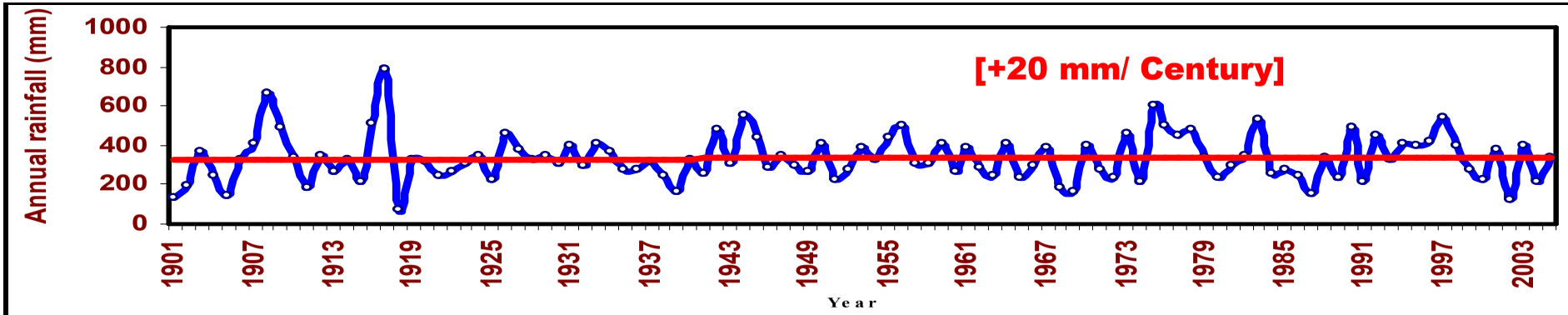
Dryland Management: Its Future

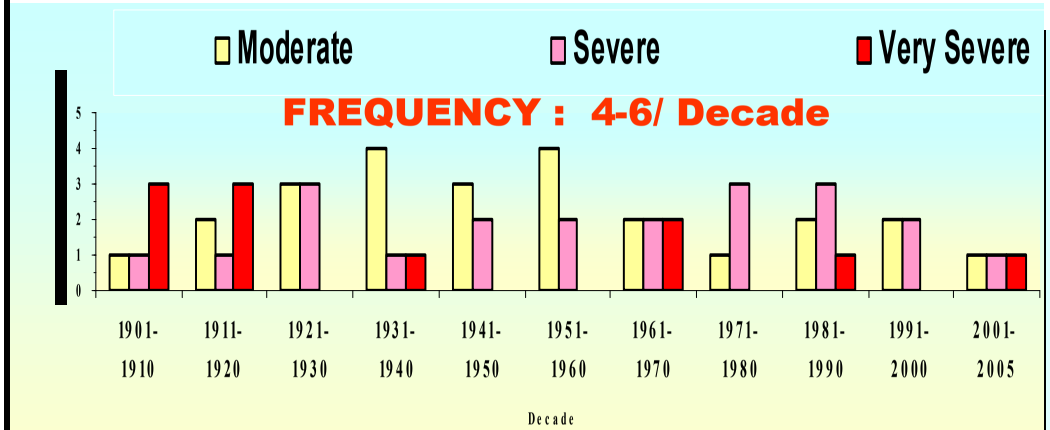
With the inputs of….
IITM, IMD, India
Hadley Center, UK
NIES, Japan
IPCC

