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ESD/RIM/2007/INF. 4
12 November 2007

ENGLISH ONLY

UNITED NATIONS
ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC
in collaboration with
FAO Regional Office for Asia and the Pacific
UNCAPSA
UNCCD Asia Regional Coordinating Unit
UNEP Regional Office for Asia and the Pacific

Regional Implementation Meeting for Asia and the Pacific for the sixteenth session of the Commission on Sustainable Development (CSD-16)

26-27 November 2007
Jakarta, Indonesia

BACK GROUD PAPER ON DROUGHT – AN ASSESSMENT OF ASIAN ANDPACIFIC PROGRESS

(Item 3 of the provisional agenda)

This paper was prepared by Dr. Lianyou Liu of the International Centre for Drought Risk Reduction, for the Regional Implementation Meeting for Asia and the Pacific for the sixteenth session of the Commission on Sustainable Development (CSD-16). The views expressed herein are those of the author and do not necessarily reflect the views of the United Nations. The paper has been issued without formal editing.

EXECUTIVE SUMMARY

1. This report aims to provide background information on the theme of drought at the Regional Implementation Meeting (RIM) for the Asia and Pacific region in preparation for the 16th and 17th sessions of the Commission for Sustainable Development (CSD) in 2008 and 2009 respectively. The report reviews general status of drought in the past decades and impact of drought on sustainable development in the Asian and Pacific region, evaluating tendency and challenges for different subregions. It also analyzes commitments to drought risk mitigation and implementation, and proposes policy and countermeasures for future drought-relief.

Key messages

2. Drought disaster is still a serious problem in the Asian and Pacific region due to global warming and human activity. Countries in South-West and Central Asia faced more challenges for drought mitigation than other countries in Asia due to severe drought combined with the effects of protracted socio-political disruption. Drought caused by the El Niño effect in the Pacific is a serious and increasingly regular occurrence.

3. Political commitment, strong institutions, and appropriate governance are essential for integrating drought risk issues into a sustainable development and disaster risk reduction process. Moreover, advocating local empowerment that recognizes the strengths inherent in local knowledge about conditions, practices and values, thus providing a comprehensive state-wide support structure to help communities and impacted sectors be better prepared for drought in the future.

4. An efficient and environmentally-sound demand side management of the available water resources in each country needs to deal with the following issues: safeguarding water to meet basic needs for various uses; minimizing water losses; allocating scarce water for socioeconomic development; and protecting the environment from degradation and loss of productive capacity. Water demand management is not just as a technology to apply or a programme to deliver, but is a form of governance.

5. Training farmers, pastoralists and women in special techniques such as soil and water conservation, water harvesting, small-scale irrigation and agro-forestry can play a major role in the process of drought disaster mitigation.

Main findings

6. Asia and the pacific has experienced severe drought in recent years. An increasing number of nations have begun developing drought policies over the last decades. Moreover, increased importance has also been placed on provincial and local drought policy and planning, emphasizing self-reliance and drought resilience. Drought monitoring, risk assessment, and the identification of appropriate risk reduction measures are principal components of a drought policy and plan, which should establish a clear set of principles or operating guidelines to govern the management of drought and its impacts as well as the development of a preparedness plan. Infrastructure reform for drought risks should be managed from the top, and its information should be transferred from the international, country, state to county or city. The successful practices for drought mitigation and sustainable economies include: operational activities drought monitoring, policy

development and implementation, cash distribution, online education and community-based programmes.

GENERAL STATUS OF DROUGHT

Spatial and temporal distribution of drought

7. Drought is a natural hazards and a threat to people's livelihood and socio-economic development. Droughts are classified into four interrelated categories: meteorological drought; hydrological drought; agricultural drought and socio-economic drought. Meteorological drought is defined by climatic variables (precipitation, humidity) and the duration of the dry period. Hydrological drought is associated with effects on surface or subsurface water supplies (i.e., stream flow, reservoir, lake levels, and ground water). Agricultural drought links impacts of meteorological drought to agriculture, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, crop failure, etc. Socio-economic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply. In easier to understand terms, drought can be defined as a 'prolonged absence or marked deficiency of precipitation', a 'deficiency of precipitation that results in water shortage for some activity or for some group' or a 'period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance' (Heim, 2002).

8. A drought disaster is caused by the combination of both a climate hazard (the occurrence of deficits in rainfall and snowfall) and a societal vulnerability (the economic, social, and political characteristics that render livelihoods susceptible in the region influenced by the deficits). The severity of the drought depends upon the degree of moisture deficiency, the duration, and the size of the affected area. Drought tends to occur less frequently than other hazards. However, when it does occur, it generally affects a broad region for seasons or years at a time. This can result in a larger proportion of the population being affected than when other disasters occur. Globally, drought disasters account for less than 10 per cent of all disaster occurrences, but they account for nearly 40 per cent of all people affected by natural disasters. The impact of drought varies regionally and over time. Disasters triggered by prolonged drought in Africa can affect millions of people and contribute to malnutrition, famine and loss of life, whereas droughts in the United States primarily result in economic losses. Severe drought often results in extensive desertification and more frequent sand and dust-storms from arid and semiarid regions.

9. According to United Nations estimates, one third of the world's population lives in areas with water shortages and 1.1 billion people lack access to safe drinking water. Globally droughts are the second most geographically extensive hazard after floods i.e., covering 7.5 per cent and 11 per cent of the global land area each. The land area, population and GDP loss affected by drought amount to 970 million km^2, 57.3 billion and US$108.6 billion respectively. The percentage of Earth's land area stricken by serious drought more than doubled from the 1970s to the early 2000s, according to a new analysis by scientists at the National Centre for Atmospheric Research (NCAR). Widespread drying occurred over much of Europe and Asia, Canada, Western and Southern Africa, and Eastern Australia. Rising global temperatures appear to be a major factor provoking more frequent and intense droughts in sub-tropical areas of Asia and Africa, exacerbating food

shortages in some of the world's poorest countries. Dai and others (2004) find that the fraction of global land experiencing very dry conditions (defined as -3 or less on the Palmer Drought Severity Index) rose from about 10-15 per cent in the early 1970s to about 30 per cent by 2002.

10. Asia is also a drought-hit area. A severe drought hit much of South-West Asia between 1999 and 2003, including Afghanistan, Kyrgyzstan, Islamic Republic of Iran, Iraq, Pakistan, Tajikistan, Turkmenistan, Uzbekistan and parts of Kazakhstan (Waple and Lawrimore, 2003; Levinson and Waple, 2004). The persistent multi-year drought in Central and South-West Asia has affected close to 60 million people. Agriculture, animal husbandry, water resources, and public health have been particularly stressed throughout the region. Preliminary analysis suggests that the drought is related to large-scale variations in the climate across the Indian and Pacific Oceans, including the recent "La Niña" in the Eastern Pacific. In 2006, a severe drought in a region of Southern China has left 520,000 people short of drinking water and damaged crops. The drought affected areas throughout the poor, mountainous Guangxi region on China's southern coast. Nearly 102,000 hectares (254,000 acres) of crops were damaged, causing losses of more than 400 million RMB Yuan (US$50 million). China's South-Western city of Chongqing, located along the upper reaches of the Yangtze River, suffered from its worst drought in half a century. In the 75 days from June 1 to August 14 of 2006, Chongqing and neighbouring Sichuan province measured an average rainfall of no more than 287.1 millimeters, about 103 millimeters less than the median rate. And in the 35 days from July 10 to August 13, there were 25 days when the city's temperature climbed above 40 degrees Celsius—about 13 days more than normal, setting another record in modern history. The 2006 drought caused Chongqing financial losses of nearly 8.04 billion RMB Yuan (US$1.04 billion). Nearly 8 million local residents had difficulty accessing drinkable water, and some 2.07 million hectares of farmland have been affected. Droughts in areas across China that summer left 18 million people short of drinking water. Chongqing drought raised climate change worries, some experts believe the unusual drought in Chongqing and Sichuan in the summer of 2006 was just one of the many footnotes to indicate an increase in abnormal climatic occurrences related to global warming.

