This article covers one aspect of a study carried out between March 1993 and April 1994 on a forest reserve that is experiencing a squatter problem in Zimbabwe. Under Zimbabwean law, Mzola Forest has been a "demarcated forest" since 1954, in keeping with colonial land apportionment provisions for timber production and watershed management. In the mid to late 1970s some people took advantage of the war that was raging in the then Rhodesia to occupy parts of the forest: they were to constitute the pioneers of a squatter population that now poses a management challenge for the forest area. The rest of this article provides a brief outline of the study area and then explores the potential of multitemporal satellite image analysis in monitoring human encroachment.

The Study Area

Mzola Forest covers about 68, 000 ha and is situated between 18° 10' and 18° 26' S latitude and 27° 20' and 27° 55' E

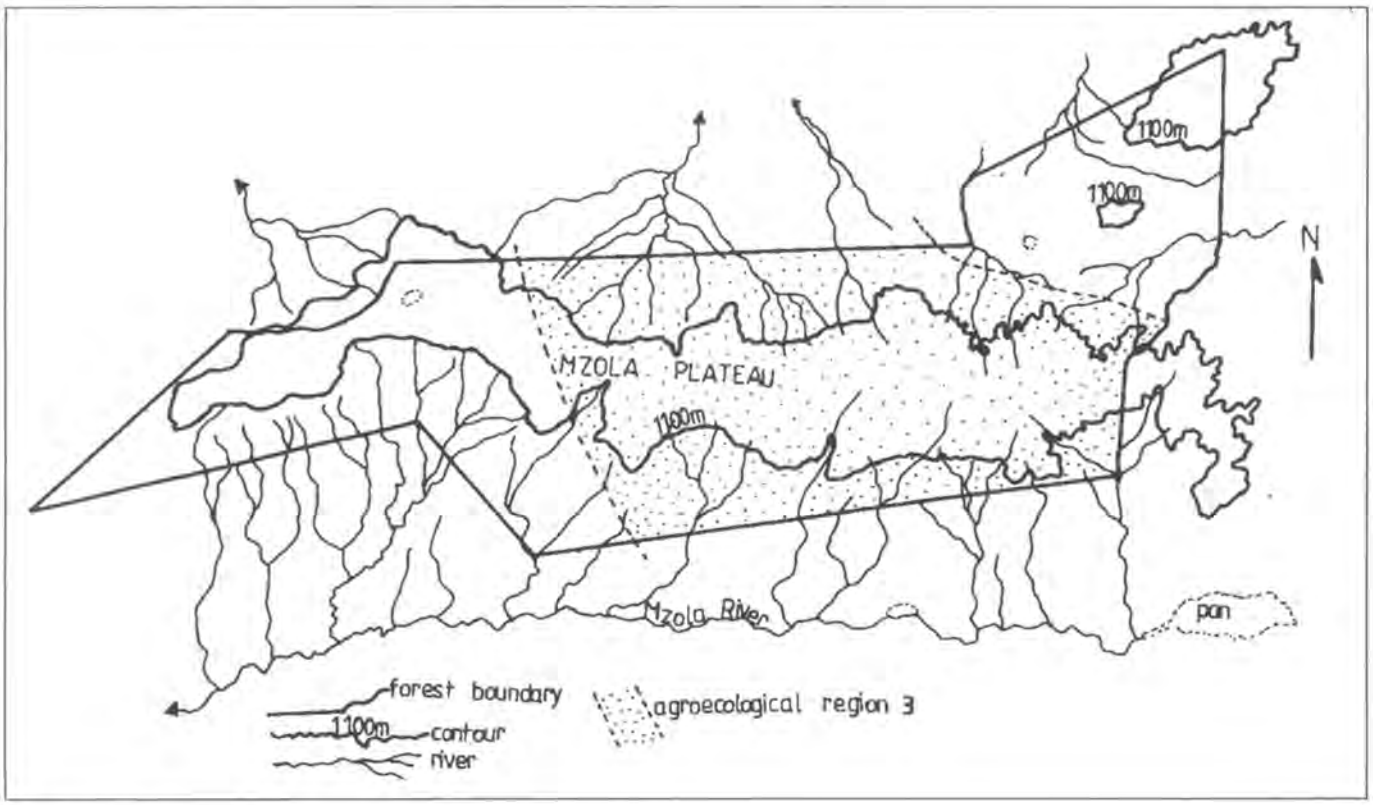


Fig. 1: Mzola Forest as a watershed

longitude. The forest's central feature is a plateau of Kalahari Sand that stands at an average of 1,100 m altitude (see Fig. 1). The plateau falls off to a Forest Sandstone area in the east and to Zambezi Escarpment Grit in the north, both of which are products of sedimentation activity which took place mainly during the Triassic period.

The Forest Sandstone is of desert derivation but it also contains basal beds of pale sandstone passing up into white sandstone and ultimately aeolian sandstone. The aeolian sandstone exhibits dune bedding and is reddish in colour due to iron oxide coating on the rounded wind-blown grains (Stagman, 197 8). The Escarpment Grit is coarse-grained and contains water-worn pebbles of quartzite and angular fragments of rocks belonging to the granites and gneisses. It grades upwards through fine-grained sandstone into alternating maroon and grey mudstones covering large areas of the Zambezi Basin. Basalt and shale intrusions also occur along the northern and southern scamps close to large, rivers. Kalahari Beds give rise to very loose sandy soils which carry important forests of indigenous timber. If the forest is cleared, the soils can grow good crops for a year or two, but fertility rapidly falls off and erosion may become a menace. More than 50% of Mzola Forest lies in Agroecological Region III (see Fig. 1). According to the Zimbabwean land classification system, such a region receives moderate rainfall (650 mm to 800 mm per year) but suffers from severe mid-season dry spells and high temperatures. The region is suited to semi extensive livestock production and provides marginal conditions for maize, tobacco and cotton. The rest of the forest lies in Agroecological Region IV, which is a worse category than Region III.

The main plateau drains into the Mzola River in the south, through the Shangani, and Gwayi, and ends up in the Zambezi. The area to the north of the main plateau drains into the Busi-Sengwa system which runs northwards and eventually flows into the Zambezi. Isolated pans occur throughout the area but the majority do not hold water all year round. Rainfall amounts to about 600 to 800 mm per year and is received between October and April. Mzola Forest is considered an important catchment area especially with regard to its location relative to the Zambezi rainforest system (Fig. 2), the southernmost rainforest in Africa, excluding Madagascar.

The major tree species found on the plateau include *Brachystegia spiciformis, Baikiaea plurijuga, Pterocarpus angolensis, Julbernardia globiflora, Combretum collinum and Diplorrhyncus condylocarpon. Colophospermum mopane* is by far the most common tree occurring below the plateau, especially in areas with patches of sodic soils, and it is often found in nearly pure stands. *Brachystegia boehmii and Burkea africana* occur on the contact between the plateau and the 'mopani flats' (grasslands with isolated *C. mopane and Acacia* trees) or in depressions. *Kirkia acuminata is* usually found on the contact and basalt slopes in association with *B. boehmii and C. mopane.*

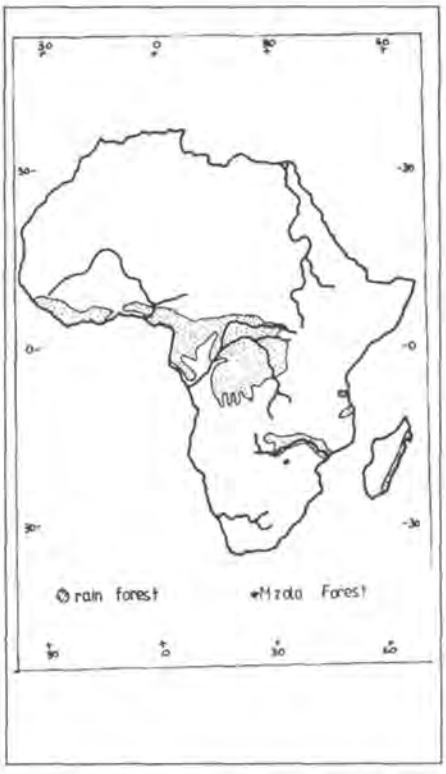


Fig. 2: Map of Africa showing tropical rain forests in the continent. (Source: Beyer, 1980)

Methods

Literature research on the forest area was carried out mainly at the Forestry Commission's Bulawayo regional offices. In August 1993 four participatory rural appraisal (PRA) sessions were conducted with the forest inhabitants and some of the communities surrounding the forest. The sessions consisted of informal group workshops with villagers, these were supplemented by semi-structured interviews with selected key informants and government administrative officials of the districts from which the majority of the illegal settlers originated. The PRA sessions were used as a dialogue medium between the settlers on the one hand and the forest officers and researchers on the other. Over the period prior to the study, (from around the early 1980s to the early 1990s), relations between the settlers and the forest officers had deteriorated so much that both sides had assumed a militant stance. The creation of a conducive environment for dialogue was also considered an institutional investment in terms of future management plans for the forest area as direct confrontation or the use of coercive means to address the encroachment problem are considered to be out of the question.

Soon after the PRA sessions, ground survey techniques were employed to map out the extent of human encroachment as well as that of different vegetation types. Such field observations were effected through vehicle and foot traverses using compass and chain, and guided by 1: 50 000 topography maps of the area. In selecting the traverse directions, deliberate effort was put on covering as many topographical gradients as possible. An equally important, though indirect, objective of this exercise was to collect ground truth information needed at a later (laboratory) stage in satellite image analysis and interpretation.

Two cloud-free Landsat TM images (see Table 1) covering the study area were acquired in digital form for analysis. Data processing was carried out using different procedures contained in the software package EASI/PACE (Engineering And Scientific Interface/Picture Analysis Correction Enhancement). Since the 1984 image was not georeferenced, the 1992 image was used as a standard to achieve the georeferencing and registration of the foraier image.

A vector digitisation module (VECDIG) was used to create a vector GIS (Geographical Information System) for the forest area. To achieve this, lines and points on the Zimbabwe Surveyor General's layered (topographical) map (Sheet SE-35-1 1: Kamativi) of 1985, scale 1: 250 000, were interactively digitised using a CALCOMP 9100 tablet. The vector data digitised included the forest boundary, rivers, tracks, roads, pans/marshlands, trigonometric beacons and contour lines. Selected vectors were later "burnt" into the images to constitute an integrated GIS.

Image classification was carried out for the forest area only. It was possible to isolate the forest area by delineating or "masking" the forest using the forest boundary vector attribute collected during the digitisation process. Unsupervised classification using the k-means clustering (KCLUS) programme was carried out on both images . This classifier operates on the premise that data values of similar cover types remain close in spectral response, while data of different classes will be separated. The programme AGGREG was used to aggregate classes into the following aggregates:

- forest;
- agricultural fields; and
- other land.

After class aggregation, the programme MLR (Maximum Likelihood Report) was run in order to calculate the area (in hectares) and the relative size (% of area mask) of each aggregate. Change calculation was based on area change by aggregates between 1984 and 1992.

Results and Discussion

About 150 km of traverses were covered on foot and by vehicle. As a result of those traverses, the settlements in the forest area were mapped (see Fig. 3). Using the dot-grid method of area calculation, it was estimated that by 1993 a total of 7,000 ha of forest had been converted to agricultural fields and/or settlement area. This corresponds to just over 10% of the forest area or an average and uniform encroachment rate of 0.7% of the forest area per year, assuming that the first settlers arrived in 1979, as indicated by both the Forestry Commission records and results of the PRA.

Landsat image	1	2
Date	20/6/1984	7/4/1992
Bands	3; 4; 5	2; 3; 4
Scene	172-73	172-73
Pixel size (resampled)	25m x 25m	25m x 25m
Georeferenced	no	yes

Table 1: Landsat TM image acquisition

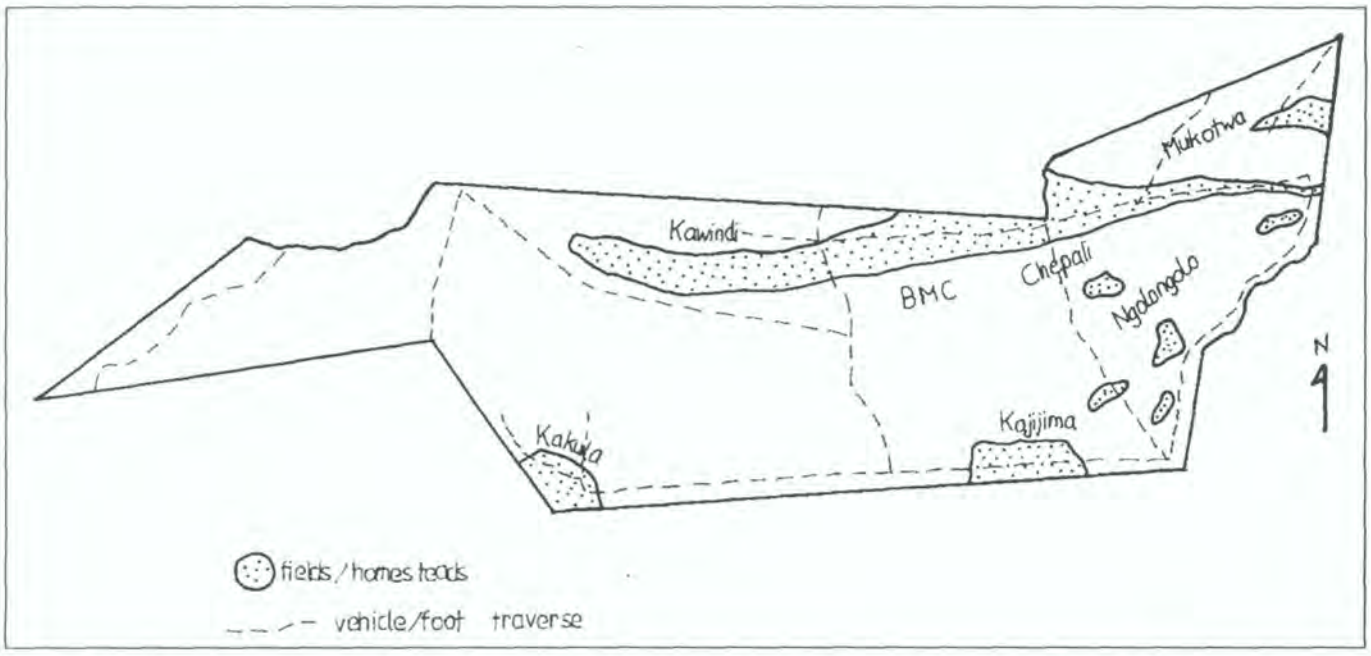


Fig. 3: Extent of encroachment on Mzola Forest. Map extrapolated from ground survey results, August, 1993.

Encroachment is concentrated in the eastern half of the forest area although the great majority of the people (87% of the households) originate from districts situated to the south of the forest area. Agricultural fields and vegetable gardens are located along river valleys and often at river sources or on slopes, where the soils are more fertile and possess a higher moisture holding capacity than the sandy soils on the plateau. This pattern is more clearly illustrated in Figs. 4, 5, 6 and 7.

The satellite image copies, represented by Figs. 4 and 5, provide a synoptic view of the land cover types in the forest and surrounding area in 1984 and 1992, respectively. The 1984 image (Fig. 4) shows that the area to the south of the forest was already heavily settled by that year. On the other hand, the area to the north of the forest was virtually unsettled by that same time. By 1992, however, many settlements had been established to the north of the forest. At the same time, there was a parallel expansion of settlements inside the forest area although such additional settlements were not only concentrated in the northern section of the forest but the eastern and south-eastern as well (Fig. 5).

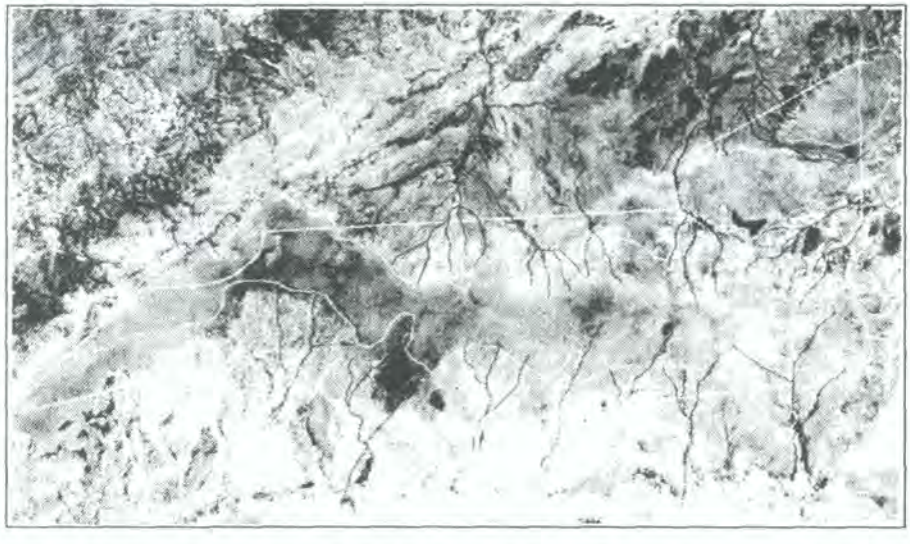


Fig. 4: 1984 unclassified Landsat TM image of Mzola Forest and surrounding area. (NB: coordinates in UTM units).

Calculations based on the three land cover class aggregates in Figs. 6 and 7 estimated the extent of agricultural fields at 2, 907 her (i. e. 4.25% of forest area) in 1984 and 4, 015 her (or 5.87% of forest area) in 1992 (see Table 2). This is equivalent to a uniform deforestation of 0.2% of forest area per year, attributable to agricultural expansion alone. However, the forest category decreased from 80.61% in 1984 to 72.78% in 1992 (an average deforestation rate of 0.98% of the forest area per year over that period). During the same period, the "other land" category increased by the equivalent of 6.2% of the forest area, or 0.78% of the area per year. These observations call for a more detailed explanation.

1. As is evident from Table 1, the two satellite images were acquired at different times of the year (April, for the 1984 image, and June for the 1992 image). this obviously affects the comparability of the spectral responses in the two images since vegetation phonologically aspects and soil moisture conditions are different during those periods. In addition, data from different band combinations (see Table 1) were used for the analysis.

Although individual classification was

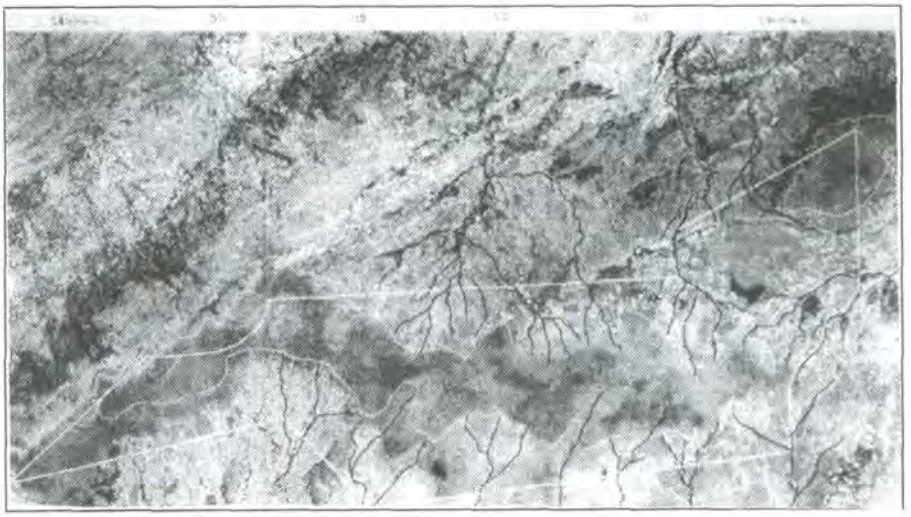


Fig. 5: 1992 unclassified Landsat TM image of Mzola Forest and surrounding area.

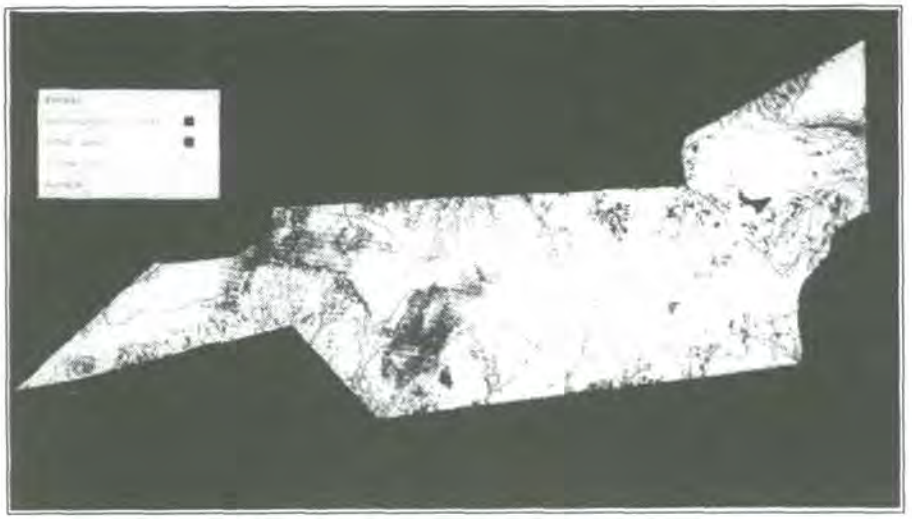


Fig.6: 1984 classified image of Mzola Forest area showing extent of encroachment.

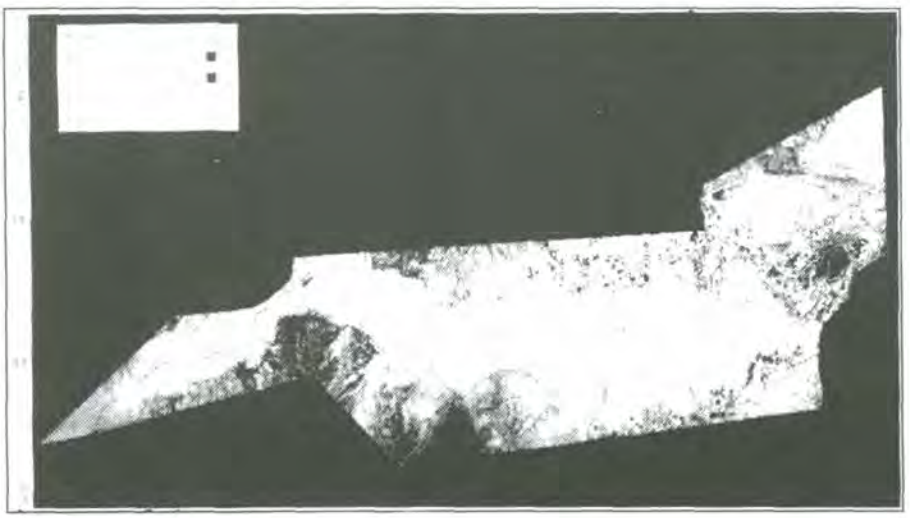


Fig. 7: 1992 classified image of Mzola Forest area showing extent of encroachment.

carried out for each image, it was not possible to apply a direct image differencing technique because the pixel-by-pixel differences (i.e- 1992 pixel values versus those of 1984) would give a false picture of the change assumed to have taken place at the level of each pixel between 1984 and 1992. A related complication was that while 1983/1984 had a good/normal rainfall season, 1991/1992 was a drought year (see Table 3).

2. The type of agriculture being practised by the settlers is a variant of restricted shifting cultivation in which sections of some fields are left fallow or are abandoned completely while new fields may also be opened or the existing ones expanded. This results in a complex spatial system. In forests with shifting cultivation, cleared areas frequently tend to multiply rather than expand individually (Singh, 1986). Many cleared areas of irregular shape and limited size, representing different stages in the cultivation-regrowth cycle, become intermixed with mature forest and/or bare land or other land cover type. In this respect, the cultivation system itself makes objective change detection imprecise. For this reason, the estimates of cultivated fields based on the 1984 and 1992 images alone are underestimates because the pieces of land adjoining agricultural fields and which were classified as "other land" (which, incidentally, referred mainly to bare ground or, in the south-west and north-west of the forest, to *C. mopane* areas apparently bare because at this time of the year most of these trees are without leaves) are, in fact, agricultural fields. The same may apply to pieces of land enclosed within fields but classified as "forest": these could be areas of prolonged fallow now reverting back to forest. More information on the rate at which the disturbed land reverts back to forest can be a useful indicator of the resilience of the system.

	1984		1992	
	area (ha)	% forest	area (ha)	% forest
forest	55 137	80.61	49 782	72.78
agricultural fields	2 907	4.25	4 015	5.87
other land	10 356	15.14	14 603	21.34
TOTAL	68 400	100.0	68 400	100.0

Table 2: Land cover class sizes calculated from the 1984 and 1992 images.

DATE	OCT	NOV	DEC	JAN	FEB	MAR	APR	YEAR
83/84	13.0	42.0	161.5	136.0	208.5	97.0	14.0	672.0
91/92	4.5	39.0	136.5	68.0	43.0	159.0	24.0	474.0

Table 3: Rainfall figures(mm) for Lusulu (18° 04'S; 27° 50°E).
source: Zimbabwe Meteorological Services, Harare.

Conclusion

Human encroachment on forest reserves in Zimbabwe is a real phenomenon and, for relatively fragile ecosystems like Mzola Forest, this raises concern over the inevitable degradational and desertification processes that may follow such encroachment, especially as some people start to occupy more marginal areas.

Satellite imagery offers good opportunities for monitoring land cover changes including deforestation due to human encroachment on forest areas. However, results from multitemporal satellite image analysis can be reproduced better and be more informative and effective if the different images are acquired at the same time of the year and provided data from the same band combinations are used. Unfortunately, this is not always the case since researchers/workers may have to make do with the images available (as was the case in this study). In order to enhance the credibility of the results obtained from image analysis, substantial field work should be carried out to furnish adequate ground truth data. Related to that, supporting cartographic data such as topographic maps should be up to date so that the collection of ground control points during image georeferencing and registration is made easier and more accurate.

Research and Policy Implications

The Mzola PRA sessions produced information which underlines the fact that the problem of human encroachment on state lands is only a facet of much broader land ownership-related issues, which are, in turn, further complicated by the general state of the economy. There is a need for land policy redress including a change in state land management to involve local people. The fact that a local government councillor and some forestry employees were among the illegal settlers in Mzola Forest serves to illustrate the all-embracing nature of the problem. In the event that large-scale resettlement of people is envisaged, thorough environmental impact assessments should precede such settlement programmes irrespective of where the resettlement will take place.

Acknowledgements

The Swedish Agency for Research Cooperation with Developing Countries (SAREC) funded the field work in which I was assisted by students from Zimbabwe College of Forestry and three forestry employees. Daragh Little and Andrew Collins of the Forestry Institute of Remote Sensing helped me with image analysis as part of an MSc dissertation from University College, Dublin.

References

Barbier, E.B., Burgess, J.C. and Markandya, A., 1991. The economics of tropical deforestation, *AMBIO* 20(2): 55-58.

Beyer, J.L., 1980. *Attica,* in G.A. Klee (ed.) World systems of traditional resource management, John Wiley and Sons, p5-39.

Cardy, F., 1993. Desertification - a fresh approach, *Desertification Control Bulletin,* 22: 4-8.

Katerere, Y., 1"3. Poverty and desertification: can the cycle be broken? *Our Planet, 5(2):* 10-1 1.

Oppong, J.E., 1993. Desertification in northern Ghana, *Desertification Control Bulletin,* 23: 44-49.

Pearce, D. and Maler, K.G., 1991. Environmental economics and the developing world, *AMBIO,* 20(2): 50-54.

Stagman, J.G., 1978. An outline of the geology of Rhodesia, *Rhodesia Geological Survey Bulletin,* number 80. Govt.. Printer, 126 pp.

Singh, A., 1986. *Change detection in the tropical forest environment of northeastern India using Landsat,* in M.J. Eden and J.T. Parry (eds.) Remote sensing and tropical land management, John Wiley and Sons, p237-254.

Tolba, M.K., 1982. *Development without destruction: evolving environmental perceptions, Tycooly* Int. Publ. 197pp.

