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Drought Network News

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From the Director

I recently participated in an advanced course, "Management Strategies to Mitigate Drought in the Mediterranean: Monitoring, Risk Analysis, and Contingency Planning", in Rabat, Morocco (May 21–26). The course was organized by the Mediterranean Agronomic Institute of Zaragoza (CIHEAM–IAMZ) and the Institut Agronomique et Veterinaire Hassan II in Rabat, Morocco, with contribution from the European Commission. The National Drought Mitigation Center's Mark Svoboda also participated. Other lecturers included M. Wassif (Desert Research Center, Cairo); Eddy dePauw (ICARDA); Ana Iglesias (Universidad Politecnica, Madrid, and Center for Climate Systems Research, Columbia University); Karl Monnik (Institute for Soil, Climate and Water/ARC, South Africa); Manuel Menendez (CEDEX, Madrid, Spain); José Guerrero Ginel (Universidad de Córdoba, Córboda, Spain); and Tayeb Ameziane, Omar Kerkat, and Mohammed Doukkali from IAVII, Rabat, Morocco. About 30 persons from 11 countries within the region participated in the course.

The goal of the course was to provide participants with methodologies and technical tools to develop and implement comprehensive drought preparedness plans. The format for the course was a series of lectures and a series of practicals focused on climatic indices and GIS techniques. The specific objectives of the course were included in the Fall 2000 issue (Volume 12, No. 3) of D*rought Network News*. I hope to include a more detailed summary of the course in a subsequent issue of this newsletter.

My travels and interactions with scientists and policy makers throughout the world repeatedly illustrate the importance of working together to reduce societal vulnerability to drought. To enhance national capacities for drought preparedness, I am currently launching a Global Drought Preparedness Network through both the International Drought Information Center and the National Drought Mitigation Center at the University of Nebraska. The goal is to create a "network of regional drought preparedness networks" to facilitate the sharing of information within and between regions and undertake specific regional projects. This concept was accepted for the Mediterranean region at the advanced course in Morocco (discussed above), and plans are underway to establish networks in South America, North America, eastern and central Europe, and Sub-Saharan Africa. I am hoping to

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encourage the adoption of this concept through the development of several regional networks in Asia in the near future. I have prepared a concept paper on this networking project that will be included in the next issue of *Drought Network News*. In the meantime, I will be contacting key organizations to garner support for this network and enlist their cooperation and collaboration. If you are interested in finding out more about this project, please contact me by e-mail at DWILHITE1@unl.edu.

This issue of *Drought Network News* contains articles on drought in Iran, India, and Nebraska. Readers are invited to submit articles for the next issue; the deadline to do so is August 20, 2001. Readers are also encouraged to submit announcements of workshops, conferences, and other information of interest to our network members.

Donald A. Wilhite

Contents

Emergency Managers Adopt Position on Drought Policy

At its Mid-Year Retreat at the FEMA National Emergency Training Center in Emmitsburg, Maryland, the International Association of Emergency Managers (IAEM) adopted a position in support of the development of a national drought policy. IAEM called on Congress, the Federal Emergency Management Agency (FEMA), and other federal agencies to give high priority to "the establishment of a National Drought Policy Council to coordinate the activities of more than 47 Federal programs dealing with drought and to evaluate the recommendations of the National Drought Policy Commission." The text of IAEM's Position Paper can be found at http://www.iaem.com/national_drought_policy.html. IAEM is a nonprofit organization of more than 1,700 emergency management professionals from local, state, and federal governments; military; private industry; and volunteer organizations.

Results of a Rapid Appraisal Study

Agricultural Producers' Perceptions of Drought Vulnerability and Mitigation—Howard County, Nebraska

Introduction

Drought is the leading natural disaster in the United States in terms of monetary losses. The National Research Council (1995) estimates that drought costs the United States an average of $6–8 billion per year. Because of these losses and the great effects of drought on many citizens' quality of life, drought planning is gaining widespread support in the United States. However, U.S. drought planning within the agricultural sector has historically focused on response measures that help producers, primarily farmers, deal with and recover from drought. It has been found that these often ad-hoc drought responses are very expensive and do little to reduce ongoing drought vulnerability (Wilhite, 1997).

Subsequently, current national drought planning efforts, as discussed in *Preparing for Drought in the 21st Century* (National Drought Policy Commission, 2000), have shifted to an emphasis on drought mitigation programs—that is, modifying operations before a drought strikes in order to reduce the impending negative impacts. In terms of agricultural drought planning, these programs necessitate increased communication between agricultural producers, private businesses, and government planners.

Since its inception in 1995, the National Drought Mitigation Center (NDMC) has striven to promote drought mitigation planning and increase the communication between federal, state, and local drought planners. Essential in these endeavors is input from agricultural producers that deal with drought at the "ground level." Therefore, a study was undertaken to gain insight into agricultural producers' perceptions of current drought issues, which yielded valuable information on several topics, including perceptions of drought vulnerability, the use of climate forecast information, the implementation of drought mitigation measures, and the roles of external groups in drought planning.

The Study

A rapid appraisal study was undertaken by graduate students at the University of Nebraska as part of a course project with cooperation from the NDMC and the University of Nebraska Howard County Cooperative Extension Service. The study focused on agricultural producers in Howard County, Nebraska, selected by a random sampling conducted by the Howard County Cooperative Extension Service. The research consisted of analyzing a mail-back survey and a focus group using a combination of qualitative and quantitative methods. The mail-back survey yielded 29 surveys containing a variety of closed and open-ended responses, while the focus group provided an in-depth discussion with four local producers. The study was completed in November 2000, which was seen as an opportune time since local producers had just experienced a severe drought over the previous year.

