Sequía ЗАСУХА 干旱 Sécheresse

Drought Network News

February 1997

A Newsletter of the International Drought Information Center and the National Drought Mitigation Center

Volume 9 No. 1

From the Director

In the October issue of *Drought Network News*, I briefly discussed two policy initiatives that developed in response to the severe and widespread drought that affected the Southwest and southern Great Plains states in the United States during 1996. The first of these activities, a multistate workshop (and its subsequent report), was coordinated by the Federal Emergency Management Agency. This report was submitted to President Clinton in late August; it contained a series of recommendations that focused on short- and long-term issues. The second initiative, under the leadership of the Western Governors' Association (WGA), was not available in final form as we went to press with the last issue of the newsletter. This report is now available and is summarized below.

In June 1996, the WGA adopted a resolution, sponsored by Governor Johnson of New Mexico: "The western governors believe that a comprehensive, integrated response to drought emergencies is critical . . .[and that] it is important to work together and cooperatively with other affected entities to plan for and implement measures that will provide relief from the current drought and prepare for future drought emergencies." From this resolution, a WGA drought task force was created and charged with (1) coordinating the drought response needs of the states by immediately identifying barriers to effective response at the federal level; (2) working with existing state, federal, and private entities to develop criteria for assessing various stages of drought and corresponding emergency response measures and mutual assistance; and (3) sharing solutions and relief measures that can be implemented within the states and localities in the West. Beginning with a meeting of the Drought Task Force in September, four working groups (drought management, agriculture, water resources, and wildfire and forest health) began working on a report that was to be presented at the November 1996 meeting of the 19 western governors.

The recommendations contained in the drought management section of the WGA Drought Task Force report primarily address longer-term mitigation and preparedness issues:

- develop a national drought policy or framework that integrates actions and responsibilities among levels of government;

Published in cooperation with the World Climate Program of the WMO

- ensure that each state develops a drought contingency plan that includes early detection, monitoring, decision-making criteria, short- and long-range planning, and mitigation;
- establish a regional drought policy and coordinating council to develop sustainable policy, monitor drought conditions and state responses, identify impacts and issues for resolution, facilitate interstate activities, and work in partnership with the federal government to address needs brought on by the drought;
- establish a federal interagency coordinating group with a designated lead agency for drought coordination with states and regional agencies;
- provide federal funding for the National Drought Mitigation Center to assist states with drought preparedness, planning, and mitigation;
- ensure that drought is an essential element in any national discussion of water policy (i.e., the Western Water Policy Review Advisory Commission assessment currently in progress).

The other three working groups also offered numerous, far-reaching recommendations. For example, the water resources group urged enhanced water conservation programs; additional state and federal assistance for drought preparedness, response, and mitigation for small communities and rural water systems; revisions of existing laws and policies on water rights on a short-term basis; and improved funding for the U.S. Geological Service's cooperative stream gauging program and an integrated climate data collection and dissemination system.

The recommendations emanating from both the FEMA and WGA reports reflect an important philosophical change in the way states and others believe droughts should be managed in the United States—from one that predominantly stresses a "relief-oriented" crisis management approach to one that encourages and promotes risk management. Whether these recommendations move beyond the discussion phase will depend largely on how vigorously states collectively pursue their implementation and how receptive federal agencies are to a more integrated (within and between levels of government) and proactive approach to drought management.

I encourage *Drought Network News* readers to obtain a copy of the WGA report and read it carefully. The report can be found on WGA's website (http://www.westgov.org) by clicking on WGA Publications from the home page and scrolling down to the Lands and Waters section, clicking on the link for the drought plan.

This issue of *Drought Network News* includes a wide range of articles on drought-related issues, including linkages between famine and drought in Zimbabwe, drought management strategies in the arid region of India, experiences with medium-range weather forecasting over Kashmir, and a 1996 summary of drought in the United States.

As always, I encourage members of the network to submit articles and reports for publication in *Drought Network News.* The information reported in this newsletter is extremely valuable to scientists, natural resource managers, and policy makers worldwide. **The deadline for receipt of articles for publication in the June issue of *Drought Network News* is May 5, 1997.**

Donald A. Wilhite

Contents

Famine and Drought:

The Question of Food Security in Zimbabwe

Introduction

From the time that the London Missionary Society first took Zimbabwean rainfall records at Hope Fountain in 1888, the worst droughts on record are the consecutive dry spells from 1911 to 1914, the 1946–47 drought, the 1960 drought, and the 1972–73 rainy season, which was the driest period of colonial Zimbabwe. The country also had serious food shortages in 1903, 1916, 1922, 1933, and 1942. Although the people of pre-colonial Zimbabwe experienced recurrent droughts, they generally had well-developed coping mechanisms that prevented high death tolls (Iliffe, 1990).

The Good Neighbor

Zimbabwe's rainfall pattern has always been one of greater precipitation in the northern parts of the country, with gradually diminishing rains from north to south. This has meant that in any given year there is never a "total" rainfall failure and therefore a "total" crop failure. Scarcity in most cases has been localized, and local food shortages in pre-colonial Zimbabwe therefore rarely degenerated into famines that killed.

The tradition of sharing among the peoples of pre-colonial Zimbabwe was one of the pillars of famine prevention strategies that had its roots in the ethics of the peoples' culture. No one was allowed to die when someone else had a surplus of food. There was a well-established barter trade system, in the form of either in-kind or exchange of food for labor. Only those who were unable to exchange either of the two resorted to begging. Even in this begging, the beggar provided some form of service (for example, entertainment) in exchange for food.

Agriculture and Food Gathering

Major settlements in pre-colonial Zimbabwe were centered on the high rainfall belt in the highveld at the center of modern Zimbabwe. This region is known for its agriculturally rich soils and abundant natural resources, including game and other wild sources of food. The people had relatively well-developed agricultural skills. They grew drought-resistant crops, mainly finger millet and bulrush millet.

During times of plenty, some of the surplus was stored in secluded natural silos (often caves), as a strategic reserve during wartime. These reserves could also be used during a famine. In addition, traditional leaders like the king and at times the chief always kept strategic reserves for their people in case of famine. This is best captured by Shona praise poetry at the accession of a chief:

> You are the chief of everyone,
> Father of orphans and of those who suffer.
> Your senior wife,
> Your second wife,
> Your third wife,
> They are to cook for the hungry, serve those who wait for food.
> (Hodza and Fortune, 1979)

Perhaps the greatest asset that the people had was the overabundance of wild foods. Early European explorers who came noted that "starvation was impossible in the Zambezi Valley" (Scudder, 1971).

Colonial Invasion

The establishment of colonial rule in the 1890s coincided with severe food shortages. The causes of the shortages included drought, locust invasions, and the animal disease rinderpest, which decimated cattle herds, especially in Matabeleland. The situation was made worse by the civil conflict that followed the invasion of Matabeleland by Europeans. Spiritual leaders had warned of the impending famine if the "whites were not driven off." Food shortages were quite acute in 1896, when people died from famine because of the combination of natural phenomena and the rebellion against colonial domination.

