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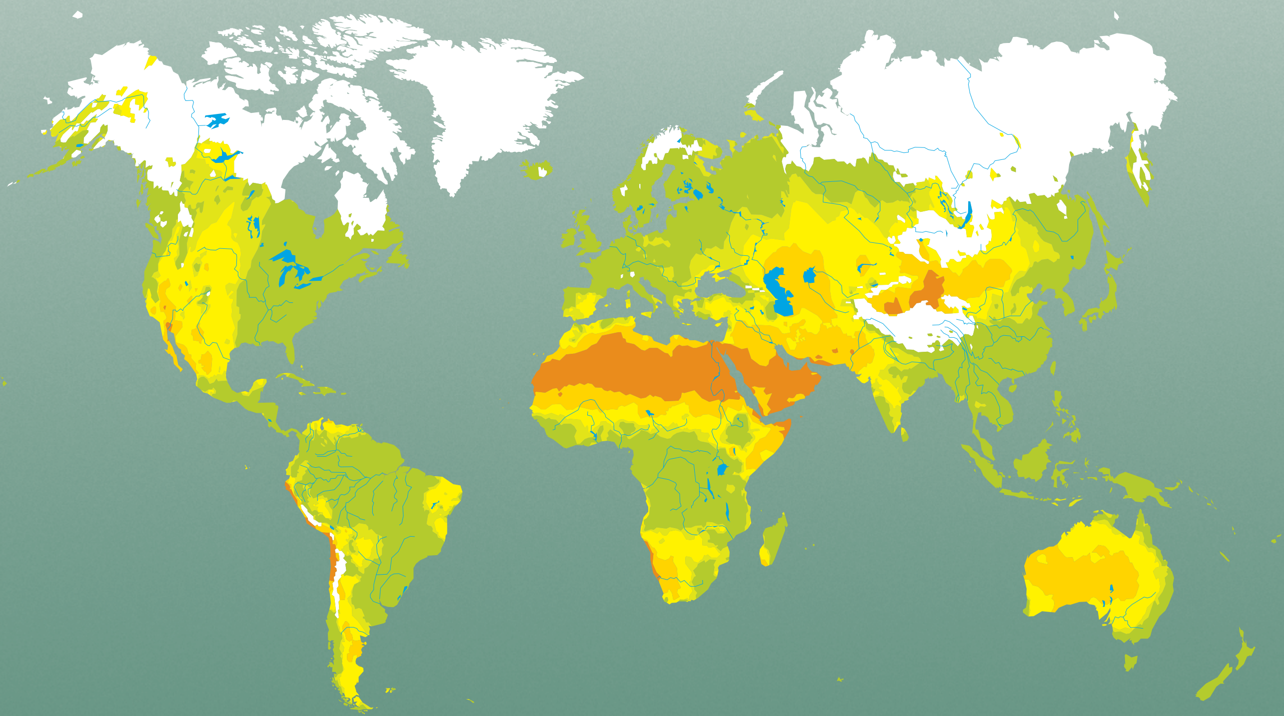
EARLY WARNING SYSTEMS



The United Nations Convention to Combat Desertification (UNCCD) Ad Hoc Panel

Committee on Science and Technology (CST)

First published March 2003

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EARLY WARNING SYSTEMS
BY
UNCCD AD HOC PANELS

31 May - 3 June 2000, Königswinter, Bonn, Germany
4 - 8 June 2001, Fuji Yoshida, Yamanashi, Japan

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INTRODUCTION

The Conference of the Parties by its decision 14/COP.5 requested the Secretariat of the Convention to seek the necessary resources to publish and distribute in a suitable form, as widely as possible, the report together with the background papers reviewed by the reappointed ad hoc panel on early warning systems.

The Terms of Reference of the two ad hoc panels has been defined by decision 14/COP.3 and 14/COP.4.

This booklet represents the reprints of the report of the ad hoc Panel on Early Warning Systems to the Conference of Parties, COP.4 and COP.5. These documents are available in all six United Nations languages on our website http://www.unccd.int.

We are confident that this document will be useful to all those who are in one way or another involved in early warning systems in those countries which are severely affected by drought and desertification.

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Decision 14/COP.3

Early warning systems

The Conference of the Parties,

Recalling decision 12/COP.2 on the work programme of the Committee on Science and Technology,

Having reviewed the contributions of Parties received by the secretariat on early warning systems1/,

Taking note of the reports prepared by the secretariat for the third session of the Committee on Science and Technology on early warning systems,

Taking note also of the existence of networks of early warning systems and desertification monitoring and assessment at the national, subregional and regionallevels,

1. Decides to appoint an ad hoc panel composed of 10 experts with the following terms of reference: relating to early warning systems, to review and elaborate on the following technical topics emerging from national reports of Parties and regional forums on implementation of the Convention:

(a) Data collection, accessibility and integration;

(b) Evaluation and prediction of drought and desertification, and measures for preparedness, in cooperation with the follow-up to the International Decade for Natural Disaster Reduction;

(c) Dissemination of information to end-users on the applications of early warning systems and desertification monitoring and assessment, and strengthening of appropriate response mechanisms, particularly in the national action programmes to combat desertification;

2. Invites the relevant institutions which have operational responsibilities in areas related to desertification and drought and information systems drawn from each thematic programme network in various regions to provide experts and/or reference materials in order to support the ad hoc panel;

3. Requests the secretariat to make the necessary arrangements to facilitate the functioning of this ad hoc panel.

11th plenary
25 November 1999

1/ ICCD/COP(3)/CST/6.

THE REPORT OF THE AD HOC PANEL ON EARLY WARNING SYSTEMS

Meeting held 31 May - 3 June 2000, Königswinter, Bonn, Germany

I. INTRODUCTION

1. By decision 14/COP.3, the Conference of the Parties of UNCCD appointed an ad hoc panel of 10 experts "to review and elaborate on the following technical topics emerging from national reports of Parties and regional forums on implementation of the Convention:

(a) Data collection, accessibility, and integration;

(b) Evaluation and prediction of drought and desertification, and measures for preparedness, in cooperation with the follow-up to the International Decade for Natural Disaster Reduction;

(c) Dissemination of information to end-users on the applications of early warning systems and desertification monitoring and assessment, and strengthening of appropriate response mechanisms, particularly in the national action programmes to combat desertification."

2. The ad hoc Panel convened in Bonn, Germany, from 31 May to 3 June 2000. The ad hoc Panel members who attended are listed in annex I. The Panel selected the following officers:

Chair:	Dr. Kazuhiko Takeuchi (Japan)
Vice-Chair:	Mr. Abdellah Ghebalou (Algeria)
Vice-Chair and Secretary:	
	Dr. Anneke Trux (Germany)
Vice-Secretaries:	Dr. Patricio Aceituno (Chile)
	Dr. Ali Umran Komuscu (Turkey)

3. In accordance with decision 14/COP.3, experts from relevant technicalinstitutions with operational responsibilities in desertification and drought information systems also participated in the meeting (see annex I).

4. The participants reviewed the background documents, including reports provided by Panel members and experts (see annex II).

5. Based on those documents, the participants developed a common understanding of the terms of reference and engaged in a substantive discussion.

6. The discussions responded to article 16 of UNCCD, which states that "The Parties agree, according to their respective capabilities, to integrate and coordinate the collection, analysis and exchange of relevant short-term and long-term data and information to ensure systematic observation of land degradation in affected areas and to understand better and assess the processes and effects of drought and desertification. This would help accomplish, inter alia, early warning and advance planning for periods of adverse climatic variations in a form suited for practical applications by users at all levels, including local populations."

7. Recognizing the importance of building on existing operational early warning systems within the framework of National Action Programmes to Combat Desertification (NAP), the participants reviewed and elaborated the three technical topics defined in decision 14/COP.3 and agreed to the conclusions covered in the following sections.

II. DATA COLLECTION, ACCESSIBILITY AND INTEGRATION

The participants recognize that data collection, access, and integration are the responsibilities of Governments at the national level. National Action Programmes should address these data responsibilities and define clear objectives for data collection, access and integration of programmes as well as the need for better data access.

Data collection

• It is far more important to maintain and strengthen existing observation networks than to expand or create new systems. Hydrological and meteorological networks in many desertification-affected countries, especially in the developing regions are falling into disrepair. The Panel recommends that Parties provide adequate support to maintain existing observation networks.

• Early warning systems should capitalize on the techniques and methods developed already by researchers and operational programmes and operationalize them as soon as possible.

• The participants underlined the need for data reliability. Metadata, which fully describes the details of data format, sources and calculation, should accompany every database. Organizations involved in data collection must pay attention to standardization and compatibility in data content and format and compatibility among scales of analyses, from local to subnational, national, subregional, regional, and global levels.

• Where appropriate, the local population should be actively involved in the data collection process and efforts must be made to ensure that useful information is conveyed back to them.

• Given the extend of the drought and desertification problem, data collection should span a range of spatial and temporal scales and should serve longterm planning.

• Some indicators are common to both drought early warning systems and desertification information systems.

Data accessibility

The participants recognized the following constraints:

• Inadequate infrastructure

• High costs in cases when data are treated as commercial property

• Political restrictions, e.g. national security

• Lack of protocols for data exchange between institutions In order to improve data accessibility, the Panel recommends the following:

• Easy and unlimited public access to databases is a prerequisite for effective early warning systems: However, the issue of data sovereignty must be taken into account in facilitating universal access to the differentactors involved

• Define appropriate distribution and pricing policies in order to have the easiest and most cost-effective access to data and information for the different categories of users

• Take advantage of the recent development of technical tools especially in telecommunication in order to facilitate decentralized data management and access.

Data integration

• The participants recognize the development in the use of such tools as geographical information systems (GIS) for faster and more efficient integration of data from different sources. Attention should be paid to developing capacities at national, subregional and regional levels to take advantage of such tools and techniques.

• The Panel invites the Parties to encourage donors who are in a position to provide assistance to support such capacity-building activities in developing countries.

• Early warning systems operate through a multi-disciplinary approach. Therefore, partnerships between different disciplines that strengthen cooperation and transparency will advance the work of early warning systems.

III. EVALUATION AND PREDICTION OF DROUGHT AND DESERTIFICATION, AND MEASURES FOR PREPAREDNESS, IN COOPERATION WITH THE FOLLOW-UP TO THE INTERNATIONAL DECADE FOR NATURAL DISASTER REDUCTION

For its deliberations, the participants recall the definitions in Article 1 of the Convention of "desertification," "drought," "combating deserti-fication", and "mitigating the effects of drought".

The Panel and the experts also examined early warning systems in the light of the approach adopted by the International Strategy for Disaster Reduction (ISDR). This approach proceeds from hazard protection to risk management through four stages: public awareness, commitment from community leaders and public authorities, implementation of measures to enhance the resilience of communities to disaster, and the mitigation of social and economic losses.

General comments

• Early warning for drought prediction and assessment, and monitoring and assessment for desertification are fundamentally interrelated yet operationally different activities. Currently no operational early warning system exists for desertification.

• In the short-term, early warning systems for drought prediction and assessment provide information for contingency response planning. Desertification monitoring and assessment will provide information in the long-term to improve systems of community-based natural resource management and institutional capacities.

• Desertification monitoring systems should be built in connection with the operational drought early warning systems.

• Early warning systems for drought and desertification monitoring systems must examine the full range of biological, physical, climatic, social and economic factors involved in desertification.

• In the interest of sustainability, operating costs of early warning systems must be taken into account. The profitability of early warning systems is related to their utilization. Assessment of drought

• Drought is a natural hazard originating from a deficiency of precipitation that results in a water shortage for some activities or some groups. Lack of precipitation occurring over an extended period of time, usually a season or more in length, is often associated with other climatic factors (such as high temperatures, high winds and low relative humidity) and can aggravate the severity of the event. From a hydrological viewpoint, extended shortage of rainfall forces a corresponding flow variability in dryland rivers, and consequently in runoff and in soil moisture. The latter, of critical importance to crop productivity, is affected not only by the amount and seasonal incidence of rainfall, but also by the ability of soils to absorb and store water and by moisture losses through evapotranspiration.

• For effective assessment of drought, systematic observation, collection, analysis and exchange of meteorological, climatological and hydrological data and information are necessary. National Meteorological and Hydrological Services (NMHSs) are actively involved in these activities and in the development of relevant techniques for the assessment of drought. The Panel emphasized the importance of enhancing national climatological, meteorological and hydrological capabilities for timely assessment of drought and its dissemination of information as enshrined in article 10 of the UNCCD.

• It is important to remember that drought severity is dependent not only on the duration, intensity and geographical extent of precipitation deficiency, but also on the demands made by human activities and vegetation on region's water supplies. Drought assessment efforts must take into account the influence of these factors.

• Drought assessment can use climate, hydrological, physical, biological and socio-economic indicators. These indicators can be used alone or in combination and sometimes two or more indicators can be combined to form derived indices. Meteorologists and climatologists have made considerable progress in drought assessment and have developed a number of indices. There are a number of indices in use for drought assessment and these provide specific information on a range of issues related to drought assessment.

Prediction of drought

The socio-economic upheavals that have occurred, especially in Africa, over the past few decades due to drought, have underlined the urgent need to predict interannual climatic variations for drought, prediction still heavily relies on the monitoring of observed patterns of monthly and seasonal rainfall, streamflows, groundwater levels, snowpack and other parameters. Developing predictive skills for large geographical regions on monthly and seasonal timescales (e.g. physically and statistically based Global Circulation Models (GCMs), offers promise for increasingly useful forecasts of the onset, severity and duration of drought.

Climate variability brings lower precipitation in some areas and higher precipitation in others. CLIVAR, a research programme on climate variability and prediction for the 21 century, in the framework of the World Climate st Research Programme and the advances made in the use of the predictive properties of Sea Surface Temperature (SST) and ocean-atmosphere coupling processes have led to improvements in drought prediction. For example, a strong coherence of climate anomalies in the Asia and Pacific region is associated with El Niño – Southern Oscillation (ENSO) phenomenon; this is the basis for current prediction on seasonal time scales. Practicable, usable seasonal and inter-annual forecasts of precipitation in areas with a strong ENSO signal are becoming more reliable and can be made with longer lead times. Significant advances have been made in the past three years through the organization of climate outlook forums in different regions of the world under the auspices of the Climate Prediction and Information Services (CLIPS) of the World Meteorological Organization (WMO) in issuing climate forecasts. Drought related forecasts were issued during the 1997-1998 El Niño event and were stated in terms of probability of below average, average or above average precipitation. Some meteorological services have developed a drought watch service, utilizing real-time hydrological and meteorological data.

The Panel highlights that augmenting the growing capability to provide seasonal and inter-annual climate forecasts is essential to combat the effects of drought in diverse regions of the world. Data from meteorological satellites are being used for prediction of rainfall and remotely sensed data from geostationary satellites and polar orbiting satellite are being used as input data for seasonal rainfall prediction. Early warning systems currently provide maps of the location of socio-economic groups vulnerable to drought and organizations involved in drought mitigation urgently need this information for quick action.

Assessment of desertification

Assessment of desertification depends on the availability of physical, biological, social and economic information from different sources. The most useful parameters, among others, are climate, land-use and cover change, vegetative productivity, soil productivity, land management practices, demographic factors as well as institutional parameters.

The Overall Assessment of Desertification (OAD) proposed by the UNCCD secretariat will provide information on trends of degradation of natural resources, specifically water, vegetation and soils as well as the main socioeconomic and driving factors on a global scale. National, subregional and regional desertification assessments should provide data on a smaller scale.

The Panel concludes that it is essential to concentrate assessment on the elements that can eventually be influenced. Identification of populations at risk and conducting desertification assessment in the context of sustainable development is crucial to programmes that are beneficial to local communities.

Prediction of desertification

• Desertification is difficult to predict because of the complexity of the interaction of the multiple driving forces and its long-term nature. Therefore the Panel suggests using "monitoring" rather than "prediction" where desertification is concerned.

• At least two types of analysis that currently help assess desertification vulnerability are current vulnerability analyses produced by operational drought early warning systems and global desertification assessments.

• One key end product of desertification monitoring systems will be the spatial identification of populations at risk to promote timely appropriate action.

Measures for drought preparedness

Provision of information for preparedness is an integral part of an early warning system and should be designed to help each population at risk to effectively prepare for risks and hazards.

The information on measures for preparedness must take into account a range of coping strategies of the population at risk as well as their perception of risks and the costs to them, particularly in proportion to the expected benefits.

Public information and education about the risk of drought and desertification also improve the acceptance of the information concerning preparedness by strengthening people's capability to understand and interpret the information on risks.

Long-term adaptation involves the development of community based natural resources management plans, developed and implemented through a participatory approach, and making full use of traditional knowledge.

Recommendations

• Use the proposed UNCCD Overall Assessment of Desertification (OAD) as a baseline for monitoring at the global level.

• Establish National desertification information systems and include country profiles on desertification.

• Operational drought early warning systems should incorporate desertification monitoring into their activities and integrate systems to address both drought and desertification rather than establishing separate systems.

• Establish benchmarks and monitor indicators of desertification over time and strengthen institutional arrangements at all levels in accordance with the methodology developed by the ad hoc panel on benchmarks and indicators and contained in ICCD/COP(3)/CST/3/Add.1, and produce maps of vulnerability to desertification.

• Integrate early warning results with the results of other climate prediction systems such as the Climate Information and Prediction Services (CLIPS) and the Climate Variability Programme (CLIVAR).

• Encourage the further development and application of seasonal climate forecasting and long-range forecasting as tools for early warning systems.

• Establish institutional arrangements that improve coordination at the local, subnational, national, subregional, regional and global levels.

4. DISSEMINATION OF INFORMATION TO END-USERS ON THE APPLICATIONS OFEARLY WARNING SYSTEMS AND DESERTIFICATION MONITORING AND ASSESSMENT, AND STRENGTHENING OF APPROPRIATE RESPONSE MECHANISMS, PARTICULARLY IN THE NATIONAL ACTION PROGRAMMES TO COMBAT DESERTIFICATION

A. Dissemination of information

Methods and means

• The methods for information dissemination for drought and desertification may differ both between and within countries depending on the user and levels of development. Methods and means include the following:

- Local satellite receivers located at village level to provide one wa video and two way audio communication
- Digital radio with printing capabilities
- Internet
- Workshops, farmers meetings and village meetings
- Extension programmes
- Knowledge centres
- Traditional methods of information dissemination such as cultural events and religious meetings

• The type of information to be disseminated needs to be well defined. It is also important to ensure that the information be conveyed to communities rather than to individuals. The information also needs to be relayed with proposals for action to local communities.

• Vulnerability analysis provides an effective tool to disseminate information contained in early warning systems

• Vulnerability analysis combines historical series of bio-physical and socio-economic data

• For desertification carrying capacity analysis can indicate populations at risk

• Vulnerability mapping assists in priority setting in natural resources management policies in time and space

• Integration of vulnerability assessments at various spatial and temporal scales can assist in rational distribution of scarce resources.

Guiding principles

• The guiding principles for information dissemination include the following:

- Use of local languages
- Set priorities in information and response
- Adapt scale of information to users
- Monitor the impact of information
- Let users define information needs and adapt time, place and means of communication to local use
- Relate drought warning information to support options for the populations concerned.

B. Strengthening of appropriate response mechanisms within NAPs

• NAPs need to identify key decision-making authorities at national and local level for issuing warning and coordinating response.

• The information must be streamlined and the information flow needs to be both vertical and horizontal. It is always important to target high-risk areas that are more prone to desertification. Telecommunication infrastructure also needs to be in place particularly in high-risk areas.

• Response to desertification and drought will be different. It is necessary to look at the response at the three levels listed below. It is important to stress that response mechanisms must be able to meet the needs of the local populations, so as to enable them to use the information effectively.

• Response mechanisms to drought
  - Short-term response measures have embedded crisis management elements such as water and food and supply
  - Medium- and long-term gradual and broadening mechanisms cited below for desertification also serve as medium- and long-term mechanisms for the mitigation of the effects of drought
  - Utilize existing tools of other early warning systems and test them at local level

• Response mechanisms to desertification
  - short term response measure are mostly technical measures
  - gradual response mechanisms: change of behaviour, production patterns, agricultural systems and consumption patterns at local level
  - Broader measures: overall sustainable development strategies, change of agricultural policies,
  - Utilize tools existing in other early warning systems and test them at local level

• Response mechanisms to both drought and desertification
  - at local, subnational, national, subregional, regional and global levels
  - defining which response has to come from which

level
- non-governmental organizations, with assistance from the Government, have responsibility at the local level
- Assess land capability criteria: soil, slope, micro-climate etc.

Implementation of the response measures within NAP

• Include responses in the NAPs

• Establish multidisciplinary national expert networks for drought early warning systems and monitoring and assessment of desertification

• Promote structured international exchanges on drought early warning systems and the monitoring and assessment of desertification

Concluding recommendations

Concluding, the Panel makes the observation that further work is needed in order to elaborate on pending questions on early warning systems and monitoring and assessment of desertification. Whereas ISDR already is in charge of an ad hoc group for disaster reduction including drought as a natural disaster, there is not such a platform regarding the monitoring and assessment of desertification.

With regard to the pending questions:

• Critical analysis of the performance of early warning and monitoring, and assessment systems;

• Open questions on methods and approaches for the prediction of drought and monitoring desertification;

• Mechanisms to facilitate exchange between scientific and technical institutions

• More detailed measures for drought preparedness

The Panel recommends to the COP to reappoint the present Panel on drought early warning systems and monitoring and assessment of desertification to keep the actual members in order to assure continuity and to ask the Panel to elaborate in depth on the above-mentioned questions.

Annex I

PARTICIPANTS TO THE AD HOC PANEL MEETING ON EARLY WARNING SYSTEMS

MEMBERS OF THE AD HOC PANEL ON EARLY WARNING SYSTEMS

Mr. Patricio Aceituno	Chile
Mr. Abdellah Ghebalou	Algeria
Dr. Ali Umran Komuscu	Turkey
Mr. Zengyuan Li	China
Mr. Richard Muyungi	United Republic of Tanzania
Mr. Octavio Perez Pardo	Argentina
Dr. Valentin Sofroni	Republic of Moldova
Dr. Kazuhiko Takeuchi	Japan
Dr. Anneke Trux	Germany

Consultant

Dr. Ajai	Department of Space, Space Applications, ISSRO, India

Experts of relevant institutions

Mr. Alhassane Adama Diallo	Centre Regional AGRHYMET, Niger
Mr. Andrea de Vecchia	Centro Studi per l'applicazione dell'Informatica in Agricultura (CeSIA), Italy
Dr. Patrick Gonzalez	United States Agency for International Development (USAID), United States of America
Mr. Richard Masundire	Southern African Development Community (SADC), Zimbabwe
Mr. Haruo Miyata	Global Environmental Forum, Japan
Mr. Mauro Pedalino	Ministry of Foreign Affairs, Italy
Dr. M.V.K. Sivakumar	World Meteorological Organization (WMO), Switzerland
Mr. Papa Boubacar	Soumare Centre de Suivi Ecologique (CSE), Senegal

Annex II

DOCUMENTS SUBMITTED TO THE AD HOC PANEL ON EARLY WARNING SYSTEMS

Background documents

1. Decision 14/COP.3 (Early Warning Systems)

2. Document ICCD/COP(3)/CST/6 (Early Warning Systems: existing experiences of Early Warning Systems and specialized institutions operating in this field)

3. Document ICCD/COP(3)/CRP.1 (Early Warning Systems and Desertification: report of the workshop held in Niamey, Niger, from 25 to 28 October 1999)

4. Document ICCD/COP(3)/CRP.2 (Asia-Africa technical workshop on Early Warning Systems: report of the workshop held in Beijing, China, from 22 to 23 July 1999)

5. Early Warning Systems and Desertification. Paper presented to the workshop held in Niamey, Niger, from 25 to 28 October 1999. CeSIA, Florence, Italy.

6. Early Warning Systems in the context of Drought and Desertification. A background working paper for the UNCCD Ad Hoc Panel of Experts' Meeting to be held in May, 2000. Ajai, ISRO, Ahmedabad, India.

Conference room documents

1. Comments on the background paper to be discussed at the UNCCD ad hoc Panel Meeting on Early Warning Systems. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

2. Desertification Status and Trends in China. Zengyuan Li, Institute of Forest Resources Information Technique, Chinese Academy of Forestry.

3. Early Warning Systems in the Context of the UNCCD. Haruo Miyata, Committee for Research on Combating Desertification and Land Degradation in Asia and Africa, Global Environmental Forum.

4. Overall Assessment of Desertification (OAD). Background document aiming to support discussions to be held at an expert consultation on the OAD, foreseen to be held end 1999, at the UNCCD secretariat headquarters. FAO, Rome, Italy.

5. Preliminary plan for monitoring the impacts of desertification and climate change. Famine Early Warning System Network (FEWS NET), United States Agency for International Development (USAID). Patrick Gonzalez, USAID, Washington, D.C., 29 May 2000.

6. Report on National and Local Capabilities for Early Warning. Andrew Maskrey, first author, Convener of International Working Group, Member of the IDNDR Scientific and Technical Committee, and General Coordinator of LA RED (Network for Social Studies on Disaster Prevention in Latin America). IDNDR Secretariat, Geneva, Switzerland, October 1997.

7. UNCCD ad hoc Panel on Early Warning Systems. Andrea Di Vecchia, CeSIAAccademia dei Georgofili, Florence, Italy.

8. Views on early warning systems. Prof. Takashi Kosaki, Kyoto University and Prof. Masato Shinoda, Tokyo Metropolitan University. Excerpts from the Report on the study for promotion of the measures to combat desertification, FY 1999. Edited and published by the Global Environmental Forum of Japan for the Environment Agency, Japan, March 2000.

Annex III

AGENDA OF THE AD HOC PANEL MEETING ON EARLY WARNING SYSTEMS

Wednesday, 31 May 2000

0930 – 1000	Registration
1000 – 1030	Welcoming statement by Representatives of the Arbeitnehmer-Zentrum Königswinter (AZK), Dr. Eberhard Pies, Director and Ms. Mary Nisa Punnamparambil, Education & Training Officer
1030 – 1100	Remarks by the Representative of CCD Secretariat
1100 – 1130	Appointment of the Chairman of AHP/EWS, of topic Chairs and Rapporteurs
1130 – 1200	Statement by the Chairman of AHP/EWS

Topic 1:
Data collection, accessibility and integration

1400 – 1430	Presentation of Topic 1
1430 – 1615	Discussion of Topic 1
1630 – 1730	Discussion of Topic 1

Thursday, 1 June 2000

0900 – 1045	Conclusion of Topic 1

Topic 2:
Evaluation and prediction of drought and desertification, and measures for preparedness, in co-operation with the follow-up to the International Decade for Natural Disaster Reduction

1100 – 1130	Presentation of Topic 2
1130 – 1230	Discussion of Topic 2
1430 – 1615	Discussion of Topic 2
1630 – 1730	Conclusion of Topic 2

Friday, 2 June 2000
Topic 3:
Dissemination of information to end users on the applications of early warning systems and desertification monitoring and assessment, and strengthening of appropriate response mechanisms, particularly in the National Action Programmes to combat desertification

0900 – 0930	Presentation of Topic 3
0930 – 1045	Discussion of Topic 3
1100 – 1230	Discussion of Topic 3
1430 – 1615	Conclusion of Topic 3
1630 – 1800	Discussion on the conclusions and recommendations of the AHP/EWS

Saturday, 3 June 2000

0930 – 1230	Drafting of report by the Rapporteurs of AHP/EWS
1430 – 1830	Adoption of the report
1830 – 1900	Closing Ceremony

Decision 14/COP.4

Early warning systems

The Conference of the Parties,

Recalling decision 14/COP.3 to appoint an ad hoc panel on early warning systems,

Recalling also the follow-up to the International Decade for Natural Disaster Reduction,

Taking note of the report of the ad hoc panel on Early Warning Systems1/, and the recommendations of the Bureau of the Committee on Science and Technology on this subject2/,

Taking note also of the existence of networks of early warning systems and desertification monitoring and assessment at the national, subregional and regional levels,

1. Re-appoints an ad hoc panel on early warning systems to be composed of 10 experts in order to examine further the following:

(a) Critical analysis of the performance of early warning and monitoring and assessment systems, linking traditional knowledge and early warning systems, especially in the areas of the collection of data, dissemination of information and measuring for drought preparedness;

(b) Methods for and approaches to the prediction of drought and monitoring of desertification, particularly the method of analysing vulnerability to drought and desertification, especially at the local, subnational and national levels, with special regard to new technological developments;

(c) Mechanisms to facilitate an exchange of information between scientific and technological institutions, in particular focusing on national and subregional networks on the prediction of drought and monitoring of desertification;

(d) More detailed measures for drought and desertification preparedness, in cooperation with the approaches, from hazard protection to risk management, adopted by the International Strategy for Disaster Reduction;

2. Requests the secretariat to make the necessary arrangements for the functioning of the ad hoc panel, including the provision of additional expertise,particularly in the area of participatory planning and legal advice.

12th Plenary
22 December 2000

1/ ICCD/COP (4)/ CST/4
2/ ICCD/COP(4)/ IN

THE REPORT OF THE AD HOC PANEL ON EARLY WARNING SYSTEMS

Meeting held 4 - 8 June 2001, Fuji Yoshida, Yamanashi, Japan

I. INTRODUCTION

1. By decision 14/COP.4, the UNCCD Conference of the Parties reappointed an ad hoc panel of 10 experts "to examine further the following:

(a) Critical analysis of the performance of early warning and monitoring and assessment systems, linking traditional knowledge and early warning systems, especially in the areas of the collection of data, dissemination of information and measuring for drought preparedness;

(b) Methods for and approaches to the prediction of drought and monitoring of desertification, particularly the method of analyzing vulnerability to drought and desertification, especially at the local, subnational and national levels, with special regard to new technological developments;

(c) Mechanisms to facilitate an exchange of information between scientific and technological institutions, in particular focusing on national and subregional networks on the prediction of drought and monitoring of desertification;

(d) More detailed measures for drought and desertification preparedness, in cooperation with the approaches, from hazard protection to risk management, adopted by the International Strategy for Disaster Reduction."

2. By the same decision, the UNCCD secretariat was requested to make the necessary arrangements for the functioning of the ad hoc panel, including the provision of additional expertise, particularly in the area of participatory planning and legal advice.

3. The ad hoc panel was convened from 4 to 8 June 2001 at the Yamanashi Institute for Environmental Sciences in Fuji Yoshida City, Yamanashi Prefecture, Japan. The meeting was co-sponsored by the Government of Japan, in collaboration with the Yamanashi Prefecture. Annex I lists the ad hoc panel members who attended. The panel retained officers selected at the first panel meeting in Bonn, from 31 May to 3 June 2000:

Chair:	Dr. Kazuhiko Takeuchi (Japan)
Vice-Chair:	Mr. Abdellah Ghebalou (Algeria)
Vice-Chair and Secretary:	Dr. Anneke Trux (Germany)
Vice-Secretary:	Dr. Ali Umran Komuscu (Turkey)

4. In accordance with decision 14/COP.4, the secretariat invited additional experts, also listed in annex I, from relevant technical institutions with operational responsibilities in desertification and drought information systems. At the request of the Chair of the panel, additional experts were also invited.

5. The participants reviewed the background documents, including reports provided by Panel members and experts (annex II). Based on these documents, the participants engaged in a substantive discussion. The agenda for the meeting can be found in annex III.

6. The discussions responded to UNCCD Article 16, which states, "The Parties agree, according to their respective capabilities, to integrate and coordinate the collection, analysis and exchange of relevant short-term and long-term data and information to ensure systematic observation of land degradation in affected areas and to understand better and assess the processes and effects of drought and desertification. This would help to accomplish, inter alia, early warning and advance planning for periods of adverse climatic variations in a form suited for practical applications by users at all levels, including local populations."

7. Recognizing the importance of building on existing operational early warning systems within the framework of national action programmes (NAPs) to combat desertification and drought, the participants reviewed and elaborated the four technical topics defined in decision 14/COP.4 and agreed to the conclusions covered in the following sections.

II. CRITICAL ANALYSIS OF THE PER-FORMANCE OF EARLY WARNING AND MONITORING AND ASSESSMENT SYSTEMS, LINKING TRADITIONAL KNOWLEDGE AND EARLY WARNING SYSTEMS, ESPECIALLY IN THE AREAS OF THE COLLECTION OF DATA, DISSEMINATION OF INFORMATION AND MEASURING FOR DROUGHT PREPAREDNESS

Early warning systems (EWSs) for drought and food security have been operational for over 20 years; yet in some instances, famine still occurs and food security is not increasing. This is in spite of the fact that some systems have been improved so that they address not only famine but also food security. This may be an indication of some weaknesses in the current EWS information or institutional arrangements.

The panel noted several positive developments, including:

- Conceptual frameworks of EWSs;
- Improvements in data collection and analysis using remote sensing and Geographical Information System (GIS), in addition to conventional methods;
- Trained personnel.

However, major problems continue to retard the effectiveness of some of these systems, including:

- Weak institutional arrangements;
- Lack of trust/credibility among stakeholders;
- Poor communication networks;
- Lack of coordination among stakeholders;
- Untimely release of EW results;
- Use of information for political and economical reasons, or selfish ends;
- An unsupportive political environment.

Notwithstanding these problems, some successful systems exist. Even if successful, most EWSs stop at famine and do not provide protection from future famine incidents.

The participants saw the existing early warning and monitoring and assessment systems converging into a complementary framework in the future, thereby using the same institutional arrangements, similar datasets and indicators. This will improve their performance and cost-effectiveness. Thus, the conceptual and operational issues differentiating drought EWSs and desertification monitoring and assessments were revisited by the panel. The participants agreed that future effective performance and possibly combined operational frameworks may depend on the following:

1. Conceptually disentangling the complex relations between EWSs for drought and food security and monitoring and assessment of desertification

Early warning for drought prediction and assessment, and monitoring and assessment for desertification, are fundamentally interrelated yet operationally different activities. Parameters and methodologies applied for early warning of drought fall short of what would be required to realize a system for monitoring and assessment of desertification. Desertification is a phenomenon which is slow to develop. In this respect, the main areas requiring consideration, adjustment and inclusion are temporal scales and an enlargement of information on conditions.

There is a need to go beyond "state of the art" assessment and monitoring of desertification, to include vulnerability and risk assessment, using current and past data and information on the status of desertification. Such data would be derived from monitoring programmes for drought and desertification. Such a series of measurements are conducted with a view to providing a warning, should the trend become dramatic.

2. Vulnerability mapping and assessment

It was further agreed that the concept of vulnerability assessment should integrate biological, physical and socio-economic aspects, and management practices. A "system" for vulnerability assessment should not be reduced to a set of materials and data, but should be seen as an assemblage of:

- Methods (for obtaining data, analysing it, formatting, etc...);
- Practices (how things function in practice);
- Institutions and arrangements (rules and regulations for data collection, organizations undertaking data collection, analysis);
- Linkages between scientific institutions (data collection and analysis), decision-makers (action) and services (implementation),

combined in order to achieve an objective. Therefore, it was felt that vulnerability/risk mapping and assessments may be possible in the future. Comparison of the two systems is shown in table 1.

Table 1. Characteristics of early warning/monitoring systems for drought and famine and desertification

	Drought	Desertification monitoring and assessment
Objective	Operational warning of impending crises of drought and food security in order to propose immediate response	Forewarning of land degradation in order to have proof of land degradation process and to provide decision-making support for policy making
Time scale	Short term: seasonal	Long term: several years
Response	Immediate action	In practice: project/programme approach
Level	Small scale	Large scale
Information needed on	· Rainfall, aridity · Normalized Difference Vegetation Index (NDVI), vegetation cover · Population pressure	
	· Crops and livestock · Food supply and consumption · Marketing and prices	· Land information · Socio-economic issues · Human activities
Harmonization of indicators	More or less common understanding of indicators to be used among major systems	At present no agreeable set of common benchmarks and indicators

In light of the above comparison, participants agreed that both types of systems share similar databases and indicators. As previously recommended and adopted by COP 4, monitoring and assessment of desertification should build on existing EWSs. However, whether the difference between drought and desertification EW/monitoring in terms of time scale and land-related indicators would need technically and institutionally separate facilities will depend on specific national, subregional and regional situations.

3. Clearly defining the elements of a system for desertification monitoring and assessment

Desertification monitoring and assessment in its widest sense would include a framework encompassing an array of activities over a number of parameters; table 2 includes some important elements.

The concept implies fundamental research and data collection that can provide results only in the long term. The uniform collection of dataset parameters is not always possible because of differences in prevailing local or national situations. In order to meet countries' expectations of obtaining results within a short term, the following proposals were made:

- Separate scales and details of datasets for policy- making from those for validating results;
- With regard to the limited capacities in most countries, it was proposed that an up-scaling approach is mandatory and not optional; small-scale and large-scale assessment for representative vulnerable areas has to be combined. Details given at the local level are not always important at the international level. However, sufficient details are needed in order to identify vulnerable areas;
- The system must be flexible; some of the data might be dropped, in a case of lack of capacity;
- Use a framework for linkages and for identifying the reasons for collecting the minimum information required;
- Use national resources assessment databases available in most countries which will entail coping with the realities prevailing in those countries;
- "Quick and indicative" assessment methodologies should be considered as part of the system.

Table 2. Elements for implementing desertification EW/monitoring systems

Data analysis system	Understand historical, current and future responses to human and animal pressures, natural processes, landscape vulnerability
Data layers	Land resources Human resources Management practices
Analyse pressure	Decipher human and animal pressure Understand landscape response Understand degradation types
Indigenous knowledge and desertification assessment	Obtain feedback from local people on scientific results
Operation of the EWS	**Area approach** · A basin or watershed approach for biophysical resources in stream-dominated areas · An administrative area approach for socio-economic variables · An administrative area approach for all variables in arid areas without surface drainage · Ensure vertical and horizontal integration of institutions engaged in EWSs · Ensure vertical and horizontal integration of institutions working in EWSs · Improve coordination with national development efforts · Desertification assessment should promote local antidesertification actions

4. Closely linking the work of ad hoc panels on EWSs and on benchmarks and indicators

The UNCCD stresses the importance of monitoring and evaluation in order to provide better feedback and lessons learned, and to give scientific advice on the process of implementation of action programmes. In this regard, the OSS/CILSS/GRULAC/China Working Group on monitoring with regard to supporting decision making within UNCCD implementation has made several proposals:

- Inventory and follow-up of ongoing activities;
- Monitoring of implementation processes, using the criteria established by the UNCCD (participation, partnership, coordination etc.) and as adopted by the COP;
- Monitoring of policies adopted within the NAP;
- Monitoring and assessment of desertification;
- Monitoring of impact of NAP.

The last two are closely interlinked; indicators for impact monitoring of NAPs are being developed and tested.

5. Developing close links between activities on early warning and monitoring and assessment with traditional knowledge

Scientific data often requires calibration and validation; crosschecking and identifying collaborative evidence; and filling gaps and identifying explanations of scientific research results. These often need contextual interpretation based on traditional and local knowledge in order to be relevant and sound. Nevertheless, it should not be a one-way flow of information; partnership and sustainability require mechanisms for feedback to local-level decision makers, including local government, communities, and resource users/owners.

6. Conclusions

- Reviewing lessons learned from drought early warning systems, the participants recognized that early warning is a concept which has developed mainly in the context of natural hazards, especially drought, with a view to improving food security. However, significant conceptual and scientific advancements could be made in existing systems which might apply to desertification as well.
- Recognizing linkages between drought EWSs and desertification, information on land degradation is also valuable for poverty reduction strategies and food security analyses. The accumulation of information on drought is important for desertification monitoring.
- Recognizing the links between benchmarks and indicators and drought EWSs, ongoing discussions and the testing of a common list of indicators for impact monitoring in several regions begin with definition

and testing of general desertification monitoring indicators.

• In order to develop realistic assessments of local situations and to ensure local ownership, early warning systems should connect local communities at risk with the technical structures of EWSs.

7. Recommendations

The panel made the following recommendations:

(a) Develop a common terminology in order to facilitate interaction;

(b) Facilitate access to, and enhance the transparency of, databases;

(c) Ensure that the systems are more demand driven and develop adequate subnational nodes;

(d) Focus on developing decision-making rather than just keeping up with technological advances;

(e) Build up real partnership in order to establish an enabling institutional and political environment;

(f) Improve drought early warning systems by integrating land degradation information;

(g) Build up desertification monitoring systems on existing drought early warning systems as much as possible;

(h) Encourage joint efforts between operational EWSs and organizations working on impact indicators;

(i) Work with community groups responsible for data collection, with particular regard to women's participation;

(j) Collect and analyze a variety of socio-economic data, disaggregated by gender where possible, and conducted with participatory tools such as field observations and individual interviews, among other participatory tools;

(k) Discuss and validate results and develop strategies with local communities, taking account of local cultural practices.

III. METHODS FOR AN APPROACHES TO THE PREDICTION OF DROUGHT AND MONITORING OF DESERTIFICATION, PARTICULARLY THE METHOD OF ANALYZING VULNERABILITY TO DROUGHT AND DESERTIFICATION, ESPECIALLY AT THE LOCAL, SUB-NATIONAL AND NATIONAL LEVELS WITH SPECIAL REGARD TO NEW TECHNOLOGICAL DEVELOPMENTS

Discussions by the panel on this topic demonstrated that there are several methods being used for the prediction of drought which do not predict desertification. Clearly, there are also a number of approaches, influenced by various factors, and depending upon different situations, especially in the sourcing of data and analytical facilities available.

1. Data

To a large extent, both desertification monitoring and drought early warning require data from remote sensing and from field surveys. Field survey data can be used independently in their original form, or used for the validation of remotely sensed information. In addition, operational drought EWSs acquire and analyse the same field and remote sensing data required to monitor the extent and impacts of desertification.

The primary data used for desertification monitoring and drought early warning on a small scale are rainfall measurements and the remote sensing-derived Normalized Difference Vegetation Index (NDVI). Other remote sensing data sources are currently available, including data from new satellite systems in orbit. Such data, as well as data obtained from the field, can be used to demonstrate changes in vegetation cover and species composition. Further, it was recognized that deserti:cation monitoring requires the systematic tracking of land conditions, work not undertaken by most drought EWSs and which the older generation of satellites do not sufficiently cover.

2. Methods and approaches

(a) Remote sensing data and field data are currently used to analyse and map vulnerability to food insecurity and to desertification in the GIS environment.

(b) Remote sensing data are mostly dimensionless indices, which require ground-truthing and calibration to transform them into real units. Specifically, effective desertification monitoring requires quantifying vegetative conditions in their current status, as well as verification of previous vegetative conditions covering a period of more than 20 years; this requires reliable and accurate records, or the use of local knowledge which can only be obtained from the residents.

(c) New developments in data analysis and integration frameworks are being carried out for both desertification assessment and monitoring and drought EW by various national and international organizations in different regions. Of particular significance, it was noted, are the prospects of using new analytical procedures to derive indicators on land conditions, soil erosion models and vegetation structure and conditions, using digital information from a series of historical sets of high-resolution satellite images which cover several years. Results can be validated using local knowledge and interpretation of the effects of previous policy regimes on agriculture or natural resources management. This can influence the formulation of new policies.

(d) GIS technology can be utilized in handling several layers of huge data sets during such an analysis. Further, GIS is mandatory for upscaling approaches and the integration of socio-economic data. There are, for example, possibilities for integrating remote sensing data analysis results with grazing statistics at the community level. This approach is new and provides better information extraction and analysis capability. Unfortunately, the cost may be prohibitive for many developing nations. Therefore, in spite of the high scientific value of the technique, it may be difficult to apply in most affected nations.

(e) Monitoring of desertification at different scales requires images of different resolutions. At the local level, high resolution images are necessary, while at national and regional levels these can be tracked using low resolution satellite information. Furthermore, the cost of these low resolution products may not be a constraint; yet they can influence decision making at local to national levels, especially with respect to drought EW. New and alternative technologies may provide better information, so long as these are cost effective.

(f) Traditional knowledge must be incorporated into the data analysis system, and more emphasis should be given to such knowledge, especially where data generation through high technology may be difficult; this will help to validate the information and to obtain feedback.

(g) Another strategy to enable the technological and cost-effective utilization of all sources of information is first to identify areas vulnerable to degradation by means of reconnaissance level studies using low-resolution images. Then the area should be rapidly ground truthed, followed by the use of recent highresolution remotely-sensed data to detail vulnerable areas. It is necessary to test and use this kind of technology and data by integrating it with socio-economic data through GIS, and to analyse the results in order to draw conclusions. Since cost is normally a factor, it should be broken down into hardware, software and data components. These may be partly one-time costs, but the collection of field information may be high for most of the developing affected countries.

3. New technological developments

The newly-launched very high-resolution satellites may provide data at a much higher resolution and are therefore better placed for tracking desertification. However, this will correspondingly require more powerful computers to handle the increased volume of data. These systems are already providing more information on land conditions than was previously possible.

Plans were also noted to launch high spectral resolution satellite systems for capturing more information on parameters necessary for predictive modelling.

4. Conclusions

In conclusion the panel agreed that:

- Long term data series (such as NDVI) and matching of different remote sensing technologies have recently made available a number of new applications. They have added value to scientific and decision-making processes at a global level, as well as contributing to better understanding of global land degradation issues, and to linkages between land degradation, climate change and modelling.

- Proof of land degradation through remote sensing is often useful to decision makers, in order to target investments.

5. Recommendations

(a) Capitalize on the experience of operational drought early warning systems in using remote sensing to track indicators which are also used to assess desertification namely, rainfall, vegetation, and land use;

(b) Capitalize on remote sensing and geographic information system experiences in assessing desertification through a wide range of physical, biological, social, and economic indicators;

(c) Improve the understandability and accessibility of remote sensing products for decision-makers and end-users;

(d) Promote dialogue between scientists and decision-makers at strategic decision points, especially during the NAP process;

(e) Integrate local communities in monitoring and assessment programs;

(f) Integrate traditional knowledge into monitoring and assessment activities.