Selected Survey Findings

Survey respondents ranged in age from 35 to 78, with an average age of 53 years. Most operations could be classified as diversified, with a majority (74%) producing a combination of corn, cattle, and hay. Four operations irrigated 100% of their farmlands while three were completely dryland. The remaining operations irrigated 15–90% of their farmlands, with an overall average of 57%.

Drought Vulnerability

In general, most producers felt that they were moderately to highly vulnerable to the effects of drought (Figure 1). As expected, 54% of producers stated that having dryland pastures and crops was the main reason why they were more vulnerable to drought than other producers were. Many of these producers felt that they were doubly affected by drought through poor pasture grass production and crop losses. Although a mix of cattle and crop production is a standard dryland adaptation, it may enhance the perception of drought vulnerability. In addition, some farmers stated that even though they irrigate, poor wells, uncertain surface water sources, sandy soils, and reliance on gravity irrigation (as opposed to pivot irrigation) made them more vulnerable than other irrigators.

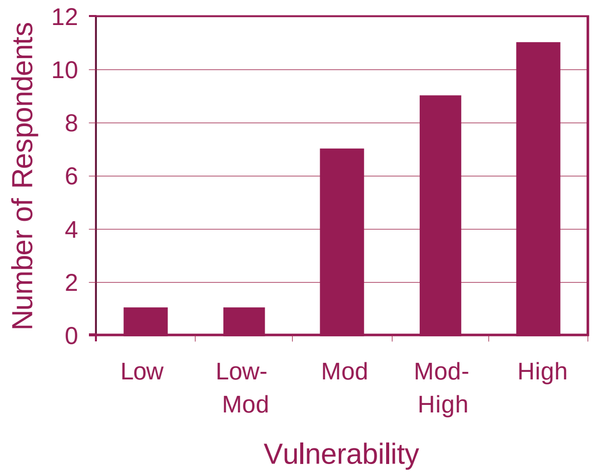

Figure 1. Drought vulnerability.

Nebraska drought researchers, such as Wilhelmi (1999), have modeled local drought vulnerability based on irrigation, climate, soils, and crop type. When asked to rank a range of drought vulnerability influences, survey respondents recognized the importance of these factors but also ranked capital reserves and soil conservation practices as equally important (Table 1). Focus group participants also cited the importance of irrigation type and crop diversity in determining vulnerability. This study suggests that, although more difficult to assess, other vulnerability factors such as capital reserves, the diversity of crops grown, type of irrigation, and soil conservation measures should also be included in future modeling efforts when possible.

Weather Information and Forecasts

Surveys showed that most producers receive their weather information from television (97%) and radio (93%), followed by Digital Transmission Network services (35%), newspapers (28%), friends/neighbors (21%), the Internet (17%), trade journals (14%), and the Farmer's Almanac (3%). In terms of long-term drought forecast models, 64% reported having seen the U.S. Drought Monitor (2001) and 32% cited that they occasionally or regularly use it to make farming decisions. The statistics were nearly identical for the Climate Prediction Center forecasts (2001).

Amount of irrigation	2.8
Climate	3.3
Soil conservation practices	4.2
Type of crop(s) grown	4.3
Amount of capital reserves	4.3
Soil types	4.8
Stocking rates	5.0
Hay or feed availability	5.5
Nonfarm income	6.6
Religion/prayer	6.7

**Ranked on a ten-point scale with "1" being the most important

Table 1. Average rankings of vulnerability determinants.

Use of Weather Forecasts

Thirty-one percent of respondents reported that they would not modify their farming operation if a drought were predicted in the next growing season. They consistently stated that this was due to the unreliability of the forecast products. One respondent also noted that they could not afford to modify their production.

On the other hand, 69% of the respondents reported that they would modify their operation through a variety of means. Instead of corn, operators would plant more soybeans, sorghum, and hay, especially on poor soils or on areas with less certain water supplies. Crops would be planted thinner for increased viability. Operators would also till less and use less fertilizer. Cattle producers would plant or acquire additional hay, silage, or pastures. Cattle stocking rates would also be adjusted or reduced. Some of the respondents suggested that some modifications may be based on forecast information while others may be undertaken during a drought as needed.

Limitations to Drought Preparedness

As a whole, producers cited many of the drought mitigation strategies recommended by the University of Nebraska Cooperative Extension Service (2000). However, each producer typically only reported implementing one or two of the suggestions in their own operation, as opposed to the multi-strategy approach envisioned by drought planners. As an explanation, 76% of operators cited many circumstances that prevent them from fully preparing for drought. These circumstances include a lack of capital reserves and the need to maintain cash flows, the unreliability of forecasts, and the lack of drought management experience.

In terms of capital reserves, operators reported that modifying operations to prepare for drought was expensive and some producers could not afford to purchase different types of tillage equipment, drill new wells, or install irrigation equipment. This was noted to be especially difficult when landlords are inflexible in their leasing structure. Others also mentioned that the market also hindered many producers from switching to more drought-tolerant crops. "If you can't sell sorghum, why produce it?" was the reply of one of the respondents. Several farmers noted that their operation must maintain cash flows to meet loan requirements and that they would look like poor managers if they planned for drought and it did not occur, especially those with low capital reserves. As one respondent stated, "with capital reserves low or none, you have to try and produce all you can if it should rain. You wouldn't look good to your banker if it started to rain in July and you figured on a drought." Finally, some producers stated that the main obstacles to drought planning are generally poor management practices. Some of these comments were based on the complexity of drought planning while others focused on the negligence of some producers.

