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Review of implementation of Agenda 21 and the Johannesburg Plan of Implementation: drought

Report of the Secretary-General

Summary

Drought has severe adverse implications for sustainable development in affected developing countries and regions, leading to food shortage and food insecurity owing to a drop in agricultural production, famine, water scarcity and loss of human life. The huge dependence of Africa on agriculture renders this continent especially vulnerable to impacts of drought. Climate change is likely to exacerbate frequency of occurrence of drought, with even greater and sustained negative impacts. Current climate scenarios predict that the driest regions of the world will become even drier, signalling a risk of persistence of drought in many arid, semi-arid and dry sub-humid areas, with greater and sustained negative impacts.

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Contents

I. Introduction

1. The present report reviews the state of implementation of the goals related to the thematic area of drought, as contained in Agenda 21,[1] the Programme for the Further Implementation of Agenda 21[2] and the Plan of Implementation of the World Summit on Sustainable Development ("Johannesburg Plan of Implementation").[3] The report should be read in conjunction with the reports on desertification, agriculture, land, rural development and Africa, which are also before the Commission on Sustainable Development at its current session.

2. The report draws on substantive contributions from United Nations agencies, in particular the Food and Agriculture Organization of the United Nations (FAO), and on regional assessments prepared by the United Nations regional commissions, in particular the 2007 "Africa Review Report on Drought and Desertification" of the Economic Commission for Africa (ECA).[4] The present report also benefited, in particular, from the United Nations Environment Programme (UNEP) report entitled *Global Environment Outlook: Environment for Development (GEO-4), 2007* and the 2005 *Desertification Synthesis* report of the Millennium Ecosystem Assessment, as well as from country and national assessments submitted by Governments and inputs from major groups.

II. Review of implementation

3. Drought is dealt with in chapter 12, "Managing fragile ecosystems: combating desertification and drought", of Agenda 21 and under chapter IV, "Protection and managing the natural resource base of economic and social development", of the Johannesburg Plan of Implementation. Both chapters address drought in the context of sustainable development. Other chapters of Agenda 21 and the Johannesburg Plan of Implementation, including those on agriculture, land and Africa, also contain drought-related provisions, underscoring the interlinkages between the thematic issues under consideration by the Commission at its current session.

A. Facts and figures on drought

4. Drought is defined as a natural phenomenon that occurs when rainfall is significantly below normal recorded levels over a long period of time. Droughts occur in virtually all climatic zones, but their characteristics and impacts on society vary significantly among regions and countries. The underlying cause of most droughts can be related to changing weather patterns. The impact of drought is exacerbated by activities such as overgrazing and poor cropping methods, which

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[1] *Report of the United Nations Conference on Environment and Development, Rio de Janiero, 3-14 June 1992,* vol. I, *Resolutions Adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex II.

[2] General Assembly resolution S-19/2, annex.

[3] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 2, annex.

[4] ECA/FSSD/ACSD-5/3.

reduce water retention of the soil, and improper soil conservation techniques, which lead to soil degradation.

5. The fact that a large share of Africa's economies depend on climate-sensitive sectors, mainly rain-fed agriculture, renders the continent especially vulnerable to impacts of drought. The drought of 1990/1991 in Zimbabwe, for example, resulted in a 45 per cent drop in agricultural production and a drop in GDP of 11 per cent. In Kenya, the drought of 1999-2001 cost the economy some $2.5 billion. The drought of 2002-2003 in the sub-Saharan region resulted in a food deficit of 3.3 million tons, with an estimated 14.4 million people in need of assistance in the subregion.[5]

6. In South-East Asia, Viet Nam has suffered from serious droughts because of climate change during the last decade, with the most serious and longest drought lasting nine months during the dry season of 2004-2005, causing tremendous losses in agriculture and forestry activities.[6]

7. In Central Asia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan have been increasingly affected by drought in the past few decades. Droughts have increased poverty, decreased food security, and caused migration. Furthermore, water stress is expected to worsen in the subregion with the melting of the glaciers and climate change.[7]

8. Drought is recognized as a serious obstacle to the development of the Latin American and Caribbean region, which is facing sharp reductions in rainfall that can lead to situations of famine in the Central American countries. The El Niño phenomenon and its associated effects, such as drought and negative impacts on health, are a recurring and constant threat in the countries of the region.[8]

9. Over the past 30 years droughts have dramatically increased in number and intensity in several European countries. The severe droughts which occurred in South-East Europe during the last decades caused significant socio-economic damage in different sectors; notably, drought-related forest fires were costly for agriculture and loss of human life.[9]

10. Water availability and quality is projected to decrease in many arid and semi-arid regions, with increased risk of droughts and floods. Changing rainfall patterns are likely to further intensify the siltation of rivers and the deterioration of watersheds. For example, lakes and reservoirs in the African Sahel are increasingly threatened to lose part of their water storage capacity, possibly leading to a complete drying. In southern Africa, wetlands of international importance and wildlife are increasingly under threat from drought.