Methods Applied for Recording Desertification and their Results from the Sahel Region of the Republic of Sudan

Mariam Akhtar [1] and Prof. Dr. Horst Georg Mensching [1] and Immelyn Domnick [2]

Introduction

The Sahel in the Republic of Sudan (cf fig. 1) is the traditional home of nomadic animal husbandry systems. Formerly, only the southern areas were characterized by extensive rainfed cultivation, more or less up to 400 mm isohyet. Technical innovations (KIRK, 1992), a growing population and also the abolition of traditional land use rights have resulted in increasing human pressure on the remaining pastures and water resources. This has triggered desertification, which can be seen as one of the most serious environmental hazards of the region. Already, it has intensified conflicts between peasant agriculturists and nomadic livestock owners. If the various forms of site degradation remain unattended, then vast areas will inevitably become deserts and will have to be abandoned.

The mapping and monitoring of desertification in the Sudan has been based on the visual interpretation and the digital classification of Landsat-MSS and -TM satellite images (quantitative methods) and field surveys (qualitative methods) since 1980. The evaluation of meteorological and hydrological data, and also laboratory analysis of plant and soil samples have supplemented field work.

Climatic variation and desertification

Deterioration in natural plant cover is the prime indicator of land degradation. Vegetative indicators are characterized by a decrease in the quality and the quantity of plant cover, up to the point of complete destruction. Besides human induced changes, and substratum conditions, characteristics of vegetation are dependent upon the level of annual precipitation and the intra-annual structure of rainfall.

The marginal tropical, arid to semi-arid Sahel is seen as a climatic and ecological transition zone from the savannahs in the south to the arid zone of the Sahara in the north. It is determined by the location of the Inter-tropical Convergence Zone (ITCZ) in summer. Since the northward advance of the ITCZ has a high inter-annual fluctuation, precipitation in the Sahel is subject to extreme spatial as well as temporal variability. This results in recurring droughts of varying periodicity (cf fig. 2). Such dry years (precipitation below long-term mean) can retard or prevent vegetative regeneration and even change botanical composition, especially after severe utilization.

Towards the south, climate variability decreases and the total amount of precipitation rises, thus enabling a more regular exploitation of natural resources. Whereas the northern Sahel can receive annual rainfall of up to 100 mm, the southern Sahel is marked by approximately 600 mm precipitation per year with three to four humid months (MENSCHING, 1991).

1 Akademie der Wissenschaften zu Goettingen Theaterstr. 7 37073 Goettingen Germany

2 (MSc. Geography) and Prof. Dr. Bernd Meissner SFB 69 / IFUS Limburgerstr. 42 13353 Berlin Germany

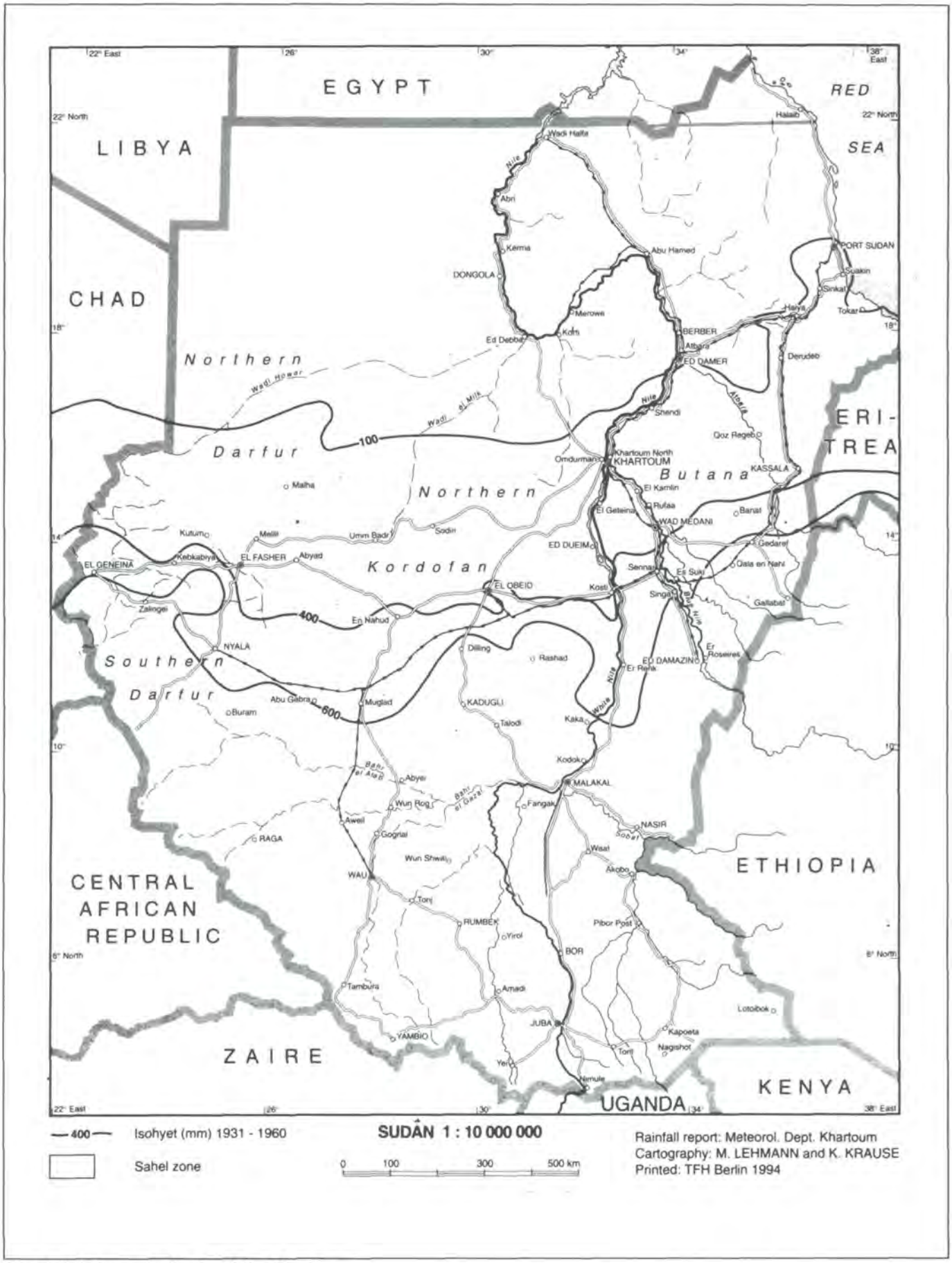


Fig. 1: Sahel zone in the Republic of Sudan

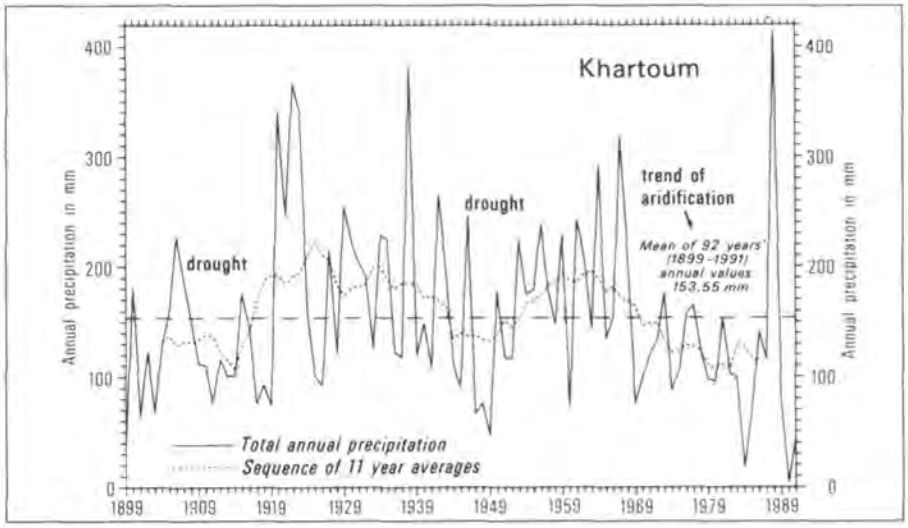


Fig. 2: Long-term development of precipitation in Khartoum, with 11 year averages (Source: World Weather Records (1899-1949), Sudan Meteorological Dept. Khartoum (1950-1991))

Qualitative analysis of land degradation

In a dry year, more drought-resistant grasses and forbs appear and pastures contain fewer species. During a wet year, however, herbaceous cover is more heterogeneous. Field studies therefore covered several years, in order to determine if the botanical composition of pastures is undergoing an irreversible change towards desertification or whether it just reflects the momentary characteristics of rainfall.

Changes in the botanical composition of pastures - a result of the combined effects of overgrazing and droughts - require a detailed mapping of grasses and forbs. After a visual inspection of the pastures, representative quadrats (1m2) were determined. Grasses and forbs growing within a quadrat were specified, cut, dried and then ranked according to BAYER'S (1983: 2) method of dry matter ranking which was slightly altered:

- dominant species = rank 1 (70% of dry matter weight)
- second most important species = rank 2 (20% of dry matter weight)
- third most important species = rank 3 (5 - 10% of dry matter weight).

In the moderately dry year of 1991, pastures were often so uniform that ranks 1 and 2 or ranks 2 and 3 were allocated to the same species. The interviewing of pastoralists and also laboratory analysis helped with judging the of quality the important grazing plants.

Investigations into the seed bank of the substratum indicated the regeneration potential of desired species in years with favourable rainfall conditions. A decrease in the productivity and in the variety of woody vegetation (recording of the age structure and of damage due to extreme browsing and wood cutting) can, for instance, affect browsers because trees and shrubs are important sources of dry season reserve feed supply in the Sahel.

Land-use systems, being the major cause of desertification, were given due consideration. The impact of land degradation on animal husbandry and thus on the livelihood of the people in the region was recorded for future development programmes.

Quantitative methods for recording land degradation

Satellite data are not cheap (prices vary from approximately US$ 0.15 (TM) to 1.5 US$ per km2 (SPOT)) and their processing and interpretation is inefficacious without qualitative analysis. Attached to detailed field investigations, however, satellite data in the long run are a quick and economic information source for desertification monitoring. Considering that one field day can cost a project up to US$1,000 through detailed field investigations can be more efficient, supported by some satellite data. In this way, the field worker can concentrate on more detailed analysis in a research area, without having the pressure to cover a large area within a certain time. Handicaps originating from the availability of satellite data at the 'right' time and from the calibration of data of different flights do not necessarily arise if appropriately considered by the adaptor. When integrating field results on land degradation/desertification into satellite image processing, it should be kept in mind that the geometric as well as the spectral resolution of satellite data can vary considerably in the different recording systems. Pixel-lengths of SPOT-pan, corresponding to 10 m, have a precise resolution, thus enabling a better integration of qualitative data during processing than NOAA data, whose pixel-lengths reflect 1 km. Spectral ranges - each wave length visualizing a different surface information in a pixel - lie between 3 (SPOT-HRV) and 7 (Landsat-TM) bands. Thus, Landsat-TM data cover most geo-factors involved in land degradation/desertification.

Not all inconsistencies arising during the integration of qualitative data into satellite image processing have been solved yet. But experiences gained on desertification monitoring during the last 13 years of project work have enabled an increasing approximation between field methods and satellite image processing.

Focal points of research can be summarized as follows:

- digital classifications with different algorithms (supervised / unsupervised)
- application of different satellite data
- a multi-temporal comparison
- desertification monitoring
- field check
- desertification mapping
- suitability for a GIS

Socio-economic development and desertification in Butana

The Butana is a region which since time immemorial has been known to have excellent pastures. Although the natural resources of the area were always affected by droughts, tribal practices formerly controlled the grazing and water resources in the area according to tribal structures and needs (KIRK, 1992), thus securing pastures from permanent over-exploitation.

In 1971, the former President Numeri's socialist inspired policy that state-owned lands, i.e. natural resources should be accessible to everybody, led to the abolition of communal grazing areas, thus eliminating tribal rights over resources (KIRK 1992). The disorganized utilization of grazing lands since then has triggered a rapid spread in desertification. Sedentarization of formerly nomadic groups added to the strain on the environment.

During the last 40 years, agricultural development has cut down the size of crucial dry season pastures in the south. In a dry year such as 1991, for instance, major pastures (their northward range lying more or less close to the 150 mm isohyet) were totally encircled by mechanized rainfed agriculture in the south (cf fig. 3, areas IV and V). Simultaneously a sequence of lean years during the last decades prevented the regular emergence of vast grazing lands in northern Butana. In moderately dry years such as in 1991, only a (at most) 70 km wide strip was left in eastern central Butana, providing the bulk of biomass production. This leads to a congregation of large numbers of animals, thus by far exceeding the carrying capacity for livestock in eastern central Butana. Although crop residues from the neighbouring areas of mechanized rainfed cultivation and of irrigated schemes are important and reliant sources of feed supply, they have to be paid for. This cost further encourages the severe exploitation of the natural and 'free of charge' pastures.

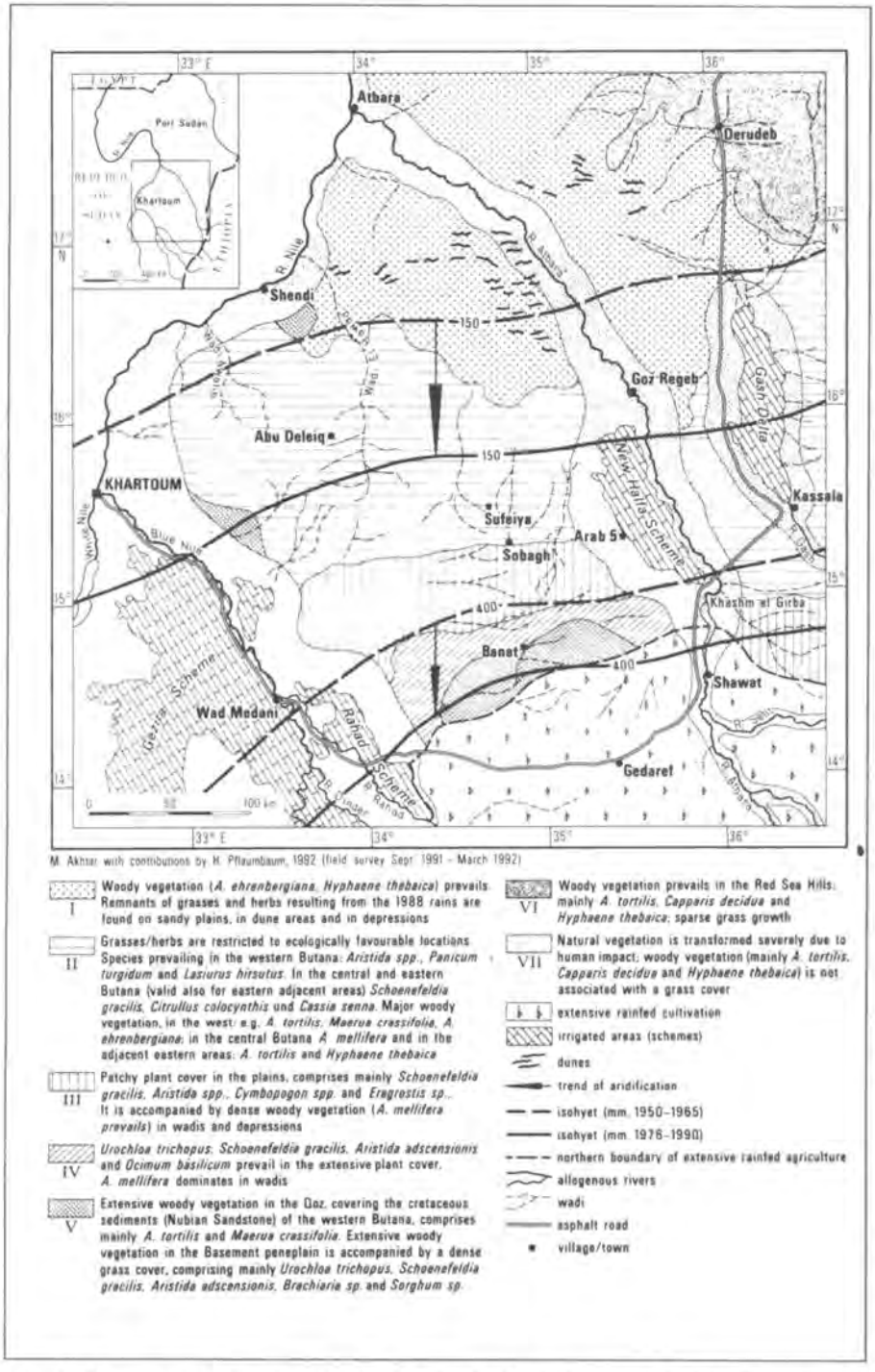


Fig. 3: Vegetation formations in the Butana in 1991. Sources: Field surveys; Landsat-TM (1991); Landsat-MSS (1986); Terrain Units Image Map of Central Sudan 1: 1 million, Range and Pasture Administration Khartoum 1990; Data of Sudan Meteorological Dept., Khartoum

Recent processes of land degradation in Butana

Due to this, the highly nutritive *Blepharis edulis* (Arab. 'Siha') - formerly characteristic of the Butana pastures, and an important dry season grazing plant (HARRISON 1955) - has almost entirely disappeared. In the humid year of 1992 it was only located in more remote pinpoint sites, indicating that its extinction is mainly the result of overgrazing. Instead, the annual grass *Urochloa trichopus*

(Arab. 'Taf fa'), which is not favoured by livestock holders, and which was formerly encountered in the more arid northern Butana, has spread dramatically over the remaining dry season or dry year pastures (fig. 3, IV and V).

A very low regeneration rate of woody vegetation was recorded in all relief units (cf fig. 4). Tree shoots originating from the very wet year of 1988 were grazed out in the following lean years. A solitary wet year in a dry decade does not lead to a regeneration of trees and shrubs.

In the clastic Mesozoic sediments (KLITZSCH 1989) of the 'Nubian Formation' in western Butana (cf fig. 4), extensive degradation of plant cover has increased deflation, triggering a reduction in fine size particles of the substratum of the western Butana and at the same time reducing the seed contents of the soils. Vast areas were bare of any herb-layer vegetation even in very humid years. The sandy substratum accelerates the appearance of desert-like conditions due to sand encroachment and the development of dunes. Only recently, some wadis in the north have been subject to blocking by sand masses.

In the lower Atbara Region in the far north of Butana the construction of the Khashm el Girba Dam in the sixties caused further damage (fig. 3). Enhanced fluvial erosion beyond the dam increased lateral erosion along the river banks (GLAESER et al 1988). Driftwood disappeared, which prior to the dam used to meet the requirements of construction wood of the riverine population. Wood cutting around settlements and the absence of run-off for half a year after the construction of the dam has also increased the processes of deflation.

The decline in natural resources initiated a migration to the perimeters of Butana. People who had lost all or a large proportion of their herds tried to find work in towns or stayed near areas which maintained fodder supply even in very dry years. From 1989 to 1993, field surveys revealed that the surroundings of rivers and irrigation schemes were most severely affected by desertification (cf. fig. 5, area 1). Here the poisonous *Calotropis procera* (Arab. 'Usher') was found in dense stands and grasses and forbs only appeared after about 20-25 km., thus showing the migration radius of cattle, sheep and goats away from permanent water points.

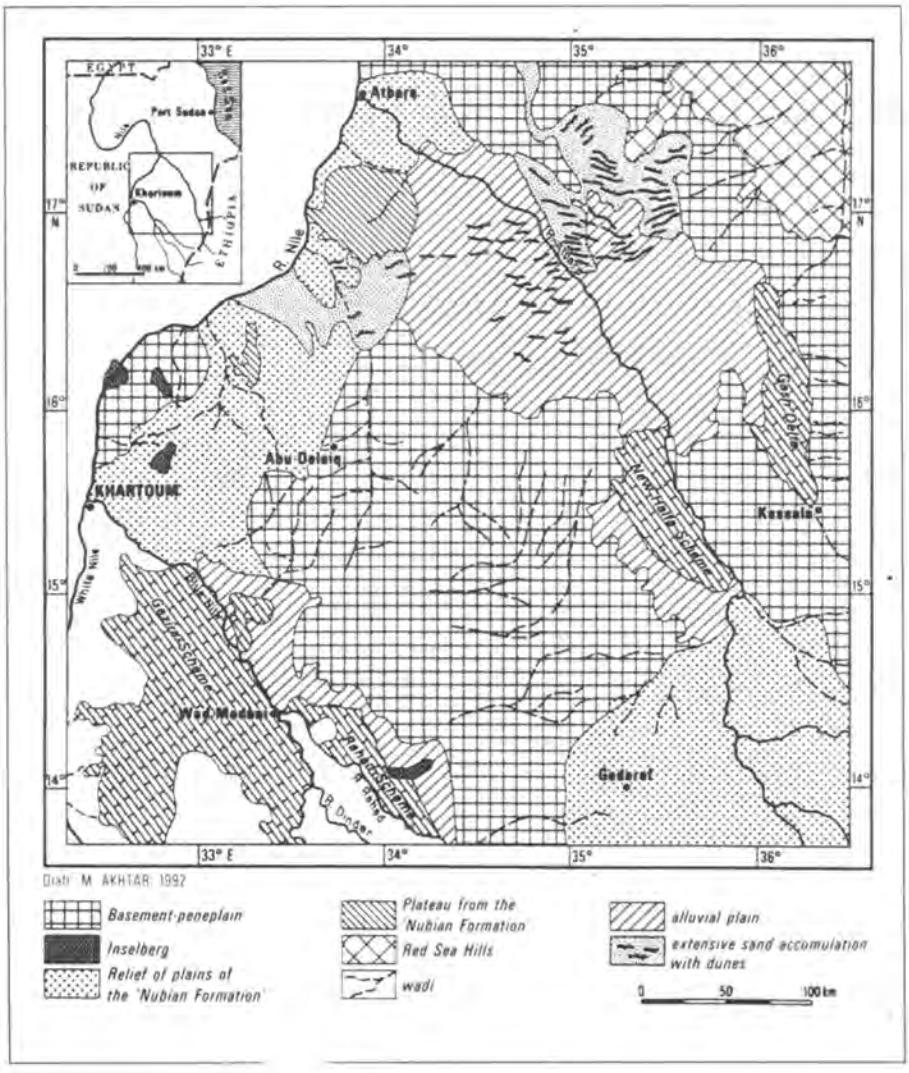
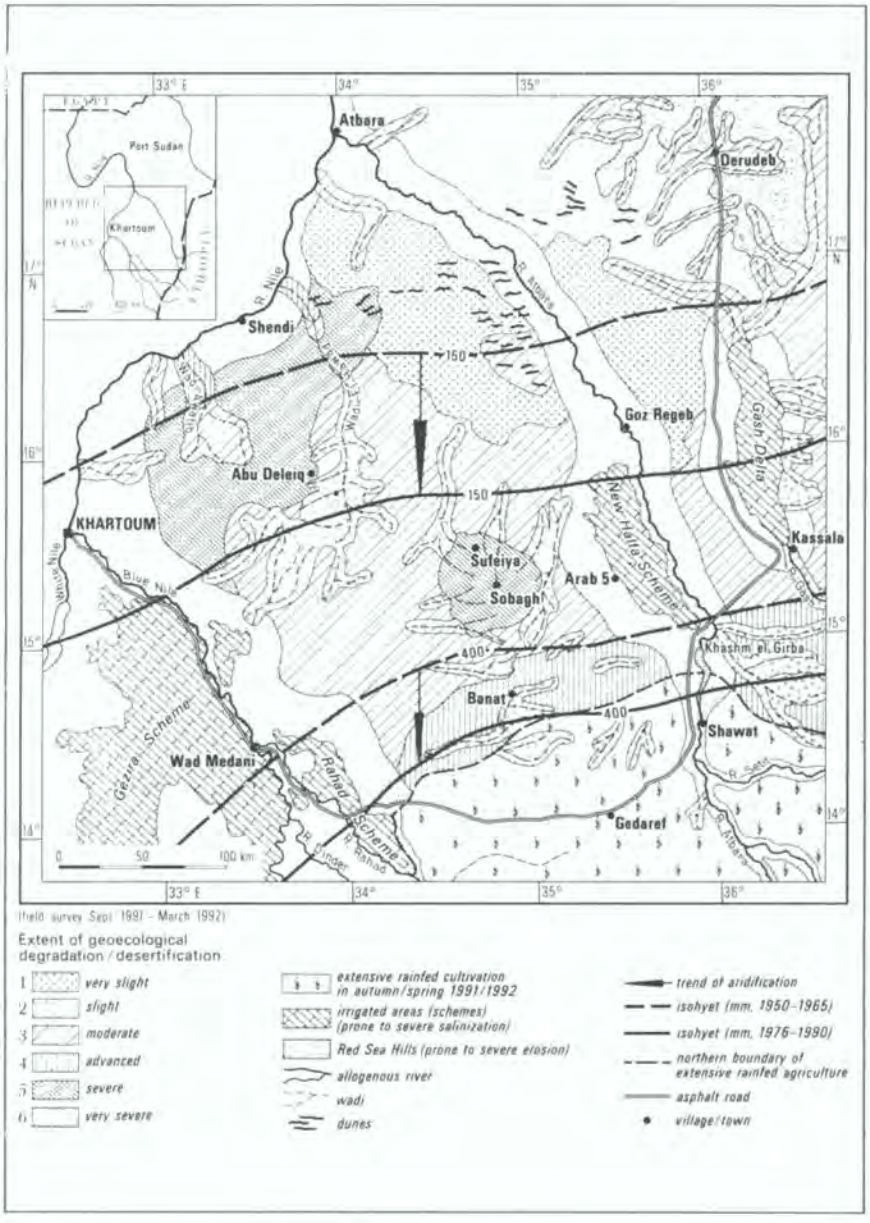


Fig. 4: Major geomorphic units in Butana. Sources: Field surveys; Landsat -MSS (1986); Geological Map of Sudan 1:2 million, Paris 1981

Desertification in the Jebel Marra forelands

Regardless of the high climatic variability in the marginal tropics, the old dune systems 'Qoz' of the Jebel Marra forelands are subjected to extensive cultivation of *Pennisetum typhoides* (Arab. 'Dukhn'). Combined with severe overgrazing and augmented by wood cutting by a growing and increasingly sedentarized population, cultivation has destroyed natural plant cover. This has enhanced deflation, thus reactivating old dunes. Desertification, as already described by IBRAHIM in the beginning of the eighties, currently has progressed beyond the Qoz systems of the Jebel Marra forelands, reaching the pediment and pediplanes of the Basement complex. Nomads, having lost their formerly good grazing lands in the Qoz and in search of new pastures have diverted their migrations into these areas with increasing frequency (see also GFE/GTZ 1989: 42).

The extent of site degradation in the forelands, east of Jebel Marra, is based on the evaluation of a digital classification. The ERDAS (Earth Resources Data Analysis System) software, installed at the 'Technische Fachhochschule' (TFH) Berlin was applied for digital image processing. A geometrically corrected



Draft: Mariam Akhtar 1992 Fig. 5: Environmental degradation / desertification in the Butana Sources: Field surveys; Landsat TM (1991); Landsat-MSS (1986); Terrain Units Image Map of Central Sudan 1:1 million, Range and Pastures Administration Khartoum 1990; Data of Sudan Meteorological Dept. Khartoum

map was indispensable in presenting the results gained from the digital classification of remote sensing data. Therefore, a series of image enhanced topographic maps (scale 1: 100 000) was developed. The results are delineated in the map on 'Classification of Surface for Desertification Monitoring'- sheet Korma.

Due to the higher geometric and radiometric resolution, thematic mapper (TM) sensors are more effective for the monitoring of desertification than the multispectral scanner system (MSS) sensors. The higher spatial resolution of TM systems enables a good separation of individual units. In MSS scenes, on the other hand, surface objects constitute mixed pixels so that units are mingled and an unambiguous allocation during the classification proves difficult.