IV. MECHANISMS TO FACILITATE AN EXCHANGE OF INFORMATION BETWEEN SCIENTIFIC AND TECHNOLOGICAL INSTITUTIONS, IN PARTICULAR FOCUSING ON NATIONAL AND SUBREGIONAL NETWORKS ON THE PREDICTION OF DROUGHT AND MONITORING OF DESERTIFICATION

The regional thematic programme networks (TPNs) that have been developed under the UNCCD offer useful frameworks for promoting information exchange. In accordance with UNCCD regional annexes, Africa, Asia, Latin America and the Caribbean, the Northern Mediterranean and Eastern and Central Europe have been developing TPNs on specific topics. An overall review was presented to the panel on institutions offering mechanisms to facilitate the exchange of information between scientific and technological institutions, in particular focusing on national and subregional networks, for the prediction of drought and the monitoring of desertification. It was noted that the roles of such scientific and technological institutions under review are:

• data collection, accessibility, and integration

• evaluation and prediction of drought and desertification and measures for preparedness

• dissemination of information to end-users on the application of EWSs and desertification monitoring and assessment, and strengthening appropriate response mechanisms
• research institutions producing information
• research institutions monitoring basic processes

Analysis showed that there are some differences in the institutional arrangements from one region to another due to historical and environmental situations and differences in priorities set by those regions.

1. Conclusions

The panel observed that a number of the networks cited showed some characteristics or indications which encompassed some key factors for a successful network: set clear common goals; establish well-defined intermediate goals to ensure feelings of progress; and encourage strong leadership.

The panel noted that the following categories of actors need to be recognized as partners in the networks at every level of operation. These actors involved in networks include, among others:

(a) Non-governmental organizations (NGOs);
(b) Local communities;
(c) Grassroots organizations;
(d) Government technical agencies;
(e) Political decision makers;
(f) The private sector;
(g) Research institutions;
(h) Educational institutions;
(i) International organizations.

2. Recommendations

(a) Move from a project to a programme approach, first establishing frameworks in the context of national, subregional, and regional action programmes;

(b) Reinforce or establish communication mechanisms by promoting direct contact among individuals representing the relevant institutions, and by providing the proper technical means, such as data bases, meta-data bases, and e-mail lists;

(c) Facilitate free access to data and information, through negotiating frameworks, with definite rules for direct and innovative arrangements and with guidelines developed by regional, subregional and national organizations and networks;

(d) Cultivate clear agreements on institutional networking and on responsibilities and leadership at the regional, subregional and national levels;

(e) Promote ownership by network members, for example through common publications, Web sites, and other communication mechanisms;

(f) Enhance capacities through technical assistance and training.

V. MORE DETAILED MEASURES FOR DROUGHT AND DESERTIFICATION PREPAREDNESS, IN COOPERATION WITH THE APPROACHES, FROM HAZARD PROTECTION TO RISK MANAGEMENT, ADOPTED BY THE INTERNATIONAL STRATEGY FOR DISASTER REDUCTION (ISDR)

The similarities of both the International Decade for Natural Disaster Reduction (IDNDR) and the UNCCD processes with regard to minimizing the impacts of natural disasters, particularly drought, were considered. This has created an opportunity to develop synergies and linkages between the UNCCD and ISDR (which succeeded IDNDR in 1999) in areas of drought and desertification. The main point to be noted is the ISDR's goal of moving from short-term disaster protection approaches to risk management strategies which focus on disaster prevention in the long-term, and which embrace sustainable development. It was also noted that the UNCCD promotes sustainable development and encourages the inclusion of NAPs in National Development Frameworks.

The purpose of the national action programmes is to identify the factors contributing to desertification and also the practical measures necessary to combat desertification and mitigate the effects of drought. Consequently, national action programmes constitute the fundamental framework for desertification preparedness.

The socio-economic and political impacts of drought have a long history in some drylands of the world. In recent years, it has been shown that the economic impact of drought can be very serious. It causes serious social disruption, reduced food and crop production, health problems, reduced hydropower generation, conflicts over resources and political insecurity. This is in spite of the fact that droughts are expected events, for example in arid and semi-arid regions in Africa.

To overcome some of these problems, especially in the use of information for planning purposes, participatory planning in EWSs was considered. This approach emphasizes the importance of involving the people at risk, the communication and exchange of information, methods of raising awareness, planning, and participatory monitoring and evaluation. In order to identify a realistic assessment of local situations and to ensure ownership of measures to be taken, EWSs should not be based entirely on scientific and technical information, but should include communities at risk as well.

1. Conclusions

• Existing and even improved EWSs in Africa have not necessarily led to effective drought mitigation

• Weaknesses in the EWSs include: (a) weakness in EWSs information dissemination and use, (b) institutional constraints including coordination problems, (c) logistical constraints leading to untimely responses, (d) political constraints and (e) the lack of inclusion of participatory planning approaches

• Few countries are systematically adopting drought risk management approaches instead of continuing with drought hazard protection

• The use of EWS data and information for long-term national development programmes and strategies intended to minimize or prevent drought and desertification hazards is not apparent. In other words, information on drought and desertification is not used adequately in national planning

• There are few examples of measures being undertaken for desertification preparedness, although examples relating to drought preparedness abound

2. Recommendations

Detailed definitions of, and measures for, desertification preparedness and for combating desertification must be part of the NAP process. Because the NAP process is a consultative process which includes all stakeholders, the guiding principles for such measures are:

(a) Create appropriate conditions for the participation of local resource users in the planning, implementation and evaluation of local action programmes;

(b) Create appropriate conditions for decentralization of decision-making in land management;

(c) Create appropriate mechanisms for funding at the local level;

(d) Assure communication and consultation among key stakeholders;

(e) Reinforce local capacities through training and the sharing of experiences;

(f) Negotiate partnership arrangements;

(g) Arrange appropriate NAP monitoring and evaluation mechanisms.

In accordance with these principles, the panel recommends that organizations carry out desertification assessment and monitoring in the context of desertification preparedness plans, especially through vulnerability and risk assessments which would estimate the possible magnitudes of problems within different scenarios. This approach should facilitate the preparation of suitable local interventions and action programmes to combat the problems.

Achieving this form of desertification preparedness depends on the following:

(a) Surveying existing information;

(b) Using scientifically sound information on desertification which integrates traditional knowledge;

(c) Establishing feedback mechanisms with local and grassroots organizations;

(d) Integrating cultural considerations into desertification countermeasures.

All countries host a range of institutions for national development. Appropriate synergies between these institutions and the principal actors involved in the NAP, especially local resource users, research and development institutions engaged in desertification activities, administrative offices and local representatives, could produce more effective responses to prepare for, and to combat desertification.

Annex 1

PARTICIPANTS AT THE AD HOC PANEL MEETING ON EARLY WARNING SYSTEMS

Members of the ad hoc panel

Ms. Nana Bolashvili, Georgia
Dr. Edmundo Garcia Moya, Mexico
Mr. Abdellah Ghebalou, Algeria
Dr. Ali Umran Komuscu, Turkey
Mr. Octavio Perez Pardo, Argentina
Dr. Valentin Sofroni, Moldova
Dr. Anneke Trux, Germany
Dr. Kazuhiko Takeuchi, Japan

Consultant

Mr. Ruben K. Sinange, Kenya

Experts of relevant institutions

Mr. Alhassane Adama Diallo, Centre Regional AGRHYMET, Niger
Dr. Patrick Gonzalez, U.S. Geological Survey, the United States of America
Dr. Patrick Hostert, University of Trier, Germany
Dr. Amal Kar, Central Arid Zone Research Institute, India
Mr. Haruo Miyata, Global Environment Forum, Japan
Dr. Tadakuni Miyazaki, Yamanashi Institute of Environmental Science, Japan
Ms. Hortense Palm, Organisation Internationale de Recherche et de Formation Technique, Mali
Dr. Masato Shinoda, Tokyo Metropolitan University, Japan

Annex II

DOCUMENTS SUBMITTED TO THE AD HOC PANEL ON EARLY WARNING SYSTEMS

Background documents

1. Decision 14/COP.4 (Early warning systems)

2. ICCD/COP(4)/CST/4 (Report of the ad hoc panel on early warning systems)

3. Document ICCD/COP(3)/CST/6 (Early Warning Systems: existing experiences of Early Warning Systems and specialized institutions operating in this field)

4. Towards an Early Warning System for Desertification. Dr. Amal Kar and Dr. Kazuhiko Takeuchi, The University of Tokyo, Tokyo, Japan.

5. Advances in Desertification Monitoring and Drought Early Warning. Dr. Patrick Gonzalez, U.S. Geological Survey, Washington, D.C., U.S.A.

6. Mechanisms to facilitate an exchange of information related to early warning systems between scientific and technological institutions, in particular focusing on national and subregional networks, for the prediction of drought and monitoring of desertification. Mr. Haruo Miyata, Global Environmental Forum, Tokyo, Japan.

7. Measures for drought and desertification preparedness, with particular reference to African countries. Mr. Ruben Sinange, Nairobi, Kenya.

Conference room documents

1. Remote Sensing Driven Early Warning Systems for Desertification and Land Degradation, Results and Conclusions from DeMon-II: An Integrated Approach toAssess and Monitor Desertification Processes in the Mediterranean Basin. Department of Remote Sensing, Faculty of Geography and Geosciences, University of Trier, Trier, Germany.

2. Proceedings of UNCCD Regional Meetings for Asia, Beijing, China, July 22-27, 1999: Asia-Africa Technical Workshop on Early Warning Systems held from 22-23 July, 1999.

3. La Planification Participative dans le Système d'Alerte Précoce. Ms. Hortense Palm, Bamako, Mali.

4. Système d'Alerte Précoce: Contribution du Centre Regional AGRHYMET. Mr. Alhassan Adama Diallo, Niamey, Niger.

Annex III

AD HOC PANEL MEETING ON EARLY WARNING SYSTEMS
Fuii-Yoshida City, Japan, 4-8 June 2001

Agenda

Location: Yamanashi Institute for Environmental Sciences,
Fuji-Yoshida City, Yamanashi Prefecture, Japan

Monday, 4 June 2001

09.30 - 10.00 Registration

10.00 - 10.45 Opening session - Opening remarks by:

Mr. Hidetoshi UKJTA, Director for the Global Environment Division, Ministry of Foreign Affairs, Japan

Mr. Katsunori SUZUKI, Director for the Global Environmental Issues Division, Ministry of the Environment, Japan

Mr. Kimihiko NAGANUMA, Deputy Director General, the Yamanashi Prefecture on behalf of Mr. Ken AMANO, Governor of the Yamanashi Prefecture

Mr. Ahmed Cissoko, Senior Scientific Advisor, United Nations Convention to Combat Desertification

10.45 - 11.00 Coffee break

11.00 - 11.30 Opening remarks by Chairman of ad hoc panel

11.30 - 11.40 Remarks by the Representative of the UNCCD secretariat

11.40 - 12.30 Appointment of Topic Chairs and Rapporteurs

12.30 - 14.00 Lunch break

Topic 1: Critical analysis of the performance of early warning and monitoring and assessment systems, linking traditional knowledge and early warning systems, especially in the areas of the collection of data, dissemination of information and measuring for drought preparedness.

14.00 - 15.00 Presentation of Topic 1

15.00 - 16.15 Discussion of Topic 1

16.15 - 16.30 Coffee break

16.30 - 17.30 Discussion of Topic 1

Tuesday, 5 June 2001

Topic 2: Methods for and approaches to the prediction of drought and monitoring of desertification, particularly the method of analyzing vulnerability to drought and desertification, especially at the local, subnational and national levels, with special regard to new technological developments.

09.00 - 10.00 Presentation of Topic 2

10.00 - 11.00 Discussion of Topic 2

11.00 - 11.15 Coffee break

11.15 - 12.30 Discussion of Topic 2

12.30 - 14.00 Lunch break

14.00 - 16.00 Working groups on Topics 1 and 2

16.00 - 16.15 Coffee break

16.15 - 17.30 Conclusion of Topics 1 and 2

Wednesday, 6 June 2001

Topic 3: Mechanisms to facilitate an exchange of information between scientific and technological institutions, in particular focusing on national and subregional networks on the prediction of drought and monitoring of desertification

09.00 - 10.45 Presentation of Topic 3

10.45 - 11.00 Coffee break

11.00 - 12.30 Discussion of Topic 3

12.30 - 14.00 Lunch break

Topic 4: More detailed measures for drought and desertification preparedness, in cooperation with the approaches, from hazard protection to risk management, adopted by the International Strategy for Disaster Reduction

14.00 - 16.00 Presentation of Topic 4

16.00 - 16.15 Coffee break

16.15 - 17.30 Discussion of Topic 4

Thursday, 7 June 2001
Working groups on Topics 3 and 4

10.45 - 11.00 Coffee break

11.00 - 12.30 Conclusion of Topics 3 and 4

12.30 - 14.00 Lunch break

14.00 - 16.00 Drafting

16.00 - 16.15 Coffee break

16.15 - 17.30 Drafting (continuation)

Friday, 8 June 2001

09.00 - 11.30 Drafting conclusion by Rapporteur of AHP/EWS

11.30 - 12.15 Adoption of the Report

12.15 - 12.30 Closing ceremony

12.30 - 14.00 Lunch break

14.00 - 17.30 Field visit (experimental sites on reforestation and biodiversity)

Decision 14/COP.5

Early warning systems

The Conference of the Parties,

Considering the reports and recommendations of the ad hoc panels on early warning systems[1] as well as the recommendations of the Bureau of the Committee on Science and Technology[2],

Recalling decision 14/COP.4 to reappoint an ad hoc panel on early warning systems,

1. *Requests* the secretariat to seek the necessary resources to publish and distribute in a suitable form, as widely as possible, the report together with the background papers submitted to the reappointed ad hoc panel on early warning systems;

2. *Invites* the Parties, according to their financial and technical capacities, to carry out pilot studies on early warning systems utilizing the recommendations of the ad hoc panel, and to report on progress to the CST at an appropriate session;

3. *Encourages* Parties and international organizations to provide technical and financial support to developing country Parties wishing to carry out such pilot studies on early warning systems.

11th Plenary
12 October 2001

1 ICCD/COP(4)/CST/4 and ICCD/COP(5)/CST/4.
2 ICCD/COP(5)/INF.6.

ANNEXES

Presentations made by countries or institutions to the ad hoc Panel Meetings

1. CISSOKO, A. S. – UNCCD Secretariat
2. TAKEUCHI, K. – University of Tokyo – Chairman
3. KAR, A. & TAKEUCHI, K. – University of Tokyo
4. GONZALEZ, P. – US Geological Survey
5. DeMon-II-Universität Trier
6. CILLS – Centre Regional Agrhymet
7. Global Environment Forum – Japan
8. PALM, H. – Union Mondiale ORT
9. SINANGE, R. K. – Dept. Res. Surveys - Nairobi

Réunion du groupe d'experts sur les systèmes d'alerte précoce

Intervention du Secrétariat de la Convention des Nations Unies sur la Lutte contre la Désertification

A. S. Cissoko

Fuji-Yoshida City, le 4-8 juin 2001

CCD Postal address: P.O. Box 260129, Haus Carstanjen, D-53153 Bonn, Germany
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E-mail (Personal): secretariat@unccd.int Web site: www.unccd.int

Monsieur le Président,
Messieurs les représentants du gouvernement,
Monsieur le représentant des autorités locales,
Messieurs les responsables de l'université,
Mesdames et Messieurs,

Je voudrais au nom du Secrétariat de la Convention et en mon nom propre, adresser mes sincères remerciements et ma profonde gratitude aux autorités japonaises pour leur contribution généreuse et leur engagement constant dans la mise en œuvre de la Convention sur la lutte contre la désertification et l'atténuation des effets de la sécheresse.

Mes remerciements s'adressent aussi au Président du groupe spécial sur les systèmes d'alerte précoce ainsi qu'aux responsables de l'université qui ont tout entrepris pour faciliter la tenue de cette importante réunion dans ces locaux.

Voici très succinctement quelques traits saillants de la Convention des Nations Unie sur la lutte contre la désertification et l'atténuation des effets de la sécheresse.

La Convention fixe le cadre international dans lequel se structure la lutte contre la désertification. Elle apparaît plus précisément comme un cadre juridique novateur pour la promotion du Développement Durable dans les écosystèmes fragiles. Elle détermine le moyen d'améliorer le rôle des collectivités locales, de l'Etat, des organisations internationales, régionales, sous-régionales et non-gouvernementales. Elle apparaît, à cet effet, comme un outil privilégié pour lutter contre la pauvreté et valoriser les ressources locales.

La désertification est présente dans la plupart des régions arides, semi-arides et subhumides sèches dans le monde, aussi bien dans les pays développés que dans les pays en voie de développement. Elle touche plus d'un milliard d'êtres humains. Son incidence quoique variant sensiblement d'une région à une autre se traduit, entre autres par une perte de la productivité des sols, de la diversité biologique et aussi par une altération des eaux et des régimes pluviométriques, ce qui induit, notamment dans les régions rurales un accroissement de la pauvreté, une dégradation de la qualité de vie, et une accélération des phénomènes de migration.

Au moment où je m'exprime, 174 pays ont ratifié la Convention et ce dans un laps de temps finalement très court. La Convention est entrée en vigueur le 26 decémbre 1996 après la cinquantième ratification Cela reflète, je crois, une extraordinaire manifestation de la volonté politique forte qui anime ces pays.

Il convient d'ajouter que bien souvent, la ratification intervient après un large débat initié depuis les séminaires publics d'information et de sensibilisation, jusque sur les bancs des Assemblées Parlementaires.

J'ai parlé auparavant d'un intérêt politique, bien plus que cela, d'aucun verrait dans cet accomplissement la traduction d'un mandat clair que nous avons tous la responsabilité d'exécuter désormais.

Dans maints pays nous avons été témoins d'une franche collaboration engagée entre différentes catégories d'acteurs dans l'esprit d'un véritable processus participatif.

De même, les politiques du passé en matière de lutte contre la désertification ont commencé à être l'objet d'une relecture critique, et là où cela est nécessaire, des réorientations sont entreprises ou envisagées en vue d'une meilleure internalisation des plans et projets existants, donc de leur adéquation avec les programmes en cours d'élaboration.

Monsieur le Président,

Nous attendons beaucoup de cette Convention. Elle est une approche novatrice de la problématique du développement durable. L'espoir qu'elle véhicule prend sa source à la fois dans l'effort de reconquête de la principale source de richesse qu'est la terre, mais également dans l'ambitieux défi qui consiste à faire travailler ensemble tous les acteurs concernés. Chacun ici a le devoirs moral de repousser dans la mesure de ses moyens, un tant soit peu les frontières de la désertification.

Cette Convention ne vise pas uniquement une reconquête de la fertilité des terres, même s'il s'agit déjà d'un objectif très ambitieux. Les orientations préconisées dans ce traité contribuent à asseoir les bases d'une véritable politique de développement durable.

Monsieur le Président,

La Convention souligne à l'attention des Parties de nombreuses questions clés, parmi celles-ci la création et l'utilisation des systèmes d'alerte précoce (article 10 paragraphe 3a, 3b, et 3c)

Cependant très peu de travaux ont porté sur les systèmes d'alerte précoce pour la désertification. Certains doutent même de l'intérêt de principe de l'alerte précoce appliqué à la désertification, toutefois, un nombre important de systèmes d'alerte précoce en sécurité alimentaire fonctionne de par le monde.

Dans les systèmes d'alerte précoce nous abordons d'une part, les notions d'indicateurs et de seuil et d'autre part, le concept de mise en alerte ou état d'urgence.

Enfin, l'alerte n'a de sens que si elle déclenche une action. Cette exigence pose des questions en termes de coordination et d'articulation institutionnelle entre les scientifiques qui sont chargés de la collecte, du traitement des données, les politiques (qui décident d'actions) et en bout les services en charge de la mise en œuvre.

Par ailleurs l'échelle temporelle des systèmes d'alerte de la désertification s'étend sur le moyen et long termes car la vitesse d'évolution des processus de la désertification est long et il faut intégrer à la fois les facteurs socioéconomiques et physique. La difficulté est réelle pour les phénomènes socioéconomiques car ils concernent les comportements humains pour lesquels les données qui s'y rapportent sont plus délicates à collecter, à quantifier et surtout à spatialiser.

Nous constatons que dans les rapports sur la mise en œuvre de la Convention soumis à la Conférence des Parties (COP) par les Parties, les organisations sous-régionales, régionales et internationales il ressort ente autres que des pays sont dotés de systèmes d'alerte précoce avancée opérationnels, mais que ces dispositifs concernent surtout la sécurité alimentaire et ne sont pas suffisamment ciblés sur la désertification. Cela nous le savions.

Par ailleurs, de nombreux indicateurs sont élaborés au titre d'autres initiatives d'environnement, cependant, la plupart des pays entendent mettre au point des repères et des indicateurs dans le cadre du processus d'application du programme d'Action National (PAN) afin que des politiques se fassent selon une approche plus systématique.

De nombreux pays ont noté l'insuffisance des systèmes d'information géographique (SIG), et ou des systèmes d'information environnmentale (SIE) auxuqels ont accès les centres de liaison pour la désertification.

Vous comprendrez donc aisément pourquoi la COP a désigné un groupe spéciald'experts sur les systèmes d'alerte précoce pour se pencher sur ces questions. Le groupe spécial a fourni sous la conduite du professeur Kazuhido Takeuchi un travail remarquable dans ce domaine.

Le groupe spécial a été reconduit sur la conduite de son président pour accomplir d'autres tâches définies par la décision 14/COP.4.

En souhaitant plein succès aux délibérations du groupe spécial sur les systèmes d'alerte précoce, je vous remercie pour votre aimable attention.

Ad hoc Panel Meeting on Early Warning Systems Yamanashi Institute of Environmental Sciences, Fuji-Yoshida City, Japan - June 4-8, 2001

Opening Remarks by the Chairman of the Meeting, Professor Kazuhiko Takeuchi, The University of Tokyo

I cordially welcome all the distinguished Members of the Ad hoc Panel on Early Warning Systems, the Additional Participants to the Ad hoc meeting on Early Warning Systems, and the distinguished Representatives of the UNCCD Secretariat to Japan, and especially to the Yamanashi Institute of Environmental Sciences, located at the foot of Mt. Fuji, in the City of Fuji-Yoshida, Yamanashi Prefecture.

I take this opportunity to welcome also the two newly appointed members of the Ad hoc Panel, namely Dr. Edmundo Garcia Moya of Mexico, and Ms. Nana Bolashvili of Georgia.

I am associated with the Yamanashi Institute of Environmental Sciences for quite some time now as a Visiting Researcher. So, it is my great pleasure, and indeed an honour, to welcome all of you at this relatively new institute of environmental research, established at the initiative of the Governor, Mr. Amano, who is very much interested in environmental issues. In fact he propounded the idea that Yamanashi be developed as the environmental capital of Japan, and he is an ardent supporter of the causes of environment.

I would like to express my sincere thanks to the Director of the Yamanashi Institute of Environmental Sciences, Dr. Iriki, for readily agreeing to my proposal to hold the meeting at the Institute, and for extending all help to us. I also express my sincere thanks to the Ministry of Foreign Affairs and the Ministry of Environment, Govt. of Japan, as well as the Yamanashi Prefectural government for agreeing to hold the meeting here. I take this opportunity to thank all the researchers and officers of YIES for their help in making available the venue in a very functional manner. I thank the Consultant and the other learned scholars for preparing the Background Papers and other Conference Documents for this meeting. I also thank the UNCCD for doing so nicely all the administrative and secretarial work that are involved in arranging such a meeting.

This Ad hoc Panel meeting was preceded by a meeting at Koenigswinter, Germany, from 31st May to 6th June, 2000.

The meeting had decided that the following questions were still to be attended to:

1. Critical analysis of the performance of early warning and monitoring, and assessment systems,

2. Open questions on methods and approaches for the prediction of drought and monitoring desertification,

3. Mechanisms to facilitate exchange between scientific and technical institutions, and

4. More detailed measures for drought preparedness.

Consequently, the Panel recommended to the Conference of Parties that the present Ad hoc Panel be reappointed to elaborate in-depth on the above-mentioned questions. During my presentation of the recommendations of the Panel to the Bureau of the Committee on Science and Technology (CST), it emerged that the importance of analysing vulnerability to drought and desertification, and linking traditional knowledge and early warning systems, especially in the area of collection of data, dissemination of information, and measuring for drought preparedness, can not be ignored. It was also felt that inclusion of members with expertise on social and political sciences could be useful for properly addressing some of the questions before the panel.

It was decided by the CST that the members of the Ad hoc panel on early warning systems should be re-appointed to continue its work, in particular focusing on facilitating national and sub-regional networks on the prediction of drought and monitoring desertification. I was requested by CST to clearly define the objectives and a programme of work for Phase Two of the work.

Consequently, I recast the objectives, and finally these were reflected in the Decision 14 of COP.4 as follows:

1. Critical analysis of the performance of early warning and monitoring and assessment systems, linking traditional knowledge and early warning systems, especially in the areas of the collection of data, dissemination of information and measuring for drought preparedness;

2. Methods for and approaches to the prediction of drought and monitoring of desertification, particularly the method of analysing vulnerability to drought and desertification, especially at the local, subnational and national levels, with special regard to new technological developments;

3. Mechanisms to facilitate an exchange of information between scientific and technological institutions, in particular focusing on national and subregional networks on the prediction of drought and monitoring of desertification; and

4. More detailed measures for drought and desertification preparedness, in cooperation with the approaches, from hazard protection to risk management, adopted by the International Strategy for Disaster Reduction. For this meeting CCD has decided that Dr. Amal Kar will be presenting the case for EWS on desertification under Topic 1, i.e., critical analysis of the performance of the early warning and monitoring and assessment systems, linking traditional knowledge and early warning systems.

Dr. Patrick Gonzalez will be the main speaker under Topic 2: Methods for and approaches to the prediction of drought and monitoring of desertification, particularly the method of analysing vulnerability to drought and desertification, especially at the local, subnational and national levels, with special regard to new technological developments.

Dr. Patrick Hostert will be presenting the case for DEMON-II, developed for dryland monitoring of the European Mediterranean region, as an additional resource to evaluate Topic 2.

I understand that the distinguished participant from AGRHYMET, as well as the distinguished participant from Global Environmental Forum, will be the speakers for Topic 3: Mechanisms to facilitate an exchange of information between scientific and technological institutions, in particular focusing on national and subregional networks on the prediction of drought and monitoring of desertification.

Mr. R. Sinange will be the principal speaker for Topic 4: More detailed measures for drought and desertification preparedness, in cooperation with the approaches, from hazard protection to risk management, adopted by the International Strategy for Disaster Reduction. Mrs. Hortense Palm of Mali will be the other speaker in the session, especially on participatory planning.

I feel that it is necessary to balance between the drought early warning system and the desertification early warning system, as has already been discussed during the previous meeting. I also think that it is necessary to find the means to link between early warning systems and the local knowledge, more commonly known as the traditional knowledge, and early warning systems for drought and desertification cannot be separated from indicators and benchmarks on desertification. So, we have to deliberate on how all these three concepts of early warning systems, indicators and benchmarks, and traditional knowledge can be interwoven to find a definite goal of reducing the risk of drought and desertification hazard. In this context, it is also necessary for us to find the links between the international, national and local levels for efficient working of the system. I hope it will be possible for the meeting to come out with concrete suggestions and action plans that can be followed up at the UNCCD for a better future.

I welcome you once again, and hope that our discussion during this week form the basis for better understanding of the Early Warning Systems, leading ultimately to concrete action plans for adoption.
Thank you.

TOWARDS AN EARLY WARNING SYSTEM FOR DESERTIFICATION

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EXECUTIVE SUMMARY
The concept of Early Warning System (EWS) is still intertwined with drought. Several global and national level EWS for drought are being run by different organizations. Performances of these systems have been reviewed recently. Reviewing the functioning of six major early warning systems on drought and food security CeSIA, Accademia dei Georgofili of Italy (Anon., 1999) remarked that although EWS has become technologically more sound, more efficient and socially more relevant, especially due to the revolutions in information technology during the last one decade, so far all the major systems concentrate on drought and food security, and no system is specifically devoted to desertification. It also cautioned against the EWSs becoming more of a technological push than a demand-driven system.

The basic philosophy behind EWS for desertification is somewhat broader than that behind an assessment and monitoring of desertification, in that the primary objective of an EWS for desertification is to forewarn the people about some impending crises of land degradation, as well as to suggest some remedial measures. These objectives cannot be met without a proper understanding of the processes responsible for desertification. The EWS for drought can hardly play a role for understanding desertification and forewarning people, although it has been suggested that "due to intrinsic correlation with human and socio-economic factors, desertification could be measured also by means of the same methodologies utilized by the food security" (Anon., 1999; p. 29). The time scale of an EWS for drought is much shorter than that for desertification. In later case the time scale must extend over a period of several years in order to see remarkable changes in evidence. Moreover, the database for EWS on desertification should be more broad-based than that for drought, and should include several parameters related to land condition.

A set of indicators is usually taken for assessment of desertification. Unfortunately, there is still a dearth of common basic indicators to measure desertification. In Africa the OSS and the CILSS tested the CCD methodology 'for elaborating impact indicators', and found the "low level of regular collection, standardization and characterization of data, the absence of georeferenced data and quantifiable economic data relating to the environment and to the natural resources, absence of a formal national framework for harmonizing and compatibilising existing databases relating to desertification control, the weakness of consultation mechanisms, information exchange systems, and institutional and technical capacities of the actors involved" are the major constraints towards calculating the selected indicators (Anon., 2000, p. 15). The European efforts for selecting indicators for the Mediterranean region enlarged the scope of the Pressure – State – Response (PSR) model used so far for the African situations to the Driving forces – Pressures

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– State – Impact – Responses (DPSIR) model, "because it seemed to be the most comprehensive amongst those designed to describe interactions existing between the components of the natural and socio-economic system" (Enne and Zucca, 2000; p.195). New techniques of integrating information from the field, remote sensing, and other sources through GIS and simulation modeling are being proposed for understanding the present and the future scenarios. Unfortunately, many of the concepts and data requirements for these activities are beyond the reach of many developing countries where the drylands occur, and are difficult to test because of the lack of a suitable enabling environment. The Permanent Interstate Committee for Drought Control in the Sahel and the Sahara (CILSS) and the Sahel Observatory (OSS) are engaged in finding out suitable indicators and benchmarks for desertification assessment and have been requested to report on benchmark and indicators to the Committee on Science and Technology (CST) of CCD. Meanwhile, many institutions are using their own methodologies to assess desertification. If agreed upon, the indicators for assessment, and the benchmark sites from where the data is collected, can also be helpful in establishing database on EWS for desertification.

We feel that EWS for desertification should begin at, and give more emphasis on, the local levels, rather than begin at the global and the regional levels. For this the regular census and other socio-economic data may be pooled at village level or at the next higher level of administrative units, while the information on natural resources may be gathered at 1:50,000 scale to 1:250,000 scale (depending on the availability of information). The natural resources data layers are generally available in most of the research and development institutions. Some data, especially on the human and animal resources, infrastructures, etc. are routinely collected through census of humans, animals, crops, etc. Part of the data may be in non-spatial format (tabular and statistical), but most are spatial. Organization of the datasets into a coherent sequence of land resources, human resources, animal resources, infrastructural facilities and management practices may be the first step towards starting an EWS on desertification.

We propose that the data layers for natural resources may be arranged in the following sequence: climate, terrain, soils, vegetation, surface water, groundwater and land use. For the human resources the layers are: demography, workers, literacy, persons below poverty line, land holding, land fallowing, implements for ploughing, fuel wood, etc., while for the animal resources the layers are: domesticated animals, and their number per household, adult cattle units, animal products, etc. Facilities and infrastructures may include markets, connectivity and other facilities. The management practices may include land and water management practices and livestock & range management practices. The type of data needed for all the layers and their frequency has been mentioned. The need for some specific types of data, e.g., cropping season weather, sand dunes, palaeochannels, catchments and watershed boundaries, confining layers in soils, above-ground biomass production, etc. have been explained.

The database can be used in a data analysis system where the following measurements can be made: natural process acceleration, inherent vulnerability of landscape, and the human and animal pressures (including socio-economic factors). From these measurements one can deduce the current and historical response of the landscape (i.e., degradation, etc.) under the major land use systems. A basin/watershed approach for the biophysical resources, especially those in the semi-arid and dry sub-humid areas, as well as in the stream-dominated areas of the arid areas, will help to effectively integrate the information, and processing of the data for estimating possible future soil loss, etc., basin-wise. On the other hand, an administrative unit approach is good for the socio-economic variables. Linking the basin/watershed units with the administrative unit may be cumbersome and difficult if done manually, but may be easier if done under a GIS environment. For the arid areas without surface drainage all the data may be collected within the administrative units.

The results, in text and map forms, may be discussed thoroughly at the local level, especially with the representatives of the land users, to validate the results and to get feedback for improvement of the results.

The quantity, rates, direction and the spatial dimension of the processes and the responses, as derived from the above activities, have to be analysed and suitably modeled to find out the trends in landscape changes and the factors responsible. Simulation modeling, remote sensing and GIS will play critical roles in the analysis. However, simulation models have to be used cautiously, and should be based on sufficient local information. Similarly, digital remote sensing is likely to play a larger role, but the signatures need to be verified in the field.

Rigorously tested modern scientific knowledge will form the basis of this system, but traditional and other indigenous knowledge will also supplement, especially after these are tested for validity in the local contexts. It may be worthwhile to catalogue first the local traditional knowledge, test these through scientific procedures and then use these in the analysis system. Under a technologically driven, fast-changing environment some of the traditional knowledge may lose its relevance. Since traditional knowledge is based on local environmental conditions, it can have higher relevance at the local levels. Consequently, the collection and processing of the traditional knowledge has to be done sectorwise. Indigenous knowledge that may or may not be tradition-bound will be more relevant in understanding the future changes. Since the scheme suggested here builds up from the local level, it is possible to integrate the local indigenous knowledge into it, by first collecting the views of the local land users on future degradation (type, degree, location, direction), as well as on the causes, discuss the views at selective locations and find reasoning for the views, and then use the information in the scientific database.

Once the analysis is done objectively it may be possible to find out the possible future responses of the landscape. The trends and the future responses may be spelt out separately for each of the major land use categories.

Operation at a large scale with accuracy is a proposition that requires huge investment of time, human resources and money. Since field-based information has to be collected and discussed, field-knowledge will be very essential. Remote sensing and other such tools will supplement parts of the needed data. One solution for tackling large areas may be to carry out first a reconnaissance level analysis of the problems to identify the areas that need more focused attention, and then launch a detailed or semi-detailed analysis in the targeted small areas. Detailed manuals for characterization and analysis of features have to be prepared by a group of specialists, and field-tested, wherever necessary. These manuals should have local relevance, because many features at that scale are specific to the climate, terrain and socioeconomic framework to which these belong. Manpower training is a must, and linkages with appropriate International institutions are needed to provide adequate training to the researchers. A close liaison between the EWS research organizations and the local development agencies is also necessary. The EWS institutions should be able to provide details of the problem sites to the development agencies, and the development agencies should provide the details of their activities, so that the results of such activities could be monitored to find out the effects.

Linkages between the local and the national level organizations, the administrative set up, the national node, the regional and the international institutions and the CCD has to be strengthened, for which a tentative scheme has been suggested.

TOWARDS AN EARLY WARNING SYSTEM FOR DESERTIFICATION

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Early Warning System: Previous Major Work

Early Warning System (EWS) is a concept that has been nurtured and developed in the wake of severe droughts that engulfed large areas of different continents, especially during the last three decades of the 20th Century. The concept largely remains to date an adage to the natural climate-related disasters like droughts and floods, and the related food security systems. A detailed description of the current state of EWS for drought preparedness and drought management in different countries, as well as the policy and technology frameworks for the same have been discussed in Sinange (1999) and Wilhite et al. (2000). It is now increasingly felt that EWS should also exist for desertification, so that pro-active actions can be organized in a much coherent and coordinated manner for preventing land degradation in the arid, semi-arid and dry sub-humid areas.

It is in this context that the 3rd Conference of the Parties of UN Convention to Combat Desertification decided to appoint a ten-member Ad-hoc Panel to examine the modalities of Early Warning Systems and suggest better functioning of the systems for drought and desertification.

Assessment by CeSIA, Accademia dei Georgofili, Italy

As a part of the activities to understand the functioning and utility of the different early warning systems the CeSIA, Accademia dei Georgofili of Italy prepared a global report on the current understanding of the Early Warning Systems and Desertification (Anon., 1999). Thereport reviewed the structure, functioning, utility and relevance of the following major EWSs on food security: Alerte Precoce et Prevision des Production Agricoles (AP3A), Food Insecurity and Vulnerability Information

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and Mapping Systems (FIVIMS), Global Information and Early Warning System (GIEWS), Southern Africa Development Community (SADC), Famine Early Warning System (FEWS), and Vulnerability Analysis and Mapping (VAM).

The report is quite informative. It has been noted that although EWS has become technologically more sound, more efficient and socially more relevant, especially due to the revolutions in information technology during the last one decade, so far all the major systems concentrate on drought and food security, and no system is specifically devoted to desertification. It points out that many of the indicators are good for desertification EWS also, and that some of the indicators indirectly measure desertification. However, it cautions that the temporal scales of EWS for food security (for drought) and for desertification are different, that the desertification processes take a longer time to manifest, and hence the systems developed for food security can not as such be applied for desertification EWS. It suggests that the time scale of an EWS for desertification should be extended over a period of several years in order to see remarkable changes in evidence. In conclusion, the study has suggested that few questions need to be answered in near future to make the system more "demand-driven" (i.e., towards fulfilling the needs of the affected people) than to be "technological push" (i.e., systems that may be technological novels and, hence, should be used, but may not appeal to the affected people). The questions are as follows (Anon., 1999, pp. 29-30).

"Need to develop a common language. The integration between a risk analysis and a vulnerability analysis, as the structural frame of reference, has become a generally shared approach. The different meanings of particular terms, i.e. vulnerability and risk, in different systems are still misleading, making interaction difficult and causing isolation.

Facilitated access to and transparency of data. As of today, access to baseline data, in particular, is really neither free nor facilitated, due both to the difficulties in making the data bank's network operational and to the idea that data collection would be the final objective. Accelerated interaction towards the real partnership . partnership. A complex system requires – especially at this stage – the real willingness to co-operate with a partnership attitude, vis-à-vis those institutions that might contribute to its development and the donors/agencies who are asked to establish a political and institutional 'enabling environment'.

Production of a focused information for decision-making. At present, the conceptual capability of interpreting information is still behind the information production potential, and the risk arises that an unfocused information will be generated. This would charge the user with the task of selecting the information, rather than commanding it.

Users are required to identify the information they need. Users are not a homogeneous category, as regards both their technical skills and their information demand. This is certainly a further difficulty facing the EWSs that must decide, without any active interface, the type of information that is to be provided.

Adequate development of national/sub-national nodes. All the systems under consideration are operating at regional or sub-regional level, even if they produce information at the national or local level. How can any national and local EWS be functionally and institutionally developed, so as to be introduced into the existing network of systems like those under consideration?

Technological development should not be considered as a priority. The information technology is sharply and quickly developing. New generations of satellites are rapidly becoming operational. Therefore, the EWSs are endowed with theoretically more and more powerful tools. In this framework, it is of capital importance that – with respect to these new tools – priority be given to the development of those applications that would be really suited to the end users."

The above observations need consideration even for building a realistic EWS on desertification.

Objectives and a Search for Indicators of an EWS for Desertification

The primary objective of an EWS is to forewarn the people about some impending crises of land degradation, as well as to suggest some remedial measures. The basic philosophy behind EWS for desertification is, therefore, somewhat broader than that behind an assessment and monitoring of desertification. While the former has to analyze sets of biotic and abiotic parameters (indicators) to find out the vulnerability and risk as well, both spatially and temporally, the latter is more about the state of the art at a given time, and the scenario as it unfolds over time. Both the concepts, however, may rely upon almost the same or identical sets of data for derivation of results. The author has not yet come across any concrete study on EWS for desertification, although several studies hint at the possible future scenarios of desertification, based on the trends in patterns of landscape properties, land uses and vulnerability.

Indicators are the most vital necessities for preparing either an assessment of the status of desertification, or an EWS. CCD is specific that the indicators should be (1) bio-physical and (2) socio-economic, so as to achieve the objectives of providing users with tools, especially the local communities and the decision makers, and to help set up an early warning system for drought and desertification. In other words, searching for indicators should involve a holistic, multi-disciplinary approach, including the sciences devoted to the natural environment, as well as the sciences on the social and the economic aspects. In spite of the fact that these philosophies are in circulation for more than a decade or two, unfortunately, there is still no commonly used indicators and data format for either assessment and monitoring of desertification, or for EWS on desertification. Considering that the indicators and benchmarks for desertification provide the basic tools for EWS on desertification, the scenario for desertification EWS becomes precarious without an agreeable set of indicators that are interwoven with each other for deriving logical conclusions on future trends and necessary interventions.

Indicators in EWS for food security

The scenario is most unlike that for the EWS for food security, where the major practitioners use some definite sets of indicators. It is worth mentioning the indicators, as summarized in "Early Warning Systems and Desertification" (Table 1; Anon., 1999).

Table 1: Indicators of early warning systems for food security (used by major systems)

Indicators	AP3A	FIVIMS	GIEWS	SADC	FEWS	VAM
Food crop performance	✓		✓	✓	✓	✓
Crop conditions	✓		✓	✓	✓	✓
Crop production forecast	✓		✓	✓		
Marketing and price information		✓	✓	✓	✓	✓
Food supply/demand		✓	✓	✓	✓	✓
Health conditions					✓	✓
Food crops and shortages			✓	✓	✓	✓
Food supply			✓	✓		
Food consumption			✓	✓		
Crop areas	✓	✓	✓	✓	✓	✓
Pests			✓	✓		
Food balance		✓	✓	✓	✓	✓
Vegetation front	✓					
CCD	✓		✓	✓	✓	✓
NDVI	✓		✓	✓	✓	✓
Biomass	✓					
Seeding risk areas	✓					
Expected season length	✓				✓	✓
Estimated seeded areas	✓			✓		
Estimated seeding date	✓					
Vegetation cover						
Agro-ecological zones						✓
Crop use intensity						✓
Variation coefficient of agricultural production						✓
Cash crop production area	✓		✓	✓		✓
Coping strategies						✓
Average cost to travel to nearest market						
Livestock production	✓					✓
Population density	✓		✓	✓	✓	✓
Access to water						✓
Children education						✓
Rainfall	✓		✓	✓	✓	✓

AP3A= Alerte Precoce et Prevision des Production Agricoles (by AGRHYMET);
FIVIMS= Food Insecurity and Vulnerability Information and Mapping Systems (by FAO);
GIEWS= Global Information and Early Warning System (by FAO);
SADC= Southern Africa Development Community (from Zimbabwe);
FEWS= Famine Early Warning System (by USAID);
VAM= Vulnerability Analysis and Mapping (by WFP).
Source: Anonymous. 1999. Early Warning Systems and Desertification. CeSIA Accademia dei Georgofili, Florence, Italy, p. 17. (30 pages)

Relevance for EWS on desertification and constraints

As we have mentioned earlier, the report on "Early Warning Systems and Desertification" (Anon., 1999) observes that "land degradation being together a cause and an effect of food security, it is generally indirectly monitored by the EWS". It then suggests "due to intrinsic correlation with human and socio-economic factors, desertification could be measured also by means of the same methodologies utilized by the food security" (p. 29). However, when we look at the indicators followed by EWS for food security (Table 1), these appear insufficient for an EWS on desertification. The reasons are that the indicators hardly consider majority of the parameters related to land conditions that are crucial to the philosophy of desertification, save and except the vegetation component, including the crops. We shall deliberate on desertification indicators in a subsequent section.

Appropriate indicators for desertification assessment and monitoring are still being debated and refined by experts at different levels, including the Permanent Interstate Committee for Drought Control in the Sahel and the Sahara and the Sahel Observatory that have been requested to report on Benchmark and Indicators to the Committee on Science and Technology (CST) of CCD. Many countries and institutions are, however, following their own sets of indicators, leading to different kinds of assessment that are difficult to compare. One of the reasons for this situation is that the resources and the data sets available to the different actors are not identical. Many countries have now a system of collecting quantitative data on the meteorological aspects at certain spatial scale, but a similar system is not available for the land and water monitoring systems. It is still very difficult to assess wind and water erosion quantitatively over large areas. Also, there is hardly any scale against which the measured values could be evaluated for the degree of severity. Consequently, when a land is to be assigned a degradation class it is often the subjective opinion of the interpreter that prevails rather than any quantified value. One notable exception is the degree of land salinization, for which the limits of electrical conductivity (EC), exchangeable sodium percentage (ESP) and pH values are defined for different classes of severity. The degree of severity assigned to any other kind of degradation is still subjective, and that leads to differences in the output.

It is a fact that neither the 'desertification indicators', nor the 'impact indicators' of the CCD that are discussed at the highest decision-taking level, are yet circulated well. Also, these have not been tested and discussed vigorously among the participating countries and their institutions, and especially among the data collection and analyses groups. So, the chosen indicators are not only less known among the scientific and other organizations engaged in desertification reporting, but are also not evaluated properly for a meaningful dialogue for acceptance across the globe. In the cases where the 'common basic indicators' have been circulated for implementation, some African countries for example, the results have been mixed. The experiences of the Observatoire du Sahara et du Sahel (OSS) and the Comite permananet Inter-etats de Lutte contre la Secheress dans le Sahel (CILSS) in testing the CCD methodology 'for elaborating impact indicators' are worth mentioning here (Anon., 2000; Tables 2-4).