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[5] Economic Commission for Africa, "Follow-up to the implementation of the outcomes of the World Summit on Sustainable Development (WSSD): Regional Review Report Africa", Addis Ababa, November 2007 (ECA/FSSD/07/03), p. 117.

[6] Yang Youlin and Lu Qui, "Challenges and Priority Areas to Implement UNCCD and NAPs of SEA countries", Asia Regional Coordination Unit of UNCCD Secretariat/UNESCAP/ China National Research and Development Centre for Combating Desertification, Chinese Academy of Forestry, p. 66.

[7] Economic Commission for Europe, Regional Implementation Meeting on Sustainable Development, Geneva, 28 and 29 January 2008, Note by the secretariat (ECE/AC.25/2008/3), paras. 37-46.

[8] Economic Commission for Latin America and the Caribbean, Regional Implementation Forum on Sustainable Development, Santiago, Chile, 28 and 29 November 2007, p. 8.

[9] ECE/AC.25/2008/3, para. 41.

11. The projected higher frequency of dry spells might encourage dryland farmers to increase water withdrawals for irrigation. Since sea level rise induced by global warming is likely to affect coastal drylands through salt-water intrusion into coastal groundwater, the reduced water quality in pumped aquifers would further impair primary production of irrigated croplands.[10]

12. Famine has been among the most severe consequences of drought, particularly in Africa. The consecutive droughts that have occurred in southern Africa since 2001 have led to serious food shortages. The drought of 2002-2003 resulted in a food deficit of 3.3 million tons, with an estimated 14.4 million people in need of assistance.[11] The 2007 World Bank and United Nations International Strategy for Disaster Reduction Report on the Status of Disaster Risk Reduction in the Sub-Saharan Africa (SSA) Region estimated that food aid to the subcontinent accounts for approximately 50 per cent of the yearly budget of the World Food Aid Programme.

13. The impact of drought on the energy sector is demonstrated by the case of Ghana, where for the first half of 2007 the water level at the Akosombo dam had fallen below the minimum level of 240 feet, leading to a severe reduction in electricity generation from hydropower and hence load-shedding of electricity in the whole country.[12]

14. Recent events associated with climate change, particularly the increasing frequency of droughts notably associated with El Niño, have exerted tremendous pressures on affected communities to further exploit the already degraded and overexploited natural resources. The increasing frequency of El Niño alternating with local drought has created a new and emerging climate pattern called seasonal aridity or periodic drought, where in every other year, the extended dry spell can last as long as six to seven months. This significantly causes severe and long-term damage to soil organic matters and ultimately reduces soil capacity to sustain high crop yields without an increase in external inputs.[13]

B. Drought management

15. The impact of droughts on society depends not only on the severity and duration of the drought, but is also determined by the level of resilience of affected households and communities to drought. Drawing upon a range of studies, a 2004 analysis on drought in the African Sahel prepared by the United Kingdom-based Tyndall Centre for Climate Change Research stated that a resilient society with well-developed coping strategies might survive a severe drought without suffering widespread famine or economic collapse.[14]

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[10] World Resources Institute, *Ecosystems and Human Well-being: Current State and Trends*, chapter 22, "Dryland systems", p. 650.

[11] Economic Commission for Africa, "Africa Review Report on Drought and Desertification (Main report)" July 2007 (ECA/FSSD/ACSD-5/3), p. 14.

[12] ECA/FSSD/ACSD-5/3, pp. 15 and 16.

[13] Yang and Lu, op. cit., p. 13.

[14] Nick Brooks, *Drought in the African Sahel: Long-term Perspectives and Future Prospects*. Tyndall Centre for Climate Change Research, University of East Anglia, Norwich, United Kingdom, Working Paper No. 61, October 2004, p. 9.