To create dependency and ensure the acceptance of their rule, the invading Europeans destroyed most of the grain the people had stored. The period 1895–97 was disastrous. The combined effects of the Shona and Ndebele rebellions of 1896 and 1897, the plunder and destruction of grain by European troops, and the invasion of locusts and rinderpest disease all hurt food security. The British South African Company (BSAP) reported widespread starvation throughout the country during the peak of the rebellion in 1897.

Food Handouts Introduced

Indeed, the people succumbed to the power of the Europeans and, in October 1896, the first-ever food distribution center was set up in Bulawayo by the BSAP. This center distributed food to some 3,000 people every day.

The establishment of the Bulawayo Food Distribution Centre became a turning point in the history of food production in the country. By 1903, the colonial administration had set up 16 "Native Reserves" in Matabeleland and 80 "Native Reserves" in Mashonaland. Africans who still occupied what was now "European land" were forced to pay taxes by colonial authorities who wanted to force them into the reserves. However, despite having their land usurped, African farmers produced more grain than the Europeans. The *Rhodesia Herald* of September 19, 1903, commented, "It is hardly a bright reflection on the state of (European) agriculture to note that so soon as the Kafir trade in this commodity fails, customers have to take the imported article."

Another famine occurred in 1903. The colonial authorities' famine policy then rested on two principles. One was to rely wherever possible on private trade. The second principle was that men should earn money to buy food by migrating to wage employment on white farms and in urban areas.

The call to wage labor was received with little enthusiasm, especially in Mashonaland and the Zambezi Valley, as most men shunned the mines and labor camps. This response surprised the Europeans. It also illustrates the fact that famine survival during the 1903 drought owed little to government aid or the European economy. The people survived the famine by traditional means, especially by exploiting wild food. As long as wild food was available, men would stay at home, eat forest products, and sustain their families. This traditional practice was so strong that many communities had no idea that there was a government relief operation.

This resistance to food handouts was also evident during the 1912 famine, when people in the Masvingo District "refused absolutely to accept any advance of grain or meal either from private individuals or from the government," as Native Commissioner Bazeley reported in May 1912.

Furthermore, the authorities' fear of African pauperization clashed with African expectations of reciprocity. The starving Africans got the famine relief food at famine prices, yet they had to repay the food during normal times. The authorities of Southern Rhodesia had no famine disaster code at that time but had a "tradition of expecting starving Africans to work, encouraging private trade, giving some help with transport, and confining direct relief to the incapacitated" (Peires, 1982). This thinking was to be the "official policy" adopted by Southern Rhodesia administrator Sir William Henry Milton during the 1912 famine.

This policy persisted even up to the 1916 famine. There were a number of problems with the policy. First, the already overstretched Africans had neither the resources nor the willingness to pay for the grain. Second, the Africans felt that since they were paying tax (hut tax) to the government, the government had an obligation to feed them since they did not see any reason for paying the tax in the first place.

In 1922, the country experienced another famine, the impact of which was far different from all the previous famines. There were country-wide food shortages, yet the country had enough grain stocks to feed the entire nation—and even to export. This was the first sign of the impact of the alien economic system introduced by the Europeans. Cattle prices had gone down, weakening the purchasing power of the African population. Worse still, the traditional famine-coping mechanisms of the Africans had been weakened because much of their traditional land had been usurped. Even where wild food was still obtainable, the practice of wage labor contrasted with the traditional hunting and foraging strategies that for years Africans had found most dependable.

Policy Shift

Famine policy shifted in 1922, when the colonial government for the first time introduced public works where those employed were paid in food. This policy was introduced partly because private employers could no longer provide employment to all those who needed it and partly because the need for public infrastructure like roads in the rural areas became more apparent during that time.

The 1930s saw a major shift in African average food production levels since the 1890s, with the rate of increase in average yearly production falling from the previous decade's 3.8% to 2.06%. For the first time, African food production declined steadily. Food scarcity became permanent for the poor while the wealthy always had food. This scenario was particularly disastrous given that the African population was growing fast and at the same time was being driven to more arid regions of the country. The Africans now heavily depended on grain from the grain marketing boards because many could not produce enough for themselves.

The Country's Segmentation and Land Pressure

By 1943, according to R.W.M. Johnson (Johnson, 1964), 13.2 million hectares (ha) had been settled by whites, 6.4 million ha were set aside for future white occupation, 0.4 million ha were forest reserves, and 7.2 million ha had not been allocated to either race. This arrangement left Africans with a mere 11.7 million ha. The pressure on the African reserves was particularly acute after World War II as the colonial authority began a deliberate and systematic removal of "unwanted Africans" from white land.

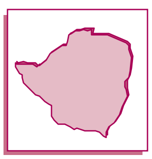
Before 1980, the country had two systems of agriculture: commercial, which was highly sophisticated and mainly the domain of the white community, and peasant, which was largely neglected and totally black. The peasant sector, which was then called the Tribal Trust Lands, constituted 41.8% of the total land mass of the country. The commercial sector amounted to 42.7%, and the state held the balance in the form of game parks, forests, and so on. The commercial sector occupied the best agriculturally productive parts of the country, while the peasant sector languished in generally poor agricultural land.

Maize and Cotton Revolution

Despite the condition of agricultural land in the communal sector, grain production experienced a phenomenal growth after independence in 1980. This was mainly due to favorable agricultural policies adopted by the new government, which provided incentives for the development of communal agriculture. The communal farmers increased their maize production level by marketed output by more than 50% compared to the pre-colonial period. In 1985, for the first time since the early 1900s, communal farmers marketed more maize and cotton than their commercial counterparts.

Despite the growth in communal food production in the communal areas, the problems of food security and malnutrition persist. The droughts of the 1980s and the famous one of 1992 found many ill-prepared (if at all) for the inevitable food shortages, despite the mini-agricultural revolution of the previous years. Many communal farmers found themselves literally government "dependents," queuing for the miserly handouts distributed through the various government drought relief programs

The question of food security has generated a lot of debate and discussion, not only in Zimbabwe but in southern Africa as a whole. The Zimbabwean government, faced with another drought in 1995, sought ways of feeding needy people without necessarily bearing the costs alone.



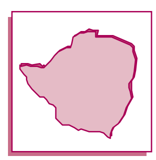
Disaster Declared

Zimbabwe's president, Robert Mugabe, declared a state of disaster as a result of the severe drought affecting most parts of the country. In an announcement published in the *Government Gazette* of July 7, 1995, the president said, "And whereas it appears to me that the said disaster is of such a nature and extent that extraordinary measures are necessary to assist and protect the people of Zimbabwe residing in communal, resettlement and small scale farming areas which are affected, or the circumstances are likely to arise making such measures necessary; now therefore, I hereby declare that, with effect from the 28th July 1995, a state of disaster exists in the communal, resettlement and small-scale farming areas of Zimbabwe."

The declaration of a disaster obligates the government to provide relief services to people in need. The Zimbabwean government announced three forms of disaster relief: the Grain Loan Scheme (GLS), which is estimated to benefit some 5.05 million Zimbabweans; the Free Food Programme (FFP), which is estimated to benefit about 733,000 people; and the Supplementary Feeding Programme (SFP), which is estimated to benefit more than 800,000 children.