11. Australia is the driest inhabited continent even though some areas have annual rainfall of over 1200 millimetres. Large areas of Eastern Australia suffered generally drier than normal conditions from mid-1979 through to the end of 1981. For the 10-month period from April 1982 to February 1983, almost all of Eastern Australia was severely affected and large parts of South-Eastern Australia suffered their lowest rainfall on record. The worst losses occurred during this latter period, accounting for an amount in excess of A$3 billion of the total estimated loss. Research indicates that severe drought affects some part of Australia about once every 18 years; intervals between severe droughts have varied from 4 to 38 years. Severe drought occurred in 1982, 1994 and 2002. Severe long-term drought, stemming from at least three years of rainfall deficits, continued during 2005. The most serious drought occurred in 2006 adn was estimated as the worst in 1,000 years.

Impact of drought on sustainable development

12. Drought has multiple impacts on global agricultural, hydrological, eco-environmental and social-economical systems. Unusual periods of rain-free weeks can bring soil water deficits, result in high livestock mortality rates and disrupt reproduction cycles, and thus increase the likelihood of food shortages leading to malnutrition and hunger.

13. ***South-East Asia:*** Drought conditions currently exist in many parts of South-East Asia, particularly in Indochina (Myanmar, Cambodia, Lao People's Democratic Republic, Thailand and Viet Nam). The drought has stressed rice, coffee, sugar and other crops in the region, and sharply lowered the supply of water for drinking and irrigation. In 2004 the wet season ended about a month ahead of schedule, and drought conditions quickly developed across an area that stretched from Central China to Southern Thailand to Luzon, Philippines. The Thai government announced that 70 of its 76 provinces had been hit by drought that year, affecting more than 9 million farmers and almost a million hectares of paddy fields. The 2004/05 rice crop was estimated at 17.0 million tons, down 1.0 million from 2003 (USDA, March estimate), and trade sources expected the sugar crop to drop by about 30 per cent in 2004/05.

14. ***North-East Asia:*** Drought often occurs in North-East Asia. Chinese agriculture sources estimated that the national wheat crop to dropped nearly eight per cent, to 105 million tons from 113 million tons, in large part due to the drought in 2000. Prolonged drought persisted in China's northern plains, with wheat one of the crops worst affected. In the northern province of Shaanxi of China, the drought affected some 667,000 hectares, 40 per cent of the province's farmland. The mighty Yellow River, tapped by factories and farmers along its 3,000-mile (5,000 km) course, is reduced to an intermittent stream by the time it reaches its mouth in Shandong Province. In Beijing, the water table and key reservoirs are at their lowest levels since the early 1980s. Water resources per capita are 300 cubic meters just 3.3 per cent of the world average in the capital city. Reduced plantings and a serious drought have led to a sharp reduction in wheat production.

15. The distribution of China's deserts is closely related to the pattern of rainfall, which is in turn strongly influenced by the East-Asian and Indian summer monsoon and the moisture sources from the South, South-West and South-East. The deserts in China are located in the interior of the Eurasian continent away from these moisture sources, as the high mountains to the south and west prevent the transport of moisture to these regions. In winter, the desert regions are dominated by the Siberia high-pressure system, causing then to have extremely dry and cold climates. As a combined consequence of these factors, the desert regions of China form the largest arid area in the temperate climate zone. High winds in the desert regions mobilize large quantities of dust into the atmosphere. Plants eventually wither and then die due to short of water. Forest and grass fires occur more frequently and can spread quickly if dry, arid conditions continue. It has been reported that the desertified area in China was about 1.74 million km^2 in 2004, which accounted for 18.12 per cent of the total land area and most of it distributed across Northern and Western China. Deficient topsoil moisture at planting may stop germination, leading to insect infestation, plant disease and low plant populations, especially the water deficiency below the ecological-demand will lead to the degradation of the whole ecosystem. The drought has led to much more frequent sand and dust storms in Northern China. In 2000 and 2001, Beijing was struck by about 15 sandstorms which primarily originated from the arid and semi-arid deserts in the North-West. Severe drought spread from the mainland's north and threatened the southern provinces. 2004 was labeled as the worst in the past 50 years and was a catastrophe for Southern China. Water in hydrologic storage systems such as rivers and reservoirs are often used for multiple purposes such as flood control, irrigation, recreation, navigation, hydropower and wildlife habitat. The drought emptied reservoirs and cut power supplies. In the hardest-hit region of Guangxi Province, 1,100 reservoirs went dry and hydropower generation cut dramatically. The socio-economic loss from drought

was enormous. With shift in resources to drought relief, it can cause real spending on health, decline in domestic purchasing power and production, and even lead to inflation.

16. ***South Asia:*** From early 2000 onwards, severe drought affected vast areas of South Asia, including Western India, Southern and Central Pakistan. In India, a large numbers of people were affected by the drought. Some 7,500 villages spread over 145 blocks in 15 districts were severely affected during year 2000. In Pakistan, government officials estimate that nearly 3 million people - mostly villagers faced starvation in 2000. More than 100 people died as a result of the drought, most because of dehydration.

17. ***South-West and Central Asia:*** This subregion represented the largest region of persistent drought from 1999 to 2001 in the world. A persistent multi-year drought in Central and South-West Asia has affected close to 60 million people as of November 2001. In Afghanistan, the worst drought in 30 years spread across the broken country and almost half of its 20 million people were affected. Chronic political instability in many parts of this region and the recent military action in Afghanistan have further complicated the situation. Most parts of the Islamic Republic of Iran recently experienced an exceptional drought that lasted more than 2 years (1998–2000). In some areas, drought has also extended into winter 2001. The 1998-2000 droughts inflicted $3.5 billion in damages, killing 800,000 head of livestock and drying up major reservoirs and internal lakes (Pagano et al., 2001).

18. ***Oceania:*** In 2006, the Australian Bureau of Agricultural and Resource Economics painted a dire picture for the country's agricultural sector. More than half the country's farmland was classified as drought-stricken, and the bureau estimated that production of the three main resource crops - wheat, barley and canola - would be cut by more than 60 per cent. Prices for sheep were down by as much as 80 per cent in some areas, and cattle by 40 per cent. The bureau also expected the drought to cut growth in the country's gross domestic product by 0.7 percentage point. The indirect effects of the Australian drought were also felt worldwide: Global wheat prices hit a 10-year high, fueled by supply worries sparked by the country's dismal crop forecasts. In New Zealand, the Ministry of Agriculture noted in the recent post-election briefing papers, that the drought had-cut farm gate income by nearly US$1 billion and hacked 0.8 per cent off gross domestic product in 1997-1998, 3 per cent in 1998-1999 and 1 per cent in 1999-2000.

19. The Pacific island countries, islands range from larger and mountainous (Fiji, Papua New Guinea and Solomon Islands) to small, low and scattered (Cook Islands, Kiribati and Tuvalu) to tiny and isolated (Nauru and Niue). Islands are more isolated and distant from one another and from the nearest continental masses than the Caribbean islands. Many small islands rely exclusively on rainwater plus shallow groundwater in lenses sometimes sitting above saline water. Drought caused by the El Niño effect in the Pacific is a serious and increasingly regular occurrence. Each El Niño event has resulted in water shortages and drought in American Samoa, Fiji, Kiribati, Marshall Islands, Federated States of Micronesia, Papua New Guinea, Samoa and Tonga. Drought often threaten food security in the Pacific islands, most Pacific island countries still depend very heavily on the agricultural sector for food, income and employment, but the sector itself is constrained by low productivity. Agricultural production is mainly to meet domestic demand and in many cases is failing to keep up with such demand.