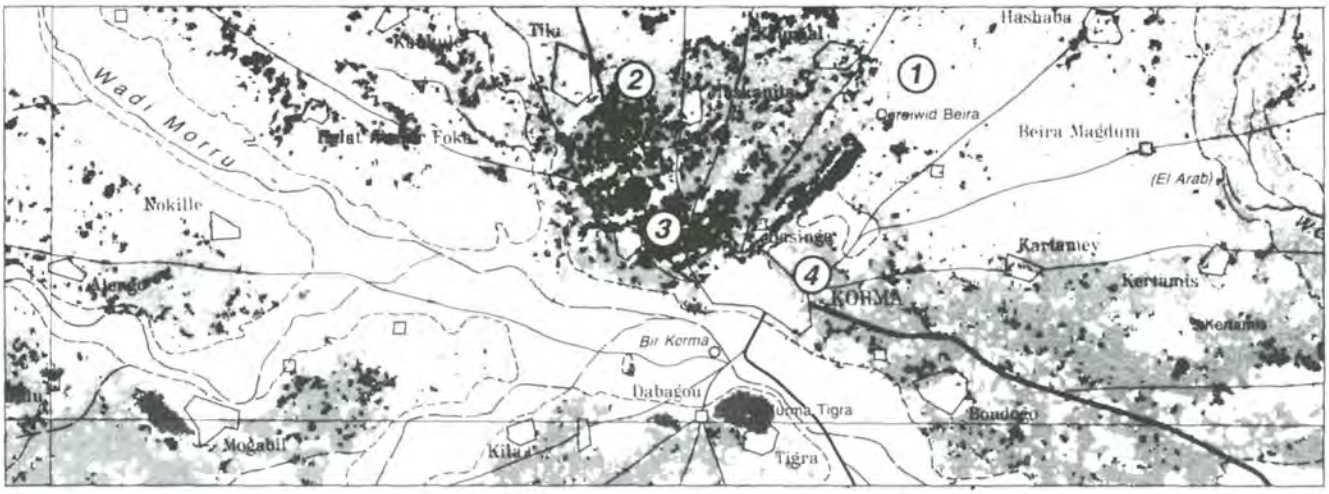
High altitudinal variations also aggravated the digital classification in the mountainous regions of the Jebel Marra, principally due to differing intensities of light. Areas with surface bedrock were neglected during desertification monitoring.

Unclassified or wrongly-classified surfaces were not interpreted. In the map these areas remain grey (band 3). Thus the map Qoz and pediplane regions in the Basement can clearly be distinguished. The quality of more detailed differentiation of the Qoz is, however, dependent upon the time of the shot and upon the training areas taken during field surveys. In order to determine the exact expansion of cultivated areas in the Qoz or the extent of recent sand accumulations in the vicinity of bare dunes, the interpretation of satellite images inevitably requires a ground check at the time of shot. The visual comparison of images based on different systems of data recordings (MSS and TM scenes) proved questionable during the monitoring of desertification. Although temporal environmental changes were indicated in both scenes, differences in geometric and radiometric resolutions did not enable a reliable interpretation of regional desertification, when based on different systems of satellite recordings. Multitemporal investigations should thus be done on one satellite system.

Ground checks showed that the supervised digital classification correlated excellently with the actual surface conditions. Global Positioning Satellite Systems (GPS) and the geometrically corrected maps enabled a clear allocation of classified degradation units with the surface conditions in the field. (see fig. 6).

Conclusions

Although about 1,000 km apart, desertification in the Butana Region and in the Jebel Marra forelands is the result of similar factors. During recent years, sedentarization, the abolition of traditional land -use rights and the expansion of agriculture have put continuous stress on the fragile resources of the study areas. Based on the qualitative analysis of small training areas, supervised classification of digital satellite data enabled a comparatively quick and efficient assessment of degradation over a vast region.



Extract of **Sudan 1:100 000, sheet KORMA - Classification of Surface for Desertification Monitoring** - Meissner, Ripke & Domnick / TFH 1992

(1) Qoz, stabilized dunes with natural vegetation, occasional rainfed cultivation

(2) Qoz, intensively cultivated

(3) Reactivated, degraded Qoz

(4) Surrounding of Korma village
A - Mobil dune ***B*** - Depression
C - Korma village ***D*** - Wadi area

Draft: Immelyn Domnick 1994

Fig. 6: Classified Landsat-TM data indicating the transformation of ecological units Sources: Extract of the coloured map SUDAN 1 : 100 000, sheet KORMA, TFH Berlin 1992. Photos: Domnick

The significance of detailed ground checks prior to a digital classification has to be emphasized. The making of a digital map for the study area implies its integration into a regional Geo Information System (GIS), hence drawing up the interaction of various factors causing site degradation. The visualization of interim and final results in 'dynamic' maps enables the development of measures combatting desertification at different levels of operation, i.e. on monitor, plots and maps.

Knowledge of regional landuse systems and current ecological conditions of investigated regions helped in the development of recommendations for more ecologically adapted landuse systems; a temporary exclusion of seriously afflicted surfaces from landuse and the identification of very endangered areas.

References

Akhtar, M.; Mensching,.G. (1993). *Desertification in the Butana.*- In: Geojournal 31.1, pp. 41-50.

Bayer, W. (1983): *Evaluation of pasture dry matter ranking.* Revised draft for Handbook on Pasture Production and Evaluation (proceedings of ILCA/ KPU workshop held at Kurmin Biri, Nigeria in April 1982).

Domnick, I. (1992): *Regionale Anwendung von Fernerkundungsdaten füz Desertifikationsmonitoring - am Beispiel des stlichen Jebel Marra Vorlandes (Darfur/Republik Sudan).*- Thesis unpublished, Freie Universit t Berlin.

Gesellschaftrforschung und Entwicklungs projektierung (GFE) (1989): *Development Potentials of the Wadi-Systems in Darfur, Sudan.* Vol. I & II (Annex). Aachen.

Glaeser, B.; Abdel Ati I, H.; Mensching H.G. & Poertge K.-H. (1988): *Untersuchungen zum Kulturlandschaftswandel am unteren Atbara (Republik Sudan).*-In: Die Erde 119: pp. 193-202.

Harrison, M.N. (1955): *Report on grazing survey of the Sudan.* Department of Animal Production, Khartoum.

Ibrahim, F.N. (1984). *Ecological Imbalance in the Republic of the Sudan - with Reference to Desertificaiton in Darfur.*-Bayreuther Geowiss. Arb., 6.

Kirk, M. (1992): *Verf gungsrechte ber Ressourcen und technologischer Wande l: Neuere Entwicklungen und Perspektiven in der Butana.* Ed.: Institute of Rural Development, discussion paper no. 12.

Klitzsch, E. (1989): *Zur Stratigraphie Nubiens. Das Ende des Nubischen Sandsteins als stratigraphischer Begriff.* - In: Zeitschrift dt. geol. Ges., G ttingen, 140, pp. 151-160.

Meissner, B.; Ripke, U. (eds.) (1993): *Examples of Remote Sensing Cartography in Arid and Semi-arid Regions.*- In: Berl. Geowissenschaftl. Abh., C, vol. 14, Berlin.

Meissner, R. B.; Wycisk, P. (eds.) (1993): *Geopotential and Ecology - Analysis of a Desert Region.*- In: CATENA, supplement 26.

Mensching, H.G. (1991): *Die Sahelzone: Naturpotential und Probleme seiner Nutzung.*- In: Problemr ume der Welt (ed. H.BECK & M. STRAESSLER), Koeln, vol. 6

Land Degradation in East Africa*

By Michael Stähl

Michael Stähl was head of the SIDA's Regional Soil Conservation Unit (RSCU) in Nairobi 1991-94. He has a Ph.D. in political science from Uppsala University and is associate professor at the Department of Water and Environmental Studies, Linkbping University. He has long experience in research and development administration in Ethiopia, Tanzania and Kenya. He is since July 1994 Head of SIDA's Development Cooperation Office in Ethiopia

The highlands of East Africa have a high agricultural poiential and have historically supported kingdoms with stratified social structures. Today, traditional fertility practices cannot be maintained under conditions of mounting population growth and land scarcity. Land degradation is now threatening the very basis of the farming communities. This paper discusses land degradation in East Africa in the context of soil conservation. It describes technical and institutional responses to land degradation including regional cooperation and concludes that degradation is not yet irreversible. Relatively low-cost technologies exist that have the potential, given supportive institutions and incentives, to achieve widespread adoption among small holders.

Introduction

At present, development has come to a halt in most parts of East Africa. Living standards are declining and the environmental situation gives cause for concern. Environmental assessments by the World Bank, the United Nations Environmental Program (UNEP), the Worldwatch Institute and the World Conservation Union (IUCN) questions Africa's ability to prevent its environmental degradation and to sustain livelihoods by the end of this century (1-4). Afro-pessimism is growing at a time when the North has environmental issues to address in its own hemisphere.

It is customary to be pessimistic about development prospects for Africa in the near future. From a broad perspective, factors contributing to this situation include recurrent drought, unfavorable terms of trade, unwise use of loans and grants, rapid population growth, corrupt leadership, civil strife, etc. (5,6). Though all these factors are acknowledged as important, this paper discussed only one aspect of the crisis: land degradation in the context of soil conservation. The geographic area discussed is limited to the highlands o East Africa, including Kenya, Uganda, Tanzania and Ethiopia.

The information presented is based on the literature and on the author's experiences as Head of the Swedish International Development Agency's (SIDA) Regional Soil Conservation Unit (RSCU). SIDA has actively supported soil conservation in East Africa, notably in Kenya and Ethiopia. In 1982, SIDA established the RSCU in Nairobi with the mandate to facilitate exchange of regional experience in soil conservation. RSCU organizes training courses, workshops and study tours, produces and distributes training material, gives technical advice and initiates pilot activities with integrated agriculture, agroforestry and livestock management. The aim is to facilitate regional competence in soil conservation, broadly defined as environmentally-sound land management (7).

The setting

The highlands of East Africa have a high agricultural potential and, until the mid 20th century, were resilient to exploitation. The fertile soils and abundant rainfall attracted farmers to the region many centuries ago. The productivity of the land supported chiefdoms and kingdoms with stratified social structures, notably in Ethiopia and around the great lakes (8). As recent as the late 1800s, these societies were organized on an ecologically sustainable basis. The land was not only able to produce subsistence for its inhabitants, but a surplus as well. Soil fertility was maintained through fallow periods, crop rotation and use of livestock manure (9).

Today, land degradation is threatening the very basis of East African peasant societies. Degradation has proceeded furthest in Ethiopia where the northern highlands, once the cradle of the Axumite civilization (in the first few centuries A.D.), have become chronically dependent on food aid.

Current agriculture, characterized by an increase in expansion of impoverished small-holders and land scarcity, is making traditional fertility-maintaining practices (long fallow periods, etc.) impossible. Poor farmers cannot afford to buy fertilizer and they are generally uninformed about alternative means of maintaining soil fertility. Their planning horizon stretches to the next harvest and they

* This article was originally published in AMBIO Vol. 22, No. 8, 1993.

lack the incentive to engage themselves in long-term conservation.

Population pressure in the highlands has led to encroachment by the landless into sub-humid patches in the drylands. As a consequence, pastoralists have been pushed aside into the more barren areas and their production system is under severe stress (10, 11).

At the local level, rapid population growth together with technical backwardness in food production and lack of off-farm employment opportunities, produce conditions where the ecological basis of food production is undermined. East Africa, has an annual population growth rate of 3% and, like the rest of the continent, is in the midst of a demographic transition from high fertility and mortality rates to reduced mortality, which may eventually result in lower fertility rates. In 1960, the former British East Africa (Uganda, Kenya and Tanzania) and Ethiopia had an estimated total population of 47 million. The population had grown to 117 million in 1990, and is projected to reach 330 million by the year 2025 (4).

However, land degradation is not irreversible. There are a number of initiatives by national governments, foreign donors and local groups to prevent further degradation. Low-cost technologies that can potentially provide a basis for sustainable resource management are emerging from engineering and agroforestry experiments, training and extension programs. In Kenya, Uganda, Tanzania and Ethiopia a number of initiatives have been taken including the launching of national conservation strategies, environmental action plans, community forestry and soil conservation campaigns (12-14). Achievements are most conspicuous in Kenya.

Responses by the Government of Kenya

Kenyan authorities have given official recognition and have devoted resources to environmental rehabilitation (12). At the 1972 UN Conference on Human Environment in Stockholm, the Kenyan delegation stated that land degradation was the most severe environmental problem threatening agricultural production. As a follow-up to the conference, a Soil and Water Conservation Branch was set up within the Kenyan Ministry of Agriculture with funding and technical assistance from Sweden. A National Environmental Secretariat and a Permanent Presidential Commission on Soil Conservation and Afforestation were set up in the mid-1980s. In 1989, responding to the concern for rapid exploitation of the drier areas, the Goverrunent of Kenya established a Ministry of Reclamation and Development of Arid, Semi Arid and Wastelands. This ministry coordinates the activities of the line ministries and other bodies, on environmental management in the drylands. A growing number of Kenyan NGOs are active in environmental extension, advocacy and research programs.

The Soil and Water Conservation Branch runs a continuous and intensive in-service training program including theoretical courses and study visits. Over the years, the Branch has developed methodologies for soil and water conservation and implemented a huge training and extension program for agricultural technicians. More than 18 000 agricultural officers have undergone training and more than one million small farms have adopted conservation measures (15).

Although these achievements are impressive the general trend in the Kenyan highlands, as elsewhere in East Africa, is that land is still being degraded. An estimated two-thirds of the small farms needing conservation measures have yet to be reached.

Bunds and terraces

The major environmental degradation problem in the settled highland is soil erosion. Since the terrain varies from undulating to hilly to mountainous, most agricultural land is situated on slopes. To facilitate planting and weeding, conventional agricultural practices leave the soil bare and loose at the onset of the rains. On bare ground, the rainfall, which often comes in heavy showers, carries away topsoil and nutrients from the agricultural fields. Rill, sheet and gully erosion are common (16). Various methods to delay and reduce rainwater runoff have been introduced to alleviate this problem (16-18).

From its start in 1974, the Kenyan soil conservation program targeted smallholder farms using labor-intensive methods and drawing upon past experience (19). For example, the hand-dug terrace, the "fanya juu" might be widely adopted. In the "fanya juu" system, a ditch is dug along the contour line of a slope and the soil is thrown uphill so that an embankment is formed. The distance between embankments varies according to the slope. On very steep slopes the distance is only a few meters. When the rains set in the soil eroded from the upper part of the plot is delimited by the two bunds, to the lower part where it is caught by the embankment. Gradually, a bench terrace is formed and the cultivated plot is levelled.

A whole range of other soil-conservation structures have been developed through the collaboration of the Soil and Water Conservation Branch and farmers. The bunds can be constructed downslope of the ditch "fanya chini", and the terraces can be made level, inward sloping or outward sloping. Water diversion ditches can be constructed to lead the runoff water safely down the slope. In some cases, a dug terrace is not required. Instead trash lines, formed by branches, twigs, leaf, and litter, are laid out along the contour and grass is planted. This biomass line function as a soil-conservation structure. Using this technique, a terrace is built up using a minimum of labor. The design of the structure recommended by extension staff to farmers depends on local circumstances such as slope, soil erodibility, rainfall, choice of crops, labor availability, and farmers' preferences.

In areas with high rainfall, the purpose of bunds, terraces etc. is to reduce soil and nutrient runoff. Supplementary water diversion ditches above fields are sometimes necessary to cope with the enormous water masses. In areas with little or erratic rainfall, the function of terraces is to trap rainwater, thus providing moisture to the root zone of growing crops by causing the water to infiltrate down into the soil. Without terraces rainwater would simply run downslope to

seasonal rivers.

A gradual shift has occurred in the soil-conservation approach during the 1980s- The primary aim now is not only to prevent soil erosion at any cost. Instead, soil conservation has been put in the context of good land husbandry: i.e. the aim is to maintain productive capacity. The implication is that soil conservation should be integrated into general agricultural extension rather than being looked upon as a special engineering activity (20) Methods are being developed to "make the terraces green" Agroforestry is an important technique in this respect.

Agroforestry

Agroforestry is defined as "the deliberate growing of woody perennials on the same unit of land as agricultural crops and/or animals either in some form of spatial mixture or in sequence"(21). There are a number of introduced species which are doing well in East African farming systems. Moreover, research and trials are underway to screen indigenous trees and bushes with a potential for use on smallholder farms. Trees can have many functions. Some provide building poles and fuelwood, others enrich the soil (by nitrogen fixation) provide feed for livestock, or fruits for sale. Many trees species can fulfill at least two of these functions. Trees can be planted on terrace banks and in waterdiversion ditches. They can also be planted along farm boundaries, around homesteads and in small woodlots. A special technique advocated by the International Centre for Research on Agroforestry (ICRAF), with headquarters in Nairobi, is to plant multipurpose trees in hedgerows with crops in between. Preferred tree species do not compete with crops for soil moisture and sunlight, are fast growing, and can be pruned, pollarded or harvested after a few years (21-26).

Livestock Management

Livestock management must be included in soil conservation strategies. The free roaming of cattle, goats and sheep on agricultural land after harvest can lead to destruction of terraces. In the central Kenyan highlands, land is now so scarce that pastures have more or less disappeared and fodder must be grown. Terrace banks can be gainfully used for growing grass. A number of fast growing and nutritious, mainly exotic, grasses have been screened, bulked up and distributed to farmers for planting on bunds and terraces. In this way, zero-grazing systems are developing. However, this is only profitable if the farmer has access to crossbred dairy cows. In Kenya, the dairy industry is to a large extent dependent on milk supplied by smallholders, and there is a market for milk in all small towns.

The major requirements for zero-grazing dairy systems include veterinary services, access to upgraded cattle (which requires artificial insemination or bull-stations) and access to protein-rich grasses and trees. In some cases, farmers have introduced silage practices where grass is cut when the protein content is at its peak, thrown into an earthen pit, covered with plastic followed by a layer of soil. The silage is used as fodder during the dry season as a nutritious supplement to poor range grazing.

Property Rights

A major impediment to long-term improvement in land is land tenure. At the farm level, the presence or absence of clearly defined property rights makes the difference between active interest in investing in soilconservation measures or apparent indifference to environmental degradation. In Kenya, the areas where soil-conservation measures have been most readily adopted roughly coincide with the areas where land has been adjudicated, registered, and land titles obtained.

Many agricultural officers in Ethiopia, Uganda and Tanzania believe that the low interest of farmers in soil conservation is largely due to landownership system (27). Where the government is the official landowner and land-use rights are allocated by chiefs or elders according to age-old traditions, farmers are seldom prepared to invest in land improvement. Customary rules do not adequately deal with mounting population pressure. Prolonged occupancy cannot be taken for granted by the individual land-user. This is not to say that customary tenure as such is detrimental to land improvement. There are cases where land right have been solidly vested in individual households under customary tenure, and where heads of households are indisputable owners of their land, although this is not expressed in title deed.

The socialist land tenure enforced upon Ethiopian farmers by the Mengistu regime is an extreme example of how institutional insecurity can force people to pursue destructive land-use practices. During the 1980s, the Ethiopian authorities introduced massive campaigns to plant trees and construct terraces. The physical results were impressive, but the peasants had no secure land use rights whatsoever. Huge relocation projects took place in the form of resettlement, collectivization and villagization. As a result the farmers developed short-term planning horizons, focusing on the next coming harvest (28). When the regime crumbled, the farming communities were left without direction.

In 1991, considerable destruction of previous environmental investments took place. Tree plantation were cut down and soil bunds function as conservation terrace on agricultural fields were plowed in (29). The shortterm reasons for this are obvious: trees were cut because people needed building poles, which were in scarce supply. Bunds are plowed in because they have accumulated nutritious soil, which if spread over the whole field, functions as fertilizer. However, this holds true only for the next season. The long-term consequences of these practices are negative. When asked about their behaviors, farmers give a logical explanation that they have heard that the government will leave the farmers alone for two years; after which the farmers believe there will be new rules and new relocations of people. There is thus no guarantee that an individual household will be allowed to continue cultivation on its presently held plots. Long-term land improvement is then, from the farmers' perspective, irrational. It is better to use the biomass for the household's immediate consumption even if this means further degradation and lower yields later (30).

Institutions and Research

Agricultural and forestry research has a long tradition in East Africa, but problem-focused farming-system research geared to the needs of small holders is a relative novelty. Academic research emphasizes specialization and tends to be compartmentalized with individual researchers narrowing in on a particular subject. Moreover, research is mainly based on trials at research stations where conditions differ from the true conditions on the small holder . During the 1980s, alternative research-approaches have been introduced, emphasizing farmer involvement in the research process and the need or an interdisciplinary approach, including subjects such as crops, trees, livestock, soil and water, and rural sociology (31, 32). Small holder-relevant research first emerged among committed professionals in rural-development studies but is gradually gaining a foothold in the established agricultural research institutions.

The Participatory Rural Appraisal (PRA) where researchers from several discip@es, extension agents and farmers, jointly identify the problems of a community, has been instrumental in pinpointing the need for an interdisciplinary approach (33). It has also been acknowledged that farmers possess a wealth of knowledge about species and ecological processes, which is more or less unknown to academic researchers. Hence, indigenous technical knowledge is becoming respectable as a potential means of enriching scientific knowledge.

Such trends favor the development of sustainable conservation based production systems. In order to succeed however, researchers and extension staff must be supported by resourceful, dynamic, and innovative institutions. The managerial aspects of innovation must be given increased attention (34). In this respect, East African institutions have many shortcomings. It is generally known that research is underfunded, that researchers do not communicate frequently across disciplines (let alone with extension staff), that research has low status, that the expertise of researchers is seldom drawn upon for official policy formulation, and that the research infrastructure is on the verge of collapse in many institutions (35). It should not come as a surprise that few innovations emerge from these institutions.

Extension staff face an even worse situation. The typical Ministry of Agriculture in East Africa uses about 90% of its running costs on salaries. Extension staff lack transport, daily allowances, instruction materials and access to recent research findings. Often, they sit demoralized in resourcestarved offices. As a result, they are ignorant about local farming conditions and may react with arrogance and bureaucratic highhandedness when faced with farmers seeking advice.

The Future

Despite the lack of systematic scientific data at the farm level (36), it is clear that soil conservation pays. The conservation activities outlined above contribute to the development of an ecologically sustainable agricultural system. Studies from Kenya and Ethiopia have shown substantial increase in annual crop yields as a result of proper terracing (37-39). Agroforestry and dairy cows yield cash incomes, if the farmers have access to a market. The Kenyan highlands have a good road network and many small urban centers where milk, building poles and fruit are in high demand. In Ethiopia, Uganda and Tanzania, market access is much less developed and hence discourages commercialization of agricultural practices.

Soil conservation and agroforestry require labor inputs and technical advice, but only limited cash outlays. The cost of tree seedlings from government nurseries is low, and farmers have learnt to develop their own backyard nurseries. Physical conservation structures help to prevent soil loss and to retain moisture. The use of trees, bushes and grasses, stabilize conservation structures, enrich the soil and make zero-grazing possible. Stall-fed dairy cows contribute to cash income and the manure can be collected and spread on fields.

Since the agro-ecological setting and the farming systems show similarities throughout East Africa, there is scope for regional cooperation. Soil conservation experts from Kenya have, through RSCU's assistance, contributed to the development of conservation practices in neighboring countries. A regional pool of expertise can facilitate and speed up adaptation of conservation technologies in East Africa.

Despite the initiatives mentioned above, the impact on the ground is still limited. Especially female headed or female maintained households, with less than average holdings, come up against major difficulties in attempts to make their farms viable. They face labor shortages, have less income, and must devote much time to child rearing and household work. The farms owned by poor women may degrade because the women lack labor, cash income, and access to technical know-how (40).

The major soil and environmental conservation enemy is a confused property regime. For development activities to be successful, there is an urgent need to understand what rules, *de facto,* govern land transactions. This is especially important in areas where several land-holding systems are intermingled, e.g. state ownership, customary tenure, collective farms, etc.

In addition, almost all East African environmental institutions are budgetstarved. A conspicuous fact is that they are almost completely dependent on donor funding, both for capital and most of their running costs. This raises questions about sustainability of whether governments, in fact, consider environmental issues a priority.

At the same time, donor-fatigue has become obvious in Africa. Continuous external support to rural development cannot be taken for granted. If the macroeconomic situation and political stability of countries in the region continue to deteriorate, development aid may be drastically reduced. In a political and economic crisis, there is little likelihood that national governments will give priority to supporting the development of environmentally-friendly technologies for smallholder production. Population dynamics must also be considered in this

context. Continued population growth may overload the capacity of smallholder farming systems, even if farms are strengthened by conservation measures along the lines mentioned. ff the present rural population, plus a large majority of the additional population in the near future, have to earn a living from the crop and animal husbandry used today, then the ecological basis for food production may collapse entirely.

Thus, in part, the solutions to the problem of land degradation, lie outside the small farm sector. A drastic transformation in the official attitude to research and extension development is required both in East Africa and internationally. What is required are dynamic and flexible research and extension institutions that work in local communities and treat farmers as resource persons. These institutions should have an absolute minimum of red tape, be well equipped, have access to international research, and be blessed with highly motivated staff. Despite the pessimism that the dominant present trends are leading to, there is no doubt that solutions do exist for the problems facing East Africa.

Reference and Notes

1. **IUCN 1992.** *Caring for the Earth. A Strategy for Sustainable Living,* Gland, Switzerland.
2. **UNEP, 1992.** *Saving our Planet, Challenges and Hopes.* Chapman and Hall, London. 3. World Bank, 1992. *World Development Report 1992, Development and the Environment.* Oxford University Press.
4. **World Resources Institute, 1992.** *World Resources 1990-91.* Oxford University Press, Oxford.
5. **Fruhling, P. (ed.) 1988.** *Recovery in Africa, A challenge for Development Cooperation in the 90's.* Swedish Ministry for Foreign Affairs, Stockholm.
6. **World Bank 1989.** *Sub-Saharan Africa, From Crisis to Sustainable Growth.* Washington.
7. **Ståhl, M. 1992.** *RSCU's efforts towards soil conservation. Innovation, A Magazine for Technology and Sustainable Development. No.2.*
8. **Murdock, G.P. 1959.** *Africa, Its people and Their Culture History.* McGraw-Hill, U.S.A.
9. **Allan, W. 1967.** *The African Husbandman.* Oliver and Boyd, London.
10. **Hjärt af Omäs, A. (ed.) 1992.** *Security in African Drylands, Research Development and Policy,* Depts of Human and Physical Geography, Uppsala University, Uppsala.
11. **Hjört af Omäds, A. and Salih, M. 1991.** Research and Development issues for African drylands, Ambio 20,388-394.
12. **Kiriro, A. and Juma, C. 1991** *Gaining Ground Institutional Innovation in Land-Use Management in Kenya.* ACTS Press, African Centre for Technology Studies, Nairobi.
13. **Kamugisha, J.R. 1992.** *Environmental Policies and Legislation in Uganda.* Report No.11 Regional Soil Conservation Unit/SIDA, Nairobi.
14. **Wood, A. and StAhl, M. 1990.** *Ethiopia, National Conservation Strategy, Phase I Report .* IUCN, Gland, Switzerland.
15. **Mbegera M., Eriksson, A., and Njoroge, S.N.J. 1990.** Soil *and Water Conservation Training and Extension - Kenyan Experience.* Paper presented to the ISCO Conference, Addis Ababa, Ethiopia.
16. **Hudson, N. 1984.** *Soil Conservation.* Batsford Academic and Educational, London.
17. **Hurni, H, 1986.** *Guidelines for Development Agents on Soil Conservation in Ethiopia.* Community Forests and Soil Conservation Development Department, Ethiopia.
18. **Wenner, C.G., 1981.** *Soil Conservation in Kenya, Especially in Small Scale Farming in High Potential Areas Using Labour Intensive Methods.* Ministry of Agriculture, Nairobi.
19. **Eriksson, A. (ed.) 1992.** *The Revival of Soil conservation in Kenya, Carl-Gdsta Wanner's Personal Notes, 1974-81.* Report No.1, Regional Soil Conservation Unit/SIDA, Nairobi.
20. **Lundgren, L. 1993.** *Twenty Years of Soil Conservation in Eastern Affica.* Report No. 9, Regional Soil Conservation Unit/SIDA, Nairobi.
21. **Nair, P.K.R. (ed.) 1989.** *Agroforestry Systems in the Tropics.* Kluwer Academic Publishers, London.
22. **ICRAF 1989.** *Agroforestry Development in Kenya.* Proceedings from the 2nd National Seminar on Agroforestry, ICRAF, Nairobi.
23. **Kerkhof, P. 1989.** *Agroforestry in Africa, A Survey of Project Experience. PANOS,* London.
24. **Rocheleau, D., Weber, F. and Field-juma, A. 1988.** *Agroforestry in Dryland Africa.* ICRAF, Nairobi.
25. **Sjöholm, H. 1989.** *Guidelines for Development Agents on Community Forestry in Ethiopia.* Community Forestry and Soil Conservation Development Department, Ethiopia.
26. **Young, A. 1989.** *Agroforestry for Soil Conservation.* ICRAF and CAB International, Exeter.
27. This is based on the author's extensive discussions with agricultural officers in Ethiopia, Uganda and Tanzania.
28. **Stähl, M. 1990.** *Environmental degradation and political constraints in Ethiopia.*

Disasters. J. Disaster Stud. Mgmt. 14, 140-150.