Table 2: Common basic indicators selected (by OSS, CILSS, UNESCO, 1999)

Elimination of poverty	1. % of the population living below the poverty line
	2. Relationship of female earnings to male earnings
	3. Rural-urban drift
	4. Nutritional status of under-five
Natural resources management	1. Land use
	2. Vulnerability of soil
	3. Rainfall (in time and space)
	4. Evapotranspiration
	5. Geographical distribution of water resources harnessed (quantity and quality)
	6. Index of exploitation of exploitable water resources
	7. Evolution of vegetation cover
	8. Evolution of plant biomass
	9. Agricultural resources
	10. Animal biodiversity

Table 3: Objectives and specific indicators of the Tunisian NAP

Specific objectives of the NAP	Specific impact indicators for the NAP
Improve the socio-economic conditions of the people	1.1. % of the population living below the poverty line
	1.2. Relationship of female earnings to male earnings
	1.3. Rural-urban drift
	1.4. Nutritional status of under-five
Combat encroachment by sand Combat the salinization of soil	2.4. Evapotranspiration
	2.1. Land use
	2.2.1. Changes in soil condition
	2.2.2. Land affected by desertification
	2.3. Rainfall (index of monthly rainfall)
	2.5. Geographical distribution of water resources harnessed (quantity and quality)
	2.6. Index of the exploitation of exploitable water resources
Participatory management of natural resources with the involvement of users	2.7. Evolution of vegetation cover (obtained using satellite imagery)
	2.8. Evolution of biomass
	2.9. Agricultural resources
	2.10. Animal biodiversity
	2.11. Arable land per capita
	2.12. Protected areas
	2.13. Per capita annual energy consumption
Improvement of organization in the field of desertification control and mastering the information and M+E systems	3.1. % of the state budget allocated to local communities
Institution building at various levels	3.2. % of local communities conducting a local development plan
	3.3. Investments realized by activities, projects and programmes that are part of the NAP
Support for research	4.1. Budget allocated to research and development in the field of desertification control
	4.2. Number of research teams working on R+D programmes that are part of the NAP
Plan to combat aridity; Establishment of a monitoring and warning system to fight aridity	2.3. Index of national monthly rainfall

Table 4: Objectives and specific impact indicators of the Desertification Control NAP, Burkina Faso

Objective	Impact indicator
Natural resources management	Land use #
	Soil fertility *
	Vulnerability of the soil *
	Rainfall and deterioration of the climate #
	Evolution and accessibility of water resources #
	Evolution of vegetation cover #
	Level of stabilization and preservation of animal diversity *
	Dissemination of new energy and renewable energy technologies *
Improvement in the living conditions of the people and creation of the concomitant environment	Degree of satisfaction of water needs (broken down by department) *
	Level of coverage of energy needs (broken down by region) *
	Evolution of migratory flows in the zones affected #
	Agricultural yields (by region) #
	Nutritional status of under-fives in the zones affected #
	Relationship of female earnings to male earnings #
	Population of the country living below the poverty line #
# Common basic indicators selected at regional level; * Specific indicators	

It was noticed in the report (Anon., 2000) that some basic common indicators proposed at regional level had to be re-formulated at national level. "For Tunisia, for example, the evolution of vegetation cover is understood to mean the index of vegetation obtained using satellite imagery. Burkina Faso did not select the basic indicator evapotranspiration. The indicator evolution of biomass was deleted from the list in favour of the single indicator evolution of vegetation cover. The problem of scale also arose. The scale of data collection should first be specified for each indicator. For instance, in Burkina Faso the indicator degree of satisfaction of water needs was judged to be more pertinent at village level. Calculating this indicator at regional level would dispel some of the information necessary for understanding the phenomenon. This is therefore an impact indicator at local level. On the other hand, most of the approved and calculated indicators are indicators on a national scale. If the structure remains cut off from regional and local scales which express the diversity of the situations and strategies, there is a strong risk of seeing these not very operational national indicators in terms of decision-making aids. Profound reflection on the aspects of scale interlocking could constitute one of the avenues of consideration to be explored in future for assessing an operational monitoring and evaluation system as a decision-making aid" (p. 13).

It was concluded that the "low level of regular collection, standardization and characterization of data, even for indicators such as rainfall, the absence of geo-referenced data and quantifiable economic data relating to the environment and to the natural resources, absence of a formal national framework for harmonizing and compatibilising existing databases relating to desertification control, the weakness of consultation mechanisms, information exchange systems, and institutional and technical capacities of the actors involved" are the major constraints towards calculating the selected indicators (Anon., 2000, p. 15). The conclusions apply to many other countries as well.

The European experience

In contrast to the African experience the European efforts towards selecting indicators for the Mediterranean region are more broad-based. At the conceptual level it has sought to enlarge the scope of the Pressure – State – Response (PSR) model used so far for the African situations to the Driving forces – Pressures – State – Impact – Responses (DPSIR) model, "because it seemed to be the most comprehensive amongst those designed to describe interactions existing between the components of the natural and socio-economic system" (Enne and Zucca, 2000; p.195). It has elaborated ten steps for finding the useful impact indicators and their applications, as is summarized in Table 5. It has been recognized that the selected indicators should have relevance to the context, simplicity, ease of communication and comparability, and have, therefore, been made a part of step 4. The characteristics are also part of the methodology that the African nations have followed.

Table 5. Summary of procedures for the production of impact indicators of desertification for the European Mediterranean region

Step	Activity
Step 1	Identification of the general and specific objectives and their classification according to the specific field of application and users
Step 2	Establishment of a mechanism for consultation amongst all the potential users and the potential providers of data
Step 3	Integrated analysis of the objectives and key issues to which they pertain, referring the DPSIR logical framework
Step 4	Identification of indicators able to best describe, at each level, the key issues identified above
Step 5	Identification and characterization of necessary data to measure and/or derive the adopted indicators and benchmarks
Step 6	Analysis of national and/or local situations relative to production and/or availability of data on the different key issues identified
Step 7	Calculation/measurement and analysis of indicators
Step 8	Preparation of an action plan to provide for the production of necessary but as yet unavailable data
Step 9	Dissemination of results
Step 10	Testing perception (feed-back from users)
Source: Enne and Zucca, 2000. *Desertification Indicators for the European Mediterranean Region*. ANPA, Rome, and NRD, University of Sassari, Sassari, pp. 172-173.	

The European effort has also prepared methodological sheets for each of the desertification indicators, like population density, rock fragments, soil depth, slope, rainfall, aridity, fire risk, erosion protection, drought resistance, plant cover, employment index, old age index, aridity index, rain erosivity, drought index, urban sprawl, infiltration capacity, stability of the surface horizon, grazing intensity, etc. (The indicators have been arranged here in the same sequence that these have been listed in Annex II (a) of the document; Enne and Zucca, 2000; pp. 212-249).

One important activity under desertification monitoring in the European Mediterranean is the running of a series of projects to model the landscape variables through remote sensing and GIS to predict landscape changes over time and space (DeMon-I, DeMon-II). The projects are highly ambitious and can provide excellent results on potential and, possibly, actual degradations, when based on sufficient ground and remote sensing data. For example, the SEMMED model proposes to simulate the runoff and soil detachment and erosion through field-based data on rainfall and soils, elevation data from maps and remote sensing data on vegetation cover to calculate the cumulative overland flow and soil loss. Utility of remote sensing techniques like 'normalized temperature' from the thermal band of Landsat TM (band 6) as a surrogate for bare surface/ degradation potential of land and that of 'Spectral Mixture Analysis' to derive spectral information content related to the erosional state of the soils have been demonstrated (Hill et al., 1995, 1998; Anon. 1998). Unfortunately, many of the conceptsand data requirements for these activities are either still beyond the reach of many establishments in developing countries where the drylands occur, or are difficult to test because of the lack of a suitable enabling environment. However, sporadic attempts have been made in some drylands of the developing countries, using remote sensing and GIS (for example, Grunblatt et al., 1992). It is to be emphasized that a beginning has to be made soon to carry out such testing in other drylands also to understand how simulation modeling can help in estimating the degradation under different bio-physical settings, and that the intellectual faculties in the different regions should be engaged to the best of their abilities for solving the problems that still surround the concept of desertification assessment and monitoring, as well as EWS on desertification.

The debate continues

The very fact that the European effort had to embark upon a new system and a new methodology is testimony that the one suggested earlier was still not acceptable to the scientific communities. The effort was not a result of the new demands of time, but perhaps a response to the demands of the specific environment for which they had to formulate the ideas and find the solutions. As Rubio and Bochet (1998) commented on the need for desertification indicators for Europe "The diagnostic criteria for desertification.... require special consideration of the European natural and socio-economic aspects of desertification" (p.116). Yet, there should be some 'common basic indicators' of natural and socio-economic activities, that are easy to follow, and that can be integrated with each other. For this the actors at the ground level should form a multi-disciplinary team, and the indicators for each discipline should be arranged in such a way that a coherent logical step from one to the other is apparent and is easy to link.

One wishes that the indicators in the African and the European efforts in the tables above were listed in a sequence that a traditional multi-disciplinary team of researchers involved in both the natural and socio-economic fields would be comfortable to look at and connect intuitively to the total environmental set-up through logical steps. For example, indicators of climate, the major exogenous process for landscape change, could be mentioned at the beginning of the stratification layer, followed by the geological (if any) and the terrain (geomorphological) indicators, and then by the indicators for soils, vegetation and water resources (for the natural or the dominantly physical environment), as well as by the human and animal populations, land use, infrastructures, markets and so on (for the human use system, or the dominantly biological environment). Such an arrangement of the indicators, perhaps, helps each of the multi-disciplinary team members to think more coherently about his or her indicators, their position in the hierarchy of the system, linkages with other fields in the physical/biological environments, and the steps needed to make an integrated analysis possible. One is not sure if at least a part of the present confusion set in during the refinement process of the indicators since the first sets were proposed in the late 1970s and the early 1980s (Reining, 1978; Dregne, 1983), or due to drift towards a discussion on which sets of processes, the socioeconomic and the bio-physical, be given how much weightage (qualitatively).

Other methodologies in currency

In spite of the differences on the concepts, or the refinements of the methodologies suggested by CCD, many other methods have been suggested and are followed at different levels (FAO, 1978, 1984; Kharin et al., 1985, 2000; Grunblatt et al., 1992; Singh et al, 1992; Babaeyv et al., 1993; Kadomura, 1996; Kust and Andreva, 1998; Harahsheh and Tateishi, 2000; etc.). Some of these have worked well for the local situations for which these were suggested. Yet, the methods could not be accepted universally. So far the Global Assessment of Humaninduced Soil Degradation (GLASOD) methodology for identification and mapping of degradation categories (Oldeman, 1988), and its modified version, ASSOD (the Assessment of the Status of Human-induced Soil Degradation in South and Southeast Asia; Middleton and Thomas, 1997) that puts more emphasis on impact of degradation on productivity than the degree of degradation, has found more acceptance than the other methodologies. Yet, as we shall discuss in the next paragraph, there is a need to find an alternate methodology.

Mapping of the degradation classes is one of the major steps towards understanding the spatial aspect of desertification. Some of the confusions still remain unsolved in this sphere. It has been noticed that often the methods for global-scale mapping are copied for the local level mapping, without consideration of the scale, leading to some erroneous results. Methodology like GLASOD (Oldeman, 1988) that proposes inputting of approximate percent area under different degradation classes within a parcel of land is usually suitable for small-scale mapping, where depiction of different degradation classes and their severity can not be shown separately because of the poor spatial resolution of the maps. If the indicators of desertification are to be used for the ultimate purpose of understanding the different degradation processes and for finding area-specific solutions to the problems, then it is necessary to map the phenomena at large scales, where the areas under each degradation class and its severity can be represented separately, without much difficulty (say at 1:25,000 to 1:50,000 scale, or even at 1:250,000, depending upon the spatial variability of degradation). Even if the degradation classes in some areas are difficult to separate spatially at the resolutions of these scales, a simpler method of representation like the one proposed for the UNCOD 1977, may be sufficient. It was then proposed to map the most dominant and the associate processes of degradation together, and attach a degree of severity to each class. The method was simple, although the assessment of the processes and sub-processes were difficult and somewhat unrealistic. Warren and Khogali (1992) concluded that GLASOD could not be used as a baseline for desertification monitoring. When GIS technology is used it is not difficult to prepare maps of different degradation types as separate layers, and integrate them at the end of the process, although for mapping at local level the simpler the methodology the better. Bergkamp (1995) suggested a hierarchical approach for assessing desertification, and emphasized that a true understanding of the changes related to desertification is possible when we are able to understand the changes in landscape processes at fine scale. Mouat et al. (1997) developed a GIS-based model, using potential erosion, grazing pressure, drought severity index, vegetation greenness and invasion of weeds as indicators, to determine risk for land degradation in the USA.

A Fresh Look at the Data Layers Needed and Available

As we have hinted earlier, indicators for the desertification EWS may have much in common with the indicators for assessment and monitoring of desertification. Also, the desertification EWS will possibly succeed if it starts at, and gives more emphasis on, the local levels, rather than begins at the global and regional levels. We shall now attempt to catalogue a set of data that are usually consulted for desertification assessment and can be used for early warning system as well. The data are generally used by most organizations that attempt to assess the desertification situation, but our aim here is to re-state them in an orderly sequence (Table 6). Many of the natural resources data are generated by the research and development organizations, and are based on the detailed field and remote sensing studies, as well as on the interpretation of topographical sheets, secondary information, etc. The results are usually available in the form of maps (spatial format) and reports. Majority of the data on human and animal population are generated by national surveys at an interval of five to ten years, and are in both spatial and non-spatial formats. The list is not exhaustive, but highlights that the needed data to initiate the process of EWS on desertification can mostly be generated or obtained without much difficulties from the existing sources.

Table 6. Database needed for developing an EWS on desertification

Major resource groups	Types of resource	Data layers	Data frequency/ type	Spatial context of the data		
				Point	Line	Polygon
Land resources	Climate	Rainfall	Annual, cropping season(s)	✓		
		Temperature	Annual, cropping season(s)	✓		
		PE	Annual, cropping season(s)	✓		
		Rainfall intensity	Annual, monthly			
		Wind speed and direction	Annual, monthly	✓		
		Drought	Periodicity			✓
		Flood	Periodicity			✓
		Any other				
	Terrain	Landform	Major groups			✓
		Elevation	Contours, spot heights	✓		✓
		Slopes	Major categories			✓
		Drainage net	Stream orders		✓	✓
		Basins	Small watersheds to higher order catchments			✓
		Sand dunes	Types and relative stability			✓
		Palaeochannels			✓	✓
		Any other				
	Soils	Soil Groups	Great groups & sub-groups	✓		✓
		Texture	Surface, sub-soil	✓		✓
		Depth	With confining layer(s) like calcrete, gypsum, etc.	✓		✓
		Water holding capacity	0-30, 30-45, 45-90 cm depth	✓		✓
		EC	0-45, 45-90 cm depth	✓		✓
		pH	0-45, 45-90 cm depth			
		Fertility	N, P, K, S, Zn	✓		✓
		Any other				

Table 6. (cont.)

Major resource groups	Types of resource	Data layers	Data frequency/ type	Spatial context of the data		
				Point	Line	Polygon
Land resources (cont.)	Vegetation	Major types	Trees, shrubs, grasses			✓
		Communities	Dominant, sub-dominant			✓
		Canopy cover	Density of different types	✓		✓
		Useful plants	Species	✓		
		Biomass	Aboveground biomass production			✓
		Fuel wood estimates	Potentials under existing condition			✓
		Any other				
	Surface water - Streams	Stream flow character	Ephemeral/perennial		✓	
		Bank character	Rocky/sandy/alluvial		✓	
		Water discharge	Average at major tributary junctions & outflows	✓		
		Suspended load	Average at major tributary junctions & outflows	✓		
		Water quality	EC, pH, harmful chemicals	✓		
	Surface water - Canals	Canal networks	Lined/unlined, command areas		✓	
		Water discharge	Main canal, distributaries	✓		
		Irrigation schedules	Water allowance, frequency			
		Any other				
	Groundwater	Aquifer type	Rock type/alluvial			✓
		Depth to water	Before and after rainy season	✓		✓
		Water quality	EC, pH, SAR, harmful chemicals	✓		✓
		Wells (number)	Energized/ traditional	✓		
		Wells (uses)	Drinking, irrigation	✓		
		Utilizable resource	Annual rechargeable water, per aquifer type			✓
		Net draft	Annual, per aquifer type			✓
		Balance water	Annual, per aquifer type			✓
		Water potential	Annual, per aquifer type			✓
		Any other				

Table 6. (cont.)

Major resource groups	Types of resource	Data layers	Data frequency/ type	Spatial context of the data		
				Point	Line	Polygon
Land resources (cont.)	Land use	Major land uses	Irrigated cropland (canals, wells), rainfed cropland, grazing/pasture land (also called permanent pasture or rangeland), culturable wastes, unculturable wastes, forest, water bodies, settlements, transport network			✓
		Major crops and their production	Cereals, pulses, oilseeds, vegetables, horticultural crops			✓
		Fodder estimates	From crop fields, grazing lands, other lands			
		Forest products	Estimated green biomass, dry biomass, fuel wood, other products			
		Any other				
Human and animal resources	Human resources	Demography	Village and urban population densities, male/female ratio, age distribution, average household, occupation structure			✓
		Workers	Percentage of total population, % cultivators to total workers, % agricultural labourers, % pastoralists, % other workers			
		Literacy	In different age groups			
		Persons below poverty line				
		Land holding	% small, medium and large holders, fragmentation of holding in different size groups			
		Land fallowing	Frequency and area fallowed by small, medium and large land holders			

Table 6. (cont.)

Major resource groups	Types of resource	Data layers	Data frequency/ type	Spatial context of the data		
				Point	Line	Polygon
Human and animal resources (cont.)	Human resources (cont.)	Implements for ploughing	Area ploughed by animal-driven and tractors			
		Fuel wood	Sources, consumption per household			
		Any other				
	Animal resources	Number of domesticated animals	Cattle, sheep, goats, camels, etc.			
		Number per household	According to occupational structure of people (average), composition			
		Adult Cattle Units (number)	Density			✓
		Animal products	Milk, meat, hide & skin, etc.			
		Any other				
Facilities and infra-structures		Markets	Distance, type, major commodities	✓		
		Connectivity	Roads, railways, etc.		✓	
		Other facilities	Banks, etc.	✓		
		Any other				
Manage-ment practices	Land & water management	Soil conservation	Types of structures, area covered	✓		✓
		Water conservation	Types of structures, area covered	✓		✓
		Agronomic practices		✓		
		Horticulture		✓		✓
		Other vegetative measures, including forestry		✓		
		Others				
	Livestock & Range management	Controlled grazing		✓		✓
		Sown pastures		✓		✓
		Livestock improvements		✓		✓
		Other range improvements		✓		✓
	Others					

Note: Most data on human and animal resources are statistical in nature and are tabular.

Explanations for including some specific data types

Climate: We may explain here the need to include some of the data types. Under climate, information on cropping season weather may be helpful in estimating agricultural droughts and related phenomena, while that on periodicity of droughts and floods helps to find out the trends in and cyclic nature of the climate over time.

Terrain: Under terrain, it is necessary to catalogue the different types of sand dunes and their degree of near-surface stability (qualitatively) to assess the possible future sand reactivation patterns in a sand-covered area. Sometime the percent area covered by sand dunes is considered as suggesting a measure of wind erosion (e.g., Harahsheh and Tateishi, 2000, for non-arable lands). This may not be true everywhere. Studies have shown that many sand dune features in the arid-semiarid fringe areas are the products of a previously dry climatic phase, and that these have now attained a significant degree of stability because of increased rainfall and associated bio-physical processes in the sand bodies. Also, the wind speed in the fringe areas may not be as high as in the core of the arid lands (see e.g., Kar, 1993, 1996 a,b; Thomas et al., 1999). Consequently, demarcation of wind erosion areas on the basis of dune-covered areas may be misleading, irrespective of whether the sites are under arable or non-arable land uses. Information on palaeochannels provides a basis for understanding and evaluation of the waterlogging and land salinization problems in the alluvial plains. These are usually identified and mapped from satellite remote sensing and aerial photo-interpretation. Stream ordering, based on topographical sheets, as well as basin and watershed mapping, helps to understand the water erosion potentials and possible depositional zones.

Soil and Water: Information on soil depth and soil texture immensely help in deriving answers on erosion potentials and a host of crop-related questions, while information on useful plants, biomass and fuel wood potentials have relationship with the human use systems. Information on stream flow, especially water discharge, sediment load, etc., are usually lacking for a large number of ephemeral and perennial stream basins in the drylands, especially in the arid and semi-arid lands. Only some major perennial streams have few gauging stations to collect the data, and are inadequate to make realistic assessment of soil erosion from smaller catchments. Even though it is unrealistic to suggest a network of hydrological stations to collect the needed data, because of the numerous logistic problems, it is important to have as much data as possible from the different morpho-climatic locations to match these with the results of soil erosion modeling efforts under given environmental conditions, and ultimately to use the model outputs confidently as surrogates for actual erosion.

Land use: One important consideration during collection of data on land use is to resolve the difference between different formats and nomenclatures of the data. In most countries several research organizations and academic institutions are engaged in analysis and mapping of the land use. At the same time, some Government Land Revenue departments are also engaged in collecting similar data at fixed intervals (usually once in a year). The revenue departments generally have their own standard classification of the land that suits the legal formalities for resolving land disputes and that assists in the collection of the revenues for crops grown and other resource uses. The system is elaborate and the data is tagged to large-scale cadastral maps of villages, showing individual plots and their uses. The land use classification of the research and academic organizations do not sometime match the classification by the revenue departments, and this leads to problems in assessing the data under different land categories. Since the revenue records have generally an elaborate system of data collection from village level onwards, with large-scale cadastral maps that can be consulted by the individual land owners, and have legal status, it is time that the land use mapping by the research and development organizations use nomenclatures that are synonymous with that of the revenue departments.

Other data: Although many of the socio-economic data, including several variables in the human and animal population data, are difficult to put in the spatial context that we have discussed so far, it is possible to use the mean values for each village to find out a spatial pattern. Most countries have their own land and water improvement plans, which have their impact on desertification control. Data on management practices will help to relate the trends in improvement or otherwise of the management activities.

Integration of Data and a Data Analysis System

Accurate prediction of the future scenario of land degradation is a difficult task. Much of it will perhaps be based on modeling of the landscape processes and anthropogenic activities, the rates of different processes and simulation of the system behaviours under induced conditions. Remote sensing and GIS should help much in these efforts. The data layers that we have listed above may be useful in arriving at somewhat realistic estimations.

It is possible to interpret the gathered data under a Data Analysis System, with the following major segments of analyses: inherent vulnerability of landscape; natural process acceleration; human and animal pressures; historical and current landscape response (degradation, etc.) under major land use systems; possible future response (degradation, etc.) under major land use systems; effects on long-term sustainable production (Fig. 1).

Natural process acceleration

We think that it is necessary to find out first the natural processes that lead to accelerated erosion and deposition. The main driving forces for erosion and deposition are the dynamics of climate and tectonics of the earth, which set in motion the natural processes. Anthropogenic activities (like human and animal pressures) help to accentuate the rates of the natural processes, leading to degradation, but often the rates of the processes are also accentuated by short-term climatic aberrations or tectonic disturbances. We may illustrate our point with some examples. Some fluvial features like rills and gullies are mentioned as indicators of desertification, but in a tectonically stable landscape system these features take a long time to enlarge under the prevailing land use systems of the semiarid and dry sub-humid areas. In fact, unlike many of the recent aeolian depositional features in the arid lands, which are vividly manifest and which can form in very short periods, most fluvial erosional features in the semiarid and dry sub-humid areas take a long time to develop. Yet, the average long-term erosional rates may be exceeded during the periods of abnormal floods that could be related to short-term aberrations in climate. Similar process acceleration can also be expected due to not-so-short term changes in climate. The scenario is different in tectonically mobile areas like the Kachchh region of Gujarat that experiences major earthquakes at regular intervals, the last major being in January, 2001. Such earthquakes and a slow upheaval of the terrain (like that in the mobile mountain belts of the Himalayas) lead to constant changes in the base level of erosion for the streams. The consequent efforts of the streams to adjust to the changes lead to vigorous downcutting by the main streams, formation of deep tributary gully network and faster dissection of the landscape. Similarly, the aeolian activities may increase many-fold during prolonged droughts, if assisted by high wind activities, as has been noticed in the Thar desert. Hence, it is necessary to find out and understand the signatures of natural process accelerations before we get into the task of collecting signatures of anthropogenic degradations (Table 7).

Table 7. Information needed for understanding major natural process acceleration

Process acceleration through	Types of manifestation	Kind of output
Climatic aberrations/ climate change and Tectonic disturbances (including earthquakes)	Drought	Map, table
	Flood	Map, table
	Landslide	Map, table
	Enhanced gully formation	Map, table
	Enhanced stream incision	Map, table
	Enhanced soil stripping	Map, table
	Enhanced sand deposition/erosion	Map, table
	Other manifestations	

Inherent vulnerability of landscape

It is also necessary to find out the inherent vulnerability of the landscape. The major outputs required for it are catalogued in Table 8. Land capability classification is routinely carried out by the soil scientists and is a simple measure of the suitability of the soil for some agriculture-related activities (and by proxy the vulnerability of a soil to different activities). Erosivity refers to the driving forces that can potentially detach sediment particles from the surface (like rainfall intensity and strong wind), while erodibility is a measure of how susceptible the soil/sediment is to detachment and erosion, and is largely influenced by the physical characteristics of the soil, but is also determined by the land use conditions and management techniques. Water erosivity can be calculated using the data on rainfall and the rainfall intensity, while wind erosivity can be found out from wind speed, rainfall and temperature data (Chepil et al., 1962; FAO, 1978; Yaalon and Ganor, 1966). Soil texture data can be used to measure erodibility under natural condition (FAO, 1978; Skidmore, 1988). Mapping of the erosivity and erodibility can be helpful in understanding the potentials of landscape to change under both natural situations and human-induced pressures, and by reasoning the possible future areas of accelerated erosion. Linking these potentials to the current climatic conditions/ vegetation cover/ human activities through deductive reasoning can significantly enhance our knowledge of the system operation for understanding the spatial patterns of degradation under induced conditions.

Table 8. Major outputs for deciphering inherent vulnerability of the landscape

Category	Output	Kind of output
Land capability classification	Land capability classes and sub-classes	Map
Erosivity	Water erosivity	Map
	Wind erosivity	Map
Erodibility	Water erodibility	Map
	Wind erodibility	Map
Soils prone to waterlogging and salinization	Heavy textured soils	Map
	Sub-surface barriers in soils: Depth of barrier Kind of barrier	Map; Table

Human and livestock pressures

To understand the anthropogenic degradation it is better to begin with the types of human and animal pressures on the landscape, as well as the severity of the pressures. Some scales are needed to quantify the amounts of pressures. For example, we find that agriculture and allied activities (including pastoralism) are the most dominant land uses in the drylands. Therefore, it is obvious that maximum pressures are exerted by these activities. Now, if we consider number of cultivators per ha of cultivated land as a pressure, we may also find out a threshold values of the optimum number of cultivators per ha that can be sustainable in long term under a given land use system (e.g., irrigated, non-irrigated, etc.). The values may differfrom region to region, depending on the technological levels, soil quality, etc. Similar is the case with the grazing pressure and the other pressures listed in Table 9. It is usually customary to convert the different grazing animals into a fixed animal unit (e.g. sheep unit, as in China;

Adult Cattle Unit, ACU, as in India), and then find out the threshold values for carrying capacity analysis. Mwendera and Saleem (1997), Imagawa et al. (1998) and Fernandez-Gimenez and Allen-Diaz (1999) provide some recent case studies on carrying capacity and grazing pressures. However, the concepts of 'carrying capacity', 'grazing pressure', and by implication the pastoralism in drylands, are being increasingly debated (Ellis and Swift, 1988; McLeod, 1997; Roe, 1997 and rejoinder by Scarnecchia, 1998; Roe et al., 1998; Oliva et al., 1998; Ward et al., 1998; Harrison and Shackleton, 1999; Hiernaux et al., 1999; DeYoung et al., 2000). Consequently, this pressure needs to be measured cautiously.

Technogenic pressure on land: In many countries modern technologies for exploitation of land resources are now spreading fast into large parts of the drylands, especially due to the national efforts to improve the living standards, but also due to the affluence of the rural people. For example, rural electrification programme in the arid western part of Rajasthan state, India, has led to sinking of many new wells for irrigation that draw water from deeper sources, using pump sets that run through electricity. Consequently, the groundwater reserve is dwindling in many areas. The problem is compounded by the choice of crops, like the growing of the high water-demanding wheat and groundnut in the sandy terrain. The crops are not for subsistence. In arid Gujarat the large farmers grow groundnut because they consider it as a status symbol, although the other factor is the market. Wheat is grown for its market value.

Table 9. Major outputs to decipher some of the human and animal pressures on landscape

Category	Derived from	Kind of output
Population pressure	Human and animal population densities per productive arable land and rangeland	Table, map
Cultivation pressure	Cultivators per ha of cropland + fallow land	Table, map
Pressure on groundwater	Net draft as % of the utilizable resource	Table, map
Pressure on fuel wood resources	Fuel wood consumption as % of estimated available	Table, map
Grazing pressure	ACU per ha grazing land + cropland + culturable wastes	Table, map
	Estimated biomass consumed as % of biomass produced (green+dry)	Table, map
Technogenic pressure on land	Areas ploughed by tractors in moderate to highly erosive and erodible land	Map
	Types of industries and the amount of untreated effluents discharged in the open	Table, map
	Commodity mined, type of mining, disposal of mined wastes	Table, map
Other pressures • Less incidence of land fallowing • Fragmentation of cropland • Social status in choice of crops/ animals • Market pressure on cropping (through choice of crops & related water and nutrient needs) • Market pressure on livestock and its products • Other market forces • Tourism and off-road vehicles • Forced transhumance • Others		

As a consequence of the spread of such high water-demanding crops the arid coastal plains in Gujarat are now facing not only a decline in groundwater level, but also incursion of saline sea water into the fresh water aquifer.

The technological changes have also influenced the implements for land preparation. The animal-driven wooden ploughs are being replaced in large parts of arid Rajasthan (India) by tractor-driven implements. In the sandy terrain with high erosivity and erodibility values deep ploughing is leading to churning up of a thicker layer of soil and consequent high wind erosion problem. Thus, affluence, and not poverty, is becoming a major factor of desertification, though the relation between poverty and desertification has also been noticed (see for example, Esikuri, 1999; Barbier, 2000). Opinion surveys in arid Rajasthan show that the villagers now favour hiring a tractor for few hours to keeping a draught animal for a whole year, because of the cost factor, although they are aware of increased sand blowing through such activity. In other words, economic considerations override the environmental considerations (Kar, 1996b; Venkateswarlu and Kar, 1996).

Similarly, unplanned open cast mining of evaporites and hard rocks of economic importance like sandstone, limestone, marble, etc., in the vicinity of agricultural lands and a common apathy towards reclamation of the land on which mine refuses are dumped, are threatening the land quality. Some of the mined materials, like limestone, China clay, Fuller's Earth, calcite and gypsum generate fine particles which are washed downslope with run off and get deposited in the adjoining cultivated fields as a less pervious layer. Ultimately this leads to waterlogging and salinity build-up.

Industrial establishments, which release high amounts of toxic elements into the land and the atmosphere, are also increasing rapidly. In the absence of strict enforcement of environmental laws, such establishments become a major source of land degradation in their surroundings. For example, effluent discharge from the textile printing and dyeing industries into the ephemeral stream beds in some towns of arid Rajasthan has contaminated surface and ground water downstream of the effluent discharge sites. Irrigation with such toxic water has degraded the quality of land and affected crop productivity (Aggarwal and Kumar, 1997).

Less incidence of land fallowing and land fragmentation: Continuous cultivation of the generally impoverished arid soils, instead of keeping the land fallow for some period, can also lead to declining productivity. A study in the arid western part of Rajasthan has shown that continuous cultivation of the shallow sandy soils, instead of keeping the land fallow periodically, has affected crop productivity, especially because the limited soil nutrients have been plundered with the harvest of crops, and these are never replenished to the desired level. Available P, which cannot be supplied by fixation like nitrogen, suffered the most and became a crucial factor in the decline of productivity (Tsunekawa et al., 1997). Keeping the land fallow and rotational cropping are, however, almost impossible to practice now, especially due to the increased population and consequent fragmentation of the land holdings. Opinion survey in a sample village of arid Rajasthan revealed that the present average per family agricultural land in the village was 10.1 ha and that too in many fragmented segments; in the previous generation the average holding was 17.8 ha (few fragmentation), and before that 44.0 ha (almost no fragmentation). These three generations together accounted for a period of about 50 years. As the land holdings became smaller and more fragmented farmers had little choice to select land parcels for cultivation. Fallowing, therefore, had to be abandoned, and whatever land holdings one was left with had to be ploughed for subsistence (Anantharam et al., 1999). In the absence of adequate farmyard manure and fertilizers the nutrient status of the land became precarious, and so the production started showing a declining trend.

Social status in choice of crops: This sometimes becomes a factor of faster land degradation. For example, in the arid parts of Gujarat the well-to-do farmers sow groundnut in the sandy soils, because they consider it as a status symbol. The water demand for the crop is high, and has to be met through groundwater irrigation. Since the soil is also highly permeable there is faster depletion of water, followed by incursion of saline water into the aquifer. Cultivation with such water is leading to land salinization.

Market pressures: Markets play a major role in the rural economy, but sometimes the market forces become a strong determinant of the choices of crops or livestock a land user makes about. For example, in many countries of the African Sahel region the groundnut and cotton are grown extensively for the price that the crops fetch in the market, in spite of the fact that the crops demand high water and lead to impoverishment of the soil. This is also becoming a factor of land degradation in parts of the semi-arid fringe of Rajasthan and Gujarat states where many farmers have shifted to high-value and high water- and other input-demanding cash crops, as the large multi-national agro-industrial companies readily procure the products at remunerative prices. International macro-economic policies like dumping of subsidized European beef to Sahel countries in the early 1990s led to overgrazing by the unsold livestock of the local pastoralists (Danish, 1995).

CCD. The indicators will be valuable for the EWS on desertification, and the data from benchmark sites will provide a basis for understanding the possible future threats. Presently, assigning a degree of severity to any class of degradation is subjective. There is still a dearth of commonly acceptable set of field-based and satellite image-interpretation-based indicators for assigning the degree of severity to the major forms of degradation like water and wind erosions. In the Indian part of the Thar desert in western Rajasthan a number of field indicators of water and wind erosions were chosen for the mapping of degradation, keeping in mind the climatic gradient in the desert, from wetter east to drier west, so that the variations in efficiency of the different processes from east to west and spatial variability of their impact on landscape are understood for scaling the severity of any particular degradation process (Table 11 and 12; modified after Singh et al., 1992, in Kar, 1996a). An element of subjectivity was involved in the assessment, as many of the features could not be rigorously measured over large areas, and interpreter's experience (and perhaps a bias) was involved in discrimination of the units. The indicators were, however, helpful in mapping, when the data gathered was used in conjunction with the satellite image-derived patterns of degradation. Some problems, like equating rills and gullies everywhere with desertification, could not be solved. Also, the degree of brightness of sandy

Table 10. Response of landscape to pressures under major land use systems

Major land use systems	Types of response (degradation)	Severity of degradation	Indicators from
• Irrigated cropland • Unirrigated cropland • Rangeland/ grazing land, permanent pasture, Common Property Resource • Forest • Barren & unculturable • Industrial uses • Other uses	• Water erosion • Wind erosion • Waterlogging • Salinization • Soil compaction • Soil crusting • Chemical degradation • Vegetation degradation • Increasing weeds and non-palatable species • Degradation due to industrial effluents • Degradation due to mine spoil • Others	• Slight • Moderate • Severe • Very severe	• Field • Remote sensing • Map • Local opinion

The response of the landscape

The pressures lead to various kinds of responses, many of which are well known. Since much of the dryland degradation takes place under some kind of land uses, it is better to see the responses in the context of the uses. The concept was suggested by Dregne (1983). Table 10 lists a set of responses under the major land use categories.

The scientific communities have discussed the responses for long. The Permanent Interstate Committee for Drought Control in the Sahel and the Sahara (CILSS) and the Sahel Observatory (OSS) are currently engaged in finding out suitable indicators and benchmarks for desertification assessment and have been requested to report on benchmark and indicators to the Committee on Science and Technology (CST) of areas in satellite images did not always relate to the degree of sand reactivation pattern. For example, in the wetter eastern fringe of the desert the brightness of sandy terrain sometimes was from a very thin layer of reactivated sand over an otherwise stabilized dune. Knowledge of the landscape inheritance from past processes, the erosivity pattern and the local land use helped to understand the situation (Kar, 1986, 1992).

Table 11. Field indicators for assessing wind erosion/ deposition in the Thar desert

Terrain	Average rainfall (mm)	Major indicators for assessment	Severity
Flat sandy plains with dominantly loamy sand to sandy loam soil	100-550	Fresh sand sheet up to 30 cm thick; few scattered new fence line hummocks and nebkhas up to 100 cm high	Slight
Moderately sandy undulating plains and sand dunes with loamy sand soils; thickly sand sheeted plains	Above 300	Presence of reactivated fresh sand of 50 to 150 cm thickness on stable dunes, sandy plains and fence line hummocks; many recently formed nebkhas	Moderate
Moderately sandy undulating plains and sand dunes with sand to loamy sand soils	Below 300	Reactivated and fresh sandy hummocks (nebkhas) and sand ridges of 90-300 cm height; sand sheets of 60-150 cm thickness between undulations; reactivated stable dunes with fresh sand deposits of 70 to 200 cm thickness; exposed plant roots to a depth of 40 to 100 cm in the sandy plains indicate erosion	Moderate
Moderate to strongly undulating sandy plains with closely spaced hummocks and high sand dunes with sand to loamy sand soils	100-550	Closely spaced sandy hummocks and sand ridges of 1 to 4 m height with fresh sand cover; sand deposits of 100-300 cm thickness usually present between undulations; highly reactivated sand dunes are covered by fresh sand and superimposed by crescentic bedforms of 2 to 4 m height	Severe
Barchan dunes and very thick sandy plains with loose sand throughout the profile	100-550	Areas of drift sand, especially as fields of barchans of 2 to 5 m height, which encroach upon roads, settlements and agricultural fields; also areas with very closely spaced nebkhas of 2-5 m height	Very severe

Table 12. Field indicators for assessing water erosion in the Thar desert

Terrain	Average rainfall (mm)	Major indicators for assessment	Severity
Plains with 30 to 90 cm deep medium to fine textured soils and good stand of tree vegetation	Above 300	Sheet erosion imperceptible, but rills of 0.3 to 0.5 m depth and 0.4 to 0.9 m width are usually present	Slight
Plains with 7 to 20 cm deep soils and poor stand of 300 vegetation	Below 300	Carbonate nodules exposed in pockets due to sheet erosion; widely spaced rills are present	Slight
Gently undulating plains with sand to loamy sand and sandy loam soils	Above 300	Sheet erosion as evidenced by few pebbles and carbonate nodules on the surface. Soil depth is generally less than 30 cm	Moderate
Hills, rocky/gravelly plains and sandy undulating plains with sand, sand and gravel and loamy sand soils	Below 300	Rills of 0.5 to 1.5 m depth and 1.0 to 2 m width; widely spaced gullies of 4-8 m depth and 6-15 m width	Moderate
Moderately sloping uplands, rocky/gravelly surfaces and gentle to moderately sloping plains with sand, sand and gravel and loamy sand to sandy loam soils	Above 300	Exposed carbonate nodules and pebbles, suggesting complete stripping of soil through sheet wash; gullies of 6-10 m depth and 7-25 m width with narrow interfluves	Severe
Steeply sloping hill ranges, associated obstacle dunes and sandy undulating plains	Above 300	Closely spaced gullies of 10-15 m depth and 20-40 m width; almost no mappable interfluves	Very severe

The above indicators may not hold true for other regions. Also, since subjectivity is involved in the process, there is a need for searching more acceptable and easily determinable criteria that are measurable. Digital image processing techniques may help in solving the problem to some extent, but scaling of the digital signatures in tune with the levels of degradation as measured in the field, and standardization of the digital signatures received from different satellite sensors over the decades for the same type and degree of degradation is a task that needs attention. Even for the same degree of degradation, the signatures are found to vary from scene to scene, depending on a variety of environmental factors. As we have discussed earlier, the degree of land salinization can be determined through the measurement of EC and ESP (Middleton and Thomas, 1997). Establishment of a good library of surface reflectance from different kinds of surfaces may help in better understanding of the signatures on satellite images.

Vegetation degradation continues to be a subject of serious studies involving satellite image interpretation. NDVI and other similar indices are being routinely employed for measuring the degree of vegetation degradation. Yet, as Dregne (1997) has lamented, rangeland degradation maps are still non-existent, even though about 70% of the world's rangelands have suffered at least moderate degradation (Dregne and Chou, 1992). Among the few attempts that have been made in the direction mention may be made of the effort to map the vegetation degradation of West Asia through GIS and remote sensing (Harahsheh and Tateishi, 2000). Some recent developments concerning the measurement of Net Primary Productivity (NPP) from medium- to high-resolution satellite images (Running et al., 1994, 2000) now open the scope of linking the status of vegetation cover with biomass production, and will help to address one of the basic demands of desertification monitoring, i.e. estimating the changes in biological productivity as a result of degradation. Although the methodology has been developed for global-scale analysis of data from the moderate resolution imaging spectroradiometer (MODIS), carried by the US satellite Earth Observation System (EOS), researchers are also using it for regional and sub-regional scale estimation of productivity. For example, researchers in the University of Tokyo and the Chinese Academy of Forestry are now collaborating to use and improve the method to estimate NPP in Inner Mongolia, using NOAA-AVHRR data (Tsunekawa, 2000a). If successful the method is likely to be used for estimating NPP changes over Asia. Concepts like linking desertification with environmental heterogeneity (Schlesinger et al., 1990), especially that of vegetation and soil, are being researched and applied through remote sensing (Seixas, 2000).

Linking traditional knowledge to desertification assessment process

The responses of the landscape that we have discussed above are from the viewpoint of researchers dealing with the biophysical environment. The vast majority of landowners, whose well-being should be the goal of the studies, are seldom consulted under this framework. Yet, the people who tend the land know better about its properties and its behaviour under different practices, although the language in which it is told is different. The knowledge of the landowner stems from his/her intimate relationship with the land, and is partly handed down from generation to generation, with periodic updating of the knowledge-base under changed technological scenarios. Therefore, it has been recognized in recent years that the 'traditional' (also called the 'grassroots' or the 'indigenous' knowledge) should be given its due place in the process of desertification assessment, monitoring and control. According to Hambley (1996) "grassroots indicators can be a far more powerful tool to identify, and possibly predict, environmental change". Social scientists and other researchers are, therefore, making efforts to understand the language of local people and trying to make these an integral part of the indicators to evaluate the land conditions (e.g., Hambley and Onweng-Angura, 1996; Sterk and Haigis, 1998; Bharara, 1999). However, as Seely (1998) has rightly pointed out "Often the indigenous knowledge is the subject of 'scientific study' but does not constitute an input into the scientific process or into decision-making based upon the scientific information (originally indigenous knowledge) gained" (p. 269). Some studies have tried to evaluate the local knowledge-base vis-à-vis scientific information, analysed their relevance under a changed environmental set up, or have tried to integrate them with the scientific indicators to prepare a set of 'hybrid indicators' (e.g., Krugmann, 1996; de Vreede, 1996; Ward et al., 2000).

In our opinion the local or indigenous knowledge on the land conditions is very crucial to assessment of land conditions at the scale of villages and communities. This is why many field researchers discuss the related issues with the landowners, respect their views, verify the information through standard scientific procedures, and convert the information to scientific language. Our interactions with villagers suggest that most of the opinions of rural folk have sound scientific basis, even though they are more concerned with gaining more from the land for economic well being, rather than a heightened concern for land degradation. As Mainguet (1991) has said, " farmers and stock breeders are very impressive in their knowledge of the land, but this knowledge is turned toward land exploitation rather than conserving resources" (p.282). Informal discussion with villagers in large parts of the non-irrigated (rain-fed) croplands of the Thar desert in India suggests that villagers are ready to share some risk of land degradation for added economic benefit. Concern for the land was noticed more in the irrigated areas, where waterlogging and salinity due to over-irrigation degraded large areas of fertile plains, and are threatening new areas. Also, the indigenous knowledge is more directed towards problem solving, rather than for the sake of knowledge gain alone. Thus, a wealth of simple, local technologies for desertification control can be gathered for distribution in affected areas.

Many of the views of rural folk on land degradation can be tested with modern scientific tools and then used to improve the data obtained from independent measurement of biophysical indicators, or to understand the processes. The landowners are, however, concerned with their own land and the land in their vicinity. Therefore, most opinions are site-specific or area-specific, and can hardly be used universally with certainty. Consequently, any scheme to integrate the indigenous knowledge with the 'scientific' database should begin at the grassroots level, at a village or similar administrative level for which the basic data is available, rather than beginning at the national or sub-regional level and then trickling downward. Since the scientific data gathering and analysis system is better established and have certain commonality over space and time, it may work better and faster if the results of scientific assessment, as discussed in previous sections, are thoroughly discussed in the concerned village and other local committees, through maps and diagrams, get feedback from the people, make corrections, if necessary, and then proceed to the next step of analysis.

Analysis and Modeling of Data for Understanding Future Patterns of Desertification

The major role of the EWS group is to understand the possible future threats of degradation so that remedial measures could be taken well in advance. The task requires a detailed analysis of the results from the vulnerability analysis, natural process acceleration scenario, the different kinds of pressure and the kinds of response that the landscape has shown. The task also requires careful study of the basic database, like the one in Table 6, and integration of the information. For example, information on wind erosivity, erodibility, terrain type, population and livestock pressures, the changes in land uses and the present patterns of erosion can provide clues to the expected patterns of wind erosion in near future.

Simulation modeling is likely to play a major role in estimating the quantity and direction of degradation. Simulation modeling without actual data set may, however, lead to erroneous results. This is especially true for the soil erosion modeling. To find out the potential water erosion the most commonly used method now is the empirical model of USLE and its revised version RUSLE (Renard et al., 1991). Process-based models like CREAMS (Knisel, 1982), ANSWERS (Beasley and Huggins, 1982), WEPP (Lane and Nearing, 1989), EUROSEM (Morgan et al., 1993) and EROSION-2D and -3D (Schmidt, 1996), and other synthetic models (e.g., Kirkby et al., 2000) are also being used for many situations. Predictions from these models, even at plot scale, are not yet accurate (Schroder, 2000), and using the models without verification can lead to gross miscalculation of the pattern of sediment yield and soil erosion. As the system becomes larger and complex the calibration of input parameters becomes increasingly less precise, and with time/length of run the systematic errors become so large that the results tend to become unrealistic (Pickup, 1988, 1990). Not surprisingly, therefore, the results from soil erosion modeling are being criticized and questioned even in the USA (Trimble and Crosson, 2000). Using the models for small watersheds may minimize the scale of the problem (e.g., Obayashi et al., 2001, using USLE for a small watershed), but considering the persistence of the problem, the values of erosion need to be taken with some caution. Jetten et al. (1999) assessed the results of model application to plots of 0.01 to 10.00 ha sizes (6 fieldscale models) and to a 41.5 m catchment (7 catchment models), and concluded that presently no model can be used without calibration, but calibration is difficult, undesirable, unacceptable from the user's point of view.