16. Similarly, studies conducted in semi-arid areas of sub-Saharan Africa suggest that there is a strong correlation between the ability of farmers to cope with living in marginal, risk-prone environments, on the one hand, and their decisions to invest in particular livelihood strategies, such as agriculture or livestock production, on the other hand.[15]

17. In many developing countries, communities in drought-prone and drought-affected regions have their traditional ways of coping with drought. The central issue for these communities is to implement measures that can further reduce the risks of drought and to minimize the economic and physical damage associated with drought. In the Sahel region of sub-Saharan Africa, for example, livelihood strategies, in particular of smallholder farmers, are primarily geared towards coping with a high degree of uncertainty, risk minimization and meeting subsistence needs, rather than maximizing production and profits, owing to increased aridity of the region.

18. Given the Sahel region's propensity for drought and its dependence on rain-fed agriculture, adaptation to this natural phenomenon is critical. In parts of the Sahelian zones of northern Nigeria and the Niger, for example, successful adaptation to climatic desiccation has been achieved through more intensive but small-scale agricultural practices involving higher livestock densities, soil and water conservation, crop diversification and integrated farm management approaches. Despite reduced rainfall and increased population densities, the communities have been able to manage land productivity and soil fertility in those areas.[16]

Box 1
Drought management in Mauritania

The Tenadi Cooperative Group of Mauritania has worked against a background of years of persistent drought in the Sahel region of Africa that since 1973 has killed 90 per cent of livestock and annihilated the hopes of the nomadic people who have been living there for centuries. In an effort to stop the movement of dunes and solve the problem of drinking water, the Tenadi Cooperative Group has sunk boreholes with immersed pumps and reforested the area around them. Thanks to the Cooperative's activities, a large number of families have chosen to settle around the Tenadi oasis, where they are being trained in new income-generating agricultural techniques, including the introduction of drought-resistant crops.

Source: "Desertification Campaigners Recognized", UNEP News Release 2006/49 — http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=486&ArticleID=5399&l=en

[15] Charlotte Boyd and Cathryn Turton (eds.), "The Contribution of Soil and Water Conservation to Sustainable Livelihoods in Semi-Arid Areas of Sub-Saharan Africa", Agricultural Research and Extension Network, Network Paper No. 102, London, January 2000, p. 2.

[16] Brooks, op. cit., p. 11.

19. In the Southern African Development Community (SADC) subregion, heightened attention is being given to programmes on drought and food security, as a result of frequent droughts that have had devastating impacts on agriculture and food security. Large investments in irrigation have resulted in an area under irrigation that grew from 1.63 million hectares in 1985 to an estimated 1.96 million hectares in 2005. In addition, investments are being made in research and development of drought-tolerant seed varieties. The SADC region has also developed and adopted the Dar es Salaam Declaration on Agriculture and Food Security in the SADC region, which is a regional framework aimed at ensuring food security and reversing chronic food shortage.[17]

20. Many drought-affected developing countries are encountering difficulties in achieving effective integration of drought management plans with national development and budgetary frameworks. Weak institutional structures, lack of technical capacity, limited progress in mobilizing stakeholder participation and investment, and lack of in-depth understanding of the benefits of effective drought management for poverty reduction and economic development are often cited as main constraints to effective integration.

21. There are a number of noteworthy initiatives at the regional and international levels to support effective drought management in affected developing countries The African Drought Risk and Development Network, established with the support of the United Nations Development Programme and the United Nations International Strategy for Disaster Reduction, promotes the development of coordinated strategies for effective drought management at country level. The network has assisted policymakers at national and community levels in addressing drought risks and their implications for development.

22. The Global Environment Facility (GEF) Strategic Priority on Adaptation project is piloting a range of coping mechanisms for reducing the vulnerability of farmers and pastoralists to future climate shocks. Components include piloting coping strategies, improving early warning systems, assisting governments in developing drought management and adaptation plans and integrating climate change/drought across sector policies, and finally replicating and disseminating the results. The project is ongoing in Kenya, Mozambique, Zimbabwe and Ethiopia.[18]

23. Since 2001, the FAO Regional Office for the Near East (FAO-RNE), the International Center for Agricultural Research in the Dry Areas (ICARDA), and the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) have been involved in capacity-building activities such as training courses, workshops and seminars on drought management and have established the Network on Drought Management for the Near East, Mediterranean and Central Asia (NEMEDCA Drought Network). The Network assists in strengthening technical cooperation among concerned national, regional and international organizations in the geographical region covering the Near East, the Mediterranean and Central Asia, particularly in the exchange of information and experience among the member countries and in building capacity on drought management.