Challenges of drought risk

20. Drought is an insidious natural hazard that is a normal part of the climate of virtually all regions. It should not be viewed as merely a physical phenomenon. Rather, drought is the result of interplay between a natural event and the demand placed on water supply by human-use systems. Asia is an area of extremely rapid growth in demand for water, water shortages are reportedly limiting industrial production in localized areas to varying extents, and droughts have reduced agricultural productivity and livelihoods in every subregion. Managing water resources to meet competing demands in the agricultural, industrial, residential and increasingly the services sector (in particular tourism) is complicated by a high variation in the distribution of water resources, in both temporal and spatial terms, across the region. Moreover, Asia is high dependent on irrigated agriculture, and water use and management are inefficient in most countries. Therefore more attention should be paid on demand management to improve water efficiency to meet the rapidly growing water demand in a cost-effective manner.

21. There are many challenges before us if we are to improve our management of droughts. Firstly, drought must be accepted as a natural hazard within the natural hazard community of scientists and policy makers. Because of its slow-onset characteristics and lack of structural impacts, it is often disregarded unless serious problem appear. This lack of recognition of the importance of drought by the natural hazards community has been an impediment to obtaining adequate research support and, in many instances, an obstacle to building awareness among policymakers at the local, national, regional and international levels. This lack of awareness in turn has resulted in an under appreciation of drought and its far-reaching impacts. The process of dealing with drought in a crisis management mode could be facilitated only when the knowledge and technology necessary to improve preparedness and mitigation impacts is readily available.

22. A second challenge is to build awareness of drought as a normal part of climate. It is often considered to be a rare and random event, thus the lack of emphasis on preparedness and mitigation of drought exists. Improved understanding of the different types of drought and the need for multiple definitions and climatic/water supply indicators that are appropriate to various sectors, applications, and regions is a critical part of this awareness-building process.

23. A third challenge is to erase misunderstandings about drought and society's capacity to mitigate its effects. Many people consider drought to be purely a physical phenomenon and seldom ask what control measures should we take to reduce its impacts as much as possible. Drought originates from a deficiency of precipitation over an extended period of time. The frequency or probability of occurrence of these deficiencies varies spatially and represents a location's exposure to the occurrence of drought. Some regions have greater exposure than others, and we do not have the capacity to alter that exposure. As with other natural hazards, drought has both a physical and social component. It is the social factors, in combination with our exposure, determine risk to society. Some of the social factors that determine our vulnerability are level of development, population growth and its changing distribution, demographic characteristics, demands on water and other natural resources, government policies (sustainable versus non-sustainable resource management), technological changes, social behaviour, and trends in environmental awareness and concerns. It is obvious that well-conceived policies, preparedness plans, and mitigation programmes can greatly reduce societal vulnerability and, therefore, the risks associated with drought.

24. A fourth challenge is to convince policy and other decision makers that investments in mitigation are more cost effective than post-impact assistance or relief programmes. Evidence from around the world, although sketchy, illustrates that there is an escalating trend of losses associated with drought in both developing and developed countries. Also, the complexity of impacts is increasing. It seems that investments in preparedness and mitigation will pay large dividends in reducing the impacts of drought. A growing number of countries are realizing the potential advantages of drought planning. Governments are formulating policies and plans that address many of the deficiencies noted from previous response efforts that were largely reactive. Most of the progress made in drought preparedness and mitigation has been accomplished in the past decade or so. Although the road ahead will be difficult and the learning curve steep, the potential rewards are numerous. The crisis management approach of responding to drought has existed for many decades and is ingrained in our culture and reflected in our institutions. Movement from crisis to risk management will certainly require a paradigm shift. The victims of drought have become accustomed to government assistance programmes. In many instances, these misguided and misdirected government programmes and policies have promoted the nonsustainable use of natural resources. Many governments have now come to realize that drought response in the form of emergency assistance programmes only reinforces poverty or lack of self reliance.

25. Demand side management is a promising but challenging approach to drought mitigation. An efficient and environmentally sound management of the available water resources in each country needs to deal with the following issues: safeguarding water to meet basic needs for various uses; minimizing water losses; allocating scarce water for socio-economic development; and protecting the environment from degradation and loss of productive capacity. We can not consider water demand management just as a technology to apply or a programme to deliver, but a form of governance. Demand management is not limited to on-farm measures and practices but the whole economy. Emphasis on appropriate water conservation policies should begin as soon as possible, especially in countries that are not self-sufficient in water. Rural-urban water sharing are important issues in Asia countries. Increasing population in urban area will add to the existing water crisis in the cities. For example, it is estimated that, by 2050, 48 per cent to 61 per cent of India's population will be living in urban areas. While rural water demand is assessed on an allocation of 40 litres per capita per day (lpcd), the corresponding urban demand is against a norm of 135 lpcd. A population shift means additional demand on already shrinking urban water resources. If the accepted level of allocation (135 lpcd) is to be sustained in the year 2050, each of the cities will have to search for fresh sources of water to meet the growing demand. Already, cities like Delhi, Bangalore and Chennai ferry water from as far away as 200 km. Should this trend continue, rural areas will be robbed of their water, creating a deep rural-urban divide on the one hand and an inverse impact on food production in the countryside on the other.

COMMITMENTS TO DROUGHT RISK MITIGATION

Objectives

26. Mitigating drought—taking actions in advance of drought to reduce its long-term risk—can involve a wide range of tools. The components of a drought mitigation plan are

the following: prediction, monitoring, impact assessment and impact assessment Early-warning systems to forecast drought will make possible the implementation of drought-preparedness schemes. Integrated packages at the farm and watershed level, such as alternative cropping strategies, soil and water conservation and promotion of water harvesting techniques, could enhance the capacity of land to cope with drought and provide basic necessities, thereby minimizing the number of environmental refugees and the need for emergency drought relief. At the same time, contingency arrangements for relief are needed for periods of acute scarcity.

27. During the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992, three main objectives to combat drought were identified: (a) to develop national strategies for drought preparedness in both the short and long-term, aimed at reducing the vulnerability of production systems to drought; (b) to strengthen the flow of early-warning information to decision makers and land users to enable nations to implement strategies for drought intervention; and (c) to develop and integrate drought-relief schemes and means of coping with environmental refugees into national and regional development planning. Then, at the nineteenth special session of the United Nations General Assembly in 1997, delegations re-energized their commitment to drought management, stating that "The international community is urged to recognize the vital importance and necessity of international cooperation and partnership in combating desertification and mitigating; the effects of drought; the transfer to developing countries of environmentally sound, economically viable and socially acceptable technologies relevant to combating desertification and/or mitigating the effects of drought, with a view to contributing to the achievement of sustainable development in affected areas, should be undertaken without delay on mutually agreed terms". In 2002, the World Summit on Sustainable Development held in Johannesburg, called on countries to integrate measures to prevent and combat desertification as well as to mitigate the effects of drought through relevant policies and programmes, such as land, water and forest management, rural development, early warning systems, environment, energy, national resources, health and education and poverty eradication and sustainable development strategies.

Commitments to drought mitigation

28. Commitments to drought mitigation have been made by Asia and the Pacific governments at regional and international official forums and through treaties and codes of practice. The private sector, including the finance sector has also increasingly committed to sustainable codes. The most important commitments are to land and water management, agricultural management, training, strategies for drought preparedness and financing.