Under the GLS, the government will loan grain to those in need. This scheme is designed for the able-bodied. The grain would be paid for in the form of cash or grain after the next harvest. The biggest impediment to the success of this program is that it assumes the next harvest will be normal. The FFP, which caters to the incapacitated, was in existence even during colonial times. The SFP, which is being run by the Ministry of Health, provides food to targeted children under five years, but now feeds even older school children when there is need.

Although these schemes are noble, the question of sustainability still remains, as the government of Zimbabwe, like most governments in southern Africa, does not have the material and financial resources to implement these programs. Food insecurity will still be a problem if the fundamental questions of poverty, agricultural and land policies, drought preparedness, and the whole area of disaster management are not fully addressed. This is particularly so because communal people, or the poor in general, are always affected by drought despite bumper harvests in previous years.



Information

For years, the Southern African region has been hit by droughts of varying magnitudes and durations. A lot has been written about these droughts. Information on droughts is stored in government archives, humanitarian organizations' offices and libraries, and research institutions. The circulation of such information has hitherto been limited to a "select" group of persons or organizations. There have been few (if any) regional information sharing mechanisms through which documentation on drought and drought management could be channeled. Even at the national level, people in drought management, though many in number, often operated individually, without sharing their experiences.

It was not until March 1995 that the International Federation of Red Cross and Red Crescent Societies, along with the Southern African Research and Documentation Centre (SARDC), launched the Disaster Management Information Project (DMIP). The Project's primary purpose is to improve the availability, accessibility, and dissemination of drought-related information, as well as information on other disasters. The Project focuses on the 12 Southern African Development Community states.

Joshua Chigodora
India Musokotwane Environment Resource Centre for Southern Africa (IMERCSA)
15 Downie Avenue, Belgravia
P.O. Box 5690, Harare,
Zimbabwe

References

Hodza, A. C.; and G. Fortune, eds. 1979. *Shona Praise Poetry*. Clarendon Press, Oxford.

Iliffe, J. 1990. *Famine in Zimbabwe, 1890–1960.* Mambo Press, Gweru, Zimbabwe.

Johnson, R. W. M. 1964. *African Agricultural Development in Southern Rhodesia: 1945–1960.* Food Research Institute, Stanford University, Stanford, California.

Peires, J. B. 1982. *The House of Phalo: A History of the Xhosa People in the Days of Their Independence.* University of California Press, Berkeley.

Scudder, T. 1971. *Gathering among African Woodland Savannah Cultivators: A Case Study—The Gwembe Tonga.* Manchester University Press for the University of Zambia, Institute for African Studies.

Changing Climatic Scenarios and Strategies for Drought Management in the Indian Arid Region

Introduction

Western Rajasthan constitutes 62% of the 0.32 million km^2 that make up the hot Indian arid region (Figure 1). The average annual rainfall of the area varies from less than 100 mm (coefficient of variation [CV] = 70%) in the western parts to just above 500 mm (CV = 40%) in the eastern parts of arid Rajasthan. During July and August, the eastern parts of the arid region have an assured crop growing period of 12–15 weeks, whereas the western parts mostly depend on the vagaries of the southwest monsoon. The annual potential evapotranspiration rates are 3–8 times higher than the annual rainfall, resulting in extreme water deficits and aridity conditions in the region (Figure 2). Pearl millet, which is a principal cereal crop of the arid region, needs about 90 days for its maturity, and any weather aberrations after sowing result in considerable reduction in crop yields. Agricultural droughts have been found to occur in the region in 25%–48% of the years during 1901 to 1995, with a frequency and intensity varying from one location to another, severely affecting food and fodder production.

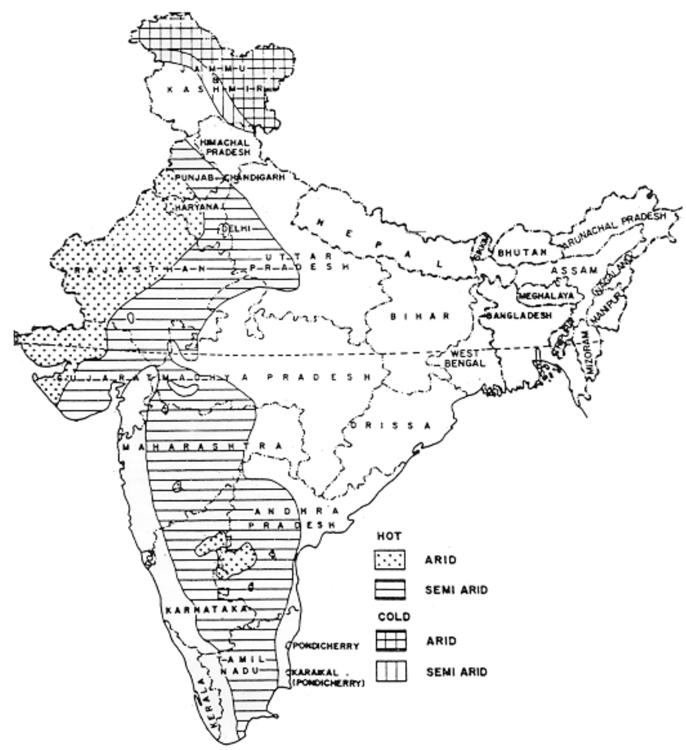


Figure 1. India's arid and semiarid zones.

Spatial Variability in Rainfall and Crop Production

The spatial variability of the long-term productivity (1966–90) of pearl millet in western Rajasthan has been found to closely follow the variability of annual rainfall distribution (Figure 2). The crops in Ganganagar in the north are mostly irrigated through downstreams of northern states to Rajasthan. The productivity of rainfed pearl millet was 580 kg ha^{-1} in the north, 368 kg ha^{-1} in the east, 117 kg ha^{-1} in the south, and 32 kg ha^{-1} in the western parts of Jaisalmer region. The probability of drought that affects pearl millet production also followed the variability of spatial distribution of rainfall. Such probability was highest (36%–40%) in the west and lowest (21%–30%) in the northern and eastern parts of arid Rajasthan.