[17] ECA/FSSD/ACSD-5/3, pp. 27 and 28.

[18] Martin Krause, “Coping with Drought and Climate Change”, Project Inception Meeting, Nairobi, 2005.

1. Introducing climate-resilient crops

24. Informed selection of crop patterns that accounts for seasonal availability and water productivity responses of crops and crop varieties has become an important element of crop management under drought conditions. It is guided by the recognition that drought poses a significant threat to crop production. If farming communities are to adapt successfully to climate change, they will need crop varieties with greater tolerance to stresses such as drought and heat.

25. A report commissioned in 2006 by the United Nations Framework Convention on Climate Change (UNFCCC) entitled "Impacts, Vulnerability and Adaptation to Climate Change in Africa" noted that several national reports, such as those for the Sudan, South Africa and Ghana, mentioned more and better heat- and drought-resistant crops as promising adaptation options for agriculture, food security, and for improving soil productivity. In Zimbabwe, dry-land farmers have switched from maize, which is difficult to grow in persistent drought conditions, to more drought-tolerant and pest-resistant sorghum, and are supplementing this with wetland rehabilitation, goatherding and seed nurseries.[19]

26. Drought reduces global maize yields by as much as 15 per cent annually, representing crop losses of more than 20 million tons of grain. In order to curb those losses, scientists of the Consultative Group on International Agricultural Research (CGIAR), in cooperation with the International Maize and Wheat Improvement Center (CIMMYT), are working with national partners in sub-Saharan Africa to develop drought-tolerant varieties. So far, more than 50 such varieties have resulted from this work, and they are being grown on a total of about one million hectares. In search of further yield gains, CIMMYT scientists are identifying areas of the maize genome that are linked to drought tolerance, with the aid of a molecular genetic map, based on data indicating the performance of different types of tropical maize in diverse environments. Through complementary efforts in the West African savannas, researchers at the International Institute of Tropical Agriculture (IITA) have made significant progress in developing early and extra-early maturing maize varieties that can grow in regions with short rainy seasons.[20]

27. Resulting from the work of the Africa Rice Center and its national partners, drought-resilient rice varieties have been developed that combine the high productivity of Asian rice with the ability of African rice to tolerate harsh growing conditions. Varieties for rain-fed uplands are already being planted on 200,000 hectares and are being tested in 30 African countries.

28. Barley breeders at the International Center for Agricultural Research in the Dry Areas (ICARDA) have demonstrated how drought tolerance in this crop can be markedly improved through a method involving farmer participation. Having first proved successful in the Syrian Arab Republic, the approach is now being applied in seven other countries of the Middle East and North Africa.

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[19] Balgis Osman Elasha, Mahmoud Medany, Isabelle Niang-Diop, Tony Nyong, Ramadjita Tabo and Coleen Vogel, "Impacts, Vulnerability and Adaptation to Climate Change in Africa". Background paper commissioned by the United Nations Framework Convention on Climate Change Secretariat for the African Regional Workshop on Adaptation, Accra, 21-23 September 2006, p. 34.

[20] Consultative Group on International Agricultural Research (CGIAR), CGIAR and Climate Change. Research and Impact: CGIAR on Global Issues (Briefing Dossier, 2007-2008).

29. The International Center for Tropical Agriculture (CIAT) has succeeded in breeding drought-tolerant common beans after nearly a quarter century of research. The new beans yield 600 to 750 kilograms per hectare under severe drought, roughly double the maximum yield that Latin American farmers get from commercial varieties under the same conditions. Bean researchers are actively testing the new varieties in Central America and eastern Africa, while combining their drought tolerance with other traits that farmers need.[20]

30. The United States-based company Pioneer Hi-Bred International, Inc. is developing drought-tolerant corn that uses water sources more efficiently, helping growers to maintain yields during periods of water scarcity. The company is taking multiple approaches that include conventional breeding, molecular breeding and transgenic programmes that might move novel genes into corn. Pioneer also uses a variety of tools, including gene shuffling, which optimizes desired traits by multiplying the effectiveness of beneficial genes.[21]

31. New scientific tools developed by CGIAR scientists are proving to be helpful in accelerating the progress of crop improvement. One of them consists of techniques from molecular biology that enable plant breeders to identify and select genes controlling stress tolerance with far greater efficiency. Such techniques are especially important for successfully transferring desirable traits from wild plants related to crops into commercial varieties of the domesticated species. A second set of tools involves farmer participation in plant breeding, which is highly effective for ensuring that crop improvement takes into account valuable local knowledge and gives results that are truly relevant to local needs and preferences.[20]

