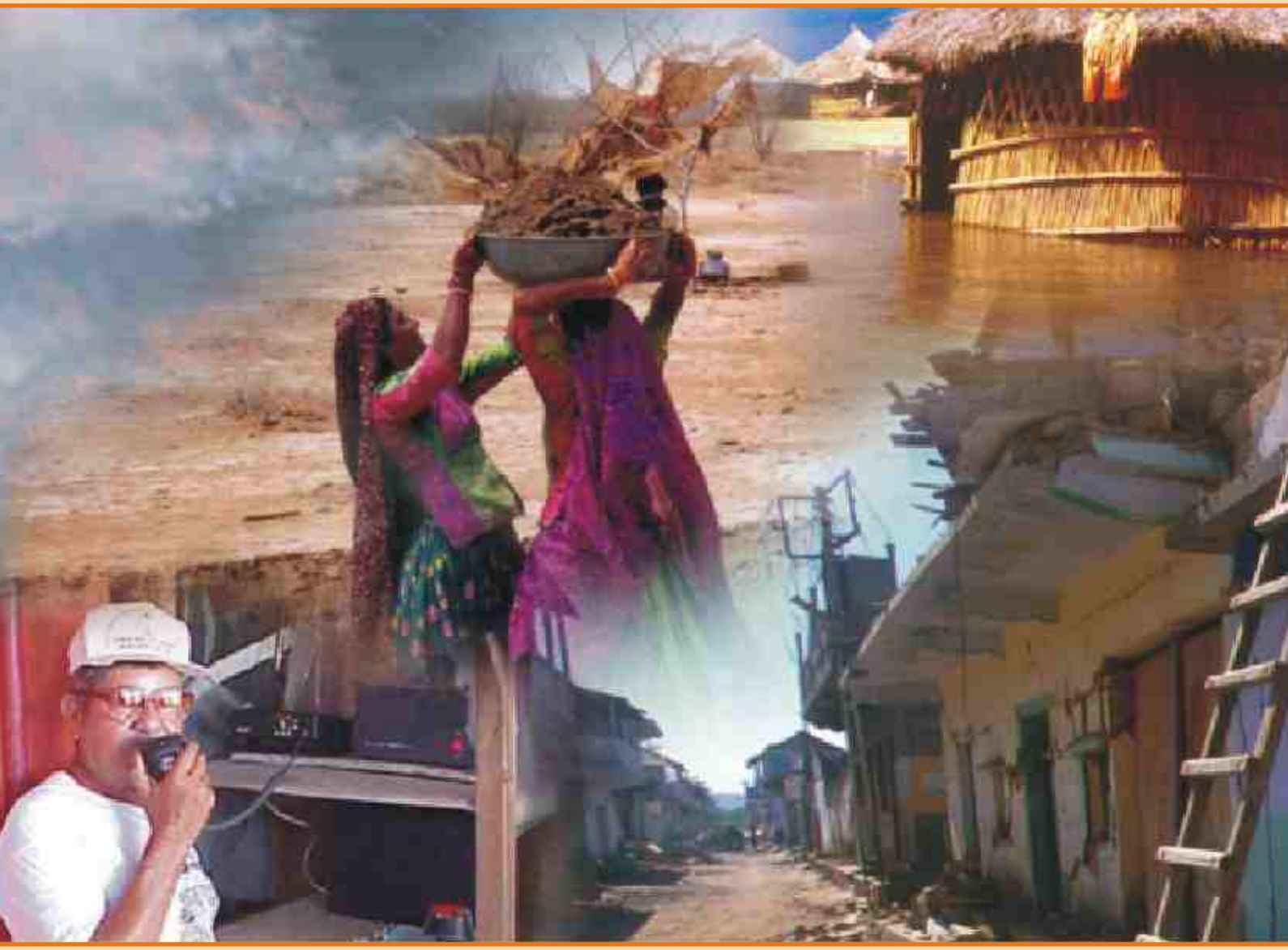
Africa

Regional consultation in preparation for EWCII

23-24 June 2003 - Nairobi, Kenya



EWCII
Second International Conference on Early Warning

International Strategy for Disaster Reduction

Federal Foreign Office

REGIONAL REPORT ON EARLY WARNING OF NATURAL DISASTERS IN AFRICA

Report Prepared for the

Second International Conference on Early Warning
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Prepared by
Seth D. Vordzorgbe
Consultant
UN/ISDR Africa
Nairobi, Kenya

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Abbreviations and Acronyms

ACMAD	African Centre of Meteorological Applications for Development
AGRHYMET	Specialized hydrometeorological institute of CILSS
AP3A	Alerte Precore et Prevision des Production Agricoles (Early Warning and Agricultural Production Forecast Project)
CBD	Convention on Biological Diversity
CILSS	Permanent Interstate Committee for Drought Control in the Sahel
CRONGD	Conseil Regional des ONGS pour le Developpement
DIAPER	Projet Diagnostique Permanent
DMCH	Drought Monitoring Centre Harare
DMCN	Drought Monitoring Centre Nairobi
DMU	Disaster Management Unit
EARS	Environmental Analysis and Remote Sensing
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
ENSO	El Nino/Southern Oscillation
EWFIS	Early Warning and Food Information Systems
FEWS	Famine Early Warning System
FEWSNET	Famine Early Warning Systems Network
FIVIMS	Food Insecurity and Vulnerability Information and Mapping Systems
GHACOF	Greater Horn of Africa Climate Outlook Forum
GHGs	Green House Gasses
GIEWS	Global Information and Early Warning System on Food and Agriculture
GIS	Geographical Information Systems
GTPA	National AGRHYMET Multidisciplinary Working Groups
HIV/AIDS	Human Immuno Virus / Acquired Immune Deficiency Syndrome
IGAD	Inter-Governmental Authority for Development
ISDR	International Strategy for Disaster Reduction
ITCZ	Inter-Tropical Convergence Zone
NAPs	National Action Plans
NAO	North Atlantic Oscillation
NEPAD	New Partnership for African Development
NEWCS	National Early Warning Committees
NEWS	National Early Warning System
NGOs	Non-governmental organizations
NMHS	National Meteorological and Hydrological Services
OFDA	Office of Foreign Disaster Assistance
OSS	Observatoire du Sahara et du Sahel
PRESAO	Prevision Saisonniere en Afrique de l'Ouest
RCMRD	Regional Centre for Mapping of Resources for Development
REWS	Regional Early Warning System
REWU	Regional Early Warning Unit
ROSELT	Network for Long-term Ecological Monitoring Observatories
RRIS	Regional Integrated Information System
RRSU	Regional Remote Sensing Unit

RSMC	Regional Cyclone Monitoring Centre
RTNC	Radio et Television National de Congo
RVAC	Regional Vulnerability Assessment Committee
SADCC	Southern African Development Community
SAP	Systems d'Alerte Precore
SARCOF	Southern African Regional Climate Outlook Forum
SRAP-GHA	Sub-Regional Programme to Combat Desertification for Greater Horn of Africa
SRAP-WAC	Sub-Regional Programme to Combat Desertification in West Africa and Chad
SWIO-TCC	South West Indian Ocean Tropical Cyclone Committee
UMA	Maghreb Arab Union
UNCCD	United Nations Convention to combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Fund
VAM	Vulnerability Analysis and Mapping
WARN	West African Early Warning and Response Network
WSCU	Water Sector Coordinating Unit
WSSD	World Summit on Sustainable Development

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1. Background and context

1.1 International concern with disaster management and early warning

Several natural processes or phenomena of geological, hydrometeorological and biological origin in Africa constitute hazards to the environment of the region, the lives, property and livelihoods of the population, and, the overall socio-economic development of the continent. Due to the high vulnerability of individuals, households and communities, the occurrence of these natural events often results in disasters that further drive the continent towards greater environmental degradation, hunger, poverty, social deprivation and political conflicts, thereby undermining Africa's development.

Over the last few decades, the international community has paid increasing attention to addressing the problem of the negative developmental impacts of disasters as well as ensuring that development interventions do not exacerbate vulnerability to hazards. These efforts culminated in the International Decade for Natural Disaster Reduction (1990 – 1999), the enunciation of the principle of the Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and its Plan of Action, as well as the IDNDR programme forum mandate of Geneva entitled: "A safer World in the twenty-first century: risk and disaster reduction".

Concomitantly, there has been a growing recognition among the disaster management community that the successful application of early warning is one of the crucial elements of effective development interventions to prevent, reduce and mitigate disasters. Both the 1994 Yokohama World Conference on Natural Disaster Reduction and the 1998 Potsdam Conference on Early Warning Systems for the Reduction of Natural Disasters (EWC '98) re-affirmed the crucial role of early warning in engendering effective disaster reduction and prevention. Also, both Agenda 21 and the 2002 World Summit on Sustainable Development (WSSD) proposed several recommendations for action to expand, deepen and strengthen local, national and international actions to develop early warning in particular, and disaster management in general, as critical tools for promoting sustainable development and poverty reduction.

Development practitioners in Africa have also recognized the key role of early warning in effective disaster risk management. Consequently, the 1999 IDNDR-UNEP regional meeting for Africa on disaster reduction in the 21st century reaffirmed that risk analysis and early warning systems are fundamental tools for disaster prevention and mitigation on the continent.

1.2 International consultation on early warning: From Potsdam to Bonn

The First International Conference on Early Warning (EWC'98) in Potsdam provided recommendations to guide the development of early warning systems at community, national, sub-regional, regional and global levels. These recommendations comprised: (a) making early warning a key element of future disaster reduction strategies, (b) ensuring multi-sector, multidisciplinary and inter-institutional collaboration in developing

early warning systems, (c) meeting local community and national needs while strengthening regional and global efforts in early warning, (d) featuring early warning issues in the agenda of the UN and other inter-governmental fora, and, (e) creating an international institutional mechanism within the UN system to continue the efforts of the IDNDR to institutionalize Early warning systems.

As a follow-on to EWC'98, the Second International Early Warning Conference (EWC II) to be held in Bonn from October 16 – 18, 2003 will build on the outcomes of EWC'98 by focusing on strategic issues and institutional requirements. The objectives of EWCII are to: assess the effectiveness of early warning, identify successful early warning practices, and, develop recommendations for replicating best practices in early warning. To achieve these objectives, EWC II will emphasize three themes: emerging issues in early warning, application of early warning mechanisms in the context of sustainable development, and, issues in sustaining the early warning dialogue among stakeholders. The focus is on integrating early warning in public policy.

1.3 African regional consultation and report

Preparations for EWC II have involved a series of regional consultations to provide the content and direction for issues to be discussed at the international forum to be held in Bonn in later in the year. As part of the process culminating in the African Regional Consultation, a number of sub-regional discussion papers were prepared to identify the major issues of relevance to early warning in the Southern African Development Community (SADC), the Great Horn of Africa (GHA), the Economic Community of West Africa States (ECOWAS) and the Maghreb Arab Union (UMA) sub-regions. A draft African Regional Report placed the major issues identified in the sub-regional papers (Vordzorgbe 2003, Mutua 2003, Jalil 2003, Le Centre Regional Agrhymet 2003, and Chang-Ko 2003) within a continental context to provide a regional perspective for discussions at the African Regional Consultation held on 23-24 June 2003 in Nairobi, Kenya.

The UN/ISDR Africa Office organized the African Regional Consultation with financial support from the Ministry of Foreign Affairs of the Federal Republic of Germany and the Bureau for Crisis Prevention & Reduction (BCPR) of UNDP. The Drought Monitoring Centre of Nairobi (DMCN) provided conference support services. A total of 47 participants from 32 organizations and institutions attended the Consultation.