Short-duration pulse crops normally escape the effects of drought. This can be observed from the higher yields of pulses (compared to pearl millet) in the low rainfall zone (central and eastern). However, grain yields of pearl millet were higher than those of pulses in the eastern parts because of better rainfall distribution to support long-duration crops. The productivities of pearl millet and pulses are reversed as we move from the eastern high rainfall

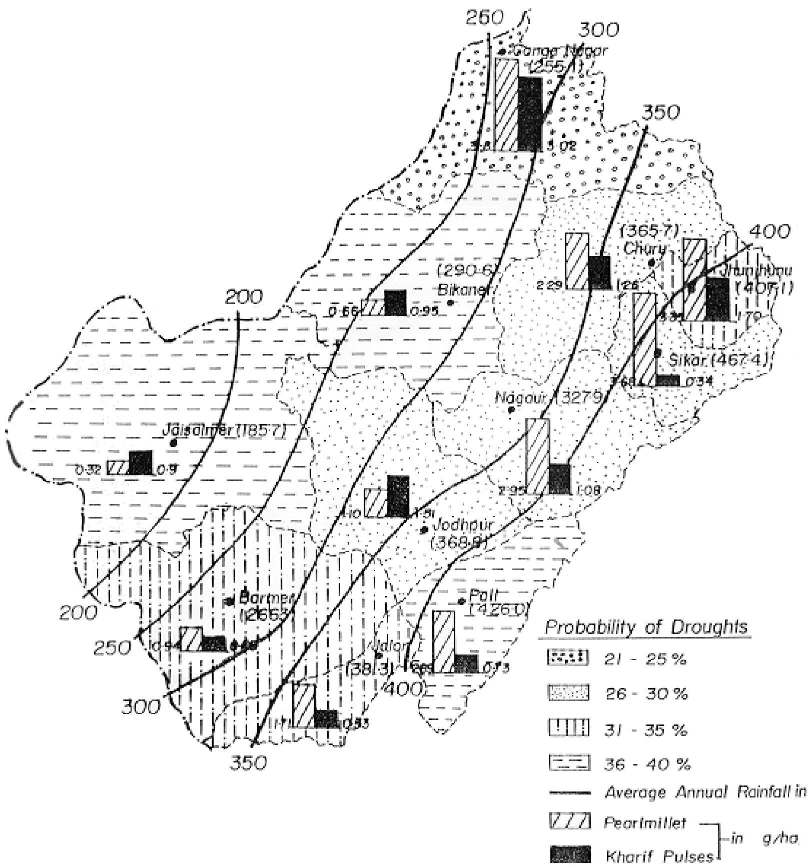


Figure 2. Droughts and crop production in western Rajasthan.

zone to the western low rainfall zone. This demonstrates that the classification of agricultural drought should be based on location specific data, and separate cropping strategies should be adopted for different agroclimatic zones.

Changing Rainfall Patterns

The annual rainfall conditions over arid Rajasthan during the past 5 years (Table 1) show that a major portion of arid Rajasthan has been experiencing above-normal rainfall conditions during the last four years, with a remarkable reduction in wind erosion and the frequency of dust storms. The last episode of severe drought in the region was in 1986 and 1987. The annual rainfall was normal or above normal at Bikaner, Churu, Jalor, Jaisalmer, and Jhunjhunu during 1992 to 1995—i.e., it was normal in all the locations except in the extreme southwestern parts of Barmer region. During 1996, the southwest monsoon was very active, with heavy rains in many parts of arid Rajasthan and reports of flood damage. But it is not known how long the favorable rainfall conditions will prevail. Historical rainfall records of the Indian arid region show that such favorable periods are short-lived. Droughts normally occur about 4 out of every 10 years.

Drought Monitoring and Its Impact on Crop Production

The incidence and spread of agricultural drought over western Rajasthan is monitored each cropping season using a methodology suggested by Sastri et. al (1982), using water availability at different crop phases of pearl millet and pulses. The probability of drought-free conditions in pearl millet is high for Sikar (75%), followed by Barmer (53%), Nagaur (50%), Jodhpur (44%), and Jaisalmer (22%). Computer models like SPAW (Soil-Plant-Air-Water) have also been used successfully for assessment of daily crop water stress and grain yield of pearl millet in Jodhpur district (Rao and Saxton, 1995).

Cropping Strategies for Aberrant Weather Conditions

Crop production strategies for aberrant weather conditions are being developed for the Indian arid region. Selection of short-duration varieties is an important strategy to combat droughts. Pearl millet (var., MH-179, CZP-9401, ICMV-155, CZH-859), Mung bean (var., S-8, K-851, P-9075), clusterbean (var., Maru, JDM 1, FS 277), mothbean (var., Maru, Jadia, CZM 79), and sesame have been found to be drought-tolerant and are grown in the region. Intercropping of pearl millet and grain legume also helps in overcoming drought. Mid-season corrections like reducing plant population (thinning), transplanting pearl millet, spraying anti-transpirants like kaolin, weeding, and creating soil mulch are some of the strategies used to reduce the effects of drought. Cropping strategies under favorable conditions such as the early onset of monsoon might include pearl millet with high density planting followed by a leguminous/fodder crop. Under normal monsoon rainfall conditions, cropping strategies might be pearl millet with a reduced population followed by a legume/fodder crops. One interculture after 25 days of planting is required to control weeds and soil compaction. Under delayed onset of monsoon conditions, short-duration pearl millet, clusterbean, mothbean, cowpea, sesame, or moong could be grown. Sometimes mixed cropping is adopted as insurance against total crop failure.

Runoff Farming

Runoff farming is an age-old practice used by farmers for successful crop production in arid regions. There are two types of runoff farming. In the first, on gently sloping lands, bunds are constructed across the prevailing slope to intercept the runoff. The water thus harvested remains stored in soil profile and is available to the crop during the dry period. Alternately, the field is divided into a series of micro-catchments/ridge and furrows. The water harvested from micro-catchments/ridge is used by the crop grown in furrows. This practice is recommended for areas with adequate soil depth. Field trials over two decades showed successful crop production with this technique. The second practice

Location	1991	1992	1993	1994	1995	Long-term average
Barmer	49	404	378	608	294	264
Bikaner	159	316	227	314	314	288
Churu	305	394	511	377	486	358
Ganganagar	200	354	207	341	273	239
Jalor	164	745	394	733	429	375
Jaisalmer	127	233	371	196	259	183
Jhunjhunu	337	509	401	547	718	399
Jodhpur	232	526	235	396	413	366
Nagaur	275	443	323	255	502	338
Pali	305	686	296	650	578	418
Sikar	159	333	516	400	550	456

Table 1. Annual rainfall (mm) over the Indian arid region.

is the collection of water from natural/artificial catchments in farm ponds, *tanka,* and *nadis*. The water thus collected is used for drinking, plantation, or life-saving irrigation. This has been tried and tested in many locations in western Rajasthan. Studies on the development of improved farm pond design are in progress at the Institute.

Tillage and Residue Management

Both primary and secondary tillage are important in terms of soil preparation, improved infiltration, crust breaking, weed removal, and so forth. The results of field studies for five years showed that minimum tillage for soil preparation with mulching improved soil moisture status by reducing evaporative loss and reduced thermal regimes of soil, thereby minimizing the effects of drought on crops.

Integrated Watershed Approach for Sustainable Production

The Jhanwar watershed project near Jodhpur is adopting an integrated watershed approach for sustainable production by conserving soil and water. Twelve farm ponds were constructed within the watershed for harvesting runoff water for reuse. The integrated approach showed an overall increase in average productivity of various agricultural components, namely, horti-pastoral (*Zyziphus)* fruits (24.0 q ha^{-1}), grass (3.42 t ha^{-1}), pearl millet (10.43 q ha^{-1}), mothbean (4.20 q ha^{-1}), moongbean (5.80 q ha^{-1}), and clusterbean (7.10 q ha^{-1}) (Bhati, 1996).