2. Coping with water scarcity

32. The central element of drought is water deficit. Projected climate change is expected to intensify the already critical water situation in many drylands. A study from Bristol University projects that areas of western Africa are at most risk from dwindling freshwater supplies and droughts as a result of rising temperatures. Southern Africa, being one of many water-stressed regions, could thus see a further decrease in stream flow and in the ability of groundwater aquifers to "recharge".[22]

33. According to the 2007 ECA "Africa Review Report on Drought and Desertification", projections suggest that by 2025 southern Africa would not have sufficient water resources to maintain its current level of per capita food production from irrigated agriculture — even at high levels of irrigation efficiency — and also to meet reasonable water needs for domestic, industrial and environmental purposes. To sustain their needs, water will have to be transferred out of agriculture into other sectors, making those countries or regions increasingly dependent on imported food.[23]

34. In many countries across sub-Saharan and West Africa, the Middle East, Central and East Asia and Latin America, drought-prone dryland communities have

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[21] "Desertification Campaigners Recognized", UNEP News Release 2006/49 — http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=486&ArticleID=5399&l=en.

[22] ECA/FSSD/ACSD-5/3, pp. 6 and 7.

[23] Ibid., p. 16.

developed traditional water-harvesting methods to support farmers' adaptation to drought and to provide water and nutrients to crops and trees.[24]

35. Traditional water-harvesting techniques called "zai" and "demilunes" are used in West Africa after the recent drought period in order to concentrate and make more effective use of rainwater and to enhance the reliability of agricultural production. Water harvesting is gaining increasing attention in western Sudan, where results are very encouraging for improving agricultural production and livelihoods. Farmers in Mali and the Niger obtained spectacular results through improved "zai"/"tassa" planting pits that catch more of the sparse rainfall and to which dung/compost is added, for more efficient use of plant nutrients and moisture.

36. Run-off water from adjacent catchments channelled to underground rainwater reservoirs (cisterns) remains an important source of water, e.g., in drylands of Jordan, the Syrian Arab Republic and Egypt. The collected water is mainly kept for human and animal consumption, but is sometimes also used to irrigate vegetables and fruits in domestic gardens. "Hafaers", also called "khadens", are earthen surface ponds created by herders to water livestock. They can, for example, be found across the Middle East and in India. Rooftop-water harvesting provides low-cost water for drinking and household uses for dryland communities in Latin America, the Middle East and sub-Saharan Africa.[25] Ancient underground water distribution systems ("qanat") allowing specialized and diverse cropping systems are used in the Islamic Republic of Iran, Afghanistan and other Central Asian countries, with associated home gardens and endemic blind fish species living in underground waterways.

37. Maintaining residue crops to retain soil moisture (reduced evaporation; wind and water erosion) is a practice that has proven effective, even under low rainfall conditions (200-350 mm/year). An example from the north of the United Republic of Tanzania showed increased rainwater productivity of 200-300 per cent. Even in years with 400 mm or less of rainfall, farmers harvested maize yields of about 2 tons/ha while maize crops failed in neighbouring conventional systems. Restoration of soil organic matter is also vital to increasing soil moisture retention and water-use efficiency. Both cover and organic matter are used in conservation agriculture systems.

38. There is scope for improving rain-fed agriculture, including through better efficiency in rainwater-harvesting and -management. GEO-4 noted that established, though incomplete, evidence suggests that two thirds of the necessary increase in production needed from rain-fed farming can be achieved through better rain-use efficiency. Analysis of more than 100 agricultural development projects found a doubling of yields in rain-fed projects compared with a 10 per cent increase for irrigation.[26]

39. With its "Programmatic Approach to Water Use Efficiency and Agricultural Productivity", FAO intends to provide a framework for coping with water scarcity in general and with drought in particular. The framework uses an integrated demand-

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[24] Food and Agriculture Organization of the United Nations, 2004, "Drought-resistant soils: optimization of soil moisture for sustainable plant production" (Synthesis report of the FAO electronic conference).

[25] Theib Oweis, "Improving access to water in deserts and drylands", Policy Briefs, Science and Development Network, October 2006, p. 2.

