CAZRI

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A DESERTIFICATION MAP OF ARID RAJASTHAN AND GUJARAT

As part of the nation-wide land degradation mapping using 1:0.5 million scale AWiFS satellite sensor of Indian Remote Sensing Satellite for 2003-04 (coordinated by Space Applications Centre, ISRO), we mapped desertification under different land uses in the arid western part of Rajasthan and Gujarat, covering 28.5 million ha area (Fig. 1). It has revealed that ~76% area of western Rajasthan is affected by wind erosion, encompassing all the major land uses, but mostly croplands and dunes/sandy areas, while water erosion has affected ~2% area (mostly in croplands and scrublands), salinization ~2% (mostly in croplands) and vegetation degradation ~3% (especially in scrublands and forests). Mining activities have spoiled so far only 0.10% area, and degraded rocky areas cover 1% area. About 18% area is severely degraded and 66% slight to moderately, while 16% area is not affected by degradation. About 1.3 million ha area of croplands in western Rajasthan has been found to be under severe wind erosion (mostly un-irrigated).

In arid Gujarat, water erosion is the most dominant process, affecting ~43% of the total area (mostly in croplands), followed by salinity (38%), while vegetation degradation (10%) and wind erosion (5%) cover smaller areas. About 44% area is severely affected, 53% slight to moderately, and 3% area is not affected. Large area under severe degradation is due to the vast expanse of Great Rann of Kachchh and the Little Rann with high natural salinity.

Despite recency, the present map does not replace the earlier CAZRI's map on Western Rajasthan (1991; updated 2005) that was based on Landsat TM with ground truth, because distinction between slight and moderate degradation proved difficult from AWiFS due to poor resolution. Nevertheless, it forms a part of the first nation-wide map on desertification.

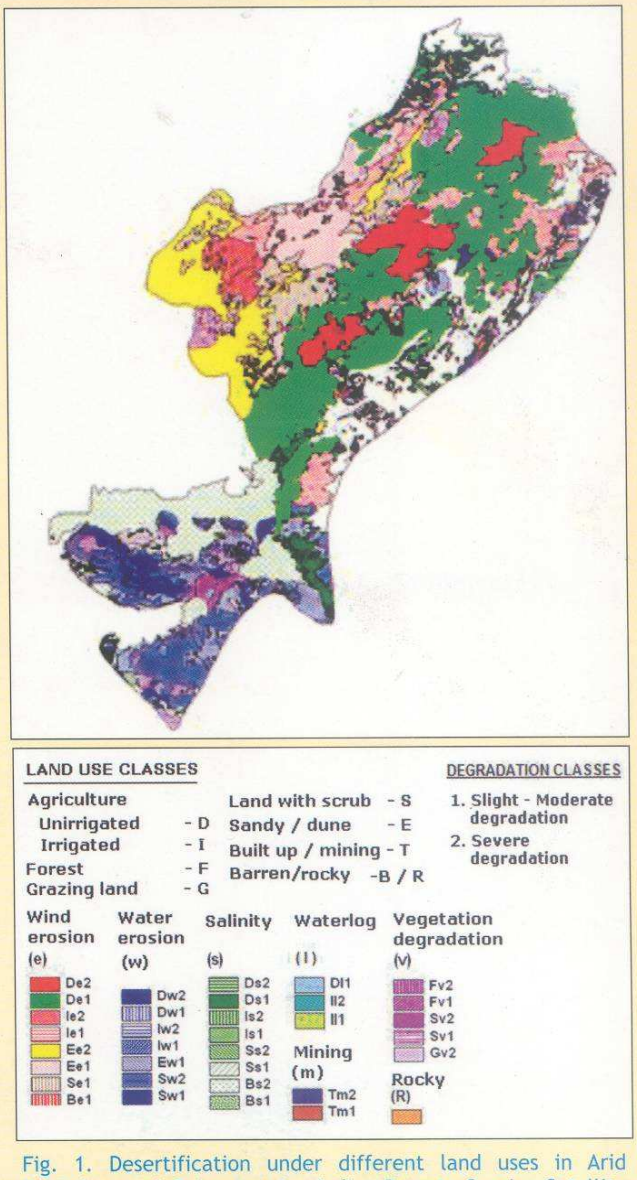

Fig. 1. Desertification under different land uses in Arid Rajasthan and Gujarat, using Indian Remote Sensing Satellite AWiFS images of 2003-04.