Central Arid Zone Research Institute, Jodhpur

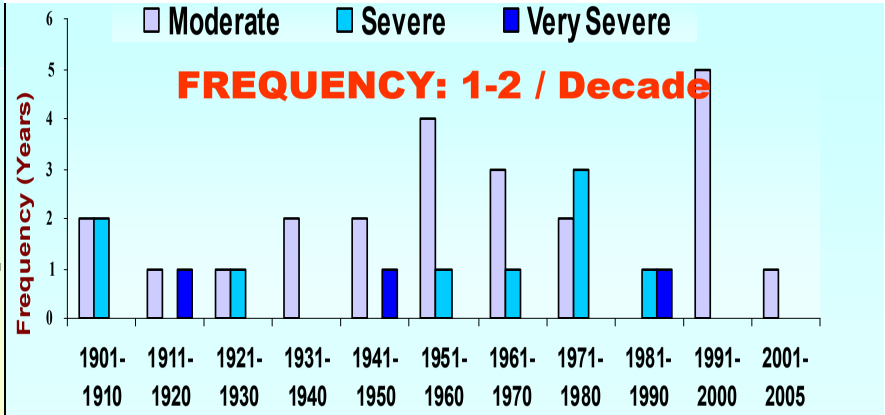
Rainfall



LONG-TERM RAINFALL TREND IN ARID RAJASTHAN



DECADE-WISE DROUGHT YEARS IN ARID RAJASTHAN



DECADE-WISE FLOOD YEARS IN ARID RAJASTHAN



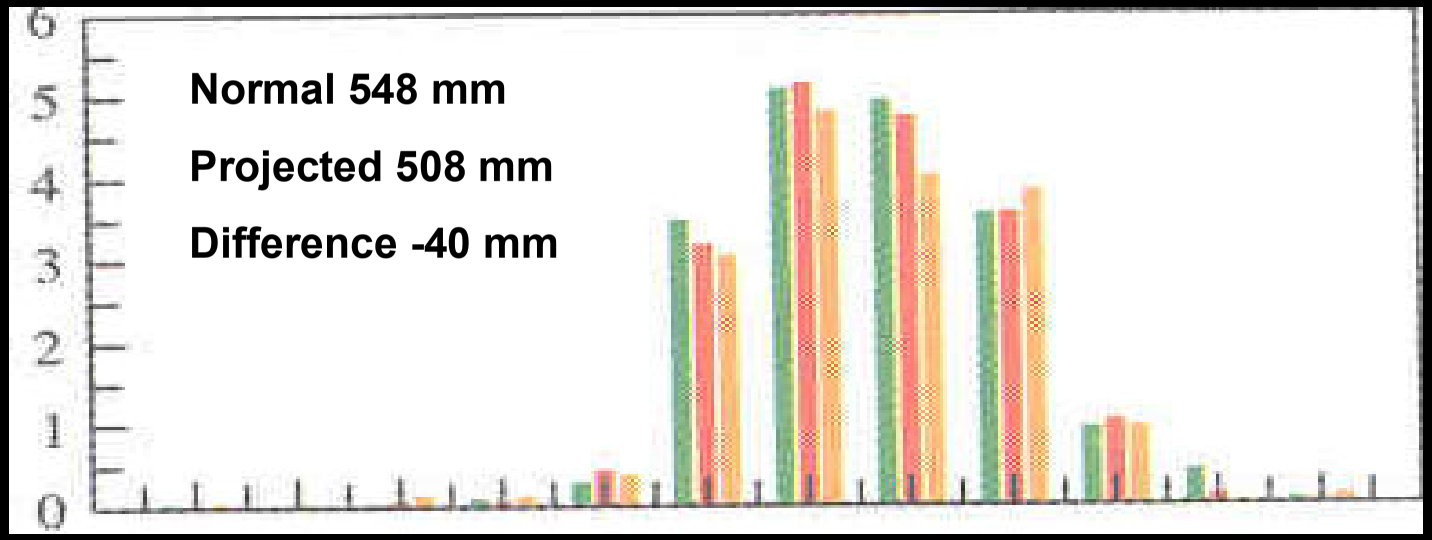