29. **Kebede Tato, 1992.** "The role of grassroot organizations in development - opportunity lost for soil conservation in Ethiopia". *Proceedings froom the 7th International Soil Conservation Organization Conference in Australia, 27-30 September, 1992, Sydney*
30. I am indebted to Yeraswerq Admassie for this information which will be further analyzed in his forthcoming Ph.D. dissertification on soil aspects of soil conservation in Ethiopia.
31. **Chambers, R. 1983.** *Rural Development, Putting the Last First.* Longman, London.
32. **Chambers, R., Pacey, A and Thrupp, C.A. (eds.) 1989.** *Farmer First, Farmer Innovation and Agricultural Research.* Intermediate Technology Publication, London.
33. **McCraken, J.A., Pretty, J.N. and Conway, G.R. 1988.** *An Introduction to Rapid Rural Appraisal for Agricultural Development.* IIED, London.

34. **Juma, C. and Ojwang J.B. (eds.) 1990.** *Innovation and Sovereignty, The Patent Debate* in African Development, African Centre for Technology Studies, ACTS Press, Nairobi.
35. **SAREC 1990.** SAREC's *Support to Research on BioResources and Rural Development. A Survey and Guidelines for the 1990's.* SAREC Report 1990-2, Stockholm.
36. **Bojö, J.P. 1991.** *Economics of land degradation,* Ambio 20, 75-79.
37. **Dixon, J.A., Jones, D. and Sherman, P.B. (eds.) 1990.** *Dryland Management, Economic Case Studies.* Earthscan, London.
38. **Yeraswerq Admassie 1992.** *The Catchment Approach in Soil Conservation in Kenya,* Regional Soil Conservation Unit/SIDA, Nairobi.
39. **Gebre-Mikael, Y. 1990.** *Crop Production and Conservation Methods in Andit Ted Area, Northern SUwa.* Working Paper in Ethiopian Development, Universitetet i Trondheim, Norway.
40. **Khasiani, S.A. (ed.) 1992.** *Groundwork, African Women as Environmental Managers.* ACTS Press, African Centre for Technology Studies, Nairobi.

New Evidence of Desertification from Case Studies in Northern Burkina Faso*

Sven Lindqvist
Anna Tengberg

Department of Physical Geography
University of Göteborg
Reutersgatan 2C
413 20 Göteborg

Abstract

Case studies on desertification in northern Burkina Faso, in the Western Sahel, using satellite-aided ground navigation technology, have shown that noticeable environmental degradation took place between the late 1960s and 1990. Analyses of aerial photographs and satellite images indicate that the most severe land degradation occurred during the first of a series of droughts, which started in the late 1960s, when large areas of bare ground developed. Despite increased rainfall since 1985, the areas with bare ground have not recovered. The main cause is a combination of human impact and repeated droughts.

Introduction

During the last few years there has been considerable discussion about whether desertification is a myth or not (e.g. Dregne and Tucker 1988; Forse 1989; Binns 1990; Helldén 1991). The conception of the advancing desert edge is undoubtedly wrong; this has been demonstrated by an increasing number of scientists (e.g. Helldén 1991; Tucker et al. 1991). The fact remains, though, that severe land degradation and in some cases desertification are existing problems in the semi-arid areas bordering deserts.

Desertification in the African Sahel has often been discussed in connection with the long-lasting drought that began in the late 1960s. However, a variety of definitions and concepts of desertification and land degradation exist. In connection with the Rio Conference on Environment and Development the following definition was adopted: Desertification is land degradation in arid, semi-arid and dry subhumid areas resulting from various factors, including climatic variations and human activities (UNCED, 1992/93). Degradation implies reduction of the resource potential by one process, or a combination of processes, acting on the land.

The Sahel is the semi-arid zone south of the Sahara desert, where there is a sharp alternation between a short, rainy, summer season and a long dry season; it lies between the isolines for precipitation of 100 to 650 mm/year. The vegetation is steppe throughout and changes to Sudanian savanna and open woodland in the south. In the north Sudan zone south of the Sahel, the rainfall is between 650 and 1000 mm/year and the rainy season does not exceed 6 months (Monod 1985; Sivakumar and Gnoumou 1987).

There are a few reports of land degradation in the Western Sahel. Ecological degradation between 1950 and 1986 in relation to land use in northern Nigeria, has been studied in aerial photographs as well as in the field (Mortimore 1989). It was found that rangeland dunes had increased noticeably since 1950. Their earlier development was attributed to grazing pressure, whereas their increased size and frequency during the last two decades, has been attributed to deteriorating rainfall.

Kusserov (1990) found, by comparing satellite images, that between 1976 and 1985, 45% of the closed savanna structure in the South Sahel North Sudan transition zone, in an area in Mali, had been degraded. In another study from central Mali, using satellite images and aerial photographs, the same trend was observed. A marked degradation of tree and shrub savanna units had taken place during the 1952-1987 period, coinciding with the expansion of the area under crops (UNEP 1992). In a study of the Mossi plateau in central Burkina Faso, 32.2% of the area investigated (60,000 km^2) was mapped, using satellite images, as being degraded savanna in 1975. Twelve years later, in 1987, this percentage had risen to 65.3 (Poppel and Lekkerkerker 1991). Widespread degradation of the Sahelian

* This article was originally published in *Geografiska Annaler*, 75A; 127-135, 1993

savanna vegetation has also been reported from southern Mauritania (Middleton 1987).

Results from remote sensing studies of desertification in the Republic of Sudan are not in accordance with the above mentioned studies. No trend in the creation or possible growth of desert patches, nor major changes in vegetation cover or crop productivity during the 1962-1984 period were found (Helldén 1984; Ahlcrona 1988). This discrepancy can be due to differences in rainfall trends between the Eastern and the Western Sahel (Mattson and Rapp 1991).

The major objective of the present study is to assess spatial and temporal variations in the extent of desertification in northern Burkina Faso, and to relate it to variations in the rain regime.

Spatial and temporal variations in the rain regime

The precipitation in northern Burkina Faso has great spatial and temporal variations. Changes in the position of the intertropical convergence zone (ITC) are of course of great importance for the amount of precipitation, as well as the moving disturbances called easterly waves. They are a band of storm activity, often associated with squall lines, which give 70% of the precipitation (NASA/GSFC 1984). The limits are given by the tropical easterly jet and the African easterly jet.

However, our experience is that thunderstorms are also important. One example is from May 1991. When travelling in the northern part of Burkina Faso, the existence of heavy, very localized precipitation was obvious. The meteorological station at Dori (Fig. 1) had recorded unusually high precipitation values around May 20th. Fifty kilometres to the north, at Gorom-Gorom, the amount of rain had been even higher, 124 mm, of which 82 mm fell during one heavy storm on May 20th and 42 mm the adjoining day. This was more than the total May precipitation over the past ten years. The total May precipitation at Dori in 1991 was 78 mm, which fell during nine days.

Meteosat images have been used in order to analyze the weather situation during these heavy rains. At noon on the 19th the whole of Burkina Faso had clear skies, but several cumulonimbus clouds were present close to the Gulf of Guinea. During the night between the 19th and 20th, two groups of these clouds moved northeast from Liberia towards central and northern Burkina Faso (Fig. 2). In the following days these storm centers moved father northeast.

The only official station in northern Burkina Faso is Dori. This station is also used when making comparison between different stations in the Sahel or in the country, as well as in calculations of mean values from a number of stations in the Sahel and Sudan regions. However, the Dori values are not very representative and are therefore of limited use.

The Meteorological Office in Ouagadougou provided data from the unofficial precipitation stations in the area investigated. The precipitation stations are Gorom-Gorom, 50 km to the NW of Dori, Markoye, 70 km to the N, Aribinda 100 km to the WNW, and Djibo, 180 km to the W. Striking differences can be seen in the annual precipitation values (Fig. 3). For some years, one station can have a relatively high value, while it is relatively low at a station nearby. Depending on the time period chosen, the given mean value for Dori is just above 500 mm/year. From 1951 to 1990 the highest value is 770 mm (1953) and the lowest 260 mm (1987). The corresponding values are: for Djibo 835 mm (1964) and 175 mm (1985);

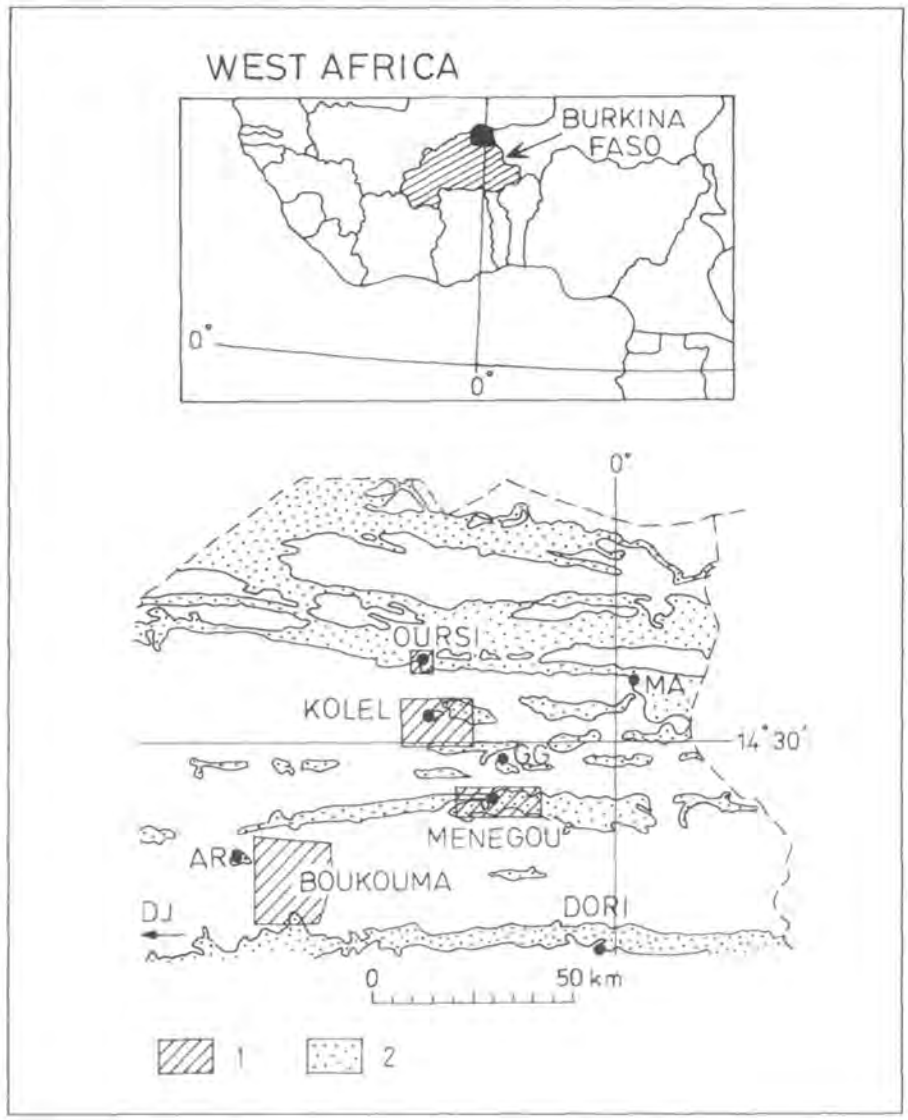


Figure 1. The area investigated; 1 = case studies, 2 = ancient dune systems, GG = Gorom-Gorom, MA = Markoye, AR = Aribinda, DJ = Djibo.

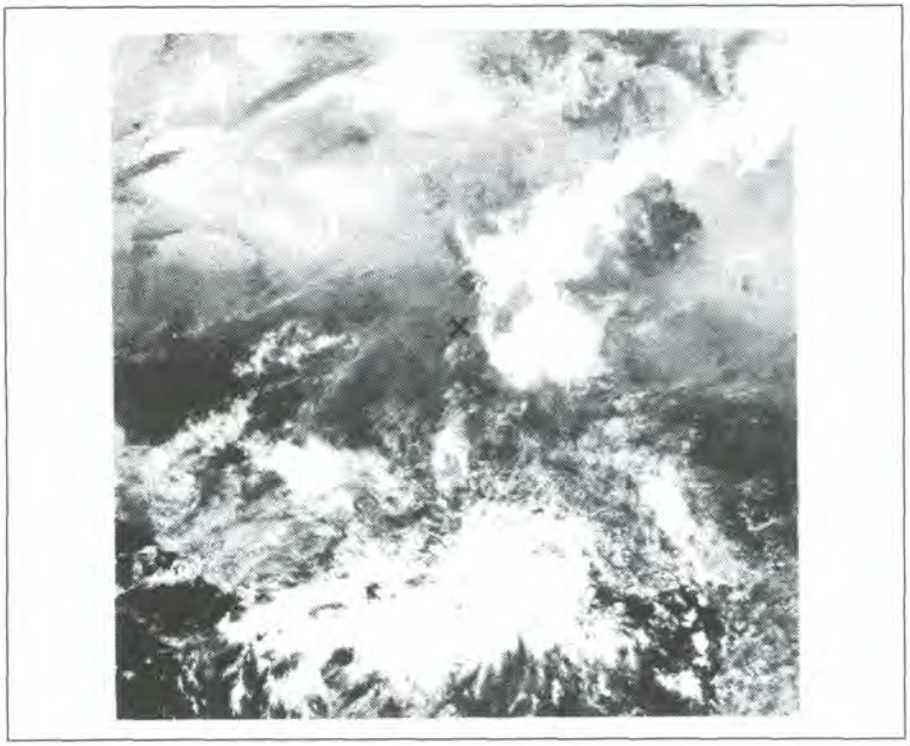


Figure 2. A Meteosat image with heavy rainfall cells from north of the Gulf of Guinea recorded on 20th May 1991 at 1155 GMT. Gorom- Gorom is marked with a cross.

Aribinda 843 mm (1965), 272 mm (1986); Gorom-Gorom 691 mm (1958), 149 mm (1987) and Markoye 657 mm (1958), 155 mm (1985). It is evident that the precipitation amounts are more homogeneous between 1972 and 1982.

The great spatial and temporal variations between the precipitation values at the stations can easily be explained by the rainfall regime, with heavy thunderstorms being the most important factor. It is more difficult to understand the reasons for the differences in an east-west direction. The three stations at Dori, Aribinda and Djibo are almost at the same latitude but the drought is more intensive towards the west.

It is difficult to analyze the tendencies because of the significant differences from year to year and between the stations. However, when studying the values from the official station at Dori with a 5-year running mean, it is clear that the annual mean values fell from 1963 until 1984 (Fig. 4). After that time there is a tendency towards more normal conditions, even if the variations are considerable. Dori had 528 mm in 1991 and 522 mm in 1992. These tendencies are well in accordance with precipitation analyses for the western Sahel region (Nicholson 1989; Hulme 1992).

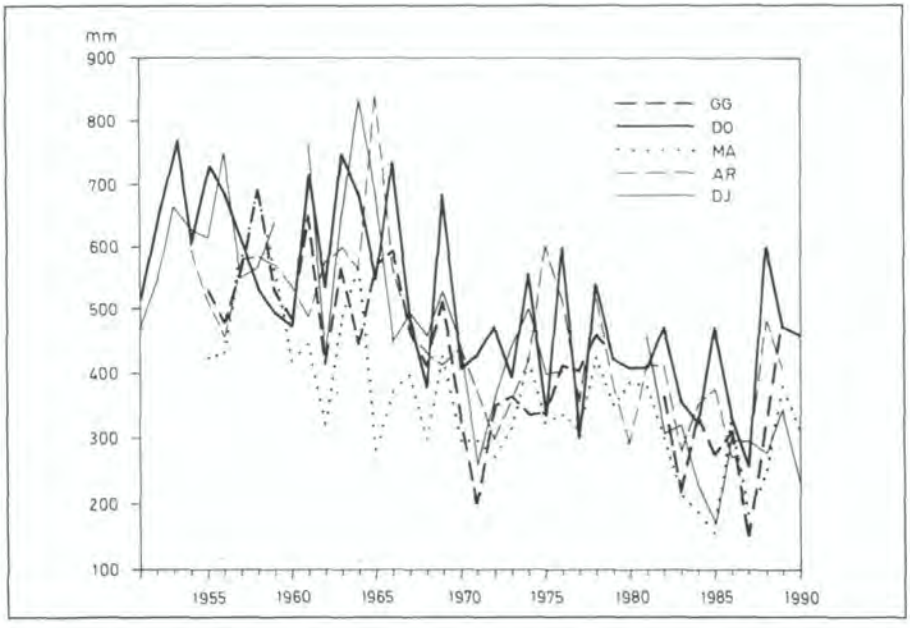


Figure 3. Annual precipitation at five different sites in northern Burkina Faso. GG = Gorom-Gorom, DO = Dori, MA = Markoye, AR = Aribinda, DJ = Djibo.

Imagery analysis

Recent studies have emphasized the advantages of different observation levels in investigations of soil erosion and land degradation, utilizing aerial photographs and satellite imagery in combination with extensive field work. A relatively good correlation between air photo interpretation and visual interpretation of satellite data is found when the same classification is used in all the imagery (e.g. Strömquist et al. 1988; Strömquist 1990; Grumblatt 1991).

In the present study, multitemporal studies of aerial photographs from 1955, 1974 and 1981 and of satellite images (SPOT, panchromatic) from 1989/90 were carried out in order to identify areas affected by land degradation. The imagery has been taken during the dry season, lasting from October to May. All aerial photographs are taken around the 20th of December. The satellite images from 1989 and 1990 were registered on March 12 and on December 23, respectively.

The imagery has been interpreted visually and the classification of the vegetation, adapted to the varying quality and resolution of the imagery, is based on the density of trees and bushes on a surface. The following classes have been identified according to tonal and textural characteristics:

class 1 -bare or almost bare surfaces

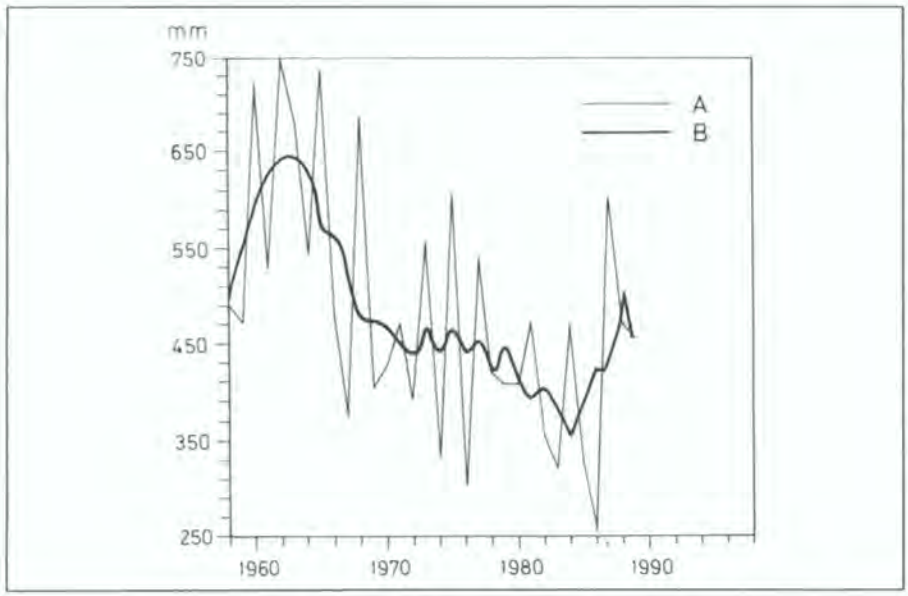


Figure 4. Precipitation tendencies at Dori (A) with a 5-year running mean (B).

class 2 - steppe with scattered patches of bare ground
class 3 - steppe with discontinuous bush cover
class 4 - stepp e with continuous bush cover
class 5 - relatively dense vegetation, such as riparian forest and striped vegetation (brousse tigrée).

The analysis was conducted in five steps:

1. Identification of different landscape units in the satellite images relevant to the study (see case studies for description) And selection of case study areas representing the different units.
2. Interpretation of vegetation classes in the aerial photographs covering the case study areas.
3. Interpretation of vegetation classes in the satellite images in the case study areas.
4. Detailed field check of the different classes in the case study areas using satellite-aided ground navigation technology (GPS), operating with a precision of 30m.
5. Reconnaissance flight sampling of areas not accessible from the ground and verification of the satellite image interpretations.

When the interpretations of vegetation classes from the different years were compared, changes from higher to lower classes were classified in steps of degradation (1-4 steps) and changes from lower to higher classes were classified as improvement, regardless of the number of steps.

In the interpretation of vegetation classes, no consideration was taken as to whether the ground was cultivated. Separate interpretations of the cultivated area were carried out in the aerial photographs and will be presented in the different case studies below.

Case studies of desertification

The extent of land degradation was studied in four areas with differing soils and land use; the Kolèl, the Ménégou, the Oursi and the Boukouma areas (Fig. 1). The dominant features in the landscape are vegetation-fixed longitudinal dune systems, which were formed during more arid climatic phases, 16,000 to 20,000 and 40,000 years ago (Courel 1977). The youngest of the dune systems attains heights of several tens of metres, while the older series can hardly be discerned in the terrain, giving rise instead to bands of sandy soils. The dune systems have been superimposed on a very flat, ancient pediplain with loamy soils, cut by broad ephemeral watercourses.

Kolèl

The Kolèl has an area of 21,120 ha and is partly covered by bands of sandy soil, but the soils in the major part of the area are loamy. Three quite large villages are situated on the ancient sand dune and the majority of the cultivated area is also concentrated on the dune.

In 1955, the main portion of this area was covered by relatively dense vegetation and continuous bush steppe (73%), although narrow bands of bare ground, running parallel to the contour lines, could be found in the areas with dense vegetation. More uniform and extended areas with very sparse vegetation (class 2) corresponded to the extension of the ancient sand dune and the cultivated ground and to a lesser extent to areas bordering the watercourses (Fig. 5a).

Nineteen years later, in 1974, it was observed that only 4% of the denser vegetation remained, and that degradation by one step had taken place in 66% of the area, primarily owing to changes from class 4 to class 3. No noticeable changes had occurred in the cultivated areas. The most severe degradation had taken place near the watercourses in the upper parts of the drainage basins and at the base of an inselberg situated in the central part of the area.

By 1981, the area with very sparse vegetation (class 2) had expanded, and larger zones with completely bare surfaces were observed for the first time. Degradation by one step had taken place in the cultivated areas and severe degradation by three steps had occurred in the proximity of the villages. Improvement of the vegetation cover had developed in 3% of the area, basically in the watercourses.

Between 1981 and 1990, degradation by one step took place in 73% of the area and by 1990 the whole area had become seriously degraded; only areas with very sparse vegetation (class 2) and bare surfaces (class 1) remained. The totally bare surfaces were, as earlier, found along the margins of the watercourses.

According to the aerial photographs, 13.5% of the area was cultivated and 2.7% lay fallow in 1955. In 1974, the corresponding figures were 11% and 6%. The same also applies for 1981. Although

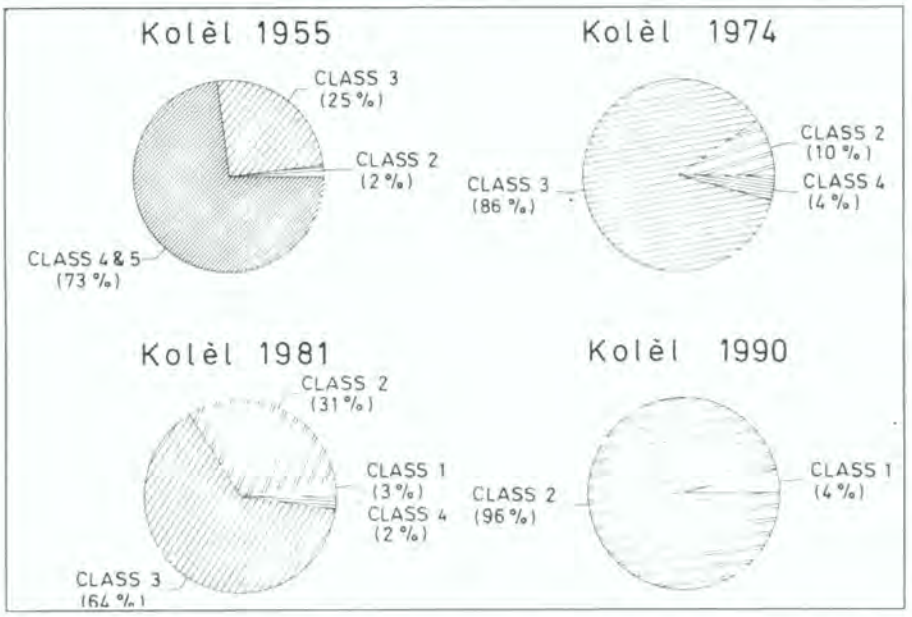


Figure 5a. Vegetation classes in the areas investigated. The Kolèl area in 1955, 1974, 1981 and 1990.

it is very difficult to distinguish between fallow and cultivated fields, it is evident that no major changes of the extension of the cultivated area have taken place. Rasmussen and Reenberg (1992), who studied land use around Kolèl village with satellite remote sensing, found that the cultivation of millet (the dominant crop in the region) to a large extent was done on a permanent basis with little or no use of fallow.

In conclusion, the degradation of the vegetation in this area has occurred chiefly in the rangelands, occupying the plains, which surround the cultivated dune areas.

Ménégou

The Ménégou area covers 13.915 ha and stretches along a distinct dune corridor, about 1.5 km long and 25 m high, built up of both the older and the younger dune systems. Only the soils of the older dune system are by tradition cultivated, since they are richer in clay than the younger dunes.

In 1955, most of the area was covered by class 3 and 24% by relatively dense vegetation (class 4 and 5). Only 6% of the area was covered by class 2.

Between 1955 and 1974, an extension of the areas with sparse vegetation (class 2) took place, caused by further degradation of class 3. In addition, bare surfaces developed during these same 19 years. In 1981, partial recovery was identified. The bare surfaces had disappeared and class 3 increased, owing to a reduction of class 2 (Fig. 5b).

In summary, 7.5% of the total area improved its vegetation cover between 1955 and 1981, which is basically due to changes from class 2 to class 3 on the fallow fields on the dune. 14.3% of the area deteriorated by one or several steps, primarily owing to the disappearance of trees and bushes.

In 1955, approximately 40% of the dune was cultivated. In 1974, this had increased to 77%. In the time that followed, the extent of the cultivated area decreased, and was 70% in 1981. Several areas on the dune were abandoned after 1974, and it is these areas that have degraded since then. According to a SPOT image, the situation in 1990 was similar to that in 1981 with respect to cultivated and degraded areas.

Some of the zones with bare ground (class 1) were studied in detail in the field in November 1991 and it was found that all these zones:

- were situated on the fragile soils of the youngest dune system
- had all been cultivated at some time in the past
- were located at high points on the dune and there were no trees or bushes in surrounding areas reducing the impact of wind erosion.