The African Regional Consultation offered a first-time opportunity for early warning practitioners and some key stakeholders, including political authorities, regional and sub-regional organizations, United Nations agencies, bilateral donor partners, academics and civil society organizations to interact and network on developing the science and art of early warning and promoting its integration into public policy. The meeting was not to seek political approval for the draft report nor was it a political meeting of official representatives of the sub-regional organizations expected to pronounce official positions on early warning Africa. The consultation was a technical meeting to identify, discuss and propose ways of addressing key issues pertinent to for improving early warning in

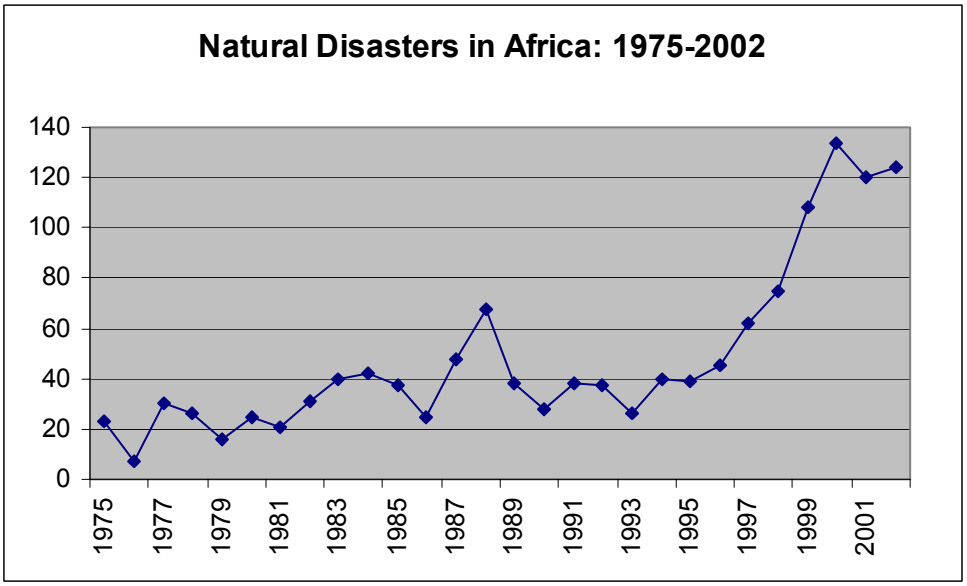
Africa through incorporation in public policy. This report is largely based on the discussions and recommendations at the regional consultation.

2. Disaster profile of Africa

2.1 Natural disaster events, outcomes and impacts

The occurrence of natural disasters has shown a positive trend as annual incidents of disaster events have increased on the continent (Figure 1).

Figure 1



Source: From the EM-DAT: The OFDA/CRED International Database

Not only is the trend of occurrence of natural disasters increasing in Africa, it is the only continent whose share of reported disasters in the world total has increased over the last decade from 15% in 1992 to 26% in 2001 while the share of other continents either declined or stagnated, as seen from Table 1.

Table 1

Percent share of the continents in total global number of reported disasters: 1992-2001*

Continent	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Average annual share
Africa	15	12	14	15	15	13	17	24	26	26	19
Asia	44	52	45	43	44	46	43	39	38	41	43
Americas	24	22	20	24	23	24	23	22	19	18	22
Europe	14	11	17	16	14	14	13	13	16	13	14
Oceania	3	3	4	2	4	4	4	3	2	2	3

*Excludes data on epidemics
Source: Computed from IFRC Disaster Database

The increasing incidence of disasters in Africa during the last decade has been fuelled by a rising trend of disasters in East Africa: the sub-region has exhibited the fastest increase in disaster events, followed by West Africa and Central Africa since the beginning of the 1990s. East Africa accounted for the largest share (39%) of cumulative disaster occurrences in Africa since 1975, followed by West Africa (29%), Central Africa (13%), Northern Africa (11%) and Southern Africa (8%).

The most common individual natural disaster threat in Africa is from epidemic disasters, accounting for 32% of cumulative disaster events during the period 1975 – 2002, as seen from Table 2. However, considering the three major natural disaster categories, hydrometeorological disasters dominate, representing 58%, while biological disasters were 35% geological events accounted for 4%. Famines accounted for 4 percent of all disasters during the period.

Table 2

Occurrence of disasters by type in Africa: 1975 – 2002

Type of disaster event	Share in total (%)
Epidemic	31.5
Flood	26.7
Drought	20.5
Windstorm	8.8
Insect infestation	3.9
Famine	3.4
Earthquake	2.1
Landslide	1.4
Wildfire	1.3
Volcano	0.8
Extreme temperature	0.6

Source: Computed from the CRED database

This overall pattern differs by sub-region: epidemics dominate in East, West and Central Africa, but drought is the most common disaster in Southern Africa while flood is most prevalent in North Africa, as seen from Table 3.

The number of people affected by disasters in Africa shows a positive trend but exhibits a decal pattern with peaks occurring every ten years from 1975, as seen from Figure 2. In the two worst years of 1984 and 2002, an average of about 30 million people were affected annually, due mainly to drought.

The sub-regional distribution of number of people affected follows a pattern similar to that of disaster occurrences: East Africa accounted for 65% of the cumulative number of people affected by disasters in Africa during the period 1975 – 2002, followed by West Africa (15%), North Africa (10%), and Central and Southern Africa (4% each).

Table 3

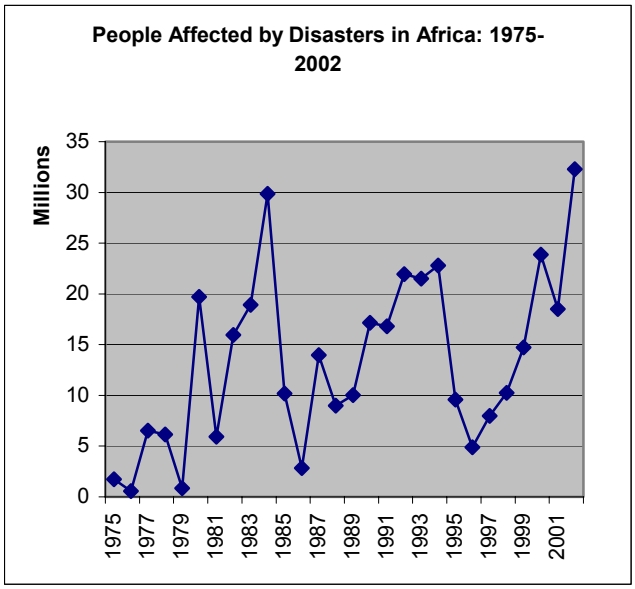
Ranking of Disaster Events in Sub-Regions of Africa: 1975 – 2002*

East Africa	West Africa	Southern Africa	Central Africa	North Africa
Epidemic (29.8%)	Epidemic (39.9%)	Drought (29.7%)	Epidemic (46.5%)	Flood (42.7%)
Flood (25.6%)	Drought (20.7%)	Flood (24.3%)	Flood (21.8%)	Drought (14.4%)
Drought (21.2%)	Flood (21.7%)	Windstorm (18%)	Drought (16.1%)	Epidemic (13%)
Windstorm (13%)	Insect infest. (6.1%)	Epidemic (10.8%)	Volcano (3.5%)	Earthquake (9.6%)
Famine (4%)	Windstorm (4.6%)	Wildfire (6.3%)	Insect infest. (3.5%)	Insect infestation (7.8%)
Insect infest. (2.1%)	Famine (3.8%)	Famine (5.4%)	Famine (2.9%)	Windstorm (5.5%)
Earthquake (1.7%)	Landslide (1%)	Earthquake (2.7%)	Windstorm (2.3%)	Extreme temp. (2.7%)
Landslide (1.3%)	Wildfire (!%)	Extr. Temp. (0.9%)	Landslide (1.7%)	Landslide (2.7%)
Volcano (0.8%)	Extr. temp. (0.8%)	Insect infest. (0.9%)	Wild fire (1.2%)	Wild fire (1.4%)
Wildfire (0.4%)	Earthquake (0. 3%)	Landslide (0.9%)	Earthquake (0.6%)	Famine (0.7%)
	Volcano (0.3%)			

*Numbers in parenthesis are percentages of the total for each sub-region accounted by each disaster type

However, the data show that the effect of disasters is worst in East Africa: the sub-region's share in the number of people affected is very disproportionate to its share of disaster events.

Figure 2



The single worst episodes of the major types of disasters in Africa is shown in Table 4

Table 4

Single worst episodes of major disasters in Africa

	Country	Year	No. killed	Country	Year	No. affected (millions)
Drought	Ethiopia	1984	300,000	Ethiopia	2002	14.3
Epidemic	Uganda	1901	200,000	Kenya	1994	6.5
Famine	Niger	1931	26,000	Ghana	1982	12.5
Flood*	Somalia	1997	2,311	Sudan	1999	1.8

*Since 1990

Source: CRED database and other sources for flood data

2.2 Major hazards and key vulnerabilities

Disasters are triggered by natural phenomena when the occurrence of natural events or processes of geological, hydrometeorogical and biological sources impairs the capability of communities, populations or individuals at risk to address the effects of the phenomena without external assistance. It is important to note that not all emergencies constitute, or result in, disasters; the outcome depends on the extent of vulnerability of affected communities indicated by the degree of exposure to the threat and the ability of individuals and communities to withstand the imminent threat without external input.

The African Regional Consultation yielded a fairly comprehensive listing and categorization of existing and emerging hazards and vulnerability factors. These cover natural phenomena and processes as well as socio-economic factors shown in Table 5. The hazards and vulnerability factors are not presented in any order of priority.

Table 5
Classification of key disaster threats in Africa

Existing hazards (covered under existing early warning and surveillance systems) (a) Drought (b) Floods (c) Epidemics (d) Cyclones and windstorms (e) Infestations (locusts and livestock diseases)	Existing vulnerabilities (covered by existing information and surveillance systems) (a) Food security (food production, availability, accessibility) (b) Economic sectors impacting production systems • crop and livestock agriculture • trade and industry • transportation and mobility (c) Poverty and the poor
Emerging hazard interests (existing and emerging hazards in which interest is increasing) (a) Climate Change • Pollution (air and water) • Allergens • U.V. radiation • Desertification • Sea level rise • Coastal erosion (b) Small scale hazards (such as flash floods, hailstorms, frost and lightning) (c) Weather-related road accidents (d) Landslides (e) Volcanoes (f) Wildland fires (g) Earthquakes	Emerging vulnerabilities (emerging vulnerability factors or emerging interest to address existing vulnerabilities) (a) Political stability (b) Lack of knowledge of environmental conservation (c) Soil fertility (d) Pastoral farmers (mobility) (e) Water availability, including rain-fed agriculture (f) Bio-diversity (g) Urban vulnerabilities

The following discussion will focus on key existing and emerging hazards and vulnerabilities from among those presented in Table 5.

2.2.1 Climatic factors

These factors play a major role in the development and impact of many of the key hazards facing Africa. The continent is mainly tropical and hot is characterized by the following climatic zones: (a) temperate regions in the extreme north and south and high altitudes, (b) humid areas of west Africa and the western parts of central Africa, (c) semi-humid areas fringing these humid areas southwards and northwards where precipitation levels are high during the unimodal or bimodal (in parts of east Africa) wet season but is sparse during the dry season, (d) the semi-arid zone of extremely unreliable rainfall, (e) desert regions of the Sahara and the Kalahari-Namib.

In general, the climate of Africa is largely affected by monsoon conditions in the neighbouring Atlantic and Indian ocean systems as well as local terrestrial features. In southern Africa the Inter-Tropical Convergence Zone (ITCZ) is the main rainfall-bearing system but rainfall levels and inter-annual variability are also influenced by the ENSO, (the main perturbation causing inter-annual variations), and the Botswana High atmospheric system. In western Africa, the high seasonal and inter-annual variability of the sub-regional climate are due to variations in several factors such as global atmospheric circulation conditions, including the tropical Atlantic ocean sea surface temperature (SST) and easterly wave activities, and the development of the ITCZ (CLIVAR 2000). The ENSO effect is greatest in the Sahel during the dry season. In northern Africa, the North Atlantic Oscillation (NAO) is the dominant factor of inter-annual variability while the ITCZ influences both rainfall occurrence and variability in eastern Africa.

In recent times, most of the continent has experienced increased aridity as mean annual rainfall has reduced by 5% to 10% between 1931-1960 and 1968 – 1997. The decline in Sahelian rainfall has been the largest sustained decline recorded anywhere in the world since instrumental measurements began while deviations from the trend have been larger than in other dryland areas of the world. Rainfall variability in southern Africa is comparable to that of the Sahel in parts of Botswana, Lesotho, Namibia and South Africa. Rainfall variability in eastern Africa is lowest in the humid areas of Lake Victoria basin and the highlands areas and highest in the semi-arid areas of northwestern and eastern Kenya, southern, eastern and north-eastern Ethiopia, as well as northern Sudan and Somalia. In Central Africa, rainfall levels are high, drought is a major threat only in the Sahelian parts of Chad and in northern Cameroon, but flooding is more prevalent in the humid zones. In northern Africa, all the countries are prone to drought

2.2.2 Drought

The precipitation extremes experienced in Africa have two main effects: prolonged deficiencies result in climatological drought and contribute to agricultural and

hydrological drought while excesses contribute to floods of various intensity and durations.