Drought Response Assistance

Survey results indicate that these producers rely most on their families, communities, and churches to help them cope with drought situations (Table 2). This demonstrates the often-overlooked role that these groups play in helping people through hard times. Given the importance placed on finances in drought mitigation, it is no surprise that bankers and loan officers rank next, with the federal government close behind. State government, extension agents, trade and industry groups, and county/city governments played lesser and nearly equal roles.

External Groups	Average Rankings
Family and/or community support	2.25
Church or other faith community	1.93
Bank or loan officer	1.86
Federal government	1.79
Extension agent	0.85
State government	0.81
County/city government	0.59

** Ranked on a four-point scale with "3" being the most important

Table 2. Reliance on external groups during drought.

Selected Conclusions and Recommendations

- Drought Vulnerability Modeling—Drought vulnerability modeling efforts such as Wilhelmi (1999) are essential for understanding and identifying local and regional vulnerability factors. When feasible, attempts should be made to incorporate other social and localized factors such as irrigation type, capital reserves, conservation techniques, and farm/ranch diversity into drought vulnerability modeling efforts for enhanced representations.
- Drought Education—Several respondents noted a lack of training and/or negligence as the primary limitation to drought planning, which stresses the continuing need for drought education. This study shows that the majority of operators receive weather information through television, radio, Digital Transmission Network services, and newspapers. Information products should be tailored for these media outlets along with other contemporary government outlets such as the Internet, public meetings, and mailings.
- Enhanced Cooperation—Although many farmers would make some modifications to their operations during drought, many are hesitant to fully commit to mitigation efforts because of their uncertainty about long-term weather forecasts and financial concerns. Enhanced three-way communication between producers, financial lenders, and drought planners may allow for a broader understanding of forecast benefits and limitations and "get everyone on the same page" in terms of financial needs and expectations for the long-term viability of local agricultural communities.
- Production Markets—Reliable and adequate markets for alternative crops must be established in order for many farmers to change planting strategies. There is a realization that many of these related issues are decided at the federal level, but it was suggested that state and local planners could provide incentives and help ensure local markets.
- Rental Agreements—Landlords and tenants should work together to develop flexible arrangements that increase the viability of the land and operation before and during drought. "Floating" rate structures on leases was mentioned as a particularly useful agreement to reduce drought risk.
- Financial Assistance Programs—Additional or more identifiable state, federal, and private incentives and

assistance programs may be needed to help operators implement capital-intensive mitigation and response measures. The National Drought Policy Commission (2000) cites roughly 80 federal and state drought programs. These programs should be marketed to local producers along with adequate technical assistance during the implementation and application process.

- Social Assistance Programs—Family, community, and church support is seen as essential in sustaining producers through periods of drought. Family counseling specialists and members of the clergy should be included in drought planning and response efforts. This is often stated as important in drought planning but rarely done.
- Further Research—Similar research should be conducted in other areas for a better understanding of regional drought variations.

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Droughts and Dew Bean Productivity in Northwestern Arid Rajasthan, India

Arid ecosystems constitute an important part of the world's dry climates. The Indian arid zone is characterized by a harsh and fragile system, which influences the productivity (both quantitative and qualitative) and socioeconomic status of the inhabitants. The study discussed in this article was conducted in the Bikaner region, which is one of the most drought-prone districts of Rajasthan (Figure 1). Annual rainfall in the district is 268 mm, of which 85% occurs during the southwest summer monsoon (July–September). The region is known to experience extreme variations in diurnal and seasonal temperatures and high wind velocity, particularly during summers, associated with high evaporative atmospheric demands. Skies tend to be clear (cloud free) in these regions throughout most of the year. Soils of the Bikaner region are characteristically light and sandy, with a high infiltration rate and <100 mm field capacity, and are prone to wind erosion. Cultivation of crops is a challenging task under prevailing hostile atmospheric situations and soil limitations.

Agriculture is predominantly rainfed in this region. Among the arable crops, dew bean (Vigna aconitifolia [Jacq.] Marechal), commonly known as moth bean, is rated as one of the most adapted arid legumes in the region, because of its tolerance to drought and heat (Kumar, 1996). It matures in 70–75 days, matching the length of the rainy season in the region, and it fits well in harsh climates with rainfall of 200–250 mm, even when rainfall distribution is erratic. Hence, 25% of the moth bean area (269,971 ha) of Rajasthan state is confined to the arid district of Bikaner. The moth bean crop is grown as a "neglected" crop in this region, left up to the mercy of farmers. As such, no crop improvement programs have been adopted for this crop. It forms an important protein supplement in vegetarian diets and is used for several confectionary items throughout the country.