Dr. Amal Kar and Dr. P.C. Moharana.

EFFECT OF CLIMATE CHANGE ON PEARL MILLET PRODUCTIVITY IN THAR DESERT

Agriculture, involving crop cultivation and livestock rearing, is the predominant land use in western Rajasthan that forms a major part of the Thar Desert. Agriculture is also the principal occupation of the Thar inhabitants. Although agriculture has a long tradition of more than five millennia in the desert, during which cultivation practices, crop selection, etc., have been evolved especially to withstand drought and other weather variability, the current climatic trends pose more uncertainties for crop production. Several studies have suggested that during the current century the desert region may register a decline in rainfall in its northern part by up to 30%, an increase in the southern and eastern parts by up to 15%, and a gradual rise in temperature by 4-5°C everywhere. The monsoon, which brings >80% of the annual rainfall to the region, and on which the *kharif* cropping strategies depend, is expected to be more abnormal.

Cultivated during the summer monsoon, pearl millet, the dominant kharif crop of the Thar Desert, is very well adapted to harsh climate, including drought at various stages of its growth. It is a staple food for the vast majority of rural masses, and provides fodder to the large livestock population. Here we shall show some results of our simulation studies on how the crop is likely to respond under changing rainfall and temperature conditions.

First we provide a brief account of the current crop-growth environment in the region. The annual rainfall in the desert is low (150-450 mm) with high inter-annual variability. The monsoon season (June-September) is characterized by frequent and intermittent droughts, with uncertain onset and recession. High solar radiation (18-20 MJ m^{-2} day^{-1}) and high wind speed (10-20 km h^{-1}) lead to high potential evapotranspiration demand. Soils are mostly coarse-textured with low water holding capacity and low fertility. Because of these reasons crop productivity is very low.

Fortunately, pearl millet has a good tillering habit due to which the plant can adjust well to the available soil moisture and nutrients, and can withstand long droughts to resume rapid growth upon termination of the drought. It can also extract moisture from deeper soil layers and has high moisture utilization efficiency. Its excellent photosynthetic mechanism ensures efficient conversion of solar energy into grain and stover. Despite these qualities, however, its productivity is likely to be adversely affected under the predicted climate change scenario, especially due to high temperature and exacerbated effects of water stress. We used a crop growth model (CERES-Millet) to