Drought is the resultant outcome of the interrelationships among the varied complex natural and anthropogenic factors that are yet to be fully understood. However, emerging knowledge indicates that drought factors in Africa include sea surface temperatures anomalies (SST) such as ENSO and North Atlantic Oscillation (NAO), atmospheric dynamics, and land surface effects linked to vegetation cover and other terrestrial conditions.

Droughts differ from other natural hazards because they are slow-onset phenomena, their occurrence and effects cover wide spatial areas, and their impacts are largely environmental and human but non-structural. Droughts exert environmental, economic and social impacts that retard sustainable development in Africa. They aggravate environmental degradation through ecosystem and climatic effects, including phenomena such as deforestation, livestock overgrazing, soil erosion, wildland fires, biodiversity loss and water pollution. Social effects include reduced potable water supplies with negative health and sanitation consequences, especially for the vulnerable groups, and increased drudgery by women in collecting water for household consumption. Droughts also impact environmental disease incidence, including malaria and meningococal meningitis. For example, during the 1991-92 drought, the worst case of cholera arose in Mozambique while there were high cases of typhoid fever. Furthermore, droughts increase the likelihood of food shortages leading to malnutrition and hunger.

In economic terms, the cost of droughts in Africa is enormous. For example, the economic impacts of the 1991/92 drought in Southern Africa included reduced agricultural production, increased unemployment, heavy government expenditure burden and reduced industrial production due to curtailed power supply. In 1991-92, the drought in southern Africa resulted in a decline in the GDP of the sub-region by an estimated $3 billion (Clay et. al. 2003) and devastation of the agricultural sectors of national economies. For example in Lesotho, the drought affected between 200,000–400,000 people while loss of cereal production alone was 24% of the 1990 agriculture GDP (Vordzorgbe 1992). A decade later, the 1992-2001 La Nina-related drought in Eastern Africa cost the Kenya economy alone about $2.5 billion.

2.2.3 Flood

Most African countries suffer from four types of flood: flash floods from rapid and intense downpours due to convective storms, steady flood caused by synoptic heavy rainfall and human factors, river basin flood, and, coastal zone flooding with devastating effect. Flash and steady floods are often associated with mud, land slides and avalanches, causing severe erosion and vegetation loss.

In the east Africa, areas of high vulnerability to river basin and synoptic flood include: the mountain Elgon and western mountain ranges of Uganda, the lowlands of Burundi and the Nile Rivet channel upstream of Khartoum (Mutua 2003). In northern Africa, areas most vulnerable to steady flood include the north-western plains of Morocco, the

littoral of Algeria and Tunisia while the mountainous zones of Morocco, Algeria and Tunisia are prone to flash floods (Jalil 2003). In southern Africa, parts of Mozambique, Tanzania, South Africa, Zimbabwe and Malawi are routinely affected by flood. West Africa is also prone to flood: for example, annually flood inundate up to 4.6 million hectares of the Sahel flood plains during years of high rainfall.

The effects of floods are devastating. In northern Africa, the 2001 disastrous flood in northern Algeria resulted in about 800 deaths and economic loss of about $400 million. In east Africa, the El Nino-related flood in 1997/98 destroyed infrastructure and property worth about $1.8 billion in Kenya. In Mozambique, the 2000 flood, worsened by two cyclones) reduced the annual economic growth rate from 10% to 4%, caused 800affected almost 2 million people of which about 1 million needed food, displaced 329,000 people and destroyed agricultural production land, among other negative effects.

2.2.4 Epidemics

Human health challenges due to major epidemic diseases pose significant disaster risks in Africa and seriously undermine its progress and development potential. The major risks are from vector-bone diseases (mainly malaria) and communicable diseases (particularly HIV/AIDS and tuberculosis). The latter includes water-habitat and hygiene diseases, such as cholera.

Malaria is a major scourge of Africa and is prevalent in almost all areas of the continent. It is unarguably the single most important health risk in Africa, causes between 1.5 to 2.7 millions mortalities annually, 90% of which are children under 5 year of age, slows economic growth by up to 1.3% annually in addition to the treatment cost, and was estimated to have cost about five times more than all development assistance to the region in 1999 (UNEP 2002). Its control would generate short-term economic benefits of between $3 trillion and $12 trillion annually to Africa.

The upsurge of epidemics of malaria in non-traditional areas of limited transmission during the past two decades underscores the growing menace of this already disastrous disease. Epidemics have occurred due to (a) post-drought conditions in several southern African countries (such as Zimbabwe, Botswana, Swaziland, Mozambique and South Africa), (b) torrential rainfall (during 1997/98 in East Africa, (c) climate change (such as in Uganda, Burundi, Kenya and Rwanda) and (d) resurgence in areas of reduced spraying effort (such as in Madagascar) (WHO 2001).

The risk posed by malaria is a complex challenge that best illustrates the effect of different vulnerability factors in engendering disasters. These factors are: climatic (rainfall patterns and rising temperatures), vector-specific (resistance to quinolines and behavioral changes), political (armed conflicts and civil unrest causing about 30% of the mortalities from the disease), demographic (high population growth and migrations), and development-based (water facilities that provide breeding sites and reduced financial resources for control activities).

The other major health crisis of disaster proportions, that also signifies the influence of several factors including socio-economic status, is the HIV/AIDS pandemic. This is a maturing emerging hazard with very disastrous impacts and consequences, particularly for sub-Sahara Africa. As at the end of 2002, a total of 29.4 million people were living with HIV/AIDS in the sub-region (72 % of the global total), representing a prevalent rate of 8% (compared to the global rate of 1.3%), 3.5 million were newly infected (70% of the global total) and 2.4 million died, representing 77% of total global mortalities (UNAIDS/WHO 2002). National adult prevalence rates in four southern African countries are highest: Botswana (38.8%), Zimbabwe (33.7%), Swaziland (33.4%) and Lesotho (31%). The effect on life expectancy, food security, poverty, economic activity, national resources and social impacts are serious.

Unfortunately, the full impact of the epidemic is only now unfolding: without increased attention and effort at prevention, treatment and care, the death toll is expected to keep rising before peaking at the end of the decade. However, the positive experience of Uganda in reducing prevalence rates and the emerging trend of prevalence reduction among the youth in some countries (such as Ethiopia and South Africa) bodes well for the future but there is the urgent need to intensify and expand efforts to roll back the disease.

2.2.5 Tropical storms and cyclones

The principal tracks of tropical storms in Africa follow two pathways and affect two zones (a) Madagascar, other Indian Ocean states, Mozambique and eastern South Africa, (b) parts of eastern Somalia. However, the track sometimes follow the Limpopo valley and affect inland Mozambique, Malawi, Zambia, South Africa and Zimbabwe. Hurricanes often develop near the center of cyclones while extratropical winter storms also afflict southern parts of South Africa. The effects of these tropical windstorms are devastating. For example, in Mozambique alone, Cyclone Eline that affected south-eastern Africa during 1999-2000, caused $273 million physical damage, $295 million in lost production and $31 million in food imports.

2.2.6 Poverty

Poverty is both a contributory factor and outcome of disasters from natural triggers. The poor depend strongly on the natural resource base for their livelihoods, live in marginal areas, have weak socio-political status and cannot access the resources required for coping with and reducing disasters. These, and other attributes of poverty, weaken the vulnerability to and the ability to recover socio-economic productive capacity after disasters.

The high level of poverty in Africa is the greatest single vulnerability factor in the continent, particularly to natural hazards from hydro-meteorological events. The region, with about 40% of the population living on less than one dollar a day, is the poorest in the world and contains 30 of the poorest nations on earth in 2000.

Food security and poverty are intrinsically linked as both represent aspects of weak entitlement of those affected to human security rights embodied in access to human, social, physical, economic and environmental capital required for livelihoods and human development.

In Africa, famine and food insecurity are the human outcomes of drought and desertification crises, constitute the visible face of disasters and are often associated with disease epidemics and other vulnerability factors such as economic inefficiency and social inequity. Food production has lagged behind demand but despite food imports, chronic and episodic food insecurity is still high in Africa with 27% of the population estimated as being undernourished as at 2000 (United Nations 2001). Undernourishment, as an indicator of inadequate access to food, was highest in central Africa (50% of the population), followed by eastern Africa (46%), southern Africa (29%), western Africa (16%) and northern Africa (7%).

A major causative factor of poverty and food insecurity in Africa is the low rate of economic development: Africa accounted for 13% of the world population but only 4% of the GDP as at the end of 2000. At national level, saving and capital formation rates are inadequate to meet investment needs, external inflows are minimal and declining while the debt burden is worsening. Consequently, unemployment is high while national incomes are low and are growing very slowly (even declining in some countries) over the past three decades with the result that living standards have only improved marginally in some countries and actually declined in several African countries. Consequently, at the people's level, poverty is endemic and worsening with dire consequences for the vulnerability of the sub-region.

2.2.7 Climate change

Climate change: A major emerging disaster threat derives from climate change that will produce several impacts on the vulnerability of people, the environment and social system due to climate-induced changes in sources of livelihood. The impacts of climate change in Africa are likely to encompass the following (AfDB et. al. 2002):

(a) increase in drought, flood, windstorms and other extreme climate phenomena will negatively affect water resources through reduced freshwater availability, food security, human health (such as spread of malaria in the arid zones), industrial production and weakened physical infrastructure base for socio-economic activity, resulting in reduced development;
(b) changes in rainfall (including likely wetting in east Africa and drying in southeast Africa) and more intense land use will result in increased deforestation, loss of forest quality and woodlands degradation across the continent that will worsen desertification (particularly in west, northern and southern Africa). This will exert greater pressure on already strained coping strategies and will very likely result in increased poverty;
(c) sea level rise leading to coastal erosion and flooding, particularly in west, eastern and north Africa, and bleaching of coral reefs along the Red sea and Indian ocean

coastal zone. With more than one-quarter of the population living within 100 km of the coast and most cities concentrated along the coastline, the vulnerability to marine-induced disaster from tidal waves and storm surges will increase;

(d) the decrease in river basin run-of and water availability for agriculture and hydropower generation due to changes in rainfall and river sensitivity to climate variation will likely result in increased cross-boundary tensions. This will result in more conflicts, intensification of existing conflicts or reduced ability to resolve them.

Currently, the contribution of Africa to global emissions of green house gases (GHGs) is insignificant. However, the increasing levels of investment in the development of the hydrocarbon resources of the region, particularly in the Gulf of Guinea, will undoubtedly exacerbate the pressures leading to higher input of emission from the continent. This could likely reinforce climate change effects globally and in the region.

These climate change effects have implications of the nature and function of early warning systems. Given the relatively undeveloped state of Africa, climate change will worsen Africa's vulnerability to ecosystem hazards, quite apart from exacerbating the effects of the hazards. Hence, due to the weak economic situation of Africa, we cannot afford to invest significantly in classical mitigation interventions: the key to reducing disaster risks from climate change is to focus on developing adaptive management systems and initiatives (Vordzorgbe 2002).

Furthermore, since increasing climatic variability impacts different classes of people in different ways necessitating assessment of the expected increase in vulnerability on different target groups. Hence, early warning systems need to anticipate risks, expand their scope to encompass measurement of potential changes in vulnerability status of target populations, and generate the requisite information for enhancing the resilience of communities.

Small scale hazards (such as flash floods, hailstorms, frost and lightning) do not often receive the requisite attention at the national level but have high impacts at personal and community levels. These have major implications for the livelihoods of individuals and communities at the local level

2.2.8 Desertification

Generally, desertification is the result of frequent droughts, deforestation, extensive cultivation and overgrazing (Ahmed 2000). In Africa, the major cause of desertification is overgrazing, responsible for degradation of 57% of the total desert area, followed by arable farming accounting for 29% of the area and deforestation causing desertification on 14% of the total desert area in Africa (UNEP 2002).

Land-atmospheric interactions via vegetation changes that affect moisture regimes are important in shaping drought conditions and desertification in the semi-arid areas of Africa. Vegetation changes affect climatic conditions in complex ways, including

through the albedo and other land surface effect that reduces rainfall, the drag effect on atmospheric patterns, and dust release from soil erosion (CLIVAR 2000). These ecosystem-climate relationships include the effect of hydrological characteristics, particularly run-off, on soil moisture and the water cycle, which affects rainfall conditions and regimes.

Desertification is a major disaster hazard in the Africa, reducing soil fertility, vegetative productivity and diversity thereby causing reduced agricultural productivity and output that ultimately contributes significantly to food insecurity and famine.