The crop is cultivated alone and in various cropping systems on plains and sand dunes. Its water requirement is very low. On average, the evapotranspiration rate is 1.8–2.2 mm day^{-1} during emergence and

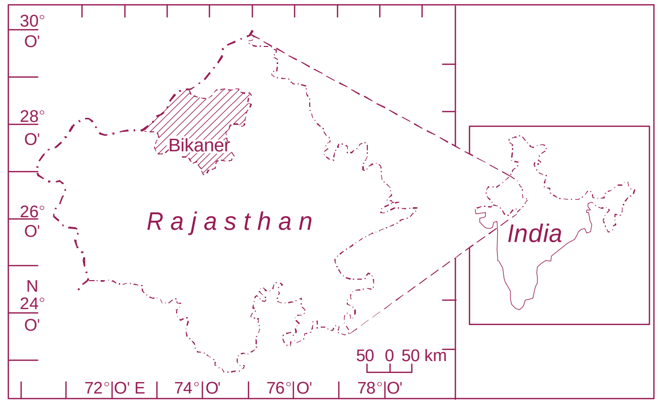

Figure 1. Location of study area.

early growth stages of the crop, with a maximum of 4.8 mm day^{-1} during flowering and pod formation stages (Singh et al., 2000). It is, however, susceptible to yellow mosaic virus disease. In the Bikaner region, insufficient and erratic rains, coupled with exceptionally longer dry spells (20–40 days), cause poor emergence and seedling mortality, which in turn result in patchy and poor plant stand. This study focuses on the relationship between interannual variability in crop productivity and rainfall, using drought frequencies and their intensities to discuss crop performance over the last 30 years (1968–97).

Interannual Variability in Moth Bean Production

Variation in net sown area (hectares) and total production (tons) of moth bean over the 30 years in this study is shown in Figure 2. Normal production of moth beans was 39,643 tons against the long-term mean area of 269,971 ha. Variability in crop production (90%) was many times higher than the variability in the net sown area (16%). Slight to negligible reduction in crop area in drought years shows farmers' preferences for this crop. Long-term linear trends also indicate that there was no significant change in net sown area and total production over the reported periods, excepting 1975–78. Thus, stagnation in area and production of this important arid legume over the last 30 years is a matter of great concern, considering its potential in arid ecosystems. It is grown as a second-choice crop by small and marginal farmers only, which is not a healthy trend.

Rainfall and Crop Yields

Year-to-year fluctuations in rainfall (July–September) and crop yields (kg ha^{-1}) are shown in Figure 3. Average crop yield was 139.1 kg ha^{-1} and average rainfall during the cropping season (July–September) was 191 mm. The maximum crop yield (613 kg ha^{-1}) occurred in 1977, which had good monsoon rains. The worst crop yield year was 1987, which experienced severe drought. The long-term trend in crop productivity data emphatically indicates that there was no change (increasing or decreasing) in the productivity pattern of the moth bean crop in this dry region. There are few visible technological impacts on the productivity of this legume in the Bikaner region. A positive sign, however, is the crop's responsiveness to variations in rainfall. Higher yields of the moth bean during 1975–78 are explained by adequate, well-distributed rainfall. Thus, moth bean has tremendous potential in arid regions of northwestern Rajasthan, and rainfall during July–September plays an important role in determining its yield. The linear regression between the crop yield (Y) and rainfall (X) during July–September is given below.

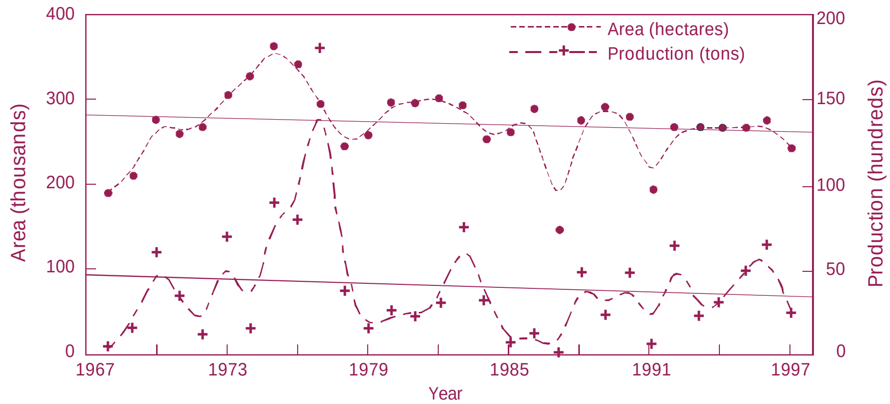

Figure 2. Interannual variability and trends in moth bean area and production from Bikaner region of Indian desert (1968–97).

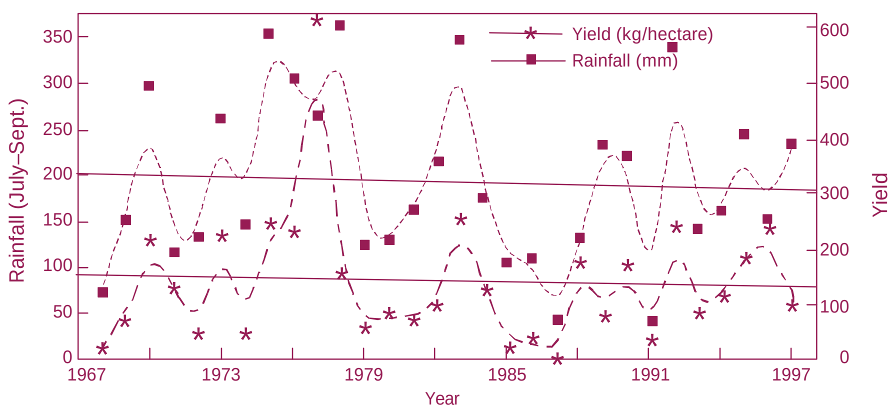

Figure 3. Interseasonal fluctuations and trends in rainfall and moth bean yield from Bikaner district of Indian desert (1968–97).