An added problem is that many drylands of the developing countries are not properly equipped to measure actual soil erosion that can be used to validate any model. Therefore, even the recent GIS-based modelling efforts rely more on potential erosions than the actual values (e.g., Grunblatt et al., 1992). Large-scale water erosion risk mapping in Kenya has been attempted through SOTER method (Van Engelen and Wen, 1992) that has used the modified USLE concept, and has calculated the risk on the basis of data from rainfall, slope, soil erodibility factors, land use and land management (see Middleton and Thomas, 1997). Although the outputs are impressive, these can hardly be used for anti-desertification or development purpose.

Wind erosion modeling has advanced significantly during the last two decades and has demonstrated the applicability of different models to field to regional scales (Shao et al., 1996; Shao and Leslie, 1997; Fryrear et al., 1998, 2000; Zobeck et al., 2000). Remote sensing and GIS applications are playing greater roles in the efforts to understand possible threats of wind erosion. However, as Mainguet (1996) has observed, the human impact on wind action system is still not fully appreciated.

Integrating the socio-economic data with the biophysical data set is a prime requirement. This can be done through GIS where all the input parameters are given some measurable values, or are converted into some kind of indices. In many cases the biophysical data sets are taken as surrogates for human impact, while in some models (like Kharin et al., 1985; Grunblatt et al., 1992; Babaev et al., 1993) the socio-economic data is fed into the calculation procedures, mainly by providing some weightage to the concerned factors. Perhaps, what is to be emphasized in the whole process is an integration of the data sets for an objective analysis of the situation.

Remote sensing, especially digital remote sensing, is also to play a larger role in the understanding of future degradation sites. New techniques of information extraction are proving to be more helpful in understanding the patterns (e.g., Pickup and Chewings, 1988; Hill et al., 1995; Hill and Schutt, 2000). As we have discussed earlier, finding out NPP over time and space may be a better idea to replace NDVI (Tsunekawa, 2000b). Albedo mapping will help to understand the patterns of bare ground formation. However, at the local scale, where much of the information is to be gathered from field level, high-resolution geo-referenced data will help in understanding the patterns of change, and in matching the interpreted results with landscape and socio-economic trends observed in the field (e.g., Amissah-Arthur et al., 2000, for the Sahel).

Analysis of traditional and other indigenous knowledge for understanding desertification

Since one of the goals of desertification EWS is to allow for effective preparedness for controlling the degradation, the analysis and modeling efforts must necessarily be directed at the local level, i.e., the level at which development activities are taken up. To be effective at the local level, the EWS has to consult the local people for the degradation problems, their genesis and their evolving patterns. Therefore, as we have stated in the earlier section on assessment of desertification, a consultative mechanism has to be evolved to link the institution-based scientific evaluation system with the indigenous knowledge-based evaluation system. There is growing evidence in the scientific literature of the soundness of the vast indigenous knowledge base on land conditions. This also includes 'traditional knowledge', although we have a feeling that under a technologically driven, fast-changing environment some of the traditional knowledge may lose the relevance. For example, when a land use changes from rainfed monocropping to irrigated multi-cropping system, or from a dominantly pastoral to a dominantly agricultural system, the local traditional views on degradation or improvement of land qualities may not apply. One cannot stop such changes to occur, as these are also the parts of evolution. It is to the immense credit of land users, however, that they learn about the land's responses to the changed circumstances in a relatively short time, and the knowledge base evolves with time as new inputs are applied for better yield and for higher income. Thus, we may differentiate between the purely 'traditional knowledge' and the not-so-traditional, but indigenous knowledge.

To effectively integrate the traditional knowledge with the EWS on desertification it may be worthwhile to catalogue the local traditional knowledge, test these through scientific procedures and then use these in the analysis system. As we have noted in the earlier section, traditional knowledge base is based on local environmental conditions, hence can have higher relevance at local levels. Therefore, the collection and processing of the traditional knowledge has to be done sectorwise.

As in the case of desertification assessment, indigenous knowledge that may not be tradition-bound may be more relevant in understanding the future changes. Since the scheme suggested here builds up from the local level, it is possible to integrate the local indigenous knowledge into it, by first collecting the views of the local land users on future degradation (type, degree, location, direction), as well as on the causes, discuss the views at selective locations and find reasoning for the views, and then use the information in the scientific database. As in the case of desertification assessment, again, the information sharing may take place at the local committee levels and with local data sets and maps.

Possible Future Response and Effects on Long-term Sustainability

Once the analysis of the gathered data is objectively done it may be possible to find out the possible future responses of the landscape (Table 13). We propose that the exercise be done for the major land use systems, and maps prepared at 1:50,000 scale, so that these can be used for development purposes at local level. The perceived effects of the processes on long-term sustainability and on human activities may be indicated.

Table 13. Future response of landscape to pressures under major land use systems

Major land use systems	Types of response (degradation)	Severity of degradation	Types of output
• Irrigated cropland • Unirrigated cropland • Rangeland/ grazing land, permanent pasture, Common Property Resource • Forest • Barren & unculturable • Industrial uses • Other uses	• Water erosion • Wind erosion • Waterlogging • Salinization • Soil compaction • Soil crusting • Chemical degradation • Vegetation degradation • Increasing weeds and non-palatable species • Degradation due to industrial effluents • Degradation due to mine spoil • Others	• Slight • Moderate • Severe • Very severe	• Large-scale maps • Reports

Vertical Linkages: National, Regional and International

As we have discussed, much of the primary data for the above scheme is either available or can be gathered at the local to the national level. Relevant data is also being gathered and compiled at the regional and global scales by several international institutions (e.g., monitoring of climate and related phenomena, global bio-physical resources, including topography, soil, water, vegetation, major land uses, etc., as well as population, economic conditions, etc.). Our reviews have shown that advanced researches on understanding the landscape degradation processes through field and satellite methods, as well as through modeling efforts are also continuing in many industrial countries. Advanced methods of satellite remote sensing, GIS, and other analytical tools are being applied to generate the data. Although most data sets have coarse resolution, these can provide vital clues to the trends of degradation, as well as on the risks. The techniques applied to generate and analyse the data are often unique, and beyond the reach of many developing countries that are afflicted by desertification.

Many researches are yet to percolate to the developing countries because of the lack of suitable resources and enabling infrastructural facilities. Although ideally an enabling environment is to be established for each nation, the process will take time. Meanwhile, enormous data is being generated at the different international and regional institutions. Therefore, it is necessary to appropriately link the local and the national data sets with the higher order data sets at regional and international levels. The national nodes may collect and filter the data to make it appropriate for sending to CCD, as well as make the information available through the Internet. CCD will continue to be the central node where information from the national nodes as well as from the international and regional institutions will be stored and distributed. Since much of the database will be publicly available through Internet there may not be any problem in the exchange of data between the national nodes and the higher levels. However, the availability of the data to the lower levels, i.e., at the local levels may still be a problem, insofar as providing efficient internet facilities are concerned. Fig. 2 provides a scheme of the possible linkages.

Notes on the Operation of the System and Linkages

The system, as envisaged above, is based on resources available at the local level. The following points need attention for implementing an EWS for desertification.

• Considering that people are to be forewarned well in advance of the problems of risk, and the anti-desertification development activities are to be carried out on the basis of such reports, it is necessary for the system to function at a scale large enough to address to the local problems. As Dregne (2000) has pointed out, "maps at a scale of about 1/1,000,000 or smaller cannot be used to obtain accurate information on site-specific conditions such as land degradation. Land reclamation requires much more detailed maps".

• Operation at a large scale with accuracy is a proposition that requires huge investment of time, human resources and money. Since field-based information has to be collected and discussed, field-knowledge will be very essential. Remote sensing and other such tools will supplement part of the needed data. One solution for tackling large areas may be to carry out first a reconnaissance level analysis of the problems to identify the areas that need more focused attention, and then launch a detailed or semi-detailed analysis in the targeted small areas.

• A basin/watershed approach for the biophysical resources, especially those in the semi-arid and dry sub-humid areas, as well as in the stream-dominated areas of the arid areas, will help to effectively integrate the information, and processing of the data for estimating possible future soil loss, etc., basin-wise. On the other hand, an administrative unit approach is good for the socio-economic variables. Linking the basin/watershed units with the administrative unit may be cumbersome and difficult if done manually, but may be easier if done under a GIS environment. For the arid areas without surface drainage all the data may be collected within the administrative units.

• It may not be possible for a single institution or agency to gather all the information and analyse them, especially if a large area is to be covered. A number of institutions with specialists in scientific and development activities may be required for the task. A mechanism for vertical and horizontal integration of the institutions has to be worked out at national level.

• To ensure uniformity of approach in data collection, analysis and mapping, detailed manuals for characterization and analysis of features have to be prepared by a group of specialists, and field-tested, wherever necessary. These manuals should have local relevance, because many features at that scale are specific to the climate, terrain and socio-economic framework to which these belong.

• Integration of the collected information at local level to the national level is a task that can be better performed at the levels of different administrative units, e.g., at district, state, and country level. This will enable further processing and dissemination of the generated data at country level.

• Manpower training is a must, and linkages with appropriate International institutions are needed to provide adequate training to the researchers, especially in the areas of handling sophisticated instruments, advanced calculation/estimation procedures, and other new techniques. Joint field programmes with the training institutions will help the training institutions to get adequate feedback for sharpening the tools. Moreover, a mechanism to facilitate frequent exchange of ideas and results, especially through holding joint meetings and arranging field visits in different countries for the involved researchers, will help to improve the capabilities of the researchers as well as of the system as a whole.

• One major goal of the EWS is to help direct development activities to counter land degradation and the processes that lead to such degradations. Therefore, EWS should have adequate linkages with the national development efforts. A close liaison between the EWS research organizations and the local development agencies is necessary. The EWS institutions should be able to provide details of the problem sites to the development agencies, and the development agencies should provide the details of their activities, so that the results of such activities could be monitored to find out the effects.

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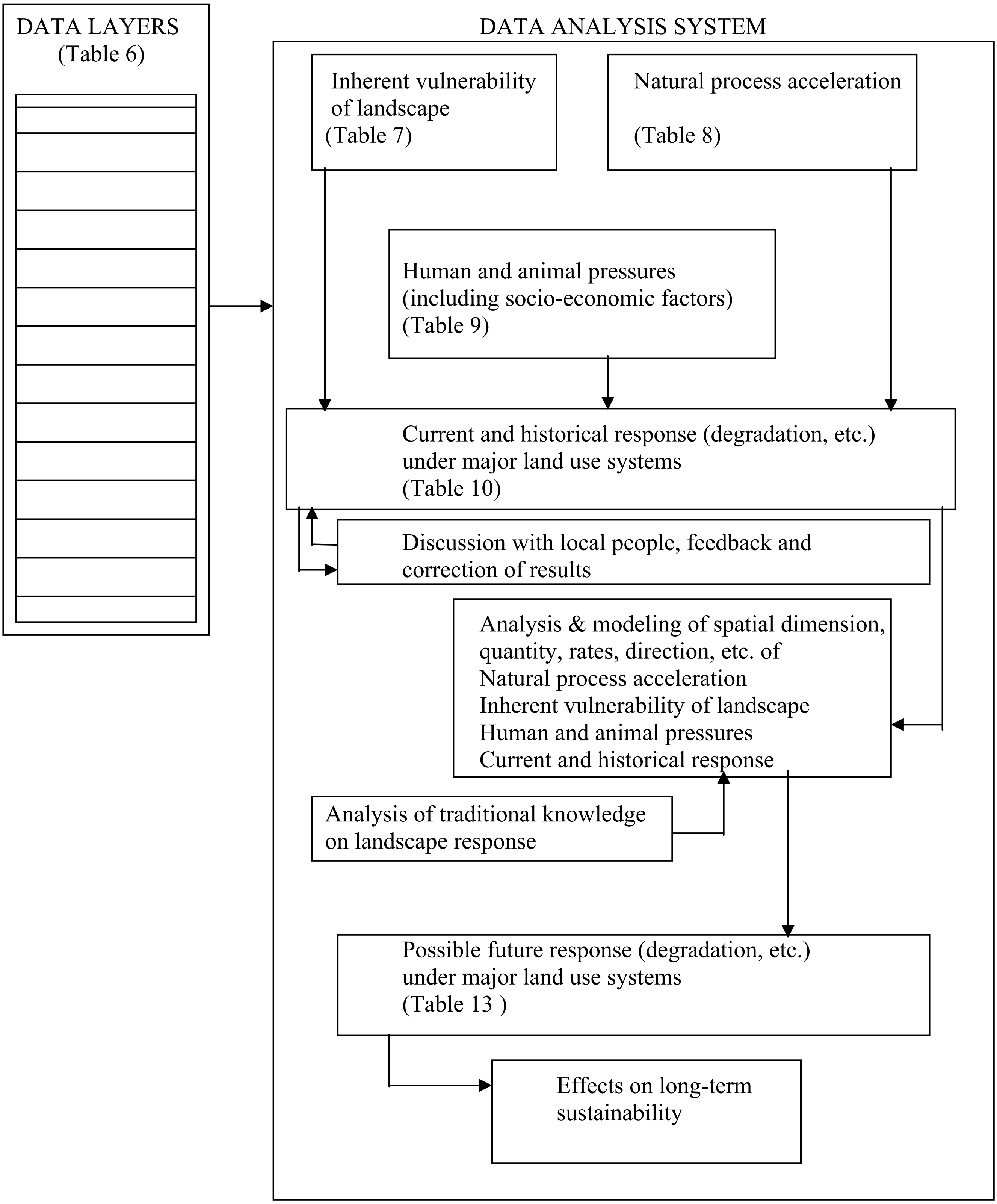

Fig. 1. A framework for EWS on desertification.

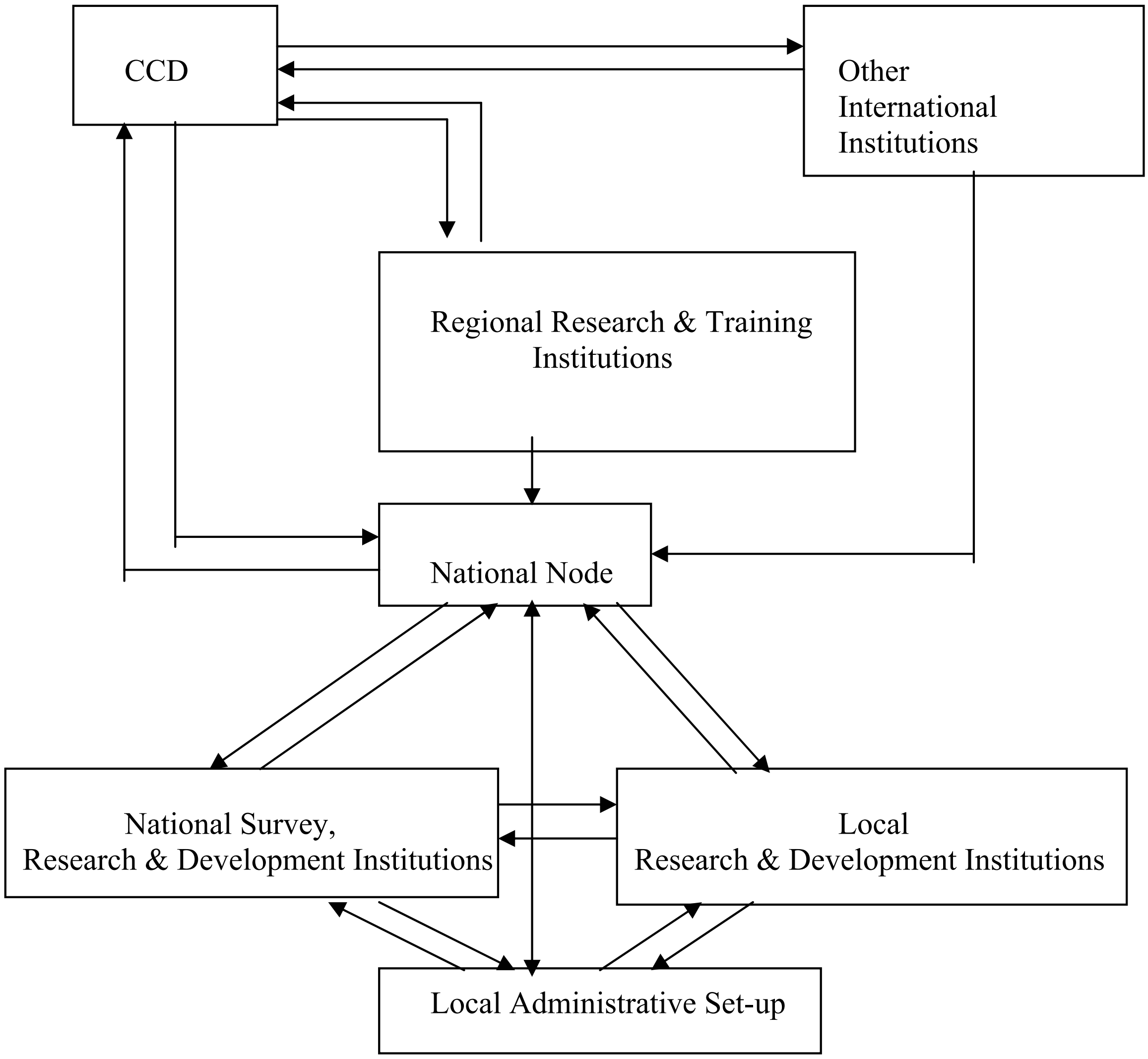

Fig. 2. Provisional scheme of linkages between the International, Regional, National and other Local level organizations engaged in EWS activities for desertification.

Advances in Desertification Monitoring and Drought Early Warning

Report to the U.N. Convention to Combat Desertification Ad Hoc Panel on Early Warning Systems

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June 1, 2001

Introduction

Desertification monitoring and drought early warning both require data from field surveys and from remote sensing. Indeed, operational drought early warning systems acquire and analyze the same field and remote sensing data required to monitor the extent and impacts of desertification.

The objective of this report is to describe recent technological advances in drought early warning and their application to desertification monitoring. The paper specifically addresses U.N. Convention to Combat Desertification (UNCCD) Decision 14/COP.4, paragraph (b), which identifies one of the four topics for examination by the UNCCD Ad Hoc Panel on Early Warning Systems: "Methods for and approaches to the prediction of drought and monitoring of desertification, particularly the method of analyzing vulnerability to drought and desertification, especially at the local, sub-national, and national levels, with special regard to new technological developments."

This report draws upon the experiences of the many organizations and programs that actively work on drought early warning, including, among others, Centre de Suivi Écologique (Senegal), Centre Régional AGRHYMET (Comité Permanent Inter-États de Lutte Contre la Sécheresse dans le Sahel), Disaster Prevention and Preparedness Commission (Ethiopia), Drought Monitoring Centres (Kenya, Zimbabwe), Famine Early Warning System Network (FEWS NET) (USA), Food Insecurity and Vulnerability Information and Mapping Systems (Food and Agriculture Organization (FAO)), Food Security Assessment Unit (Somalia), Global Information and Early Warning System (FAO), Instituto Nacional de Pesquisas Espaciais (Brazil), Joint Research Centre (European Union (EU)), National Agricultural Drought Assessment Monitoring System (India), National Desertification Monitoring Center (PR China), National Drought Mitigation Center (USA), National Remote Sensing Agency (India), Observatoire du Sahara et du Sahel (Tunisia), Regional Early Warning Unit (Southern African Development Community), RESAL (EU), Systèmes d'Alerte Précoce (Mali, Niger), Vulnerability Analysis and Mapping Unit (World Food Program). A comprehensive report by the Centro Studi per l'Applicazione dell'Informatica in Agricoltura (1999) detailed the data products of several major programs.

First, this report reviews the primary tools used for desertification monitoring and drought early warning: rainfall measurements and the remote sensing-derived Normalized Difference Vegetation Index (NDVI). The report then reviews other remote sensing data sources. Next, the report presents preliminary results of field-work by FEWS NET showing widespread changes in forest species richness following decades of desertification in the West African Sahel. Finally, the report reviews analyses of vulnerability to food insecurity and to desertification.

This report concludes that the work of operational drought early warning systems provides the fundamental data required to monitor desertification. Nevertheless, effective desertification monitoring will require further work on quantifying vegetative conditions more than 20 years ago for comparison to current remote sensing data on vegetation. Moreover, desertification monitoring requires systematic tracking of soil conditions, work that drought early warning systems do not undertake.

Rainfall monitoring

The UNCCD defines areas subject to desertification by the ratio of precipitation to potential evapotranspiration (P/PET). For the purposes of the Convention, desertification affects only the arid ($0.05 < P/PET \leq 0.2$), semi-arid ($0.2 < P/PET \leq 0.5$), and dry-sub-humid ($0.5 < P/PET \leq 0.65$) zones (UNEP 1997). Figures 1-2 show the aridity zones for Africa, Asia, and Latin America (UNDP 1997).

Rainfall varies more than potential evapotranspiration on both an inter-annual and an inter-decadal basis. Therefore, rainfall measurements constitute the most fundamental data source for monitoring desertification. Because drought is defined in terms of lack of rain, measurements of rainfall also produce the fundamental data for drought early warning. Rain gauges physically collect precipitation for manual or automatic measurement. The World Meteorological Organization coordinates the daily collection of rain data from gauges from around the world in a network called the Global Telecommunications System (GTS).

Since 1968, the West African Sahel has experienced the most substantial and sustained decline in rainfall recorded in the world since rain gauge measurements began (Nicholson 2000). Linear regression of 1901-1990 rainfall data from 24 stations in the West African Sahel yields a negative slope amounting to a fall of 1.9 standard deviations in the period 1950-1985 (Nicholson & Palao 1993). Since 1971, the average of all stations fell below the 89-year average and showed a persistent downward trend since 1951. Spatial analysis of 1950-2000 rain gauge data (Diouf et al. 2000) shows a southward shift of isohyets, lines of equal rainfall (Figure 3).

Because rainfall is related to the duration of low temperature clouds, temperature measurements from the Meteosat series of satellites offer a remote sensing indicator of precipitation. Many early warning systems now produce rainfall maps based on cold cloud duration. Since 1995, the U.S. National Oceanic and Atmospheric Administration (NOAA) has produced a satellite rainfall estimate for the African continent that uses GTS rain gauge data to ground truth the Meteosat data (Herman et al. 1997). In January 2001, NOAA further refined its satellite rainfall estimate by adjusting the Meteosat data with data from the Defense Satellite Meteorological Program (DMSP) Special Sensor Microwave/Imager (SSM/I) and the NOAA Advanced Microwave Sounder Unit.

NOAA posts daily precipitation estimates at 0.1-degree resolution for Africa for public access at <http: //www.cpc.ncep.noaa.gov/products/fews>. The U.S. Geological Survey (USGS), the remote sensing agency for the United States, archives all NOAA satellite precipitation data for public access at <http: //edcintl.cr.usgs.gov/adds>. USGS also <produces images comparing satellite rainfall estimates to the five-year satellite rainfall estimate mean and to the 1920-1980 rain gauge mean.

Weather forecasting is the prediction of the state of the atmosphere a few days into the future. The chaotic nature of the atmosphere makes weather forecasting very sensitive to the initial conditions of mathematical models of the atmosphere. The inevitable errors in assigning initial conditions, therefore, limit accurate weather predictability to approximately two weeks (Lorenz 1982). Weather forecasting is useful for drought early warning, but not for desertification monitoring.

Seasonal forecasting, or climate forecasting, is the prediction of properties of the atmosphere and the Earth's surface up to six months into the future (Cane et al. 1986). In general, climatologists either use general circulation models based on the physical principles driving atmosphere and ocean processes or they use statistical models of the historical correlations of precipitation to sea surface temperature anomalies, mainly due to the El Niño-Southern Oscillation. Seasonal forecasts exhibit modest skill (Stern & Easterling 1999), although not enough for use in either drought early warning or desertification monitoring.

Normalized Difference Vegetation Index (NDVI)
National Aeronautics and Space Administration (NASA) scientist Compton Tucker (1979) developed NDVI as a remote sensing tool for monitoring vegetative growth. NDVI constitutes the principal indicator that drought early warning systems and environmental monitoring programs use to track vegetative cover.

NDVI is an indicator of vegetative production derived from remotely sensed data in the red and near-infrared spectral regions. Because chlorophyll-a absorbs a maximum amount of light at a wavelength in the red region, 640 nm, photosynthetic efficiency is maximized and reflectance is minimized at this wavelength. The Advanced Very High Resolution Radiometer (AVHRR) sensor of NOAA satellites, a series of heliosynchronous, polar-orbiting satellites with a nadir spatial resolution of 1.1 km, senses light in the red region, wavelengths 550-680 nm, on Channel 1. The Channel 1 spectral response is therefore inversely related to chlorophyll density. AVHRR Channel 2 senses nearinfrared light, wavelengths 730 nm-1.1 μm. The Channel 2 spectral response is directly related to scattering in individual leaves and between leaves in the canopy. Combining the two channels accounts for differences in irradiance and indicates the intercepted fraction of photosynthetically active radiation or photosynthetic activity: NDVI = [Channel 1–Channel 2]/[Channel 1+Channel 2]. AVHRR Channel 5, which senses at 11.5-12.5 μm, detects temperatures <12 C and provides a mask with which to correct NDVI for clouds.

The NOAA satellite orbits the Earth once a day, but the limited memory of the on-board computer prevents storage of one day's 1.1 km resolution data for the entire world. Acquisition of 1.1 km AVHRR data therefore requires a ground station in the country that requires the high resolution data. Because the U.S. Government broadcasts the NOAA satellite data for free, any country with a receiver can acquire the high-resolution data. The satellite does sample the global data set to derive a data set at 8 km resolution that NASA downloads every day in support of FEWS NET, FAO GIEWS, and other programs. USGS continually posts ten-day composite 8 km NDVI data for public access at <http://edcintl.cr.usgs.gov/adds>. FAO GIEWS posts graphics, but not data, of NDVI images at <http://www.fao.org/giews>.

NASA has corrected the entire 1981-2000 8-km NDVI data series for Africa for atmospheric anomalies and inter-sensor differences. USGS has archived the entire data series for public access at <http://edcintl.cr.usgs.gov/adds>. Figure 4 shows the NASA-NOAA-USGS image of mean NDVI for Africa for this period. Figure 5 shows the FAO GIEWS images of mean 1982-1998 bi-weekly NDVI for Argentina. FAO GIEWS now derives NDVI from the French SPOT satellite. Figure 6 shows the FAO GIEWS image of NDVI for May 2001 for the People's Republic of China, calculated from SPOT data. FAO posts graphics, but not data, of SPOT-derived NDVI at <http://metart.fao.org>.

The 20-year data series now permits comparison of current NDVI with a longer-term mean. Figure 7 shows the NASA-NOAA-USGS comparison of the May 10-20, 2001 NDVI for West Africa with the 1981-2000 mean.

Mathematical integration of an NDVI time series over an entire year produces an indicator of total annual production (Tucker et al. 1981). Calculating the annual integrated NDVI from 1980 to 1990 along the Sahara-Sahel margin, longitude 16°W-39°E, Tucker et al. (1991) tracked the inter-annual variation of the 200 mm y-1 isohyet, the approximate limit of vegetative growth and beginning of the Sahara Desert. They found that this limit fluctuated significantly until its 1990 position lay 130 km south of its 1980 position.

Comparison of annual integrated NDVI to the annual mean NDVI since 1981 can reveal trends in potential vegetative production and, therefore, land degradation. Currently, USGS is conducting integrated NDVI analyses for the United States and for Africa.

Ultimately, net primary productivity (NPP) and standing biomass can provide more useful indicators of desertification than NDVI alone. Careful measurements of biomass and modeling of vegetative growth (Cramer et al. 1999) can generate close estimates of NPP. In Senegal, the Centre de Suivi Écologique (CSE) has measured green biomass at ground sites since 1987 and correlated NDVI to green biomass production. CSE now measures green biomass at 56 sites across the country.

NDVI also serves as an input in modeling attempts to determine the relative importance of anthropogenic and climatic factors in explaining rainfall variability in the Sahel. Zeng et al. (1999) compared actual rainfall data from the period 1950-1998 with the output of a coupled atmosphere-land-vegetation model incorporating SST, soil moisture, and NDVI. Their results indicate that actual rainfall anomalies are only weakly correlated to SST by itself. Only when the model includes variations in vegetative cover and soil moisture does it come close to matching actual rainfall data.

Finally, NDVI provides data useful for land cover characterization. USGS analyzed 1.1 km NDVI globally for the period 1992-1994 for the International Geosphere-Biosphere Program (IGBP). Figure 8 shows the final result of the IGBP Global Land Cover Characterization (GLCC), the only satellite-based global land cover analysis.

Other remote sensing sources

Drought early warning systems and environmental monitoring programs have adopted NDVI enthusiastically because of its low cost and ease of analysis. The limited spectral range of the original AVHRR data and the coarse resolution of NDVI prevent NDVI from serving certain resource analysis applications.

Table 1 shows the range of satellites useful for desertification monitoring and drought early warning. LANDSAT and SPOT, with resolutions up to 10 m and wide spectral ranges, permit spatial analysis of land use at a small scale. The financial cost of acquisition and analysis make these remote sensing products more expensive than NDVI. Terra, launched in 2000, offers NDVI at 250 m resolution. Yet, this is only one of two planned satellites that NASA plans for its series, unlike the long-standing commitment that NOAA has had to maintaining a continuous line of NOAA satellites. As far as spectral range, SeaWiFS, launched in 1997, senses in the visible range, producing realcolor images. NASA used SeaWiFS to track the dust storms in 2000 and 2001 that started in the desert areas of the western parts of the People's Republicof China and crossed the entire Pacific Ocean.

Table 1. Principal remote sensing data sources for desertification monitoring and drought early warning.

satellite	sensor	product	organization
Defense Meteorological Satellite Program (DMSP)	SSM/I	rainfall estimate	U.S. Air Force
Indian Remote Sensing-P4	IRS-WiFS	infrared imagery	India NRSA
Indian Remote Sensing-1C	IRS-LISS	land cover imagery	India NRSA
LANDSAT-7	Enhanced Thematic Mapper (ETM+)	land cover imagery	NASA, USGS
Meteosat-7	Infrared	rainfall estimate	Eumetsat
NOAA-16	AVHRR	8 km and 1 km NDVI	NASA, NOAA
SeaWiFS	SeaWiFS	visual imagery	NASA
SPOT-4	Vegetation	4 km and 1 km NDVI	CNES France
Terra	MODIS	250 m NDVI	NASA
Tropical Rainfall Measuring Mission (TRMM)	Microwave Imager (TMI)	rainfall estimate	NASA

Tracking permanent vegetation change in Africa

Forest species guard against desertification and climate change through the provision of multiple ecosystem services, including soil erosion control, storage and transpiration of the water required for precipitation, carbon sequestration, and the formation of habitats for a diverse array of plant and animal species. Not only do trees and shrubs provide these ecosystem services, but they also provide firewood, structural timber, traditional medicines, staple foods, and drought emergency foods. Therefore, tracking forest species richness can serve both desertification monitoring and drought early warning.

In Senegal, field inventories of forest species documented a 25–30 km shift of the Sahel, Sudan, and Guinean vegetation zones (Figure 9) in the past half century of desertification (Gonzalez 2001). Arid Sahel species expanded in the northeast, tracking a concomitant retraction of mesic Sudan and Guinean species towards areas of higher rainfall and lower temperature to the southwest. Densities of trees of height >3 m declined from 10 trees ha-1 in 1954 to 7.8 trees ha-1 in 1989, while the species richness of trees and shrubs fell from 64 species per 4 km2 area ca. 1945 to 43 per 4 km2 area in 1993.

This shift of xeric Sahel species into mesic Guinean areas in the Sahel is similar to a permanent 2000 m shift of xeric piñon-juniper woodland into mesic ponderosa pine forest in New Mexico, USA, caused by a 1954-58 drought in which precipitation there fell to their lowest recorded levels (Allen & Breshears 1998).

As a result of the changes in Senegal, human carrying capacity fell by 1993 to approximately 13 people km-2, at observed patterns of resource use, compared to an actual 1988 rural population density of 45 people km-2 (Gonzalez 2001). The fall in species richness has also reduced people's options qualitatively. For example, rural women depend on two particular shrub species for firewood because of the size of the branches, high wood density, and ease of collection. Beyond that, few fallback species remain. With respect to traditional medicine, 25 useful species have diminished significantly. Furthermore, eight species that provided fruit, leaves, and gum in past droughts have disappeared from as much as 53% of their range. If a grave famine hit the area in its current condition, people would not be able to find the emergency foods that saved others in past episodes.

FEWS NET has undertaken similar work showing changes across the Sahel consistent with the changes documented in detail in Senegal. We took a forest species inventory, consisting of a systematic listing of the presence or absence of all forest species in a village's lands. Village elders provided information on distributions around the time of independence in 1960 and field observations gave current distributions. In semi-structured interviews, village elders also discussed their observations of environmental change and their adaptive responses. Table 2 shows the preliminary results of the field work, showing declines in forest species across the Sahel. Furthermore, farmers and herders have scrambled to adapt to the environmental changes with significant modifications to agricultural and pastoral production systems as well as migration to cities.

Table 2. Preliminary results of FEWS NET field work on forest species declines in the Sahel.

country	village	ethnic group	latitude	longitude	forest species richness		Survey
					ca. 1960	2000-2001	
Burkina Faso	Nampabuum	Mossi	13°20' N	0°50' W	46	42	Feb. 2000
Chad	Akar	Ouaddaï	13°56' N	20°53' E	35	20	May 2001
Chad	Bourtey Ganoun	Ouaddaï	14°01' N	20°40' E	30	26	May 2001
Chad	Kardofal	Ouaddaï	13°22' N	21°10' E	45	41	May 2001
Chad	Marchout	Ouaddaï	13°34' N	20°50' E	50	49	May 2001
Chad	Ningelin	Ouaddaï	13°31' N	21°12' E	49	43	May 2001
Mali	Fabougou	Bambara	14°15' N	6°15' W	55	55	Feb. 2000
Mauritania	Aten	Hal Pulaar-en	16°15' N	13°40' W	43	26	Jan. 2000
Mauritania	Dioude Waalo	Hal Pulaar-en	16°15' N	13°40' W	44	22	Jan. 2000
Niger	Banizoumbi	Zarma	13°50' N	2°56' E	46	26	May 2001
Niger	Dan Tsuntsu	Hausa	13°50' N	7°30' E	52	41	May 2001
Niger	Guidimouni	Hausa	13°42' N	9°31' E	59	56	May 2001
Niger	Tamaka	Hausa	13°54' N	3°20' E	55	37	May 2001

Vulnerability analyses

Drought early warning systems conduct analyses of people's vulnerability to food insecurity. These vulnerability analyses generally look at the short term, identifying geographic areas where people may be at risk of hunger in the following 12 months. FEWS NET has posted for public access at <http://www.fews.net> the maps and reports from five years of annual vulnerability analyses for Burkina Faso, Chad, Mali, Mauritania, and Niger. The vulnerability analyses start with a calculation of the balance between agricultural production and off-farm income and projected food needs. FEWS NET also assesses socio-economic indicators of access to food. Vulnerability analyses like these do not examine desertification, although an analysis of vulnerability patterns over the long term could reveal impacts of desertification.

The Centre Régional AGRHYMET has also produced vulnerability analyses covering Burkina Faso, Mali, Niger, and Senegal (CILSS 2000). They examined temporal NDVI patterns as well as cereal balances. The World Food Program Vulnerability Analysis Mapping unit works on similar vulnerability analyses, but has produced little public information.

The U.S. National Drought Mitigation Center produces a weekly Drought Monitor that maps those areas in the United States vulnerable to agricultural problems, water shortages, or wildfire due to drought conditions. The Drought Monitor is available for public access at <http://enso.unl.edu/monitor>. The monitor uses a suite of six indicators, including the Palmer Drought Index (Palmer 1965), the Standardized Precipitation Index (McKee et al. 1993), seasonal precipitation as a fraction of long-term mean precipitation, soil moisture, stream flow in surface waters, and NDVI.

The Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture (USDA) has attempted to produce a global map of vulnerability to desertification (Eswaran & Reich 1998) based mainly on soil characteristics (Figure 10). Using soil characteristics such as texture, slope, moisture retention capacity, and pH derived from the FAO (1991) soil map of the world and climate data, the NRCS vulnerability analysis classifies areas qualitatively according to potential impacts on grain production.

Conclusion

Operational drought early warning systems provide the fundamental data required to monitor desertification. These systems monitor and analyze rainfall and vegetative production, two of the most important indicators for tracking desertification.

Remote sensing makes possible drought early warning and desertification monitoring. The principal advantage that remote sensing data offers is the ability to monitor and analyze the spatial patterns of environmental phenomena across vast spaces on a repetitive basis. Indeed, satellite data products fill in the substantial gaps of ground-based coverage to provide information where otherwise none would exist.

Nevertheless, effective desertification monitoring will require further work on quantifying vegetative conditions more than 20 years ago for comparison to current remote sensing data on vegetation. Finally, desertification monitoring requires systematic tracking of soil conditions, work that drought early warning systems do not undertake.

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Figure 1. Aridity zones for Africa (data Hutchinson *et al.* 1995, analysis UNDP 1997, map USGS).

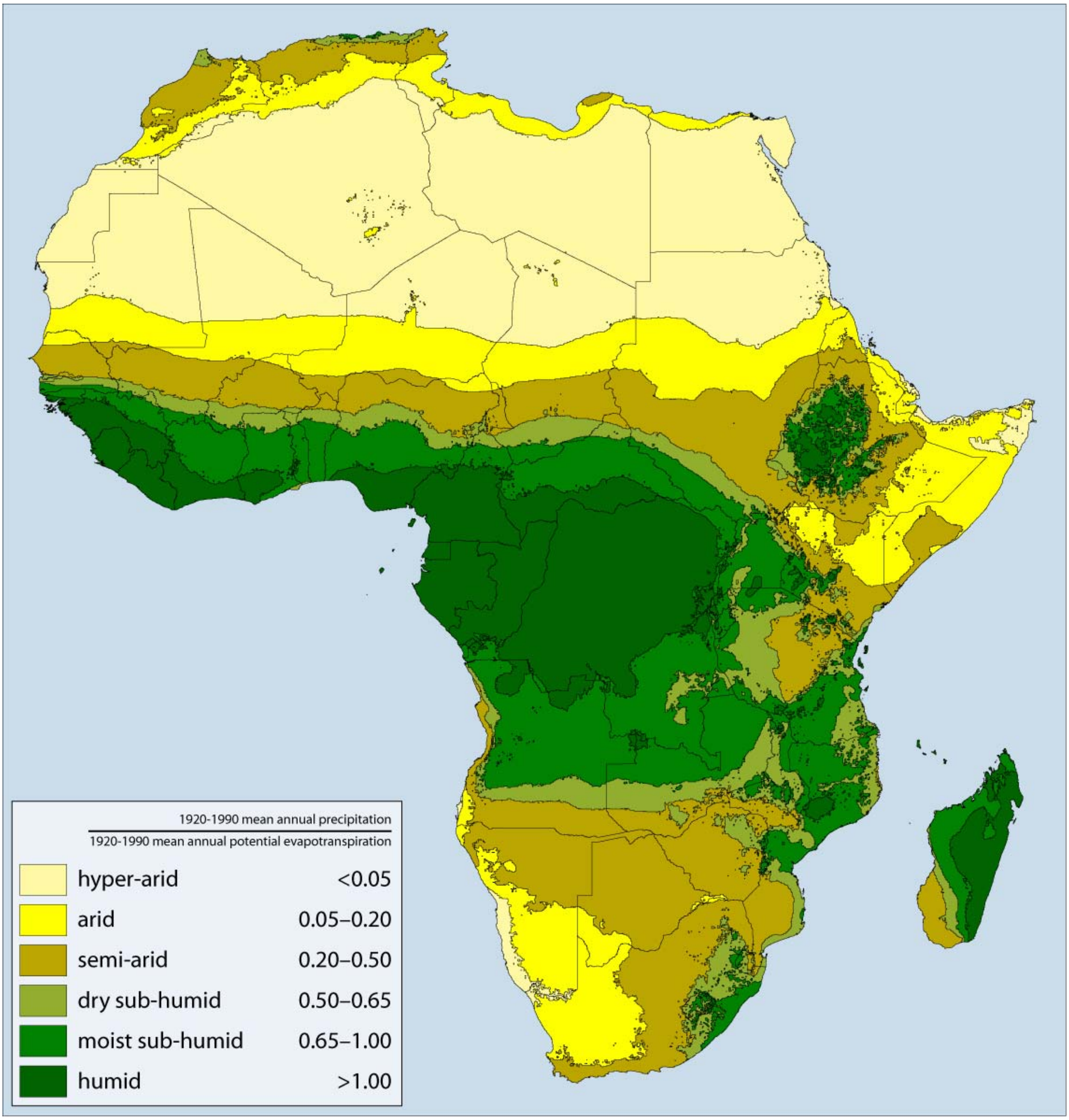


Figure 2. Aridity zones for Latin America (data Hutchinson *et al.* 1995, analysis UNDP 1997, map USGS).

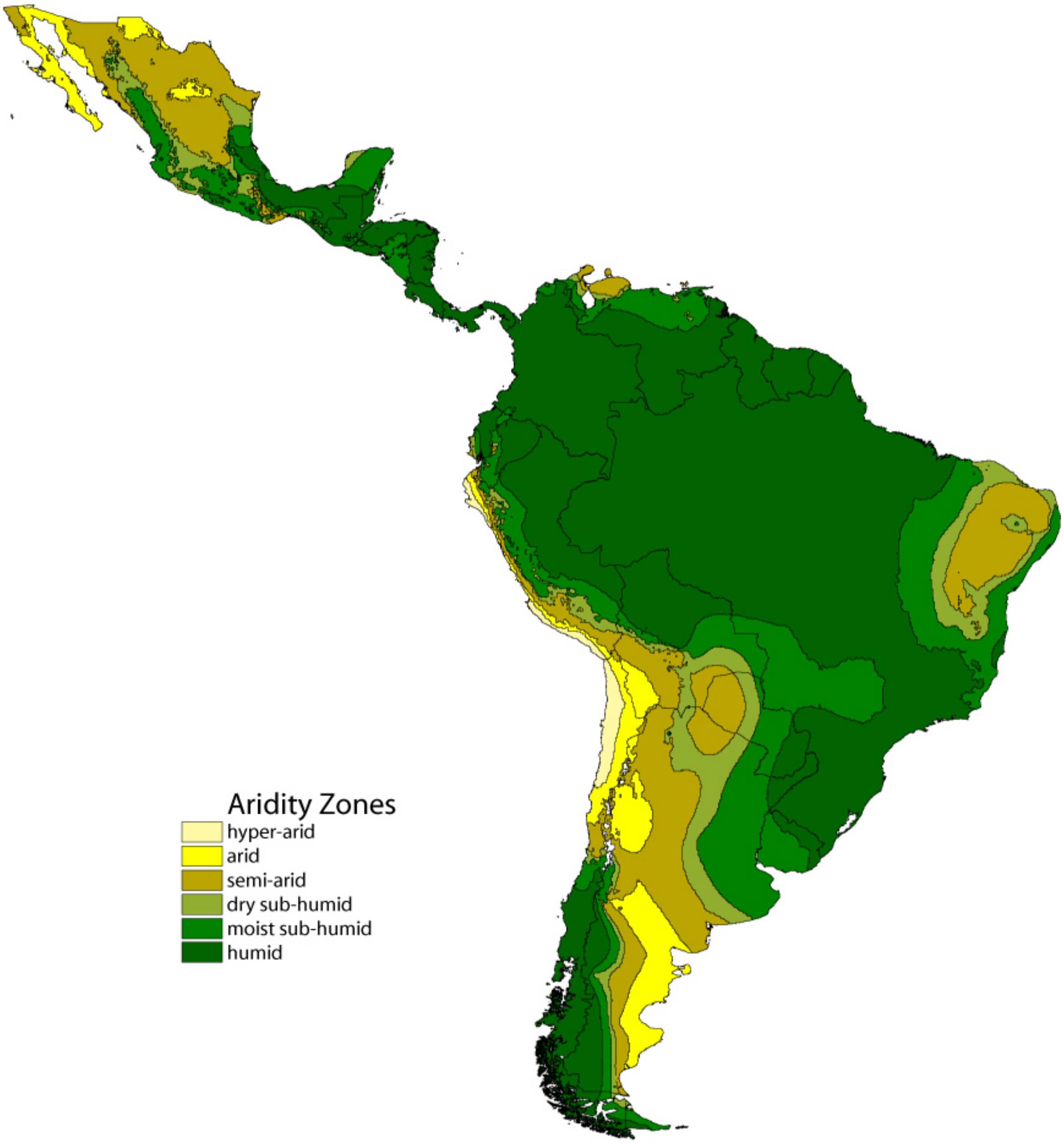


Figure 3. Southward shift of mean July-September rainfall across West Africa between the periods 1950-1967 and 1968-2000 (Diouf *et al.* 2000, *Centre Régional AGRHYMET*).

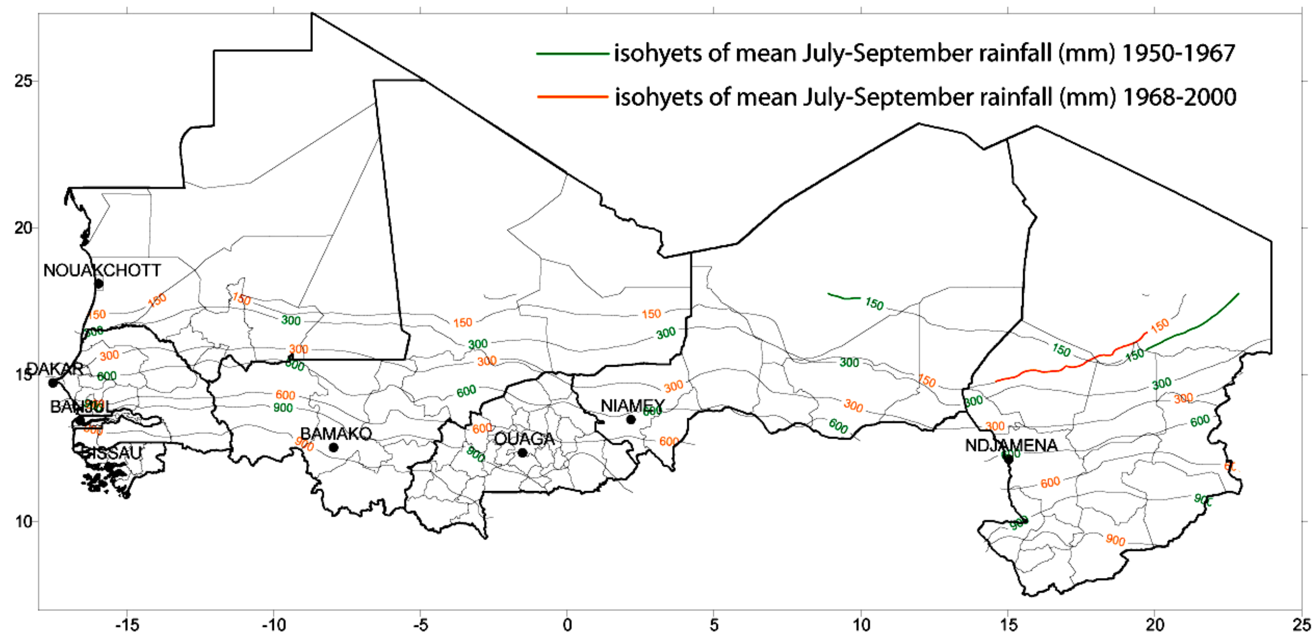


Figure 4. Mean 1981-2000 NDVI for Africa (NASA, NOAA, USGS).