2.2.9 Conflict and political instability

There exists a two-way relationship between disasters and conflicts. Not only do conflicts affect natural disaster outcomes but the type, onset and intensity of conflicts are also influenced by environmental factors and circumstances. For example, severe land degradation has increased the frequency of land conflicts between sedentary agriculturalists and migratory livestock herders (IFAD 2002, UNEP 2003). These issues of conflict over access to shared resources are often underpinned by disputes over common property rights and access (OECD 2002). This relationship of mutual determination underscores the need to integrate both issues in the development of comprehensive early warning systems that cover both disasters and conflicts in the region (UNEP 2003).

The disaster landscape in Africa is replete with disasters conditioned by armed conflicts and political instability. Conflict disasters are akin to slow onset disasters (such as drought-induced famine) in that they slowly develop and their outcomes persist so long as the underlying conflict factors are operative. Both natural and conflict disaster situations result in humanitarian crises signified by famine, weakened health status, destruction of property and ecosystems and dislocation of social systems, with disaster situations caused by conflicts referred to as complex humanitarian emergencies.

These conflict situations undermine individual, state, regional and ecosystem security. They also exacerbate the effects of natural hazards, such as famine and epidemics, because they weaken the vulnerability status of populations already stressed, thereby worsening the level of disaster risks. For example, about 30% of malaria mortalities in Africa are in areas of armed conflict. Also, during 1996-1998, the incidence of malnutrition in Africa was highest in conflict countries on the continent: Somalia (75%), Burundi (68%), Eritrea (65%), DRC (61%), Mozambique (58%), Liberia (46%), Sierra Leone (46%) (United Nations 2001).

2.2.10 Urban vulnerabilities:

Urbanization has resulted in increasing vulnerability to disaster hazards in Africa, but is often overlooked. Currently, the projected annual rate of urban population growth (3.7%) in Africa during the period 2000 – 2005 is higher than that of the total population (2.3%) and that of the rural population (1.2%). Furthermore, the African urban population is

growing at a faster rate than the global urban growth rate of 2% (United Nations 2001). The projected annual rate of growth of the urban population during this period is higher than 5% in several countries: Ethiopia (5.1%), Somalia (5.2%), Tanzania (5.4%), Niger (5.5%), Burkina Faso (5.6%), Uganda (5.7%) and Malawi (7.3%).

This fast pace of urbanization in the sub-region requires that the provision of and access to essential economic and social services keeps up with the demand for them so as to minimize the deterioration in the vulnerability of the disadvantaged and the poor. Urban settlements are prone to disaster damage mainly due to unplanned urbanization that is the result of the lack of integrated physical and economic planning involving national spatial policy frameworks that include national physical development plans. Consequently, the legal framework for town and country planning regulations is weak, structure plans for key settlements are absent, and compliance with urban planning and development policies, controls, and standards is low.

Vulnerability of the population in urban settlements is high also due to various forms of deprivation. For example, the quality, reliability and accessibility of social services is poor, the urban poor are more prone to risks to life and health from poor sanitation and endemic diseases, air pollution, crime and violence, and the breakdown of traditional familial and communal safety nets is greater in urban areas.

Due to the weak state of public finances, public resources are inadequate to provide the requisite investment in to reduce disaster impacts. Consequently, the physical capital base, including public infrastructure, such as transport, communication and health facilities and services necessary for maintaining and enhancing the coping, survival and resilience capabilities of disaster communities, is relatively undeveloped. This weakens the human capital base and is manifest in vulnerability outcomes such as low educational levels, weak health status and low access to information.

3. Effectiveness of early warning systems in Africa

3.1 Early warning and disaster risk management

Early warning is a key component of disaster risk management. It involves the generation, dissemination and use of information about potential risks, hazards and vulnerabilities to empower individuals and communities under threat from natural and other hazards to take effective and timely decision-making to protect lives, property and the environment from the effects of disasters.

The function of early warning in disaster risk management is to contribute to the information, communication and planning systems required for addressing the effects of imminent threats from natural and related phenomena that have the potential to result in disasters. To be effective, early warning systems must be an integral part of comprehensive disaster risk management capabilities.

Within this context, early warning systems have to contain five essential elements to be complete. These are: (a) an institutional structure for organizing and managing the system; (b) a warning sub-system for monitoring and forecasting hazards involving the production and communication of information on potential hazards and vulnerabilities to authorities responsible for disaster management; (c) a risk information sub-system for disaster management authorities to generate scenarios of potential impacts of imminent risks targeted at specific vulnerable groups, sectors and areas of society, (d) a preparedness sub-system for developing strategic actions to be taken to avoid or reduce potential hazard loss or damage, (e) an education and communication sub-system for empowering vulnerable groups through information dissemination and awareness creation on potential threats, risk scenarios and recommended preparedness strategies for effective mitigating measures in vulnerable areas.

Thus, the African Consultation identified the roles of early warning in disaster risk management as: (a) risk forecasting and prediction, (b) recommendation of alternative protective actions targeted to different end-users, communities and types of risk, (c) engendering shift from reactive response to proactive reaction to warnings through education and other awareness creation activities on impending threats.

3.2 Typology of operational early warning systems in Africa

3.2.1 Brief historical perspective on development of formal early warning in Africa

The practice of formal early warning in Africa started in West Africa. The droughts and resultant famines that afflicted West and Eastern Africa during the late 1970s engendered the need for mechanisms to mobilize resources to avert similar future occurrences. The immediate response paradigm, particularly under the ORSEC Plan of the French Cooperation in West Africa, was grounded in the provision of food aid, a need that was deemed to be linked to excessive dry conditions. Thus, early efforts at early warning in

West Africa during the early 1980s were based on decisions linking food insecurity to meteorological trends based on agro-meteorological evaluation models of crop yields (Italian Cooperation 1999).

Similarly, efforts to develop early warning in the Horn of Africa, were in response to the droughts and famines that occurred between 1973/74 and 1984/85 and resulted in the establishment of the Inter-Governmental Authority for Drought and Development (IGADD) in 1986. From 1987 to 1995, IGADD implemented an EWFIS project aimed at institutionalizing the regional system and supporting establishment of national systems (Bonnard 2000). Since 1996, the renamed IGAD has focused on developing the sub-regional early warning system (UNDP 2000).

In Southern Africa, technical assistance from FAO during 1988 to 1996 initiated efforts to develop early warning practice based on food deficit information at the sub-regional and national levels that accelerated after the 1991-92 drought and famine (Chopak 2000).

Thus, early warning systems currently operational in the region have evolved from a common root grounded in the need to reduce food insecurity and its deleterious impacts.

3.2.2 Status of early warning systems in sub-regions of Africa

Several types of early warning systems are in operation in Africa covering a range of the common hazard factors. Some features of these systems are as follows:

- systems for food security are the most developed and widespread
- drought warning systems are often integrated with climate and weather warnings mainly because most of the drought forecasting systems focus on climatological drought prediction
- early warning systems for other major threats (apart from food insecurity, drought, flood, and climatic factors) are undeveloped or are limited to the surveillance and monitoring sub-systems without being part of comprehensive early warning systems
- desertification monitoring systems are only now being developed under the ambit of the NAPS produced under the UNCCD
- each of the major sub-regional groupings in Africa have developed early warning systems common to each sub-region, covering food security, drought and climatic factors
- the UMA zone has not developed a sub-regional early warning system for any of the hazards considered partly due to the lack of a common sub-regional strategy for natural disaster management. However, Morocco, Algeria and Tunisia are cooperating under a UNDP/GEF regional project to address climate change effects (Jalil 2003)
- Similarly, the Economic Community of Central African States (ECCAS) has yet to develop a sub-regional early warning system, but Chad and Cameroon are operating national systems.

The range of early warning systems at sub-regional and national levels is shown in Table 6.

3.2.3 Major early warning systems at national level

Almost all African countries initiated the practice of formal early warning through the use of the major early warning systems of international origin: Famine Early Warning System Information Network (FEWSNET), Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS), Global Information and Early Warning System on Food and Agriculture (GIEWS) and Vulnerability Analysis and Mapping (VAM).

Famine Early Warning System Information Network (FEWS NET): This USAID-supported system was initiated in Africa in 1985 as the Famine Early Warning System (FEWS) to help provide more effective food security information to reduce disaster risk of vulnerable groups. The first three phases focused on developing tools and methods for early warning monitoring with relatively little attention to developing the contingency and response planning component of early warning (Chemonics 2000). As at 1999, it operated in 16 countries in all the sub-regions of African (Italian Cooperation 1999).

The current phase of the programme follows a multidisciplinary approach, utilizes a wide range of environmental and socio-economic data and focuses on integrating risk and vulnerability. It has significantly improved data collection and analysis and strengthened links between data analysis for early warning and disaster response (Chemonics 2000). In addition, the programme now encompasses the monitoring of desertification and climate change impacts as part of efforts to provide more comprehensive early warning information on chronic vulnerability to guide both short-term food crisis response and long-term mitigation of adverse climatic and environmental events in Africa (Gonzales 2000, 2002). Furthermore, FEWSNET has piloted the Livelihood Zoning approach in Africa and the developing world (FAO 2002). These developments reflect the FEWS NET objectives of increasing the usefulness of early warning information to decision makers and improving response planning based on early warning (Chemonics 2000).

Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS): This FAO-supported network aims at improving policy formulation and programme management in food security through assembling, analyzing and disseminating information about food insecurity and vulnerability. FIVIMS is more of a knowledge and action network for food security than a true early warning system for disaster reduction, despite its significant contribution to risk assessment[1]. However, it's role in early

[1] FIVIMS will now be used in the Common Country Assessment (CCA) and UN Development Assistance Framework (UNDAF) processes and also inform other country development assistance programming process, such as monitoring and review of the Poverty Reduction Strategy Papers (PSRP).

warning systems for disaster risk is increasing. For example, in West Africa, Chad and Mauritania already applying traditional food security and early warning systems

Table 6 - Overview of early warning systems and institutions in Africa

Types of Hazard/Threat	WEST AFRICA		SOUTHERN AFRICA		GREAT HORN	
	Sub-regional level	National level	Sub-regional level	National level	Sub-regional level	National level
Food security	AGRHYMET system for CILLS countries	-SAP* -EWFIS (through GIEWS) -FEWSNET	REWS (REWU, RRSU, RVAC, DMU)	NEWS	REWS (emphasizing vulnerability analysis) & integration with conflict warning system)	NEWS in at various levels of development
Climate/weather	-Sub-regional system (ACMAD & PRESAO) -CLIMAG initiative	National meteo networks	Sub-regional system (DMCH, RRSU, SARCOF, meteo networks)	Meteo networks, DMCH	Sub-regional system (DMCN, RCMRD, GHACOF, meteo networks)	Meteo networks, DMCN
Drought[1]	-AGRHYMET system for CILLS countries -SRAP WAC under UNCCD developed	-National meteo networks -National drought forecasting systems in some countries under UNCCD NAPs	Sub-regional system (DMCH, REWU, RRSU, DMU, WSCU)	National systems (NEWUs, meteo services, DMAs, Depts. Of Water Affairs, etc)	Sub-regional system (REWS, DMCN, RCSSMR, RIIS, meteo services) -SRAP GHA under UNCCD developed	-NEWS more developed in few countries (e.g. Ethiopia, Kenya), undeveloped in most -NAPs developed

Table 6 (continued)

Types of Hazard/Threat	WEST AFRICA		SOUTHERN AFRICA		GREAT HORN	
	Sub-regional level	National level	Sub-regional level	National level	Sub-regional level	National level
Flood	Water resource variability, river flow models & hydrological being developed	-systems for river and coastal flood forecasting undeveloped -flash flood warning systems exist, or are being developed in some countries	-Sub-regional system (WSCU, RRSU, DMCH, REWU, DMU, river basin networks) -River flow model risk maps developed (FEWSNET & others)	National capabilities exist in some countries, developing in some countries	Under development; river flow model risk maps developed (FEWSNET, DMCN)	National systems undeveloped
Desertification	-ROSELT/OSS -AP3A for CILLS areas by AGRHYMET	Being developed under NAPs	None	National monitoring mechanisms	SRAP GHA under UNCCD developed	NAPS being formulated
Conflict	Early warning initiatives being developed (WARN)	-Not formalized	SADC mechanism for conflict monitoring	National mechanisms	Sub-regional Conflict Early Warning Unit newly established	National mechanisms at various levels of effectiveness

Table 6 (continued)