Summary of drought mitigation commitments

Improve land and water management
- Undertake research on ways of reducing water loss from soils, on ways of increasing the water absorption capacities of soils and on water harvesting technologies in drought prone areas. - Provide assistance in the use and diffusion of appropriate water conservation technologies, e.g., through technical and financial support and capacity-building.
Promote agricultural management and provide trainings
- Promote the use and dissemination of indigenous knowledge and know-how inagricultural and pastoral systems and in activities to enhance natural vegetation cover. - Develop and/or transfer basic and improved agricultural and pastoral technologies to farmers, including through multi-stakeholder approaches and public-private partnerships, to increase agricultural production and food security.

- Undertake training programmes of land users and farming communities, particularly women and indigenous groups, to develop their technical skills and to facilitate their equal access to economic opportunities.
- Promote efficient extension-service facilities, particularly for training farmers, pastoralists and women in such special techniques as soil and water conservation, water harvesting, small-scale irrigation and agro-forestry.
- Provide training to decision makers and land users, in particular women and local communities, in the effective utilization of information from information and early warning systems.

Develop strategies for drought preparedness

- Develop national strategies for drought preparedness both short- and long-term.
- Develop drought-relief schemes and means of coping with environmental refugees, and integrate them into national and regional development planning.
- Develop and/or strengthen, with international assistance, climate and weather information and forecast and national early-warning systems, with particular emphasis on the areas of risk-mapping, remote-sensing, agro-methodological modeling, integrated multidisciplinary crop-forecasting techniques, and computerized food supply/demand analysis.
- Improve networking among existing information and early warning systems.
- Build the capacity for assessing the social, economic and environmental impacts of droughts and developing methodologies to forecast drought.
- Strengthen the implementation of the UNCCD, as a vital instrument to assist countries in the integrated planning and implementation of policies and programmes related to drought adaptation and preparedness.
- Encourage the UNCCD, the UNFCCC and the CBD to continue exploring and enhancing synergies, with due regard to their respective mandates, in the elaboration and implementation of plans and strategies under the respective Conventions.

In drought-prone areas

- Design strategies to deal with national food deficiencies in periods of production shortfalls.
- Improve national and regional capacities for agro-meteorology and contingency crop planning.
- Prepare rural projects for providing short-term rural employment to drought affected households.
- Establish contingency arrangements, where necessary, for food and fodder distribution and water supply.
- Establish budgetary mechanisms for providing, at short notice, resources for drought-relief.
- Establish safety nets for the most vulnerable households.

Mobilize Financing

- Mobilize adequate and predictable financial resources at all levels and from all sources, including for the implementation of drought-relevant projects under the UNCCD.
- Promote access to credit and mobilize savings, e.g., through the establishment of banking systems.
- Establish a revolving fund for credit to rural entrepreneurs and local groups to facilitate the establishment agro-businesses and credit for agro-pastoral activities.
- Provide financial and technical support for Africa's efforts related to drought mitigation, including in the context of the UNCCD.

Initiatives and priorities

29. In Asian and Pacific areas, to combat drought disaster and achieve sustainable development, the following priorities are identified:

(a) Improve the understanding of the different types of drought and the need for multiple definitions and climatic/water supply indicators to help to construct an awareness-building process. For example, some scientists point out that Australia's devastating drought is far more likely to be part of a natural cycle than a result of climate change;

(b) The relationships between drought, food production, food reserves, food security and food provision are complex and need to be understood on a case-by-case basis to improve existing situations. Tools to conduct drought risk assessments in rain-fed agriculture and water supply systems should be applied;

(c) Drought is the result of interplay between a natural event and the demand placed on water supply by human-use systems; inefficient surface irrigation systems are employed in more than 90 per cent of Asian irrigated areas. New, more affordable irrigation technologies and water management should be developed to establish water efficient irrigation system;

(d) In drought-prone areas, improve national and regional capacity for agro-meteorology and contingency crop planning, and establish contingency arrangements, and budgetary mechanisms for providing, at short notice, resources for drought relief;

(e) There is a need for greater cooperation at the regional level in the areas of drought monitoring. Regional drought monitoring or scientific centers could help to harmonize observation and planning, improve prognosis, provide early warning, engage in training, and develop capacity in promising new technologies, such as remote sensing.

REVIEW OF IMPLEMENTATION

(a) Progress on combating drought in different countries

Drought Risk Identification, Impact Assessment and Early Warning

30. ***Drought risk assessment:*** Understanding the physical nature of drought hazard and corresponding impacts and underlying vulnerabilities, and communicating these dangers in an effective manner, forms the basis for developing informed drought mitigation and preparedness measures to reduce the impact of drought. The National Drought Mitigation Centre has developed a guide, "How to Reduce Drought Risk", to help entities better understand their own drought risk and develop locally based risk reduction measures. To mitigate the effects of the recurring droughts in the region and develop the effective long-term drought management policies, the issue of drought should be explored in a multidisciplinary context and through regional cooperation. The “Drought Assessment and Mitigation in South-West Asia” website <www.iwmi.cgiar.org/droughtassessment/ index.asp> brings together scientific community and civil society organizations in West India, Pakistan and Afghanistan in the attempt to identify gaps in current drought assessment and management practices and to share lessons and experiences that the countries can learn from each other. The project lasted for 18 months and was completed in 2005. It is designed to be a portal of drought-related studies, news and information for the South-West Asia region and as a meeting place for scientists, managers and policy makers dealing with different aspects of droughts.

31. ***Drought impact assessment:*** Drought leads to extensive direct and indirect impacts on economy, environment and society. NDMC proposed a checklist of historical, current,

and potential drought impacts, including 90 indices, which were classified into 15 categories. The centre also created a national drought impact database to assist in documenting and understanding the effects of drought. Users can query the Drought Impact Reporter database to search for impacts that are occurring or have occurred in their region (see *http://drought reporter.unl.edu*). Impacts are grouped by category, such as agriculture, water, energy, environment, fire, social, etc. This type of activity will help planners identify the range of impacts that are important in a region. In Australia, external sites relating to drought include: Drought Situation Reports for Queensland; Areas of NSW suffering drought conditions; Drought Information for Victoria; Drought Information for South Australia. However, in most Asian countries, impact assessment is yet incomplete and sometimes inaccurate.

32. ***Vulnerability analysis:*** Vulnerability reflects susceptibility of a social system to a specific drought attack. The Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS), the World Food Programme's Vulnerability Analysis and Mapping (VAM) system, and the Food and Agriculture Organization of the United Nations (FAO) food security system could gather information of vulnerable populations, and help decision makers target mitigation actions.

33. ***Drought monitoring and early warning systems:*** Drought is typically a slow-onset phenomenon, which means that it is often possible to provide early warning of an emerging drought. Such information allows for a shift from reactive to proactive hazard management and represents a change in focus from disaster recovery to disaster prevention. Drought monitoring systems have also been developed in countries such as China, Australia, and the United States, as well as a collaborative North American drought monitoring system between Canada, the United States and Mexico. Each of these countries has developed unique monitoring systems to suit their needs and capacities. For examples, China relies heavily on the Standardized Precipitation Index to monitor drought occurrence, and Australia quantifies precipitation percentiles. The United States Drought Monitor (USDM) and the North American Drought Monitor (NADM) utilize multiple climate indices and indicators to assess drought conditions. NOAA's Climate Prediction Centre also provides a monthly drought outlook across the United States, illustrating regions where drought is expected to linger, become more serious, or degrade. The FAO Global Information and Early Warning System on Food and Agriculture (GIEWS) is the most globally complete system, but other systems, including the USAID sponsored Famine Early Warning System (FEWS NET), are also important. FEWS NET is mainly focused on Africa, where the majority of food security warning systems operate, but it also covers parts of Central Asia, Central America, and the Caribbean. Another example of online drought monitoring is given by the South Asia Drought Monitor (SADM), based on remote sensing data, drought related indices and GIS. This near-real-time drought monitoring and reporting system covered Afghanistan, Pakistan and western parts of India.