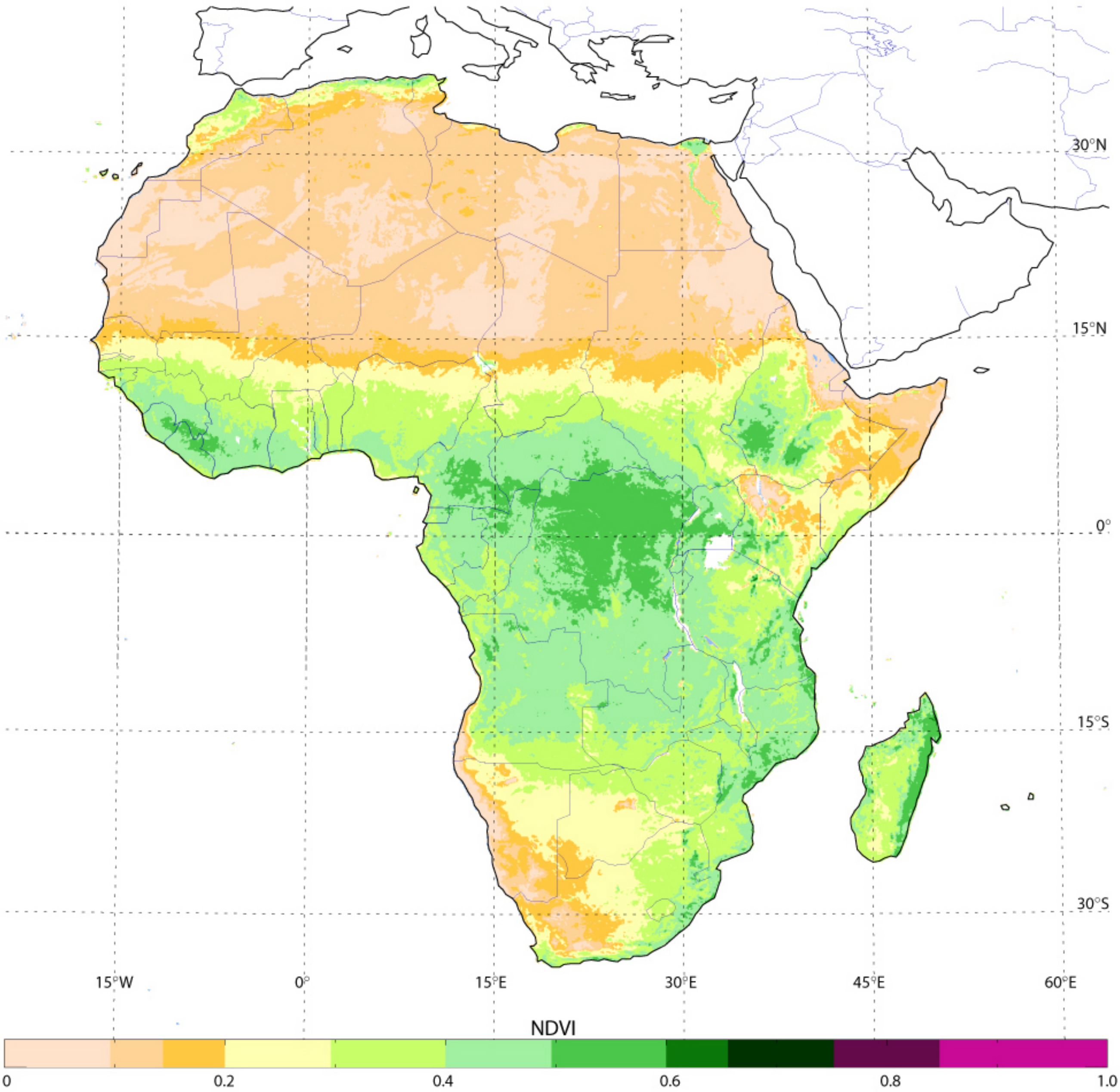


Figure 5. Mean bi-weekly 1982-1998 NDVI for Argentina (data NASA, NOAA; maps FAO GIEWS).

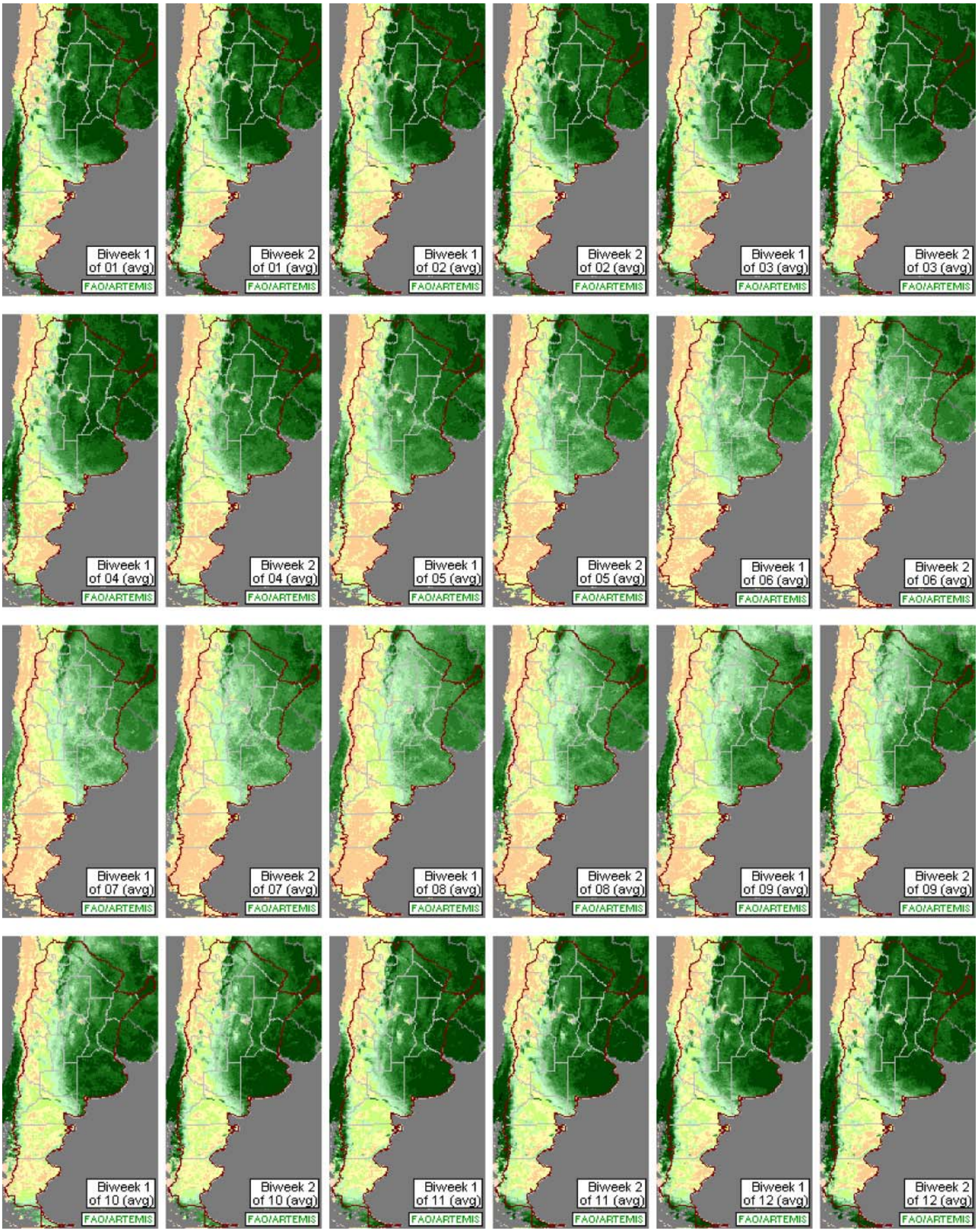


Figure 6. May 2001 NDVI for the People's Republic of China (data CNES, map FAO).

Figure 7. May 10-20, 2001 NDVI for West Africa and difference from mean 1981-2000 NDVI (data NASA, NOAA; maps USGS).

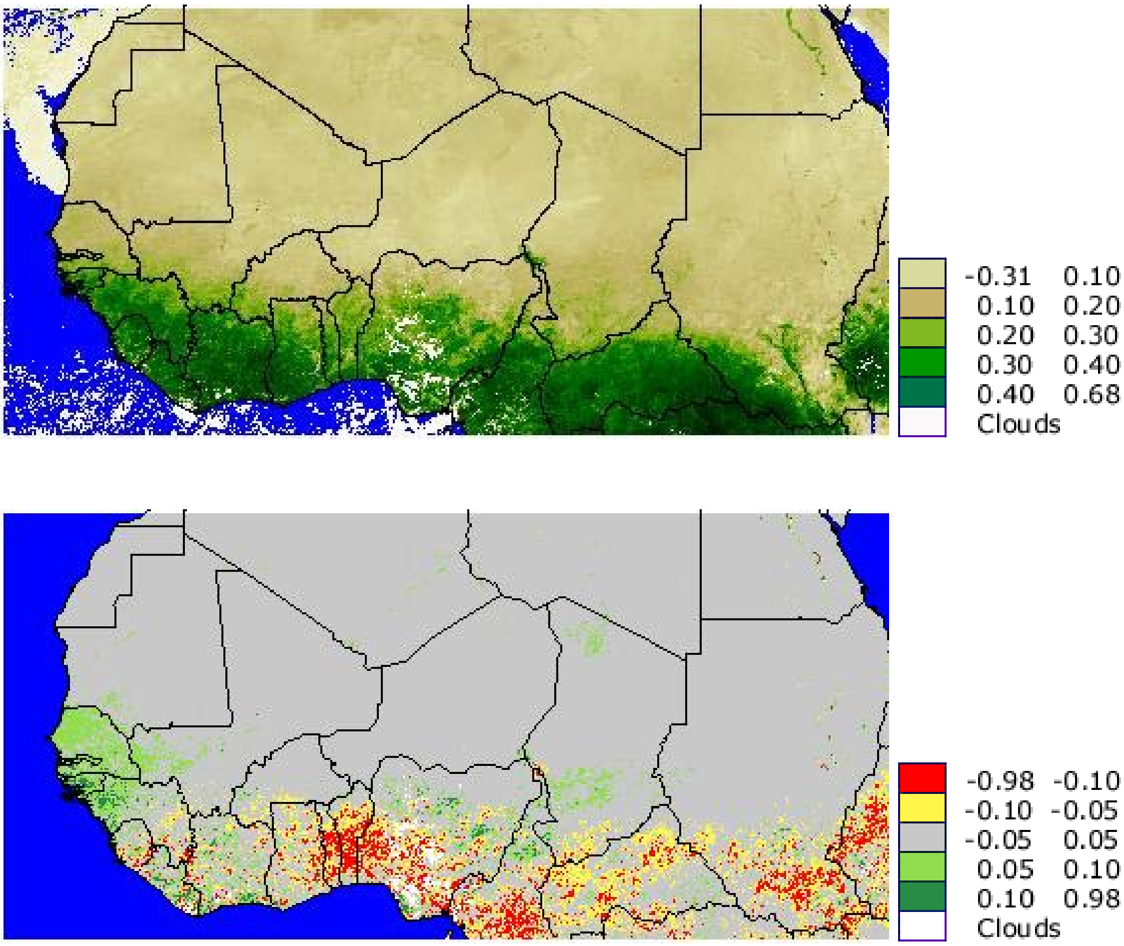


Figure 8. Global land cover characterization (data NASA, NOAA; map USGS).

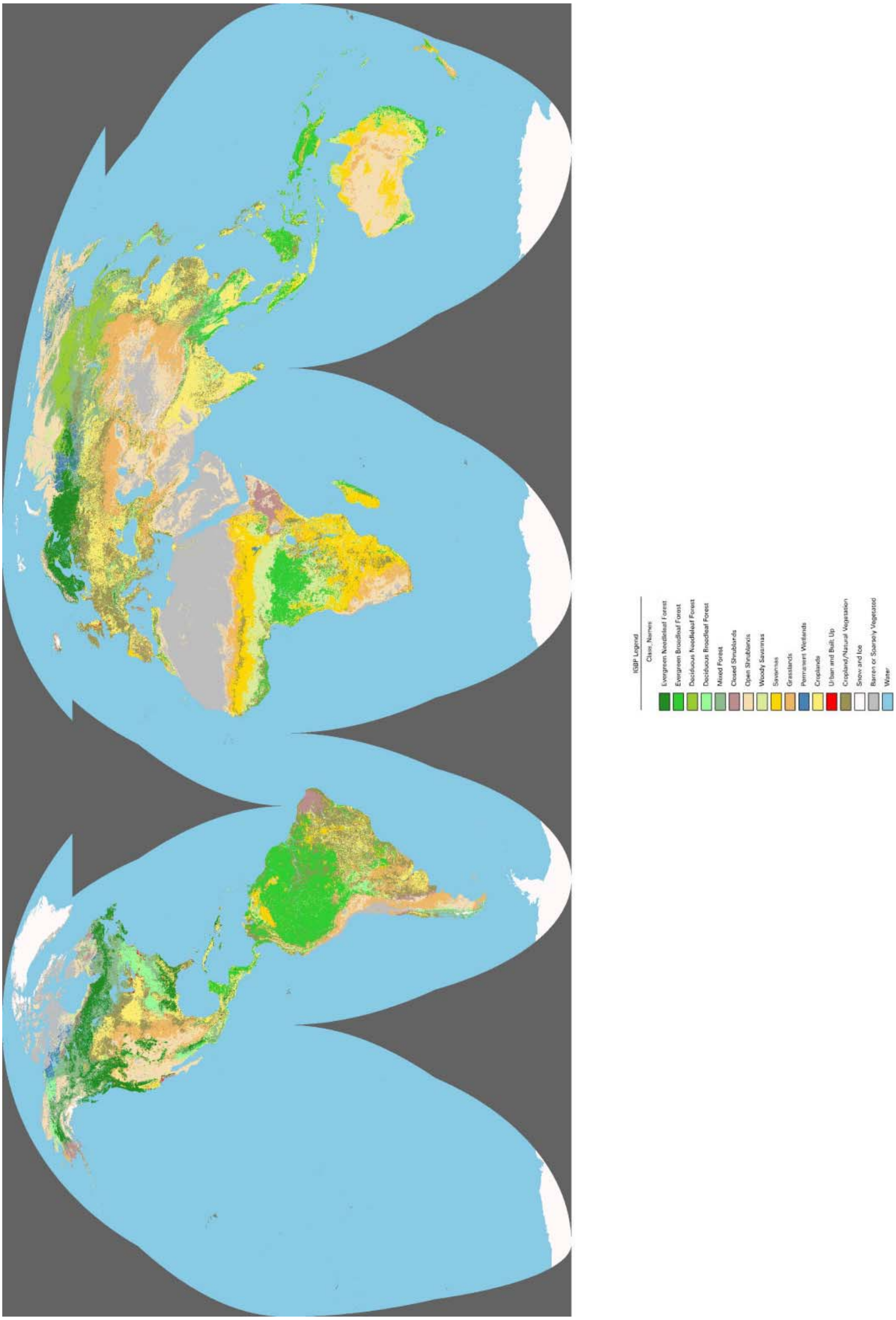


Figure 9. Shift of the Sahel and Guinean vegetation zones in Northwest Senegal (15º00'-16º01' N, 16º00'-16º42' W) from ca.1945 to 1993 (Gonzalez 2001).

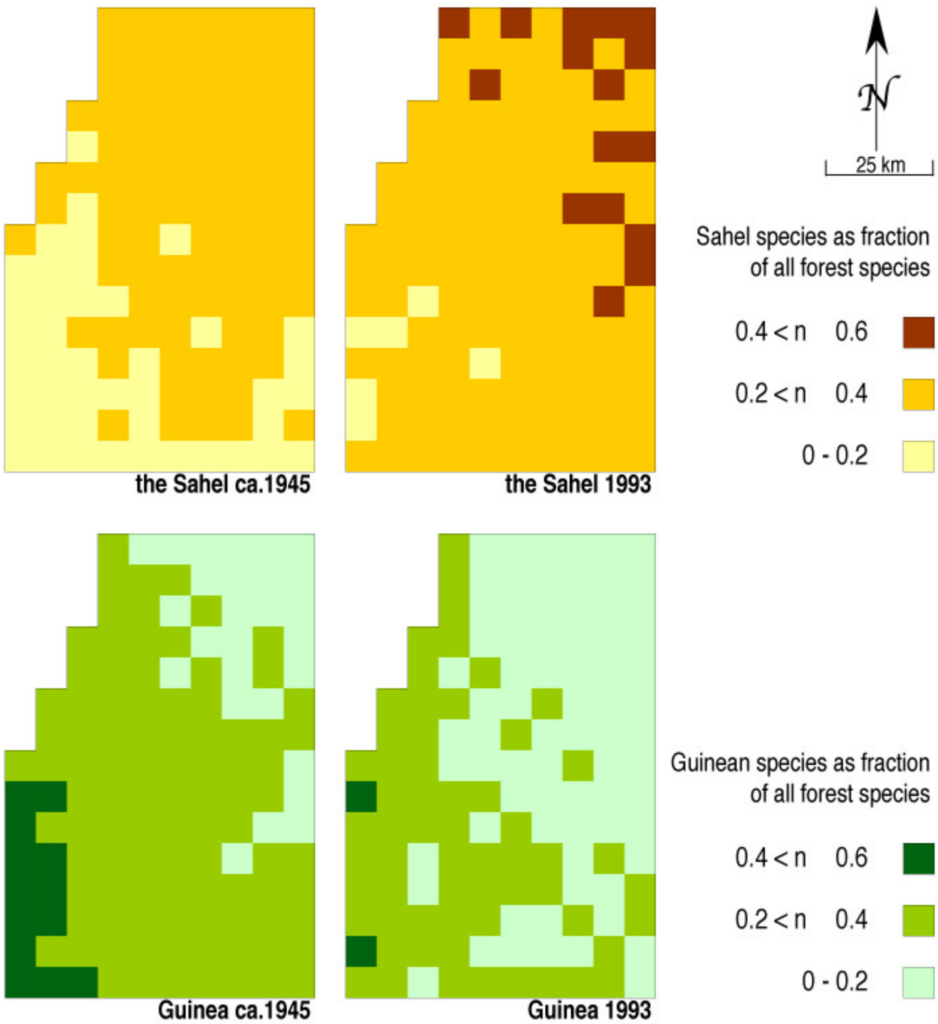
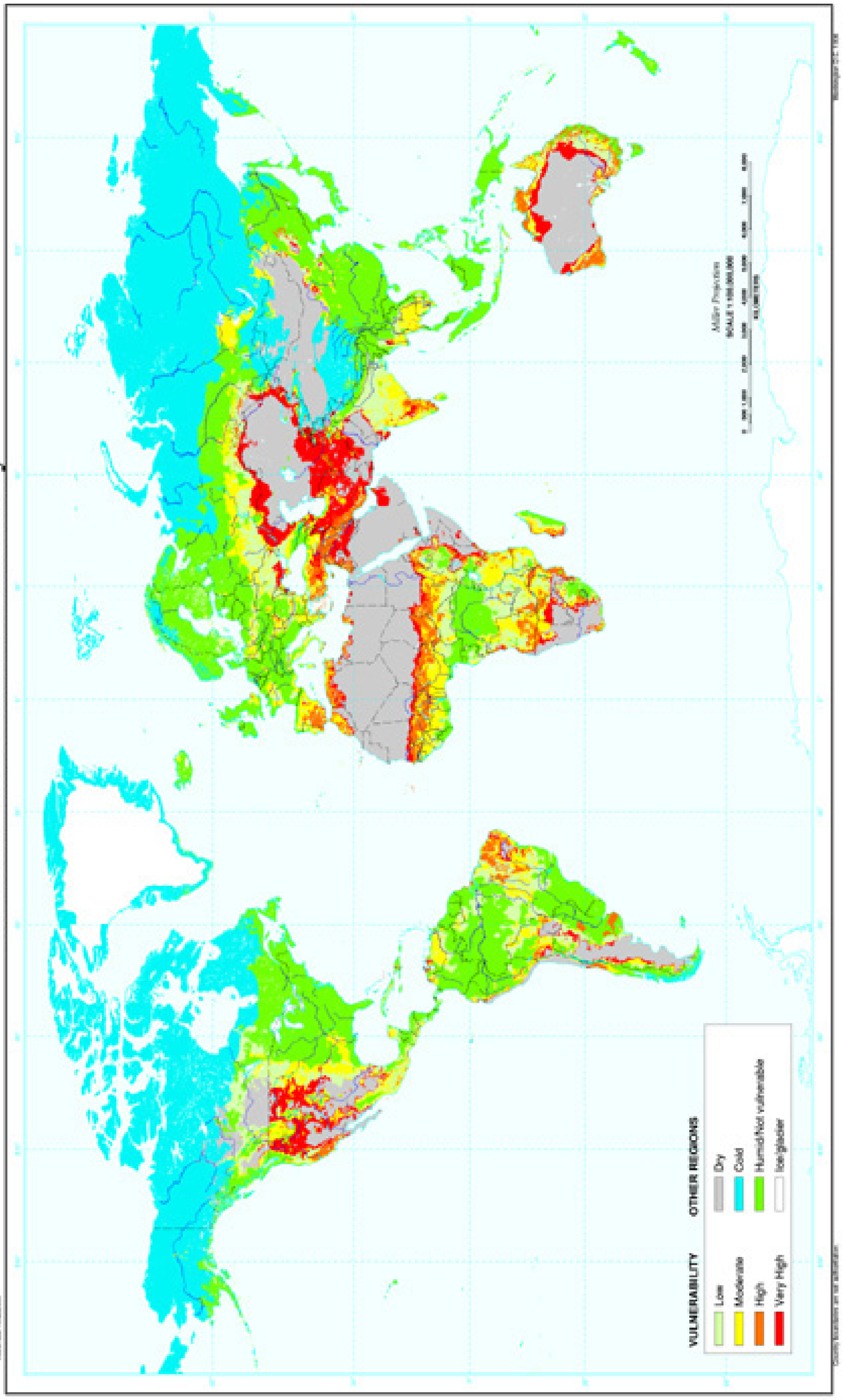


Figure 10. Global desertification vulnerability (data FAO, UNESCO, USDA NRCS; map USDA NRCS).



Remote Sensing driven Early Warning Systems for Desertification and Land Degradation

Results and Conclusions from

DeMon-II

An Integrated Approach to Assess and Monitor Desertification Processes in the Mediterranean Basin

funded by the Commission of the European Communities in the frame of the Environment and Climate Programme (1994-1998) contract no.: ENV4-CT95-0166 (DG 12 - DTEE)

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Desertification – a challenge for scientists and policy-makers

In the past decades, images of barren landscapes have drawn public awareness to the problems of desertification and degradation of previously fertile lands. The reasons for such a dramatic loss of natural resources are numerous, including unfavourable natural boundary conditions and negative human impact. Environmental determinants in areas prone to degradation and desertification are often characterised by marginal soils and low precipitation rates, along with a generally high variability of climatic conditions. In sensitive ecosystems inadequate land-use, such as overgrazing or deficient agricultural practices, frequently results in accelerated soil erosion, vegetation degradation, or an overall loss in biomass, often accompanied by salinization of soils or lower ground water levels. Depending on the location, this might be further aggravated by the ongoing threat of climate change. Beyond the irreversible destruction of natural habitats, these hazards may ultimately lead to an overall destruction of the basis of human welfare.

In this context it has been acknowledged by policy-makers that the only solution to these problems is a sound development based on the concept of sustainability. However, programs have often concentrated on mitigating the effects rather than fighting the causes. In recent years, the idea of effective early warning systems has been raised to counteract this deficit by national and global organizations. Appraising the initiatives advanced by the UNCCD and the European Union it is apparent that many of the objectives concerning the Southern Mediterranean EU member states are coherent with those related to the countries of the UNCCD Annex-IV (Menenti et al. 1999; Documents resulting from the Conferences of Parties of the UNCCD in Recife, 1999, and Bonn, 2000, especially from the Committee on Science and Technology, e.g. ICCD/COP(3)/CST/6, ICCD/COP(4)/L.6 or ICCD/COP(4)/L.7).

The DeMon-II project can be regarded as an example for illustrating the possibilities of a Long Term Early Warning System in the sense that it was targeted at detecting trends in the slowly changing determinants of the productivity of land. The approach was based on information derived from operational Earth Observation Satellites (EOS) to assess and repeatedly monitor regional scale indicators of sensitivity to desertification, which in our case have been based on the spatial abundance of photosynthetic active vegetation.

New Pathways in Assessing Desertification Risks

Most operational monitoring concepts are based on large-scale approaches with corresponding limitations in the level of detail. Hence, it is vital to complement these with resource assessments on a regional to local scale. The quality of such assessments relies on the consistency of the results as well as on the possibility to update databases. Adding this to the objective of cost effectiveness and logistic constraints, satellite data offer distinct advantages over conventional field based approaches, namely the replicability of operational processing steps to achieve coherent results, the possibility to continually incorporate actual data, and less financial and logistic efforts than to organise extensive field campaigns. Furthermore, desertification is not a spontaneous but a temporal process. Therefore, the current state of ecosystems has to be analysed in relation to the past and to the development in between.

Nevertheless, many studies on desertification and degradation risk assessment solely rely on programs of national meteorological services focussing on the development of precipitation or NDVI-based drought or desertification indices. This information indeed plays an important role in evaluating the state of the environment on small scales such as continental appraisals. However, while data from meteorological satellites such as NOAAAVHRR or Meteosat often serve as a good source for obtaining an overview on the state of environment, we believe that approaches based on such sources often neglect basic boundary conditions which are vital for a genuine analysis of desertification phenomena.

Basically, data acquired with these systems lack the necessary geometric and partially also spectral characteristics to seriously monitor and model the actual and future state of the environment at levels where most desertification processes do occur. Certainly, desertification processes usually do affect vast areas, but their local or regional threat may vary extremely. Only high resolution EOS data, such as data from the Landsat system, can fulfil the mandatory accuracy levels on a local to regional scale while covering extended areas at the same time. Moreover, information such as weekly or monthly maps of NDVI derived from NOAA-AVHRR data tend to exhibit pseudo-abundances of vegetation in sparsely vegetated areas (Hill et al. 1998). Consequently, the approach proposed in the following envisages an upscaling strategy, where coarse resolution data form the basis for deriving an overview in extensive areas, while hot spots are monitored in more detail for gaining vital information on actual processes at appropriate scale levels.

During a first project phase (DeMon-I) it could already be shown that the degradation of permanent semi-natural vegetation and the erosional state of soils are tangible items which can be observed with high-resolution satellite systems (Hill 1996). A standardised approach was developed, suited to be routinely applied to large regions and to identify environmentally sensitive areas. In parallel, it was demonstrated that inputs from remote sensing data can be used to drive deterministic models, which are needed to evaluate soil erosion risks in environmentally sensitive areas.

DeMon-II aimed at a further development and improvement of regionalised concepts and a suitable parameterisation of spectral features for deriving satellite-based degradation indices (i.e., indicators of sensitivity to desertification). Attention was also paid to the GISbased integration of ancillary information layers, such as bedrock lithology and digital elevation data (Hill et al. 2000).

The methodological improvements have been aimed at an approach for long-term monitoring of degradation. The main objective was to identify regional scale degradation processes and environmentally sensitive areas through the retrospective analysis of extended time series of EOS data for three representative target areas in Greece, Spain and France. The synoptic results and experiences derived from remote sensing data interpretation and GIS-based analysis lead to an approach for future projections of desertification, particularly with respect to the risk of further degradation of vegetation communities and soil erosion. The "susceptibility-index" proposed in DeMon-I was a first attempt to combine image-derived information layers on soil and vegetation conditions for predicting whether the present physiographic potential increases degradation susceptibility through a strictly formalised procedure. In DeMon-II, the objective was to revise and further develop this approach by incorporating degradation trends as derived from the retrospective analysis of EOS data and additional information, such as terrain parameters, modelling outputs, or socio-economic indicators.

The prerequisite was to demonstrate that the synoptic interpretation of remote sensing derived information on the development of environmental indicators together with statistic and environmental data can serve as a basis for the sustainable management of sensitive ecosystems. An exemplary case study conducted for the rangelands of central Crete shall serve to illustrate the possibilities of such an approach in a heterogeneous environment. With its wide range of ecozones, varying between dry-subhumid to semi-arid climatic conditions, Crete can serve as a surrogate study area for degradation phenomena found in most of the Northern Mediterranean countries as well as for many regions along the North African rim. Taking into account the socio-economic boundary conditions, e.g. intensive grazing schemes or the man-induced fire regime, Crete is an ideal example for the implementation of monitoring schemes tailored towards the monitoring of degradation and desertification processes.

Retrospective Analysis for Prospective Risk Assessment

Following the above mentioned considerations, the DeMon-II approach aimed at characterising the development of resources in grazed mountainous areas of central Crete over the maximum period covered by suitable EOS data. With respect to the design of available satellite sensors and the thematic background, the Landsat programme offered the best compromise between scale on one, and level of detail on the other hand. On top of that, the suite of Landsat imagery dates back as far as 1972, hence supporting the assessment of resource development over almost 30 years. In the context of this study, the spatial abundance of photosynthetic active vegetation cover was employed as the main indicator to characterise the state of ecosystem at a given date.

A set of Landsat images from the earliest dates to 1997 has been acquired and a data processing chain set up where every step is operational and repeatable, and where the only auxiliary data required are digital elevation models which are also routinely available from satellite data sources. For multi-temporal analyses on a local to regional scale it is crucial to compare identical locations and avoid errors that may be introduced by geometric inaccuracy. Consequently, a SPOT-derived digital elevation model was included in the geometric processing to account for non-linear distortions in the satellite imagery due to the local terrain.

The second, even more important step is to ensure that any change detected from satellite imagery is due to actual change on the ground. Such changes may be either camouflaged or pseudo-variation can be introduced due to interferences, such as the influence of atmospheric conditions at the time of data acquisition or fluctuations in the sensor sensitivity. In our approach, these effects are accounted for by a model combining three inter-related components, one for the sensor calibration, the second for the simulation of the radiative transfer of the electromagnetic radiation between sun, ground and sensor, and the third for the influence of the topography. This model requires only a small number of individual driving factors which can be derived from the respective images themself. In the resulting stack of data layers, each layer represents one time slice, overlaying picture elements represent corresponding locations at different times, and the digital values of such picture elements are purely related to the composition of surface components or changes thereof.

While designing a processing chain for geometrically and radiometrically corrected multitemporal datasets is an important methodological step, a framework to assess desertification risk needs to be based on parameters which are directly indicative of the ecological situation. The concept of linear spectral mixture analysis (SMA) interprets the signal recorded by the sensor as a combination of the spectral response of a number of different surface types and allows to infer the relative amount of each of these. With respect to the local conditions of central Crete, vegetation has been chosen for this study as the indicator to be monitored. Different indicators, like the abundance of soils or exposed bedrock, are feasible depending on the environmental settings. Employing SMA, it became possible to derive quantitative amounts of vegetation cover for an extended timeseries, resulting in a set of vegetation cover maps. In the project context, extensive field estimates of vegetation density and species composition had been carried out, which supported the validity of results obtained from satellite data analysis.

With quantitative data on vegetation cover being available for an extended period the base is laid for a temporal analysis of the vegetation development with time. Since such monitoring approaches need to be as much as possible operational and automatic, software tools were developed to calculate trends along with a number of additional statistical information. Mean vegetation cover and cover changes were combined to yield a degradation index. This result allows for the first time to employ satellite data to quantitatively monitor the development of vegetation cover as one of the primary indicators of ecological stability and to identify areas at risk of desertification on a regional to local scale. Moreover, compared to standard indices – such as NDVI – there are no constraints due to existing environmental boundary conditions, as for example extremely low vegetation cover levels.

Summarising the results of the case study, it becomes evident that the mountains of central Crete exhibit a vast mosaic of differently developing regions. While in many areas a significant decrease of vegetation has to be stated, also regions with stable or even increasing vegetation cover can be observed. However, the combination of trend with cover levels shows that in many regions this is often stability on a very low level.

In the frame of DeMon-II, our objective was not only to establish the monitoring chain and identify risk areas. Rather, another task was to identify the major driving forces for this development. This is crucial for the step that has to follow the identification of areas at risk – the formulation of mitigation strategies.

Assessing physical geographic factors, such as altitude, aspect, geological substrate etc., their influence on the vegetation development is to be expected. However, these boundary conditions are by far not sufficient to explain the pattern of decrease, increase and stability. Following the discussion on causes for desertification and degradation, human mismanagement is often cited as one major factor in desertification of lands beside the physical background. As a consequence, this called for an incorporation of socio-economic data into our interpretation scheme. It could be concluded that degrading areas in central Crete are indeed an example where inadequate human practices trigger local decrease of vegetation cover.

While the mountainous areas under observation has been utilised by man for long times, the last twenty years have brought an immense increase in the number of grazing animals, which for Crete are mostly sheep and goats. As a consequence, the stocking rates in many regions are far above the carrying capacity, and can partially only be sustained by supplying additional food. One of the reasons for this increase in animal numbers is believed to be Greece joining the European Union in 1981. To evaluate the thesis of policy and man being – if indirectly – responsible for degrading natural resources, statistical information on grazing animal population on a communal basis has been synoptically analysed with the satellite-derived degradation index. For most cases, it became evident that there is significant correlation between an increase in grazing animals and a general decrease in vegetation cover, which in this case supports the request for more sustainable utilisation of resources and a restructuring of funding policies in certain areas.

Concluding, the spatial distribution of the pattern of vegetation development, which is believed to be strongly triggered by human management, and the expertise of field ecologists have been combined to propose a management scenario for the grazed areas under observation. Nowadays it is agreed that protection from desertification and degradation of resources, as well as maximum biodiversity are not simply attained by excluding grazing animals or human utilisation in general. Rather, different intensities of use have been reported to support and sustain a variety of different ecosystems. Consequently, the proposed management scheme is adapted to the different vegetation communities and their species compositions, and aims at a mosaic of different ecosystems with different utilisation intensities, since such diversified landscapes are believed to present the best protection for Mediterranean lands against the processes of desertification and degradation.

Consequences for Designing Early Warning Systems

The results show that today we do dispose of a sound processing chain for Landsat TM and MSS derived satellite imagery, allowing for the precise geometric and radiometric processing of such data. The operationality of the methodologies is assured by the derivation of necessary auxiliary information from other routinely available satellite imagery or from the images themselves. Adding sophisticated interpretation concepts, such as Spectral Mixture Analysis, long timeseries of satellite data can be quantitatively interpreted. It was also demonstrated that this methodology can be used to assess vegetation in an appropriate manner, even under semi-arid conditions and consequently low vegetation cover. The approach was tested in the frame of retrospective studies, which were partly extended by aerial photography back until 1945. Finally, the expertise acquired in the frame of the project was concentrated on the formulation of options to realise a sustainable management of grazing in the mountainous ecosystems of Crete.

One of the main results was the breakthrough in interpreting satellite derived quantitative data on trends in vegetation development over extended timeseries of 20 years or more. Today, time spans of 30 years are feasible and will allow for even more reliable end products. Importantly, outputs based on such an interpretation scheme are practically not influenced by phenological variation, as the approach levels seasonal changes through linear trend analysis. The obtained accuracy margins seem to lie in a range of ± 5% for vegetation cover. On the other hand, this kind of satellite observatory for regional desertification assessment does not only allow for retrospective data analysis, but – most essentially – also permits to turn the look at predictive information extraction. By further adding multi-temporal datasets it is possible to assess changes in vegetation trends and to locate areas at risk with a high confidence level. Where meteorological systems fail to resolve changes in heterogeneous areas, high-resolution EOS data enable an accurate risk assessment at scales of about 1:100,000.

Future approaches will focus on further integration of GIS-based ecological modelling with satellite-derived information layers. Moreover, incorporating socio-economic indicators shall provide ways to determine future changes with sophisticated scenarios based on both the physiographic setting and anthropogenic drivers in the respective ecosystem. One conclusion of the insights gained during DeMon-I and DeMon-II was the implementation of the EU-funded project GeoRange during the 5th framework programme[1]. GeoRange will analysis pathways and develop methodologies to integrate data in a way that potential end-users in regional and local governments, administrative bodies or scientific institutions will be able to run change scenarios in a pre-defined setup. Retrospective monitoring will routinely be applied to extended time series of EOS data including new sensors such as Landsat-7. By integrating bio-physiological and socioeconomic indicators into a modelling centred approach it will be possible to build a frame for refined ecosystem assessments, especially for the implementation of sustainable regional management schemes.

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[1] GeoRange is hosted at the Remote Sensing Department at the Universität Trier, Germany, and incorporates partners and end users from Spain, Italy and Greece.

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ICCD/COP(3)/CST/6
ICCD/COP(4)/L.6
ICCD/COP(4)/L.7

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CILSS

CENTRE REGIONAL AGRHYMET

Contribution du Centre Régional AGRHYMET

à la réunion de la CCD

TOKYO - JAPON

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SYSTEME D'ALERTE PRECOCE :
ECHANGE D'INFORMATIONS

COMMENT FACILITER L'ECHANGE D'INFORMATIONS ENTRE LES INSTITUTIONS TECHNIQUES ET SCIENTIFIQUES

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Plan de la présentation

- INTRODUCTION
- LES PRODUCTEURS DE L'INFORMATION
- LES UTILISATEURS DE L'INFORMATION
- LES ACTIVITES
- LES INDICATEURS DE LA DESERTIFICATION
- LES CONDITIONS DE REUSSITE

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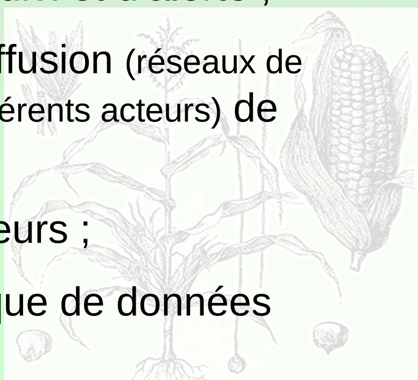
Introduction

- **Identifier tous les acteurs :**
  - les producteurs de données et informations
  - les utilisateurs de données et informations élaborées
- **Identifier les activités qui seront mises en chantier :**
  - mise en place d'un dispositif de suivi et d'alerte ;
  - collecte, traitement, analyse et diffusion (réseaux de communication conséquent reliant les différents acteurs) de données ;
  - élaboration de produits et indicateurs ;
  - mise à jour périodique de la banque de données



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...introduction

Organisation des acteurs :

- mise en place d’un dispositif de communication ;
- réseaux de point de mesure de données ;
- développement et transfert d’outils de traitement et d’analyse.

Evaluation périodique des activités grace au dispositif.

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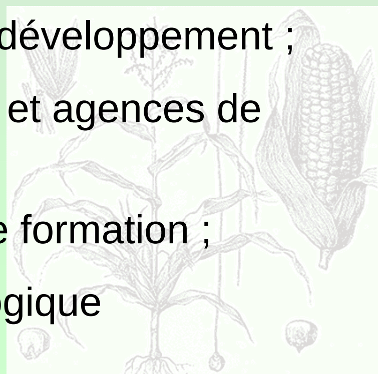
Les producteurs de l’information

Le niveau national

- les services techniques publics ;
- les organisations de producteurs

Le niveau régional

- les institutions de recherches et développement ;
- les organisations internationales et agences de coopération ;
- les institutions d’application et de formation ;
- les centres de surveillance écologique



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...le niveau national

les services techniques publics :

Elaborent et disseminent des produits et informations destinés aux décideurs, communautés villageoises et partenaires de coopération. Pour ce faire, ils s ’appuient sur divers réseaux (collecte, traitement et diffusion).

les ONG et organisations paysannes :

Elles doivent participer aux même activités que les services techniques. Cependant, leur territoire reste relativement limité. Elles produisent des informations à une échelle plus réduite et pour une population locale.

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...le niveau régional

les institutions de recherche, d’application et de formation, les centres de surveillance écologique

Les activités de ces institutions sont :

- **la centralisation et l’organisation des données (développement de banques de données régionales) ;**
- **l’élaboration et la diffusion de produits élaborés et d’indicateurs à destination des utilisateurs ;**
- **la formation des acteurs ;**
- **le développement d’outils de diagnostic, de suivi et d’analyse ;**
- **la surveillance écologique.**

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Systèmes de collecte de l'information

Les utilisateurs de l'information

- les décideurs politiques
- les experts des services techniques nationaux
- les organisations non gouvernementales
- les institutions privées
- les communautés rurales
- les communicateurs

Echelles d'intervention

Quels utilisateurs ?

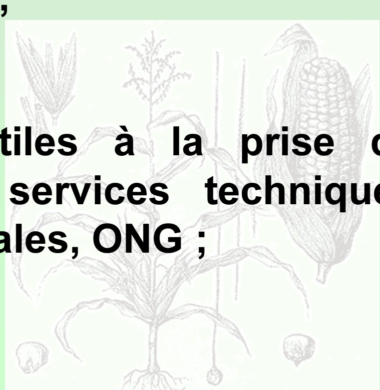
INFO	DECIDEUR STRATEGIQUE	CONJONCTURISTE TACTIQUE	Paysan-Éleveur LOGISTIQUE
DECISION	Achat	Bilan	Semis - Pâturage
NATURE	Où - Combien	Indicateurs	Quand - Où
TEMPS	Annuel	Mensuel/Décadaire	Journalier
ESPACE	National	Administratif/Strate	Terroir
PRECISION	Faible	Moyen	Haute
SUPPORT	Négociation	Discussion	Orientation

⇨ Système d'information du CRA dimensionné pour : Stratégique et Tactique

⇨ Déploiement vers la Logistique

Les activités

- **la collecte, le stockage et la transmission des données brutes : services publics nationaux, ONG, institutions sous régionales ;**
- **l'élaboration d'outils et de méthodologies : services techniques nationaux et régionaux ;**
- **la production d'informations utiles à la prise de décisions (produits élaborés) : services techniques nationaux, institutions sous régionales, ONG ;**



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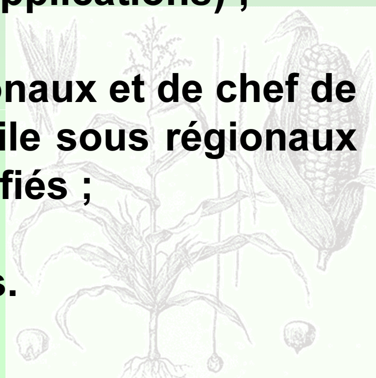
...les activités

• formation des utilisateurs à l'exploitation de l'information environnementale : services techniques nationaux et institutions sous régionales ;

• ateliers techniques (harmonisation des concepts et de définition des tâches, restitution des résultats de recherche ou de développement d'applications) ;

• désignation de points focaux nationaux et de chef de file sous régional ou de chefs de file sous régionaux si plusieurs thématiques sont identifiés ;

• évaluation périodique des activités.