[26] UNEP, *Global Environment Outlook: Environment for Development* (GEO-4), Valetta, Malta, 2007, p. 136.

supply approach. The demand-side approach aims at managing the demands for water use in agriculture, with the objectives of improving water use efficiency and agricultural productivity, farm water management, irrigation system performance and adjustments of national water and irrigation policies. The supply-side approach aims at managing conjunctively the use of surface and groundwater, reuse of wastewater and drainage water, and desalination, where appropriate.

3. Index-based weather insurance

40. As a major share of agricultural production in many developing countries is based on rain-fed agriculture, production is highly susceptible to extreme, uncontrollable weather events such as drought, in terms of both quality and yield of crops. Consequently, drought has become an important risk factor in investment decisions of both agricultural producers and financial institutions working with farmers, making it necessary to develop and use investment schemes that would include drought in financial risk management.

41. Index-based weather insurance represents an emerging innovative market scheme for managing risks associated with drought. Rather than simply insuring against crop failure, as traditional agricultural insurance contracts do, index-based weather insurance contracts are written against an index that describes an established relationship between, for example, lack of rainfall and crop failure. In case the amount of rainfall is below an agreed trigger point, the farmers receive payouts. The scheme also bundles insurance with a loan for the purchase of seeds and fertilizer.[27]

42. Index-based weather insurance schemes are being piloted in Ethiopia and Malawi, which are expected to demonstrate the viability of insuring extreme risks, such as drought, and enhance farmers' access to finance. Mozambique's policy strategy also encourages people to adopt risk insurance mechanisms and other preventive or mutual assistance instruments, while Namibia's National Drought Policy and Strategy promotes on-farm risk management.[28]

C. Early warning and climate and weather information

43. There is increasing recognition that the establishment and effective operation of systems and networks for drought monitoring, early warning and drought impact assessment are essential to the identification and formulation of effective and timely response actions.

44. Responding to the need for long-term drought mitigation planning for effective and proactive drought management, a number of initiatives have been taken. Under the European Commission-funded Mediterranean Drought Preparedness and Mitigation Planning (MEDROPLAN) project, for example, a framework for a timely

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[27] Hellmuth, M. E., Moorhead, A., Thomson, M. C., and Williams, J. (eds.), *Climate Risk Management in Africa: Learning from Practice* (Policy Brief), International Research Institute for Climate and Society, Columbia University, New York, 2007; Erin Bryla and Joanna Syroka, "Developing Index-Based Insurance for Agriculture in Developing Countries", Sustainable Development Innovation Briefs, Issue 2, United Nations Department of Economic and Social Affairs, March 2007.

[28] ECA/FSSD/ACSD-5/3, p. 32.

implementation of drought mitigation measures has been developed. Regional drought monitoring systems have been established, including the Regional Early Warning System of the Southern African Development Community (SADC) established by the Intergovernmental Authority on Development (IGAD) in the Horn of Africa and the West African Permanent Interstate Committee on Drought Control in the Sahel (CILSS) and its Regional Training Centre for Agrometeorology and Operational, Hydrology and their Applications (AGRHYMET).

45. Though some progress has been made to improve the number and the capacities of existing drought monitoring and early warning systems, the general situation in many drought-prone regions remains far from satisfactory.

46. A major weakness of drought monitoring and crop forecasting is the lack of accurate and updated climate and weather information. The ability of meteorological stations to deliver such information has been eroding in many countries over the last decades or so, making impact assessments more uncertain in the face of the increasing frequency of constraints on agricultural production systems. Of particular relevance is the improvement of seasonal forecasts, i.e., forecasts beyond the reach of traditional weather forecasts that typically do not exceed 10 days.

47. As demonstrated by the experience of several developed countries, a better understanding of the longer term mechanisms of climate variability, such as El Niño, has the potential to avert the most serious impacts of droughts and floods when coupled with impact simulation models. Although some initial work has been done on the subject in developing countries, the potential of the approach is such that significantly more efforts in this direction are needed.

48. Space-based technologies and their applications, such as Earth observation systems, meteorological satellites, communication satellites and global navigation satellite systems, are increasingly being used to support the monitoring and assessment of the environment, managing the use of natural resources, supporting early warning systems and disaster management activities and contributing to providing education and health services in rural and remote areas.