Oursi

The most spectacular example of desertification in our investigation area is in the area of Oursi, where we studied a tract covering 2,060 ha. Oursi village is situated between a dune corridor and a lake (mare), which is one of the few, in this part of the Sahel, which does not dry up during part of the year. This has led to a concentration of cattle here in the dry season, since the access to water and pasture is relatively safe. Thus, the studied dune area is intensively grazed, but it

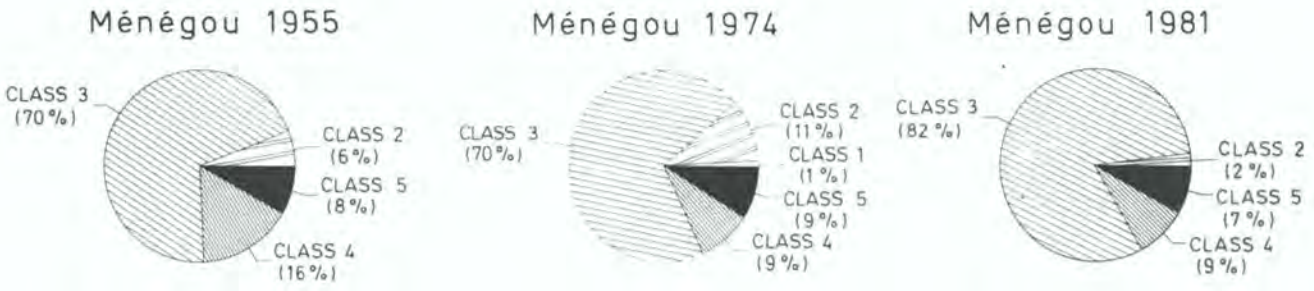


Figure 5.b. The Ménégou area in 1955, 1974 and 1981.

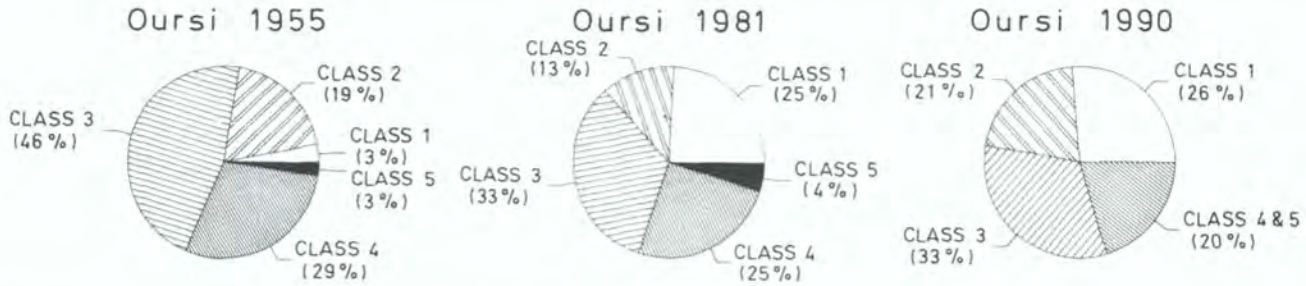


Figure 5c, The Oursi area in 1955, 1981 and 1990.

has not been cultivated during the period considered.

In 1955, the reactivated dune area (class 1) measured 56 ha. By 1981, it had increased to 446 ha, almost eight times as much as in 1955. According to a SPOT-image and ground checks, the situation in 1990/1991 was not any worse, but on the other hand there had not been any recovery (Fig. 5c and 6).

Boukouma

At still another site, in an area of 38,310 ha, situated on the plain around Boukouma, we studied the changes which occurred between 1981 and 1989. Here, intensive, continuous cultivation is practised on 4% of the area and only in the ephemeral watercourses. Intensive, discontinuous cultivation is practised in 6% of the area, along the margins of the watercourses.

According to a SPOT-image from 1989, the completely bare surfaces border upon areas with dense vegetation, mainly riparian forest. Between 1981 and 1989, 20% of the area had undergone degradation, by one to four steps, and 19% had improved (Fig. 7). When looking at the distribution of the changes, it is interesting to note that they are a result of improvement in the depressions and of degradation on the interfluves. This can be interpreted as a sign of increased run-off resulting from land degradation. This process leads to an accumulation of fine soil particles and water in the depressions, which in turn favours the vegetation at these locations (Mainguet 1991). Many of the bare surfaces are found in formerly cultivated, now abandoned areas, but the drought is probably also responsible for their development, which is indicated in many cases by large, bordering zones of dead vegetation.

Analysis of oblique aerial photographs

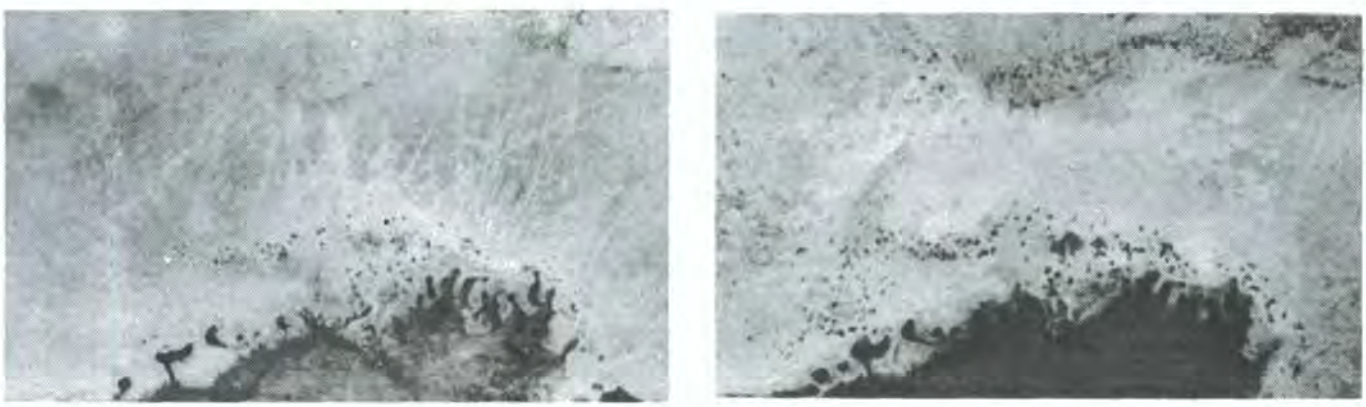


Figure 6. Aerial photographs covering the Oursi area from 1955 (a) and 1981 (b). In the Photographs it is possible to see how hundreds of cattle tracks radiate to the lake and cross the dune, which has become in part reactivated (the light zones).

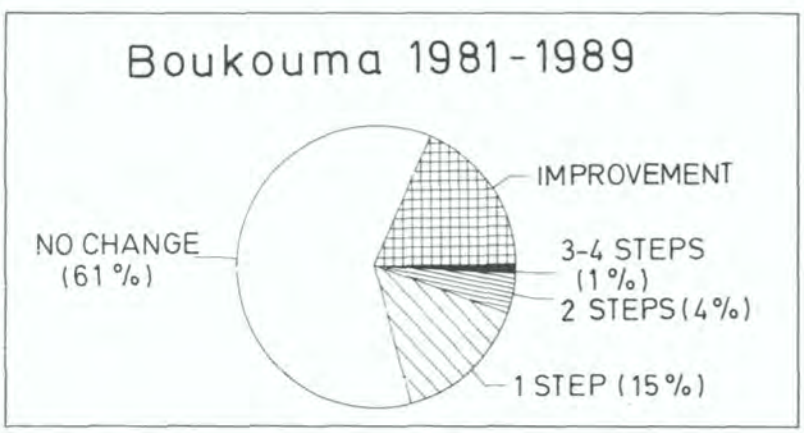


Figure 7. Vegetation changes between 1981 and 1989 in the Boukouma area.

from November 1991, covering all four areas, shows that the extension of bare surfaces (class 1), has been slightly underestimated in the interpretation of SPOT-images.

Conclusions

The case studies presented and the results from other studies in the Western Sahel all support the conclusion that land degradation and, in some cases, desertification are serious problems in this part of Africa, although local variations are considerable. It is possible that the Western Sahel suffers more severe land degradation than the Eastern Sahel. This is indicated by the more negative rainfall trends to the west. Furthermore, contradictory results from a number of land degradation assessments in the Eastern and the Western Sahel also imply different conditions.

In our study area, the most severe land degradation occurred during the first of a series of droughts which started in the late 1960s. Since then, the situation has stabilized somewhat. The most degraded areas were found in the rangelands on the plains, surrounding the ancient dune systems in the region. A recovery of the vegetation during the last decade can be observed in depressions, whereas it is seen that the interfluves are subject to enhanced erosion. This indicates an increased run-off, owing to continued land degradation. The absence of recovery, despite increased rainfall since 1985, of the bare surfaces in all areas save Ménégou, indicates deterioration of ground resilience in areas with sensitive soils.

The degradation of vegetation and the development of bare surfaces in the region are not primarily due to an extension of the cultivated ground, as demonstrated clearly by the Kolèl case study. Decreased rainfall during a 20-year period is one important factor. Other important factors are changes in grazing pressure, in the consumption of fuelwood, as well as in other human activities.

References

Ahlcrona, E., 1988: The impact of climate and man on the land transformation in Central Sudan - Application of remote sensing. Med. från Lunds Universitet Geografiska Inst. Avhandlingar no. 103, Lund University Pres, 140 p.

Binns, T., 1990: Is Desertification a Myth? *Geography*, 75: 106-113.

Courel, M. F., 1977: Etude géomorphologique des dunes du Sahel; Niger nord occidental et Haute-Volta septentrional. Thèse de 3e cycle, Univ. Paris VII, 389 p.

Dregne, H. E. and Tucker, C. J., 1988: Desert Encroachment. *Desert. Contr. Bull.* 16: 16-19.

Forse, B., 1989: The myth of the marching desert. *New Scientist*, 1650: 31-32.

Grumblatt, J., 1991: Kenya Pilot Study to Evaluate FAO/UNEP Provisional Methodology for Assessment and Mapping of Desertification. *Desert. Contr. Bull.* 19: 19-25.

Helldén, U., 1984: Drought Impact Monitoring - a remote sensing study of desertification in Kordofan, Sudan. Rapporter och Notiser No. 61. Lund Univ. Naturgeorafiska Inst, 61 p.

—— **1991:** Desertification - Time for an assessment? *Ambio*, 20: 372-383.

Hulme, M., 1992: Rainfall changes in Africa: 1931-1960 to 1961-1990, *Int. J. of Climatology*, 12: 685-699.

Kusserov, H., 1990: Anwendung von Landsat - Daten zur Erfassung der Vegetationsdynamik in desertifikationsgefährdeten Gebieten Malis. *Die Erde*, 121: 39-53.

Mainguet, M., 1991: Desertification. Springer. Berlin, 306 p.

Mattsson, J. O. and Rapp, A., 1991: The Recent Droughts in Western Ethiopia and Sudan in a Climatic Context. *Ambio*, 20: 172-175.

Middleton, N. J., 1987: Desertification and wind erosion in the western Sahel: the example of Mauritania. *Res. Pap. 40*, School of Geography. University of Oxford, 26 p.

Monod, T., 1985: The Sahel zone north of the equator. In: Evenari, M., Noy-Meir, I. and Goodall, D. W. (eds.): Ecosystems of the world: Hot Deserts and Arid Shrublands, 203-243.

Mortimore, M., 1989: Adapting to drought. Cambridge University Press. Cambridge, 299 p.

NASA/GSFC, 1984: The global climate system. WMO, 50 p.

Nicholson, S., 1989: Long-term changes in African rainfall. *Weather*, 44: 47-56.

Poppel, J. W. P. M. van and Lekkerkerker, C. L., 1991: Le suivi de la dégradation de l'environnement par des observations hydrométriques et piézométriques. *Bull. Liais. Com. Interafr. Etudes Hydrauliques*, 83: 2-17.

Rasmussen, K. and Reenberg, A., 1992: Satellite Remote Sensing of Land-use in Northern Burkina Faso - The Case of Kolel Village. *Geografisk Tidsskrift*, 92:86-93.

Sivakumar, M. V. K. and Gnoumou, F., 1987: Agroclimatology of West Africa: Burkina Faso. *ICRISAT (Int. Crops Res. Inst. Semi-Arid Trop.) Inf. Bull.* 23: 192 p.

Strömquist, L. (Ed), 1990: Monitoring Soil Loss at Different Observation Levels. UNGI Rapport No 74: 89 p.

Strömquist, L., Larsson, R. Å. and Byström, M., 1988: An Evaluation of the SPOT Imagery Potential for Land Resources Inventories and Planning. UNGI Rapport No 68: 43 p.

Tucker C. J., Dregne, H. E. and Newcomb, W. W., 1991: Expansion and Contraction of the Sahara Desert from 1980 to 1990. *Science*, 253: 299-301.

UNCED, 1992/93: Agenda 21 (Swedish version). Nordstedt. Stockholm, 467 p.

UNEP, 1992: World Atlas of Desertification. Edward Arnold. London, 69 p.

Acknowledgements

Financial support was received from Stiftelsen Futura, KVVF, SSAG and SAREC. Thanks are due to Burkina Faso's Ministry of Environment and Tourism, the Department of Geography at the University of Ouagadougou, and T. Emricsson, A. Persson and K. Thylander for assistance in the field. We also thank R. Langlais and J. Vesterlund for the English revision, and S. Svensson for the drawings.

Survey of Research into Improving Salt Resistance of Acacia species of Djibouti

By L. Bray, and M.N. Di Michele,

Laboratoire de Lutte contre la Desertification, ISERST, BP 486, Djibouti, Republique de Djibouti.

Abstract

A biotechnology research programme was initiated at the beginning of 1992 in Djibouti, a country of arid climate currently affected by desertification. The present study aims at improving the salt resistance of *Acacia nilotica var. tomentosa* and *Acacia ehrenbergiana syn flava* by using *in vitro* methods. The first step was the initiation of *in vitro* micropropagation. Juvenile material was obtained by sterile germination and cotyledonary buds were cultivated on a Murashige and Skoog's medium (1962) containing 50g.l^{-1} sucrose and 2 mg.l^{-1} kinetine. The next step was micropropagation on the above mentioned medium containing 1mg.l^{-1} 6-benzyl aminopurine and 2mg.l^{-1} α naphtyacetic acid. Rooting was eventually obtained on a medium with α-indolyl acetic acid for A. *nilotica* or without hormones for *A. ehrenbergiana*. Salt stressing of *A. ehrenbergiana* vitroplants demonstrated that this species was able to adapt to a 100 mM NaCl concentration. Pre-stress treatment with a particular betaine, the trigonelline, did not improve the salt resistance of this species. Transformed cells of *A. ehrenbergiana* were obtained by cocultivation of microcuttings and *Agrobacterium tumefaciens*. Perspectives are to ameliorate micropropagation processes, especially the rooting phase, and to complete salinity clonal tests which identify salt resistant clones for rehabilitation of degraded lands affected by desertification.

Abbreviations

IAA : β-indolylacetic acid ; NAA : α-naphtyacetic acid ; BAP : 6 benzyl-aminopurine ; Kin : kinetine

Key-words

Acacia, biotechnology, salinity, micropropagation, betaines, trigonelline, Agrobacterium

Introduction

Biotechnology has been developed during the last decade in African countries and some tropical plants produced by tissue culture are now well-known : oil-palm for which somatic embryogenesis (Pannetier et al, 1981) and cryopreservation (Engelmann, 1991) have been described, date-palm for which micropropagation enables the cloning of trees resistant to bayoud (Falcone and Marcheschi, 1988 ; Bagniol and Engelmann, 1991), prosopis (Wainwright and England, 1987) and some herbaceous species such as sugarcane (Eksomtramage et al, 1992).

These examples illustrate that tissue culture has been used mainly with the following objectives : (i) food self-sufficiency, (ii) increasing quality and quantity of cash crops and making them disease resistant, (iii) reforestation and combatting desertification.

In this context, a biotechnology research program with a regional aim was initiated in 1992 in Djibouti. Like most countries on the Horn of Africa, Djibouti, a country of 21,000 km^2, is affected by desertification (Comité National pour l'Environnement, 1991) due to its arid climate (UNESCO, 1977) and to overexploitation of the vegetation by nomadic populations (overgrazing by large number of livestock and use of fuelwood). Salinisation of water and soils is one of the most notable consequences of this phenomenon.

To improve salinity resistance of local multipurpose trees, preliminary studies were conducted on the following points : (i) characterisation of species of national priority to combat desertification,

(ii) *in vitro* micropropagation of these species, (iii) *in vitro* salt treatments for clonal selection, (iv) pre-stress treatment with betaines, osmolytes which protect many organisms from osmotic and saline stress (v) sensitivity test to Agrobacterium tumefaciens to test feasibility of genetic transformation.

Characterisation of species

Two local tree species of the Mimosaceae family were found suitable for reforestation because they are traditionally used by nomads for multiple purposes and are recognised to be resistant to drought and to temporary floodings, which are usual in the country :

Photo 1 : Naturally grown Acacia nilotica cv tomentosa *in Djibouti (Djibouti). Photo: Laurent Bray.*

Photo 2. A naturally grown Acacia ehrenbergiana syn. flava Haynes *at Gabode (Djibouti). Photo : Laurent Bray.*

- Acacia nilotica var tomentosa was previously defined as one species of national priority to combat desertification (De Framont, 1990). It is a multipurpose tree which is mainly used in the northern districts of the country for fodder. It is known to be resistant to drought but also to waterlogging (Audru *et al,* 1993). Forests of A. nilotica are mainly situated in the North of the country and only a few trees grow in the south of the country (Photo 1).

- Acacia ehrenbergiana syn. flava Haynes has the same uses and habitat (Photo 2) (Audru *et al,* 1987). Because of its localisation in the south of the country, seed harvesting was possible throughout the project period.

In vitro micropropagation

Seeds of Acacia nilotica were collected at Magdoul (Djibouti) and those of A. ehrenbergiana at Gabode (Djibouti). After harvesting, seeds were stored at 4°C until pre-germination treatment in concentrated sulfuric acid : 45 mn for A. nilotica and 10 mn for A. ehrenbergiana. Seeds were then soaked 10 mn in alcohol (70°), 10 mn chlorine bleach (12° available chlorine), washed twice in sterile distilled water and germinated axenically on water containing $8g.l^{-1}$ agar.

First step of micropropagation was cultivation of cotyledonary buds (juvenile explant) as described by Duhoux and Davies (1985). Germination and growth studies had shown that cotyledonary buds of A. nilotica and A. ehrenbergiana should be excised from two-week-old seedlings, then micropropagated on a medium containing Murashige and Skoog salts with $50g.l^{-1}$ sucrose and $2mg.l^{-1}$ kinetine (Kin) to obtain an average multiplication rate of two (Di Michele and Bray, 1994).

Second step was subcultivation of microcuttings on an elongation medium as the above mentioned, except for the hormone combination which is $1mg.l^{-1}$ Kin and $2mg.l^{-1}$ α-naphtyacetic acid

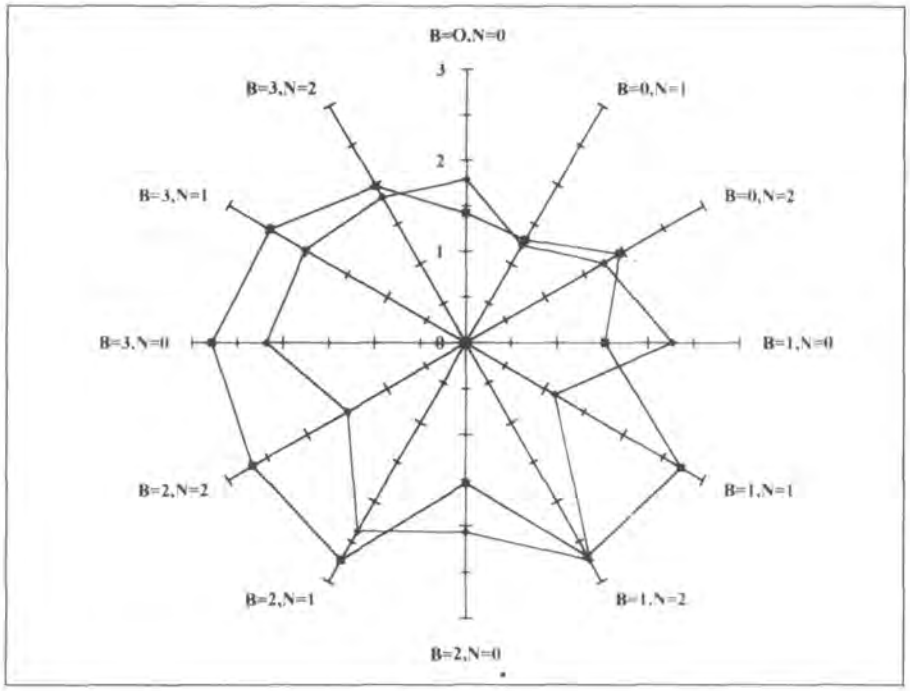


Figure 1 : Effects of different combinations of BAP (B), concentrations of 0, 1, 2 or 3mg.l^{-1}, and NAA, concentrations of 0, 1 or mg.l-^{1}, on the stem growth of A. ehrenbergiana. *Each axis represents the stem growth for one of the 12 hormone combinations. Average stem growth was calculated for more than 30 plants after 4 weeks and after 8 weeks of the first (■) and the second (◆)subcultures.*

(NAA) to allow stem growth.

A decrease in growth capacity was observed after each sub-cultivation. To solve this problem, different 6 benzylamino purine (BAP) and NAA combinations were also tested on microcuttings of about 1.3 cm mean length. Results are summarised in figure 1. After 4 weeks (Fig.1), stem growth after the second subcultivation was lower than after the first subcultivation whatever the hormone concentrations. Taking into account all combinations, stem growth was of 0.91 cm + 0.12 cm for the first cultivation (mean ± 95% confidence interval) and twice as low after the second cultivation : 0.57 cm + 0.11 cm.

After 8 weeks (Fig.1), a decrease in stem elongation was observed from the first subculture to the second one except for (BAP=0, NAA=0) ; (BAP=1,NAA=0) and (BAP=1, NAA=2). With the latter combination, growth was equal for the two sub-cultivations and was at its maximum : about 2.75 cm of elongation after 8 weeks . This medium was subsequently used for micropropagation, because it preserved stem growth capacity.

Vitroplants were eventually rooted on the same medium without hormones for *A. ehrenbergiana* or with 0.5 mg.l^{-1}

β-indolyl acetic acid (IAA) for *A. nilotica*. The percentages of rooted vitroplants were low, respectively 12 % and 50 % after 50 days.

Studies are continuing in order to improve this rate by using others hormones or using an induction phase to rooting as described by Badji *et al* (1992) on *A. senegal* for which a rooting percentage of 100 could be obtained by transferring vitroplants onto a "rooting induction" medium containing 5.10^{-5} mol.l^{-1} (about 9.3 mg.l^{-1}) NAA for 12 days, then onto a "root expression" medium without hormone.

In vitro salt treatments

Preliminary studies on salt resistance were conducted with 2 month-old vitroplants of *A. ehrenbergiana* transfered onto media containing 100 or 200 mM NaCl. Thirty clones have already been tested. The leaf index, i.e. the difference between the number of leaves at the time of measurement and the initial number of leaves divided by the initial number of leaves, was calculated weekly. Results are presented in figure 2.

Five days after the transfer, vitroplants showed necrosis of leaves in all conditions. After 5 to 10 days, leaf initiation continued for control plants : the average leaf index for controls was significantly higher than for plants transferred to 100 and 200 mM (mean comparison by tests).

At 100 mM, leaf index decreased until the tenth day. Then no more salt necrotic effects were observed, and the average leaf index increased to a value of -0.3 and became nearly constant. At 200 mM, no habituation was observed, and more than 56% of leaves were necrotic 20 days after the transfer. Statistical analysis showed that leaf indexes were normally distributed at 1 % (figure 3).

As vitroplants of *A. ehrenbergiana* had the ability to adapt to a 100 mM salt-stress, further clonal selection experiments will be carried out only on a medium containing 200mM NaCl. At this concen-

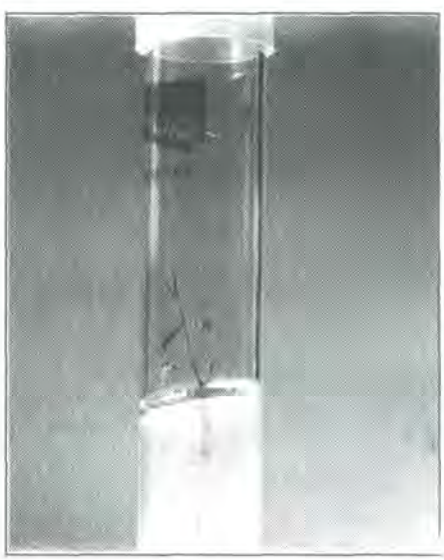


Photo 3 : Three-week old A. nilotica *vitroplant on rooting medium (Murashige and Skoog salts, 50 g.l^{-1} sucrose and 0.5 mg.l^{-1} IAA). Photo : Maria Di Michele.*

tration, it will be possible to distinguish adaptation and salt resistance, which can be revealed only at high salt concentrations. Clones are now screened with salt concentrations of 200 mM. Clonal leaf indexes of each experiment are compared 20 days after the transfer when 60 % of the leaves are necrotic (value determined by the normal probability plot in figure 3). Clones are then classified according to the following table.

This type of *in vitro* clonal selection based on morphological criteria has been carried out with Vigna radiata (L.) Wilczek : salt-resistant plants were identified by screening cotyledon explants on a medium containing 200 mM NaCl, a concentration that completely inhibited shoot regeneration (Gulati and Jaiwal, 1993). A drastic treatment has the advantage to limit the number of selected clones to work on, but the disadvantage is that interesting genomes which are not expressed in the experimental conditions are eliminated.

In vitro selection of cotyledon explants and of young seedlings of *A. ehrenbergiana* will also be developed. Explants will grow in sterile conditions on gelified water or on a multiplication medium containing a salt concentration allowing 50% of the seeds to germinate or 50% of the juvenile explants to survive. A simple criterion of selection is vigour determined on the basis of seedling growth or shoot regeneration. Clone classification will be based on the principles explained above.

Class of salt resistance	Value of the clonal leaf index (fi)
1. High resistance	$fi \rangle m + t_{(n-1;0.001)} \times \frac{s}{\sqrt{n}}$
2. Moderate resistance	$m + t_{(n-1;0.05)} \times \frac{s}{\sqrt{n}} \langle fi \leq m + t_{(n-1;0.001)} \times \frac{s}{\sqrt{n}}$
3. Normal resistance	$m - t_{(n-1;0.05)} \times \frac{s}{\sqrt{n}} \langle fi \leq m + t_{(n-1;0.05)} \times \frac{s}{\sqrt{n}}$
4. Low resistance	$m - t_{(n-1;0.001)} \times \frac{s}{\sqrt{n}} \langle fi \leq m - t_{(n-1;0.05)} \times \frac{s}{\sqrt{n}}$
5. Very low resistance	$fi \leq m - t_{(n-1;0.001)} \times \frac{s}{\sqrt{n}}$

Proposed classification for salt resistance. fi: clona leaf index: m : mean of the different leaf indexes; s :estimated standard deviation of the clone population; n : number of tested clones ; t : value of t at 1% or 5% according to the degrees of freedom (n-1).