VERY HIGH SPATIAL VARIABILITY



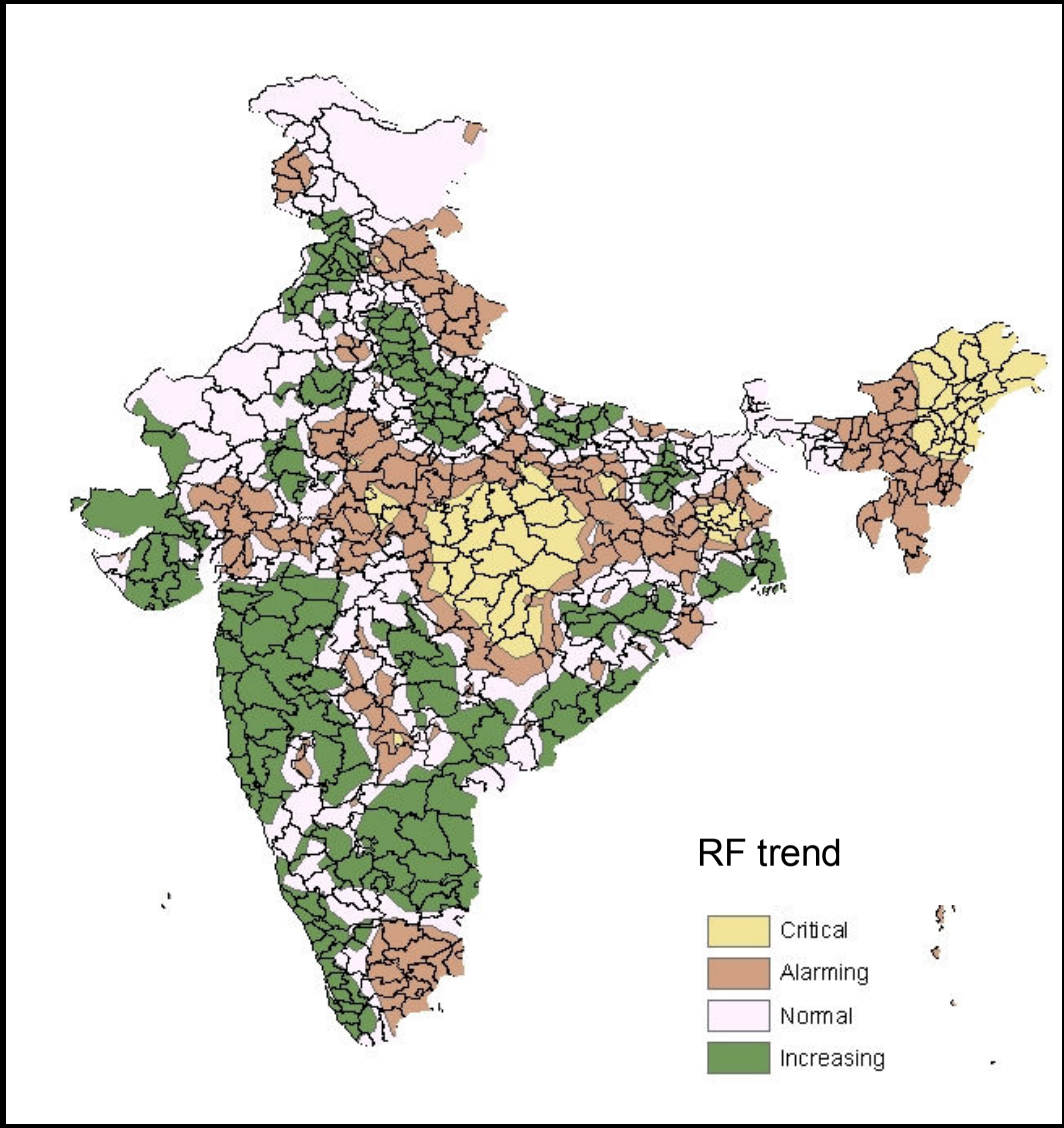
Climate Change Scenarios for 21st Century in Rajasthan

A_2 Scenario 3-5^{0}C B_2 Scenario 2.5-4.0^{o}C

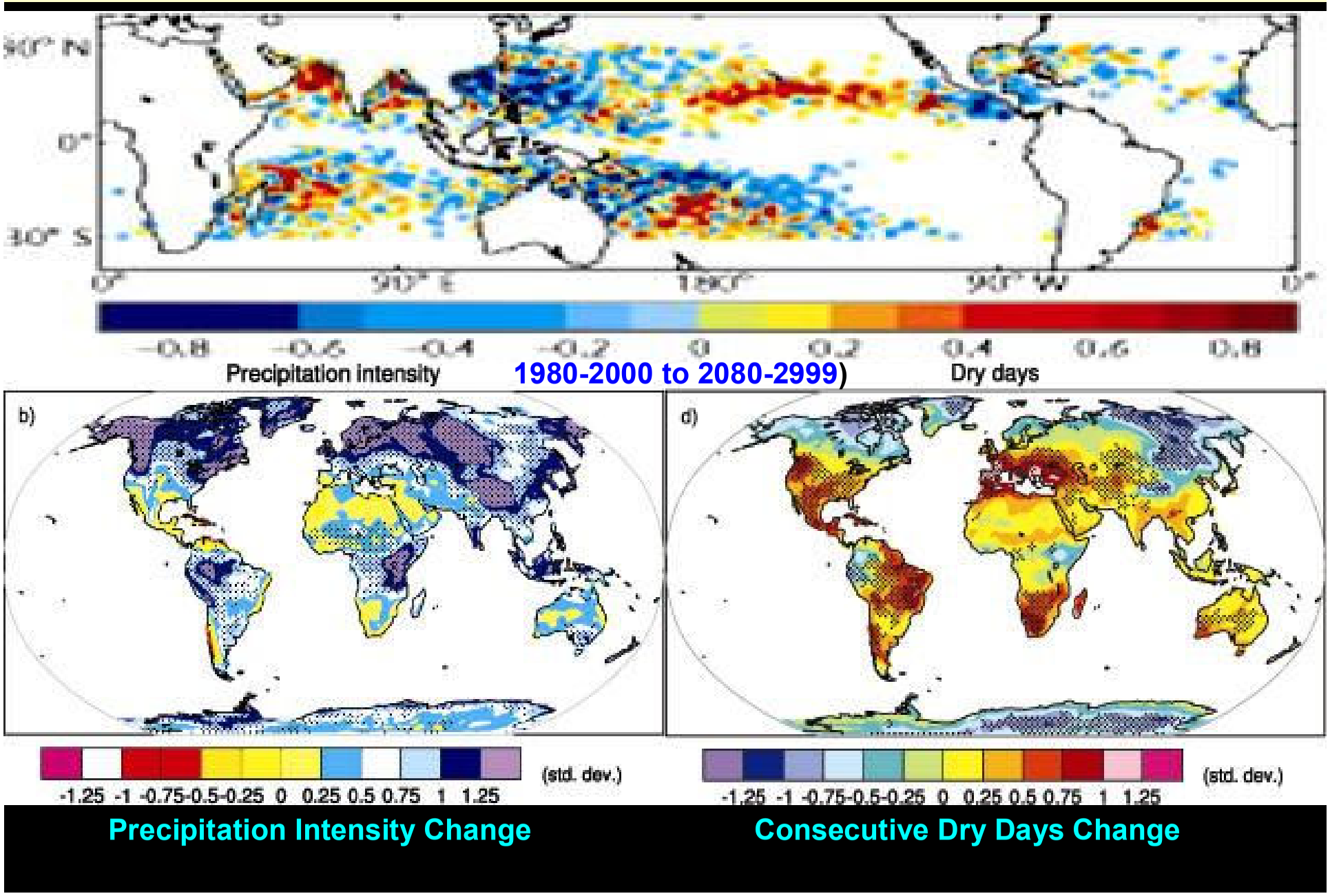
(Current Science 90(3): Rupa Kumar *et al.*, 2006)