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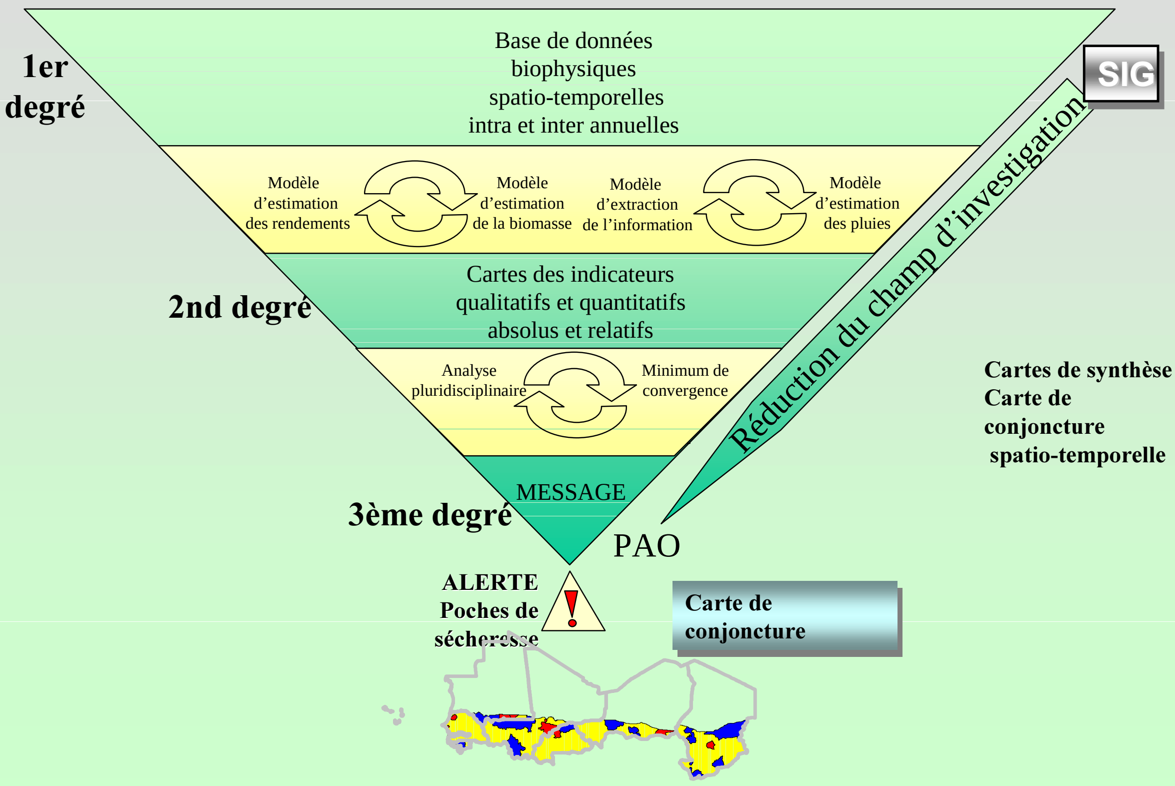
Traitement de l'information



Les indicateurs de la désertification

A travers l'expérience du Centre Régional AGRHYMET, les indicateurs qui permettent de suivre la dégradation des écosystèmes sahéliens sont :

- la baisse de la pluviométrie entre 1970 et 1990 par rapport aux années humides antérieures ;
- la durée moyenne de la saison des pluies ;
- la diminution des ressources en eau ;
- les variations du cycle de végétation et l'intensité du changement de la végétation ;
- le suivi de l'activité humaine : détection des changements d'occupation et de l'utilisation des terres ;

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Indicateurs liés au climat

Objectifs

- Détecter précocement les poches de sécheresse
- Evaluer l'intensité des fluctuations des cumuls pluviométriques
- Mettre en exergue les variations de la longueur de la saison de pluies

① - Indicateurs d'état

☐ Estimer et spatialiser les cumuls pluviométriques

✷ - Indicateurs de dynamique

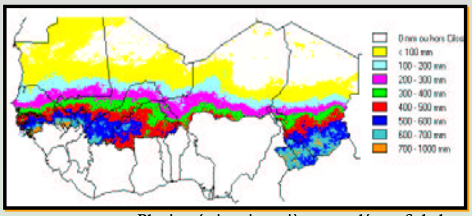
☐ Comparer la pluviométrie actuelle à celle de référence

☐ Evaluer l'intensité des variations

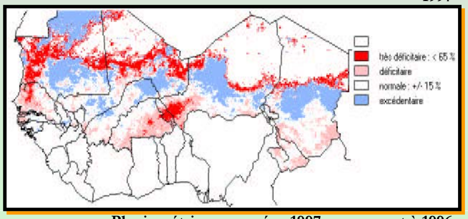
✹- Indicateurs d'alerte

☐ Détecter les changements

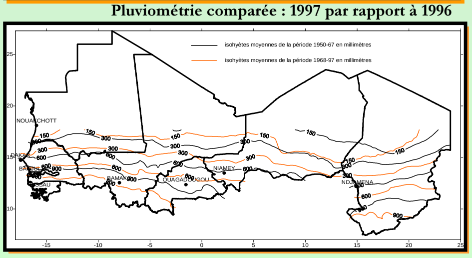
☐ Prédire les tendances du climat



Pluviométrie saisonnière cumulée au Sahel : 1997



Pluviométrie comparée : 1997 par rapport à 1996



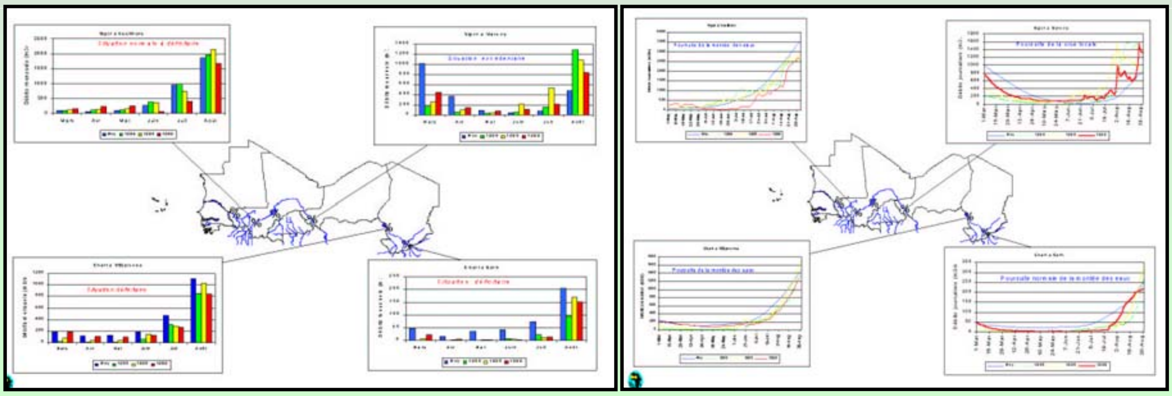
Baisse cumulée de la pluviométrie au Sahel :
Isohyètes moyennes choisies des périodes 1950-1967 et 1968-1997

Indicateurs liés aux ressources en eau

Objectifs

- Déterminer les caractéristiques hydrologiques saisonnières
- Etablir le déterminisme spatial des états paroxystiques et intermédiaires
- Prédire les variations (hauteurs d'eau et leur extension spatiale) des ressources en eau

1. Une évaluation régulière du régime des cours d'eau

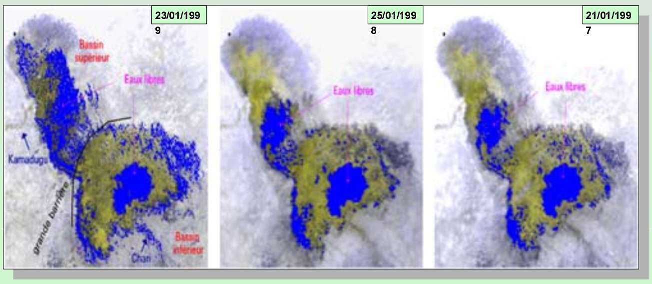


Indicateurs liés aux ressources en eau (suite…)

Objectifs

- Déterminer les caractéristiques hydrologiques saisonnières
- Etablir le déterminisme spatial des états paroxystiques et intermédiaires
- Prédire les variations (hauteurs d'eau et leur extension spatiale) des ressources en eau

2. Une surveillance continue par télédétection des plans d'eau de surface (Ex. Lac Tchad)



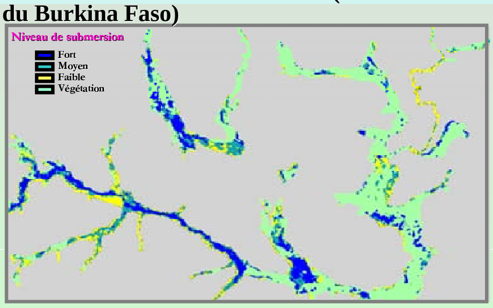
Méthode

- Classification automatique d´images NOAA/LAC
- Suivi du front et de la surface en eau

Résultats

- Progression du bassin supérieur de 40 km vers le Nord en 1999
- Accroissement de 80% de la surface en eau libre

3. Inventaire et caractérisation par télédétection des zones humides (Ex. Sud-Ouest du Burkina Faso)

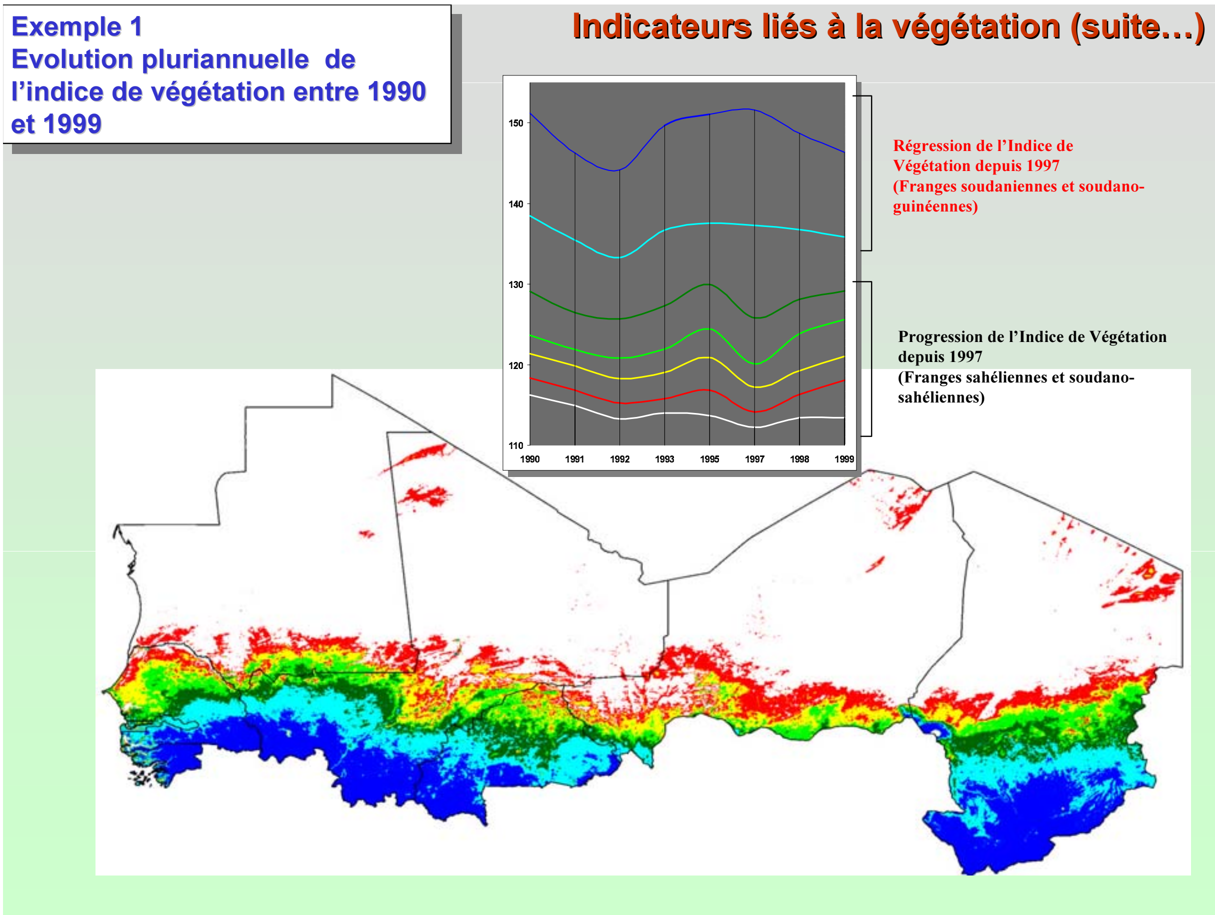


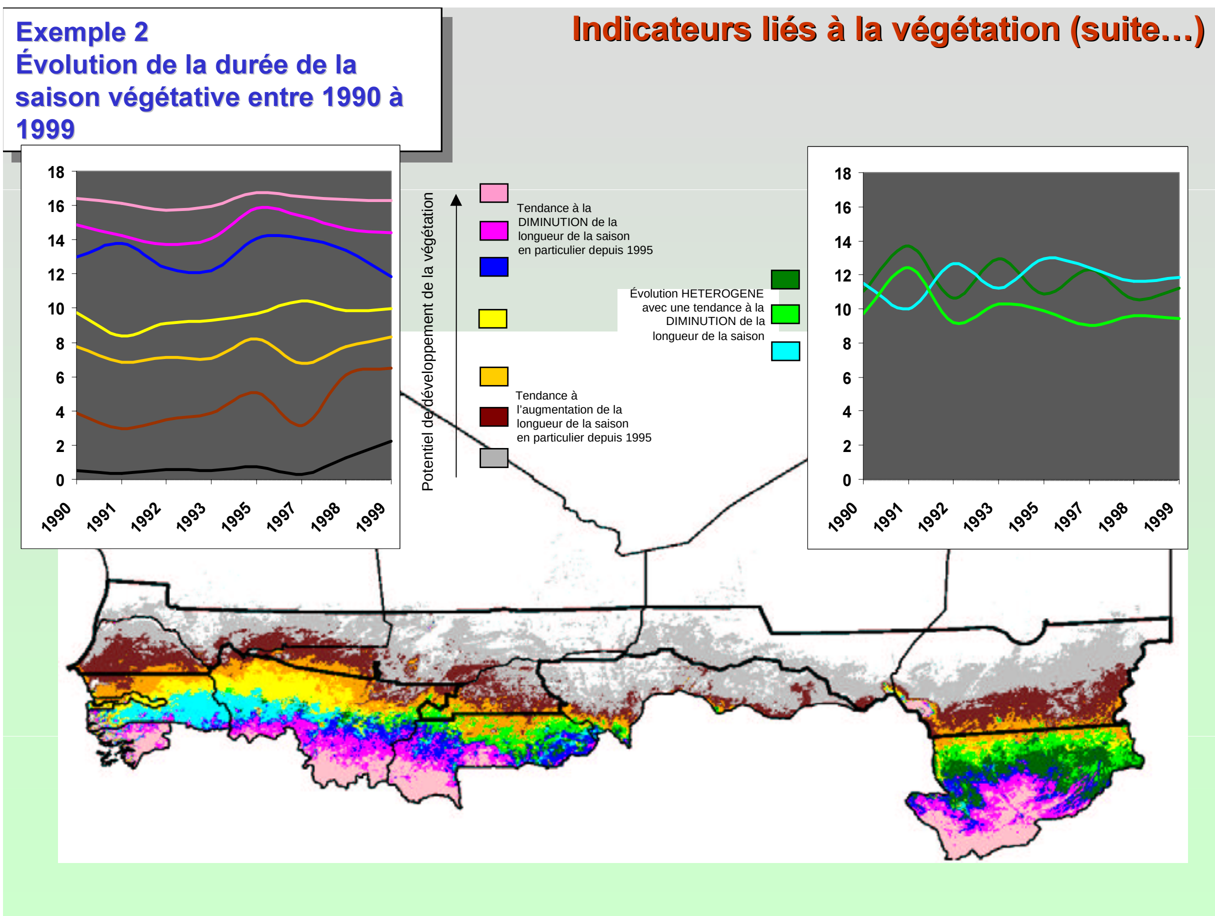
Méthode

- Agrégation de l'information selon des gradients d'humidité calculés sur les images satellitales

Résultats

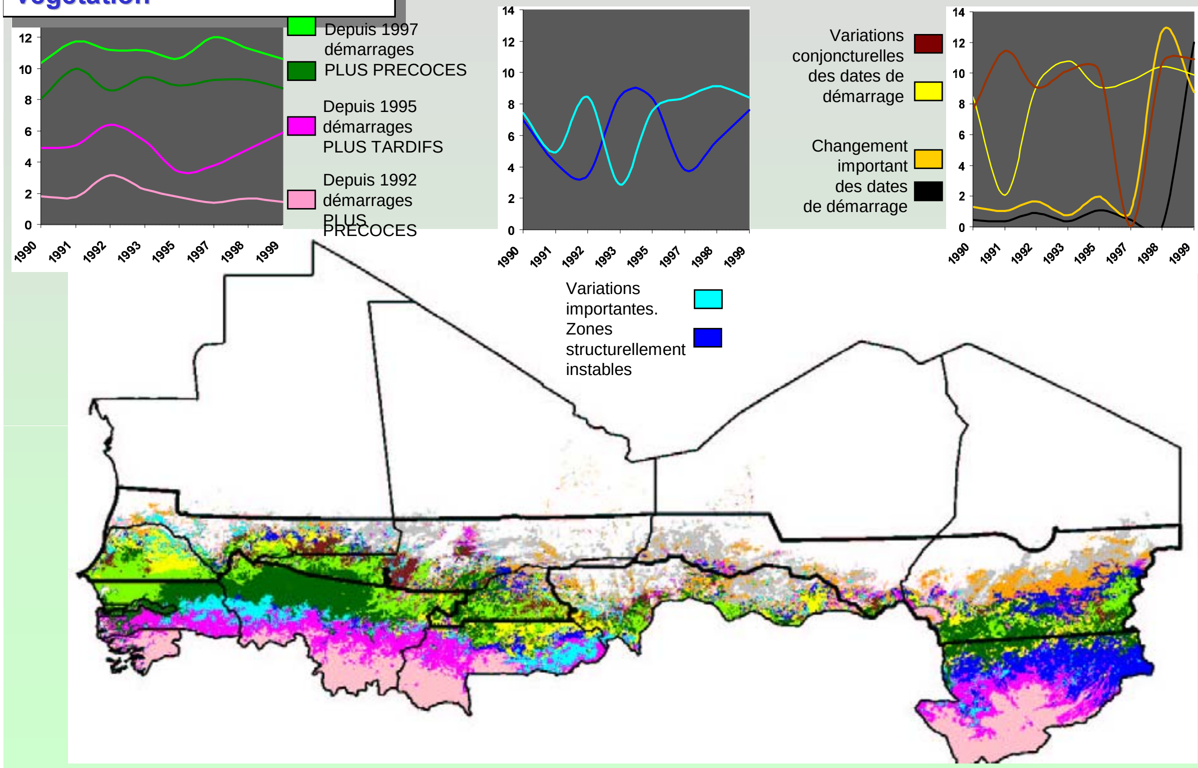
- Extension spatiale des zones humides
- Niveau de l'engorgement


Exemple 1
Evolution pluriannuelle de l'indice de végétation entre 1990 et 1999
Indicateurs liés à la végétation (suite…)
150
140
130
120
110
1990
1991
1992
1993
1995
1997
1998
1999
Régression de l'Indice de Végétation depuis 1997
(Franges soudaniennes et soudano-guinéennes)
Progression de l'Indice de Végétation depuis 1997
(Franges sahéliennes et soudano-sahéliennes)


Exemple 2
Évolution de la durée de la saison végétative entre 1990 à 1999
Indicateurs liés à la végétation (suite…)
18
16
14
12
10
8
6
4
2
0
1990
1991
1992
1993
1995
1997
1998
1999
Potentiel de développement de la végétation
Tendance à la DIMINUTION de la longueur de la saison en particulier depuis 1995
Tendance à l'augmentation de la longueur de la saison en particulier depuis 1995
Évolution HETEROGENE avec une tendance à la DIMINUTION de la longueur de la saison

Exemple 3 : Évolutions des dates d'émergence de la végétation

Indicateurs liés à la végétation (suite…)



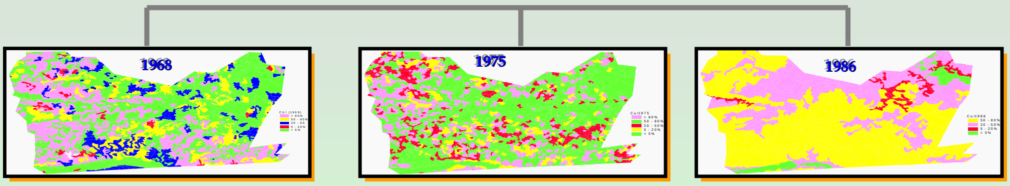
Indicateurs liés à l'occupation des sols

OBJECTIFS

•Mettre en évidence les tendances, les effets et les interrelations existantes entre les différentes causes qui concourent au processus de dégradation des terres

• Identifier et proposer en temps utile les mesures de correction des effets liés à l'activité humaine

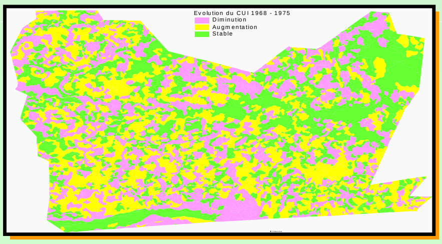
Analyse diachronique à partir de données de télédétection



Sud du Niger : Evaluation comparée des variations de l'occupation du sol sur trois années de référence

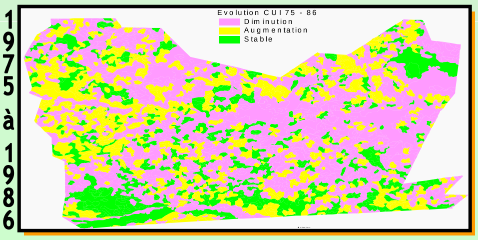
Caractérisation et quantification des changements d'occupation des sols

1968 à 1975



Une augmentation des surfaces cultivées au dépens de la végétation

1975 à 1986

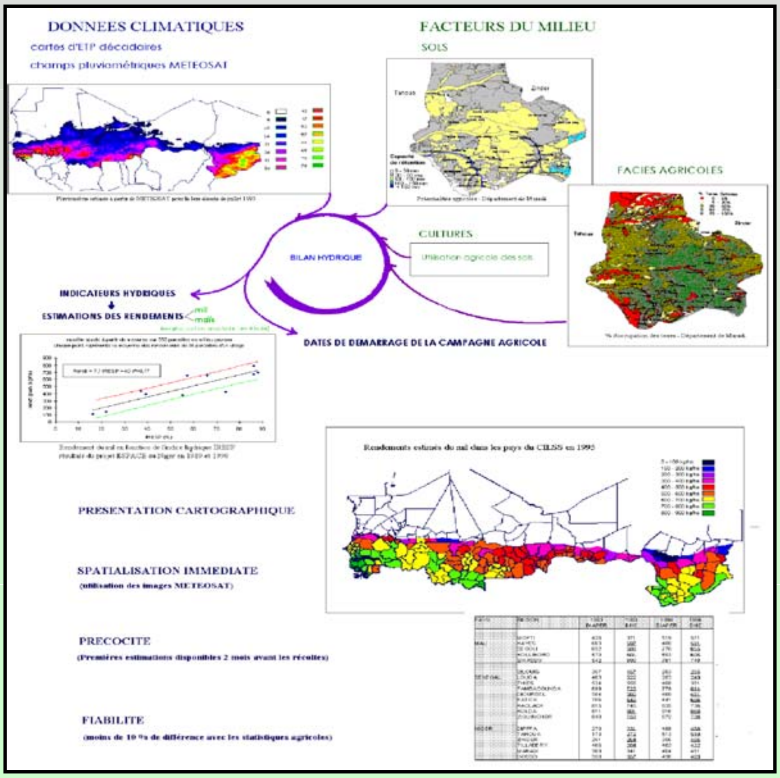


Une régression des surfaces emblavées au profit des sols dégradés

Indicateurs liés à la sécurité alimentaire

OBJECTIF

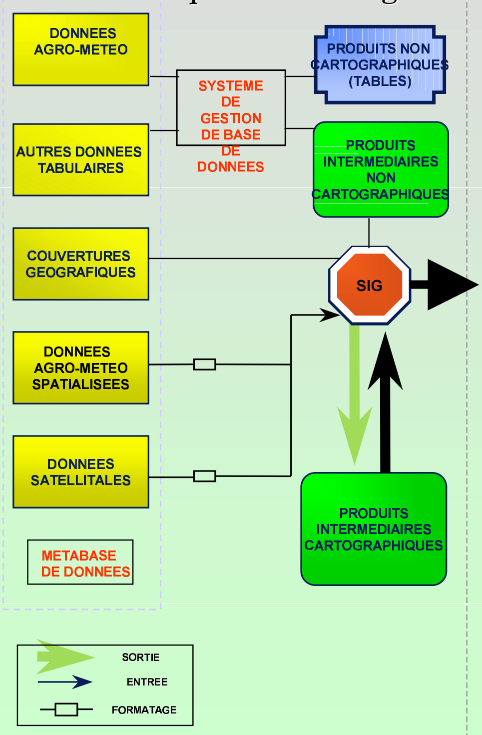
- Effectuer un diagnostic hydrique des cultures par pas de temps décadaire
- Estimer précocement les rendements (Alerte précoce)



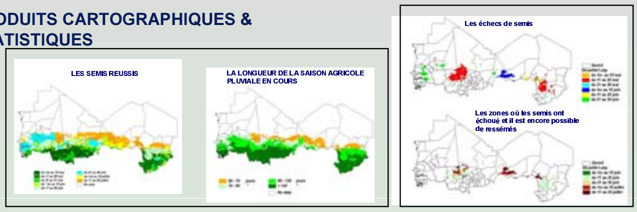
Indicateurs liés à la sécurité alimentaire (suite…)

Objectif

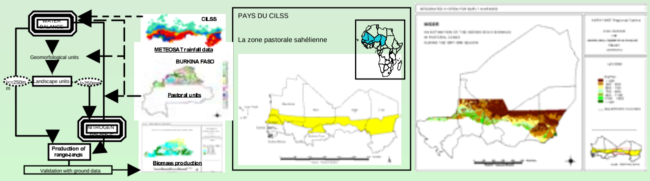
- Caractériser la vulnérabilité agricole
- Evaluer le risque structurel agricole



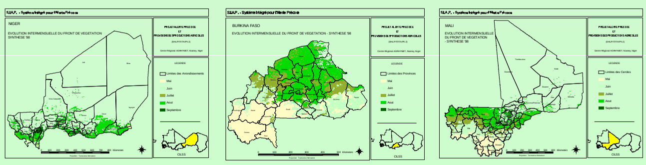
PRODUITS CARTOGRAPHIQUES & STATISTIQUES



MODELE DE PRODUCTION DE LA BIOMASSE



FRONT DE VEGETATION



Les conditions de réussite

- mise en place d'un dispositif de collecte et de stockage de manière à constituer un bon référentiel de bases de données
- coordonner les efforts entre les trois conventions de RIO dans chaque pays ou au niveau sous régional pour mettre en place une Association des Utilisateurs des informations produites par les systèmes d'information de ces conventions ;
- le dispositif, tant au niveau national que régional, doit avoir des moyens de communications rapides, performants et appropriés, capables de en un temps minimum de relier tous les acteurs du système d'alerte précoce.

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Mechanisms to facilitate information exchange between scientific and technological institutions, in particular focusing on national and subregional networks, for the prediction of drought and monitoring of desertification

(Re-appointed Ad Hoc Panel on Early Warning Systems: Terms of Reference (c))

Ad Hoc Panel on Early Warning Systems
United Nations Convention to Combat Desertification
4 - 8 June 2001, Fuji Yoshida, Yamanashi, Japan

Global Environmental Forum, Japan

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I. Introduction

The basis of the discussion of this topic should be a review of the existing mechanisms against the objective of the CCD ("to combat desertification and mitigate the effects of drought" (Article 2), particularly in the context of "prediction of drought and monitoring of desertification" (Terms of Reference (c)). According to the last preambular paragraph of Decision 14/COP.4 of the Conference of the Parties at its fourth session, the review should be made in "[t]aking note ... of the existence of networks of early warning systems and desertification monitoring and assessment at the national, subregional and regional levels". If the review results show that the existing mechanisms are effectively facilitating "exchange of information between scientific and technological institutions, in particular focusing on national and subregional networks on the prediction of drought and monitoring of desertification", then no special action of the Conference of the Parties is required. If the existing mechanisms are not working so, analyses should lead to recommendations of measures to make such mechanism to effectively function for this purpose or, if this is not practical, a new mechanism should be proposed.

II. The role of scientific and technological institutions in prediction of drought and monitoring of desertification

(1) The roles of scientific and technological institutions

The terms of reference on the following three topics given to the Ad Hoc Panel in 2000 by COP decision 14/COP.3 indicates the roles scientific and technological institutions may play in early warning systems of drought and desertification:

- *Data collection, accessibility, and integration;*
- *Evaluation and prediction of drought and desertification, and measures for preparedness; and*
- *Dissemination of information to end-users on the application of early warning systems and desertification monitoring and assessment, and strengthening of appropriate response mechanisms*

(2) Scientific/technological institutions and other agencies

Before identification of different kinds of scientific and technological institutions, it should be noted that in these three, scientific/technological institutions and

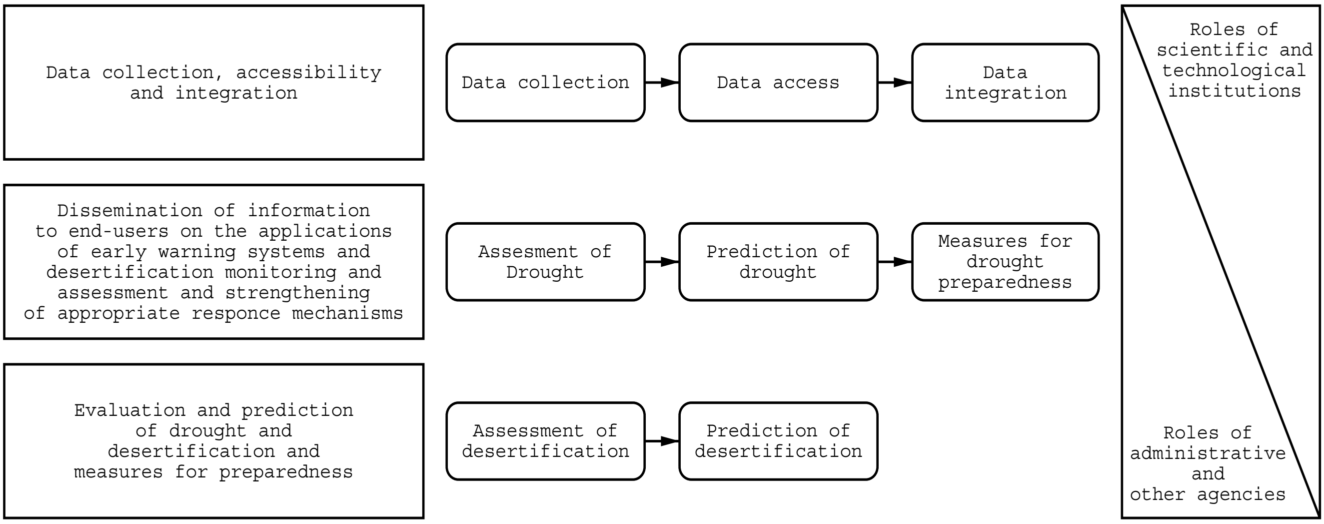

Chart 1. The topics of the Ad Hoc Panel on Early Warning Systems and the roles of scientific/technological institutions and administrative and other agencies

In this work, the terms of reference given to the original Ad Hoc Panel by decision 14/COP.3 of the Conference of the Parties at its third session should also be fully taken into account so that the conclusions and recommendations of this re-appointed Panel could be consistent with the overall framework given there.

administrative and other agencies perform different roles. Scientific and technological institutions perform primary roles in data collection and integration.

The accessibility to data is a critical issue to scientific and technological institutions but often is effectively improved with the help from administrative and other institutions. The role in evaluation and prediction of drought and desertification is also performed primarily by scientific and technological institutions. But the evaluation and prediction must be done in such a way that they can be efficiently used by the agencies, including administrative agencies, responsible for the measures for preparedness and dissemination of information to end-users. As the dissemination of information to end-users is primarily the responsibility of administrative agencies, scientific and technological institutions must give due consideration for effective dissemination of information for such purposes. As such, there is a need for close collaboration and linkage between scientific/technological institutions and administrative agencies.

(3) Different kinds of scientific and technological institutions in different kinds of activities

However, different kinds of scientific and technological institutions are involved in different kinds of activities related to prediction of drought and monitoring of desertification. Institutes for production sectors such as agriculture are vital for appropriate response and development of preparedness. Also vital are research institutes collecting, collating, processing and analyzing basic data on meteorological, hydrological and other data.

Because the time-frames for the phenomena of drought and desertification are different, different types of research institutes, particularly with regard to basic data, are playing roles of different importance. For drought, which requires relatively quick responses, institutes for meteorology and hydrology are more important. On the other hand, institutes for climatology, ecology and geopraphy play important roles for desertification because this requires responses to more longer-term ecological change. Socio-economic research institutes are also important as the Ad Hoc Panel in 2000 pointed out.

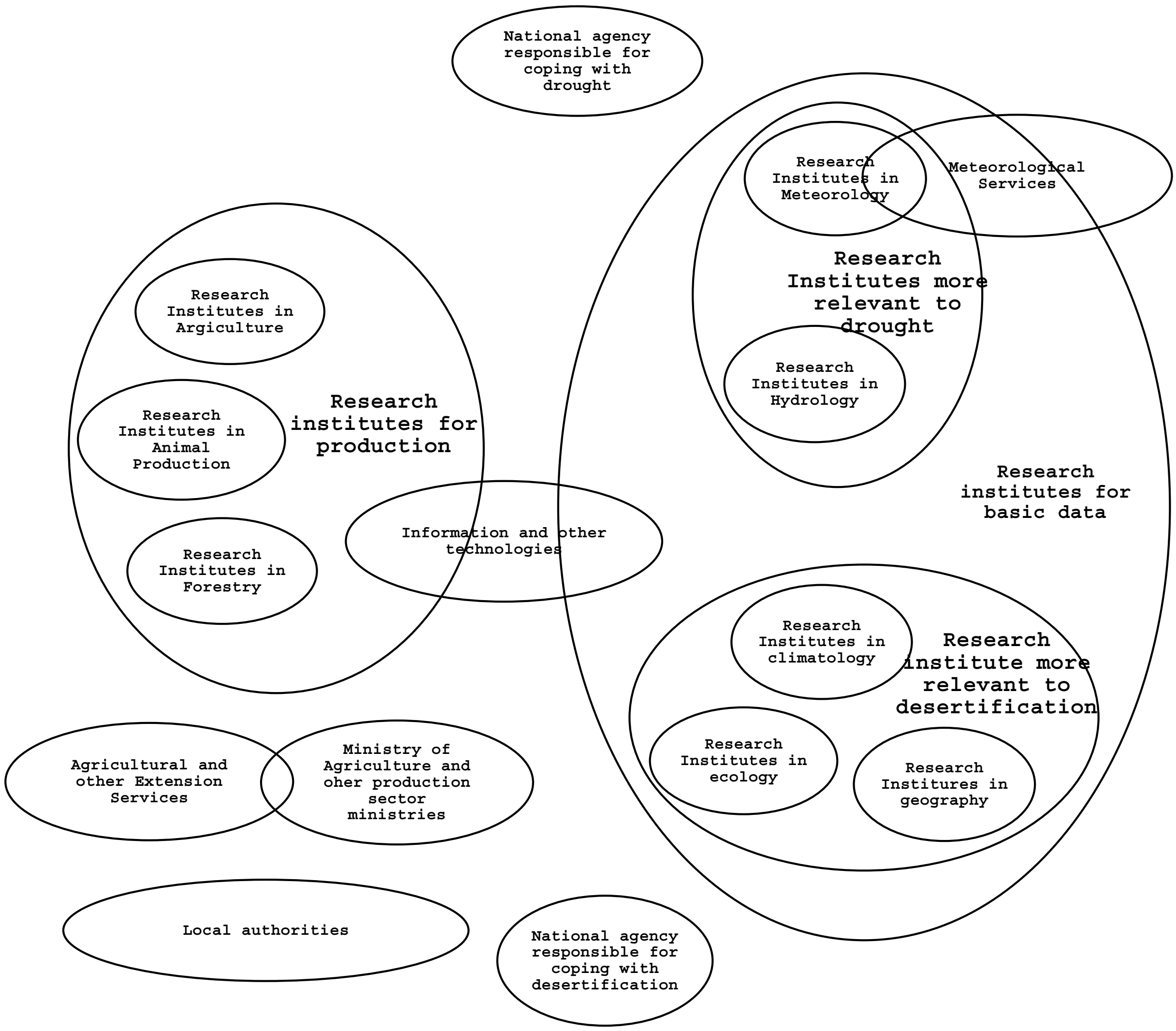

Chart 2. Different kinds of scientific and technological institutions in different kinds of activities

(4) Importance of always giving due regard to the objective of the Convention

Decision 14/COP.4 instructed the Ad Hoc Panel to discuss the mechanisms to facilitate information exchange between scientific and technological institutions for the prediction of drought and monitoring of desertification. However, the mandate of the Committee on Science and Technologies is not restricted to the matters of scientific and technological institutions. Actually it is to provide the Conference of the Parties with information and advice on scientific and technological matters relating to combating desertification and mitigating the effects of drought (Article 24, paragraph 1). And subsequently the mandate of ad hoc panels is to provide the Conference of the Parties, through the Committee, with information and advice on specific issues regarding the state of the art in fields of science and technology relevant to combating desertification and mitigating the effects of drought (Article 24, paragraph 4). It is critical that these mandates be interpreted in the context of the objective of the Convention, i.e. to combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification (Article 2, paragraph 1) and the formally supplemental but actually definite aim, i.e. leading to improved living conditions, in particular at the community level (Article 2, paragraph 2). Without recognition of the objective and aim of the Convention, discussions would be simply to help scientific and technological institutions exchange information for their own objectives, not for combating desertification and mitigating the effects of drought as the Convention provides for.

III. Need for cooperation and collaboration beyond national boundaries

The Ad Hoc Panel in 2000 recognized that data collection, access, and integration were the responsibilities of Governments at the national level and recommended that National Action Programmes should address these data responsibilities and define clear objectives for data collection, access and integration of programmes as well as the need for better data access.

However, meteorological and climatological conditions, which have the most significant effects on drought and desertification among the natural elements, are not always confined within national boundaries. Mountains, prevailing winds, cold or warm sea currents and others give similar conditions to the countries in a subregion and thus give similar or sometimes common meteorological and climatological conditions, subsequently causing a series of drought or desertification phenomena.

Also important is the linkage with subregional economic and political communities because actions in combating desertification and mitigating the effects of drought require political, economic and other actions.

Accordingly, due considerations should be given to such subregional meteorological, climatological, economic, political and other regimes as appropriate, in addition to national actions.

IV. Existing national and subregional arrangements relevant to the prediction of drought and monitoring of desertification

(1) The information available

Most Parties to the Convention submitted reports to the third and fourth sessions of the Conference of the Parties in 1999 and 2000. Some of such reports provide some information on their networks relevant to the prediction of drought and monitoring of desertification at the national and subregional levels. Some of the reports submitted by subregional and other organizations, particularly those submitted to the third session on the activities in support of African Parties, also give such information, in particular:

- *Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD)*
- *Arab Organization for Agricultural Development (AOAD)*
- *Solidarité Canada Sahel*
- *Centre for Environment and Development for The Arab Region and Europe (CEDARE)*
- *CILSS/CEDEAO (Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel/Communauté Economique des Etats de l'afrique de l'Ouest)*
- *International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)*
- *IGAD Sub-regional Action Program (IGAD-SRAP)*
- *Observatoire du Sahara et du Sahel (OSS)*
- *Southern African Development Community (SADC)*
- *Union Economique et Monétaire Ouest Africaine (UEMOA)*
- *Union du Maghreb Arabe (U.M.A)*
- *World Meteorological Organization (WMO)*

The paper of Mr. Ruben K. Sinange submitted for the re-appointed Ad Hoc Panel on Early Warning Systems in 2001 (Sinange, 2001) also gives information of several African countries, i.e. Ethiopia, Botswana, Mali, South Africa, Chad, Kenya and Sudan. It not only well describes outlines of the early warning systems of the countries but also well analyzes the positive and insufficient aspects of them.

The Database prepared in Phase 1 of the UNCCD Information Network Project (Survey and Evaluation of Existing Networks, Institutions, Agencies and Bodies) conducted by an international consortium under the auspices of UNEP provides basic information on so many as currently 1,167 institutions, organizations and networks that are working on desertification-related issues and is available in the Internet at http://ag.arizona.edu/cgi-bin/cstccd.cgi. The information given there include: name of the institution, date of establishment, postal address; country, telephone, fax, email, web address, contact person's name and title, nature of the institution, language, specialty, number of staff in accordance with gender, funding sources, level of the funding, involvement in national action plans, and involvement in national coordinating body/steering committee.

The following documents submitted to the meetings of the Conference of the Parties also contain some relevant information:

- *ICCD/COP(1)/CST/2/Add.1: Survey and Evaluation of Existing Networks*
- *ICCD/COP(1)/CST/4: Report on Work of Other Bodies Performing Work Similar to That Envisaged for the Committee on Science and Technology*
- *ICCD/COP(2)/CST/2/Add.1: Survey and Evaluation of Existing Networks, Institutions, Agencies and Bodies*
- *ICCD/COP(2)/CST/4: Report on Work of Other Bodies Performing Work Similar to That Envisaged for the Committee on Science and Technology*
- *ICCD/COP(3)/CST/4: Survey and Evaluation of Existing Networks, Institutions, Agencies and Bodies*
- *ICCD/COP(3)/CST/5: Report on the Work of Other Bodies Performing Work Similar to that Envisaged for the Committee on Science and Technology*
- *ICCD/COP(3)/CST/6: Early Warning Systems: Existing experience of early warning systems and specialized institutions acting in this field*
- *ICCD/COP(4)/CST/3/Add.1: Survey and Evaluation of Existing Networks, Institutions, Agencies and Bodies: Addendum*

(2) Existing national and subregional arrangements relevant to the prediction of drought and monitoring of desertification

Africa

According to Sinange (2001), not a small number of African Parties have been making efforts to develop their capacities, including development of committees or consortia of institutions from different areas such as meteorology, hydrology, agronomy, livestock management, forestry, the environment and others, in prediction of drought and monitoring of desertification (Box 1). The organizations participating in such efforts include governmental agencies, national or other public research institutes and universities. In not a small cases, non-governmental organizations and intergovernmental organizations are also involved.

Such efforts are mostly based on the activities to cope with recurrent droughts rather than to cope with desertification. Also, Sinange (2001) observes that there is a shift from famine-oriented early warning systems in the 1970's to the present food security-oriented systems. However, the shift has not yet been complete or successful in all cases due to political problems, lack of resources, bureaucracy and others.

Box 1. Early Warning Systems in several African Parties (Sinange, 2001)

In Ethiopia, Disaster Prevention and Preparedness commission (DPPC) co-ordinates the EWS. The country EWS was highly centralized with data collection, analysis interpretation and report writing being carried out at the federal level from Addis Ababa. The strategy has changed and the EWS decentralized with being established at regional, zonal and district levels. The Country EWS is headed by an Early Warning Committee at all levels. These committees report to the National committee which oversees all the operations of the Ethiopian system. The EWS of Ethiopia depends on various government agencies for information such as central Statistical Authority (CSA) for crop production forecast and market and the National Meteorological services Agency (NMSA), which provide climate data as drought is the main threat to food security. The EWS system in the country has been supported by donor funding but was poorly resourced due to unfavorable aid climate during the Mengistu regime. The major drawbacks of Ethiopian EWS was mistrust over figures for relief assistance provided, with the donors feeling that the figures are exaggerated and used our political expediency. There is also lack of co-ordination of activities and communication between the government and the donors.

In Botswana, The structure of the Botswana EWS in hierarchical in which the information is gathered by various ministries and departments of these ministries and shared in the monthly meetings of Early Warning Technical Committee (EWTC). The EWTC advises the Inter-Ministerial Drought Committee (IMDC) which meets monthly or bi-monthly depending on the time of the year. The Botswana early warning system follows the bottom-up approach from the individuals, communities and district government. This is through having members of EWTC drawn from technicians, managers and administrators within several ministries. The Ministry of Agriculture has an Early Warning Unit (EWU), which has an important co-ordinating role and ensures that data provided to EWTC are reliable. It is also the link with regional early warning unit of the Southern African Development Community (SADC) and the Botswana drought early warning system. The weaknesses of the Botswana system are:

* *Lack of technical capacity*
* *Lack of collaboration between Ministries and data providers*
* *Lack of dissemination information in understandable forms to district and village levels*
* *Vulnerability mapping not well developed.*

The Malian EWS is known as the système d'alerte Précose (SAP). Mali is also covered by the regional early warning systems such as CLISS/AGRYMET system as well as the FAO's GIEWS. The SAP EWS has three critical stages namely, Monitoring. Reporting and decision Making, which leads to response being triggered in case of a bad drought. The SAP is based on the existing government structure and it has succeeded in standardizing data- gathering methods and reporting requirements. The regular monthly publication of SAP bulletin has made sub-national-level information available. The EWS has a bottom up approach with information collected the circle or district regional to the national level. This allows consensus building among the various agencies involved in EWS. The drawback of Mali EWS is over-institutionalization of the response time, leading to long bureaucratic delays which lead to delay in release of SAP recommendations. The strength of Mali EWS and response is as a result of building of donor/ government co-ordination established for the cereal market restructuring.

In South Africa forecasting is mainly a responsibility of National Meteorological Services (NMS) but for developmental and disaster management, the Ministry of Agriculture takes the leading roles. When disaster set, it usually reveals lack of adequate data and information on which decisions are based. Lack or inadequate coordination in the EWS is also observed. So is the lack of clear co-ordination at the political and departmental levels leading to ineffective systems of management. Budgetary constraints are common at all levels.

The Chad EWS, the système d'alerte Précose (SAP), is a famine oriented system geared to identifying, recommending and justifying required distribution of food aid, located within the Direction de la Promotion des Production Agricoles et de la Sicurité Alimentaire (DPASA), restricted to provision of information and not involved in the decision process nor in the implementation of response. Other components of the Chad EWS include Bureau de la Statistique Agricole (BSA) and Organisation Nationale de développement Rurale (ONDR). These provide data on monthly food production which is produced in form of a bulletin. Other inputs to SAP are from the regional EWS in the region such as AGRHYMET, FEWS and FAO/CILSS. SAP activities are funded by EU with technical assistance provided by the Association Europeénne pour les Développement et la Santé (AEDES). Lack of consistent funding to sustain SAP operations is observed.

Kenya has a well established EWS involving several government agencies, regional organizations and NGOs. The government organizations involved in early warning activities are: Kenya Meteorological Department KMD), Ministry of Agriculture (MOA), Central Bureau of Statistics (CBS), and the Department of Resource Surveys and Remote Sensing (DRSRS). The KMD provides meteorological and climatic data. MOA disseminates EW information and has data on crop hectarage and yield production estimates. CBS has data on human population collected through census and socio-economic data. DRSRS uses remote sensing techniques to estimate area under crop, yield and production of two stable crops (maize and wheat). It also uses NOAAAVHRR NDVI data to monitor vegetation status in the Kenya rangelands. Subregional agencies supplementing the Kenyan EWS are the Drought Monitoring Centre (DMC), IGAD, FEWS and GIEWS. Kenya has also a decentralized EWS focusing on some of the most vulnerable districts in the country. These are coordinated by the Office of the President. The district-based EW are faced by financial crisis due to inadequate donor funding to the programs. What is weak also is a coordinating body to collate the different data sources from many agencies involved in EWS, as well as a district level information into a single EW source at national level.

In Sudan, the national EWS set up in 1986 and based in the Relief and Rehabilitation Commission, is highly centralized and carried out with no primary data collection. This has affected the development of baseline data for the system. Other regional agencies involved in EW activities in the country include IGAD, FEWS, WFP, IGAD, and FAO. It was almost stopped after one year when donor funding was withdrawn. The EWS continued to function with poor resources and high staff turnover due to frequent changes of government.