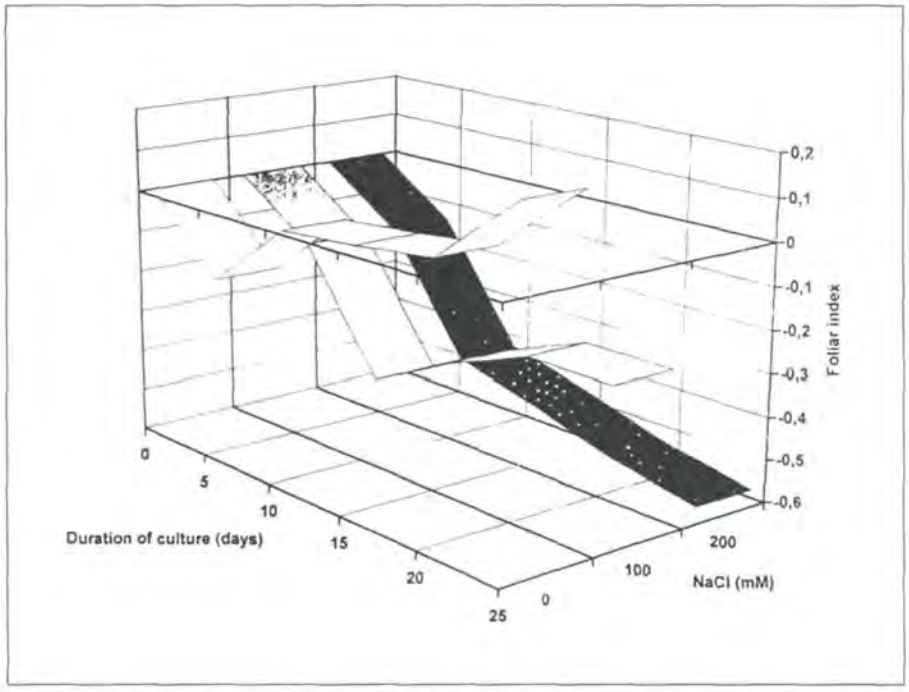


Figure 2 : Evolution of the leaf index after subculture on media containing 0, 100 or 200 mM NaCl. The leaf index is the difference between the number of leaves at the time of measurement and the initial number of leaves divided by the initial number of leaves. The represented values are the means of 12 clonal leaf indexes.

Photo 4 : Six-week old A. ehrenbergiana vitroplant on rooting medium (Murashige and Skoog salts, 50 g.l-1 sucrose. Photo : Maria Di Michele.

Pre-stress treatment by betaines

Betaines are osmolytes which protect many microorganisms and herbaceous

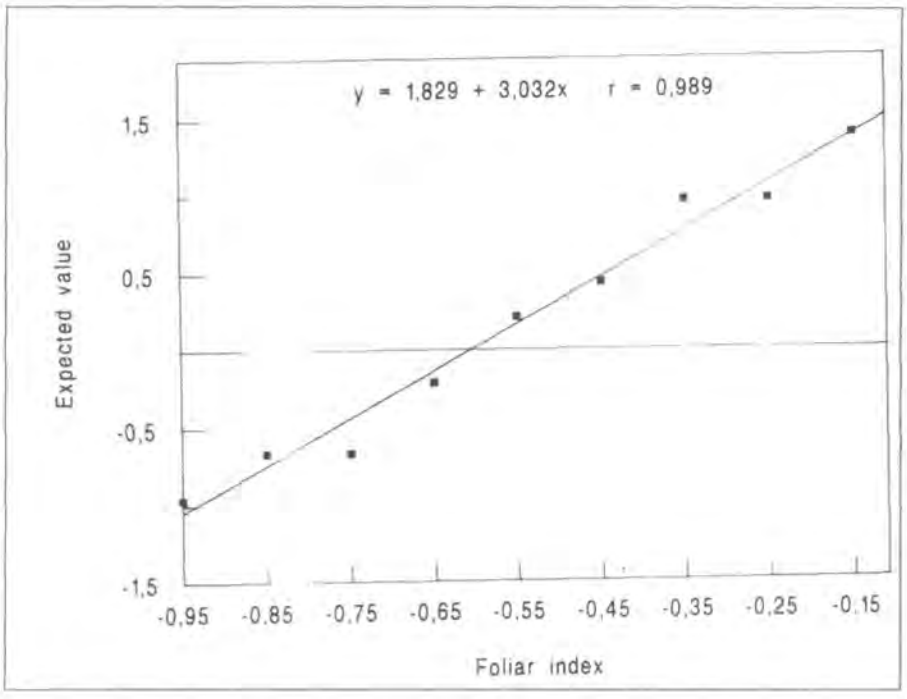


Figure 3. Normal probability plot of the leaf index. The mean and standard deviation calculated with the equation of the fitted line give respectively -0.603 and 0,330 when observed values were -0,556 and 0.312. Coefficent of correlation is significant at 1%.

species from stress (Le Rudulier *et al*, 1984). Glycine betaine has been studied more than any other betaines and a gene implicated in its metabolic pathway has even been cloned (Weretelnyk and Hanson, 1990). Another betaine, the trigonelline (TRG) can be considered as a sensitive stress indicator for poplars (Bray *et al*, 1991). A pre-stress treatment of 5 days with 5 or 500 µM TRG was found to have protective effect against salt-stress (Bray, 1990). TRG is of particular interest to the study of salt resistance of *Acacia* because genes encoding its catabolism are also involved in the symbiotic steps of the *Rhizobium*-legume association (Boivin et al, 1990). TRG, known as the "G2 factor" (it promotes cell cycle arrest in G2) is widely distributed among plants and found in various legumes (Evans and Tramontano, 1984).

Taking into account these data, vitroplants of *A. ehrenbergiana* were treated with TRG varying from 50 to 250 µM before a 200mM NaCl stress.

No effective protection has been actually observed (unpublished results). This could be due to a non-accumulation of TRG during the pre-stress treatment. This hypothesis should be tested by making HPLC betaine analysis. Nevertheless, some other experiments will be conducted by using TRG directly with NaCl in medium : a method which in fact corresponds to what could be carried out in *in vivo* conditions.

Sensitivity test to *Agrobacterium tumefaciens*

Obtaining transgenic plants showing an increased salt resistance is one possible long term solution to combat desertification. Transformed tobacco expressing the mannitol-1-phosphate dehydrogenase accumulates mannitol (Tarczynki *et al*, 1992) and has an increased ability to tolerate high salinity (Tarczynki et al, 1993). *Agrobacterium* is usually used as vector of genetic transformation (Weising et al, 1988). Prior to transformation, sensitivity of the species to *Agrobacterium* has to be proved.

Microcuttings of *A. ehrenbergiana* and *A. nilotica* were inoculated by cocultivation with a binary strain of *Agrobacterium tumefaciens* LBA 4404 containing the *npt II* (kanamycine resistance) and *uidA* (encoding ß-glucuronidase) genes (strain furnished by the laboratory of Molecular Genetics of INSA-Lyon).

After inoculation, microcuttings were grown on a medium for callogenesis containing 250 mg.l^{-1} cefotaxim (to kill bacteria) and 150 mg.l^{-1} kanamycin (to select transformed cells). Only inoculated microcuttings could develop calli for both species, but test for ß-glucuronidase activity was positive only for *A. erhenbergiana* cells (Bray *et al*, 1994).

References

Audru, J., César, J., Forgiarini, G. and Lebrun, J.P., 1987. *La végétation et les potentialités pastorales de la République de Djibouti.* I.E.M.V.T., 384 p.

Audru, J., Labonne, M., Guérin, H. and Arun Bilha, 1993. *ACACIA NILOTICA* Son intérêt fourrager et son exploitation chez les éleveurs Afars de la vallée du Magdoul à Djibouti, in *Bois et Forêts des Tropiques*, no 235, pp 59-70.

Badji, S., Mairone, Y., Ndiaye, I., Merlin, G., Colonna, J.P., Danthu, P. and Neville, P., 1992. Multiplication végétative *in vitro* du gommier : *Acacia senegal L.* (Willd.), *in Symposium UIFRO-AFOCEL* Bordeaux sept. 1992, pp 155-156.

Bagniol, S. and Engelmann, F., 1991. Effects of pregrowth and freezing conditions on the resistance of meristems of date palm (*Phoenix dactylifera* L. var. Bou Sthammi Noir) to freezing in liquid nitrogen, in *Cryo-Letters*, no 12, pp 279-286.

Boivin, C., Camut, S., Malpica, C.A., Truchet, G. and Rosenberg, C., 1990. *Rhizobium meliloti* genes encoding catabolism of trigonelline are induced under symbiotic conditions, in *The Plant Cell*, vol. 2, pp 1157-1170.

Bray, L., 1990. Conséquences métaboliques et cellulaires du stress

de salinité chez les vitroplants de *Populus trichocarpa x deltoides* cv. Hunnegem. *Thèse Univ. Paris VI*, 138áp.

Bray, L., Chriqui, D., Gloux, K., Le Rudulier, D., Meyer, M. and Peduzzi, J., 1991. Betaines and free amino acids in salt stressed vitroplants of *Populus trichocarpa x deltoides, in Physiologia Plantarum*, no. 83, pp 136-143.

Bray, L., Lecouturier, V. and Di Michele, M.N., 1994. Sensibilité d'*Acacia flava et d'Acacia nilotica à Agrobacterium tumefaciens, in Quel avenir pour l'amélioration des plantes?*, edited by Dubois J. and Demarly Y.

ComitéNational pour l'Environnement, 1991. *Rapport National Environnement Djibouti*, edited by ONTA/SPSE.

De Framont, H., 1990. Valorisation des ressources génétiques forestières en République de Djibouti, in *Revue de l'ISERST*, ISERST, Djibouti, no. 4, pp 13-18.

Di Michele, M.N. and Bray, L., 1994. Micropropagation *in vitro d'Acacia flava* syn. ehrenbergiana, in *Quel avenir pour l'amélioration des plantes?* edited by Dubois J. and Demarly Y.

Duhoux, E. and Davies, D., 1985. Caulogenèse à partir des bourgeons cotylédonnaires d'*Acacia albida* et influence du saccharose sur la rhizogenèse, in *Journal of Plant Physiology*, no. 121, pp 175-180.

Eksomtramage, T., Paulet, F., Guiderdoni, E., Glaszmann, J.C. and Engelmann, F., 1992. Development of a cryoperservation process for embryogenic calluses of a commercial hybrid of sugarcane (*Saccharum* sp.) and application to different varieties, in Cryo-Letters, no 13, pp 239-252.

Engelmann, F., 1991. *In vitro* conservation of tropical germplasm - a review, in *Euphytica*, no 57, pp 227-243.

Evans, L.S. and Tramontano, W.A., 1984. Trigonelline and promotion of cell arrest in G2 of various legumes, in *Phytochemistry*, vol. 23(9), pp 1837-1840.

Falcone, A.M. and Marcheschi, G.L., 1988. Embriogenesi somatica *in vitro* da tessuti di palma da dattero (*Phoenix dactylifera L.*) : risultati preliminari, in *Rivista di Agricoltura Subtropicale e Tropicale*, nos 1-2, pp 379-389.

Gulati, A. and Pawan K. Jaiwal, 1993. *In vitro* selection of salt-resistant *Vigna radiata* (L.) Wilczek plants by adventitious shoot formation from cultured cotyledon explants, in *Journal of Plant Physiology*, vol. 142, pp 99-102.

Lebrun, J.P., Audru, J. and César, J.,1989. Catalogue des plantes vasculaires de la République de Djibouti, in *Etudes et synthèses de l'I.E.M.V.T.* , no. 34, I.E.M.V.T., 277áp.

Le Rudulier, D., Strom, A.R., Dandekar, A.M., Smith, L.T. and Valentine, R.C., 1984. Molecular biology of osmoregulation, in *Science*, no. 224, pp 1064-1068.

Murashige, T. and Skoog, F., 1962. A revised medium for rapid growth and bioessays with tobacco tissue culture, in *Physiologia Plantarum*, no. 15, pp 473-497.

Pannetier, C., Arthuis, P. and Lievoux, D., 1981. Néoformation de jeunes plantes d'*Elaeis guineensis* à partir de cals primaires obtenus sur des fragments foliaires cultivés in vitro, in *Oléagineux*, vol. 36, no. 3, pp 119-122.

Tarczynski, M.C., Jensen, R.G. and Bohnert, H.J., 1990. Expression of a bacterial mtlD gene in transgenic tobacco leads to production and accumulation of mannitol, in *Proceedings of the National Academy of Sciences USA*, vol. 89, pp 2600-2604.

Tarczynski, M.C., Jensen, R.G. and Bohnert, H.J., 1990. Stress protection of transgenic tobacco by production of the osmolyte mannitol, in *Science*, vol. 259, pp 508-510.

UNESCO, 1977. *Carte de répartition mondiale des régions arides*, published by UNESCO.

Wainwright, H. and England, N., 1987. The micropropagation of *Prosopis juliflora* (Swartz) D C: Establishment *in vitro*, in *Acta Horticulturae*, no 212, pp 49-53.

Weising, K., Schell, J. and Kahl, G., 1988. Foreign genes in plants: transfer, structure, expression, and applications, in Annual Review of Genetics, vol. 22, pp 421-477.

Weretilnyk, E.A. and Hanson, A.D., 1990. Molecular cloning of a plant betaine-aldehyde dehydrogenase, an enzyme implicated in adaptation to salinity and drought, in *Botany*, vol. 87, pp 2745-2749.

Class of salt resistance Value of the clonal leaf index (fi)

NEWS FROM UNEP

UNEP/DC-PAC Training Activities with UN and Supporting Organizations in 1994

The overall aims of DC/PAC Programmes are:

- To facilitate the extensive use and application of proper anti-desertification techniques leading to a sustainable increase in food and agricultural production for the benefit of the indigenous population and to facilitate the spread of those techniques in the countries of the trainees;
- To promote development on internationally acceptable methodologies and techniques of desertification control, assessment, mapping and monitoring;
- To strengthen the capacity of national agencies in the various regions to apply such methodologies and techniques for desertification control, assessment, mapping and monitoring;
- To promote regional and international cooperation in anti-desertification activities through the exchange of information, experience and training;
- To improve the capacity of the countries concerned to deal with desertification issues by helping to increase the number of personnel in the area trained in desertification control, assessment, mapping and monitoring.

Title	Venue and Dates	Organizer	No of Participants
Training Course on Desertification Control for SADC Countries	Zimbabwe, 6-17 June 1994	UNEP/ UNESCO	22
Training Course on Conservation and Management of Salt affected soils for CIS	Volgograd, Russia 12-30 Sept 1994	CIP/ UNEP	30
Second Regional Workshop on Sustainable Land-use Management for Semi-arid and Sub-humid regions (LAC region)	Oaxtepec, Mexico July 1994	UNEP/ SCOPE	30-40
Third Regional Workshop on Sustainable Land-use Management for semi-arid and Sub-humid regions (Asia and the Pacific region)	Bankok November 1994	UNEP/ SCOPE	300-40

UNESCO-UNEP Desertification Control Training course for SADC Countries

A training course on desertification control was held in Bulawayo, Zimbabwe from 16 - 17 June 1994. It was organized by the UNESCO Regional Office in Dakar in cooperation with UNEP. The course was hosted by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). In all, 22 participants from Botswana, Kenya, Lesotho, Malawi, Namibia, Tanzania, Swaziland and Zimbabwe attended the course which was both practical and theoretical and incorporated lectures, seminars, discussions, exchanges of national experiences and field trips.

8th International Conference on Soil and Water Conservation: Challenges and Opportunities

The International Soil Conservation Organization (ISCO) will organize the 8th International Conference in New Delhi, India, between 4 - 8 December 1994. The theme of the Conference **"Soil and Water Conservation: Challenges and Opportunities"** has been chosen in pursuance of the following critical issues highlighted in Agenda 21 of the UN Conference on Environment and Development (UNCED-Earth Summit) held in Rio de Janeiro:

- Integrating environmental and conservation concerns with development goals;
- Involving people in design, implementation and evaluation of technologies;
- Developing strategies taking into account indigenous knowledge and perceptions;
- Adopting system-based approaches in viewing problems and finding solutions thereof.

The Conference will provide an opportunity to researchers, field workers and planners to interact and develop strategies for future efforts in an area vitally important for sustained development.

Scientific Programme

The scientific program will include **Plenary sessions, Symposia sessions and Poster sessions.** Detailed instructions for the presentation will be communicated along with the acceptance. Overhead projectors, slide projectors and boards for posters will be available. To achieve the objectives of the Conference, the scientific program will focus on the following topics:

- **Land Degradation - Assessment and Impact**
  Nature and extent of degradation, data base, socio-economic consequences.
- **Erosion - Processes and Modelling**
  Rainfall-runoff relationships; hydrological changes as affected by management practices; development of process-based models for prediction of soil and water losses.
- **Soil and Water Conservation for Sustainable Productivity**
  Land use management systems including agro-forestry, silvi-pasture and agro-horti practices; land configuration, including tillage and residue management; rain water harvesting and recycling; role of biotechnological approaches; common property resources.
- **Biodiversity**
  Role in soil and water conservation; impact of soil and water conservation on biodiversity.
- **Watershed Management**
  Case studies; evaluation methods.
- **Land Use Policies**
  Policies, legislation and role of financial institutions.
- **Technology Transfer**
  Constraints and impact; peoples' participation including gender issues, education, training and role of government and non-governmental organizations.
- **Traditions and Innovations**
  Developing conservation strategies based upon indigenous knowledge and perceptions.

The Rural Women-Based Integrated Project in Ruvuma Region, Tanzania

1. Project Area

Ruvuma Region is situated in the Highlands of southern Tanzania. It is comprised of Songea Urban and Rural District, Mbinga District in the West and Tunduru District in the East. The climate can be classified as ranging from subhumid to humid and two thirds of the area has adequate rainfall for agriculture although there is only one rainy season from end of November to May.

The soils of Ruvuma have medium fertility, towards the west the soils become more sandy and less drought resistant. Topography and soil characteristics are the main restrictions on agricultural production in the region.

The total area of Ruvuma Region is about 6,000,000 ha, only two per cent of which is cultivated.

The main economic activity in the region is agriculture. According to FAO the agricultural potential in the region is rated as marginal. The traditional bush-fallow shifting cultivation has gradually given way to permanent intensive agriculture. The most important subsistence crops are maize, beans, cassava and paddy. Coffee is the most important cash crop in Mbinga, and in part of Songea Rural, tobacco and oil seeds (simsim, groundnut and sunflower) are found in Songea Urban and Songea Rural while cashewnuts dominate in Tunduru.

Land degradation is one of the major constraints to socio-economic development in rural Tanzania. Population pressure on resources and consequent

overgrazing, over cultivation and deforestation are causes behind the desertification process in the semi-arid and sub-humid areas.

Loss of plant cover due to deforestation and over cultivation, high rainfall and unfavourable topography which lead to erosion of the soils, are the main factors making the area vulnerable to soil erosion which is the predominant indicator of land degradation in the region. The water erosion is severe, sheet, rill and gully erosion is evident, the most vulnerable area being the mountainous and over cultivated Mbinga district.

The quest for fuelwood by the increasing population has caused severe land degradation in large parts of the country. The dwindling sources of fuelwood have a direct bearing on rural women particularly as the collection distance and time are increasing.

2. The Women's Group

In Tanzania, the women belong to a mass movement called the Union of Women in Tanzania (UWT) which aims to mobilize self-help economic and social activities among all women in Tanzania. . It is represented at village, ward, district and regional levels throughout Tanzania. UWT is linked to the Village Committees set-up, part of the Ujamaa Villages Act of 1975.

For many years, the women of Ruvuma Region in southern Tanzania had a number of successful income-generating activities. With respect to women's interests these activities address local concerns and needs, e.g. public transport and maize mills. A huge part of this income is being invested in other group activities or common interests such as handicrafts, care centres, bakeries, small shops, guesthouses, trade, oil extraction for groundnuts and sunflowers and bus hire services, diesel and fertilizer supplies, etc.

Over the last few years, the women have started to realize that their land in Ruvuma Region is being eroded. More and more areas have been cleared for agriculture to meet the needs for increased demand for fuelwood (charcoal, brick drying). Trees have become scarce in some areas and getting firewood is a problem, especially for the women. Subsequently, some women raised this problem in meetings in order that some action be taken. The Regional Executive Committee of the UWT in Ruvuma Region organized a fact finding mission in 1987 to all districts of Ruvuma Region to look at the problems the women encountered. After the mission, 18 villages, (with a population of about 50,000), were selected and grouped into the following three categories: (i) those mostly affected by land degradation problems caused by deforestation, lack of fuelwood and lack of water supply; (ii) those which started to be degraded and (iii) those which needed preventative measures. A project proposal was sent to UWT Headquarters in Dar es Salaam and other organizations asking for assistance.

Although there has been no positive response until recently, when AGFUND and UNEP did decide to fund this project in 1987, they began with tree planting, agroforestry and afforestation activities on common and private plots without any external support. This programme refers to environment related concerns, as well as income generating activities. Now the women want to incorporate these environmentally sound activities into a project to enhance their efforts to halt the process of land degradation.

The women's project shall focus on environmental issues. The object of this women's project, which will involve afforestation/tree planting, agroforestry, soil conservation and the introduction of energy efficient stoves, is to reduce the burdens of every day life on the women. It will reduce the time spent carrying firewood over long distances, it will increase the supply of fruits, and will generate income from woodlots. Fuelwood consumption will be reduced by using energy efficient stoves and soil will be conserved as a result of the foregoing activities.

The main tree species planted are Neem, Pinus, Grevilla (agroforestry tree), Eucalyptus, and some local trees and fruit trees. Agroforestry techniques are used mainly on private horticulture plots. The women are sporadically advised by local governmental technicians from the region, this is because the Government of Tanzania is promoting a nation-wide tree planting programme. One national forestry advisor is permanently seconded from the government. The seedlings are obtained either from governmental tree nurseries, for which the women have to pay, or free of charge from nurseries supported by the EC. To date, 24 ha of land has been afforested in Ruvuma Region by the mobilized women.

The required financial inputs are meant to be used for the establishment of the women's own nurseries with permanent attendants for a ready supply of seedlings, tools, fertilizers, pesticides, and transport. Furthermore, the finance could be used to conduct training courses for technical advisors, to enhance the tree-planting programme (110 ha per year), to provide office equipment, to pay allowances for technicians seconded by the government and to improve follow-up activities in environmental and social welfare affairs.

The project embarked on its programme of afforestation in order to reduce the shortage of fuelwood and small construction wood, and to conserve soil and water for more sustainable agriculture. It also aims to introduce fruit trees to improve nutrition and increase family income. The project has a water supply scheme to ease the burden of water collection done by women, and an improved stove production component will better utilize fuelwood.

As a follow-up to the project, the local village UWT committees will continue the activities once the project has been executed. The envisaged next phase activities would be e.g. fruit marketing and processing, charcoal and timber (rafters, poles, planks) production and marketing, continued tree planting and soil conservation. The production and marketing of stoves would proceed on a commercial basis.

Another follow-up of the project will be the dissemination of the experience gained and replication of this concept by UWT in other districts and regions of Tanzania.

Land Degradation Assessment and Mapping in Kenya

The Government of Kenya, the Government of The Netherlands and UNEP/DC-PAC have started a project on 'National Land Degradation Assessment and Mapping in Kenya'. The project will bring existing data held by government agencies together in a Geographic Information System, using computer models and remote sensing imagery for extrapolation over the whole country. The project will aim at methodology development in the field of land degradation assessment and mapping.

Outputs of the project will be a national database for land degradation indicators and an improved methodology for national and possibly regional assessment and mapping of land degradation, which could be adopted by other countries particularly those in the sub-Sahelian regions. A series of thematic maps for the whole of Kenya will also be produced showing the different indicators and the status and hazards of land degradation.

Kenyan government agencies and non-governmental organizations will use the assessment and the database as a tool for planning and combating land degradation, in particular in areas indicated by the study as degraded or vulnerable to land degradation. It will also be used as a baseline for the long-term monitoring of land degradation processes.

The capacity building component of the project includes the additional experience gained by national experts, workshops to present results to policy-makers and technicians, and the supply of reference and teaching material for educational institutions.

The total cost of the project is US$ 1,240,000 of which the Government of Kenya supplies 42% (in kind), the Government of The Netherlands 50% and UNEP's Environment Fund 8% .

UNEP/CIP Project on Combating Desertification in the Kalmuck Republic of the Russian Federation

The Kalmuck Republic, situated in the south-east of the European part of Russia, occupies an area of 75.9 thousand square kilometres. According to natural geographic resources it belongs in the zone of dry steppes and semi-deserts. However, at present, nearly 13% of its territory has been converted into true desert. This has occurred within the last two decades, during which there has been unprecedented human impact on the area's natural ecosystems.

The republic's soils are subject to two types of erosion: erosion by water and erosion by wind. Owing to specific conditions of nature and climate, it is erosion by wind that has become most pervasive. Dust storms and dry winds do great damage to agriculture.

Compared with 1975, the combined area of soils in danger of erosion, has more than doubled, in particular, ploughed-land erosion has increased from 205.0 thousand hectares to 686.9 thousand hectares. The processes of erosion have produced a particularly drastic change in the ecological balance of the "Black lands". Rapid development of the latter at the beginning of the seventies has led to uncontrollable accelerated deflation.

Erosion by water has occurred mainly on sloping lands in the western and central zones of the republic. The area of agricultural land that has been washed away to various degrees is 474.6 thousand hectares.

The Kalmuck republic specializes in livestock farming and corn growing. Arable land occupies 14.3%, pastures 75.5%, and hay mowing 9.4%. Natural environments in the Kalmuck region are under the influence of strong

Fixation of moving sands, Kalmuck Republic. Photo: L. Kroumkatchev.

anthropogenic factors, which cause the worsening of vegetable composition and productivity, the sinking of natural pastures, the development of wind and water erosion and other unfavorable changes of the environment. As a result of these factors, the present ecological situation deteriorates, the processes of ecosystem degradation and desertification then become rather considerable. The area of the sand hills has increased from 13 thousand hectares in 1958 to 585 thousand hectares in 1985.

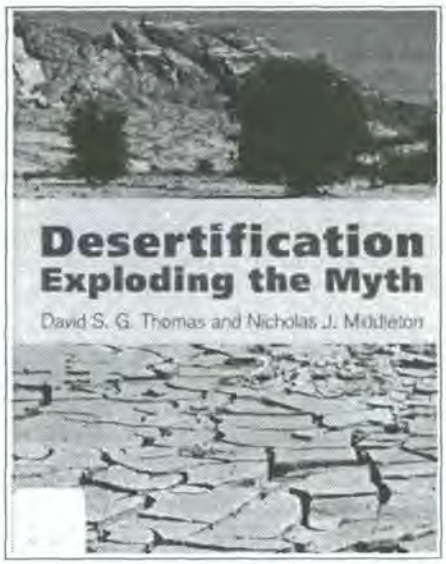
Among the main factors influencing degradation and desertification of the territory were the ploughing of soils, which was done during the 50s, climatic factors and the overloading of the fragile ecosystem with cattle. The ratio of cattle per area unit now exceeds the recommended number of livestock by three or four times.

At present, 82.7% of the Republic's territory is subject to desertification. Out of this, 47.3% has been largely destroyed. The degradation of natural ecosystems emerges from district to district. Chernosemelsky, Caspiysky, Yashkulsky, and Ustinky districts are to be classified as an ecological disaster zone, 96.17% of these lands have been degraded and 56.1% of these territories are at the stage of extensive desertification.

Bearing in mind the highly adveronditions as well as its ecological implications on natural resources, the Government of the Kalmuck Republic, in collaboration with the United Nations Environment Programme (UNEP) and the Centre for International Projects (CIP) embarked upon the preparation of a National Action Programme to Combat Desertification (NAPCD) in 1994-1995.

The NAPCD will focus on arid and desertified areas of the Kalmuck Republic receiving less than 200 mm annual precipitation. It aims to reduce and check the negative effects of desertification; to provide an expedient use of dry-lands; and to rehabilitate and reclaim natural resources. The plan aims at upgrading the ecological situation in the country as well as improving the living standards of the population in arid and semi-arid areas.

BOOK REVIEW



Desertification: Exploding the Myth

By David S.G. Thomas and Nicholas J. Middleton
Chichester, John Wiley & Sons, 194 pp.

This is a very curious book. From the title, I expected reams of scientific data aimed at disproving the phenomenon of desertification, i.e. dryland degradation. Instead, 90 per cent of the book supports everything that UNEP and others have been saying about the definition, causes and consequences of desertification. It is also a rather schizophrenic book, with the authors in different places taking opposing positions on the same issue and contradicting themselves. Perhaps it is due to the two authors differing opinions and the book's poor editing that left inconsistencies, or maybe it is because in places the authors' zeal to criticise UNEP led them to make statements they don't really believe, which they then corrected in another part of the book. The book is foremost an attack on UNEP as the institution blamed for creating so-called myths about desertification. What are these 'myths'?