No drought years	1975, 1977, 1978, 1983, 1992, 1995, and 1996 (7 years)
Mild drought years	1970, 1973, 1976, 1980, 1982, and 1997 (6 years)
Moderate drought years	1969, 1971, 1984, 1988, 1989, 1990, and 1994 (7 years)
Severe drought years	1968, 1972, 1974, 1979, 1981, 1985, 1986, 1987, 1991, and 1993 (10 years)

Table 1. Intensity and frequency of agricultural drought over Bikaner district, 1968–97.

Drought Intensity	Frequency	Average Area (ha)	Percent Reduction	Average Production (tons)	Percent Reduction (kg/ha)	Average Yield	Percent Reduction
No drought	7	285,148	—	79,307	—	274.3	—
Mild drought	6	294,267	—	47,660	40	159.0	42
Moderate drought	7	262,449	8	33,145	58	124.6	55
Severe drought	10	250,035	12	11,616	85	42.6	85

Table 2. Impact of agricultural drought on productivity of moth bean crop in Bikaner district, 1968-97.

$$Y = 0.81 \times X - 14.8; r = 0.6245^{**}$$

** significant at $P = 0.01$ with $R^2 = 0.39$ and d.f. = 29

The crop yields (Y) have a better association (r = 0.8116) with rainfall (X) during the first fortnight of September, which normally coincides with the reproductive (pod filling) stage of the crop. The linear regression is shown below.

$$Y = 3.05 \times X + 78.3; r = 0.8116^{**}$$

**significant at $P = 0.01$ with $R^2 = 0.66$ and d.f. = 29

Agricultural Droughts and Crop Productivity

The climatic water balance was determined on a weekly basis using precipitation and potential evapotranspiration data for each cropping season (July–September) over the 30-year period 1968–97, as adapted by Thornthwaite and Mather (1955). The ratio of actual evapotranspiration (AET) to potential evapotranspiration (PET) was computed for each week/growth stage of the crop to determine the intensity of drought experienced by the crop in the region (Sastri et al., 1982). The moth bean crop experienced severe agricultural droughts during 10 years, moderate droughts during 7 years, mild droughts during 6 years, and no droughts during 7 years in the region (Table 1). This also indicates that droughts are frequent and common phenomena in the region. In general, the crop suffers severe/moderate agricultural droughts in every alternate year, which adversely affects crop production.

It is worth mentioning that during severe drought situations, the cropped area was reduced insignificantly (12%) while the productivity of this arid legume was reduced about 85%. Moderate drought reduced yields by about 55%, but the cropped area was reduced by only 8% (Table 2). These figures reveal that even under moderate to severe droughts, farmers in the Bikaner region are committed to planting this drought-hardy arid legume. Lesser fluctuations in the cropped area during drought years confirm the preference of farmers for this crop and the high degree of adaptation of the moth bean to the harsh situations (drought, heat, and soil movement) in Bikaner. Compared to the total failure of other crops like pearl millet, reductions of 85% in severe drought years and only 55% in moderate drought years reveal the drought hardiness of moth beans. Increasing drought tolerance and production potential of drought-hardy legumes is necessary for bringing sustainability to this agro-ecosystem of a hot and hostile arid district of the Indian subcontinent.

Strategies for the Future

Agricultural scientists/planners should address the following issues:

- Breeding for biotic and abiotic stresses to enhance production potential.
- Development of early maturing strains of 60–65 days.
- Developing suitable innoculum for N-fixation.
- Adoption of improved agronomic practices.
- Adoption of promotional policies for increasing the area planted to moth beans, raising the status of the crop from neglect to subsistence crop levels, and forging linkages with agro-based industries in the region.

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Winter Drought in Iran: Associations with ENSO

Introduction

The Islamic Republic of Iran (Figure 1) has an area of 1,648,000 km^2 and a population of 65 million people (1995 estimate). The country has arid and semiarid climates and the occurrence of rainfall is unreliable, with a coefficient of variation as high as 70%. The average annual precipitation over the country is around 250 mm. Two mountain ridges, the Alborz and Zagros (Figure 1), which run east and southeast from the northwest corner of the country, play an influential role in determining the amount and spatial distribution of rainfall. The peaks of Alborz and Zagros are about 5,700 m and 4,000 m, respectively.

Rainfall generally occurs from October to March (winter), with extreme events during January and February. Annual rainfall over the northern sides of the Alborz range may reach 1,800 mm, but for the central and eastern deserts, the yearly total is around 50 mm. Droughts and floods are common, and the severity and hardships of these natural disasters frequently hit both rural and urban societies. Drought limits dryland farming and affects the productivity of irrigated lands. Moreover, due to massive overgrazing, large-scale soil erosion occurs during dry spells. Atmospheric and climatic incidents (i.e., floods, droughts, and lightning) account for about 97% of all natural disaster costs. Concern about water resources is currently realized as one of the most important issues for most of the Iranian scientific and management communities. 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 drought inflicted $3.5 billion in damages, killing 800,000 head of livestock and drying up major reservoirs and internal lakes (Pagano et al., 2001).