Rainfall trends across districts



CHANGE IN NUMBER OF STORMS BETWEEN THE PRESENT AND THE END OF 21st CENTURY

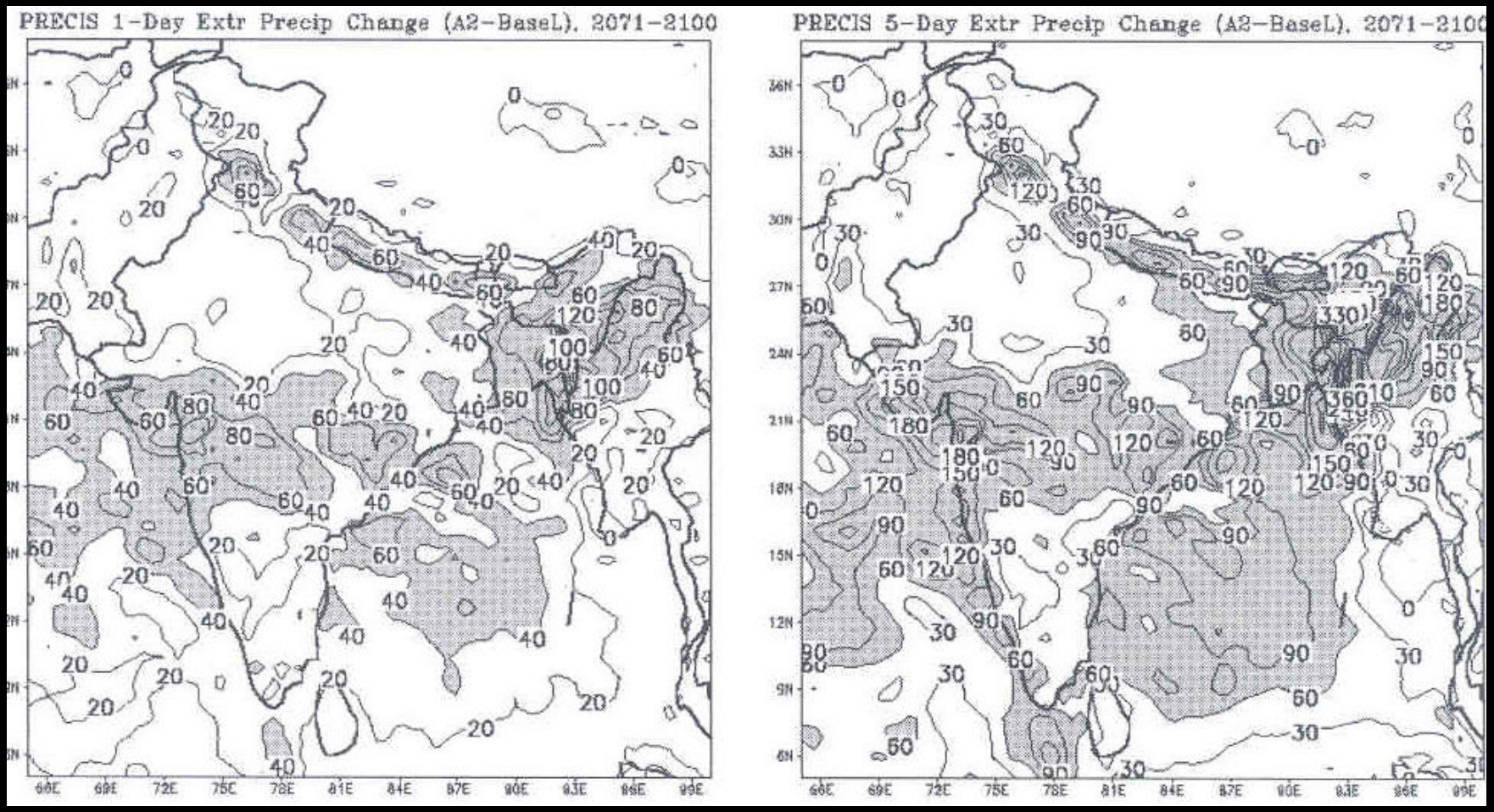


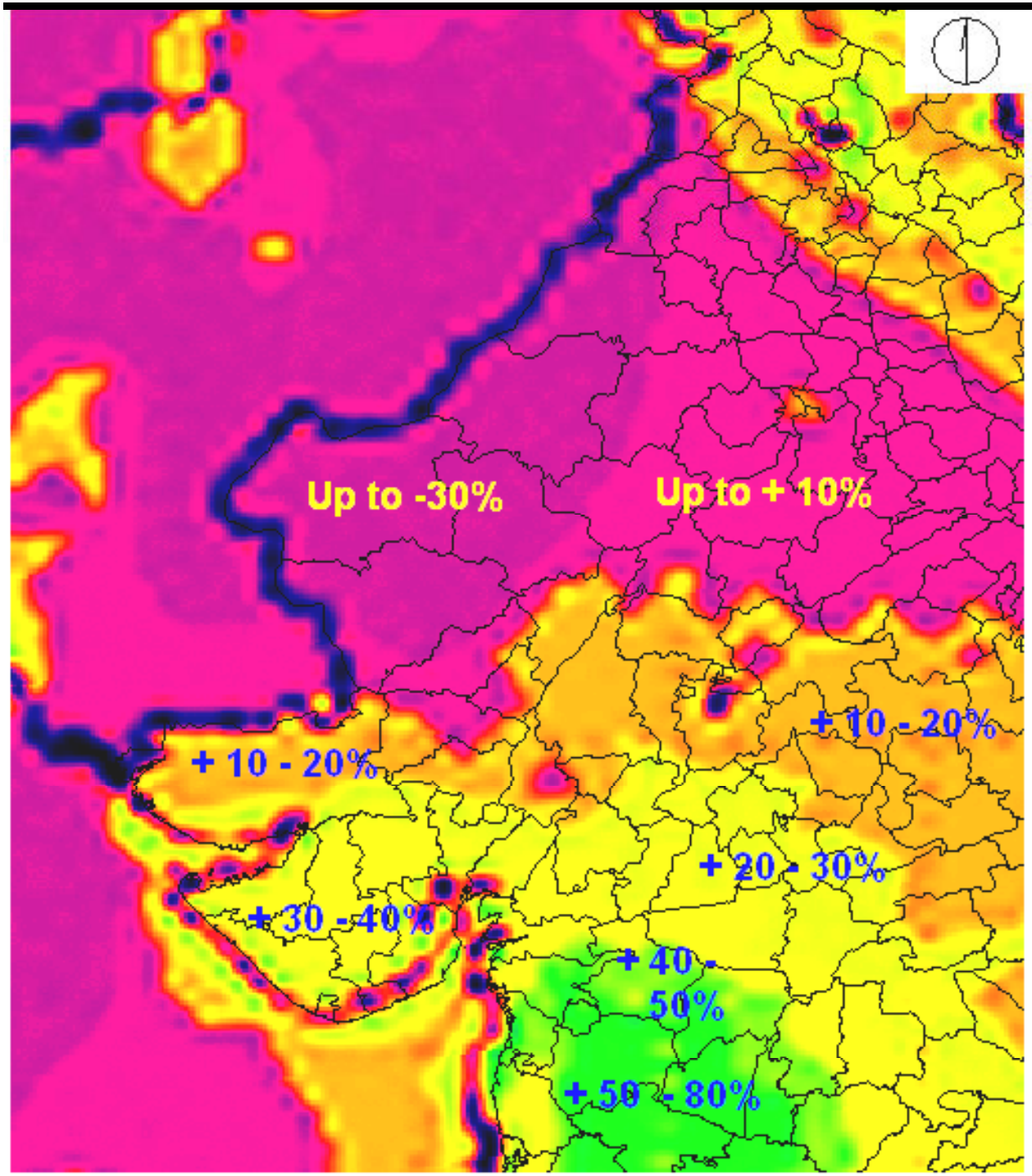
Precipitation Intensity Change

Consecutive Dry Days Change

Future projections of extremes in daily precipitations

(Shaded portions indicate changes exceeding 40 mm for 1-day precipitation and 60 mm for 5-day precipitation)