1. Desertification affects one third of the world's land area, and it is a voracious process which rapidly degrades productive dry-lands.
2. Dry-lands are fragile ecosystems that are highly susceptible to degradation and desertification.
3. Desertification is a, if not the, primary cause of human suffering and misery in dry-lands.
4. The United Nations is central to attempts to understand and solve the desertification problem.

In the following nine chapters, Thomas and Middleton try to back up their claims that the above four statements are myths that UNEP has created. Let us examine their evidence.

Chapter One discusses desertification definitions, the politicization of the issue, the United Nations Conference on Desertification (UNCOD) and UNEP's role in following up on it, social aspects of desertification, and aid and desertification. The authors contribute to the perpetuation of a myth themselves here, one that attributes UNEP as the supporter of the image of a moving desert front or wall of sand as a correct portrayal of desertification. In point of fact, several UNEP publications go out of their way to try and dispel this image, beginning with the UNCOD Plan of Action to Combat Desertification (PACD) and the conference round-up itself.

To quote from the round-up (p. 5): 'Deserts themselves are not the sources from which desertification springs....Desertification breaks out, usually at times of drought stress, in areas of naturally vulnerable land subject to pressures of land use....It is generally incorrect to envision the process as an advance of the desert frontier engulfing usable land on its perimeter: the advancing sand dune is in fact a very specialized and localized case.' Similar views have been expressed in UNEP documents and by UNEP's Executive Director and other officials in speeches. So how do the authors of this book, and others who have done the same, accuse UNEP of perpetuating the 'advancing desert' image? It seems straw men need to be set up to blow down to bolster their anti-UNEP stance.

The authors make a very damaging charge when they suggest on p. 8 that it could be incompetency to try and do something to halt desertification before the nature of the problem is fully understood. This is an extraordinary view when one considers that the consequences of doing nothing means that large areas of land and many people would be condemned to suffer the effects of desertification for years to come, not to mention the past 17 years since UNCOD. Even though, as the authors note (using UNEP data), the PACD has not been very successfully implemented, it could be argued that much land and many people are better off today than they otherwise would have been without action having been taken.

Their position is also contrary to contemporary scientific paradigms relating to dry-lands. As Ian Scoones explains in a paper presented at a workshop on 'New Directions in African Range Management and Policy', it should be accepted that the dry-lands are typified by high levels of unpredictable environmental variability. Uncertainty and indeterminacy are fundamental. 'No matter how much information is collected ....there is no way that all possible outcomes can be predicted and planned for. Rather than aim for 'complete' information...prior to intervention, it is better to act incrementally and initiate a learning process that monitors experience and feeds back lessons. This is adaptive management'. This is exactly what UNEP has been doing, and why it has revised the definition of desertification and advocated new approaches over time as understanding of the problem has increased.

The authors state that the UN's most recent definition of desertification 'firmly returns the emphasis to desert margin areas'. The straw man again. The new definition, found on the back cover of this bulletin, neither says nor implies anything about desert margins.

The section on social aspects of desertification raises some important and valid points. The authors correctly point out that anti-desertification efforts to date have been technically oriented towards the natural sciences. UNEP's DC/PAC is dominated by natural scientists, and they and others like them do not go to social scientists for explanations of the human component. That is generally true, though with DC/PAC's international workshop last year and the publication of *Listening to the People: Social Aspects of Dry-land Management* (soon to appear) an effort is now being made to pay more attention to socio-economic aspects of desertification. Much remains to be done, however, to translate words into deeds.

The concept of the 'tragedy of the commons' is criticised on p. 13, which is interesting because later on in the book it is supported. From p. 97 referring to the causes of deforestation: '..the resultant degradation is an illustration of Hardin's 'tragedy of the commons' principle.' It is also ironic that UNEP statistics on the area affected by desertification in North America are cited as an authority when the authors wish to make a point, but UNEP statistics in general are one of the main criticisms about the 'myth' of desertification in the entire book, more below.

Chapter 2 presents several examples of desertification in ancient and recent history from different parts of the world, reaffirming that it is an old and global problem. More by their tone than by explicit statements, the authors seem to be critical of the fact that the UNCOD in 1977 identified desertification and not drought as the main issue to concentrate on, since drought was the principal cause of the Sahelian tragedy.

Chapter 3 looks at institutional developments in more detail. Concern is again expressed about the variety of definitions in use, and the number of different views of what constitutes desertification. A rather good summary is presented of the documentation produced at UNCOD, and the PACD is criticised 'as a recipe for inaction' as it contains 'no focal points or strategies' and it is 'replete with platitudes and good intentions'. I think that this is a valid criticism and that it is a main reason why the PACD could not be implemented. UNEP would have performed a great service to themselves and others if they had produced a leaner and meaner 'plan' based on the PACD soon after UNCOD.

The authors show their lack of familiarity with UNEP, however, when they refer to its chief executive as Secretary General rather than the correct Executive Director, and when they call UNEP the 'executor' of the PACD. UNEP was requested to follow up and co-ordinate implementation of the PACD in Recommendation 27, not execute it. They also confuse things by claiming that the desertification Special Account had $45.5 million contributed to it by 1988, when that sum actually represented the funding generated by DESCON since its inception for projects. None of that money ever went to the Special Account, and in fact the most that the Special Account has ever held was a bit more than $300,000 in 1991.

They also seem to support the view, expressed by some, that UNEP was not the best UN institution to be given the responsibility of overseeing the PACD. It is small and has little political clout or global representation. They review UNEP's efforts and financing to highlight how little they have done in terms of projects. One would think, given the authors' expressed opinion that nothing should be done until the problem is better understood, that they would be pleased by this. But in their fervour to criticise UNEP they see UNEP's modest efforts in a negative light, again contradicting themselves by first saying nothing should be done, then saying UNEP has done too little.

National plans of action are viewed by the authors as just a 'further bureaucratic layer in the desertification business'. The national plans that UNEP has helped formulate to date are examined and found largely wanting in terms of data presented and concrete actions recommended. Few have even begun implementation. This is basically accurate and it is an important consideration for UNEP given that the 1994 Desertification Convention calls for action plans as well. Unless action plans are better conceived, integrated with other national planning efforts, and made more pragmatic so that they can be implemented, they will remain largely a waste of time and a drain on human and financial resources.

The analysis given by the authors to the General Assessment of Progress of implementation of the PACD (to which I gave the acronym GAP, referring jokingly at the time to the gaps in UNEP's data) is excellent. The GAP produced the data on the severity and extent of desertification in different regions of the world that the authors so vehemently object to, as 'they were marked by their lack of rigour, lack of consistency and lack of a clear definition or methodological foundation'. The authors are fair enough to acknowledge that UNEP was well aware of this, but they are highly critical of the fact that UNEP publicised and used the poorly-defined statistics to keep the political pot boiling.

UNEP must claim *mea culpa* to the charge, but as the DC/PAC officer in charge of the Information and Database Unit at the time, and responsible for much of the information dissemination that the authors object to, I still feel that it should have been done in spite of poor data. What difference does it make if 3.8, 3.5 or 1.5 billion hectares of dry-lands are actually affected by land degradation, or if it makes up 35 or 25 per cent of all productive land? The fact remains that it is a huge global problem affecting hundreds of millions of people. Niggling over the statistics will contribute nothing positive to solving the problem and helping people. And how are solutions to be found if none are tried and tested?

In the chapter's conclusion, the authors again criticise UNEP for urging action before achieving a clear understanding of what the problems are. They state that 'Sahelian problems were presented in an environmental context rather than blamed on the incompetence or actions of affected parties'. This gave the developing world the right to go to the developed world for assistance. Since the authors previously pointed out in the book

that desertification affected the developed world as well, this is a strange statement. Are they implying that the incompetence lies only in the developing world, and that desertification is due to something else in the developed? They go on to conclude that UNCOD was a failure, it triggered misunderstandings about desertification, and that it created a hollow framework for its understanding and solution. UNEP was at the core of the hollow framework.

Chapter 4 goes into more detail criticising the GAP data and UNEP's role in producing it. They accuse UNEP of 'massaging' the data 'to show what was required'. In this instance they are criticising UNEP for using consistent criteria for their estimates in 1977 and 1984. Mabbutt, the consultant who determined the GAP statistics, initially excluded rangelands that made up part of the UNCOD figures. UNEP asked that they be included to be consistent with the methodology used in 1977. For Thomas and Middleton, this is massaging the data, which provides a clear example of their bias.

They briefly discuss the GAP II methods and figures of 1991 and seem to be happier with the Global Assessment on Soil Degradation (**GLASOD**) soil erosion data. They are less happy that vegetation degradation statistics are added, and raise an important issue that the recent thinking on the ecology and carrying capacity of dry-lands has been changing. This is explored in more detail below. They go on to confuse two distinct issues, that of the estimates of the rate of land lost annually to desertification and the concept of the expanding desert front. One would think that people who are accusing others of confusing issues would be more careful not to do it themselves.

It is legitimate to question the figures of 21 million hectares lost to desertification annually and six million hectares reduced to zero or negative productivity (totalling the 27 million hectares they seem to be confused about on p. 60). These figures, as the book rightly says, are guesstimates, based on little hard data. They practise shoddy writing, however, when they go on to cite a number of non-UNEP sources referring to desert-front advance. They cannot find a UNEP document referring to desert front advance, so they quote others and imply they come from UNEP. They continue on the subject and support, uncritically, the Lund University team's findings in Kordofan for a lack of desert front advance.

The authors claim that the desertification concept has got out of hand because of a blurring of distinction between desertification and other forms of land degradation. It is here we begin to see a glimmer of a fundamental misunderstanding on the part of the authors of what desertification means to UNEP. For UNEP, *there are no other forms of land degradation in dry-lands other than those encompassed in the term desertification.* This understanding is the main reason why the definition was altered. It was an attempt to avoid confusing desertification and land degradation as separate in nature. As Thomas and Middleton show, the attempt was in vain. People, even experts in the subject, will retain their own particular views and will ignore whatever the UN states in order to support them.

The authors are being clearly dishonest when they claim that the concept of desertification is getting out of hand when a UNEP environmental briefing infers that desertification is happening or being controlled in the Republic of Korea, Central America, Haiti and the Himalayan foothills. I have the briefing before me, and Central America is no where even mentioned in the document. The reference to the Republic of Korea is in the context of successful social forestry actions that could be applied in the dry-lands, and Haiti and the Himalayan foothills (the Siwaliks) both have dry-land areas affected by desertification, as indicated in the *World Atlas of Desertification* which they authored themselves.

In this chapter 'massaging' the data has become 'the continued fudging of the statistics'. This charge is still based on the one instance of including rangeland categories in 1984 that were also included in 1977. They make no charge of fudging or massaging the data of the 1991 estimates of GAP II. In the chapter's conclusions, the authors again infer incorrectly (the straw man) that UNEP is responsible for characterising desertification as the advancing desert front, and they complain that politicians have used poor statistics to indicate the severity of the problem. Since they are the authors of one of the principal UNEP publications presenting these statistics, this seems a rather self-condemning charge. They, in their own words, are a main part of the 'UNEP publicity machine' that they condemn. This seems very schizophrenic indeed.

The authors in this chapter state that the idea of small, community-based projects in 1993 are now something new for UNEP. In fact, the PACD and the recommendations in GAP I for future actions contain strong references to the need for support to local community actions. DC/PAC has supported many such small projects directly and through NGO networks over the years, a fact the authors conveniently ignore in their earlier review of UNEP's activities.

Finally, the authors question the UN's central role in anti-desertification efforts and that desertification is treated as a global problem. They offer no alternatives to either, though. They also fail to realize that it was the international community, i.e. the governments represented in the United Nations, that appointed the UN and UNEP in particular to deal with desertification on a global basis. The authors may think that they know better than the assembly of most of the world's governments, but whether they agree with it or not, it is a fact, not a 'myth', that the UN is central to understanding and solving the problem.

Chapters 5 and 6 deal with the causes of desertification and why they happen. Here some of the inconsistencies of the authors are most apparently revealed. In Chapter 5 they are ambivalent about whether overgrazing actually is a cause, and discuss the complexity of dry-land grazing ecosystems and the concept of fluctuating carrying capacity in unstable ecosystems. Then in Chapter 6 a section is titled 'Why are pastoral lands abused', and here they reluctantly admit that overgrazing does lead to land degradation, but apparently only in cases where traditional management systems have been disrupted. Then, almost comically, they go on to explain all of the reasons overstocking, and by extrapolation overgrazing, occur even with traditional systems: reduced grazing area and in-

creases in herd size due to human population growth, improved veterinary care, reduction in intertribal strife, etc. In spite of all of their qualifiers, they basically conclude the same as many UNEP documents on the subject. They also recognize that boreholes are an example of external influence which can lead to degradation (p. 89), although at the same time they support Lund University's evidence that there was no creation or expansion of borehole degradation patches in the 1962-1984 period in Kordofan. If some boreholes lead to degraded patches in the piosphere area and others do not, it would be interesting to know the reasons.

The discussion of bad irrigation and deforestation could have come straight from a UNEP environmental briefing document. Their treatment of the causes of over-cultivation was poor, however, as government policies, land tenure considerations, access to capital, credits or technological inputs were all ignored as contributing factors to the problem. The Chapter 5 conclusion begins with the flat statement: 'People cause desertification.'

The Chapter 6 conclusion states that 'the underlying reasons behind people's overuse of the environment, leading to desertification,...[is] ignorance, poor planning based on inadequate understanding of the dry-land environment, and the adoption of inappropriate techniques.' What happened to the support for traditional management systems? Repeated ecological blunders by farmers or institutions 'may be a result of poor memory' (p.98). It is extremely difficult to reconcile the foregoing patronizing statements with the concluding sentence reminding the reader 'that peoples who have inhabited dry-lands for many generations have as much to offer in the search for solutions as anyone, since it is they who understand how dry-land environments work.' Even with their ignorance and poor memories?

In **Chapter 7**, 'Unravelling the myth', the authors inexplicably contradict one of their strongest criticisms with the statement on p. 100 that since UNCOD, *perhaps because of it* (my emphasis), scientific investigations have clarified and added understanding to central aspects of the desertification debate. On p. 49, UNCOD was said to have triggered all kinds of misunderstandings. The answer to this apparent contradiction is that UNCOD led to some serious thinking about dry-land degradation, the causes and solutions, that never would have occurred without it. Both misunderstandings and clarifications are the result of such a process, but they are both necessary to scientific advancement.

The authors are wrong when they claim that the UN viewed desertification in only an environmental light, avoiding the need to address land-use policies and 'agricultural interests', by which I assume they are referring to land tenure issues. A cursory thumbing of the PACD and various UNEP desertification documents will show them to be full of references to policy and land tenure issues, and many more things of a political nature. Land tenure issues have increased considerably over time as a central concern now of UNEP in promoting good land and natural resource management.

The authors state that it is not easy to make a case for desertification being a special form of land degradation. So far so good, as UNEP does not do so. They point out that the processes are the same in dry-lands as in other environments. UNEP agrees. Incredibly, they go on to argue that nevertheless desertification should be separated from other forms of land degradation because these ecosystems have 'attributes that make them particularly vulnerable to degradation. Dry-land ecosystems have been viewed as delicate, fragile systems that are highly susceptible to disturbance and degradation' (p.102). Another reason to consider desertification distinct is because the populations of dry-lands are particularly vulnerable. Desertification for these people 'is just one part of a tangled web of factors causing social upheaval, food shortages and frequently death'. Pages 103-104, p. 113 and p. 116 go on to discuss in more detail the vulnerability of drought-prone dry-lands to humanly caused actions, and they agree that desertification contributes to famine (they state this again on p. 127 and p. 156). And the authors are trying here to unravel the myths that dry-lands are fragile (myth no. 2) and that desertification is a primary cause of human suffering (myth no. 3). I would not want them on my debating team. They have just contributed to what they are calling myths.

It gets worse. After criticising the GAP I statistics as having lacked a clear methodological foundation, the authors cite Mabbutt's desertification indicators favourably and state that a compromise needs to be struck between scientific rigour and practical needs, especially when monitoring at larger scales. Since Mabbutt produced the GAP statistics, did they not make the connection? They also admit that the UN noted as early as 1975 that as rigorous approach as possible was needed for monitoring, and that a provisional methodology was produced by 1979. However, apparently this was not enough. The GLASOD data are then analysed and found to be acceptable, though still limited. In conclusion, the authors accept that collecting accurate data on the scale of desertification is difficult, but this is no excuse for the way in which some of the UNEP estimates have been used. UNEP disagrees.

Chapter 8 deals with 'Key environmental issues'. Here they contradict what they said earlier and state that dry-lands are not fragile, but rather robust, resilient and unstable (p.129). They succeed admirably in muddling the whole question of how to perceive dry-lands in relation to degradation processes. I do not think that UNEP or anyone else denies that dry-lands have significant powers of recovery after rainfall deficit stress. This is stated in the UNCOD round-up and in other UNEP documents. But as Thomas and Middleton say themselves, 'Though drought is a normal...feature of dry-land environments, increasing human utilization has raised the potential for detrimental and even disastrous impacts to occur' (p.104). It is when human actions are added to drought that degradation occurs. Short-term drought in the absence of people and animals rarely, if ever, results in significant degradation.

It is therefore in the context of human use that dry-lands are fragile and susceptible to degradation, and I do not think the authors would want to seriously contest this view. (They certainly supported it in the text of the *World Atlas of Desertification*). They can only call it a myth by talking of the natural resiliency of dry-lands under conditions of no or low human use, and in this chapter by

limiting their discussion to the complexities of rangelands and ignoring cultivated lands.

The section on remote sensing and measures of the 'desert front' treats one of the most important areas of misunderstanding about desertification today. The authors rightly point out that satellite imagery has made people more aware of the ephemeral and dynamic nature of vegetation changes in response to rainfall. Do these green biomass changes have anything at all to do with land degradation, however? I would argue that over the time periods available, i.e. a few years, they have little bearing on the problem. Except in isolated catastrophic situations, desertification is a very slow and fluctuating cluster of processes. It is unrealistic to think that it could be measured in natural vegetation production fluctuations over a few years duration.

The AVHRR imagery of north-south shifting green biomass limits in the Sahel-Sahara zone are measuring nothing more than rainfall patterns. They are irrelevant to desertification or advancing/retreating desert fronts. Measures of desert frontier would depend on a number of criteria involving soil characteristics, dominant flora structure and composition, faunal composition, and other factors. Even so, defining desert boundary changes would still be of *minimal importance* to the issue of desertification scale and extent. UNEP and serious workers on this issue are concentrating more on the patches of productive land, usually away from desert margins, that are currently under stress. All of this desert margin and marching sands business is the work of shoddy journalism.

The authors' gross misunderstanding about the difference between ephemeral vegetation production changes in response to rainfall variability and longer term degradation is exposed when they question the GLASOD soil degradation data, which shows southern Sudan and central Mali as severely degraded. Since those areas still produce green biomass when rained on the authors seem to think they cannot be severely degraded. Do they know how much vegetation biomass those areas produced 100 years ago compared to today? Or 500 years ago? I would guess these areas produce significantly less today than in the past, and it is due to soil degradation. Measurements of vegetation production changes 10 or 15 years apart in most cases are meaningless for desertification monitoring. Changes in vegetation cover and species composition say more.

Chapter 9 discusses the future. The authors make many good recommendations about supporting small-scale, community-based interventions, and by warning that governments of countries affected by food shortages and other natural disasters be held accountable for the suffering of their marginalised people. The effects of drought and desertification are their responsibilities, not a scapegoat to use to ask for aid. They realize that the quick techno-fix is not adequate to deal with something as complex as desertification, and that social, economic and political factors are more relevant. One of their main desires is that more attention be paid to scientific rigour and accurate data. I think that the UN and UNEP in particular are doing the best that anyone could do, particularly given the latter's extremely limited resources.

Only one of the authors' claimed myths can even possibly be supported: that of desertification affecting one third of the world's land area. Depending on the criteria used, it could still be true. UNEP has never to my knowledge used the terms voracious and rapid when referring to desertification. Rather, terms such as subtle, insidious and inexorable are commonly used. Thus, including this reference as part of myth no. 1 is just another straw man set up by the authors.

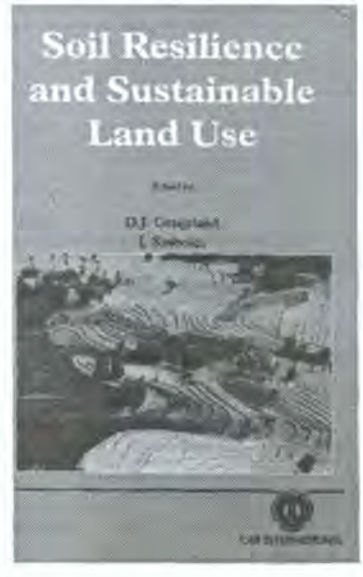
The other three 'myths' happen to be fact, using the authors' own words in the first two cases, and by international agreement in the last case. Thomas and Middleton have done the issue of desertification a great disservice in their attempts to discredit an institution for which they have demonstrated considerable antipathy. They have confused issues, muddled facts, presented distortions and misstatements. Unscrupulous, headline-seeking journalists have already used their book to claim that desertification itself is a myth, obviously not the intention of the authors. It will take some time to dispel the myths created by this book.

Daniel Stiles

Soil Resilience and Sustainable Land Use

Edited by D. J. Greenland, *former Director, Scientific Services, CAB INTERNATIONAL, and* ***I. Szabolcs,*** *Research Institute for Soil Science and Agricultural Chemistry, Hungarian Academy of Sciences.*

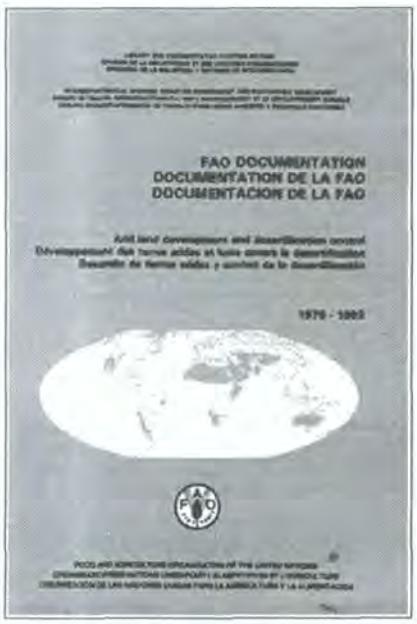
Soil resilience embraces many aspects, but may be defined as 'the soil's ability to recover after disturbance'. It is central to any concept of sustainable land use in both developed and less developed countries in times of continued increases in population. These issues form the focus of this book which presents papers developed from the second workshop on the ecological foundations of sustainable agriculture (WEFSA II) held in late 1992 in Budapest. The book is divided into six parts: sustainable agriculture and soil resilience; the extent of soil degradation; avoiding and combating soil degradation; soil; organisms and soil resilience; methodologies for the study of soil resilience and sustainable land use; and pro-



moting soil resilience for sustainable land use. Written by eminent authorities from every continent, the book represents a major review and synthesis of the field and will be indispensable for all concerned with soil science, land use and sustainable agriculture.

Available from:

CAB International Headquarters: Wallingford, Oxon OX10 8DE, UK
North America: 845 North Park Avenue, Tucson, AZ 85719, USA
Asia: P O Box 11872, 50760 Kuala Lumpur, Malaysia
Caribbean: Gordon Street, Curepe, Trinidad and Tobago.



Arid land development and desertification control

1975 - 1992

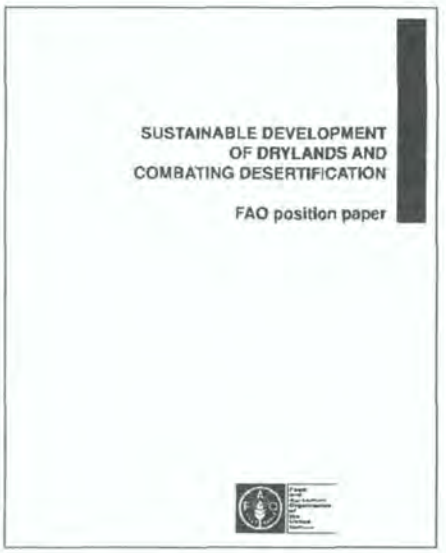
This bibliography was prepared by the Food and Agriculture Organization of the United Nations (FAO) as a follow-up to the United Nations Conference on Environment and Development, and as a contribution to the First Substantive Session of the Intergovernmental Negotiating Committee for the Elaboration of an International Convention to Combat Desertification (INCD), held in Nairobi, 24 May to 3 June 1993. This document supplements other FAO inputs into the INCD process which summarizes the experience, the strategies and the programmes of the Organization in this field.

The bibliography is arranged in chapters which reflect the activities of FAO's Regular and Field Programmes in desertification control and land development - at different levels of action, from local to global level.

The bibliographical references in each chapter are arranged by accession numbers and are accompanied by primary and secondary keywords for quick perusal. A number of references have abstracts in addition to keywords. A subject index, author index and project index, in English, French and Spanish are given at the end of the bibliography. Subject and project indexes give the first line of the document title and indicate the access number in the bibliographical list. Documents that belong to one and the same project or to one general entry are grouped together for a quick and easy overview.

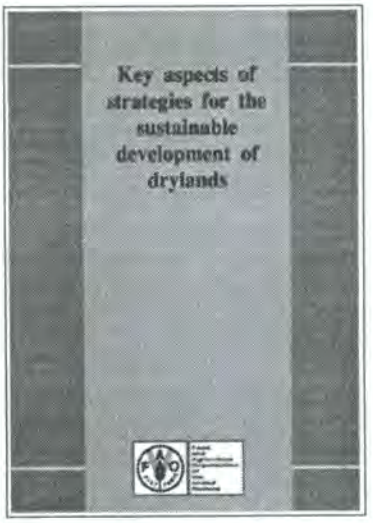
Most of the references have been extracted from the FAO Documentation database, but some of them come from various Divisional Documentation Centres, including FAO's Investment Centre. The list contains references entered in the FAO database from 1975 until the end of 1992. The modalities of access to these documents vary according to their classification. The interested user is guided on their availability at the beginning of each chapter.

This bibliography has been prepared within the framework of activities of the Subgroup on Desertification of the Interdepartmental Working Group on Environment and Sustainable Development, with the assistance of FAO's Library and Documentation Systems Division.



Sustainable Development of Drylands and Combating Desertification

Contents



Key aspects of strategies for the sustainable development of drylands

The objectives of this document are to focus world attention on dry-lands and the inputs needed to replace increasing degradation and deprivation with more sustainable and secure forms of land and resource utilization. The dry-lands, defined as those areas with fewer than 120 growing days per year, extend over at least 20 million square kilometres and are inhabited by a population of almost 500 million.

This summary of the key aspects of a strategy is derived from the policy paper 'Improving Productivity of Dry-land Areas' presented to the FAO Committee on Agriculture during 1987, and is a further step in elaborating the 'Long-Term Strategy for the Food and Agriculture Sector' presented at the FAO Conference during 1989.

This document is intended to guide national bodies in the assessment and revision of strategies for the sustainable development of dry-lands. Only at the national and subnational levels can strategies be formulated which are appropriate to local conditions and which focus inputs and actions in an effective way in order to safeguard natural resources and help alleviate poverty.

This approach emphasizes institutional reform, before technological solutions. The evidence shows that, in most instances, technology alone cannot control dry-land degradation — improved management and institutions are essential features of successful dry-land development.

The key aspects, or components, of improved dry-land development strategies are as follows:

Preconditions for Development
Relief of population pressure
- Political commitment
- Marketing and rural infrastructure

Organization and Targeting of Development
- Organizational and staff efficiency
- Community participation
- Security of tenure
- Research
- Development planning

Food Production and Range Resource Management
- Drought and food security
- Soil and water conservation
- Livestock and range management
- Fuel and agro-forestry

These key aspects are not listed in order of priority but according to extent of applicability. For instance, range management may appear low on the list, considering that less than 10 per cent of the dry-lands are cropped. However, a large part of range lands is extremely arid, and no more than 10 per cent of the total dry-land population are pastoralists. It is for national authorities to establish priorities among these elements, whilst bearing in mind that aspects on the above list are potentially important and that a systematic approach is essential

A *central precondition for development* is the assignment of a high priority to dry-lands improvement, in keeping with the prevalence of poverty and the extent of natural resource degradation in these areas. The opportunity cost of the redeployment of resources, in terms of the other zones and sectors that thereby receive less attention, must be weighed against the cost of not taking action - of increasing food aid, declining productivity, desert encroachment and even social and political unrest.