Types of Hazard/Threat	WEST AFRICA		SOUTHERN AFRICA		GREAT HORN	
	Sub-regional level	National level	Sub-regional level	National level	Sub-regional level	National level
Geological	Seismic hazard maps prepared under GHSAP	-Integrated in national disaster management platforms -earthquake hazard estimates exist for key locations in prone countries	None	National capability developed in South Africa for earthquake monitoring -hazard mapping and risk assessment underway for some prone areas	Sub-regional mechanism unavailable	Discrete monitoring mechanisms exist in some countries but are not part of comprehensive early warning sytems
Epidemics	HealthMap initiative being assessed for use in malaria surveillance	-National surveillance systems for human and animal disease epidemics and pest infestations at various stages of use -Continent-wide MARA project for malaria early warning using GIS	No indication of sub-regional system	-National surveillance systems for human and animal disease epidemics and pest infestations at various stages of use -Continent-wide MARA project for malaria early warning using GIS	No indication of sub-regional system; pest infestation warning being integrated in REWS for desertification and conflicts	-National surveillance systems for human and animal disease epidemics and pest infestations at various stages of use -Continent-wide MARA project for malaria early warning using GIS

Table 6 (continued)

Type of Hazard/Threat	WEST AFRICA		SOUTHERN AFRICA		GREAT HORN	
	Sub-regional level	National level	Sub-regional level	National level	Sub-regional level	National level
Cyclones/windstorms	Not available, but ACMAD forecasts storms	Windstorm warning part of weather warning	Regional system (RSMC, SWIO-TCC, DMC, ACMAD)	SWIO-TCC, national meteo networks	-Sub-regional system unavailable -DMCN weather forecasts	Little national capability
Wildland fires	-No sub-regional mechanism -Regional Sub-Sahara Wildland Fire Network launched	-Often part of weather, drought and desertification warning -Senegal developing capability -local community fire alarms	-Miombo Network operates GIS-based system[#] -Regional Sub-Sahara Wildland Fire Network launched	Some country mechanisms (e.g. Namibia)	-No sub-regional mechanism -Regional Sub-Sahara Wildland Fire Network launched	National systems undeveloped

Table 6 (Continued)

TYPE OF HAZARD/THREAT	WEST AFRICA		SOUTHERN AFRICA		GREAT HORN	
Livestock nutrition and growth problems	No sub-regional mechanism	National systems based mainly on veterinary surveillance	-Continent-wide MARA project for malaria early warning -No regional mechanism	National systems based mainly on veterinary surveillance	Sub-Regional LEWS (8 zones with 30 monitoring points/zone; production, nutrition & weather models; decal data disseminated; links with IGAD Secretariat & RCMRD)	-LEWS national platforms in Ethiopia, Kenya, Uganda, Tanzania -Other national systems based mainly on veterinary surveillance

Notes:
[1]Mainly climatological (or meteorological) drought, and to a more limited extent agricultural drought forecasting
*For short-term drought/food security and long-term natural resource monitoring
**In Sahelian zones of CILLS except Mauritania
[#]An informal network of scientists operating a donor-funded internet-based interactive GIS for fire detection and response in the Miombo Woodlands

approaches within the FIVIMS framework while Burkina Faso has initiated the integration of the system into the implementation of its National Plans of Action for Food Security and Nutrition (FAO 2001). Twenty-one African countries were implementing the programme as at 1999 (Italian Cooperation 1999).

Vulnerability Analysis and Mapping (VAM) system: This WFP-supported programme focuses on analysis of trends, causes and impacts of vulnerability and provides information for disaster preparedness activities. This approach integrates food accessibility analysis assessment with analysis of disaster risk based on factors such as flood or drought, vegetation cover changes, food market prices and health status. As at 1999, its operations covered 13 countries in all the sub-regions of Africa (Italian Cooperation 1999). VAM utilizes more indicators in its analysis than all the other major early warning systems discussed in this sub-Section. Also, WFP is implementing an on-going initiative in Africa and other developing countries to strengthen the contribution of VAM to disaster mitigation, including early warning efforts, in Africa through a new approach embodied in the Standard Analytical Framework (SAF) for Vulnerability Assessment but its primary focus remains the generation of better information to improve food aid targeting and long-term development programmes.

Global Information and Early Warning System on Food and Agriculture (GIEWS): This FAO-hosted programme monitors global food security, mainly supply and demand. It is the most widespread of the four systems: 51 African countries were participating in the network as at 1999 (Italian Cooperation 1999). GIEWS provides assistance to develop national capacities in establishing and maintaining the statistical base of the system through establishment of Early Warning and Food Information Systems (EWFIS) within participating countries. The system acts as one of the first sources of information at the global level on imminent or possible food crisis, due to likely famine and food insecurity from drought or other causes, and develops new approaches and technologies for early warning.

The overlapping implementation of these systems at the national level results in a multiplicity of systems in some countries. For example, as at 1999, Tanzania, Sudan and Ethiopia were operating 5 systems (comprising all four international systems and one sub-regional system), 10 countries[2] were implementing four systems (comprising three international systems and one sub-regional system) while 2 countries[3] were solely operating three of the international systems (Italian Cooperation 1999). This situation raises issues of coordination and harmonization of different early warning systems in Africa.

3.2.4 Sub-regional food security early warning systems in Africa

Given the key role of sub-regional entities in developing, supporting and implementing food security early warning systems, it is instructive to review the comparative features

[2] These were Burkina Faso, Chad, Malawi, Mali, Mauritania, Mozambique, Niger, Senegal, Zambia and Zimbabwe.
[3] Gambia and Guinea-Bissau

of the key sub-region based food security early warning systems in operation in Africa: the AGRHYMET, SADC, and IGAD systems. The presentation in Table 7 covers the five key components of an effective early warning system: (a) organizational structure of the system, (b) the warning subsystem involving hazard monitoring and forecasting, (c) risk information, (d) preparedness, (e) communication.

3.2.5 Assessment of selected early warning systems

The Africa Regional Consultation undertook an assessment of the food security early warning systems, focusing on the SADC Regional Early Warning System (REWS) and FEWSNET. This is presented in Table 8.

3.3 Hazard early warning and vulnerability monitoring

The need for early warning for vulnerability threats arises from two main reasons: (a) disaster risk is a function of the interaction between hazard outcomes and vulnerability effects, (b) the effects of vulnerability factors on livelihoods is growing in importance in Africa, even as deaths from natural disasters are decreasing. Thus, it is extremely important to endow existing early warning systems in the region with the analytical and forecasting capabilities to generate longer-term perspectives on key emerging environmental threats, such as water supply and quality, lower atmosphere pollution from biomass burning, environmental flashpoints of human security importance, habitat loss and forest fragmentation, critical zones, and endangered species (UNEP 1998).

In response, there is a growing trend towards integrating vulnerability monitoring in hazard early warning: The conceptual framework of famine and food security early warning systems has shifted to an emphasis on vulnerability analysis, mainly livelihood sustainability. Almost all the early warning systems operating in the region (such as FEWS NET, the AGRHYMET Integrated System for Early Warning of the Sahel, the SADC Regional Early Warning System and the IGAD Regional Early Warning System) have now adopted this stance in efforts to strengthen the contribution of vulnerability analysis to analysis of broader development objectives, such as sustainable development and poverty reduction. In support of this move, some early warning systems are developing methodologies to integrate warning information on drought, flood, desertification, famine and food security.

To facilitate this process, the African Regional Consultation identified differences between early warning systems for hazards and for vulnerability. These are presented in Table 9. Participants emphasized the complementarity between and necessity of both types of early warning systems in effectively addressing disaster risk. Hence, the recommendation was to view the two as sequential processes in disaster risk assessment and monitoring, with hazard early warning as the first step and vulnerability monitoring as the second. However, participants noted that the two processes often need to be undertaken non-sequentially.

Table 7: Comparative features of the sub-regional food security early warning systems

Feature	AGRHYMET	SADC	IGAD
Organization	-part of the AGRHYMET Regional Program (ARP), with National AGRHYMET Multidisciplinary Working Groups (GTPA) as administrative coordination mechanisms in CILLS countries -in addition, all CILLS countries, except Mauritania, operate another early warning system, the SAP, for the Sahelian zones of their countries. -the GTPAs support the SAPs in forming national early warning committees with a ministerial committee at the apex -non-CILLS countries adopt peculiar institutional organization modes for food security early warning systems (e.g. as part of national food security information coordination structure in Ghana)	-part of the SADC Regional Multi-Sectoral Disaster Management Strategy -REWU is part of the SADC Food Security Technical and Administrative Unit while RRSU is a component of the REWS Project -The DMC is an operational wing of SADC Meteorological Services under the Southern African Transport Communications Sector -The REWU receives information from NEWUs to develop regional early warning information	-part of IGAD Disaster Risk Management Programme -under the Strengthening Early Warning and Information Systems and Vulnerability Analysis project -DMCN is a specialized institution of IGAD for regional weather and climate monitoring, prediction and early warning -The RCMRD services the IGAD early warning system -IGAD to facilitate, coordinate and mobilize resources for disaster management enhancement, including early warning at sub-regional and national levels

Table 7 (continued)

Feature	AGRHYMET	SADC	IGAD
Warning (hazard monitoring & forecasting)	-climate monitoring and forecasts and drought projections by ACMAD, NMHS, AP3P -increased use of predictive models, remotely sensed data and GIS - initiatives to improve the capability of African countries to apply space technologies to disaster management -food security prospects from NEWCs and regional DIAPER project -PRESAO and CLIMAG review, update and harmonize forecasts -November and March CILLS meetings project food security status and needs	-climate monitoring and forecasts by DMCH, NMHS -increased use of predictive models, remotely sensed data and GIS -initiatives to improve the capability of African countries to apply space technologies to disaster management -SADC Seasonal Monitoring Group (including REWU, RRSU, DMCH, and FEWS NET) projects potential food security status and issues -forecast review and harmonization through SARCOF	-climate monitoring and forecasts by DMCN, RCMRD, NMHS -RCMRD cooperating with EARS to finalize crop yield forecasting system -increased use of predictive models, remotely sensed data and GIS -initiatives to improve the capability of African countries to apply space technologies to disaster management -RIIS to provide information on food security and environment to regional and national authorities -forecast review and harmonization through GHACOF

Table 7 (continued)

Feature	AGRHYMET	SADC	IGAD
Risk information	-risk scenario analysis of impact of threats on target groups is undeveloped -FIVIMS and VAM risk assessment models involving food insecurity and vulnerability analysis and mapping systems being applied to food security and drought early warning. Yet to be fully operationalized for risk scenario analysis of impacts of hazard events on target groups	-assessments of impacts and vulnerabilities associated with climate predictions and early warning products growing as part of early warning system e.g. analysis of impacts of these phenomena on various sectors such as health, tourism, agriculture and power generation -Regional and National Vulnerability Assessment Committees undertaking national vulnerability status analysis for bechmarking potential risk impacts of hazards	-emphasizes the key role of vulnerability analysis as complement to early warning -will integrate desertification and conflict early warning with food security early warning in generating risk scenarios
Preparedness	-Focused on ensuring food security -Integrated into the food security food security planning of national disaster management systems (e.g. Burkina Faso	-Integrated into activities of the SADC Disaster Management and Emergency Response mechanism -development of strategic mitigation measures by DMCH not fully underway	-development of strategic mitigation measures by DMCH not fully underway -to have some strategic linkages with the newly established Conflict Early Warning Unit in the area of information sharing and alerting disaster managers at national and regional levels

Table 7. (continued)

Feature	AGRHYMET	SADC	IGAD
Communication	-Largely limited to disseminating probabilistic warning information on impending hazards with relatively little information on potential risk scenarios or preparedness strategies -Dual-track approach to dissemination: (a) from PRESAO to national disaster authorities, (b) from PRESAO to directly general public -developing the potential to produce forecasts of different risk levels on varied scales (micro, meso and macro) keyed to specific vulnerable populations and geographic areas and more widely disseminated from improvements in ICT	-Largely limited to disseminating probabilistic warning information on impending hazards with relatively little information on potential risk scenarios or preparedness strategies -Dual-track approach to dissemination: (a) from SARCOF to national disaster authorities, (b) from SARCOF to directly general public -developing the potential to produce forecasts of different risk levels on varied scales (micro, meso and macro) keyed to specific vulnerable populations and geographic areas and more widely disseminated from improvements in ICT	-Largely limited to disseminating probabilistic warning information on impending hazards with relatively little information on potential risk scenarios or preparedness strategies -Dual-track approach to dissemination: (a) from GHACOF to national disaster authorities, (b) from GHACOF to directly general public -developing the potential to produce forecasts of different risk levels on varied scales (micro, meso and macro) keyed to specific vulnerable populations and geographic areas and more widely disseminated from improvements in ICT