Afforestation and reforestation

34. Reforestation and afforestation programme is an essential part of combating drought and desertification, and have been priorities for the last decade, as they will prevent or slow the rate of soil erosion, and will provide considerable benefits in terms of soil and water quality regulation, although impacts of forests on water availability are not clear, can vary from watershed to watershed, depend on soil type and species. Afforestation is common in countries such as Australia, India, China and New Zealand. The main method used by countries in extending their forests and wooded areas has been planting of forest

plantations with the aims of stabilizing sand-dunes, rehabilitating range and steppe areas, managing water catchments, and protecting agricultural areas. Starting from 1978, the windbreaker belt project in North-East, North and North-West China known as the "Three North Shelterbelt System Programme", divided into three phases and eight large projects with construction period lasting 73 years, is expected to bring to finish in 2050 and to turn 35.6 million ha of land into the woodland.

35. To tackle the problem of deforestation, national Governments have taken steps to protect forested areas, such as establishing forest parks and wildlife conservation areas, and afforestation. According to the United Nations Food and Agriculture Organization (FAO) 1990 assessment, the rate of afforestation was higher in Asia and the Pacific in the 1980-90 period than in any other region of the world for which estimates are available. For example, from 1981 to 1990, an average of 525,000 hectares of forest was planted each year throughout the Association of Southeast Asian Nations (ASEAN) region. The annual percentage increase in plantation in South Asia during the same period was close to 30 per cent. As a result of a massive tree-planting programme in China, nearly 32 million hectares of forest had been established by 1990. The Pakistan Environmental Protection Council also launched a massive afforestation programme in 1995, aimed at increasing the country's forested area from 5 per cent to 10 per cent.

Drought Mitigation and Preparedness Measures

36. Mitigation measures can be defined as structural/physical (e.g., appropriate crops, sand dams, engineering projects) or non-structural (e.g., policies, awareness, knowledge development, public commitment, and operating practices) undertaken to limit the adverse impacts of natural hazards, environmental degradation, and technological hazards. Preparedness can be defined as pre-disaster activities that are undertaken within the context of disaster risk management and are based on sound risk analysis. This includes the development/enhancement of an overall preparedness strategy, policy, institutional structure, warning and forecasting capabilities, and plans that define measures geared to helping at-risk communities safeguard their lives and assets by being alert to hazards and taking appropriate action in the face of an imminent threat or an actual disaster.

37. One possible solution to water scarcity during the dry season: the groundwater dam. Groundwater dams store water underground, rather than on the surface. Water that is stored in the soil does not evaporate like ponds and streams. It is clean and healthy - parasites will not contaminate underground water. The "Mother's Water Cellar" project launched in August 2000 by China Women Development Foundation, now provide readily accessible potable water for about one million people in rural China. Aquifer recharge is important both for hydrologic understanding and for effective water resource management in arid and semiarid areas. Enhanced aquifer recharge is one alternative to the water sustainability crisis occurring in many arid regions. Augmentation of recharge to ground water through percolation tanks is closely related to the survival of about 15 million farmers and an equal number of cattle, living in the semi-arid basaltic plateau in Western India.

38. In addition, hydrologic technologies for water harvesting have been implemented in various forms in Europe, the Middle East, Northern Africa, and Eurasia. Karez systems are very delicate irrigation systems made up of vertical wells, underground canals, above-ground canals and small reservoirs. Generally, a karez is 3 km (1.9 miles) with the longest being 20 to 30 km (12-19 miles) with several dozen vertical wells. Sometimes the number of vertical wells exceeds 300. A karez reduces evaporation, avoids getting

polluted and needs no other power equipment; it runs from high to low ground owing to gravity alone. The history of the karez in Xinjiang dates back to 103 B.C. Karezes have been found in Islamic Republic of Iran, the Sahara, Pakistan, etc. The use of gravel and sand as mulch (known as Shatian or sandy field in Chinese) to conserve the sporadic and limited rainfall for reliable crop production may date back to the period of the Qing Dynasty about 300 years ago in the semi-arid loess regions of North-West China. Gravel mulches also have been used to conserve soil moisture in the low rainfall regions of other countries in the world, such as France, South Africa, Colorado, Texas and Montana, USA and Switzerland. Many studies showed a gravel mulch to be effective in reducing evaporation and runoff, improving infiltration and soil temperature, and checking soil erosion and salinization. Gravel mulch can also effectively coordinate the dynamics of moisture, heat, air and fertilizer to alter environmental conditions at the micro-scale to meet the physiological requirements of crop.

39. At the 2nd African Drought Risk and Development Forum in Nairobi in 2006, the Commodity Risk Management Group of the World Bank put forward innovative market-based solutions to improve responses to drought. Index based weather insurance and price risk insurance linked to credit are two proposed drought risk management options that are financially viable. Swiss Re is now offering microinsurance to African farmers against drought; however, drought insurance has not been part of drought management strategies in most Asian and the Pacific countries.

Education, Training and Information Exchange and Sharing

40. Education for disaster risk reduction is an interactive process of mutual learning among people and institutions. It encompasses far more than formal education at schools and universities and in training courses. Developing a culture of drought prevention and resilience requires engraining the following messages into society: firstly, drought is a natural hazard that affects a wide range of sectors; secondly, drought is natural part of climate that should be managed; thirdly, there are proactive measures that can be taken to reduce drought risk; and finally, pre-drought mitigation and preparedness actions are more cost-effective than drought response measures.

41. There are a host of programmes around the world that provide educational programmes on natural hazard risk reduction. The National Drought Mitigation Centre produced a website "Drought for Kids" <*http://drought.unl.edu/*kids/index.htm>, it provides drought glossary, basic knowledge on drought and drought pictures. Since 1995, most governments spread knowledge to public on the World Day to Combat Desertification and Drought (June 17). In China, some cooperation and demonstration projects provide training courses to decision makers and farmers on desertification and drought control.

42. The internet media are playing more and more important role in exchanging information, knowledge, technologies on drought. Through Yahoo search, we could find about 39,800,000 pages for drought, 8,770,000 pages for drought risk, 6,290,000 pages for drought disaster, 4,180,000 pages for drought reduction, and 1,510,000 pages for drought mitigation. Since 1990, about 40 books related to drought have been issued by different publishers. Since 1997, more than 50 international and regional forums, conferences and symposiums relevant to drought have been held around the world.