Nazemosadat and Cordery (2000a) and Nazemosadat (1999) have recently revealed that the autumn rainfall in Iran is negatively correlated with the Southern Oscillation Index (SOI). The relationships were found to be strong and consistent over the southern foothills of the Alborz Mountains, northwestern districts, and central areas. Since winter rainfall contributes a major portion of Iranian water resources, the shortage of rainfall during this season is the most important cause of drought in Iran. Nazemosadat and Cordery (2000b) have therefore focused on the impact of ENSO on winter precipitation in Iran. The present study outlines some key results of the aforementioned studies.

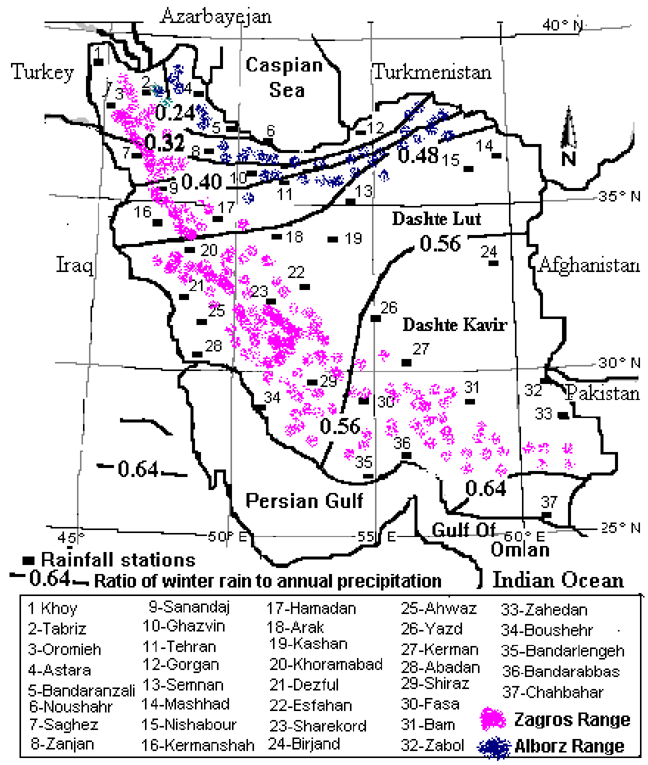

Figure 1. Rainfall stations whose data were analyzed in this study. Contour lines depict the ratio of winter rainfall to annual precipitation.

Data and Methods

The basic data used in this study were monthly rainfalls for 36 stations, obtained from the yearly Weather Books published by the Iranian Meteorological Organization (IMO) for the period 1951–95. Figure 1 shows the location of these stations. It also shows the ratio of winter rainfall to annual precipitation. Average annual rainfalls vary from 62 mm in Yazd and Zabol to 1779 mm in Bandaranzali. As indicated in Figure 1, winter rainfall contributes 25%–70% of the total annual rainfall in different parts of the country.

The SOI data (one of the ENSO indicators) were supplied by the Australian Bureau of Meteorology. The low and high phases of ENSO were identified from a list provided by Trenberth (1997). He defined El Niño and La Niña events as those where sea surface temperatures in the so-called Niño 3.4 region differed from their mean by more than ±0.4°C. The study here used these lists to detect the warm and cold phases of the SO phenomenon. In addition, for episodes in which winter SOI was greater than +5 and less than -5, the magnitudes of average rainfalls were also examined.

The time series of winter rainfalls was obtained by averaging the 3-month values of precipitation. Best results were obtained by defining winter from January to March. The same averaging procedure was performed to provide the seasonal time series of SOI data.

Nazemosadat and Cordery (1997 and 2000) and Cordery and Opoku-Ankomah (1994) have used a sequential correlation analysis (SCA) to examine the strength and temporal stability of the relationship between rainfall and climatic indices. The SCA was also used to detect trends in the correlation between variables, as well as any instability in the rainfall–SOI relationships.

The data lengths employed for the correlation analysis varied from a minimum 15-year window width to the total period of available data for every station. The selection of the various window widths allows the assessment of the effect of record length on the strength and stability of the correlations. For each selected window width, correlation coefficients were calculated for continuous data periods. For example, for 25-year window widths, correlations between Tehran rainfall and SOI were calculated for windows of 1951–75, 1952–76, ..., and 1971–95, a total of 21 windows. The correlation coefficients were computed for various window widths, but only the results for 15- and 25-year window widths are shown here. Results for other window widths were similar.

Results

Winter Drought and Extreme ENSO Phases

The linkage between SOI and rainfall during extreme phases of the SO events was also examined. Figure 2 shows the ratio of the average winter rainfall during El Niño (R_{El}) periods to the corresponding values of rainfall during La Niña (R_{La}) episodes. The ratio of (R_{El})/(R_{La}) is less than unity for most parts of Iran and greater than unity in a few stations such as Bam, Chahbahar, Oromieh, and Sanandaj. Cold (warm) events therefore generally coincided with drought (excess rainfall) conditions in these few stations. However, as indicated in Figure 2, for the main parts of Iran, El Niño episodes seem to coincide with shortage of rainfall and hydrological drought. Moreover, for some stations, including Noushahr, Bandaranzali, Zanjan, Dezful, Zahedan, Shiraz, and Arak, the ratio is less than 0.8, which suggests that, during warm episodes, severe drought is highly probable for these regions. For a number of rainfall stations, such as Esfahan, Yazd, Tabriz, Nishabour, Saghez, Zabol, and Bandarabbas, the ratios are close to unity, which indicates that ENSO has little influence on rainfall variability.