Table 8

Comparative assessment of food security early warning systems: SADC and FEWSNET

Variable	SADC	FEWSNET
Locus of the system	Regional and national	Country specific
Availability of hazard data and vulnerability information	• Variable (from country to country) • Data exchange protocols required (especially for real-time data) • Coordination issues • Remotely sensed data more available	• System generates own data at regional level as well as at country level • Variability in country level data availability
Availability of technology to transform data into usable information	• Sector specific • Better in the agriculture sector • Transferable to other types of hazards (may depend on sector)	Good (focus on food security)
Role of stakeholders in data generation and needs definitions	• Regional centers eliciting stakeholder input • National level variable	• Donor driven and determined • Diffuse constituency
Target of warning information dissemination	• Governments • Member states • Local authorities • Agricultural Producers • Commodity traders • Natural resource-based manufacturers • Utility operators	• Governments • International community • Humanitarian communities • Local audiences
Timeliness of warning dissemination	Depends on overall effectiveness of national communication systems	Can be timely, but depends on overall effectiveness of national communication systems
Media handling of warning information	Depends on overall effectiveness of national communication systems	Depends on overall effectiveness of national communication systems
Effectiveness of actions engendered	• Growing trend of usefulness • Varies from country to country	• Difficult to determine on regional basis: variable by country • Basis for several food aid management decisions

Table 9

Key differences between early warning systems for hazards and for vulnerabilities

Issue/Variable	Attributes of EWS for Natural Hazards (step 1)	Attributes of EWS for Vulnerability (step 2)
Focus	Monitoring and forecasting occurrence and magnitude of hazard events	Involves determination of who will be impacted
Coverage of event/factor	Generic	Hazard-specific
Frequency of conduct	Regular basis (even if event will not affect anyone)	Ad hoc, often done when needed (monitoring during hazards)
Target	Whole country or region at risk	Society at risk
Scope of indicators	Few key indicators	In-depth analysis of: o Livelihoods o Coping strategies o Target-group assessments
Locations monitored	Geographical hotspots	Locations of hazard-specific society at risk
Lag between warning and response	Need lead time	Often calls for long-term action to address development needs
Onset of event/factor monitored	Both fast and slow onset	Factors are dynamic
Action engendered	Often reactive; responsive	Preventive actions (pro-active)

3.4 Emerging trends and issues in early warning practice in Africa

The African Regional Consultation, and its supporting documents, identified the following key issues are representing emerging trends in the development of early warning systems in the region:

1) moving from reactive to proactive stance in responding to threats;
2) integration of warning and response through development of comprehensive disaster reduction strategies to provide context for early warning systems;
3) establishment of disaster management units, through capacity building and development, legislation, policy actions, coordination;
4) enhancing public awareness through such means as education, the media, decentralization of early warning and advocacy;
5) focusing warning on providing practical advice for risk reduction, partly through improvement in communication of warning messages;
6) integrating traditional approaches with modern practices of early warning system development;
7) development of specific early warning products targeted at particular end-users (e.g. urban, agriculture, power generation);
8) developing capabilities of early warning systems to address emerging issues of climate variability, climate change and extreme climate events;
9) capacity development of early warning systems through networking, knowledge exchanges, partnerships;
10) decentralization of early warning practice
11) advocacy for political responsibility and public participation
12) dwindling resources for early warning and the increasing need to demonstrate the economic benefits of early warning to generate increased financing from governments and development partners;
13) coordinating and harmonizing the early warning components of the multilateral environmental agreements, particularly the UNCCD, UNFCCC and the CBD.

4. Constraints to applying early warning systems for disaster risk reduction

The Second International Conference on Early Warning is aimed at promoting the integration of early warning into public policy. The key issues to be covered under this rubric have been delineated below to form the framework for subsequent discussions of constraints, lessons learned, needs and recommendations in the remainder of this report

This framework covers the following:

1. Technical identification, monitoring and forecasting of threats:
   - (a) data collection and management
   - (b) research and modeling
   - (c) forecast compilation and reconciliation
2. Information dissemination and communications management
3. Coordination and cooperation (among early warning phases, among early warning actors and stakeholders, between different levels, among various types of early warning systems, between countries in sub-regional systems, at international level)
4. Political responsibilities (development of the political, legal, institutional and financial frameworks)
5. Public participation (stakeholder involvement, decentralization, public-private partnerships)
6. Public knowledge (awareness creation through information, education and communication)
7. Skills development
   - (a) Training (technical, management, leadership, institutional development skills)
   - (b) Networking
   - (c) Information access and exchange
8. Advocacy (for all the above)

Following from the Regional Consultation and background reports, the following factors were considered key constraints to and gaps in the development of early warning systems in Africa. They are keyed to the main topics in integrating early warning into public policy above.

1. Technical identification, monitoring and forecasting of threats
   - (a) deteriorating state of monitoring stations for hazard monitoring and forecasting

2. Information dissemination and communications management
   - (a) weak communication sub-systems limit the ability of early warning systems to effectively influence effective disaster risk prevention and reduction

3. Coordination and cooperation

(a) inadequate integration and coordination of different early warning systems for the same hazard and of key institutions and actors involved in early warning and disaster prevention and mitigation

4. Political responsibilities

(a) inadequate technological and human resources for developing effective early warning systems due mainly to financial constraints that limit public investment in development of early warning systems and disaster prevention and mitigation in general and skills development in particular
(b) poor enforcement of physical development regulations and planning standards
(c) narrow focus of early warning systems on hydrometeorological disasters, with inadequate coverage of disease epidemics, conflict, small and localized hazards, and other serious threats to livelihoods
(d) deteriorating hydrometeorological networks and other monitoring setups for other hazards
(e) inadequate translation of early warning into response planning and activities
(f) inadequate integration of early warning in development planning
(g) weak trans-boundary and international cooperation

5. Public participation

(a) inadequate decentralization of early warning practice

6. Public knowledge

(a) inadequate awareness and appreciation at policy level and among the general public of natural disaster risk management which affects sustainability of initiatives on early warning systems
(b) persistence of disaster response outlook among the disaster management community
(c) inadequacies in user orientation of early warning systems partly due to dominance of scientific, technological and engineering perspectives in early warning systems and the weak role of social, political, economic and cultural considerations

7. Skills development

(a) weak capacity development of early warning systems

8. Advocacy

(a) weak advocacy for political responsibilities (development of the political, legal, institutional and financial frameworks) and public participation (stakeholder involvement, decentralization, public-private partnerships)

5. Successes in early warning and lessons learned

Despite the gaps and constraints discussed in the previous section, there do exist examples of successful application of knowledge and information to early warning as well as cases of application of early warning to disaster risk reduction in Africa.

5.1 Examples of successful applications of early warning for disaster risk reduction

5.1.1 Effective climate early warning to reduce disaster risks - the example of the South African Weather Service

The South African Weather Service (SAWS) is a modern institution that provides world-class services in meteorological hazard warning. Its human resource base is very developed with highly qualified and experienced staff while its physical resource endowment are world class, including the latest technology, such as satellite equipment for remote sensing and an extensive and well functioning network of data collection platforms such as weather radars. Its scope of warning coverage includes meteorological disasters such as tropical and extra-tropical storms with gale- or hurricane-force winds, thunderstorms, tornadoes, heat stress and cold spells. The information products of the SAWS include probabilistic standard short-range forecasts (1-3 days) and medium-range (7-10) warnings, as well as long-range seasonal forecasting from three to six months in advance. As an example of good international collaboration, the latter is driven by the output from several models developed at the SAWS, the University of the Witwatersrand, the International Research Institute for Climate Prediction (IRI) and the European Centre for Medium Range Weather Forecast (ECMWF).

This case illustrates good practice in the use of early warning to reduce disaster risks through: (a) application of resources to enhance local scientific input into the technical base of risk forecasting through international collaborative research; (b) strong coordination and cooperation among various early warning system actors, in this case scientists and the communication media; (c) effective early warning communication involving the press disseminating early warning messages in ways that people understand and utilize. Thus, the weather service contributes significantly to reducing loss of lives and property through effective warning of various hydrometeorological hazards in South Africa.

5.1.2 Integrating early warning into public policy for effective disaster risk reduction – the case cyclone warning in Mauritius

Tropical cyclones are the most destructive of all meteorological phenomena affecting Mauritius, Madagascar, Mozambique and other African countries in the Indian Ocean region. Throughout its history, Mauritius has been either suffering or recovering from economic setbacks due to cyclones as the inhabitants gradually adapted themselves to its climate and learned to live with cyclones.

On 28th February 1960, the island was hit by cyclone Carol with a central pressure of about 943 millibars and a maximum sustained wind speed of about 297 km/hr, the most violent cyclone ever registered in Mauritius. It resulted in 41 deaths, destroyed more than 40,000 homes and damaged hundreds others, rendered homeless more than 100,000 people, damaged most sugar factories and destroyed 60% of the plantations. Total damage costs were estimated at more than 34 million pounds (in 1960 values).

This cyclone marked a new era in the history of cyclone disaster prevention and preparedness in Mauritius. The government took the decision to replace the old colonial style architecture with concrete infrastructure: cyclone-proof and affordable housing estates ("*cités*") were built with concrete houses. The building of "*cités*" has been the most effective disaster prevention ever adopted in Mauritius. In addition, the Meteorological Department introduced the different classes of warning signified by a corresponding number of red flags hoisted over public buildings. Also, regular cyclone warning bulletins, in all the local languages, were being issued over the radio and TV.

When cyclone Gervaise (with a central pressure of 980.9 millibars and wind speeds exceeding 280 km/hr) struck on 5th February 1975, casualties were significantly reduced to 9 deaths, 59 wounded, 11,320 houses damaged and 1500 people made homeless. Other contributory factors were that most families could afford a transistor radio and were able to heed to the warnings issued, and take all necessary precautions. Furthermore, there had been some major improvements in the technology being used at meteorological services, thus enhancing the technological base of early warning system.

In 1994, when cyclone Hollanda (with central pressure of about 984.0 millibars and wind speeds exceeding 216 km/hr) hit, only two old persons were reported dead when a banyan tree fell over their house while 1,084 people sought refuge in 34 centers. By then, improvements in the human resources and equipment base, as well as the strong level of political support, made the Mauritius Meteorological Services has become one of the most modern in the region. Tropical warnings are now tracked through satellite imageries, weather radars and the use of traditional weather chart analysis. Consequently, cyclone Dina (as strong as Carol and Gervaise) caused only three deaths, two of which were due to road accidents while the most damage was in agriculture. The minimal damage in terms of human lives and infrastructure proved that the population has become resilient to cyclone disasters, thereby achieving a drastic reduction in loss, damage and mortalities from an existing hazard.

This case shows good practice in improving the communication sub-system of early warning by simplifying warning messages through use of simple visual signals and use of electronic media to diffuse awareness of hazard risk and dissemination of warning information. In addition, it illustrates the integration of early warning into public policy in several ways, including the development of the early warning system as a component of a comprehensive cyclone disaster management strategy and the application of early warning knowledge to reduce risks through modification of building and infrastructure engineering and construction technology and development and enforcement of cyclone-resistant building codes. (Source: Chang-Ko 2003).

5.1.3 Application of traditional knowledge in indigenous and local early warning practice:

Most societies in Africa depend on their traditional knowledge systems and practices derived from the institutional memory of their communities to assure and protect their livelihoods and resilience to hazardous natural events and processes. Traditional forecasting remains the main source of climate information in most rural communities. They utilize signals from many natural features, such as the constellations in the solar system and weather phenomena and bio-indicators involving changes in behaviour patterns of indigenous flora and fauna to detect and predict impeding variations in the onset and duration of both short and long season rainfall and dry seasons as well other phenomena such as cyclones and earth tremors and quakes with potential disastrous effects on their lives.

A key tenet of the declarations of both Yokohama and Potsdam is the need to recognize traditional means of adaptation to risks from natural phenomena, integrate these in the development of comprehensive disaster risk reduction strategies, and institutionalize indigenous early warning knowledge and practices through continuous research and education. To achieve the linkage and integration of the two paradigms of early warning, there is the need for 'modern' natural and social scientists to understand the science behind observations in traditional systems both to utilize that knowledge in the design of formal early warning systems and to appreciate the fact that true early warning is an art that goes beyond empiricism.

The growing recognition that traditional observations of changing climate factors can have scientific validity and be very accurate has engendered increased interest in harmonizing traditional and modern scientific methods of climate prediction. This has led to the initiation of studies in African countries such as Zimbabwe and Kenya to gain further understanding of traditional forecasting. For example, a study in Zimbabwe showed that years considered by farmers in the Buhera district to be drought years corresponded very closely with those designated as drought years in the OFDA/CRED International Disaster Database. Furthermore, the local people marked some years of meteorological drought that were not registered as such in the Database (Mushove 2003).