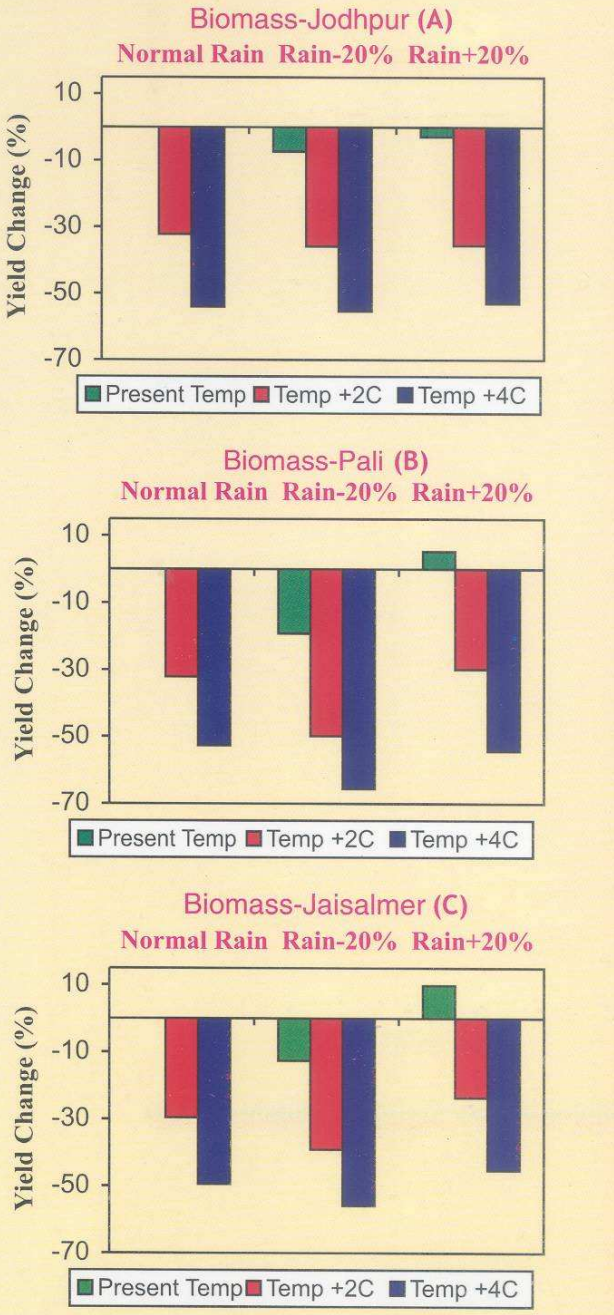

Fig. 2. Per cent change in biomass of pearl millet at Jodhpur (A), Pali (B) and Jaisalmer (C) with varying temperature and rainfall situations against current climatic conditions.

Table 1. Decline in biomass and seed yields (kg ha^{-1}) of pearl millet under rainfed condition due to temperature rise at three locations in Thar Desert

Location	Expected biomass (y) with each °C rise in temperature (x)	Location	Expected seed yield (y) with each °C rise in temperature (x)
Jodhpur	y = 5365 - 637x	Jodhpur	y = 1868.5 - 203.99x
Pali	y = 3436 - 401.55x	Pali	y = 1297.1 - 149.44x
Jaisalmer	y = 1265.4 - 141.97x	Jaisalmer	y = 428.5 - 59.3x

estimate the likely effects on its productivity in the region. The model can predict several functions involved in the growth and development of the plant. The minimum weather data needed to run this model include daily values of incoming solar radiation, maximum and minimum air temperature, and precipitation.

Performance of the crop under Jodhpur (central Thar), Pali (south-eastern Thar) and Jaisalmer (western Thar) weather conditions was first assessed for no water stress (potential yield) and water-limited condition (rainfed yield). This was followed by estimation under a rise in temperature by 1-4°C over the present mean, with or without 10% and 20% increase or decrease from the mean rainfall. Mean seasonal rainfall was 396.6mm at Jodhpur, 463.0mm at Pali and 158.3mm at Jaisalmer.

We found that under the present weather conditions, mean potential biomass and grain yields were highest at Jodhpur (6677 and 2814 kg ha^{-1}, respectively), followed by Jaisalmer (6026 and 2553 kg ha^{-1}) and Pali (4467 and 1927 kg ha^{-1}). Lower yield at Pali was due to higher cloudiness that resulted in less solar radiation. Biomass and seed yields under water-limited condition (rainfed) were also higher at Jodhpur (4912 and 1697 kg ha^{-1}, respectively). Contrary to potential yields, biomass and grain yields under rainfed condition were much lower at Jaisalmer (1157 and 387 kg ha^{-1}) as compared to Pali (3181 and 1194 kg ha^{-1}) because of less seasonal rainfall at Jaisalmer. Biomass and seed yields declined with rise in temperature at all the three locations (Table 1). In absolute terms the decline in total biomass and seed yield was maximum at Jodhpur, followed by Pali and Jaisalmer.

In relative terms (% decline over present yield) the difference among the three stations was not very pronounced (Fig 2 & 3). At Jodhpur and Pali, the biomass and seed yields declined by 50-54% over the present yield when temperature was increased by 4°C. At Jaisalmer the rise in temperature by 4°C led to a decline in total biomass yield by 49%, while seed yield declined by 62%. The larger decline in seed yield at Jaisalmer as compared to that in other two stations was due to lower rainfall and severe water stress during grain-filling stage. Rise in temperature not only influenced the crop yield but also its development (phenology). Under the present weather conditions, the crop took about 44-46 days to reach the flowering stage. With each °C rise in temperature the days taken to flowering decreased by 1.5 days.