The regional and subregional EWS serving the different parts of Africa are established and have been building capacities for EW activities: Southern African Development Community (SADC), African Centre for Meteorological Application for Development (ACMAD), the Drought Monitoring Centres (DMC) in central and eastern Africa, AGHRYMET Programme of the Inter-state Committee on Drought Control (CILSS) in the Sahel and the Inter-governmental Authority on Development (IGAD).

Subregional efforts for prediction of drought and monitoring of desertification have also been made in different subregions in Africa and Middle East according to the reports submitted by subregional organizations to the Conference of the Parties at its third session as well as Sinange (2001).

For example, the priorities of the **Intergovernmental Authority on Development (IGAD)**[1] **Sub-regional Action Program** include the following activities relevant to prediction of drought and monitoring of desertification:

- Establishment of Hydrological Cycles Observation System (HYCOS) for the sub-region, with the aim to strengthen the capacities of National Hydrological Services in the collection, processing, dissemination and sharing of hydrological data/ information on selected major river systems so as to enable them manage these water resources in a sustainable manner;

- Establishment of data-banks, meta-data banks and information systems for environmental management (EIS) is another priority in the formulation of an IGAD Regional Integrated Information System (RIIS) aiming to harmonize various information activities of the sub-region in order to enhance the sustainable production and dissemination of timely and reliable information for food security, environment protection, natural resources management, economic co-operation, policy harmonization, conflict prevention, resolution, management and humanitarian affairs;

- Strengthening electronic communications/networks for information collection and dissemination in Member States and IGAD Secretariat;

- Early warning systems and joint planning for mitigating the effects of drought, including development of disaster and drought preparedness strategies as well as programs to ensure food security in the subregion and improve strategic food reserves, transportation and other relevant infrastructure, support to centers providing early warning about natural disasters (droughts, floods), and dissemination of early warning information to Member States.

To facilitate these and other activities, an IGAD/SRAP Technical Committee, IGAD/SRAP Bureau and IGAD Committee on Science and Technology have been established. Internet connectivity between IGAD Secretariat and some national institutions relevant to SRAP, e.g. National Meteorological Services, Ministries of Agriculture, Relief Agencies, etc, has also been established.

The priority program areas of the **Sub-Regional Action Programme (SRAP) to Combat Desertification in Southern Africa** adopted by the Council of Ministers of the Southern African Development Community (SADC)[2] include Strengthening of Early Warning Systems to be implemented through a partnership involving SADC Environment and Land Management Sector (ELMS)'s EIS Technical Unit (SETU), the SADC Food Security Sector's Regional Early Warning Unit (REWU), Zimbabwe's Drought Monitoring Centre (DMC) and a SADC Commission responsible for transport, communications and meteorology. However, due to the lack of financial and technical resources available to SADC-ELMS, all have not yet been effectively implemented.

The priorities of the **Union du Maghreb Arabe (U.M.A)**[3] include a *Projet de mise en place d'un système de circulation de l'information sur la désertification (SCID), and la mise en place d'un réseau régional de surveillance continue des écosystèmes.*

The reports submitted to the Conference of the Parties also show that many multilateral and bilateral agencies have been providing assistance to the countries for strengthening meteorological services, hydrological monitoring and many other capacity development

[1]*Kenya, Uganda, Ethiopia, Djibouti, Eritrea, Sudan*
[2]*Angola, Botswana, the Democratic Republic of Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe*

required for or closely related to prediction of drought and monitoring of desertification. However, whether such activities are aimed at comprehensive capacity development for prediction of drought and monitoring of desertification, rather than capacity development in individual areas of expertise, is not clear.

Asia

The national reports of Asian Parties submitted to the fourth session of the Conference of the Parties contain the information shown in Box 2.

According to that information, in the context of the CCD, Asian Parties are making more efforts to capture the state of desertification rather than predicting drought, which has surely existed in the countries. It is understood that Asian Parties accept the issue of desertification as a new concept which the multilateral negotiations for the CCD established and which has subsequently bound the Parties, rather than an issue developed from the long standing issue of drought in contrast to the African Parties. In these circumstances, they mention or indicate involvement of similar kinds of agencies in prediction of drought and monitoring of desertification as to those in Africa. There is limited transboundary collaboration in information exchange and sharing. However, the regimes for desertification monitoring is still at an evolving stage in most countries - while institutional arrangements, including networks, have been more developed, substantive collaborative activities are yet to be developed.

Box 2. Early Warning Systems stated in the National Reports from some Asian Parties submitted to the third session of the Conference of the Parties, 2000

China: A nation-wide inventory on desertified land was carried out in China from 1994 to 1996. In accordance with the spirits of the UNCCD, the China Country Paper to Combat Desertification was compiled and Chinas desertified land area distribution map with a scale of 1:2.5 million was made. The report and the map systematically unveiled the desertified land area, distribution and causes and analyzed the desertification expansion trend. Starting from 1999, the nation-wide desertification monitoring with thousands of sampling plots has been carried out, aiming at collection of information, being aware of the dynamic status of desertification, periodical announcement of the results of monitoring so as to provide scientific evidences for decision making.

India: Government of India has established a network of national level research institutes such as the Central Research Institute for Dryland Agriculture, Hyderabad; the Central Arid Zone Research Institute, Jodhpur; the Central Soil Salinity Research Institute, Karnal; the Central Soil and Water Conservation Research Institute, Dehra Dun; the Indian Grassland Forest Research Institute, Jhansi; the National Research Centre on Agroforestry, Jhansi; the Water Technology Centre at the Indian Agriculture Research Institute, New Delhi, under the aegis of the Indian Council of Agricultural Research (ICAR). A network of forestry research institutes under the Indian Council of Forestry Research and Education (ICFRE), Dehra Dun, is conducting research on problems related to the rehabilitation of degraded lands and increasing the productivity of forests of drylands.

Several organizations are engaged in the monitoring of different aspects of desertification and drought. Work is in progress to establish an Early Warning System (EWS) and a drought management plan:

Desertification: The Central Arid Zone Research Institute, Jodhpur is one of the ENVIS centres functioning as a database on desertification, it is necessary to develop a networks at the national, state and district levels of monitoring activities covering the entire arid, semi-arid and dry sub-humid regions of the country. Collecting data/information on the impact indicators using remote sensing and GIS for developing a sound database would be an important function of these networks.

Drought: The satellite based National Agricultural Drought Assessment and Monitoring System (NADAMS) is established at the Department of Space (DOS). The programmes are being carried out by the National Remote Sensing Agency (NRSA). The Department of Agriculture and Co-operation, with support from state and central government departments, has sponsored NADAMS for providing reliable and accurate information on agricultural conditions. NADAMS uses daily NOAA-AVHRR (1.1 km) and IRS-WIFS (188 m) based biweekly/monthly vegetation index and provides periodic information on crop conditions at the district and subdistrict level in terms of drought bulletin and detail reports. This programme at present covers 10 states. There is need to strengthen the national climatological and hydrological capabilities to ensure early warning systems and to suggest measures for strengthening drought preparedness and management including drought contingency plan at local, national and regional levels.

[3] *Libya, Tunisia, Algeria, Morocco, Mauritania*

Mongolia: There is a step to establish monitoring capacity, which will monitor and observe land degradation and desertification process to prevent negative impacts in earlier stage of desertification, to use land resource in sustainable way and to create favorable ecological condition. The Information and Computer Center (ICC) under the Ministry of Nature and Environment (MNE) exchanges weather information through the telecommunication network of the World Meteorological Organization to regional centers in Novosibirsk and Beijing and disseminates weather information throughout the country. It also serve National remote sensing center. Hydrometeorological Institute, MNE receives meteorological data through internal and external nets meteorological data and processes them to distribute to the users. ICC received NOAA satellite data since 1970. Laboratory for Geo Informatics in Institute for Informatics, Academy of Sciences has processed multi channel image from outer space complex Soyuz T4-Salut 6-Soyuz 39 to get pasture, soil and vegetation status for survey. However it has not created yet real Information system on desertification under the National Committee to Combat Desertification (NCCD), but information on desertification and natural disasters needed for analyses and decision making available in the databases of Governmental or Non-governmental Environmental organizations. The most of information related with desertification is kept in Institutions under MNE as Library, ICC, HMI (Hydrometeorological Institute), LMA (Land Management Agency under MNE) and EPA (Environmental Protection Agency under MNE). Other part of information is stored in Institutes of Academy of Sciences: Geography, Geo Ecology, Botany, Biology and Informatics and in Institute for Animal Husbandry, State Geodesy and Cartographic Service and Center for Geo Information and Remote Sensing, Ministry for Agriculture and Industry. The problems like assessment of negative impacts from desertification and natural disasters, prevention from them, measures on restoration, monitoring, getting internal and external aids and implementation of projects are discussed and solved by scientific seminars, meetings of Minister's committee and Committee on science and technology in MNE or meetings of NCCD and Government.

Turkmenistan: The specialists of the National Institute of Deserts, Flora and Fauna have worked out techniques of monitoring and instructions for plotting maps of desertification, which were discussed and approved in appropriate departments of the UNEP, ESCATO and FAO. On the basis of accumulated basis data, a chart of the current state of desertification on the territory of Turkmenistan on the scale 1:1,000,000 was prepared.

"Subregional action programmes (SRAPs) processes are progressing cautiously" in Asia (ICCD/COP(4)/3/Add.1 (D) para. 91). But some regional cooperative activities have been initiated in Asia, in particular under the Thematic Programme Networks. Monitoring and Assessment (TPN1), Agroforestry and Soil Conservation (TPN2), and Range Management and Sand Dune Fixation (TPN3) have been launched. Water Resources Management for Agriculture in Arid, Semi-arid and Dry Sub-humid Areas (TPN4), Strengthening Capacities for Drought Impact Mitigating and Desertification Combating (TPN5), and Assistance for the Implementation of Integrated Local Area Development Programmes (LAPDs) Initiatives (TPN6) have also been planned. The TPN1 on the monitoring and assessment of desertification has seen the most significant progress with already organizing several meetings, including a workshop in Tokyo in June 2000 with more than 70 participants from 14 Asian countries, two developed countries from other regions and five international organizations.

West Asia has three thematic programme networks focused on: (a) information and monitoring;(b) drought preparedness; and (c) strategic studies, research and training needs. Subregional institutions, such as the Centre for Environment and Development for the Arab Region and Europe (CEDARE), the International Center for Agricultural Research in the Dry Areas (ICARDA), and the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), were identified. As mentioned in the section on Africa, these have been playing roles in prediction of drought and monitoring of desertification not only for Africa but also for their own subregion.

An Interregional Conference on the implementation of the UNCCD of the countries in Central Asia, Eastern Europe and the Transcaucasus in 1997 recognized (a) assessment, monitoring and early warning systems (EWS) for combating desertification and mitigating the impact of drought, and (b) use of transboundary water resources and monitoring of their usage at interstate levels as priority areas among others in a proposed Interregional Action Programme (IRAP) to combat desertification. However, due to the delay in the accession to the Convention by some countries of Eastern Europe, the preparation of the IRAP was postponed.

However, the Central Asian countries, all of which have already become Parties to the CCD, selected "monitoring and assessing the desertification process" as one of the priority areas of their regional action program at a Ministerial Meeting on SRAP preparation in July 2000/

Latin America and the Caribbean

The reports of the Latin American and Caribbean Parties state that they recently developed institutional arrangements in their ratification of the CCD. However, the concept of desertification is quite new to most of them, accepted only when they ratified the Convention. Again desertification is not what has developed from the concept of drought in contrast to the African Parties. In these circumstances, the institutional arrangements, including networks, are mostly just formal and substantive activities are yet to be developed.

A project on benchmarks and indicators for monitoring desertification in Latin America and the Caribbean has been proposed as a priority area of the activities of the region. The Gran Chaco Americano Project, the only project which has seen some progress in the region, covers a vast region extending over areas of Argentina, Bolivia and Paraguay, projects aimed at providing the region with instruments for the coordination and improvement of national capacities for the implementation of the Convention, through the formulation and application of NAPs. The Third Regional Meeting in1997 established the following four subregions: South America with eight Parties (Argentina, Brazil, Chile, Guyana, Paraguay, Suriname, Trinidad and Tobago, and Uruguay), the Andean subregion, with five Parties (Bolivia, Colombia, Ecuador, Peru and Venezuela), the Caribbean, with eleven Parties (Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, St. Kitts and Nevis, St. Vincent and the Grenadines), and Mesoa Mesoamerica, with eight Parties (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, and Panama). A Subregional Action Programme for Sustainable Development of Puna Americana covering the high mountain ranges of the Andes, in Argentina, Bolivia, Chile, Ecuador and Peru has been envisaged to be formulated as a framework for sustainable development. As such there has not yet been a substantive progress in the region and subregions with regard to activities closely related to prediction of drought and monitoring of desertification.

V. Analysis the existing networks of early warning systems and desertification monitoring and assessment at the national and subregional levels in the prediction of drought and monitoring of desertification

There are no mechanisms or networks specialized in exchange of information among scientific and technological institutions on the prediction of drought and monitoring of desertification at the national or subregional levels. However, there are mechanisms or networks aimed at overall strategic actions against drought and desertification, involving both scientific/ technological and administrative and other agencies. Most of them are formed in accordance with the provisions of the Convention, particularly regional action programs.

Among such mechanisms and networks, regional differences are identified. In Africa, the mechanisms and networks are mostly based on those aimed at drought which had existed before the adoption of the CCD. On the other hand, in other regions, the mechanisms or networks were created or have been in the process of creation after the adoption of the CCD and in accordance with the provisions of it. Also, in such regions, the focus of such mechanisms and networks are on desertification while that in Africa is on drought.

For African Parties, desertification is a concept developed in the line of drought. Therefore their institutional arrangements in their ratification of the CCD built on their traditional institutions to cope with drought. For the same reason, their early warning systems in response to the CCD are more focused on drought rather than on desertification. For many other Parties, desertification is a concept introduced in the process of international politics to develop the Convention, therefore new institutions are to be developed in response to the "new" concept of desertification rather than building on the traditional regimes to cope with drought.

These resulted in the difference in the time required before the establishment of the mechanisms and networks. Because the national and subregional mechanisms and networks in Africa are mostly based on existing institutional arrangements, the countries established such mechanisms and networks soon after the adoption of the Convention, although not a small number of them face financial and other constraints. On the other hand, in many other countries or subregions, particularly at the subregional level, such mechanisms or networks are still in preparatory processes. Both in Africa and in other regions, the CCD secretariat and other international agencies have been providing technical and other assistance in the establishment of such mechanism and networks. The coordinating bodies are different in different Parties. In many, particularly in African Parties, the environment ministries are playing key roles. In some countries, particularly in Asia, more Ministries of Forestry are playing key roles. In other countries, Ministries of Agriculture or sometimes Water Resources are playing key roles. In Uzbekistan, Main Administration of Hydrometeorology has been playing a key role.

In the establishment of the national and subregional mechanisms and networks, many Parties have been receiving technical and other support from bilateral and multilateral agencies. However, African Parties have been receiving much more assistance than the Parties in other regions. Also, African Parties have been assisted by various agencies both multilateral and bilateral while the Parties in other regions have received limited support from a limited number of multilateral agencies, mostly from the CCD Secretariat, UNEP and UNDP. The reasons for these differences seem to be closely related not only to the facts that the establishment of the new mechanisms or networks in other regions than Africa is more suitable for the assistance from the CCD secretariat, UNEP and UNDP and the comparatively lower per capita income of African Parties, but also to the fact that the African way of establishing mechanisms and networks builds on the existing institutional arrangements to cope with drought which had long existed before the adoption of the CCD and which both bilateral and multilateral agencies had been supporting. While donors are not familiar with the mechanisms and networks which are newly established in response to the adoption of the CCD, they are familiar with the existing networks for drought and accordingly can easily respond to requests for assistance.

Box 3. Article 16: Information collection, analysis and exchange of the CCD

The Parties agree, according to their respective capabilities, to integrate and coordinate the collection, analysis and exchange of relevant short term and long term data and information to ensure systematic observation of land degradation in affected areas and to understand better and assess the processes and effects of drought and desertification. This would help accomplish, inter alia, early warning and advance planning for periods of adverse climatic variation in a form suited for practical application by users at all levels, including especially local populations. To this end, they shall, as appropriate:

(a) facilitate and strengthen the functioning of the global network of institutions and facilities for the collection, analysis and exchange of information, as well as for systematic observation at all levels, which shall, inter alia:
(i) aim to use compatible standards and systems;
(ii) encompass relevant data and stations, including in remote areas;
(iii) use and disseminate modern technology for data collection, transmission and assessment on land degradation; and
(iv) link national, subregional and regional data and information centres more closely with global information sources;
(b) ensure that the collection, analysis and exchange of information address the needs of local communities and those of decision makers, with a view to resolving specific problems, and that local communities are involved in these activities;
(c) support and further develop bilateral and multilateral programmes and projects aimed at defining, conducting,
assessing and financing the collection, analysis and exchange of data and information, including, inter alia: integrated sets of physical, biological, social and economic indicators;
(d) make full use of the expertise of competent intergovernmental and non-governmental organizations, particularly to disseminate relevant information and experiences among target groups in different regions;
(e) give full weight to the collection, analysis and exchange of socio-economic data, and their integration with physical and biological data;
(f) exchange and make fully, openly and promptly available information from all publicly available sources relevant to combating desertification and mitigating the effects of drought; and
(g) 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.

VI. Recommendations

On the basis of the above observations, the following are recommended to Parties, bilateral and multilateral agencies, the Global Mechanism and all others concerned with the CCD:

(1) It is not practical that the mechanisms for information exchange among scientific and technological institutions are established independently from the other mechanisms under the CCD. They should be an integral part of the overall mechanisms and networks for information collection, analysis and exchange which should be done in accordance with Article 16.

(2) Uniform mechanisms or networks are not required to different Parties and subregions in accordance with the provisions of the Convention, particularly Article 16 on Information Collection, Analysis and Exchange, which provides for individual activities to be done "as appropriate". Therefore the mechanisms and networks for prediction of drought and monitoring of desertification should be flexible according to the situations in each country or subregion. While the African Parties are committed to specific subregional and regional cooperation activities by applying "shall" in their Regional Implementation Annex, specific regional and subregional cooperative activities are voluntary to the Parties of the other regions which apply "may" in their Regional Implementation Annexes. Such regional or subregional activities should be done as appropriate, not as uniform obligations under the Convention.

(3) The efforts to newly established mechanisms or networks focused on desertification have actually not only encountered delays but also received limited assistance from bilateral and multilateral agencies. The is not only because establishment of new mechanisms or networks encounters difficulties in such expertise that is not readily available but also because the bilateral and multilateral agencies are not familiar with such new ones. At the same time, it is observed that most Parties and subregions trying to establish new mechanisms or networks are focusing their efforts on desertification only, with no specific reference to the issue of drought, which is another focal area of the CCD in accordance with the provision for the objective of it as "to combat desertification and mitigate the effects of drought" (Article 2). The Ad Hoc Panel on Early Warning Systems of 2000 recommended that it is far more important to maintain and strengthen existing observation networks than to expand or create new systems with regard to data collection (ICCD/COP(4)/CST/4: Early Warning Systems: Report of the ad hoc Panel). That applies not only to data collection but also to many others. It is therefore recommended that, according to the circumstances of individual countries and subregions, due consideration should be given to establishing mechanisms or networks on the basis of the existing arrangements for coping with drought rather than creating totally new ones.

(4) There are two types of transboundary or subregional activities:

- Collaboration to share the common meteorological, hydrological, ecological, agronomical information in the subregion; and
- Exchange of information of the experiences of the Parties to share those that may be useful in other countries.

In the countries in the same climatic subregions, both the former and the latter are useful, with more importance in the former because response mechanisms much depend on political, social and economic conditions, which may not be common in the same climatic subregion. Exchange of information of the experiences of the Parties is most useful where the Parties share similar political, social and economic conditions. Therefore it should be promoted where appropriate appropriate, not at all subregions or regions.

(5) In transboundary or subregional activities, utilization of the existing meteorological, political or other regimes is important. Actually the subregional organizations in Africa are already engaged in subregional, cooperative/collaborative activities in mitigating the effects of drought on the basis of the regimes for drought which had already existed. The subregional organizations in Asia, such as ASEAN, SARRC, etc., have been engaged in cooperative activities in the areas related to meteorological and/or environmental issues, such as ASEAN's program to cope with the haze problem primarily caused by forest fires, and are therefore likely to have capacities to act as coordinating bodies in combating desertification and mitigating the effects of drought, including prediction of drought and monitoring of desertification. In the Pacific, there are various subregional collaborative activities and programs, including the South Pacific Regional Environment Programme (SPREP), which is a unique subregional intergovernmental organization for the environment. Although the SPREP may not be the most suitable organization for the desertification/ drought issue, the past successful experiences of regional collaboration among the countries there justify their capacities for similar activities for the CCD. The subregional organizations in Latin America and the Caribbean, like the Andean Pact[4], Caribbean Common market (CARICOM)[5], Central American

Common Market (CACM)[6], Latin American Integration Association[7], MERCOSUR[8], Association of Caribbean States[9], Group of Three[10], etc., are mostly oriented to economic relations and thus have not yet been engaged in cooperative/collaborative activities in the areas relevant to desertification/drought issues. However, they also seem to have certain capacities because there have been subregional collaborative activities in the field of the environment. As such, the existing meteorological, political or other regimes should be utilized so long as possible.

(6) Early warning for drought prediction and assessment, and monitoring and assessment for desertification are fundamentally interrelated yet operationally different activities as the Ad Hoc Panel of 2000 pointed out (ICCD/COP(4)/CST/4: Early Warning Systems: Report of the ad hoc Panel). Drought is a relatively shortterm phenomenon, requiring involvement of comparatively smaller number of expertise. On the other hand, desertification is a relative long-term phenomenon, requiring relatively comprehensive combination of expertise, where "information in the long-term to improve systems of community-based natural resource management and institutional capacities" (ICCD/COP(4)/CST/4) is important. Accordingly in mechanisms and networks, different emphasis should be laid on different expertise between drought and desertification.

(7) In view of the financial difficulties the existing mechanisms and networks have encountered, international support is important. However, sustainability of operations, about which the Ad Hoc Panel of 2000 expressed concern, must be ensured. Support should be addressed to building technical and management capacities of the Parties or subregional organizations rather than to covering operational costs. Also, the developing countries must not unilaterally terminate or suspend assistance before an assistance program is completed as agreed on. In this regard, the Global Mechanism must take this fully into account in performing its role to increase the effectiveness and efficiency of existing financial mechanisms, making efforts to help bilateral and multilateral agencies to ensure sustainability of the programs they support.

Reference

Sinange, Ruben K., 20001: Measures Taken for Drought and Desertification Preparedness with Particular Reference to African Countries, Working Paper to be Presented at Ad Hoc Panel on Early Warning Systems, 4-8 June 20001, Fuji Yoshida, Japan, United Nations Convention to Combat Desertification.

[4]Bolivia, Colombia, Ecuador, Peru, Venezuela
[5]Antigua, the Bahamas, Barbados, Belize, Bermuda, Dominica, Grenada, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent, Trinidad and Tobago
[6]Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua
[7]Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay and Venezuela
[8]Argentina, Brazil, Paraguay, Uruguay
[9]CARICOM Members, Colombia, Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti,
Honduras, Mexico, Panama, Surinam, Venezuela
[10]Colombia, Mexico, Venezuela

LA PLANIFICATION PARTICIPATIVE
DANS LE SYSTEME D'ALERTE PRECOCE

Tokyo 04 au 08 Juin 2001

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INTRODUCTION

PROCESSUS DE PLANIFICATION PARTICIPATIVE EN MATIERE DE SECURITE ALIMENTAIRE

1. Diagnostic

2. Organisation/Sensibilisation
   - → Identification du public cible (groupes vulnérables)
   - → Choix des problèmes prioritaires
   - → Choix des actions à entreprendre
   - → Sélection des personnes ressources et formation de l’équipe de planification

3. Elaboration du plan

4. Exécution du plan

5. Suivi/Evaluation

CONCLUSION

INTRODUCTION

La notion de planification participative est née de l'échec de ce qu'on appelait « la planification directive », qui imposait des actions aux communautés locales. Cet état de fait a expliqué en partie l'échec de certains programmes de développement. Depuis quelques années, on parle beaucoup plus de la planification participative associée souvent à la notion de développement local. la principale caractéristique de cette démarche dans le cadre du Système d'Alerte Précoce est l'implication de la communauté locale dans tout le processus de gestion de ce système. Ainsi la planification participative valorise la communauté locale tout en lui donnant une place d'acteur dans la résolution des problèmes de sécheresse et de sécurité alimentaire.

Différentes phases caractérisent cette démarche.

PROCESSUS DE PLANIFICATION PARTICIPATIVE

La planification participation est une démarche dialoguée et concertée qui crée les conditions pour que la population elle même analyse la situation locale, définisse ses propres objectifs par rapport aux problèmes posés, identifie les actions à mener et les moyens à mobiliser.

Elle est une démarche qui engage les acteurs locaux de la communauté dans la définition d'un programme mobilisateur permettant la valorisation durable des ressources humaines et naturelles locales.

En d'autres termes c'est une démarche qui vise à promouvoir une réflexion/action qui englobe les court, moyen et long termes; une démarche qui aide toutes les catégories sociales à participer à la réflexion autours des actions qui les concernent, qui concernent leur survie.

Cette démarche permet à l'ensemble de la communauté une réflexion collective autour des problèmes précis, en établissant la relation entre ces problèmes, les solutions envisagées et les ressources dont ils disposent.

L'échelon local n'est plus considéré comme le seul point d'application des recherches scientifique et technologique des intervenants extérieurs.

1. Diagnostic

A ce niveau il s'agira d'un diagnostic concerté qui vise à impliquer les membres de la communauté dans l'analyse de leur situation afin de déboucher sur un bilan diagnostic de la situation locale dans laquelle ceux-ci se reconnaissent.

L'établissement d'un diagnostic global de la situation de sécurité alimentaire porte sur de multiples domaines car l'élaboration d'une stratégie suppose la connaissance préalable ou la mise à jour d'une série d'informations essentielles.

Ainsi, différentes phases constitutives du diagnostic sont à examiner :

1. Identification des structures du système alimentaire national ou régional

- *La situation de l'environnement écologique et particulièrement du capital physique qui sous-tend la production.*
- *Les systèmes et les structures de production qui décrivent des modes de fonctionnement (des agents avec leurs techniques de production sur une terre donnée) et des modes d'exploitation (unités de production).*
- *L'analyse de la place et du rôle du secteur agricole et du secteur alimentaire dans l'économie nationale.*
- *La classification de ces différentes zones agro-écologiques permet de déterminer les capacités et les potentialités de production.*

2. L'analyse de la situation démographique, la prise en considération des valeurs culturelles et leurs influences sur la sécurité alimentaire.
3. Comportements, attitudes et pratiques traditionnelles.
4. L'identification des problèmes de sécurité alimentaire.
5. L'analyse de l'environnement politique, macro-économique et du secteur agricole / alimentaire.
6. l'analyse de l'offre et de la demande nationale ou régionale de biens alimentaires compte tenu des éléments précédents.
7. la nature des politiques spécifiques de production, commercialisation et consommation et leurs effets sur la situation alimentaire.
8. Identification des groupes de populations concernées et leur localisation géographique.
9. L'évaluation de la situation alimentaire au niveau du secteur concerné
10. L'analyse de la situation nutritionnelle.

2. Organisation/Sensibilisation

➔ Identification du public cible (groupes vulnérables)

Le choix des communautés vulnérables doit se faire dans les zones à risques ayant déjà connu des crises alimentaires sévères ou susceptibles d'en connaître. Cette identification est suivie d'une sensibilisation des responsables communautaires sur les avantages de l'approche participative.

➔ Choix des problèmes prioritaires

Cette phase consiste à collecter des données et à procéder à leur analyse.

a) **La collecte des données** peut s'effectuer selon quatre techniques, qui se complètent:
- L'analyse de la documentation existante (statistiques notamment).
- Des enquêtes (démographie, état nutritionnel de la communauté, taux de couverture des besoins nutritionnels).
- Les entretiens individuels.
- Une observation directe sur le terrain.

Toutes les informations doivent être collectées de façon participative par les agents de développement et de manière organisée afin de permettre leur interprétation.

(cf MARP - Avantages).

b) **L'analyse des données** recueillies au cours des enquêtes et des observations permet d'identifier les problèmes de tous ordres que rencontre la collectivité, et les types de solutions à y apporter.

c) **Le choix des problèmes prioritaires :** l'analyse des problèmes permet de procéder à leur **hiérarchisation**, en partant des problèmes les importants et les plus urgents à résoudre aux problèmes les plus insignifiants.

Quatre critères peuvent guider cette hiérarchisation:
- la gravité du problème,
- le niveau de prise de conscience du problème par les populations,
- l'importance de la population touchée,
- l'expérience et la perception que la population a du problème.

➔ Choix des actions à entreprendre

Les actions à entreprendre doivent répondre aux critères ci-après :

- la pertinence, c'est-à-dire qu'il répond bien au problème posé,
- le fait d'être réalisable,
- la précision,
- la délimitation dans le temps,
- le fait d'être mesurable, (en terme d'indicateurs en vue de permettre son évaluation et sa traduction en coût).

➔ Sélection des personnes ressources et formation de l'équipe de planification

Les personnes ressources seront des techniciens locaux de spécialités différentes (agriculture, élevage, santé, environnement, etc.). Ceux-ci constitueront le noyau local de coordination de la planification. Ils seront formés sur la démarche et les techniques de conduite de réunion et de d'analyse des problèmes.

3. Elaboration du plan

Le choix des actions à entreprendre ayant été effectué avec l'accord des communautés elles-mêmes, il faut nécessairement dégager les taches qui y sont liées et ajuster les modalités de leur déroulement aux ressources humaines matérielles et financières.

On peut alors procéder à l'élaboration du plan en déterminant les ressources nécessaires à chaque activité.

La responsabilité par rapport à chaque activité sera établie assorti d'un échéancier. Les indicateurs de suivi doivent être clairement définis ainsi que les coûts de chaque action.

Ce plan doit être discuté une fois de plus avec les communautés intéressées par les différentes actions.

Une recherche de consensus et de validation doit se faire autour du plan avec les autorités administratives et politiques afin de s'assurer de leur adhésion et de leur appui.

4. L'exécution des actions

Le programme ainsi élaboré puis approuvé par les intéressés, la démarche exige que l'on procède à l'exécution des actions. Cette phase ne peut s'effectuer correctement que si certaines dispositions sont prises au niveau des agents de développement membres de l'équipe technique:
- Etablissement d'un chronogramme afin de coordonner l'action des personnes ressources qui interviennent sur

un même programme (c'est-à-dire les services techniques d'encadrement). Cela permettra à chaque partie d'effectuer sa part de travail au moment voulu, à l'endroit voulu et de façon satisfaisante; Il est donc nécessaire que l'équipe technique dispose d'un **organigramme** *assorti d'un cahier de charge.*
- Suivi de l'exécution du programme afin d'apporter éventuellement des modifications en fonction des problèmes rencontrés.

5. Suivi/Evaluation

Le suivi dans cette perspective est le processus continu de collecte et de traitement de l'information relative à la sécurité alimentaire.

Il permet des observations régulières sur la situation des producteurs de la zone à risque.

Le suivi permet si nécessairement de réajuster les actions menées. Il concerne tous les acteurs responsables ou concernés par les actions menées. Le dispositif de suivi doit être:

- Léger : c'est-à-dire qu'il ne doit pas exiger beaucoup de temps et de ressources financiers.
- Ciblé: cela veut dire déterminer clairement les informations qu'il est important de connaître et de suivre en matière de sécurité alimentaire et choisir quelques indicateurs qui permettront de traiter ces informations.
- Participatif : les informations à rechercher seront choisies en concertation avec les intéressés.

L'évaluation est un processus de questionnement et d'analyse d'informations choisies. C'est un outil de réflexion qui permet de s'interroger sur l'impact des actions menées et de les replacer dans un contexte plus large.

L'évaluation est réalisée à partir des informations recueillies par le suivi mais elle demande parfois des enquêtes complémentaires.

Le suivi et l'évaluation dans la planification participative fournissent un système d'information qui éclaire la prise de décision des différents acteurs:

- Responsables d'organisations locales.
- Organismes extérieurs d'appui au développement
- Sources de financement
- Responsables politiques

Suivi et évaluation en matière de planification participative sont donc des outils de pilotage des programmes de sécurité alimentaires, distincts mais étroitement liés qui s'appuient l'un sur l'autre.

❖ **Les étapes de l'évaluation des programmes de sécurité alimentaire**

Trois étapes caractérisent la démarche de l'évaluation dans la planification participative :

- Le recueil de l'information,
- Le traitement de l'information,
- L'utilisation de l'information.

a) Le recueil de l'information

A ce niveau, la grille d'évaluation est utile pour définir le cadre général d'investigation et organiser les informations recherchées.

Les outils du MARP (Méthodes Active en Recherche Participative) sont indispensables pour donner tout le caractère participatif à cet exercice.

b) La recherche documentaire

Une recherche documentaire est absolument nécessaire dans une telle démarche. Cette recherche documentaire portera sur la zone, les fiches de suivi en matière de sécurité alimentaire et les documents comptables (approvisionnement en vivres).

c) Les entretiens

Ce sont des interviews individuels permettant de recueillir l'opinion critique de tous les acteurs directement ou indirectement impliqués dans le programme de sécurité alimentaire.

d) Les réunions

Les réunions de groupe complètent les entretiens particuliers. Il peut s'agir de petits groupes spécifiques ou de réunions inter-groupes.

e) Les enquêtes

Pour préciser certaines informations, une enquête peut être nécessaire. Une bonne articulation « suivi/évaluation » peut cependant éviter cet inconvénient en organisant une enquête préalable à l'évaluation proprement dite.

CONCLUSION

La planification participative n'a de sens ni d'intérêt que si elle se situe dans un cadre de décentralisation.
A chaque étape de ce processus il faut la participation et la contribution de la communauté. Les données recueillies selon les méthodes actives en recherche participatives (MARP) et traitées, doivent être toujours

restituées à la communauté concernée afin de s'assurer que les résultats sont compris de la même façon.

Cette restitution doit se faire dans des formes pédagogiques appropriées, avec des termes simples précis et concis.

Il est évident que cette méthode de planification permette une utilisation judicieuse des connaissances traditionnelles de la communauté ainsi que l'exploitation de ses expériences antérieures par rapport au domaines traités.

MEASURES TAKEN FOR DROUGHT AND DESERTIFICATION PREPAREDNESS WITH PARTICULAR REFERENCE TO AFRICAN COUNTRIES

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MEASURES TAKEN FOR DROUGHT AND DESERTIFICATION PREPAREDNESS WITH PARTICULAR REFERENCE TO EXPERIENCES OF AFRICAN COUNTRIES

SUMMARY

In 1989 the UN designated 1990-2000 the International Decade for Natural Disaster Reduction (IDNDR). It was a global effort to build a culture of disaster prevention. Within the decade targets were set to complete national risk assessments; implement national and/or local prevention preparedness plans; and implement global, regional, national and local warning systems. At the close of the decade in 1999, the IDNDR had made great progress in various areas. In particular, knowledge and consensus was gained on concepts of what disasters are as well as frameworks for their monitoring and management. This was with a view to formulate action plans for preventing loss of lives and property caused by disasters. Hydrometeorological hazards including droughts were identified as a major category of hazards affecting the world.

During the same period a parallel process was taking place through the UNCED-INCD-CCD axis that was making efforts to address the desertification and droughts as manmade/natural disasters that were affecting the environment, development and the future survival of man in the drylands of the world. During this period a body of knowledge was built on concepts and programmatic implications to longterm development and the environment and survival of man. This was especially with fresh memories on the damages inflicted on man, agriculture and the environment by droughts and desertification during the preceding two decades in Africa. This led to desertification being given greater attention at UNCED and subsequently leading to the negotiations of the UNCCD which came into force in 1997. Implementation of the CCD is now in progress and the aspect of Early Warning Systems (EWS) is now being addressed to.

There is tremendous convergence in the two processes as both move to implementation stage in the new millennium. This discussion paper examines the two processes with respect to their approaches in concept and implementation strategies to ameliorate the effects of droughts and desertification. The paper therefore describes the two processes first and the conceptual frameworks for their programmes and where convergence occurs especially in the area of risk management.

Case studies from a sample of African countries, sub-regional and regional Early Warning Systems are described to get an insight of their status, orientation and probable future progress. Technological advancements, programme objectives, positive and negative implementation issues/problems including those of socio-economic and political nature are also discussed in summary form. Conclusions on current operational status and constraints of EWS in Africa are presented. These include:

- Problems associated with EWS's objectives, information they provide and the usefulness of that information to the intended users including the populations at risk
- Certain weaknesses in institutional arrangements and especially institutional linkages of EWS to decision-makers and populations at risk.
- Problems associated with the broader political environment under which EWS operate including political interference on EWS and its information flow
- Logistical obstacles and problems associated with timely and adequate emergency responses and operations.

Recommendations are made, that will promote risk management.

1. INTRODUCTION

1.1 Historical Context and Justification

The UN declared the International Decade for Natural Disasters Reduction (IDNDR) 1989-1999, in 1989. Its objective was to "reduce the loss of life, property damage, and social and economic disruptions caused by natural disasters, through concerted international action, especially in developing countries". This was an action taken after realising that disasters were on the increase and cost nations dearly.

Since then the concept and definition of disasters and early warning have continued to be refined and understood better. Midterm and final reviews of the progress made by the IDNDR were made through the World Conference on Natural Disaster Reduction held in Yokohama (1994), and the International Conference on Early Warning System for the Reduction of Natural Disaster, held in Potsdam, Germany. This process finally resulted in the adoption of the "International Strategy for Disaster Reduction (ISDR) for a safer world in the 21st century" by the ECOSOC and the UN General Assembly in 1999. The IDNDR identified four major categories of hazards that bring about disasters:

- Geological Hazards
- Hydrometeorological hazards including drought
- Fires and other environmental hazards
- Technological hazards.

They are all different in nature but share a common conceptual framework when considering approaches for their early warning systems, prevention, responses, mitigation and recovery as a process. In general hazards have three broad phases: Pre-crisis (before the event), crisis (during the event), and post-crisis (after the event). Risk management can also be equally structured: risk assessment and prevention planning and long-term forecasting (for the phase one); short-term forecasting, disaster monitoring and protection/alleviation (for the phase two); damage assessment, recovery and development planning (for phase three). Early warning systems have a central role to play in all three phases. These phases can be very distinct in most hazards, but can widely overlap and indistinct in case of drought and desertification.

The Yokahama Conference set up a programme for IDNDR to co-ordinate and review existing early warning programmes and suggests means by which global practices could become better co-ordinated and made more effective. Basic review reports were subsequently published including,

- Early Warning for Hydrometeorological Hazards, Including Drought;
- Earth observations, Hazard Analysis and Communication Technology for Early Warning;
- National and Local Capabilities for Early Warning;
- Guiding principles for effective early warning.

The general conclusions arrived at by IDNDR/ECOSOC are well reflected by USA's National Science and Technology Council (NSTC) (2000):

- Disasters are an expensive and growing problem
- Timely and accurate warning can empower people to take actions that will reduce disaster losses speed response, and make recovery more effective.
- Scientists are providing more frequent and more accurate warnings.
- Current warning delivery systems have inherent limitations
- Technology exists to deliver warnings that are much more accurately targeted to the people at risk
- Warnings are primarily issued by Governments entities,
- Improvement of the current system depends either on all stakeholders developing standards and systems that are mutually beneficial or the government mandating some types of system.

Taking into account the conclusions of the individual specialised IDNDR Reports listed above and the general conclusion of the ECOSOC, the General Assembly (GA) adopted the ISDR in 1999 with the following vision, and goals.

Vision:

- To enable all communities to become resilient to the effects of natural, technological and environmental hazards, thus reducing the compound risk posed to social and economic vulnerabilities within modern societies; and
- To proceed from protection against hazard to management of risk, by integrating risk prevention strategies into sustainable development activities.

Goals:

- Increase pPublic attention of the risks that natural, technological and environmental hazards pose to modern societies;
- Obtain commitment by Public Authorities to reduce risks to people, their livelihoods, social and economic infrastructure and environmental resources;
- Engage public participation at all levels of implementation so as to create disaster resistant communities through increased partnerships of an expanded risk reduction networks at all levels;
- Reduce the economic and social losses of disasters.

The International Strategy for Disaster Reduction (ISDR) enumerated several objectives to be pursued and many activity areas to be implemented. These are to be undertaken in the 21st century under the secretariat of the ISDR of the UN.

In the meantime concerted efforts have been on since the early 1970's to understand, define and perceive the impacts of drought and desertification. This gained momentum in 1992 at the UNCED and gained prominent treatment in Agenda 21. This process culminated in the negotiation and adoption of the United Nations Convention for Combating Desertification and the Effect of Drought particularly in Africa (UNCCD) in 1994. It is now accepted that desertification is a consequence of both climate variations (including droughts) and human activities. Article 10 (3) of the convention identifies the importance of strengthening activities related to EWS to track desertification and drought in the context of the convention. Already initiatives have been taken by the CCD Secretariat as mentioned - 1.1 above, at various levels in respect to EWS.

Droughts are common in most parts of the world but they are particularly frequent and severe in African and cause great negative impacts due to prevailing conducive conditions including poverty, conflicts and political/governance problems. Drought and conflicts have been ranked highest in disasters afflicting most countries and sub-regions of Africa. About half of sub-Saharan Africapopulation (about 235 million people) face chronic food insecurity mainly due to climate variability and conflicts. Most EWS developed in the region are therefore primarily for drought and food security.

Since it has been recognised that drought is just a component of one of the areas being addressed by the IDNDR, there is merit to create some synergy and linkages between CCD and the ISDR in the areas of drought and desertification. This is in recognition that many UN entities need to strengthen their capacity in/or co-ordinating mechanism in order to effectively address the various natural and technological hazards. This paper therefore builds on the experiences gathered over the decade by the IDNDR and explores the merits of changing from disaster prevention approaches to risk management.

1.2 Objectives

From most reviews (IDNDR, 1997; CCD, 2000; Downing and Stephen, 1999; Buchanan-Smith, 1995; Wolde-Georgis, 1998; NSTC, 2000) the technological part of early warning systems for drought and famine – (data collection, analysis, prediction and dissemination) - is well advanced and continues to improve. However, weaknesses abound in areas of appropriate packaging of the information for targeted end-users, co-ordination mechanisms to ensure the information reaches targets; and appropriate and targeted interventions all put in place. Possible causes of this weakness are:

- Poor co-ordination mechanisms at all levels - institutional and legal
- Sensitisation and awareness of the populations at risk
- Lack of genuine partnership between the main stakeholders
- Lack of political commitment and /or political interference.

These can be exemplified from various experiences in Africa.

The objectives of this paper therefore are to:

- Examine measures taken for drought and desertification preparedness using the approach adopted by the ISDR, in changing EW focus from hazard protection to risk management,
- Discuss the socio-economic and political aspects of drought preparedness and mitigation of its effects in countries of Africa.

2. REVIEW OF STATE OF EW AND PREPAREDNESS FOR DROUGHT AND DESERTIFICATION WITH SPECIAL REFERENCE TO AFRICA

2.1 Conceptual Framework

2.1.1 Drought and Desertification: Definitions, Impacts and Effects

Drought has various definitions. These are in essence due to disciplinary perspectives of drought and are essentially what drought actually is and its impacts on the environment and man (NDMC 1995). This attempts to understand drought in terms of meteorological drought, agricultural drought, hydrological drought, land-use/ socio-economic drought. These are in reality sequences of drought impacts – which at the end of spectrum set in the process of desertification.

Meteorological drought is defined usually on the basis of the degree of dryness (from normal average) and the duration of that dry period.

Agricultural drought links various characteristics of meteorological drought to agricultural impacts, focus on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced ground water or reservoir level and so forth. Agricultural drought accounts for the susceptibility of crops during different stages of growth and reduction in final yield due to changes in the above factors.

Hydrological drought is associated with the effects of periods of precipitation shortfalls on surface or subsurface water supply. Hydrological droughts usually lag behind the occurrence of meteorological and agricultural droughts. The immediate impacts may be on plants, well levels, irrigation reservoirs or in general hydrological storage systems. Eventually it may affect hydroelectric power generators as reservoirs deplete. Hydrological drought increases competition for water and conflicts between water users. This is most evident in pastoral areas of Africa.

Land-use and hydrological drought: Although climate variability primarily causes hydrological drought, it can be exacerbated by factors in land-use like deforestation, poor agricultural practices, and land degradation, which in effect is desertification.

Socio-economic droughts are felt much later after a meteorological drought. This is associated with the supply and demand of some economic goods with elements of meteorological, hydrological and agricultural droughts. These are goods like supply of water, forage, crops, fish, hydroelectric power, all of which depend on weather and water supply. Shortage of these can intensify poverty which also accelerates desertification. Thus the monitoring, through EWS, of droughts is important for man and the environment.

2.1.2 The EWS Process

Understanding of droughts and their societal and environmental impacts have advanced tremendously in the last two decades. This is clearly brought forth by the reviews made by various scientists and institutions including (Downing and Stephen, 2000; Buchanan-Smith, 1999; Buchanan-Smith and Davies, 1996; Eldridge, 1997; Downing and Bakker, 1999).