Aid for drought-relief

43. Humanitarian aid is an important way for the emergent needs of vulnerable people hit by extreme drought. The United Nations, the USA, the European Commission, as well as other organizations and countries, have provided water, food, basic healthcare and financial support as emergency response and relief to Africa, and South-East Asia. The Commission has a two-pronged approach to tackling the drought-related crisis in the region. Relief assistance is provided under the humanitarian aid budget, while Medium and long-term support to mitigate the effects of the drought is financed through the food aid/food security budget. Australia gives almost three billion dollars aid to drought-hit farmers since 2001. As the economies of affected areas were seen to be at risk, a drought assistance package was introduced by New Zealand government. The package included five main components. *Adverse Events Family Income Support* was available so that farm income was not run down by family living expenses (such as feeding and clothing family members). *Farm Appraisals* were offered to assist farmers in making decisions about the future viability of their farm businesses, assess their rehabilitation needs, and plan sustainable rehabilitation and ongoing farming programmes. *New Start Grants* were available, enabling farmers who were in an untenable financial position to vacate their property and make a new start in another industry. *Drought Rehabilitation Loans* were obtainable, dependent on the future viability of the farms in question. The loans were interest-free for the first two years, with the government providing a guarantee of 80 per cent of their value for four years. The expenditure of loans was tied to certain activities, including capital stock replacement, pasture renewal, and fertilizer application. *The Technology Transfer Programme* was designed to develop and encourage the implementation of improved dryland farming techniques, through research, educational on-farm field days, and the production of information booklets. In 2007, China's Gvernment provided about 600 million RMB for drought mitigation in South-West and North-West provinces. Jilin Province, which has been plagued by severe drought for almost a month in North-East China, allocated 20 million Yuan (US$2.6 million) to reinforce water supplies. The fund would be used to provide water to people, livestock and crops along with another subsidy of US$1.6 million allocated by the provincial government.

Organizations and Networks related to drought in the Asia and Pacific

44. International *organizations* and regional communities play important roles in coordinating activities, transferring knowledge, supporting project implementation, and facilitating effective and affordable practices to combat drought. The ISDR secretariat and the National Drought Mitigation Centre (NDMC), USA, have since been working in partnership with key U.N. agencies, national agencies, NGOs, and appropriate regional and national institutions to build the Global Drought Preparedness Network with the goal of building greater institutional capacity to cope with future episodes of drought. FAO leads international efforts to defeat hunger. FAO helps developing countries and countries in transition modernize and improve agriculture, forestry, and fisheries practices and ensure good nutrition for all. FAO is also a source of knowledge and information. Through the Global Information and Early Warning System (GIEWS) it releases global watch on drought related food shortage and hunger, and takes special relief operations, especially in Africa and Asia. Since its founding in 1945, its has focused special attention on developing rural areas, home to 70 per cent of the world's poor and hungry people. The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) is the regional development arm of the United Nations for the Asia and Pacific region. It carries out work in three main thematic areas: Poverty reduction; Managing globalization; Tackling emerging

social issues. ESCAP has been working on environmental issues and the use of information, communication and space technologies (ICST) for disaster management, including prevention, mitigation and improved response. It notes that floods, drought, storms, earthquakes and wildfires are the major natural disasters in the Asia and Pacific areas. The Asian Development Bank (ADB) is to help its developing member countries reduce poverty and improve the quality of life of their citizens. ADB's main instruments for providing help to its developing member countries are: policy dialogue, loans, technical assistance, grants, guarantees and equity investments.

45. Scientific and technical networks and institutions take the task of drought risk identification, impact assessment, and early warning methodologies. The ISDR, NDMC, and other partners have also been working in collaboration to promote the development of regional drought networks. The *Asian Disaster Preparedness Centre* (ADPC), Bangkok, Thailand, was built in 1986 to promote increased awareness, knowledge and adoption of disaster reduction practices so as to mainstream disaster reduction as an integral part of the development process at community, national, subregional, regional and international levels. The *Asian Disaster Reduction Centre* provides comprehensive disaster information for the Asia and Pacific region. The *Asian Disaster Reduction & Response Network* (ADRRN) was formed in 2003. Its mission is to promote coordination, information sharing and collaboration among NGOs and other stakeholders for effective and efficient disaster reduction and response in the Asia-Pacific region.

46. *SILO/Drought*, Australia, provides a rich source of meteorological and agricultural data of particular interest to anyone involved in the agricultural arena. One of its products, "Drought Statement", provides 4-month rainfall deficiencies, 5-month rainfall deficiencies, and 12-month rainfall deficiencies. Formal drought declarations are done by either the relevant State Governments or Australian Federal Government. Information about Australian Government drought assistance is available at <www.daff.gov.au/ droughtassist>.

47. The *International Center for Drought Risk Reduction* (ICDRR) was established in Beijing on April 2007 under the auspices of the ISDR. The main functions of the ICDRR are to monitor and assess drought risk across Asia, develop knowledge and capacities for drought mitigation, promote information sharing and public awareness to reduce drought impacts, and enhance cooperation between China and other Asian countries on drought relief. *Beijing Climate Center (BCC), Drought Monitoring, China*, issues drought monitoring from China's capital city. BCC's goal is (i) to propose climate research and development projects and coordinate with other Regional Climate Centers (RCCs); (ii) to formulate plans for studies of climate variability, predictability, and impact in the region; (iii) to develop consistent practices to handle conflicting information in the region; (iv) to develop validation procedures relating to seasonal-to-interannual forecasting products and enhance co-ordination with other RCCs; (v) to develop regional models, methods of downscaling, and interpretation of global forecast products; (vi) to undertake application research; (vii) to assist development and application of specific products for various users; and (viii) to study the economic value of climate information.

48. *All India Disaster Mitigation Institute (AIDMI), India*, is a community-based action research, action planning, and action advocacy non-governmental organization. It works toward bridging the gap between policy, practice, and research related to disaster mitigation, in an effort to link the community to the (inter)national level humanitarian scenario. Promoting adoption and practice of disaster mitigation through: (i) partnership

with the poorest within disaster vulnerable communities; (ii) integrating water, food, habitat, and livelihood security; (iii) capacity-building of multiple humanitarian stakeholders; (iv) synergy between traditional and modern risk reduction strategies; (v) capturing and disseminating lessons and innovative ideas; (vi) promoting use of humanitarian standards in disaster response; and (vii) providing timely and targeted relief in a sustainable manner. The *International Water Management Institute* (IWMI), Sri Lanka, is a non-profit scientific organization funded by the Consultative Group on International Agricultural Research (CGIAR). IWMI's research agenda is organized around four priority themes covering key issues relating to land, water, livelihoods, health and environment. The Institute concentrates on water and related land management challenges faced by poor rural communities. It also maintains the IWMI Drought Network and Information Centre and the South Asia Drought Monitor (SADM).

(b) Implications for the countries/ subregions that are being left behind

49. ***Drought policy and plan Enhancement:*** To ensure that drought risk reduction is a national and local priority with a strong institutional basis for implementation, state/provincial policies on drought and local planning for drought mitigation need to be completed in many, especially in the developing countries around the Asia and Pacific. Progress made in the USA and other countries set up good examples for developing and implementing drought policies and plans from the community to national levels. Some successful countries like Australia, New Zealand, and India have prepared national, provincial policies and even community plans for drought, other countries like China, Pakistan, Bangladesh, Cambodia, Islamic Republic of Iran, Lao People's Democratic Republic, Nepal, Mongolia and Sri Lanka need to complete more detailed plans for drought. In some western and central Asian countries, like Iraq, Afghanistan, due to political instability and adverse climatic conditions, drought induced agriculture failure, diminished food security, heightened hunger and future deaths are still prominent challenges.

50. ***Drought Assessment Methodology and Warning Capacities:*** Drought impact is complex and difficult to assess, either quantitatively or qualitatively. Drought risk, impact and vulnerability assessment methodologies, maps, and standards should continue to be tested and modified to meet the needs of decision makers and stakeholders. It is essential to develop the appropriate social and technological capacity to research and implement programmes to better understand, monitor, and communicate drought occurrences and their related effects.

51. National governments and other planning entities should support the development and sustainability of the required infrastructure and scientific, technological, and institutional capacities needed to research, observe, analyze, map and, where possible, forecast natural and related hazards, vulnerabilities, and drought impacts. It is also essential to support the development and improvement of relevant databases and the promotion of full and open exchange and dissemination of data for assessment, monitoring, and early warning for drought at international, regional, national and local levels. In comparison with the Americas and Africa, the Asian and Pacific countries should make greater efforts in developing real-time drought monitoring, impact assessment and warning systems.