Use of Shelterbelts and Windbreaks

High wind velocities (up to 40 km/hr) and soil erosion are common features of the arid region that cause considerable damage to sown crops. The effects of high wind velocity have been mitigated largely through the use of shelterbelt plantations (Gupta et al., 1983; Rao et al., 1983). Shelterbelts of *Acacia nilotica*, spp. *indica*, and *Dalbergia sissao* have been successfully established over 102 km at the Suratgarh (Rajasthan). *Cassia siamea* and *Acacia tortilis* shelterbelts have also been found useful in controlling windspeeds (Gupta et al., 1983). Shelterbelts of pearl millet for summer-grown vegetable crops have been instrumental in modifying the crop microclimate and increasing the yield of okra and cowpea by 30%-40% (Ramakrishna et al., 1985)

A. S. Rao, J. P. Gupta, and A. S. Faroda
Central Arid Zone Research Institute
Jodhpur 342 003
India

References

Bhati, T. K. 1996. Integrated land use systems for drylands. *In* A. S. Kolarkar, D. C. Joshi, and Amal Kar, eds. *Land Resources and Their Management for Sustainability in Arid Regions*; pp. 175–86. Scientific Publishers, Jodhpur, India.

Gupta, J. P.; G. G. S. N. Rao; G. N. Gupta; and B. V. Ramana Rao. 1983. Soil drying and wind erosion as affected by different types of shelterbelts planted in the desert region of western Rajasthan, India. *Journal of Arid Environments* 6:53–58.

Ramakrishna, Y. S. 1985. Micro-crop shelter belts for improving crop productivity under irrigated conditions. *In* S. D. Singh, ed. *Proceedings, Development and Management Training Course on Irrigated Agriculture in Arid Regions*; pp. 661–74. Central Arid Zone Research Institute, Jodhpur, India.

Rao, G. G. S. N.; B. V. Ramana Rao; and Y. S. Ramakrishna. 1983. Wind regime and evaporative demand as influenced by shelterbelts. *Idojaras* 87(1):14–21.

Rao, A. S.; and K. E. Saxton. 1995. Analysis of profile soil water and water stress under pearl millet in an Indian arid region using the SPAW model. *Journal of Arid Environments* 29:155–67.

Sastri, A. S. R. A. S.; B. V. Ramana Rao; Y. S. Ramakrishna; and G. G. S. N. Rao. 1982. Agricultural droughts and crop production in the Indian arid zone. *Arch. Met. Geoph. Biokl*., Ser. B, 31:405–11.

Climatic Uncertainties and Recent Experiences in Medium-Range Weather Forecasting over Kashmir

Successful crop management and production require a precise and thorough understanding of agroclimatic conditions of a region. A crop experiences a range of weather conditions during its vegetative and reproductive phases. Although the agronomic inputs at optimum levels decide satisfactory and stable crop yields, the range of weather and climatic optimum prevalent at important crop stages determine the ultimate yields. Thus, even with all inputs at our disposal, we cannot afford to ignore the environmental conditions experienced by the crop. Systematic and continuous measurements of weather elements provide basic data input for tuning any type of computer-based forecasting system. This data also forms the basis for characterizing the climate of a region. We have, therefore, made an attempt to characterize the weather pattern over temperate Kashmir (India) based on location specific data, further presenting results of forecast analyses done at our level. The analysis is based on medium-range weather forecasts received from the National Centre for Medium Range Weather Forecasting, New Delhi.

The Indian Union consists of a number of states. Our study area lies in the states of Jammu and Kashmir. It is located in the northwest corner of India, bordering Pakistan. Its geographical position is between 30°17' N and 37°5' N (latitude) and 73° 26' E and 80°30' E (longitude). Its altitude is 300–8,400 m. Therefore, the state experiences a host of macroclimatic conditions—namely, subtropical valley temperate, dry temperate, and cold arid. The scope of this presentation is restricted to the valley temperate zone, which covers the beautiful valley of Kashmir. It is the cold humid zone (1,500–2,500 m msl), with two cropping seasons, locally called *Kharif* (summer season, from May to October) and *Rabi* (winter season, from October to May). During the summer season, transplanted rice is the most important crop in irrigated areas. Maize is the sec-

Month	Corresponding met. weeks	Max. temp. (° C)	Min. temp. (° C)	RH %	Total rainfall (mm)	Sunshine hours (total)
January	1 to 5	5.8	-1.2	79	48	64.5
February	6 to 9	9.3	0.6	73	84	88.5
March	10 to 13	13.3	4.0	70	135	110.0
April	14 to 18	19.3	7.8	60	131	205.0
May	19 to 22	24.1	11.6	58	71	194.0
June	23 to 26	28.4	15.5	57	34	257.0
July	27 to 31	28.6	18.2	64	114	233.0
August	32 to 35	28.6	17.7	66	70	208.0
September	36 to 39	27.0	13.0	63	30	200.0
October	40 to 44	21.2	5.6	67	34	231.0
November	45 to 48	14.7	0.8	72	26	135.0
December	49 to 52	8.4	-0.9	79	59	62.0

Table 1. Average of meteorological parameters (1983 to 1994).

ond most important crop for rainfed conditions (locally called *karewas*). Such rainfed lands experience water scarcity at critical growth stages during the summer season. The valley temperate region becomes agriculturally dormant after winter sowing, from November onward. Some important temperate fruits—namely, apples, pears, walnuts, almonds, and sweet cherries—are grown at the higher elevations while peaches, plums, apricots, pomegranates, and strawberries are grown in the lower elevations.

Our study area is near the world-famous Shalimar Gardens, where the meteorological observatory is located. Twelve years of daily data have been averaged weekly and monthly (Table 1). Important meteorological parameters measured include temperature, total rainfall, and total hours of bright sunshine. The rice-growing period is from June to September. Mean maximum temperatures during the year range from 5.8°C in January to around 28°C for June, July, and August. Similarly, mean minimum temperature varies between -1.2°C and 18.2°C. The relative humidity increases during winter months.

Many interannual variations exist for rainfall. We calculated a coefficient of variation (CV) value of 20%, which by itself is indicative of the uncertain rainfall over the region. The entire Indian subcontinent is fed by the monsoon rains, whereas our region receives 48% of its precipitation through southwest monsoons and the remaining 52% as a result of western disturbances. These western disturbances are formed as a result of strong narrow currents concentrated along a quasi-horizontal axis, usually in the upper troposphere. As we observe from Table 1, most of the precipitation (rain and snow) is concentrated between January and July, with the highest amount occurring in March. Irregular rainfall coupled with high temperatures from August onward results in moisture stress for rainfed crops like maize, beans, and so forth. Rice, being the main crop of the summer season, is subjected to erratic and untimely rains. Our 12-year average shows that July had 114 mm of rain while June had 34 mm of rain. Drastic deviations of monthly rainfall also occurred in July 1995 (350 mm) and June 1996 (185.2 mm). Consequently, the rice crop suffered severe damage during both years.