Similarly, the crop matured by 2.5 days earlier with each °C rise in temperature as compared to the present maturity period of 72-75 days. Change in rainfall amount (± 20%) also affected sowing dates during some years, and showed both positive and negative impacts on pearl millet productivity, depending upon subsequent weather conditions during the year. In general, the adverse effects of temperature rise were more pronounced when seasonal rainfall also declined. Increasing the seasonal rainfall by 20%, on the other hand, was not sufficient to reduce the adverse effects of temperature rise on pearl millet production. It is thus evident that rise in temperature due to climate change will have adverse impact on pearl millet productivity and if this rise is accompanied by decline in rainfall the negative influence will be even more severe.

Dr. D.V. Singh

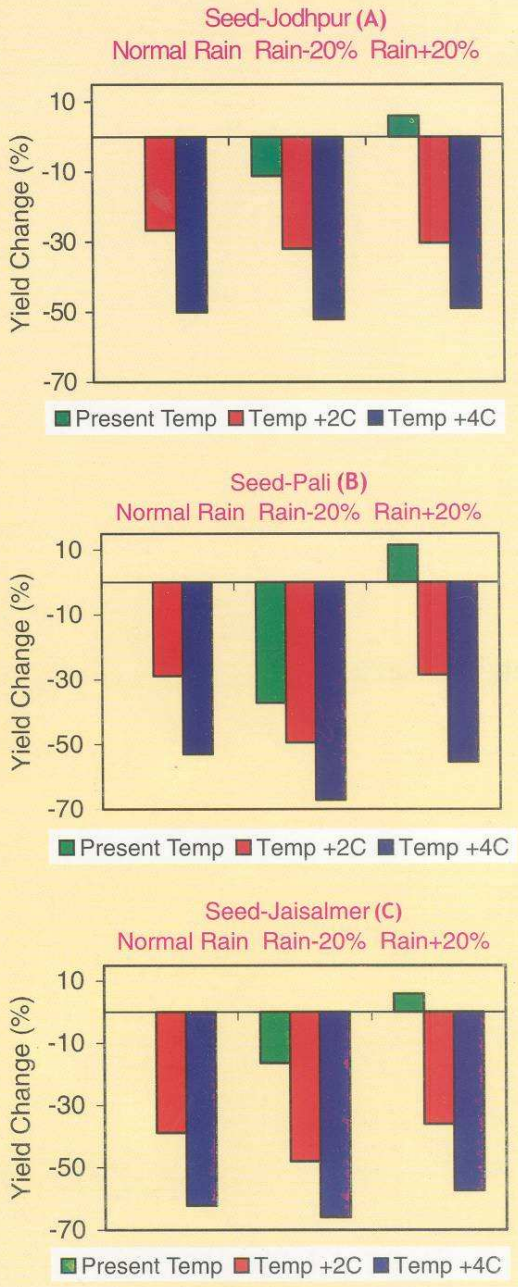

Fig. 3. Per cent change in seed yield of pearl millet at Jodhpur (A), Pali (B) and Jaisalmer (C) with varying temperature and rainfall situations against current climatic conditions.

WORLD ENVIRONMENT DAY, 2008

Like in previous year, this year also the Centre celebrated the World Environment Day (5th June). We organized lectures on 'Kicking the CO_2 Releasing Habit', where Prof. M.L. Mathur, Ex VC, JNVU, Jodhpur and Dr. Praveen Kumar, P.S., CAZRI, Jodhpur delibrated on the above theme. Dr. K.P.R. Vittal, Director, CAZRI presided over the function. Dr. Manjit Singh, Chairman, ENVIS Sub-Committee, welcomed the guests and briefed about ENVIS activities at CAZRI. Dr. D.C. Ojha, ENVIS Coordinator proposed the Vote of Thanks.

WORLD DAY TO COMBAT DESERTIFICATION, 2008

The Centre celebrated the World Day To Combat Desertification (17th June) organized an invited lecture, followed by a group discussion on 'Combating Land Degradation for Sustainable Agriculture' in which more than 50 scientists and other officers from CAZRI and other institutes participated. The speaker was Dr. P. Joshi, Former Dean & Director Personnel, Rajasthan Agriculture University, Bikaner. Dr. K.P.R. Vittal, Director, CAZRI presided over the function. Dr. Manjit Singh, Chairman, ENVIS Sub-Committee, welcomed the Chief Guest, the Speaker and the participants of the group discussion. Scientists from CAZRI and RRSSC, Jodhpur, actively participated in the discussion.