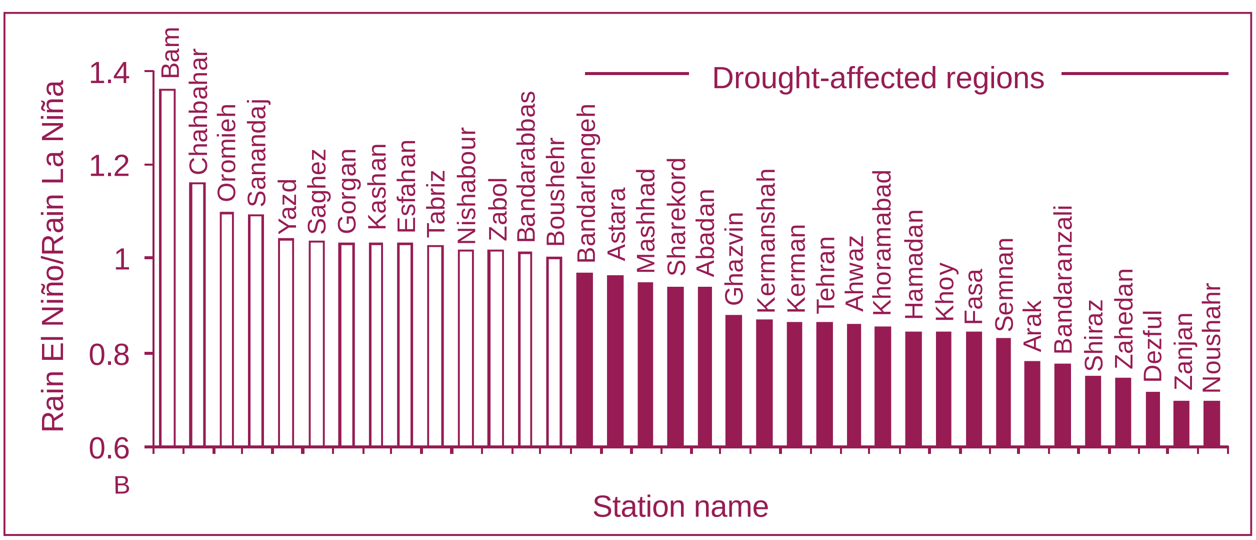

Figure 2. Ratio of winter rainfall during a cold phase of ENSO to the corresponding values during a warm phase.

Nazemosadat and Cordery (2000a) have already shown that for most of the country, rainfall in autumn is negatively correlated with SOI. By comparing the SOI–rainfall relationships during autumn and winter, it can be concluded that the influence of ENSO on Iranian rainfall is mostly reversed from autumn to winter. This reversal of the impact of the SO events on rainfall complicates the assessment of the overall effect of ENSO on annual precipitation. This reversal also complicates the prediction of rainfall during late autumn to early winter (December and January months).

The SOI–Rainfall Relationships: Decadal Aspects

The SCAs between SOI and winter rainfall for Noushahr, Bandaranzali, and Zahedan were significant (at 5% significance level) and positive. The first two stations are located on the Caspian Sea coastal strip and the others are located in the southeast. For the other stations, the correlation coefficients were found to be weak with a high temporal instability. The weak correlations were, however, positive for the majority of the stations. It is noteworthy that the correlations were generally found to be stronger and more persistent during autumn than in winter.

Figure 3 (a and b) shows the sequential correlation coefficients between SOI and winter rainfall in Bandaranzali, Zahedan, and Noushahr for 25- and 15-year window widths. Although the correlations for Zahedan, located in the eastern part of the country, are generally stronger and more persistent than for the other two stations, further research is needed to investigate why the relationships are weak for the neighboring stations of Zahedan (e.g., Bam, Birjand, and Zabol). It should be noted that during the decade 1960–70, the SOI–rainfall relationships are mostly weaker than those for the 1970–80 period. Figure 3b also suggests that the correlations are weakening when the periods after 1990 are included in the analysis. The study has concluded that the frequency of cold and warm events during these decades could justify temporal variations in SOI–rainfall relationships.

It is noteworthy that, in 1970s, the frequency of La Niña events (for winter) is more than for both the 1960s and the 1990–95 period. In the 1970s, the cold phase of ENSO occurred during 1971, 1972, 1974, and 1976. On the other hand, the warm episodes occurred only in 1970 and 1978. The total

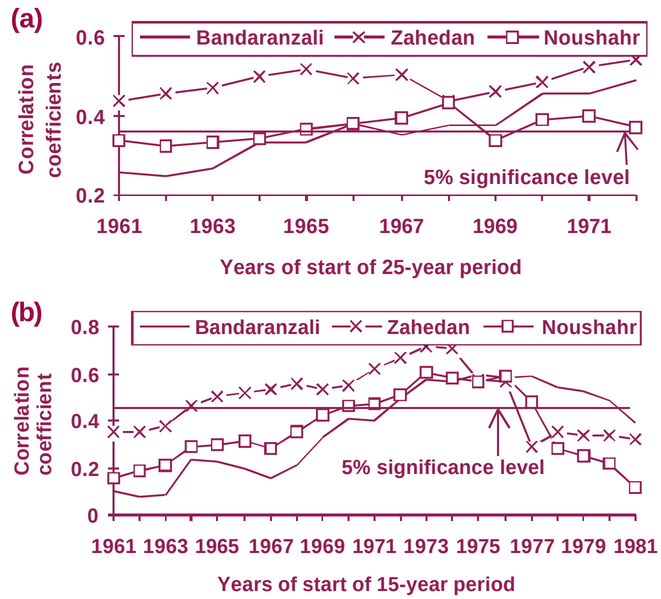

Figure 3. Sequential correlation coefficients between SOI and rainfall for winter in Bandaranzali and Noushahr for (a) 25-year window width and (b) 15-year window width. Numbers on horizontal axis refer to the first year of the window interval.