52. ***The self-reliance principle for drought:*** In Australia, the self-reliance principle for drought maintained that farmers and regional professionals were in the best position to develop the agronomic systems, practices, and business strategies that would manage

frequent agronomic droughts. This moved Australia's drought policy away from a subsidy-based, reactionary or "crisis driven" approach. The setting was created in which drought is considered a normal part of the Australian farming environment. Various kinds of water harvesting, such as "mother cellar" in China, "aquifer recharge" in India, and conservation tillage practices for the rain-fed farmland, should be carried out more extensively to prevent agricultural drought, maintain crop yield and provide drinking water in case of adverse climatic conditions.

(c) Assessment of drought risk posed by climate change

53. In the past 30 years, many works have been done to reveal the mechanisms of drought formation (McCabe et al., 2004; Zhu et al., 2003; Folland et al., 1986). The argument forcused on whether the formation of 20-30 years' drought like those in Sahel and central North China is attributed to local land-surface interaction (Zeng et al., 1999; Xue et al., 1993; Fu et al., 1986) or to the forcing of large scale SST (sea surface temperature) change (Rowell et al., 1995; Folland et al., 1986; Palmer et al., 1986). So far, not a convincing conclusion has been obtained. However, the agreement has been achieved that the long-term drought of Sahel results from large-scale SST change and the local land-air interaction help maintain and enhance the arid climate. Hoerling et al (2003) found that 1998-2002 continuous droughts in USA, Southern Europe and South-Western Africa is closely related to global SST change. Inspired by these studies, researchers have made great progress in studying the relationship between SST or the large-scale ocean climate change and the inter-decadal change of land precipitation (Zhu et al., 2003; McCabe et al., 2004). The report of IPCC (2007) indicates that global mean surface temperatures have risen by 0.74°C ±0.18°C over the last 100 years (1906–2005). The surface temperature rise has an important impact on global dry-wet variation. Except North America, drying trend enhances about 1 per cent -5 per cent in other continents, and the wetting trend in regions with increasing precipitation and surface temperature rise weakens or disappears due to warming effect. Researches show that drying trend exists in most regions across the globe under continuous warming in second half of the 20th century. Especially in Africa and Eurasia, drying trend is quite obvious. The strongest drying trend occurs in Africa, and the intensity enhances 16 per cent during 1951~2002. Far East of Russia, central North China and North-East China are regions of significant drying trend (Ma et al., 2007).

54. Despite the growing understanding of the global climate change, great uncertainties exist in the prediction of responses of arid regions to global and regional, natural and human-induced climate change. Meteorological data series show a steady increase of annual and winter temperatures in Central Asia since the beginning of the 20th century that might have a strong potential impact on the region's natural ecosystems, agricultural crops, and human health. Analyses of the NOAA AVHRR temporal series since the 1980s showed a decrease in aridity from 1991-2000 compared to 1982-1990. While most climate models agree that the temperature in arid Central Asia will increase by 1-2 °C by 2030-2050, precipitation projections vary from one model to another and projected changes in the aridity index for different model runs show no consistent trend for this region. Local and regional human impacts in arid zones can significantly modify surface albedo, as well as water exchange and nutrient cycles that could have impacts on the climatic system both at the regional and global scales (Lioubimtseva, et al., 2005).

55. It is found that the frequency of occurrence of droughts in the Republic of Korea has significant time intervals of 2-3 and 5-8 years and has been increasing since the 1980s. Correlation and composite analyses showed that the occurrence of droughts over central

Eastern China, Manchuria, and the north coast of Japan was highly correlated with those in Korea. However, the time scales of occurrence of droughts over the three regions were different. Droughts in Eastern China represented in-phase variations with those in the Republic of Korea with a time interval of 5-8 years, whereas those in Manchuria occurred with a time interval of 15 years, and those in Japan had no coincident variations (Min, Seung-Ki, et al., 2003).

POLICY OPTIONS

(a) Policy and countermeasures for future drought-relief (Government)

56. Building drought resilience thus needs to be part of other long-term considerations and an integral part of policies related to agriculture, water, food security and hazard planning. Ideally, national policies to create drought resilience work in accord with community-based policies and practices, encouraging practices that reduce vulnerability to drought. All this requires sustainable policies and governance, which may necessitate capacity development to foster meaningful participation in policy and planning processes. The development of national and local strategies for reducing drought risk, together with the implementation of such a strategy, should be guided by the following main principles:

57. Firstly, political commitment, strong institutions, and appropriate governance are essential for integrating drought risk issues into a sustainable development and disaster risk reduction process, a bottom-up approach with community participation, both in decision making and implementation, is also essential to move from policies to practices;

58. Secondly, drought monitoring, risk assessment, and the identification of appropriate risk reduction measures are principal components of a drought policy and plan, which should establish a clear set of principles or operating guidelines to govern the management of drought and its impacts as well as the development of a preparedness plan that lays out a strategy to achieve these objectives, should emphasize mitigation and preparedness rather than relying solely on drought relief; and

59. Thirdly, policy mechanisms to ensure that drought risk reduction strategies are carried out should be developed and enforced, sound development of long-term investment in mitigation and preparedness measures is also essential to reduce the effects of drought.

60. With increased understanding of the effects of drought on people and livelihoods, a greater emphasis on disaster mitigation, and the development of model drought planning processes, an increasing number of nations have begun developing drought policies over the last decades (UN/ISDR, 2007). This trend reflects in part the changing nature of the issues and problems for which political decision makers and their advisers are expected to find integrated solutions.

61. ***National-level policies for drought:*** Many countries have prepared national drought policies, such as Australia, New Zealand, India, and Pakistan in the Asia and Pacific region. While China, Japan and other countries, incorporated their policies on drought in the Law on Prevention and Control of Desertification, the Forest Law, the Water Law, and the Agriculture Law, etc. In Australia, policies that provided direct subsidies and other forms of support to underwrite drought risk were phased out in 1992 with the inception of the

National Drought Policy, developed by Australia's Commonwealth and state governments through the policy development process at ARMCANZ (Agriculture and Resource Management Council of Australia and New Zealand). For many years, the New Zealand government has played a key role in assisting farmers through adverse climatic events (including drought). The main policy agency involved is the Ministry of Agriculture and Fisheries (MAF). The types of assistance offered have changed over time, as has the philosophy behind the government's role in adverse climatic events, consistent with changes in overall national economic policy. However, most of the Asian countries should draw up drought-proofing plans to prevent a catastrophe in the future.

62. ***Local and community plans for drought:*** In addition to national drought policies, increased importance has also been placed on provincial and local drought policy and planning, emphasizing self-reliance and drought resilience. The three principles of the policy are to: firstly, encourage primary producers and other sections of rural Australia to adopt self-reliant approaches to managing climatic variability; secondly, maintain and protect Australia's agricultural and environmental resource base during periods of extreme climatic stress; and thirdly, ensure early recovery of agricultural and rural industries, consistent with long-term sustainable levels. In Australia's Community Drought Planning, drought management guidelines were completed for non-metropolitan areas in the early 1990s, and drought response plans were completed for the newly formed metropolitan retail water companies in 1995.