Another study showed the following examples of traditional indicators in the Lake Victoria area in Kenya (Ocholla-Ayayo 2003):

(a) Solar system: The Milky Way constellations Pleiades and Persus appear in March signifying the onset of the major rainy season and disappears at the end of July when the season ends. During the past 8 to 10 years, local watchers have noticed a change in the month of appearance of the constellations, corresponding to a shift in the onset of the rains.

(b) Weather phenomena: The type, onset and direction changes of winds indicate various climatic conditions. Elders in some communities can discern about a dozen different

wind types. For example, the *kumadhi* wind, an inland wind blowing towards the lake when at a time when the general direction of winds should be towards land is an early warning of a dry spell or drought. In contrast, the *genya* wind blowing from the north is a rainstorm wind indicating the onset of rainfall within a week or two. Hailstone storms (imminent when red clouds form before the rain falls) precede lightning, which is common in the year following prolonged annual drought

(c) Plants: The onset and pattern of shedding of leaves of specific trees or shrubs are indicators of changing climate. For example: the *Manera* (Terminalia brownii) sheds leaves when a dry spell is ensuing and is widely used by pastoral communities to determine when to move to another region for grass and water for the animals; the *Ngowo* (Ficus sur) sheds leaves twice a year indicating the onset and cessation of both minor and major rainy seasons; *Ober* (Albizia coriaria) drops leaves only once a year before the onset of the long rainy season but sheds leaves prematurely to portend a shortening of the long rainy season.

(d) Animals: Animal behaviour such as movement, migration or feeding patterns is used to detect potential hazards. For example: most local birds disappear or *Angetho* (Turdoides melanops) make a lot of noise many hours before the rain falls; reptiles such as lizards, snakes and mongoose are very sensitive to vibrations and their emergence from caves and other underground dwelling places indicate that tremors and earthquakes are imminent; frogs suddenly stop croaking during the rainy season to indicate premature cessation of rains or start crying during the dry season to warn of impending rainfall.

These traditional forecasting methods have several strengths. They are cost effective, reduce response time since warning and response are not separated and there are no problems of delayed communication of risk potential of natural hazards. In addition, the traditional systems utilize multiple signals in forming early warning perceptions and involve end-users directly in risk monitoring, thereby making it easier for them to internalize the warnings. Furthermore, the practice of traditional forecasting integrates early warning directly in sustainable development through its links with biological diversity and natural resource conservation.

5.1.4 Application of science to early warning for geological disaster reduction in Central Africa

This case shows the application of knowledge of a previous disaster to develop warning and mitigating plans with the aim of minimizing or eliminating a hazard.

The trend of crustal weakness called the Cameroon volcanic line runs from the Atlantic ocean through the Gulf of Guinea to central Africa. Several volcanic massifs, such as mountain Cameroon, the Adamawa plateau and the Bui plateau in Nigeria, making up the land sector of this geologic structure, carry several hundreds of volcanic cones and craters. Many of the latter contain several lakes, including lakes Nyos and Mounoun in Cameroon. In 1984 and 1986, disasters from limnic eruptions claimed about 1800 lives from asphyxiation by sudden release of large amounts of carbon dioxide trapped in the

bottom of the lakes. In addition, many others suffered from health effects including paralysis, broncho-pulmonary effects and body lesions. This catastrophe prompted urgent action by the authorities to reduce the risks of further disasters from this hazard.

Initial monitoring studies began in 1987, followed by technical design and planning studies, including gas lift experiments, conducted under a Cameroon-France joint initiative during 1991 to 1995. The strategy was to install an early warning system on lake Nyos as part of an integrated hazard reduction and mitigation programme involving: modifications to human settlements (moving the people living downstream to a safer location), application of science and technology (degassing of the lake based on the application of the gas lift technique), modifications to physical structures (strengthening an existing natural proclastic dam bounding lake Nyos), international cooperation (among the US OFDA, French government and Cameroon government), and public-private partnership (among French and Japanese companies and public authorities). The warning system includes monitoring the diphasic stream and surveillance of the de-stratification to, among others, allow field determination of the carbon dioxide concentration profiles of the lakes and provide warning of possible eruptions. From 2001, a de-gassing system was installed on the lake as part of a technical plan with the objective of totally eradicating the natural hazard.

A recent assessment of the degassing system showed its effectiveness in increasing oxygen levels within the uppermost 10 meters of the lake with no weakening of lake stability or harmful effects on the biota. Furthermore, controlled released of carbon dioxide did not negatively affect the air quality (Tanyile et. al. 2002). It is expected that an increase in the number of degassing pipes from one to five would practically reduce the carbon dioxide threat to very minimal levels within three years. Thus, the degassing component of the integrated plan is proceeding but action on strengthening the walls of the dam has delayed. Nonetheless, successful implementation of the degassing component would exemplify the application of science in early warning to contribute to a significant reduction of a natural hazard.

5.1.5 Integrating early warning in disaster response in Morocco

The Ourika flood disaster in August 1995 led the Government of Morocco to undertake initiatives to mitigate the impact of heavy rains and flooding extreme events in the future. The strategy includes options at different levels:

- Hazard reduction programmes and mitigation measures: To reduce the flood risk at the most dangerous sites, engineering measures have been taken such as re-design of flood channel, flood dams, protective dykes, etc.
- Monitoring networks: including measuring stations, automated weather and hydrological systems with radio or satellite telemetry. Special efforts are being made to cover all the vulnerable hydraulic basins with appropriate monitoring systems. The parameters measured include rainfall intensity, river flow and water levels. These networks are managed by the Directorate of Water planning and research (*Direction de la Recherche et de la Planification de l'Eau; DRPE*) and the National Meteorological Office (*Direction de la Météorologie Nationale DMN*).

- Forecast and warning systems: DMN provide forecasts at different ranges: short range forecasting, medium range forecasting and Special Weather Warning Bulletins (*Bulletins Météorologiques Spéciaux*, BMS) elaborated by the meteorologists in case of situations of heavy rain or convective storms.
- Preparedness and risk management: A guidelines booklet titled "Rainfall and Flood Natural Disasters Management, Practical Guidelines" edited and regularly updated by the Ministry of Equipment gives details about the preparedness and risk management procedure to be followed by the national and local authority to manage flood hazards. The key elements are: (i) the organisation of material and human resources involved (duty personal, technicians, telecommunications), (ii) the organisation of the monitoring bureau (Command Post), (iii) forecasting organisation (weather bulletins, alerts thresholds, warning management), (iv) organisation and management of the intervention plan and (v) intervention assessment.

This case shows the application of lessons from disasters to the development of early warning system including a warning and forecasting sub-system, a preparedness sub-system involving mitigating physical construction measures, and, a communication sub-system that set the stage for the reduction of potential losses and destruction from future occurrences of floods in Morocco. (Source: Jalil 2003).

5.1.6 Community preparedness for volcano hazard in central Africa

The community of Goma in the Democratic Republic of Congo, near the summit of the stratovolcano Nyirangongo and the shore of Lake Kivu, live with the fear of violent eruptions of the active volcano that usually has devastating consequences. Nyirangongo is associated with the East African Rift and is part of the Virunga Volcanic Chain. Goma was the camp-site of nearly one million refugees from the Rwanda civil war. During the past 25 years, the volcano has claimed many lives and caused massive destruction of property. In 1977, the lava lake contained in the crater at the summit since 1894 erupted and drained in less than one hour with lava moving at speeds up to 960 km/hour and killing about 70 people. In 2002, the volcano unleashed its fury with deadly effect: between 17th and 29th, it poured two of its red hot lava flows right through Goma, killing more than 45 people directly and 50 indirectly through ignition of a petrol station, burning half of the city, damaging 14 villages, rendering 12,000 homeless and displacing 400,000 people. In addition, the people risked being poisoned from using the lake water for drinking, cooking and bathing.

The toll was high mainly because the early warning system failed at several points: (a) monitoring of the volcano signaled the imminent hazard but warning messages were communicated late to the population, on the morning of the eruption, (b) there was no pre-planned response programme as the local political authorities debated the content of the messages and the evacuation programme to follow, (c) there was no prior education and awareness creation evacuation and safety procedures, (d) the volcanologists were not involved in crafting the messages, (e) the messages broadcast when the volcano erupted were confusing and did not contain a clear and specific response strategy and programme, thereby worsening the panic.

This series of calamities constituted a wake-up call that awakened and galvanized community action to forestall future destruction. Earlier in 2001, a coalition of international and local NGOs (led by Concern and CRONGD), scientists from the Goma Observatory (OVG), community members participating in the risk assessment and research, traditional heads in 9 municipalities, radio journalists from Okapi (the UN radio) and RTCN, and 24 community animators had initiated a UN-supported information, education and communication programme to prepare the community to reduce losses and deaths from future eruptions. Now, action on the programme was intensified.

The objectives of the programme were to strengthen: (a) community understanding of volcano-related risks, (b) information networks on risks associated with volcanoes, (c) mitigation response by affected communities. The campaign targeted a wide spectrum of groups including: local community-based organizations and local associations, churches, medical bodies, schools at all levels, the police and military, NGOs and the general population.

By May 2003, the team had sensitized a total of 222,665 residents of Goma and its environs using five types of messages covering an understanding of the risk posed by the volcano, including health impacts, the coloured flag alert system, preparation before and after an eruption, and, a response strategy in the form of evacuation planning. The team shared sensitization messages with the traditional leaders first for acceptance then discussed with the people through various means including brochures, radio broadcasts and billboards in several locations such as schools, health centres, markets, churches and other public places. Billboards showed the colour-coded alert system involving coloured flags at vantage points. Scientists of OVG collaborated with Concern, CRONGD and the radio stations to develop the messages that were both scientifically accurate and understandable and are available in four local and international languages. A communication center has been developed to support the early warning and preparedness programme. The programme adopted a participatory approach to generating information for risk assessment and mapping (instead of using existing formal risk maps) and development of early warning indicators by involving communities in the identification of risk areas as well as in monitoring and spotting local signs of potential danger of eruption. Emergency committees are being established within the communities while local administrative authorities monitor and support the programme while the local political administration has established a sub-committee of its administrative structure to have oversight and monitoring responsibilities for the programme, thereby integrating the programme in their adminstration.

Overall, the programme has been effective in raising the awareness of the people about the risks associated with the natural phenomenon they live with and has institutionalized alert messages and preventive response mechanisms to reduce loss of love and property in the event of future eruptions. (Source: Concern Worldwide 2003).

5.2 Lessons learned from applications of early warning in Africa

5.2.1 Lessons from successful applications

Each lesson is keyed to discussion framework presented in Section 4.

A. Technical identification, monitoring and forecasting of threats (data collection and management, research and modeling, forecast compilation and reconciliation)

1) Effective use of available resources can strengthen local scientific capacity to increase its contribution to hazard monitoring and forecasting. (South Africa weather service)
2) Traditional indicators in local early warning systems can often be corroborated scientifically. (Traditional early warning)
3) Traditional indicators play a key role in indigenous and local early warning systems and coping strategies and need to be understood by formal early warning practitioners. Technical identification, monitoring and forecasting of hazards need to incorporate information on traditional indicators. (Traditional early warning)

B. Information dissemination and communications management

1) Cooperation between technical experts and the press is essential for the development of effective early warning messages. (South Africa weather service)
2) The ability of the press to effectively disseminate early warning messages is important in assuring the utility of warnings in inducing appropriate response behaviour among end-users. (South Africa weather service)
3) The involvement of the press in designing and implementing early warning programmes, especially risk message formulation, enhances their effectiveness in disseminating warning messages to end users. (Public participation in Goma)
4) It is not enough to monitor and predict hazard onset: warning messages have to be communicated to end-users on time. The utility of early warning is realized only when the information leads to prompt and effective disaster response and subsequent risk reduction. Political inertia can delay the timely release of warning information to end-users, thereby undermining the usefulness of early warning information and acting as a disincentive to the progress of early warning systems. This inertia is often due to inadequate understanding of the true nature of early warning: key decision-makers have to be sensitized to develop a broader appreciation of the multiple roles involved in successful early warning systems. (Public participation in Goma).
5) The preparedness programme related to early warning of impending disaster needs to be clear, ready and known to end-users. (Public participation in Goma)
6) Effective response requires prior education and sensitization of the public. (Public participation in Goma)