49. Regional and interregional cooperation and coordination contribute to increased access to space-based technologies and their applications. The United Nations Platform for Space-based Information for Disaster Management and Emergency Response, for example, which was recently established by the General Assembly (resolution 61/110) as a programme for the United Nations Office for Outer Space Affairs, works towards providing all countries and all relevant international and regional organizations with universal access to all types of space-based information and services relevant to disaster management. Similarly, the intergovernmental Group on Earth Observations (GEO) is leading a worldwide effort to build a Global Earth Observation System of Systems (GEOSS) over the next decade. GEOSS will build upon existing national, regional and international systems to provide comprehensive, coordinated Earth observations from thousands of instruments worldwide, transforming the data they collect into vital information for society.

1. Early warning systems and tools

50. Early warning has a crucial role in decision-making and capacity-building on issues related to drought mitigation. Designed to detect the emergence or probability

of occurrence and the likely severity of drought, a well-functioning early warning system allows more effective management of the risks associated with drought and helps to build up the drought-preparedness capacity of affected communities. Early warning systems can be of great support in the formulation of preparedness plans and contingency arrangements if they are easily accessible and the information provided is up to date, accurate and available in a timely fashion. Some examples of existing early warning systems at the country level are provided in box 2.

Box 2
Early warning systems: some country examples

Droughts occur frequently in Ethiopia, where widespread poverty increases people's vulnerability, leading to food insecurity. The country has responded with the establishment of an early warning system to facilitate adopting mitigation before disaster strikes. The system has evolved into a complex information and monitoring system that gathers data from multiple sources and provides information to a large number of users. There are early warning committees at all levels of the government. The effectiveness of the system was demonstrated in 2003, when more that 13 million Ethiopians were affected by drought, but a major famine was avoided.

An early warning system is part of Kenya's Arid Lands Resources Management Project to assist government agencies in taking timely and well-informed response measures. Drought-relevant information is also made widely available to herders and farmers, who may use it in their individual management decisions, thus improving their preparedness for drought.

Syria, with the assistance of FAO, established an early warning system for drought, with particular emphasis on pastoralists and agro-pastoralists of the Syrian Steppe and its margins. The system has been fully operational since 2006.

The United States Agency for International Development (USAID) Famine Early Warning System Network (FEWS-NET) has developed national capacities for disaster prevention and early warning for food security. FEWS-NET adopts a national level "livelihood zoning" approach allowing for better understanding of vulnerability to shock and better preparedness and response to droughts and other emergencies.

Zambia's Early Warning System has facilitated the adoption of measures at the national level where drought has occurred. However, even though there has been regular collection of rainfall data and regular forecasting, there has reportedly been little utilization of that information by most decision makers because the information appears complex.

51. The seriousness of drought and its impacts on land degradation and livelihoods in affected areas prompted the Government of Indonesia to initiate efforts for the development of an early warning system. Monitoring and assessment of land

degradation attributed to drought and climate change are intended to be based on indicators such as increasing frequency of forest/bush fire, spreading areas of withered plants owing to drought, disappearance of water wells and natural springs, declining livestock population, increased rate of harvest failure, and increased areas of abandoned land. Once fully operational, the early warning system is supposed to offer quality service to both government and communities and to serve information-sharing at ministry and local levels in mitigating the effects of drought and land degradation.[29]

52. Over the years, a number of analytical tools have been developed to collect, analyse, present and disseminate information, making full use of modern information and communication technologies as well as sources of data, such as satellite remote sensing. Of particular interest is the FAO-developed set of crop yield forecasting tools known as the AgrometShell (AMS).

53. AMS is used to assess the impact of weather conditions on crops and is based on statistical and crop-modelling approaches. It is a collection of tools for the integrated analysis of ground data and low-resolution satellite information, which have been brought together under a common interface. AMS is built around a database of crop, weather and climate data that is used to compute a crop-specific soil water balance and to derive some agronomic/agro-meteorological value-added variables (indicators) used to assess crop conditions. The software includes tools to integrate data at different spatial scales, such as weather stations (points), agricultural statistics (regions) and satellite imagery about vegetation indices and rainfall (pixels).