Another parameter, hours of bright sunshine, is of immense importance to summer crops in the region. Table 1 indicates that the maximum number of hours of bright sunshine occurs in June. It then decreases until September. January, February, and December are months with a minimum of sunshine. We have already noted that rice is the most important crop of the summer season. Nursery establishments of rice commence in April. Transplanting is done by the first fortnight of June, and the crop matures by the end of September. It is important to note that there is a decrease in total sunshine hours from April to May and again from June to September. This decrease in solar energy at two points in time is probably the major climatic constraint in rice production, the first decrease affecting nursery growth and the second affecting the reproductive and maturity phases. The former results in delayed transplanting and the latter is reflected in yield.

Climatic uncertainties and consequent failures to achieve high production levels have led scientists to further characterize the agricultural climate faced by a crop or cropping system. The next step would be to predict weather behavior. Information on weather 3–10 days in advance has been termed *medium-range weather forecasting* (MRWF). It is vital information that ensures the effectiveness of modern farming practices like sowing of photosensitive varieties, need-based application of fertilizer/pesticides/insecticides, efficient irrigation, and harvesting planning. Since weather in one place may be affected in 1–2 days by weather systems that travel toward the region, it becomes imperative to take global circulation into account while forecasting. In our forecasting system, a super computer located at Delhi is fed global weather data that is processed using the T8OL18 global circulation model (GCM). The output is further matched or cross-checked with (for example) statistical models, synoptic conditions, and the current week's weather to produce a forecast valid for the next 3 days. During the period under report, we received a total of 120 days'

Meteorological parameter	*Overall picture*			*Seasonal breakdown*					
				Summer			Winter		
	C	U	Un	C	U	UN	C	U	Un
Precipitation	42.5	12.5	45.0	38.0	9.0	53.0	48.1	16.7	35.2
Max. temperature	35.8	26.6	37.5	34.8	24.2	41.0	37.0	29.6	33.4
Min. temperature	46.6	29.2	24.2	48.5	30.3	21.2	44.4	27.4	26.2

C: correct; U: usable; Un: unusable

Table 2. Forecast and reality for 120 days' reports (all values in percentages).

Measure	*Seasonal*		*Daily*					
	Summer (66)	Winter (54)	Summer d-1 (22)	Summer d-2 (22)	Summer d-3 (22)	Winter d-1 (18)	Winter d-2 (18)	Winter d-3 (18)
Ratio score	63.60	68.50	68.20	68.20	54.50	77.80	56.00	72.00
H.K. score	0.34	0.35	0.53	0.43	0.03	0.35	0.50	0.42
RMSE	11.32	7.80	7.70	14.90	10.20	6.00	10.20	6.50

(figures in parentheses indicate total reports; 'd' indicates the day)

Table 3. Nonprobabilistic and quantitative verification of precipitation: seasonal and daily.

forecast for our region. The parameters were mainly precipitation and temperature. Using some statistical procedures, we tried to verify the reliability of the forecasts. Tables 2 and 3 give the results of our analysis. In the case of overall reliability of the forecast, we found that less than 50% of the forecasts were correct. Minimum temperatures could be forecasted relatively more accurately than maximum temperatures. Seasonal analysis showed a better forecast skill for precipitation and minimum temperatures for the winter season. Because of the importance of precipitation for crop production, we conducted more analyses, the results of which are given in Table 3. The accuracy of predicting rain vs. no-rain cases is assessed by ratio score, while H.K. score is the ratio of economic saving of a hypothetical set of perfect forecasts compared to forecasts based on climatology. RMSE is a measure of the average degree of correspondence between individual forecasts and actual observations (the higher the RMSE, the lower the forecast's reliability). Analysis showed that precipitation events were more accurately forecasted for the winter season than for the summer season. Further, the daily reliability of forecasts was greater for the first day of the forecast period in both the seasons. We observed an RMSE of 11.32 for summer forecasts and 7.8 for winter, which is indicative of the irregular behavior of summer precipitation. We have observed that summer season rainfall varies from 30 mm in September to as high as 114 mm in July (Table 1), but we have not been able to forecast rainfall events very accurately. This compounds the problem of climatic uncertainties, especially during a season that is very important for crop production.

Dr. Badrul Hasan and
Ms. Rehana Habib Kanth
Division of Agronomy
S.K. University of Agricultural Sciences and Technology
Shalimar Srinagar Kashmir India—191 121

Drought in the United States:

1996 Summary and Historical Perspective

Overview

Considerable variation in moisture conditions, on both a spatial and temporal basis, occurred in the contiguous United States during 1996. A tenth or more of the country experienced severe to extreme short-term (i.e., monthly) precipitation deficits during nearly half of the months (Figure 1), but in many months there were also large areas of excessive precipitation, which resulted in overall national conditions averaging near normal to wetter than normal (again, see Figure 1). From a national perspective, long-term drought peaked at mid-year (Figure 2), when severe drought plagued the South and Southwest.

In the Beginning

The year began on a wet note for most of the nation. By the end of January, only about 3% of the country experienced severe to extreme long-term (i.e., Palmer) drought, while nearly 25% was severely to extremely wet (Figure 2). The dryness was

Month	Northeast	E.N. Central	Central	Southeast	W.N. Central	South	Southwest	Northwest	West	National
Jan.	100	96	81	88	94	26	39	77	70	85
Feb.	53	33	15	22	21	2	61	96	85	33
Mar.	29	28	45	92	51	25	20	22	43	33
Apr.	97	34	80	54	26	25	14	100	67	60
May	84	70	96	40	95	5	26	95	90	81
Spr.*	90	40	94	73	79	6	13	94	69	61
Jun.	91	78	67	36	16	60	81	21	38	43
Jul.	101	54	93	48	34	81	59	40	59	90
Aug.	9	26	16	70	32	99	41	26	15	58
Sum.**	92	54	64	43	13	97	63	9	26	75
Sep.	86	27	76	76	92	77	96	88	47	94
Oct.	83	85	37	69	93	39	62	93	48	66
Nov.	56	76	81	71	100	90	74	85	78	93
Aut.***	96	71	85	90	100	86	80	96	72	99
Dec.	95	64	25	27	101	14	45	102	101	89
Annual	102	67	88	73	86	44	45	102	97	98

*Spr.: Spring = March, April, and May
**Sum.: Summer = June, July, and August
***Aut.: Autumn = September, October, and November

Table 1. Monthly, seasonal, and annual 1996 ranks for the contiguous United States and its nine climatological regions. A rank of 1 = driest, 102 = wettest, based on data from 1895 to 1996.

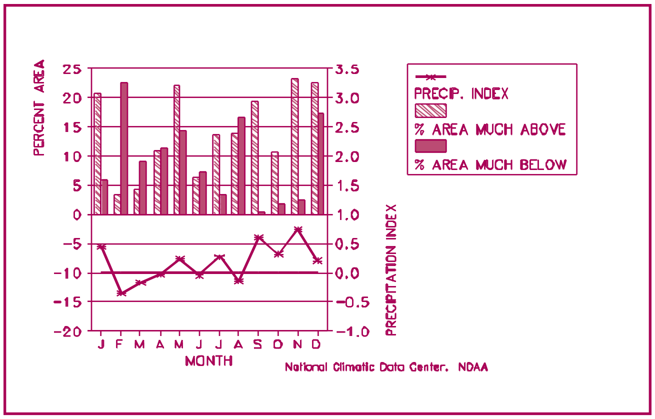


Figure 1. Percent area of the contiguous United States with much above or much below normal precipitation (top) and the monthly precipitation index averaged across the contiguous United States (bottom). Precipitation in the upper ten percentile is categorized as much above normal and that in the lower ten percentile much below normal.

concentrated primarily in the southern Plains, with the south region having the 26th driest January on record (Table 1).