C. Coordination and cooperation

1) Given the importance of traditional early warning systems, effective disaster risk reduction demands their integration in modern early warning systems. (Traditional early warning)
2) The application of risk reduction measures and early warning can substantially reduce the risk, in some instances by practically eliminating the hazardous effects of some geological hazards through the application of a combination of risk reduction measures, including early warning information. (Lake Nyos degassing)
3) International cooperation and partnering is essential in developing warning systems based on the application of science and technology. (Lake Nyos degassing)
4) Technical experts need to collaborate with social scientists to craft warning messages. (Public participation in Goma)

D. Political responsibilities (development of the political, legal, institutional and financial policies and frameworks)

1) To be effective, early warning systems should include the essential subsystems relating to risk monitoring and forecasting, preparedness programmes and a communication sub-system. (Morocco floods early warning)
2) A comprehensive approach to risk reduction, involving early warning systems, construction and preparedness measures is required to effectively reduce the risk of loss and damage from disasters. (Morocco floods early warning)
3) Prompt development and enforcement of building codes and construction practices based on risk assessment is crucial averting future disaster risks. (Mauritius cyclone monitoring)
4) Where early warning practice and physical construction are required to complement each other in reducing risks, failure to implement one timeously adversely affects the overall ability of reduce disaster risks. (Lake Nyos degassing)
5) For effectiveness, early warning systems need to be developed as part of an integrated and broad disaster management programme. (Mauritius cyclone monitoring)
6) Administrative authorities need to assume their political responsibilities to assure success of early warning systems and response plans. This can be fostered by: (a) including public officials in the early warning design and implementation process, (b) establishing political administrative mechanisms to oversee the programme, and, (c) continuous advocacy by early warning programme promoters for public support from political authorities. (Public participation in Goma)

E. Public participation (stakeholder involvement, decentralization, public-private partnerships)

1) Community participation and partnerships among various interest groups is essential in developing and effectively implementing disaster risk reduction programmes. (Public participation in Goma)
2) Effective early warning requires the institutionalization of emergency response structures at the community level. (Public participation in Goma)

F. Public knowledge (awareness creation through information, education and communication)

1) Public knowledge of early warning systems, including response mechanisms through information, education and communication initiatives enhances the success of warning messages. (Mauritius cyclone monitoring)
2) Knowledge systems of traditional early warning systems evolve over long periods and need to be studied and preserved to avoid erosion of that knowledge base. (Traditional early warning)

G. Skills development (training, networking, information access and exchange)

1) International scientific collaboration is crucial in generating forecasting information and for developing the skills base of early warning. (South Africa weather service)

5.2.2 General lessons learned from development of early warning in Africa

The presentation of various types of early warning systems in Section 3 and background documentation for as well as other discussions at the African Regional Consultation yielded further lessons learned. These are covered below:

A. Information dissemination and communications management

1) Early warning communication is more than simply the dissemination of facts: effective early warning requires that the target population not only receives advance warning of hazards and vulnerability changes but also that they understand the content of the message, accept it, believe it and know how to use to guide their response actions. The latter is catalyzed by on-going public awareness process on potential risks.

B. Political responsibilities

1) Existing government systems have been characterized as top-down, centralized structures that focus mainly on famine and saving lives. Broadening the traditional scope of early warning to not only save lives but also improve livelihoods, there is the need for multi-purpose monitoring which can be used both to warn of crises and as an annual planning tool. Adopting this approach to

early warning requires that factors other than the 'normal' agro-meteorological indicators, such as livelihoods, nutritional status and price variability, are monitored. The advantage of this more intensive and diverse form of monitoring is that data and information from the system can be used in 'normal' periods for development work and also ’expanded' when disaster crises occur. This is a key to integrating early warning in sustainable development.

2) The contribution of early warning systems to disaster risk reduction and prevention in the region will be enhanced if they possess the capacity to respond to emerging hazards. Hence, it is essential to develop early warning systems for other dominant hazards in the sub-region, in addition to those for food security, flood, drought and desertification.
3) Conflicts exacerbate the effects of natural hazards while the type, onset and intensity of conflicts are also influenced by environmental factors and circumstances. This relationship of mutual determination underscores the need to integrate both issues in the development of comprehensive early warning systems and disaster reduction platforms in the sub-region.
4) The monitoring of desertification and drought is a long-term process. Consequently, the evolution of a solid and effective capacity for the development of early warning systems in drought and desertification monitoring is a long-term affair. For example, in the case of AGRHYMET, it has taken three decades for the programme to mature enough to develop early warning systems for these hazards.
5) The sustainability of early warning systems depends on assured funding from national sources. The dependence on donor funding undermines the sustainability of early warning systems. Given the financial resource costs of monitoring the hazards in the region, early warning systems need to adopt a multiplicity of approaches to overcome resource constraints. These approaches include emphasizing the use of local resources, promoting stakeholder participation, cost recovery of selected localized early warning services utilized by private interests, and cooperation with foreign institutions engaged in collecting long-term data on environmental and human factors in desertification.
6) Regionalism is crucial for the development and sustainability of early warning systems in the sub-region for a number of reasons. First, the development of integrated early warning systems for structural vulnerabilities and livelihood risks depends on coordination at the international level. Second, assessing hydrometeorological hazards is best done over large geographic areas. Third, the approach has proved effective in promoting the development of early warning systems in the region through the CILSS/AGRHYMET, and SADC and IGAD REWS.
7) Early warning systems, like other management systems, require sustained management input to endure. In the absence of strong professional management, early warning systems lose their capability to provide useful warning information for disaster reduction.

C Skills development

1) Capacity development building efforts in early warning development in the region in the past were mainly based on the transfer of knowledge approach and were less than successful in institutionalizing early warning systems within some sub-regions. Effective early warning development requires a re-orientation towards networking, technical partnering, joint assessments, decentralization of early warning activities, advocacy activities, and similar approaches.

6. Needs and priority recommendations

6.1 Conditions for enhancing effectiveness of early warning

The Regional Consultation identified the following requisites for (a) enhancing the effectiveness of early warning systems in improving capacities to respond effectively to warnings, (b) improving their integration into sustainable development.

1. Technical identification, monitoring and forecasting of threats:
(a) ensuring availability of reliable data

2. Information dissemination and communications management
(a) existence of communication infrastructure
(b) credibility of early warning messages
(b) improving national and international communication systems

3. Coordination and cooperation
(a) integration of formal early warning with informal systems and traditional coping strategies
(b) improving regional coordination and cooperation

4. Political responsibilities
(a) safety nets for risk victims
(b) government commitment to disaster risk management
(c) ensuring that all components of early warning systems are in place
(d) early warning system exists as part of comprehensive disaster risk management system
(e) availability of adequate resources, institutional mechanisms and capabilities
(f) inter-country cooperation
(g) enhancing disaster preparedness needs through more explicit linkage of early warning systems to disaster preparedness

5. Public knowledge and participation
(a) knowledge, understanding and appreciation of risks (types, occurrence and impacts of hazards, vulnerability status)
(b) education on risk response
(c) developing awareness of disaster risk management
(d) developing a culture of disaster prevention among policy makers and implementers and the general public, including through continuous education on early warning and disaster risk prevention after disasters
(e) de-emphasizing the technical orientation of early warning systems to enhance their understanding by the general public

6. Skills development
Issues relating to capacity development of early warning systems are discussed in Section 6.3 below.

6.2 Issues to be considered in integrating early warning into sustainable development

1) Development of comprehensive risk and vulnerability information systems that are used for normal development planning and for disaster early warning during times of crises
2) Enhancing proactive risk monitoring and early warning in disaster prevention
3) Sensitizing policy makers on vulnerability issues
4) Accelerating and deepening the adoption of bottom-up approaches to disaster risk reduction, particularly by focusing on local and national levels, directing resources to the local level to induce greater willingness of communities to participate in disaster risk reduction activities, and, demonstrating the economic gains from early warning to local communities to enhance their knowledge of disaster risk reduction.
5) Integrating, harmonizing and coordinating early warning systems within countries and sub-regions
6) Considering the early warning systems being developed under the UN Convention to Combat Desertification (UNCCD) in coordinating and integrating drought and desertification early warning systems into sustainable development
7) Designing and implementing comprehensive and integrated development plans that incorporate disaster risk reduction
8) Transforming post-disaster relief assistance into a disaster risk reduction mechanism by ensuring that post-disaster rehabilitation and reconstruction assistance includes explicit risk reduction interventions and by governments maintaining their own priorities.
9) Integrating early warning into relevant sectoral development agendas of sustainable development
10) Adopting a long-term perspective and vision in developing and implementing early warning systems.

6.3 Future requirements for early warning capacity development

6.3.1 Determining approaches to capacity development needs assessment of early warning systems of various types

(a) The approaches should be varied by being considered on regional, national, sub-national or community-based basis
(b) The approaches adopted should not only comprise technical infrastructure development but should also have the recipients/beneficiaries of the systems in mind
(c) Capacity development should consider hardware and software development, institutional strengthening and human resources development
(d) Current early warning systems are top-bottom and do not take into consideration local response mechanisms or communities' response mechanisms
(e) There is need to develop capacity at policy and legislative levels as well as encouraging community participation
(f) Policy and legal frameworks should be developed at both regional and national levels to assist in the incorporation of disasters in national development programmes

(g) There is need to standardize capacity development in early warning approaches to allow replication

6.3.2 Identifying future requirements for capacity development: meeting equipment needs

(a) There is the need for inventory of early warning capacities available in various regions of Africa at institutional, national and regional levels to help in co-ordination and avoiding duplication of activities
(b) It is essential to ensure sustainability and maintenance of existing equipment for monitoring hazards
(c) Establishment of equipment and facilities at local community levels to assist in early warning information dissemination and delivery
(d) Establishment of state-of-the-art equipment and facilities to keep pace with new developments in early warning technology
(e) Employing appropriate technology as much as possible
(f) There is need for developed countries to enhance access to technology by African countries
(g) Countries need to develop their basic physical and technology infrastructure

6.3.3 Identifying future requirements for capacity development: future techniques for early warning

(a) These should emphasize community-based early warning information collection particularly with regard to traditional early warning systems.
(b) Adoption of traditional early warning system requires sensitization of decision-makers and communities regarding traditional early warning information systems
(c) In some cases, early warning techniques should be wide in terms of coverage due to trans-boundary nature of some disasters

6.3.4 Identifying future requirements for capacity development: approaches and techniques for vulnerability and risk assessment

(a) These should be multi-sectoral in nature; hence the need for coordination of various risk mapping and vulnerability assessment approaches
(b) The approaches should be region-specific because of the differences in types of disasters, but there is need to standardize approaches
(c) These should be based on enhancement and utilization of existing systems

6.3.5 Identifying future requirements for capacity development: approaches, techniques and systems for early warning data collection, analysis and management

(a) There is need for standardization of information from various early warning systems
(b) The approach should be regional/country-specific
(c) The approaches should also be hazard-specific

(d) These should be based on the free flow of information

6.3.5 Overall recommendations for capacity development for early warning systems

(a) Use existing international, regional and national platforms in data-sharing (such as that between UNEP and IGAD) to enhance knowledge sharing
(b) Conduct an inventory of training facilities and programmes available for the region
(c) Intensify the use of regional institutions (such as ACMAD, DMCH and DMCN) to provide training or as training needs assessment focal points
(d) Support the establishment or utilization of existing disaster training institutions, such as universities
(e) Promote training at different levels – community, national and regional
(f) Conduct an inventory of existing regional research programmes to develop a programme to enhance early warning capacity development through research

6.4 Recommendations

The foregoing discussions highlight several areas of improvements required to enhance the practice of early warning in Africa. The following key recommendations for improving early warning in Africa and enhancing its contribution to disaster risk reduction through better integration in public policy were identified during the Regional Consultation and add to and complement the earlier recommendations made throughout the Report.

(a) Strengthening and establishment national and sub-regional early warning systems, particularly for major threats such as epidemics, food security, drought, flood, desertification and conflicts, including through capacity building
(b) Rehabilitation, modernization and expansion of basic data and information infrastructure, particularly the maintenance and enhancement of hydrometeorological networks and facilities
(c) Establishment and development of operational processes for data and information sharing and exchange, including through networking, to enhance synergies between the different early warning stakeholders and initiatives
(d) Enforcement of the rule of law for regulations and standards, especially in the private sector
(e) Integration of early warning and disaster risk management into national and regional development policies
(f) Establishment of technical structures at country and regional levels which are able to integrate scientific and technical data into planning and decision making process
(g) Inclusion of disaster prevention and management into the NEPAD framework
(h) Strengthening conflict prevention mechanisms in Africa
(i) Support from international partners, including through financial assistance, knowledge exchanges and other capacity development resources
(j) Promoting African ownership and anchor for early warning systems development and support initiatives, particularly those driven by external partner inputs.

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