durations of cold and warm episodes during this decade are 52 and 34 months, respectively. In contrast to the 1970s, Trenberth (1997) does not report a cold winter event for the periods 1960–69 and 1990–95, in which the SOI–rainfall relationships are weak. The total length of La Niña events for 1960–69 is 9 months (May 1964 to January 1965). By contrast, total duration of El Niño episodes in the 1960s is about 40 months. The decades of the 1960s and 1970s could therefore be categorized as warm and cold periods, respectively. The correlation analyses for these periods suggest that the SOI–rainfall relationships are stronger during cold events than during warm episodes.

Combined Indicators

The study also examined which of the SOI and Niño 3.4 SST criteria could better explain variability of winter rainfall in Iran. To categorize warm and cold epochs, those years in which winter SOI were less than (-5) and above (+5) were considered El Niño and La Niña periods, respectively. For the available data set (45 years), 10 events in which SOI was less than (-5) and Niño 3.4 was more than (+0.4°C) were detected. In 7 of these events, rainfall was below normal over most of the country. The results indicate that, during warm events, the measure of the influence of ENSO events on winter rainfall in Iran depends on both the pressure gradient across the Pacific Ocean and the magnitude of Niño 3.4 SSTs. In other words, if either the SST is not sufficiently above normal or the pressure gradient is not adequately large, ENSO does not account for a significant portion of variability in winter rainfall in Iran.

For the spells for which both criteria (SOI and Niño 3.4) indicated cold events, the response of winter rainfall to ENSO was also studied and compared. The results suggest that for about 60% of the events, rainfall over most parts of the country was above normal. However, rainfall in Bandaranzali and Noushahr was found to be above normal for about 90% of the cases in which winter SOI was more than (+5) and Niño 3.4 was less than (-0.4°C). Further research is recommended to evaluate the impact of intense ENSO on Iranian rainfall.

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Announcements

IAEM's 49th Annual Conference and Exhibit

The International Association of Emergency Managers (IAEM) will hold their 49th Annual Conference & Exhibit November 3–6, 2001, in Riverside, California, USA. "Emergency Management: Interfacing with Our Partners" will consist of five concurrent conference tracks: Business Partners, Incident Management, Mitigation, Recovery, and Allied Professionals. Topics to be discussed include web-based mutual aid management tools, GIS systems, building effective public–private partnerships, organizing corporate emergency operations for crisis support, preparing for terrorist attacks, and lessons learned from recent disasters. For more information, visit the IAEM website: http://www.iaem.com/conferences.html.

International Conference on Drought Mitigation and Prevention of Land Desertification

The International Conference on Drought Mitigation and Prevention of Land Desertification will be held April 21–24, 2002, in Bled, Slovenia. The Conference will address the various aspects of drought mitigation and prevention of land desertification in the central and eastern European (CEE) regions. The Conference will explore the status of national drought mitigation strategies in CEE and other countries, through invited country reports. The impacts of drought on the environment and economies also will be discussed. Themes of the conference include the impact of climate change on CEE and Mediterranean countries; drought as a complex phenomenon; national strategies and action programs to mitigate drought; and international cooperation for solving common drought problems. For more information, contact the secretariat at the Slovenian National Committee of ICID, c/o IZVOR, Preradoviceva 44, 1000 Ljubljana, Slovenia; phone +386–1–2317–913; fax +386–1–433–51–04; e-mail SDNO–SINCID@guest.arnes.si.

New Book

Drought is a major natural hazard, resulting in significant economic, social, and environmental costs. In Europe, water shortage is an important problem in many regions. However, despite the increasing awareness of this hazard, there is no European drought policy, and institutional frameworks to cope with drought situations are only weakly developed. *Drought and Drought Mitigation in Europe*, edited by Jürgen V. Vogt and Francesca Somma, is dedicated to furthering our understanding of the drought problem in Europe and discussing policy and management options to mitigate its impacts. It covers topics ranging from detecting water stress to planning mitigation strategies. The contributions, written by world-recognized experts, represent various aspects of drought. After the introductory overview on drought in Europe (Part One), problems related to the definition of drought are highlighted from different hydrological and agricultural perspectives (Part Two). Questions of drought risk are discussed from climatological, hydrological, and pedological points of view, including issues such as vulnerability and climate change. An overview on the development of a comprehensive drought policy in the United States, which could serve as a model for Europe, is also included (Part Three). Conventional and more advanced approaches to drought monitoring are then presented and recent progress in the United States is described (Part Four). The quantification of drought impacts in socioeconomic, hydrologic, and agricultural terms and views on mitigating these impacts are central themes of Parts Five and Six. Part Seven presents conclusions and recommendations formulated by the plenum of experts contributing to this book.

Drought and Drought Mitigation in Europe (Jürgen V. Vogt and Francesca Somma, eds.) is Volume 14 (ISBN 0–7923–6589–5) of the Advances in Natural and Technological Hazard Research Series. It is available from Kluwer Academic Publishers, P.O. Box 322 – 3300 AA Dordrecht, The Netherlands; http://www.wkap.nl.

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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

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