February 1996 was much drier for most of the nation (33rd driest), with most regions east of the Rockies (all regions but the northeast) ranking within the dry third of the historical distribution (Table 1).

Spring

The dry pattern shifted during the spring months (March–May). Most regions that were dry during one or two of these months were wet during the remaining months, except for the south and southwest regions, where drought progressively worsened. Nationwide dryness peaked during May, when nearly 20% of the country experienced severe to extreme long-term (Palmer Index) drought (Figure 2).

The persistent spring dryness in the south region (Figure 3) and southwest region, according to news reports, ravaged the winter wheat crop. October through March is the growing season for the primary hard red winter wheat belt, which consists of most of Kansas, the western half of Oklahoma, and the Texas panhandle (i.e., the northern part of the south region). October 1995–March 1996 was the second driest such growing season for this agricultural belt since 1895 (Figure 4). In 1996, the south region had the second driest February, second driest January–February, eighth driest September–February, fifth driest May, fifth driest April–May, and sixth driest spring (Figure 5), based on data going back to 1895 (Table 1). The southwest region had the fifth driest November–March, fifth driest June–May, and 13th driest spring (Figure 6) on record in 1996 (Table 1).

Summer

Summer (June–August) rains brought relief from the drought to the south (Figure 3) and southwest regions. However, despite the June precipitation, the south region still had the fifth driest January–June on record (Figure 7). Short-term dryness occurred during June in the northwest and west north central regions, and during August in several regions (see Table 1). The northeast region had the ninth driest August since 1895. By the end of August, the northwest region had the ninth driest summer and the west north central region had the 13th driest summer on record.

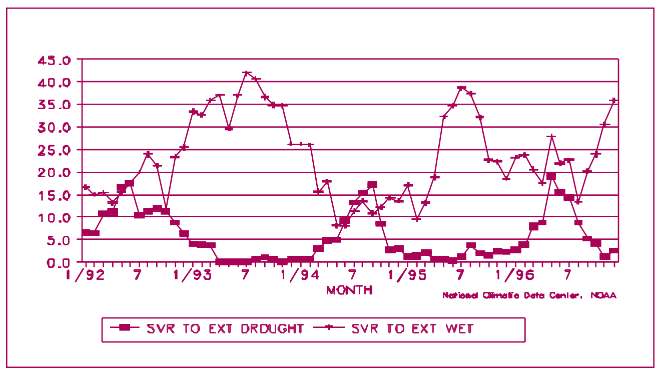


Figure 2. U.S. percent area dry and wet, January 1992–December 1996.

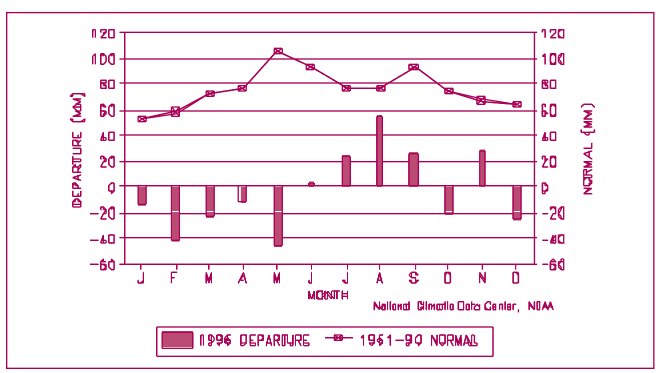


Figure 3. South region 1996 precipitation, normal and 1966 departure from normal.

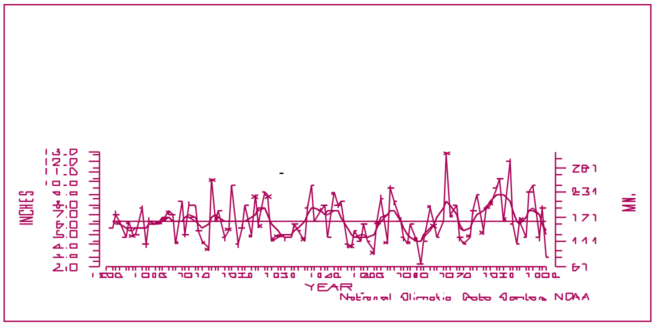


Figure 4. Primary hard red winter wheat belt precipitation, October–March 1895/96–1995/96. Thick smooth curve is 9-point binomial filter.

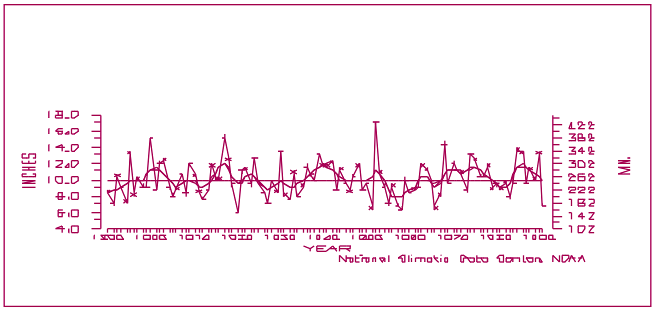


Figure 5. South region precipitation, spring (March–May) 1895–1996. Thick smooth curve is 9-point binomial filter.

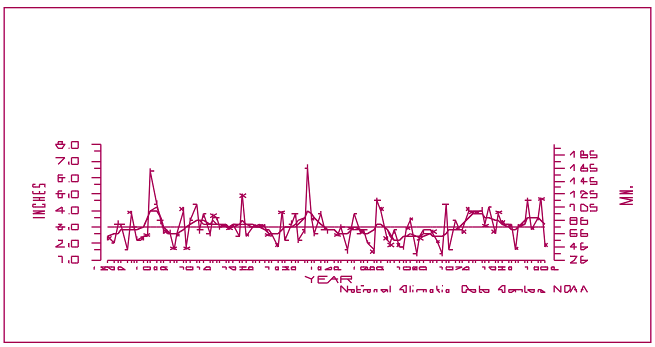


Figure 6. Southwest region precipitation, spring (March–May) 1895–1996. Thick smooth curve is 9-point binomial filter.