2. Climate and weather information networks

54. There is increasing awareness of the importance of access to climate and weather information in the context of drought preparedness and early warning. Although a network of climate and weather observation systems exists at the international level, this is often not complemented by compatible systems at regional, subregional and country levels, in particular in Africa. Addressing this issue, the report of the 2006 UNFCCC African Regional Workshop on Adaptation highlighted the urgent need for upgrading the climate and weather observation stations and networks in Africa and indicated a requirement for about 200 weather stations to support provision of services specifically related to droughts and other Africa-relevant climatic phenomena.[30]

55. In an effort to minimize the negative effects of drought and floods in the Greater Horn of Africa, the Climate Prediction and Applications Centre located in Nairobi was established, with the support of the World Meteorological Organization and the United Nations Environment Programme. The participating countries are Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Somalia, the Sudan, Uganda and the United Republic of Tanzania. The Centre monitors intensity, duration and geographical extent of droughts and their impact on agricultural production and issues early warnings in the Greater Horn of Africa.[31]

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[29] Yang and Lu, op. cit., p. 13.

[30] Balgis Osman Elasha et al., op. cit., p. 9.

[31] “Drought monitoring and early warning: concepts, progress and future challenges”, World Meteorological Organization, Geneva, 2006, p.17.

56. The Climate for Development in Africa programme is being developed, under the auspices of Global Climate Observing System and in collaboration with the Economic Commission for Africa, to guide the effective integration of climate information and services into development planning for Africa and to ensure the mainstreaming of climate considerations in achievements of the Millennium Development Goals.

57. Regional Climate Outlook Forums are convened annually by the World Meteorological Organization in the Greater Horn of Africa, in South Africa and in West Africa, to elaborate and ensure appropriate dissemination of consensual regional outlooks, bulletins and products about the next rainy season. These outlooks are directed towards the needs of users from agriculture, health, water management and energy, based upon their input and feedback.[32]

III. Continuing challenges

58. The impact of projected climatic changes, for example, a decrease in precipitation and a rise in temperature, is likely to further exacerbate the frequency and severity of droughts, with adverse impacts on food production and food security, in particular in Africa. The challenge is to reduce the vulnerability of the agricultural sector — including the risks to regional and global food supplies — to climate variability and the projected changes in extreme weather events, including droughts, heatwaves and floods.[33]

59. Where millions of the world's poorest and marginalized people rely on mostly rain-fed agriculture for their livelihoods, lack of resilience to droughts is a significant barrier to agricultural production and food security. As stated in the Secretary-General's note to the High-Level Event on Climate Change, "An immediate task in strengthening communities' resilience is preparing for more extreme weather conditions through disaster risk reduction programmes, for example to strengthen public risk awareness, early warning and disaster preparedness."[34]

60. As droughts may become more frequent and severe in nature, competition for water resources will likely increase, raising the risks of conflicts over water supplies and access to water. Water-sharing agreements between countries that share freshwater bodies will likely gain importance in the search for practical options to ensure equal access to water, while avoiding potential water conflicts.

61. Improved access to appropriate and affordable technologies and related field training and capacity-building to grow climate-resilient crops have proven to be important in maintaining soil productivity and increasing food production in drought-affected drylands.

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[32] E/ECA/ACSD/5/9, pp. 16 and 17.

[33] Discussion papers of major groups submitted to the Commission on Sustainable Development at its sixteenth session: contribution by the scientific and technological community (E/CN.17/2008/13/Add.8).

[34] "The future in our hands: addressing the leadership challenge of climate change. Background note by the Secretary-General to the High-Level Event on Climate Change", 24 September 2007, p. 3.

62. The projected persistence and severity of droughts underscores the urgency of gradually shifting priority in drought management of affected countries and regions from essentially sector-specific strategies and policies (agriculture, energy, water, forestry, etc.) to those that integrate management of natural resources and ecosystems with social and economic development strategies and action plans.

63. Moving to a proactive, risk-based approach in drought management has proven to be effective in preventing or reducing the physical or economic losses associated with drought. Taking a proactive approach to drought management is even more urgent under the scenarios for climate change. It is of particular significance to regions such as the Sahel, West Asia and the Mediterranean, where population growth and urbanization now expose many more people to the impacts of drought.

64. Inadequate financial resources and technical capacities often hamper the implementation of programmes and projects on drought risk management through, for example, education and field training and the exchange of experience and best practices.

65. Though there is increasing recognition of the crucial role that systems and networks for drought monitoring, early warning and drought impact assessment can play in drought mitigation, in many drought-affected developing countries and regions such systems and networks are not available or, where they are available, often do not effectively operate.

66. There is a lack in the systematic collection and analysis of drought-relevant data (e.g., occurrence, frequency and severity) in many affected countries, which is a constraint to fully understanding drought characteristics, hampering the ability to effectively undertake drought impact assessments (e.g., susceptibility of crops; impact of projected climate change on land productivity and water resources; and social impacts).