LIKELY CHANGES IN ANNUAL RAINFALL IN NORTHWEST INDIA BY YEAR 2071

USING PRECIS RCM FOR A2 SCENARIO

SOURCE:

HADLEY CENTRE, UK

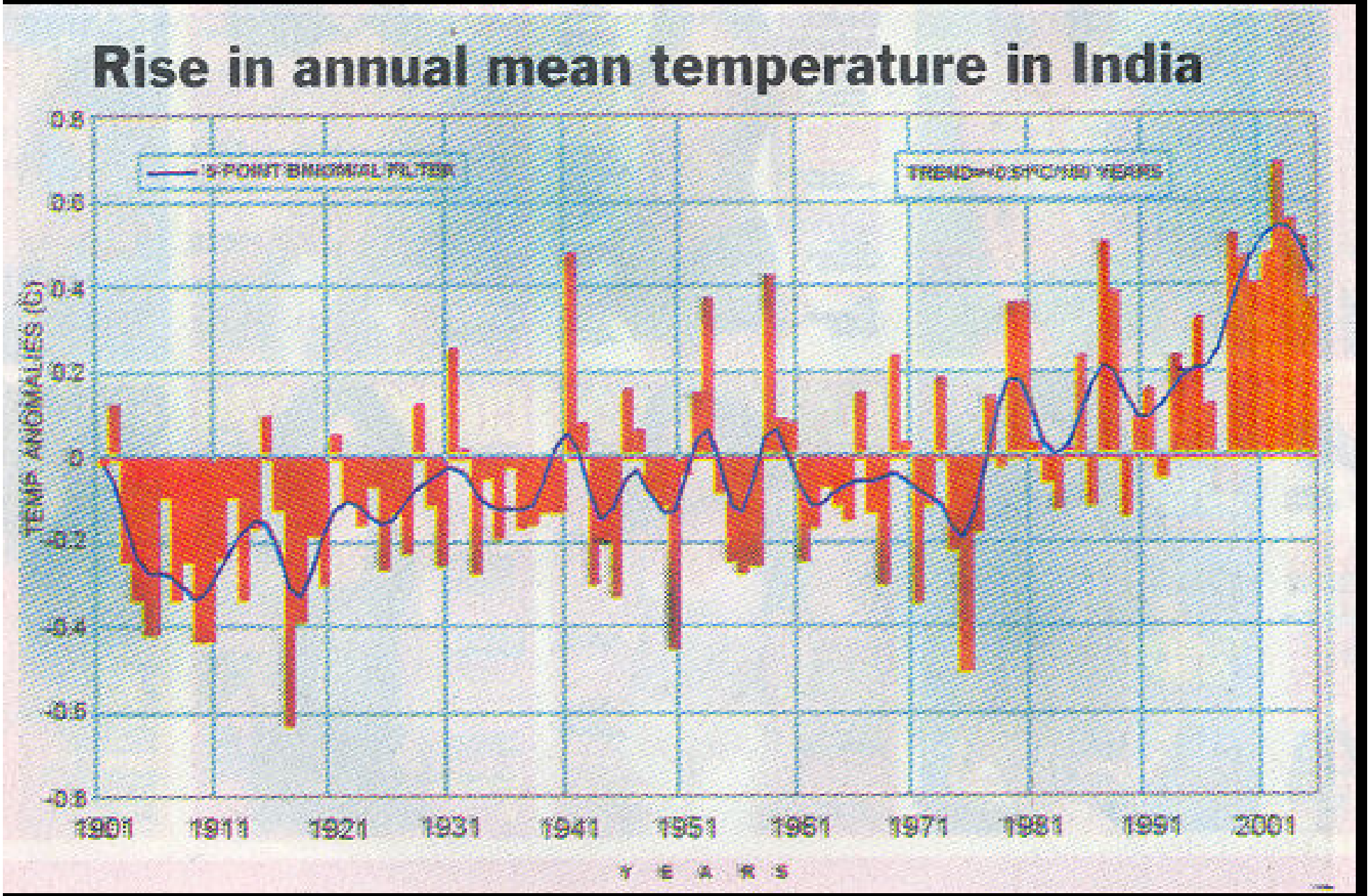
Boundaries are approximate

GIS OVERLAYS BY A. KAR

CAZRI, JODHPUR

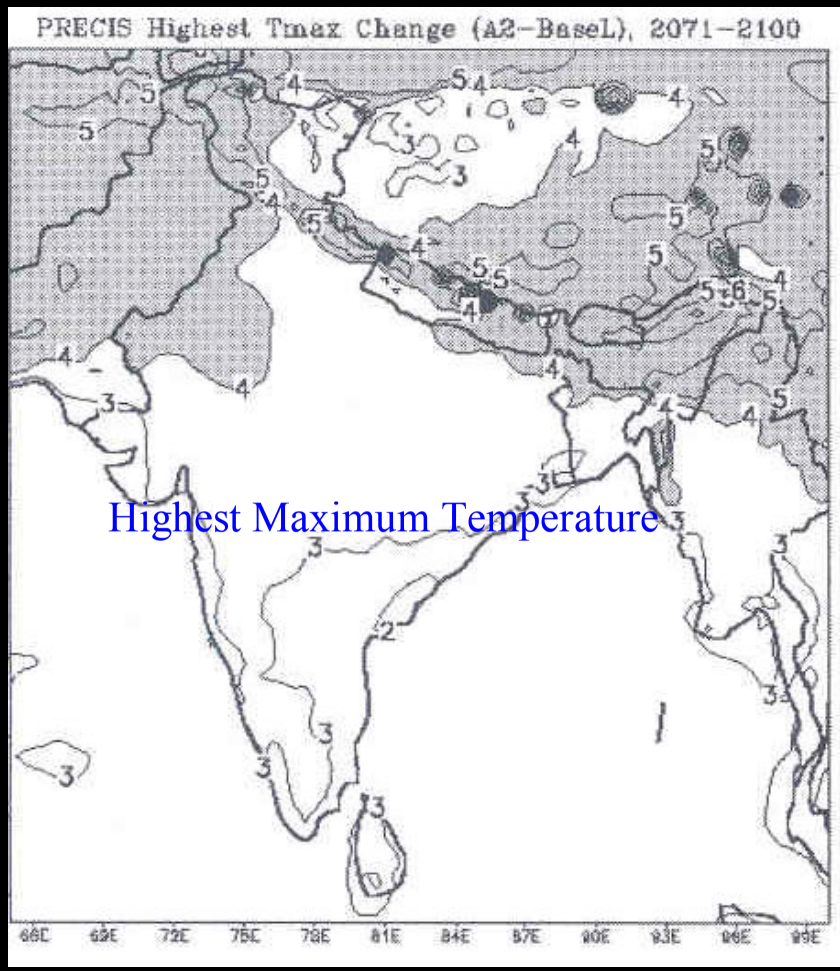