Forthcoming Conferences and Events

The Antarctic Treaty: 50 More Years of Preserving Peace? 10-12 June2009 at Washington DC. Contact: http://www.atsummit50.aq

12th International Conference on Chemistry and the Environment. 14 - 16 June 2009 at Stockholm, Sweden. Contact: http://www.chemsoc.se/sidor/KK/icce2009.htm

Training Workshop on Sustainable Water Use in Urban and Rural Areas. Aug - Sep (Dates n.a.) organised by RCUWM (Regional Center on Urban Water Management) Tehran, Iran/PFU-Tashkent, Uzbekistan. Contact:

http://www.icarda.org/Events_Aug.htm

11th International Conference on Environmental Science and Technology (CEST2009), 03 - 05 September 2009, at Chania, Crete, Greece. Contact: http://www.gnest.org/cest

International Conference on Desertification in Memory of Professor John B. Thornes. 16-18 September 2009 at Murcia, Spain. Contact: http://fobos.bio.um.es/thornesi/doku.php

FT China Energy and Environment Summit. 24th September 2009 at Park Hyatt, Beijing. Contact: http://www.ftconferences.com/Portal-ForthcomingEvents/

Energy Efficiency and Air Pollutant Control Conference. 21 - 25 September 2009 at Wroclaw University of Technology, Wroclaw, Poland Contact: http://www.energy-air-wroclaw.pwr.wroc.pl

International Conference on "Food Security and Climate Change in Dry Areas". 12 - 15 October 2009, organised by ICARDA, NCARE at Amman, Jordan. Contact: http://www.icarda.org/Events_Aug.htm

Recent CAZRI publications

CAZRI Ki Bahuposak Tatva Ahar Batika Va Misran: Swarojgar Nirman Ki Aik Safal Kahani. Eds: P.P. Rohilla, Mahendra Choudhary, H.C. Bohra, B.L. Jangid and N.V. Patil, 4p. 2008, CAZRI, KVK Pali (Hindi)

Our Products. Eds: N.L. Joshi and Suresh Kumar, 12p. 2008. CAZRI, Jodhpur.

Khetibari Hetu Upyogi Taknike Sujhav Evam Jankari. Eds: Amal Kar and Madhubala Charan, 49p. 2008. CAZRI, Jodhpur (Hindi).

Maru Kshetra mein Krishi Prabandhan. Eds: Amal Kar and Madhubala Charan, 49p. 2009. CAZRI, Jodhpur (Hindi).

VISIT ABROAD

Motilal Soni and N.D. Yadava, Arusha (Tanzania), from 8.3.2008 to 10.3.2008, attended mid term project workshop presenting Annual Report and to discuss future work plan for 2008-2009 for the Centre under International Collaboration Research on Bambara Groundnut (BANILINK Project).

N.L. Joshi, Jordan, from 2.6.2008 to 7.6.2008, attended International Planning Workshop for the Second Phase of the Sustainable Management of Marginal Drylands (SUMAMAD) project.

K.P.R. Vittal, United States, from 10.6.2008 to 19.6.2008, under USAID Disaster Management Support Project, Climatic Forecast System Component.

B.K. Garg, Dubai, UAE, from 20.7.2008 to 22.7.2008 for participation in the Meeting/Workshop of BIOSAFOR Project.

L.N. Harsh, Egypt, from 16.8.2008 to 29.8.2008, for study in the field of "Greening Deserts".

D. Kumar, Zambia, 17.8.2008 to 25.8.2008 as Key Resource Person & Field Visit to the Potential Smallholder Farming Areas of Zambia.

K.P.R. Vittal, Alexandria (Egypt), 7.11.2008 to 10.11.2008, for participation in the 9th International Conference on Dryland Development.

Motilal Soni, Germany, 12.5.2009 to 14.5.2009, to attend 3rd Annual Meeting and Scientific Workshop in the Frame Work of the EU-Funded International Research Project BIOSAFOR.

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