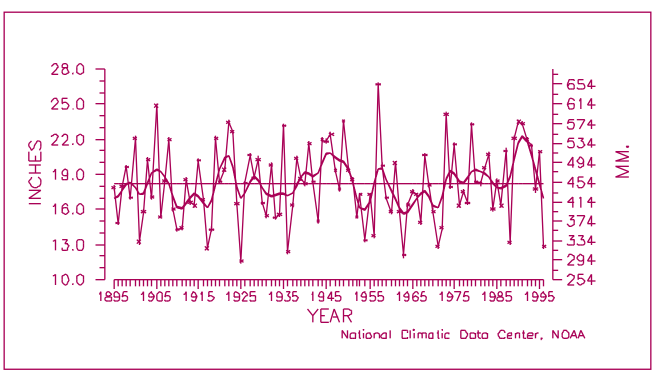


Figure 7. South region precipitation, January–June 1895–1996.

Autumn

Autumn (September–November) was wet over large parts of the United States (Figure 1), with the nation as a whole experiencing the fourth wettest autumn on record in 1996 (Table 1). Only one region (the east north central) ranked in the dry third of the historical distribution for September, and no regions ranked in this category during October and November.

Year-End

Short-term dryness returned to the south region in December, with the three regions from the Ohio Valley (i.e., central region) to the south and southeast ranking in the dry third of the historical distribution (Table 1). The large area of unusual dryness in December was offset by a larger area of unusual wetness (Figure 1), especially in the west, northwest, west north central, and northeast regions, resulting in a national precipitation rank of 14th wettest December (Table 1).

Once again, by the end of the year, only about 3% of the country was experiencing severe to extreme long-term (i.e., Palmer) drought, while more than a third was severely to extremely wet (Figure 2). Nationally, 1996 ranked as the fifth wettest year on record. For the southwest and south regions, which were plagued by severe drought earlier in the year, the 1996 annual rank was in the middle of the historical distribution (Table 1).

William O. Brown and Richard R. Heim, Jr.
National Climatic Data Center, NOAA
Global Climate Lab
Federal Building
Asheville, NC 28801
USA

Announcements

Conferences

Local Authorities Confronting Disasters and Emergencies—Third International Conference

Local Authorities Confronting Disasters and Emergencies: Third International Conference will be held June 26–July 1, 1998, in Edmonton, Alberta, Canada. The conference will provide a multidisciplinary forum to enhance global partnerships and create solutions aimed at mitigating disasters that affect people, property, and the environment in communities around the world.

Local Authorities Confronting Disasters and Emergencies (LACDE) International resulted from an initiative of a local authority association in Israel and was formed in October 1994 following the first international conference in Tel Aviv. A second international conference was held in Amsterdam in April 1996. LACDE is a growing association with a broad international support base. Its members and sponsors include the United Nations, municipalities, regional authorities, countries, and the private sector worldwide. The aim of LACDE is to increase the effectiveness of local authorities in preparing for and responding to potential disasters and emergencies, both natural and manmade.

Previous conference workshops have covered topics such as natural and technological disasters, the role of local authorities in emergencies, early warning systems, search and rescue, and media roles in disaster.

For further information, contact Dave Hodgins, Managing Director, at (403) 496–3766, or visit the conference website at http://www.freenet.edmonton.ab.ca/disaster.

1997 National Conference on Delivering Health and Medical Services in Catastrophic Disasters

The 1997 National Conference on Delivering Health and Medical Services in Catastrophic Disasters, sponsored by the National Disaster Medical System (NDMS), will be held at the Hyatt Regency at Tampa City Center, Tampa, Florida, May 3–7, 1997. Preconference courses will be conducted May 3–4, and the main conference will be held May 5–7. The 1997 conference will feature tracks focusing on the following issues: (1) public health, (2) planning management and coordination, (3) clinical medicine, (4) field response, and (5) health care facilities. For more information, contact NDMS at 1–800–USA–NDMS, extension 444.

Books

Policy Making in an Era of Global Environmental Change

The relationship between global change science and policy making is underscored in *Policy Making in an Era of Global Environmental Change* (R. E. Munn, J. W. M. la Rivière, and N. van Lookeren Campagne, eds.). The book provides an overview of ongoing global change research, focusing on the International Geosphere-Biosphere Programme and the World Climate Research Programme. Results of the latest review of the Intergovernmental Panel on Climate Change (IPCC) are also included, followed by an analysis of how business and industry and public interest groups are responding to global change research results. The book is published by Kluwer Academic Publishers Group, Dordrecht, The Netherlands.

Let Us Know . . .

*If your address has changed or needs to be corrected, if you are receiving duplicate mailings, or if you're no longer interested in receiving **Drought Network News**, would you please help us keep our mailing list up to date by filling out the form below and returning it to:*

IDIC/NDMC
239 L. W. Chase Hall
University of Nebraska
P.O. Box 830749
Lincoln, NE 68583–0749
USA
Telephone (402) 472–6707
Fax (402) 472–6614
e-mail ndmc@enso.unl.edu

If responding by conventional mail, please return this form with the mailing label still attached to the reverse side (non-U.S. members: please include the mailing label from the envelope). If responding by e-mail or fax, please include your old address as well as your new address.

____ Change/correction of address
____ Receiving duplicate mailings (please include mailing labels from all duplicates)
____ Delete my name from the *Drought Network News* mailing list

Name ______________________________

Organization ______________________________

New/Corrected Address ______________________________

____

____

____

Telephone ______________________________
Fax ______________________________
e-mail ______________________________

Drought Network News is published three times a year by the International Drought Information Center (IDIC) and National Drought Mitigation Center (NDMC). The IDIC and NDMC are part of the Department of Agricultural Meteorology at the University of Nebraska–Lincoln. Funding for the newsletter is provided by the International Activities Division, National Weather Service/NOAA, through their cooperative program with the World Meteorological Organization, Climate Prediction Center, National Weather Service/NOAA, and Cooperative State Research, Extension, and Education Service, U.S. Department of Agriculture.

Drought Network News encourages readers to submit information on current episodes of drought and its impacts; timely reports of response, mitigation, and planning actions of governments and international organizations (successes *and* failures); recent research results and new technologies that may advance the science of drought planning and management; recent publications; conference reports and news of forthcoming meetings; and editorials. If references accompany articles, please provide *full bibliographic citations*. All artwork *must* be *camera-ready*—please provide clear, sharp copies (in black/gray and white only—we are unable to reproduce color artwork) that can be photocopied/reduced without losing any detail. Correspondence should be addressed to

Drought Network News
IDIC/NDMC
239 L. W. Chase Hall
University of Nebraska
P.O. Box 830749
Lincoln, NE 68583–0749
USA

Telephone: (402) 472–6707
e-mail: ndmc@enso.unl.edu
WWW: http://enso.unl.edu/ndmc

Subscriptions to ***Drought Network News*** may be obtained, free of charge, by contacting Vicki Wilcox at the street or e-mail address or the telephone or fax number to the left.

Director: Donald Wilhite
Climate Impacts Specialist: Michael Hayes
Climate/Water Resources Specialist: Mark Svoboda
Information Specialist: Kelly Helm Smith
Publications Specialist: Deborah Wood
Graphics Designer: Sandra Wolfe Wood
Secretary: Vicki Wilcox
Systems Analyst: James Hines

Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln

IDIC/NDMC
239 L. W. Chase Hall
University of Nebraska
P.O. Box 830749
Lincoln, NE 68583–0749
USA