KAR
CAZRI

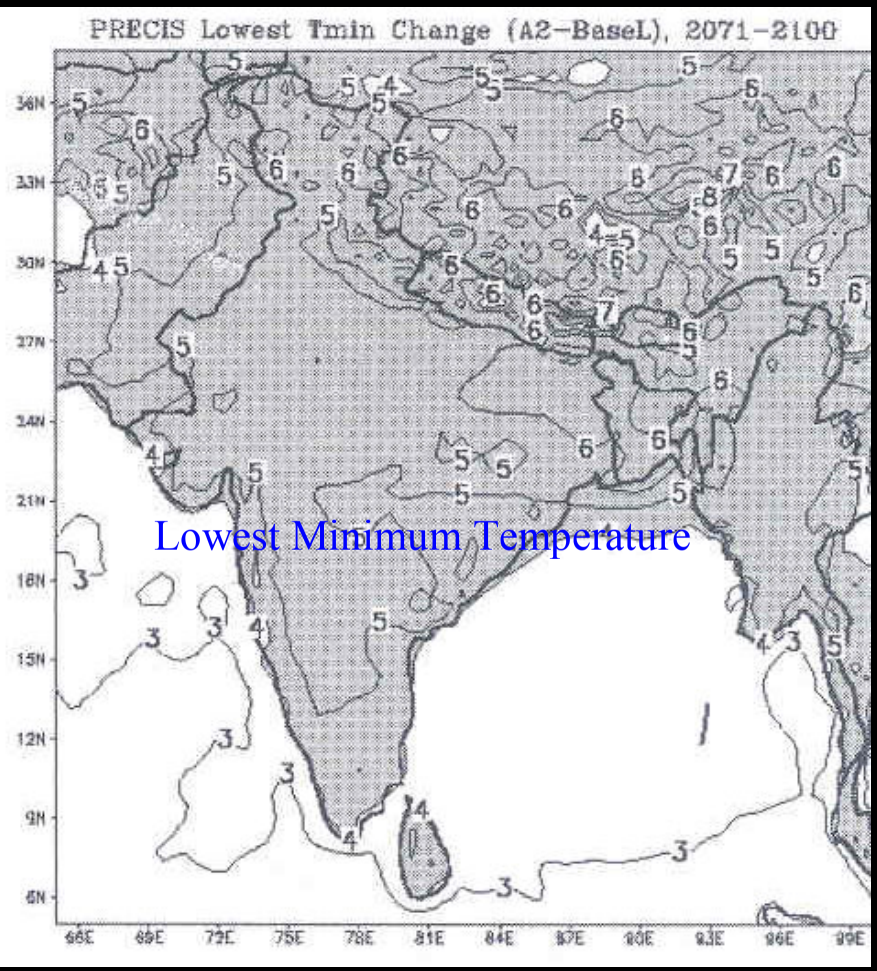
Temperature


Rise in annual mean temperature in India
5-POINT BINOMIAL FILTER
TREND=+0.57°C/100 YEARS
TEMP. ANOMALIES (°C)
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
1901
1911
1921