(b) Institutional reform for drought risks (Technology, infrastructure)

Infrastructure reform

63. The pattern of infrastructure reform for drought risks should be up to down, and its information should be transferred from the international, country, state to county or city. As to this aspect, we should learn from the experience of western countries. The Operational Drought Plan in Arizona is the key response to the current and future drought conditions in Arizona provides a good example. The Operational Drought Plan recognizes that drought events are natural disasters that touch all sectors of community, region, and state. To facilitate a coordinated response to drought events, the Operational Drought Plan identifies a process for communication and coordination between Arizona state agencies, Federal agencies, tribal governments, state lawmakers, water users, resource managers and scientists.

64. The long-term planning aspect of the Governor's Drought Task Force activities have been overshadowed as a result of the current drought conditions that Arizonans are facing today. The Governor's Drought Task Force has developed guidelines for communities and water providers, individual homeowners, and State government for responding to each stage of drought consistent with the mitigation measures in this plan.

Technology for drought reduction

65. As to the technology for drought reduction, there are many as follows:

- *Field agricultural technology*

  It concludes straw or plastic film mulch, conservation tillage and rainwater harvesting, and water saving technology such as hole irrigation, surge flow irrigation, micro-irrigation and drip-irrigation. Other methods of water

conservation have also been successfully employed including ridges across furrows to trap water, infiltration pits to soak it up and mulching.

- *Water-saving technology of chemistry*

Drought-resistant and water save technologies include promoting the use of drought resistance agent, moisture-preserving agent; it can help soil with preserving soil moisture and reducing crop transpiration, improving the drought-resistant ability.

- *Water storage cellar, sea water desalination, wastewater treatment*

One effective way for the local people to get water essential to daily life is to dig cellar to collect rainwater. Building such a water cellar help a family solve the problem of water shortage. When successive drought occurred, it will be more difficult for people and animals in drinking, agricultural production will suffer huge losses. During such a critical period, some very special measures can be used, such as overdraft more deep groundwater, but sea water desalination, wastewater treatment are the common but effective technology to resist drought and save water.

- *Drought monitoring and early warning*

We can identify various indicators of drought specific to sectors or water uses, and tracking these indicators provides us with a crucial means of monitoring and providing early drought warnings. The ISDR Platform for the Promotion of Early Warning completed a global survey of early warning systems in 2006. The survey found that early warning systems for drought are more complex than those for other hydro-meteorological hazards and are, consequently, relatively less developed globally.

(c) Best practices and new opportunities for drought mitigation and sustainable economies (Stakeholders)

66. As we seen, the practices for drought mitigation and sustainable economies are mainly in five aspects as follows, which are all more successful in mitigating drought and keep sustainable economies, society and ecosystem. From these practices we may discover any new opportunities or idea we can adopt.

Operational activities Drought Monitoring

67. In some Asia countries as China, the most common practices for drought mitigation and sustainable economies is drought monitoring, development of drought plans or reporter on drought impact. Set the programme "Drought monitoring index on the national and global basis" as an example. It is implemented by Beijing Climate Centre, China Meteorological Administration (CMA). Drought monitoring has always been one of the priorities to the operational efforts of the Beijing Climate Centre (BCC), China Meteorological Administration (CMA). The operational drought monitoring system was developed at the BCC. Several routine products for China and the globe are produced on a daily basis from real-time station-based and satellite-derived data. All of those products are available to the worldwide community for free downloading from the webpage of BCC. Some new products, such as the extreme high temperature and the heat waves are currently being developed. We also learned lessons that more station-based observation data in the worldwide range is needed to improve the present drought monitoring products. In

addition, more efforts should be made on the application of satellite-based data to drought monitoring.

Policy development and implementation

68. Other countries like Australia have the practice in policy development and implementation for drought risk reduction. Set the programme *Australian National Drought Policy* Implemented by Australian government as an example. The Australian National Drought Policy was built on the principles of sustainable development, risk management, productivity growth, and structural adjustment in the agricultural sector. The policy stressed preparedness rather than disaster response, given the propensity of the Australian climate toward drought. Assistance with improved risk management and productivity was given through the main agricultural programme, the rural adjustment scheme. The rural adjustment scheme decided when an area was experiencing 'exceptional circumstances' in terms of weather, at which point financial support became available. The rural adjustment scheme also stressed improved risk management by encouraging farmers to have financial reserves for times of crisis. The Rural Adjustment Scheme was replaced by new programmes called Agriculture-Advancing Australia that were very similar to the one they replaced. Interest rate subsidies were replaced by welfare relief. Another change was the spatial drought declaration. An entire state would qualify for exceptional circumstances once a state had 80 per cent of its land in exceptional circumstances.

Cash distribution

69. Cash distribution is the most common practice for drought mitigation and sustainable economies widely taken in some Africa countries such as Zambia-Malawi, Mali, Niger, Somaliland, Ethiopia and the South Africa. In the Asian and Pacific region, where some countries are suffering from poverty, cash distribution could also be an effective approach for the drought mitigation and sustainable economies. "A mixed cash transfer system in Mali" as an example of such a programme. It is a programme combining cash distribution and credit system. Oxfam GB initiated a combined cash and credit for work programme in the Gao Region of Mali during 2005-2006 following widespread crop failure due to insect invasion and drought conditions. Two thousand workers in the region constructed dykes, ponds, and community stores and maintained greenbelts. They were given credit at a local trader's shop in the community for a value equivalent to half of their work time. The remaining half of the value of their work was paid to them in cash every two weeks. The trader who held the credit also distributed the cash to the individuals; each participating trader was chosen by community members. Individuals were allowed to choose items for purchase on a day-by-day basis. The goal of the intervention was to meet the immediate needs of residents and also promote an increase in savings and investments that could promote the long-term security of the communities. The results of the combined programme indicate that the programme has been a success in meeting the immediate needs of the community and promoting individuals' long-term resiliency.

Education on sustainable natural resource management

70. Education on sustainable natural resource management is another practice for drought risk reduction. The *Rayalaseema Watershed Area Development Programme (RWDP)*, Andhra Pradesh, India, implemented by Krushi, Action for Food Production (AFPRO) Krushi Action for Food Production (AFPRO) began in 1991. The programme was implemented in the Chittoor district where there were many marginal poor farmers with no

capital to invest in their land or operation. Problems within the watershed included: insufficient water from shallow wells for irrigation, migration of marginal and landless farmers to cities to find work, women being paid less than men, low wages for farm work, and insufficient sanitation and hygiene contributing to poor public health. The Krushi AFPRO group met with individual farmers to prepare plans for each farm. Components of the plans often included well remediation, reducing runoff and erosion from fields through the use of bunds, diversion channels, gully plugs, contour trenches, earthen bunds and weirs, planting trees for fruit, fuel, and timber, planting crops for fodder, and digging rain catchments. Overall, marginalized communities became more influential in the watershed institutions through increased representation and involvement. People became informed about various organizations and networks, which led to greater knowledge and resources. Better skills in water and soil conservation and watershed management led to more efficient use of the resources available and better prepared to deal with the impacts of drought.

Community-based Programme

71. In some Asia countries like India, there is more emphasis on the Community-based Programme. For example, the Indo-German Watershed Development Programme, executed in Darewadi Village, India, and implemented by the Watershed Organization Trust. The Darewadi village and surrounding area in the Ahmednagar district of the Maharashtra state in India was faced with near complete desertification, limited agricultural production and the seasonal migration of villagers. Restoration activities such as tree and grassland planting and a switch to more sustainable crops were coupled with community-led pilot projects to promote soil and water conservation (education, water harvesting, and irrigation techniques) over a five year time span. The projects were carried out on both privately and publicly held land. Communities were considered eligible for participation in the programme if they were affected by drought, if the land-ownership within the region was relatively equally distributed, and if their geographical position within a watershed was conducive to the restoration activities. The programme's long-term success is most likely as a result of community buy-in and leadership.

* * * *

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