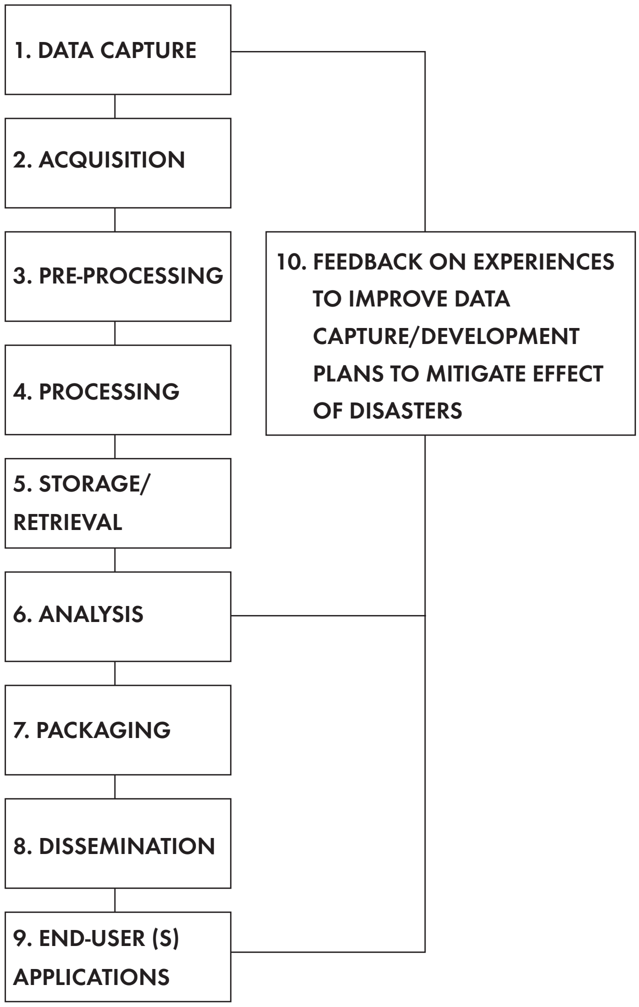
Drought is now well defined as a climatological, agricultural, hydrological and socio-economic phenomenon and hazard. It is a potential threat to human lives and their welfare as well as their environment. The process of tracking and predicting the chances of a drought occurring and its potential impacts is what constitutes early warning system. The major components of an early warning process have been reviewed (Sinange, 1999; NSCT, 2000).

Essentially these comprise:

1. Data Gathering using various sensor system and systems.
2. Data analysis and provision of information by various information providers at various levels of government e.g. (National Centers for Environmental Protection, NMS, emergency managers) giving the likelihood and level or exposures, potential damage and areas likely to be affected.
3. Dissemination of drought status information using appropriate communication systems so as to reach the target groups at risk and impress the group on the potential risks they are in.
4. Organising the information for disaster preparedness and mitigation actions by emergency services providers, the individuals, communities and other groups at risk, and the government.
5. Speedy responses and action taken by individual communities, and emergency welfare providers to reduce disaster losses and improve recovery.

This is schematically represented in figure 1.

Fig.1. Early Warning Systems Data and Information Flow



The above early warning and monitoring process is a well entrenched concept and works at any level of operation – local, sub-national, national, sub-regional/ regional and international.

As alluded to earlier, the greatest hazard most African countries always face is drought which leads to famine disasters. In the early years, early warning systems were actually famine early warning system (EWS), taking it that the ultimate and worst impacts of droughts are famines. These systems were most often formed at the national level in many cases through the initiative of international emergency welfare promoters. Their main focus was the national food balance between demand and supply (production). It was therefore the potential national production levels that were often tracked. If need be emergency food aid shipments and distribution was made to cover shortfall to shore-off hunger and famine. This was simply protection from drought (famine) hazard. The process involved very few of the stakeholders and lacked the wider concept of food security at the national and household levels.

Thus early warning systems are now changing their focus or objective from detecting and protecting communities from drought hazards (provision of food aid) to risk assessments and management, in which availability and ability to access the food is taken into account.

Drought Risk Assessment would therefore provide the basis for an effective warning system at any level of responsibility. It would identify potential threats from droughts and establish the degree of local/national exposure or vulnerability to drought conditions. This knowledge is essential for policy decisions that translate warning information into effective preventive action.

Effective EWS allow people to take action

- That improves response
- That saves lives
- That reduces damage
- That reduces human sufferings and
- That speeds recovery.

Technological advances have been increasing over the years but message delivery system to various stakeholders have failed in many countries in Africa. Secondly, the political and selfish uses of the drought hazard information by a few of the stakeholders have tended to render EWS a tool for only a few for selfish or political purpose gains.

It is therefore absolutely necessary to establish and/or improve

- EWS institutional/co-ordination mechanisms at various levels.
- EWS information delivery mechanisms according to local prevailing situation.
- Education and awareness on the rights and responsibility of those at risk.
- Ways and means of building genuine partnerships/or governance mechanism amongst all the stakeholders in order to eliminate or reduce the chances of a few exploiting a drought/ famine information to their own advantage.

2.1.3 Principles of EWS

EWSs operate at various levels of Government. At the various levels different categories of the stakeholders are central players or most important. They have different roles and responsibilities at those levels with strong co-ordination mechanism and enabling environment, the systems can become efficient and therefore deliver expected outputs. The IDNDR (1997) has enumerated the minimum guiding principles necessary for this at all levels. These are principles that are now being incorporated in National Disaster Strategies. These particularly emphasise needs, roles and responsibilities at various levels of vulnerable individuals, local communities, national governments, regional institutions and international bodies.

2.1.4 ISDR Approaches

The IDNDR had its programming targets, which it had aimed to accomplish by the end of the decade. According to the targets, by the year 2000 all countries should:

- Have a comprehensive national assessment of risks from natural hazards integrated into development plans.
- Mitigation plans of practical measures for application at national and local level to address long term disaster prevention, preparedness and community awareness.
- Ready access to global, regional and local warning systems.

The International Strategy for Disaster Reduction describes the process of realising the goals of IDNDR. The strategy recognises that disaster reduction must be integrated into development policies.

The plan of action specified the various actions, which need to be implemented at local, community and natural levels of involvement at regional and sub-regional levels and also at the international level. At the local and national level the aim is to build national and local capacities to cope with disasters in vulnerable groups and communities. At the regional and sub-regional level the emphasis is to support national initiative to build capacity to deal with disasters and share experiences with a geographical region. Also there is need to build co-operation among the regional institutions and countries within a region. At the international level the emphasis is to have activities to reduce disaster to be encouraged and supported by bilateral and multilateral co-operation.

The key components of EWS for drought using the approaches of ISDR would include:

- Risk assessment
- Hazard prediction
- Risk management

Definitions of these components are found in Annex 2.

The data information needed for these three components/phases of EWS should form an integral part of the process of anticipating streamlining and integrating disaster prevention causes in national development programmes. This then becomes a practice process rather than being reactive to disasters when they occur, which is disaster prevention during the crisis period.

The following review of some African countries EWS is meant to depict how far they have progressed in moving towards risk management rather than operating on disaster prevention basis. Issues that are responsible for no progress are identified. This analysis is based on the current optimal EWS typology (Buchanan-Smith 1995), the Principles of an EWS IDNDR (1997) and the ISDR approach.

2.1.5 The Historical Development of the EWS Paradigm: The Drought-Food-Famine Paradigm

EWS are multidimensional and multidisciplinary in nature. These aspects have been changing with time as the art is improved. In Africa where drought and famine disaster are common, the nature of EWS system have shifted from being famine prevention oriented in the 1970s to food security oriented at the present. To this end many other aspects of the EWS have equally shifted for the better. This is well depicted in the table below (Buchanan-Smith and Davis 1995).

Table 2. Shift of EWS Typology from the 1970s to the Present

Aspects of the EWS	Conventional FEWSs (1970)	Alternative Food Information System (Presently)
1. Scope	Famine-oriented	Food Security oriented
2. Determinants of food security	Food production	Access to Food
3. Level of operation	Macro, centralised	Micro, decentralised
4. Unit of Analysis	Geographic e.g. national/district	Socio-economic e.g. Vulnerable group
5. Approach	Top-down, data-centered	Bottom-up, people oriented
6. Response	Food-aid oriented	Sustainable improvement in access to food

Source: Buchanan-Smith and Davies

A critical examination of this table indicates that the alternative food information is a shift towards making responses a permanent feature of national development, which is practice and affected people oriented. The control point is that strengthening socio-economic capacities of the people at risk is a major component of risk management.

Although these shifts may not prevent famines, they are indicative of progress towards drought hazards management than protection. It is therefore, here appropriate to emphasise that equally appropriate and strong system be in place to cater for all the aspects.

2.2 Level of Technological Advancements in the Field of Drought and Desertification Monitoring and Preparedness

Since the United Nations declared the period from 1989 – 1999 to be the International Decade for Natural Disaster Reduction (IDNDR), early warning has been recognised to be of fundamental importance in realising the objective of disaster reduction. Over the years, there has been a tremendous break through on technological advances in Early Warning capabilities at the global, regional and national and local scales. In the field of drought and Desertification monitoring and preparedness several Early Warning mechanisms have been put in place all over the world and especially Africa. They range from the use of advanced sensor technologies such as remote sensing, advanced data and information communication technology, GIS and use of indigenous tradition knowledge (ITK). The commonly used technology include:

2.2.1 Remote Sensing

Remote sensing technology has been used as a tool for effective early warning for drought disasters. The satellite remote sensing technology provides a high degree of detail and a wealth of information at a global level for early warning activities (Scott, 1997; Sinange, 1999). The main characteristics that are directly relevant to early warning with implication on cost, picture, frequency and information globally are:

- Orbit return time (Temporal resolution)
- Scene area coverage (spatial distribution)
- Ground resolution (Spatial/resolution)
- Spectral resolution

Two categories of remote sensing satellites are used to capture data over the earth surface, which are crucial for early warning for resource monitoring and drought. These are:

i. High resolution imagery satellite

These are normally used for resource mapping inventory and monitory. These include Landsat MSS (80 x 80m), Landsat TM (30 x 30m) SPOT TM.

The Landsat TM is useful for mapping resources at 1: 25,000 to 1: 000,000. It has a spectral resolution of 6 bands and orbit frequency of 10 days. Its drawback is that clouds can hamper the visible band acquisition of data from the ground surface during over pass.

The Spot satellite has a better spatial resolution at 20 x 20 m for multispectoral band and 10 x 10m for the panchromatic mode. The latest Spot 4 satellite has excellent Off nadir looking capability reducing the orbit repeat times. Other high-resolution satellite system includes Japanese (MOS) and India (IRS). The radar imagery satellite for example European ERS, the Japanese JERS and the Canadian Radarsat systems offer an all weather capability, as the system can be used to acquire images on cloudy days.

ii. Low Resolution Satellite Images.

The low-resolution satellites are mostly used for early warning purposes because of their high temporal resolution. They are mainly meteorological satellite systems, which include NOAA satellite series, Meteosat etc. Meteosat is operated by EUMETSAT, a geo-synchronous satellite above the Equator at 35,000 km of altitude which allows it to observe the African, much of South America, the Atlantic Ocean, the Middle East and most of Europe every few minutes.

The two of the most useful parameters for early warning activities that can be derived from the meteorological satellites are cloud top temperatures and height. These products can be processed into Cold Cloud Duration (CCD) or Warm Cloud Duration (WCD) as well as Number of Rain Days (NRD). These are used for assessment of rainfall events over 10-day periods in areas under consideration.

Other sun-synchronous satellite orbiting the earth provide global coverage of the earth at a lower temporal resolution (6-12 hours) and higher spatial resolution than the geo-stationary satellites. These series include the NOAA – series, which are useful in determining the sea surface temperatures and for determining the vegetation indices especially the Normalised Difference Vegetation Index (NDVI). Analysis of this data is used to monitor the encroachment of desert into previously vegetated areas and for Early Warning purposes (Scott, 1997).

Recent advances

The Meteosat is planning to launch the second generation satellite (MSG). The launch of the first meteosat second generation satellite (MSG-1) is expected in the year 2002. Commissioning of MSG-1 is expected to take around 6 months. Meteosat-7 will remain in operation until at least the end of 2003. Meteosat-6 will be the operational standby satellite. It is still planned to have an overlap in operations of the two satellite systems for a period of up to three years.

The MSG will have improved spectral and temporal coverage. The product from MSG will include: various land cover products, soil moisture, evapotranspiration, NDVI at (250 m spatiatesolution) etc. The MSG will fly with other polar orbiting instruments specifically focused on the earth's environment and land surface monitoring (e.g. VEGETATION, Moderate Resolution Imaging Spectrometer (MODIS), MISR and MERIS.

MSG Advantages

- Improved data for Newcasting and severe weather (more accurate and more frequent)
- Higher resolution and more frequent data for the determination of winds and their height in the atmosphere
- Measurement of Sea Surface Temperature
- Enhanced capacity of Data Collection System for environmental monitoring and research
- Significant increase in the quality of data distributed to users
- Temporal resolution: 15 minutes instead of 30 minutes
- Spatial sampling at sub-satellite point: 3 km (1 km HR VIS) instead of 5 km (2.5 km VIS)
- More channels;1 HR VIS, 2 VIS, 1 near IR, 4 IR

windows, measuring parameters necessary for weather, agriculture and hydrology.

2.2.2. Geographical Information System (GIS)

This is a useful tool for analyses of spatial data, which is geo-referenced. The GIS have the capability of inputting (capturing), data management (data storage and retrieval, manipulation and analysis) and output spatial information. In a particular geographical location there are layers of information such as soil type, vegetation, water supply, geology etc. These layers can be manipulated in a GIS environment to produce interpretable information in form of maps. This information can be further analysed for decision making such as resource planning. Through the combination of various layers using the powerful combination techniques of GIS it has the possibility of evaluation of several scenarios and of analysing the future trends using predictive models. These can be used to map potential vulnerability areas indicating the condition that might be expected if a particular trend continues, for example desertification rate or hazard can be mapped.

2.2.3 Communication Technology

The results of any EWS can be used effectively by all stakeholders if real-time communications are established. This has been a major challenge to many areas of the world especially Africa.

The various mode of communication which can be used in EWS include

- Voice (telephone, constitution, conferencing)
- Data (e-mail, internet, GIS)
- Video
- Broadcast television and radio
- Communication satellite

These technologies are well developed and available. However, they are not all accessible to the majority of the people at risk for the purposes of communication and exchange of information and data.

2.3 Review of EWS at the National Level

Africa as a continent experiences severe droughts and threats of desertification. These are common in and sub-Saharan Africa. This has encouraged individual African countries to implement national programs to combat these problems. This section of the paper reviews efforts being made by several African countries in setting up EWS for drought and desertification.

2.3.1 Ethiopia

Ethiopia has suffered severe droughts in the past years resulting in serious humanitarian disasters. An example of this is the 1984-5 famine where an estimated one million people lost their lives (Buchanan-Smith and Davies, 1995). The country food insecure regions tend to be in the northern, central and eastern parts of highlands, where subsistence farming systems have come under increasing pressure from growing human and livestock populations, and from environment degradation (Belshaw, 1990).

The government of Ethiopia has put in place a mechanism of EW to try to help it be prepared for drought and its effects. In 1976, the Ethiopian early warning system was inaugurated. It is a complex system using data from various sources. The EWS activities were in the past managed by the Relief and Rehabilitation Commission (RRC), presently the Disaster Prevention and Preparedness Commission (DPPC) co-ordinates the EWS.

In 1989, the government of Ethiopia drew a National Disaster Prevention and Preparedness Strategy (NDPPS) in an attempt to link relief and development more closely with the long term-aim of reducing vulnerability to future drought. This was in line with the framework of IDNDR strategy for national EWS.

The country EWS was highly centralised with data collection, analysis interpretation and report writing being carried out at the federal level from Addis Ababa. The strategy has changed and the EWS decentralised with being established at regional, zonal and district levels.

The EWS system in the country has been supported by donor funding but was poorly resourced due to unfavourable aid climate during the Mengistu regime (Buchanan-Smith and Davies, 1995).

The Country EWS is headed by an Early Warning Committee at all levels. These committees report to the National Committee which oversees all the operations of the Ethiopian system.

The EWS of Ethiopia depends on various government agencies for information such as central Statistical Authority (CSA) for crop production forecast and market and the National Meteorological services Agency (NMSA), which provide climate data as drought is the main threat to food security. The main outputs of the EWS are reports such as Food-supply prospect, which has an assessment of numbers of people requiring relief assistance, synoptic food supply report, which has assessment of harvest and population in need of assistance, monthly bulletin, which gives regular early warning bullet, special reports with an update of particular services and localised problems, and report with relief plan of operation.

The major drawbacks of Ethiopian EWS was mistrust over figures for relief assistance provided, with the donors feeling that the figures are exaggerated and used our political expediency. There is also lack of co-ordination of activities and communication between the government and the donors. The EWS and other relief institutions have been geared to the extreme of food crisis. This makes the EWS ignore other underlying food-security problems.

2.3.2 Botswana

The Botswana EWS for drought was set up in mid-1960s, when the country was experiencing severe droughts. It was established as a decision tool by the central government, to enhance drought preparedness, mitigation and management. The initial focus of the early warning system was on the livestock sub-sector but has been broadened to include arable agriculture, water and human affairs.

The government of Botswana has incorporated the EWS as part of the development process with disaster management for drought being a humanitarian operation. The government has established capacity in the various ministries involved in EWS. The structure of the Botswana EWS is hierarchical in which the information is gathered by various ministries and departments of these ministries and shared in the monthly meetings of the Early Warning Technical Committee (EWTC), the secretariat of which is provided by the Ministry of Finance. The EWTC advises the Inter-Ministerial Drought Committee (IMDC) which meets monthly or bi-monthly depending on the time of the year.

The IMDC has an advisory role to Rural Development council (RDC) on current environment and socio-economic conditions throughout the country recommending causes of action with respect to relief. The RDC is the government decision-making body. The RDC recommends plan of action in drought mitigation and management through the Ministry of finance to the Cabinet. The Office of the President is the final authority in declaration of drought in the country.

The Botswana early warning system follows the bottom-up approach from the individuals, communities and district government. This is through having members of EWTC drawn from technicians, managers and administrators within several ministries. These are drawn from the Ministry of Health, the Central Statistical Office, the Ministry of Local Government, law offices and lawyers, Ministry of Agriculture and the Department of Meteorological Services (DMS). This EWTC also includes representation from the district in form of chairman of the District Drought Relief Committee (DDRC).

In predicting drought the EWTC uses rainfall values supplied by the department of meteorological services. These are in form of estimates of recent rainfall as standard map and tabular products based on meteorological station gauge and supplemented by rainfall estimates using cold cloud duration. The DMS also supply monthly vegetation conditions derived from NOAA – satellite (generated Normalised Difference Vegetation Index (NDVI). These regular products are provided monthly to EWTC and other clients.

The Ministry of Agriculture has an Early Warning Unit (EWU), which has an important co-ordinating role and ensures that data provided to EWTC are reliable. It is also the link with regional early warning unit of the Southern African Development Community (SADC) and the Botswana drought early warning system.

The declaration of drought in Botswana is followed by the implementation of drought relief. This is coordinated by the Nutrition unit of the Ministry of Health and Ministry of Local Government, Laws and Housing to implement relief programmes.

The weaknesses of the Botswana system are:

- Lack of technical capacity
- Lack of collaboration between Ministries and data providers
- Lack of dissemination of information in understandable forms to district and village levels
- Vulnerability mapping not well developed.

2.3.3 Mali

Mali is one of the few Saharan countries with fairly good potential for self-sufficiency food production. However, Mali is hit periodically by successive droughts affecting its food production potential. The country has a well-established EWS for drought monitoring.

The EWS was set up in 1987 after a severe drought of 1984-5 whose response was poor due to lack of proper information. The Malian EWS is known as the système d' alerte Prècose (SAP). Mali is also covered by the regional early warning systems such as CLISS/AGRYMET system as well as the FAO's GIEWS.

The SAP EWS has three critical stages namely, Monitoring, Reporting and decision Making, which lead to response being triggered in case of a bad drought.

The SAP is based on the existing government structure and it has succeeded in standardising data-gathering methods and reporting requirements. The regular monthly publication of SAP bulletin has made sub-national-level information available. The EWS has a bottom up approach with information collected from the circle or district regional to the national level. This allows consensus building among the various agencies involved in EWS.

The drawback of Mali EWS is over-institutionalisation of the response time, leading to long bureaucratic delays which lead to delay in release of SAP recommendations.
The strength of Mali EWS and response is as a result of building of donor/ government co-ordination established for the restructuring of the cereal market.

2.3.4 South Africa
In the framework of IDNDR, South Africa has prepared a draft paper on Disaster Management. This recognises that one of the major natural hazards in that country is drought. Drought has been recognised as being common and fairly regularly and expected. South Africa however recognised that even with very improved abilities to predict droughts, drought warning have never been perfect, partly because the effects of drought are never uniform, and partly because droughts are discrete occurring over long periods.

Forecasting is mainly a responsibility of National Meteorological Services (NMS), although currently also available from the international bodies and organisations. However, for developmental and disaster management, the Ministry of Agriculture takes the leading roles. The draft paper recommends the following:

For prevention and preparedness:
- The Farming community must accept the normal climatic variability and adapt to it as normal part of farm management.
- Since the Government cannot continue with subsidies for agricultural costs due to droughts, proactive approaches are proposed to be co-ordinated by a proposed drought management center.
- Policy on drought be developed that will ensure that a drought management plan is elaborated; the EWS is improved; a communication and information strategy that serves communities is elaborated; develops financial incentives in support of drought management;
- Develop a water demand management strategy for the rural section;
- Improve expertise and management capacity.

Preparing for and responding to drought the Department of Agriculture should take actions including:

- Improving information for EW- including data on crop production, crop condition and forecasts; condition of grazing resources, livestock and the access of livestock to water; historical comparative NDVI satellite data on greenness indices; weather forecasts – rainfall and stress days;
- Ensuring that supplies of water are served in poorer rural areas before droughts bite severely;
- Mobilising resources to cushion or reduce drought impacts through mobilising provincial and local governments support; preparing communication strategy; harnessing NGO resources; coordinating with other emergency services.

Summary of general weaknesses and constraints in the current disaster management:

At the policy planning and legislative level:
- Absence of clean policy framework and therefore no definite planning structure or approach;
- Past misconception of disaster as events over which people have no control leading to low priority being given to civil protection function until such an event occurs.
- Inadequate legislation;
- Absence of or limited guidelines for public and private sector on their roles in the event of a decision (drought);
- Criteria for state intervention based on magnitude of event, instead of needs of the community at risk.

As part of broader development strategy of the country:
- Disasters in the past seen in the context of emergency response and not part of long-term planning and development programmes; without

this vulnerability;
- The concept of disaster management needs to be integrated into national development strategies, as vulnerability to disaster can create development and other causal factors to persist.

At the level of preparedness and response:
- The criteria for declaring a disaster situation are not clearly defined;
- Affected populations are usually very ill-prepared because public awareness campaigns start after the disaster has set in. Further, the population are ill-informed or have language barriers.
- When disaster sets, it usually reveals lack of adequate data and information on which decisions are based. Only the NMS are well structured;
- Lack or inadequate co-ordination in the EWS.

At the institutional level:
- Lack of clear co-ordination at the political and departmental levels leading to ineffective systems of management – and therefore poor responsiveness including mixed signals from various sources of expert information;
- There is need for permanent well focused co-ordination structures (capabilities) at all levels of government – national, provincial or local. Major weakness in most cases are at the provincial and local levels;
- All relevant institutions, stakeholders need to understand that disaster management or risk reduction must be taken holistically.
- Budgetary constraints are common at all levels;
- In case of emergency release of funds always meet slow and bureaucratic procedures that tend to render the meaning of an emergency useless.

Recommendation: Legislative framework for disaster management including those caused by droughts and desertification.

2.3.5 Chad

Chad is a land locked country and one of the poorest countries in the world with a GNP per capita of $190 in 1989 (World Bank, 1991). The country is situated in the Sahelian Zone with a population of 5.4 million people. The country is predominantly rural, the economic mainstay are livestock herding and small-scale rain fed agriculture.

The country was severely ravaged by the 1984-5 drought, which was compounded by effects of civil war. Lack of proper information and lack of EW hampered the response to drought and relief. The country EWS – the système d' a lerte Prècose (SAP) was established in 1986. The Chad EW is a famine oriented system geared to identifying, recommending and justifying required distribution of food aid. The SAP is restricted to provision of information and is not involved in the decision process nor in the implementation of response. SAP is located within the Direction de la Promotion des Production Agricoles et de la Sicurité' Alimentaire (DPASA). SAP activities are funded by EU with technical assistance provided by the Association Europeénne pour les Developpement et la Santé (AEDES).

SAP methodology is in three phases:

- Quantitative monitoring of agricultural production;
- Social economic monitoring;
- Identification of risk areas using mobile unit.

Other components of the Chad EWS include Burea de la Statisque Agricole (BSA) and Orgnisation Nationale de development Ruler (ONDR). These provide data on monthly food production which is produced in form of a bulletin. Other inputs to SAP are from the regional EWS in the region such as AGRHYMET, FEWS and FAO/CLISS.

The decision making body in the country is comité d'action pour la Securite, alimentaire et l'Aide d'urgence (CASAAU). Its members includes government officials SAP representatives, members of bilateral and multilateral agencies and NGOs, chaired by the Secretary of State Food Security.

Weaknesses
- The SAP is still a famine oriented system as opposed to food security orientation;
- The EWS is centralised in N'diamena, so is its decision making to response. Local committees have some decision making powers;
- There are no small scale or community based EWS at the sub-national level;
- Lack of credibility on some of the results of early warning among the donors;
- The EWS does not cover all over the country especially areas occupied by pastoralists;
- Lack of consistent funding to sustain SAP operations.

2.3.6 Kenya

Kenya is located in the sub-Saharan region most referred to as the horn of Africa. The country has a vast region of semi-arid and arid region, comprising about 80% of the total country surface. This is the region, which experiences occasional droughts, the latest being the 1999/2000 drought, which was devastating. The country has a well established EWS involving several government agencies, regional organisations and NGOs. The government organisations involved in early warning activities are: the Kenya Meteorological Department (KMD), the Ministry of Agriculture (MOA), the Central Bureau of Statistics (CBS), and the Department of Resource Surveys and Remote Sensing (DRSRS). The KMD, which is the national weather forecasting facility, provides meteorological and climatic data. The climatic indicators useful for EWS provided by the department include rainfall intensities, drought indices and rainfall. The KMD produces weather forecast and seasonal outlook report, distribution of rainfall anomalies, maps and bulletins on crop performance and drought severity index. MOA disseminates EW information and has data on crop hectarage and yield production estimates. CBS has data on human population collected through census and socio-economic data. DRSRS uses remote sensing techniques to estimate area under crop, yield and production of two stable crops (maize and wheat). It also uses NOAAAVHRR NDVI data to monitor vegetation status in the Kenya rangelands.

Kenya has also a decentralised EWS focusing on some of the most vulnerable districts in the country. These are co-ordinated by the Office of the President. This office also has a committee, which has the mandate to advise on the declaration of a drought. An example of such a district in the country is Turkana. The district has its own EWS set to serve the specific needs of the drought prone and semiarid region. This system relies on the grassroots approach with continuous monitoring of nomadic and semi-nomadic pastoral people in ASAL areas. The Turkana EWS was set-up in 1987 after the devastating droughts of late 1970s and mid 1980s. The unit, Turkana Drought Contingency Planning Unit (TDCPU) was created in the district government charged with EW activities and response.

The early warning targets households and communities using locally recruited monitors. It relies on four sources of data: regular household and community survey carried out by TDCPU staff, aerial surveys data to monitor livestock number and distribution, settlement data, rainfall, NDVI and secondary data from government technical departments. The categories of indicators monitors are:

- Rural economy indicator
- Human welfare indicator
- Environmental indicator

The results of the EW are disseminated using regular quarterly bulletins. The EWS uses innovative features to define each quarter using predetermined warning stages to facilitate interpretation of results and elicit response. These are normal, alert, alarm and emergency stage to determine the situation in the district.

The response stage involves distribution of relief food in the district, emergency livestock purchase schemes and food for work. The aim of these initiatives is to change the forms of EW from famine oriented scope to food security orientation.

The district based EW are faced by financial crisis due to inadequate donor funding to the programmes. Other original agencies supplementing the Kenyan EWS are the Drought Monitoring Centre (DMC), IGAD, FEWS and GIEWS. Overall the Kenyan EWS has the capacity and infrastructure in place apart from the occasional financial problems. What is weak also is a co-ordinating body to collate the different data sources from many agencies involved in EWS, as well as a district level information into a single EW source at national level (Buchanan-Smith and Davies, 1995).

Weaknesses

- Lack of co-ordination among agencies involved in EW;
- Insufficient funding for EW activities;
- Lack of proper dissemination of EW messages to vulnerable groups;
- Insufficient and very slow response to district calls for emergency. Responses come too little too late;
- Although there is a move to institute a food security oriented programme in a few districts, nationally the orientation is still largely on famine prevention.

2.3.7 Sudan

Sudan is located in the Horn of Africa. The country EWS is an example of how a hostile political environment can affect the smooth running of EW and response systems. The country has beenundergoing turbulent political changes and the relation with donor agencies getting to all time low. The country is faced with the long running civil war in the south.

The EWS was established after 1984-1985 drought. The initial stages of development were well funded but the system stalled. The national EWS set up in 1986 was based in Khartoum in the Relief and Rehabilitation Commission supported by Nordic Countries Trust Fund. This initiative was stopped after one year after donor funding was withdrawn.

The EWS continued to function with poor resources and high staff turnover due to frequent changes of government. It is highly centralised and carried out no primary data collection. This has affected the development of baseline data for the system. Other regional agencies involved in EW activities in the country include IGAD, FEWS, WFP, IGAD, and FAO.

Weaknesses

- Hostile political environment, as a result of antagonistic relationship between government and the western donors and civil war in the south;
- Weak institutional set up and lack of capacity;
- Lack of credibility among stakeholder of the government early warning reports and results;
- Poor communication networking in the country;
- Lack of co-ordination among the stakeholders involved in EW;
- The EW results and products not released in a timely manner;
- Sub-regional organisations, not sufficiently incorporated.

2.4 Review of Regional EWS in Africa

The regional and subregional EWS serving the different parts of Africa are established and have been building capacities for EW activities. These include: South Africa Development Community (SADC), African Centre for Meteorological Application for Development (ACMAD), the Drought Monitoring Centres (DMC) in central and eastern Africa, AGHRYMET Programme of the Inter-state Committee on Drought Control (CLISS) in Sahel and the Inter-governmental Authority on Development (IGAD) covering the horn of Africa (Sinange, 1999; O. Neill, 1997; IGAD, 1999; SADC, 1998).

IGAD has started elaborating the strategies in line with IDNDR principles for regional organisations, as outlined below:

IGAD

The IGAD is a regional organisation targeting the horn of Africa. The IGAD member states are: Kenya, Sudan, Djibouti, Ethiopia, Eritrea, Uganda and Somali.

IGAD member states are vulnerable to a host of natural and human disasters. Nearly half of the region population is faced by chronic food shortages. These are as a result of episodes of environmental hazards in the region including, droughts and environmental degradation leading to desertification.

The IGAD strategy of disaster preparedness is to tackle the root causes for the disaster i.e. to prevent natural or human events leading to a disaster. This is through long-term programmes for sustainable development to provide lasting solutions to problems.

The objectives of IGAD towards disaster management, which are in line with ISDR principles for regional organisation include:

- Promote the development and implementation of suitable rational disaster preparedness strategies;
- Put in place framework of principles, policies legislation and agreements at regional and national levels which will enable disaster preparedness and response measures to be implemented by a variety of agencies;
- Ensure national, regional and international agencies collaborate quantitatively in disaster preparedness and response;
- Develop capabilities to ensure that disaster management intervention are based on adequate and timely information;
- Ensure communities attended by disaster and staff institution are aware of acting effectively when disaster strike;
- Establish mechanisms and infrastructure for timely identification and mobilisation in times of disaster for timely response.

3. SOCIO-ECONOMIC AND POLITICAL ASPECTS OF DROUGHT AND DESERTIFICATION PREPAREDNESS

3.1 Cost of Not Being Prepared

The Developmental and Social Context of Drought Hazards

Many African countries suffer from frequent droughts and therefore risks to drought hazards are expected events. There is therefore a need for clear policies on risk reduction and disaster management that are proactive rather than reactive, as is the case currently in most African countries.

Droughts are a shock to and retard development and come as exogenous factors. Development programme/ projects are retarded because financial resources are diverted to address the crisis and therefore reduces the development portfolio. But because they are always expected, their effects should be factored in development programs/projects.

Cost of Drought Disaster

It is difficult to accurately quantify damages caused by droughts. This is because droughts are indiscreet hazards. Onset and end is sometimes difficult to discern. Impacts on various plant and animal lives including various crops and livestock vary from one species to another. Its impact on various resources on a time scale also varies – for example the effects on hydrology of an area may show up several months after the peak of a drought. Effects of the economy due to various affected activities like generation of hydroelectric power may be felt much later and for a long time. The increase in poverty levels, inability to recover so as to face the next drought episode, tend to exacerbate further vulnerability of individuals, families and communities.

In summary, costs of a drought disaster may take account of the direct, visible impact such as damage to crops, livestock and power generation. However, the true cost would include many other indirect invisible losses such loss of jobs, trade, collapse of factories, poverty and tourism. These in most cases are not captured in monetary terms.

3.2 Social Disruptions of Communities

Drought disrupt the social order of a community in several ways:

- Mitigation to food aid camps, which after several years make the community acquire food aiddependency syndrome, and abandons traditional livelihood;
- Migration of people from rural areas to urban centre to enhance their survival chances. This movement is primarily as a result of agricultural employment losses.
- Loss of life that occur and that could have been prevented.
- Social impacts that include trauma, depression and grief as a result of losses of relatives, property, and self-esteem. These social impacts continue to linger for long periods after the disaster.

These long-term effects have a negative impact on community life and economic activities. And, because droughts recur frequently, the tendency is towards intensification of poverty and vulnerability. The populations cannot have employment and purchasing power for food and other needs. This becomes a vicious circle; it intensifies desertification and lowers national food production. Due to these frequent droughts and process of desertification, most African countries are not food-self sufficient. The continent is a deficit area. While global per capita food production continue to increase, in Africa it is decreasing. The deficit is met by imports through commercial purchases and food aid. For example in 1999 and 2000 Africa imported food as shown below (FAO/GIEWS 2000).

Year	Commercial purchase (,000 tons)
1999	26,408,6
2000	24,816.7

Year	Food aid (,000 tons)
1999	2,189.0
2000	2,792.3

Year	Total support requirements (,000 tons)
1999	28,597.6
2000	27,609

The value of these imports especially those met by the emergency food providers is huge. This is not sustainable in the long run and a certain proportion of this needs to be devoted to sustainable development for the affected countries/communities. Being prepared for the effects of droughts would alert most of above costs and problems.

In some respects drought hazards are different from other hazards which are sudden, intensive and cause immediate and visible physical damages. Droughts creep slowly, persist for long periods and cause other damages like loss of crops, livestock and other economic goods and services derived from use of water. Because of this nature, planning to mitigate/minimise effects of drought is possible.

3.3 Political Aspects of Drought

Drought can to a good extent be anticipated by most dryland communities who have traditional coping mechanism. However elements of politics of aid and armed conflicts (internal and external) have tendered to exacerbate famine. This is particular evident in the Horn of African Countries, Chad, Rwanda and Angola.

Internal politics may surface during assessment period on emergency phase when certain areas may, through political decision may be denied or awarded food aid. It is used as a stick and carrot.

In the same vein due to changes occurring in geopolitical stakes since the end of the cold war, donors may award or deny food aid to certain countries, which are out of favour. This is also due to alliances that have shifted from Africa to regions with better prospects for the West like Central Asia, middle East and Eastern Europe.

Internal political transitions tend to create insecurity, which may become even stronger if they coincide with a drought and a period of reduced food production.???

However major civil wars in the Horn of Africa have been major causes of catastrophic famines that have been witnessed in Sudan, Ethiopia and Somalia. These are internal conflicts originating from political issues especially on ideologies, ethnicity and religions or sectionalism.

Equally important have been minor community conflicts, which are based on resource scarcity and use conflicts. This has been very evident in parts of Kenya in recent years including the 1999/2000 drought. This conflict was evident in three categories: between pastoral neighbouring pastoral communities; between pastoral communities and commercial ranchers; and between pastoral groups and nearly settled agriculturalists in transitional areas of dry subhumid zones, which traditionally used to be dry grazing areas for pastoralists but now settled by agropastoralists from high potential agricultural area.

The result of these armed conflicts are;

- Migration to refuge camps where environmental degradation is very evident
- Migration to urban centres in search of employment opportunities and security.
- Concentration of population and livestock in safer areas leading to further degradation of the environment in these safe havens due to overuse of the resources therein.
- Intensification of poverty and over dependence on food aid.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The above case studies demonstrate that EW System do exist in many African countries and continue to improve. Most have been in existence for over 15 years but as Buchanan and Davis (1995) have concluded, the EWS have not led to effective famine prevention as originally intended. The weaknesses fall in four categories:

- EWS and information they provide and the usefulness of that information to the intended users including the populations at risk
- Institutional arrangements and especially institutional linkages of EWS to decision-makers
- Logistical obstacles to launching a timely and adequate emergency responses
- The broader political environment under which EWS operate

4.1.1 EW Information Constraints

- EWS for drought and famine in all the African countries are multi-dimensional, multi-sectorial and multidisciplinary and therefore inherently involves a large number of stakeholders. Although the science of providing particular types or categories of data is advanced, their provision in a simplified and well-understood format for all end users needs improvement. This is particularly for decision-makers and communities at risk. The indicators and warning of emergency levels must be simple and well understood.
- In most of the case studies above, the EWS sound alarms when crises are detected. It is the response system which often fails to react early and provide timely assistance
- Most EWS have developed multi-indicator models to identify food insecurity and livelihood threats but most still emphasize identification food deficits as indicators of looming famine – i.e food balance oriented system because this is what emergency providers are interested in. They should move towards risk management and development objectives. However most of the countries reviewed have not started utilizing the ISDR approaches.
- Separation of the EWS from the decision-making structure has its pros and cons especially in the bureaucratic process. In addition there is little coordination.
- Technology for drought and desertification risk assessment, and management including the use of remote sensing and GIS is globally advanced, however its optimal use to national, sub-national and local levels has not equally advanced in most countries of Africa, due to low capacities.
- There is, in many cases, poor coordination among the stakeholders involved in the EW activities. The subregional, regional and national initiatives are not always well harmonized and in some cases there is duplication of efforts.
- Most of the African EWSs lack clear policies and strategies for disseminating the EW information to vulnerable individuals and communities, due to

poor communication infrastructure. Also, awareness is low among the affected communities on the effective ways of managing drought disasters.

4.1.2 Institutional Constraints

Ownership of Information:

There is a credibility gap, in source, ownership and use of data and information amongst the major stakeholders. Specifically donors have in the past shown mistrust of information from national EWS, and would rather rely in UN agencies like FAO and WFP. They may be based on the suspicion that data could be manipulated for political reasons.- either exaggerating figures for favored regions or decreasing figure to hide inefficient system. Food aid can also be rewarded to those who need least or to those desperate for it for political favors, or withheld as a punishment. Even dissemination may be inadequate to all stakeholders and becomes a rare commodity. The information may selectively be used by a few to get a foothold in the grain market.

Demand for Certainty and Quantitative Evidence of food requirements by emergency assistance providers: Instead of relying on indicators of a developing crisis for an emergency response to start in stages, the bureaucracy in emergency providers require that accurate quantitative requirements of food aid be provided to them. This ends up often with too little too late.

Inappropriate Bureaucratic Procedures:

In-built bureaucratic rigidities reinforce the tendency to delay relief decisions until clear evidence of a food crisis exists. When this relief arrives it may not match peoples priorities – i.e. protecting livelihoods.

Centralized EW/Responses Systems:

The decisions about relief needs and mobilization of resources are made at capitals, far away from where the assistance is needed, by people far removed from the reality on the ground. These add to further delays because the urgency of the matter may not be apparent to them.

Lack of Accountability

If warnings are not heeded in time is a major constraint to effective working of an EW and response system. The real victims of late response, as was witnessed in Ethiopia and Sudan in the 1970s and 1980s, who are far removed from the process of decision-making, and only loosely connected to the process by data extracted from them by the EWS.

4.1.3 Logistical Constraints

Effective and timely response is rare. Reasons for this are as enumerated above on institutional constraints. Further to this may be added.,

- The majority of EWS are not sustainable due to lack of assured financial support. Western donors fund most of them for short periods. In some cases the support is withdrawn prematurely due to incompatible policies, bad governance affecting the programme negatively.
- Inadequate infrastructure leading to sites and communities at risk. Airdrops are sometimes used to reach such communities.
- Inadequate and often inexperienced planning on the movement and time needed for consignments to reach destination using various transportation modes. Shipment from source, port of clearance, rail/road transportation, road transport, position of distribution centers, warehousing, security etc.
- In many of the African countries where drought famine ravages, there is the often added element of security because of either external and/or internal conflicts.

4.1.4 Political Constraints

EW information can have political value, because the context in which the EW is issued or the way it is interpreted can send different messages.

- Donor governments can use offers to recipient governments on certain political conditionalities.
- Political differences between donors and recipients can seriously delay relief deliveries as negotiations have to be made and agreements reached.
- Recipient countries could also over-request by equaling the total national food needs to total aid requirements.
- At the local and national scene, governments could use food assistance to locals for political gain from certain communities or individuals.
- Denial of food assistance has been used as a war weapon in some countries, to weaken opponent position.

4.2 RECOMMENDATION

4.2.1 CCD secretariat in collaboration with ISDR to formulate an action plan to promote building of consensus on objectives of EWS and relief assistance. Is EWS for famine prevention during crisis phase or for risk management and development?

- This will ensure a better designed national EWSs in which relevant, accurate standardized data, information and indicators will be sought from specialized organization; provided on a timely basis to coordinating body; availed for use by all stakeholders in disaster management and longterm development in the interest of reducing future risks.
- The data so gathered could be used to develop predictive models/indicators in order to increase warning capabilities.
- For information to be locally relevant, EWS/ response systems should be decentralized. However for coordination and standardization purposes all data/information should be passed on to a national level system. Free exchange of data at the sub-national and community levels will enhance the capacity of local operations to effectively deal with emergencies.
- The CCD in conjunction with ISDR could coordinate case studies or pilot project in this respect in one or two countries in Africa, to elucidate the cost/benefit of the two approaches.

4.2.2 CCD secretariat in collaboration with ISDR initiates measures leading to effective institutional arrangements that promote coordination for the flow and use of information by all stakeholders at all levels - local to international. This will specifically initially focus on national and subregional levels. This will focus on the mechanisms for:

- Enhancing appropriate communication mechanisms for target groups with special emphasis on facilitation of local communities to participate in drought EW and risk management and planning
- Enhancing mechanisms for network to facilitate exchange of information and experiences
- Identification of appropriate network focal points at various levels
- Decentralisation of EWS to enable local communities to participate proactively in the process

4.2.3 Initiate capacity building programmes in the following areas:

- In the transfer of technology in remote sensing and GIS including prediction modelling and risk assessment
- Communication and information technology
- Co-operation in the transfer of technology

4.2.4 Initiate public awareness raising strategies in co-operation with the private sector and NGOs targeting the most vulnerable members of the community with an aim of:

- promoting free exchange of information, transparency in decision making, and good governance
- better understanding and appreciation of warnings and thus promote preparedness and participation in drought and desertification risk management

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Annex 1: TOR

The CCD identifies the importance of establishing and/or strengthening activities related to EWS in the implementation of Naps (Articles 10 paras 3(a), 3(b), and 3(c).

The CoP, based on the recommendations of the CST has already initiated certain activities related to EWS. At the Second session of the COP, held in Dakar from November 30 to 11 December 1998, it was agreed that the priority issue to be addressed in depth by the CST at its third session would be early warning systems in its broadest sense. Parties were requested to submit contributions to the secretariat reporting on their experiences related to EWS, and to identify specialised institutions active in this field. The submissions received from the parties were compiled into a report (ICCD/COP(3)/CST/6) for discussion at CoP3.

At the third meeting of the COP, held in Recife, Brazil from 15-26 November 1999, the CoP agreed to adopt an Ad Hoc Panel on EWS (Decision 14/COP.3) to review and elaborate on the following technical topics emerging from national reports of parties and regional forums on the implementation of the Convention:

a) Data collection, accessibility and integration;
b) Evaluation and prediction of drought and desertification, and measures forpreparedness, in cooperation with the follow-up to the International Decade for Natural Disaster Reduction;
c) Dissemination of information to end-users on the application of early warning systems and desertification monitoring and assessment, and strengthening of appropriate response mechanisms, particularly in the NAPs to combat desertification;
   The Ad Hoc Panel met in Bonn, Germany from 31 May to 3 June 2000. Its report was presented at COP4 (ICCD/COP(4)/CST/4).
   Based on the decision 14.COP4, the COP decided to reappoint an ad hoc panel on the EWS in order to further examine the following:
d) Critical analysis of the performance of early warning and monitoring and assessment systems, linking traditional knowledge and early warning systems, especially in the areas of the collection of the data, dissemination of the information and measuring for drought preparedness;
e) Methods for and approaches to the prediction of drought and monitoring of desertification, particularly the methods of analyzing vulnerability to drought and desertification, especially at the local, sub-national and national levels with special regard to new technological developments;
f) Mechanisms to facilitate an exchange of information between scientific and technological institutions, in particular focusing on national and sub-regional networks on the prediction of drought and monitoring of desertification;
g) More detailed measures for drought and desertification preparedness, in co-operation with the approaches, from hazard protection to risk management, adopted by the International Strategy for Disaster Reduction.

The consultant is required to draft a working document on the aspects identified in (d) of the above, with particular reference to the experiences of African countries. The consultant is also expected to discuss the socio-economic and political aspects of drought preparedness in different countries in the report.

Annex 2. Definitions of Risk assessment, Hazard prediction and Risk Management

Risk Assessment

Drought occurs when an unusual climatic anomaly strikes a vulnerable region. The hazard assessment include determining the probability of occurrences of such phenomena by analysing observation records and assessing the likely areas affected, duration and intensity of the drought. The vulnerability analysis includes mapping the affected areas and estimating the impacts. Risk assessment is crucial for effective EWS and disaster management.

Hazard prediction

The forecasting of drought occurrences often relies on observation patterns of monthly and seasonal rainfall, stream-flow and ground water levels etc. This is supplemented by looking at the development of NDVI, which shows the vegetation condition of an area and comparing it to the past to detect the onset and/ or of drought. Developing predictive skill over large geographical regions on monthly and seasonal time scale, however offers promise for increasingly useful forecast of the onset, severity and duration of drought. The use of satellite imagery and other numerical predictive models offer improvement in predictive skill for synoptic scale systems on short to medium range time scales.

Risk Management

This involves the measures for mitigation put in place when a disaster has been predicted. In case of drought, time involves communicating to the vulnerable communities the hazard information to take advance action. It also involves communicating the EWS information to relief agencies showing the required assistance needed by the affected communities in form of food and post drought recovery assistance.

UNCCD

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