The most costly precondition for dry-lands development is undoubtedly the provision of the rural infrastructure which is required to ensure the delivery of the necessary inputs and services. Even with cost-effective designs, substantial external support may be needed for the establishment of this infrastructure. The relief of population pressure on natural resources is the remaining precondition for the development of most dry-lands, which should be considered in the context of national plans for other zones and sectors. If action to reduce population pressure on dryland resources is not taken now, the ultimate cost will be much higher and the effectiveness of other development inputs will be limited and short-lived.

The key aspects relating to the *organization and targeting of development* do not necessarily require heavy investment, although an overall expansion of the dry-lands development effort may well require additional resources. The general principles which should guide agricultural development in favourable areas also apply to development efforts in the dry-lands - such as focusing on the needs of specific areas and communities, operating a unified extension service, ensuring community participation, giving research a farming systems perspective and designing incremental and flexible development programmes - and **may** money. Moreover, governments should not underestimate how much can be accomplished by the effective leadership and motivation of existing institutions.

Improved development planning, starting with a national strategy for dry-lands development and focusing thereaf-

ter on specific zones and communities, is essential. Adequate time must be allowed for securing effective participation of local communities in the planning process. Sound planning also requires improved information and early warning systems. Another key aspect of a strategy is ensuring appropriate tenure - particularly adequate security - for small holders and pastoralists. The strengthening of dry-land agricultural research, with a farming systems research and development approach, is a final aspect of the organization and targeting of dry-land development activities. The costs of these elements will depend on the overall time frame and scope of the dry-lands development strategy.

More specific inputs to *food production and resource management* require, for full effectiveness, prior action in the fields already noted. First, priority needs to be given to inputs that arrest land degradation and improve food security. This implies more than the better organization of food aid and the strengthening of drought strategies. It also calls for adaptive research and extension related to livestock, range and crops, including agro-forestry, which combine efficiency of water use with other attributes needed for present and future food security, such as soil and water conservation and the provision of fuel and fodder.

Improvement in pastoral areas requires coordinated, phased inputs. There is little scope for introducing more productive grazing techniques until an effective grazing management system has been established with local pastoralists; and such new techniques may be of little value in the absence of complimentary marketing and veterinary services. Long-term research and development plans are needed which take into account the certainty, but unpredictability, of both good seasons and droughts. Mobility has been a fundamental necessity for survival in many rangelands, and thus sedentarization requires careful planning if it is not to accentuate deprivation and land degradation.

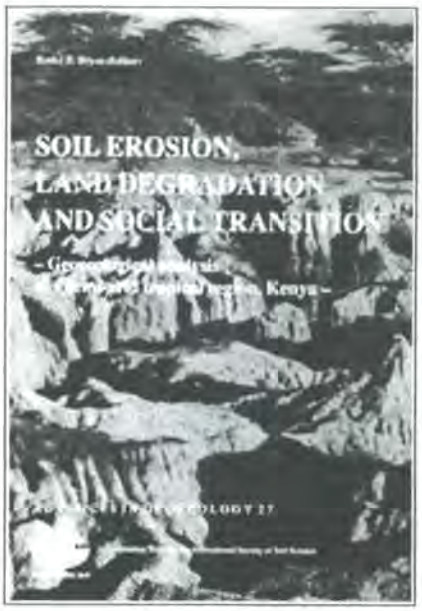
The responsibility for action rests mainly with national authorities, although active community participation should be sought in planning, managing and implementing development actions. In formulating and implementing dry-land development strategies, authorities need to ensure complementarity with development strategies for other zones and sectors. Recognizing the need for balanced development, plans for non-dry-land areas and non agricultural sectors should take into account the inhabitants of the dry-lands, and, finally, it is maintained that the dry-lands warrant substantially more attention than they have received in the past.

Geopotential and Ecology - Analysis of a Desert Region

ISBN 3-923381-35-2
price DM 189,00

The interdisciplinary approach within the study area covers in detail aspects of remote sensing data in cartography, landscape evolution and paleoclimate, sedimentary basin studies including mineral resources, groundwater assessment and management, soil associations and land suitability, landscape ecology and phytomass production of wild and cultivated plants.

The cartography unit, one of the major sub-projects, was concerned with the development of new types of maps based on remote sensing data. The map series of six "Geopotential and Ecological Maps of the Western Desert of Egypt" documents the present situation of this arid area for the first time on an 1:100,000 scale by the following thematic maps: Topography, Lithology, Hydrogeology, Soil Association, Land Suitability (for irrigated agriculture), and Vegetation.



Soil Erosion, Land Degradation and Social Transition: Geoecological Analysis of a Semi-arid Tropical Region, Kenya

ISBN 3-923381-36-0
price DM 189,00

The 12 papers collected in this volume result from research carried out in Baringo District of Kenya to provide basic information essential for land reclamation and development of environmentally and socially appropriate land use practices. Baringo has long been regarded as one of the most severely degraded in Kenya. It was chosen for research because degradation poses an immediate threat to the welfare of the population, and because the district exemplifies within a small area many of the environmental problems which have afflicted the Ken-

yan drylands and , indeed, most dryland regions in sub-Saharan Africa.

With careful and innovative use of the information now available, Baringo could become a model for effective land management in many dryland regions in Africa.

Address for orders:
CATENA VERLAG Distribution
Armelgasse 11
D-35447 Reiskirchen
GERMANY

Greening of Sand Dunes and Interdunal Plains

By R.N. Kaul

A National Afforestation and Eco-development Board, Govt. of India, New Delhi, publication, 1994, 95pp + illustr.

The book covers the following subjects: extent of the problem, process of dune formation, dune types; ecology of sand dune ecosystem; sand dune fixation methods; protection from insects and other pests; cost of afforestation and returns; research needs; peoples participation; references.

The book is available on request from the National Afforestation and Eco-development Board, Ministry of Environment and Forests, Government of India, Paryavaran Bhawan, CGO Complex, New Delhi, India.

Press Release

Where Water Meets Land
NGO Experiences in Coastal Management

The images associated with the world's coasts are changing from those of enjoyment of the beaches, and coasts as the providers of livelihoods and economic opportunities to blurred pictures of pollution, degradation, and permanent destruction. Across the world, non-governmental organizations (NGOs) are working to turn this reality around and promote the sustainable management of coastal resources.

Where Water Meets Land looks at NGO involvement in two ways. First, it highlights the strong NGO presence at the World Coast Conference held in the Netherlands in 1993, at which strategies to deal with threatening sea-level rises were discussed. At the time, international attention for coastal management had not yet resulted in binding political agreements. The influence of NGOs is recognized as especially vital to direct discussion towards sustainable management of coastal areas, and to secure participation of local communities therein.

Second, *Where Water Meets Land* presents some of the ideas, strategies, and experiences of NGOs in coastal management. The activities of NGOs included in the booklet range from research programmes, campaigns, and lobbying activities to consultations, education and public mobilization. Their diverse backgrounds, expertise and experiences provide for an unique array of ideas and approaches in dealing with the continued destruction of coastal ecosystems, and the undermining of coastal communities' livelihoods.

Where Water Meets Land gives considerable exposure to NGOs and it aims to be a contribution to the ongoing process of information exchange on coastal issues and the development of NGOs' expertise. It is intended for use by those interested in coastal management, especially other NGOs, financial institutions and governments. The booklet provides an address list of NGOs active in coastal management.

Bibliographic Information

Where Water Meets Land
72 pages, 14.8 x 21 cm, ISBN 90-801592-3-9 Price: Dfl. 15, /US$ 8,- including p&p. Available free of charge to NGOs from developing countries.

Purchase From

Both ENDS, Damrak 28-30, 1012 LJ Amsterdam, The Netherlands. (Tel: + +31.20.6230823; fax: + +31.20.6208049; E-mail: BOTHENDS@GE02.GEONET.DE)

GTZ Range Management Handbook

The Kenya Range Management Handbook Series published by the Ministry of Agriculture, Livestock Development and Marketing of Kenya and GTZ (Deutsche Gesellschaft für technische Zusammenarbeit) covers nine semi-arid and arid districts which make up approximately half of Kenya (ASAL areas).

The Series consists of an Introductory and Methodological Part (Volume 1), Text Reports and Maps on the Natural Resource Inventories of each District (Volume 11) and Reports on Special Topics in the form of Compendia, Keys, Guidelines and Handbooks.

The data provided is for planning, advisory, instructional and research purposes. Potential users are ministries, training and research institutions, donor agencies and NGOs in Kenya.

The environmental data and maps which are being digitized provide detailed information on:

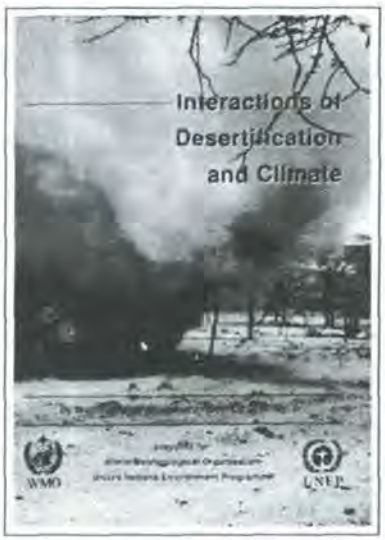
- Climate
- Landforms and Soils
- Vegetation
- Water Resources
- Range Condition
- Livestock Marketing
- Pastoral Human Ecology

Interactions of Desertification and Climate

By Martin A. J. Williams and Robert C. Balling, Jr.

Contents

I. Impact of Desertification on Climate
Human Impact on Surface and Atmospheric Conditions in Drylands
Impact of Human Activities in Drylands on Climate



II. Impact of Climate on Desertification
Impact of Climate on Soils and Vegetation
Impact of Climate on the Hydrological Cycle
Impact of Climate on Human Land Use

III. Global Climate Change and the Future of Dryland Climate
Linkages Between Interannual Climate Variations in Drylands and the Global Climate System
Future Climate Changes in Drylands

IV Possible Climatic Impacts of Mitigation and Rehabilitation Strategies
Mitigation and Rehabilitation Strategies to Combat Desertification

V Summary, Conclusions and Recommendations

Bibliographic information

Prepared for WMO and UNEP, 230 pages.

Purchase from

UNEP - DC/PAC
P.O. Box 30552
Nairobi, Kenya
Fax: (254-2) 215 615

Breaking the logjam: Obstacles to Forest Policy Reform in Indonesia and the United States

By Charles Victor Barber, Nels C. Johnson, and Emmy Hafild

Despite increased efforts to stem deforestation, recent reports indicate that tropical forests throughout the world are continuing to vanish at alarming rates. Focusing on Indonesia and the Pacific Northwest, *Breaking the* ***Logjam*** examines the underlying economic, social, and political forces that drive forest conversion and exploitation in both tropical and temperate regions. The authors identify three sets of issues essential to more sustainable forest management and use, and suggest ways in which local participation, national institutions, donor assistance, and international action can promote effective forest management.

Contents

I. Introduction
Elements of Sustainable Forest Management Indonesia's Forests: Context, Conditions and Trends

II. Ownership, Access, and Control over Forest Lands Forest Tenure in Indonesia
Forest Tenure in the U.S.

III. Economic Development and Forest Utilization
The Economics of Indonesia's Forestry Sector
The Economics of the Pacific Northwest Forestry Sector Toward Sustainable and Equitable Forest Economics

IV. The Political Economy of Forest Policy Reform
Forest Policy-making in Indonesia
Forest Policy-making in the U.S.
Toward Effective Forest Policy-making

V. Conclusions and Recommendations
Reforming Forest Policy-making
Toward Sustainable Forest Economies
Revamping Forest-Tenure Regimes

About the Authors

Charles Barber is a Senior Associate and Nels Johnson is an Associate in the Biological Resources and Institutions Program at WRI. Emmy Hafild is a Fulbright Scholar at the University of Wisconsin/ Madison and is currently on leave from WALHI

Review Copies

May be requested from Ms. Wendy Wahl, World Resources Institute, 1709 New York Ave., N.W., Washington, DC 20006, (202)662-2596.

Evaluating the Carbon Sequestration Benefits of Forestry Projects in Developing Countries

Written by Paul Faeth, Chetyl Cort, and Robert Livernash

Although the basic theory of carbon-offset forestry is relatively straightforward, devising a way to evaluate the carbon

sequestration potential of particular forestry projects is much more complicated. This report presents a unique methodology for testing and comparing the carbon-offset potentials of a broad range of forestry schemes, using a dynamic land-use model developed by the World Resources Institute. The authors provide important insights and practical guidance for policy-makers, utility executives, project planners, and anyone else interested in the possibility of offsetting carbon dioxide emissions through sustainable forestry and land-use projects.

Contents

About the Authors

Paul Faeth is a Senior Associate in WRI's Economics and Population Program. Cheryl Cort is a former Research Assistant in that program and Robert Livernash is a Senior Editor at the WRI.

Bibliographic Information

Title: Evaluating the Carbon Sequestration Benefits of Forestry Projects in Developing Countries
Authors: Paul Faeth, Cheryl Cort, Robert Livernash
Publisher: World Resources Institute; February 1994
Format: 96 pp; large-format paperback
ISBN: 0-915825-95-3
List Price: US$14.95

Review Copies

May be requested from Ms. Wendy Wahl, World Resources Institute, 1709 New York Ave., N.W., Washington, DC 20006, (202) 662-2596.

World Resources 1994-1995

World Resources Institute in collaboration with the United Nations Environment Programme and the United Nations Development Programme.

Widely recognized as an authoritative assessment of the world's natural resource base, each World Resources report is a definitive reference on the global environment with the latest information on essential economic, population, and natural resource conditions and trends for nearly every country in the world. *World Resources 1994-95* is the sixth volume in the biennial World Resources series.

Contents

Bibliographic Information

Publisher: Oxford University Press
Publication Date: March 1994
Pages: 400, large-format paperback
List Price: $23.95
ISBN 0-19-521-045-X

Order from

WRI PUBLICATIONS/P.O. Box 4852/ Hampden Station/Baltimore, MD 21211/ 410-516-6963, or call toll free: 1-800-822-0504.

Review Copies

May be obtained from Ms. Wendy Wahl, Marketing Assistant, World Resources Institute, 202-662-2596.

World Resources 1994-95 Data Base Diskette

This software program contains extensive economic, population, natural resource and environmental statistics for 176 countries. The data is compiled from the book *World Resources 1994-95*, published by the World Resources Institute in cooperation with the United Nations Environment Programme and the United Nations Development Programme. The software includes mathematical and statistical functions and enables users to browse, select, manipulate, print, and transport any or all of the data. IBM-compatible, high-density diskettes can be used with any IBM-compatible computer with a high-density disk drive, hard drive, and 512 RAM.

Contents

Approximately 500 variables for 176 countries in the following categories (time-series data is included for roughly

half of the variables):

- Basic economic Indicators
- Population and human development
- Land cover and settlements
- Food and agriculture
- Forests and rangelands
- Wildlife and habitat
- Energy and materials
- Freshwater
- Oceans and coasts
- Atmosphere and climate

Bibliographic Information

Published by: World Resources Institute
Publication Date: April 1994
Format: 3.5" and 5.25" high-density diskettes, IBM-compatible
List Price: $99.95

Order from

WRI PUBLICATIONS/P.O. Box 4852/ Hampden Station/Baltimore, MD 21211/ 410-516-6963, or call toll-free 1-800-822-0504.

Review Copies

Copies of the Data Base Diskette are available for review, but must be returned to the World Resources Institute within ten days of receipt. Please contact Ms. Wendy Wahl, World Resources Institute, 202-662-2596 to arrange to review a copy.

NEWS OF INTEREST

'Desert Margins'— a Short Description of Ongoing Activities at the International Center for Agricultural Research in the Dry Areas (ICARDA)

Introduction

In nearly all research concerning resource management, whether addressed to desert margins or other lands, the key player is usually the resource manager: his/her needs, knowledge and perceptions and the social, economic and political imperatives he/she operates under. So, in much of the work in which ICARDA is involved, considerable importance is attached to the human dimension. Of the items that follow, work on satellite imagery, wind erosion and *Atriplex* spp. hedges is still at its early stages. We define steppe as desert margin zones with vegetation, and below the 200-mm isohyet.

Genetic Resources

Over the last four years ICARDA has made germplasm collections in the desert margin zones to safeguard valuable food and forage legume germplasm from genetic erosion through over-grazing or ploughing of the steppe. In addition, germplasm from these zones is often highly drought and salinity tolerant. Over 250 accessions have been collected from desert margins below the 300 mm isohyet in Jordan, Tunisia, Libya, Pakistan (Balochistan) and Morocco.

Satellite Imagery in the Steppe

A study of a pilot area of the steppe in northern Syria has been undertaken, using software that takes user-identified sample areas of known types (e.g. wind-eroded units) and generates statistical criteria that are then used to identify all similar areas on the image. A map is being produced, using a combination of the two images and field data. Further studies of the significance of particular map units are planned, and this should allow estimates of the magnitude of irreversible degradation of steppe. It should also form the basis for the analysis of mechanisms involved.

Wind Erosion Studies

Work was initiated in 1991 in the driest arable land and adjacent rangeland of the steppe margins of northwest Syria (mean rainfall 170-230 mm) to test methods to measure soil movement by wind; use those methods to quantify factors promoting wind erosion (wind speed, surface conditions); predict possible impact of such erosion and identify the areas at risk; and test simple methods available to farmers to control erosion on their land. Subsequent seasons have seen the establishment of additional, collaborative studies with the Syrian Soils Directorate in northeast Syria and with the University of Jordan in Jordan. The methods of measurement adopted have proved successful; wind speeds have been shown to vary greatly between sites and seasons; and, in arable fields, the question of stubble retention *versus* sheep grazing is a critical one.

Atriplex spp.

Mechanized tillage in flat, low-rainfall areas brings a serious risk of erosion of vulnerable soils by wind. Stubble retention or strip tillage after harvest may be technically effective control measures, but they tend to conflict with the sheep-feed imperative. Another possibility is the use of windbreaks. But, to many farmers, windbreaks are acceptable only if economically productive. *Atriplex*

spp. are drought-resistant fodder shrubs which might, in vulnerable areas, be planted in hedges transverse to the direction of the prevailing wind. A trial was established in the 1990/91 season at a dry arable site in northwest Syria to obtain quantitative data on crop and shrub productivity in such systems. This system resembles the alley farming of the International Institute of Tropical Agriculture (IITA), based in Ibadan, Nigeria.

In addition, grazing trials are conducted in cooperation with the Syrian Ministry of Agriculture on rehabilitated steppe land (annual rainfall 180-200 mm) using *Atriplex* spp. and *Salsola* spp. shrubs. Livestock performance, biodiversity and shrub growth are measured on improved and native steppe land under different grazing regimes.

Interestingly, and against the best intentions and efforts of the Government of Syria, Bedouins are not interested in adopting shrubs. Since steppe is seen as common property, only barley planting is recognized by tribes and the Government as a rightful claim to property. Shrubs already growing wild in the steppe are seen as native plants, even when in farmers' plantations, and are therefore free to graze and not subject to ownership claims. Until the Government recognizes the same "property association" to shrubs, this valuable steppe protection scheme will not be successful. As we emphasized in the introductory paragraph of this note, desert margin protection must be developed in close collaboration with the users (resource managers) if it is to be successful.

Bedouin Systems

During 1991 and 1992, in steppe areas of northern Syria adjacent to those covered in the wind erosion work, a graduate student studied the social organization, sheep management systems and migration patterns of Bedouin farmers. It was found that some farmers are more sedentary and some less sedentary than was the case 10 years ago, but both groups are driven by the quest for cheaper feed for their sheep; that rangeland due to its overgrazed status makes only a very small contribution to annual feed needs; and that Government attempts to redistribute steppe land to pre-determined groups are still in conflict with the Bedouins' own perceptions of tribal land distribution. These studies are continuing.

Dryland Grazing Management

Two levels of phosphate fertilizer are being compared under three stocking levels on heavily degraded, sloping and stony land not suitable for cultivation. After five years of very low levels of fertilizer application, which stimulated legume growth and therefore nitrogen fertilization through atmospheric nitrogen fixation, productivity of well-managed lands more than doubled. Sustainability indicators were developed and monitored, such as seedbank in the soil, soil organic matter and percentage of legume plants in the total vegetation. This work was carried out under 330 mm rainfall, and is now repeated under 150-200 mm rainfall. Reseeding legumes from previous collection missions appeared necessary.

The economic, social and policy factors, particularly the issue of ownership of marginal lands, play a key role in efforts to rehabilitate the desert margin. ICARDA collaborates with the International Food Policy Research Institute (IFPRI), based in Washington, D.C., in evaluating the effect of various policy options.

Dry-land Resource Management Project

In 1990, with support from the Ford Foundation (and later from OPEC, IDRC and UNEP), ICARDA initiated a Dry-land Resource Management Project (DRMP). The project identified small multidisciplinary groups of national scientists in six WANA countries and developed with each group a case study of a natural resource misused or under threat from agricultural pressure. Each study had two objectives: (i) to describe and analyze current resource management practices and local land users' perceptions, for the purpose of developing alternative management practices; and (ii) to initiate national interdisciplinary activities addressing the problems of land users in the drier areas. National institution building remains an important objective of these activities.

Four of these case studies focused on 'desert margin' situations. In southern Tunisia, a locally-based team studied agricultural resource utilization in relation to farming and social systems along a transect through a dry (about 150 mm annual rainfall) but relatively densely populated area, down from the Matmata mountains to the Jeffara plain. Across the national border, a Libyan team compared systems of land use at the other end of the Jeffara plain, again under low-rainfall conditions. In Jordan, the vegetation conditions, management practices and user perspectives were studied along a transect covering five different types of land management in an area of dry rangeland in the south of the country. And in Lebanon, one of two villages, studied by a team from the American University of Beirut, practices a fruit tree -livestock farming system amid dry mountain slopes (200 mm) on the steppe fringes.

This largely analytical phase ended with a major workshop at ICARDA in 1993, at which each national team reported its findings and proposals for future action. It was agreed that the next stage is to initiate practical interventions, technical and/or institutional, with the resource users and to monitor their technical effectiveness and their social and economic acceptability. So far, donor support is provisionally agreed for this new phase of work in Lebanon, and a draft proposal has been developed by Tunisia. Funding from the Ford Foundation is expected to support a network coordinator to maintain liaison between the original six DRMP teams and their work and to initiate new studies of the same kind in other areas.

Water Harvesting Project, Jordan

In a collaborative project with the Universities of Jordan, Concordia (Canada) and Moncton (Canada), work has recently been started to develop an integrated pack-

age for optimizing strategies for water harvesting, storage and utilization in the arid and semi-arid lands of Jordan. Within a 70 sq km catchment (mean rainfall < 200 mm), climate, topography, soil, hydrology, agricultural practices and management parameters are being quantified and the data integrated in a GIS system. Field measurements will be made of surface flows and of agricultural productivity achieved by different modes of water collection, storage and utilization. The eventual aim is a model able to indicate the optimum pattern of land utilization for other low-rainfall areas of Jordan (and elsewhere) from basic sets of land and climate data.

Water Harvesting Project, Syria

Within the IDRC-funded 'Integrated Watershed Development' Project of the Syrian Ministry of Agriculture and Agrarian Reform, ICARDA will be responsible for documenting and integrating the "knowledge perspectives and aspirations" of the current users (Bedouins) of the two rangeland (< 200 mm) watersheds concerned, with the objectives to: (i) understand current constraints to rangeland utilization and what might constitute attractive improvements; (ii) detail past and present range management practices of current users; (iii) analyze those users' reactions to the improvements proposed and under test within the development project; and (iv) recommend mechanisms and approaches for the future management of the watersheds (catchments) by the user populations.

Nile Valley Regional Program (Phase II Proposals for Egypt)

In the next phase of this project (starting 1994), Egyptian scientists with ICARDA backing will undertake major programs of work in 'desert margin' areas. Under low-rainfall conditions, in northern Sinai (120-300 mm) and the north-west coast (100-150 mm), research will seek to identify the appropriate crop rotations, soil management, and inputs required to establish economic and sustainable rainfed cereal-based cropping systems in flat, wind-vulnerable fields, newly ploughed from dry rangeland and desert.

In this environment, animals (resident and/or transhumant) seem likely to prove an important component, particularly having a role in the build-up and recycling of the fertility of arable fields.

Genetic Diversity in Barley

ICARDA is firmly convinced that reliance on a few genotypes to obtain massive increases in production is not sustainable in the long-term. Taking the lead with barley improvement, the Center has developed a new, decentralized genetic improvement system to assure production increases based on maintenance and deployment of biodiversity.

Barley cultivation for livestock feed together with overgrazing are the principal causes of desertification and thus are the main constraints to steppe rehabilitation. The barley breeding program at ICARDA addresses the issues of sustainability and genetic diversity by integrating the following three concepts:

1. **Decentralized breeding**. In the traditional approach of germplasm distribution to National Agricultural Resource Services (NARS), followed by international breeding programs, the same group of a relatively small number of genetically fixed or nearly-fixed lines tested for a number of cycles (usually between four and six) are distributed to a number of NARS. Because the number of lines is small, there is a high probability that the same line is selected by several NARS leading to the development and release of one or few varieties, often closely related, grown over large areas. In addition to the displacement of local germplasm, the system tends to eliminate genetic material adapted to specific environments in the early generations. In decentralized breeding, lines not previously selected for yield and therefore widely different and segregating populations are selected directly by the NARS in the environmental conditions of their countries. The advantages are: (a) a direct involvement of NARS in selection rather than just in testing what someone else has selected for them, and (b) an increased probability to exploit specific adaptation. In the long term, this leads to a greater biodiversity spectrum of varieties within a given geographical area than by breeding for widely adapted varieties.

   ICARDA has developed this approach in four North African countries, and is in the process of preparing the genetic material to start the same approach in Iraq, Yemen, Pakistan and Afghanistan
2. **Use of landraces**. Classical plant breeding regards landraces at worst as genetically useless material only good for gene banks or, at best, as potential donors of (few) interesting genes. We regard landraces as an invaluable source of specific adaptation to difficult environments where they have sustained mankind for several thousand years. This adaptation makes landraces the ideal germplasm to use in a breeding programme that aims at adapting crops to their environment, rather than to change the environment to fit the crop. Landraces are therefore used as recipients rather than donors of genes that can improve some specific characteristics without disrupting their adaptation. The utilization of landraces in a breeding programme is conceptually related to decentralized breeding because it exploits specific adaptation, and therefore it maintains genetic diversity within a crop in the given space. Utilization of landraces in breeding programmes also preserves genetic diversity over time because their genetic heterogeneity is, on the one hand, a source of genetic variability to exploit, and, on the other hand, a lesson to the

breeder that genetically uniform cultivars may not be the best solution for difficult, variable and unpredictable environments. Eventually, the use of landraces in breeding programmes is one efficient way to preserve genetic resources within a country.

3. **Breeding for low-input conditions.** One common assumption of classical breeding is that under climatically and agronomically adverse conditions, farmers have to improve their agronomy before even considering the potential of breeding. This assumption ignores that it is the risk of farming under unfavorable conditions that prevents farmers from using improved agronomy, and not their lack of knowledge. It is based on the belief that no genetic progress can be made under unfavorable conditions. In our breeding programme for these conditions we have challenged both the assumption and the belief. By selecting and testing without using inputs of any type we found consistent and repeatable differences, often associated with the specific adaptation to adverse conditions found in landraces. This shows that it is possible to increase yield without altering the environment to an unsustainable extent, although yield increases are far from being spectacular.

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 UN Conference on Environment and Development (UNCED), Rio de Janeiro, Brazil, in June 1992.*

UNEP

Desertification Control Bulletin

United Nations Environment Programme