1931
1941
1951
1961
1971
1981
1991
2001
YEARS

Future projections of extremes in daily max. & min. temperatures 2071-2100

(Shaded portions indicate warming above 4°C)





Mean diurnal anomalies increasing with time

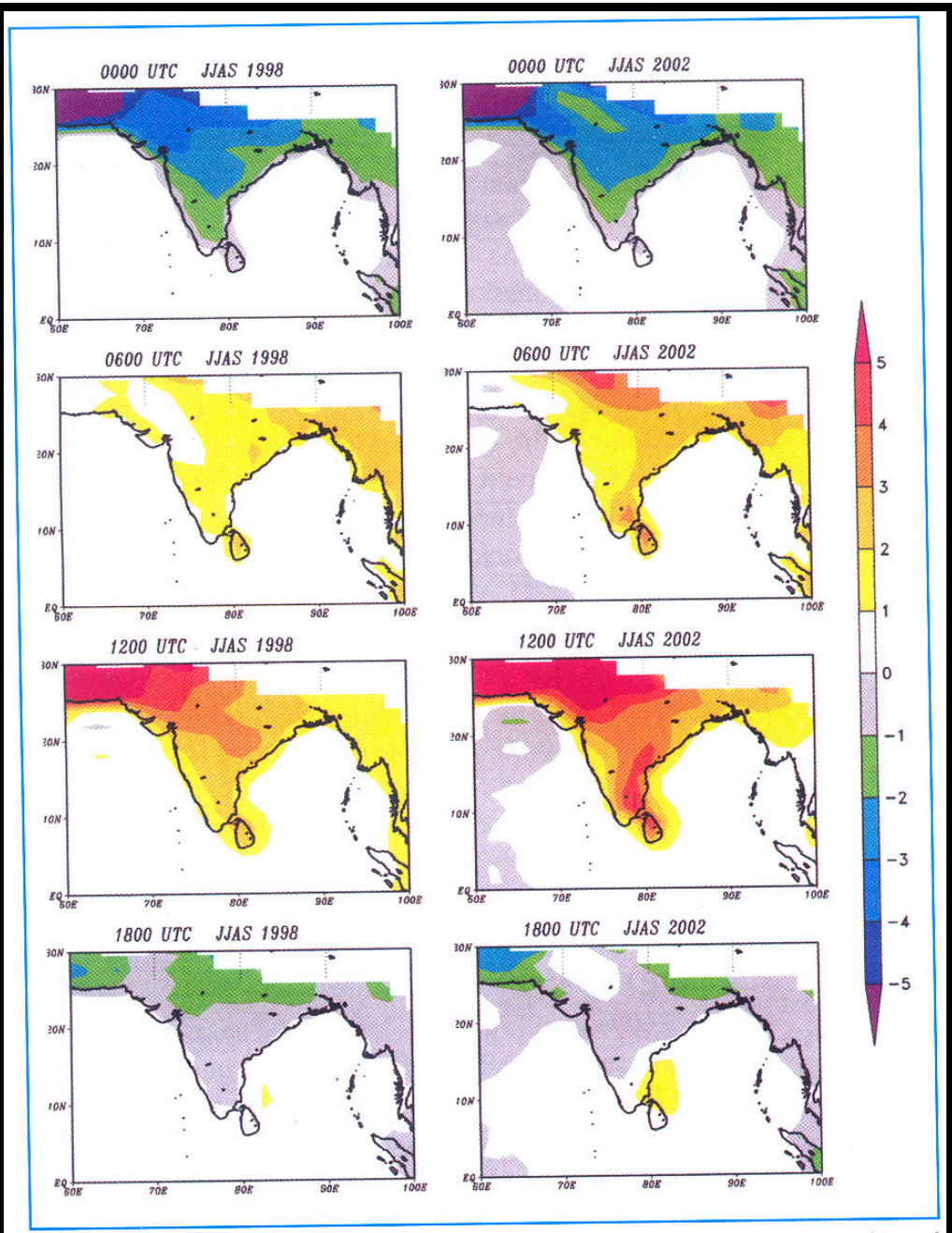
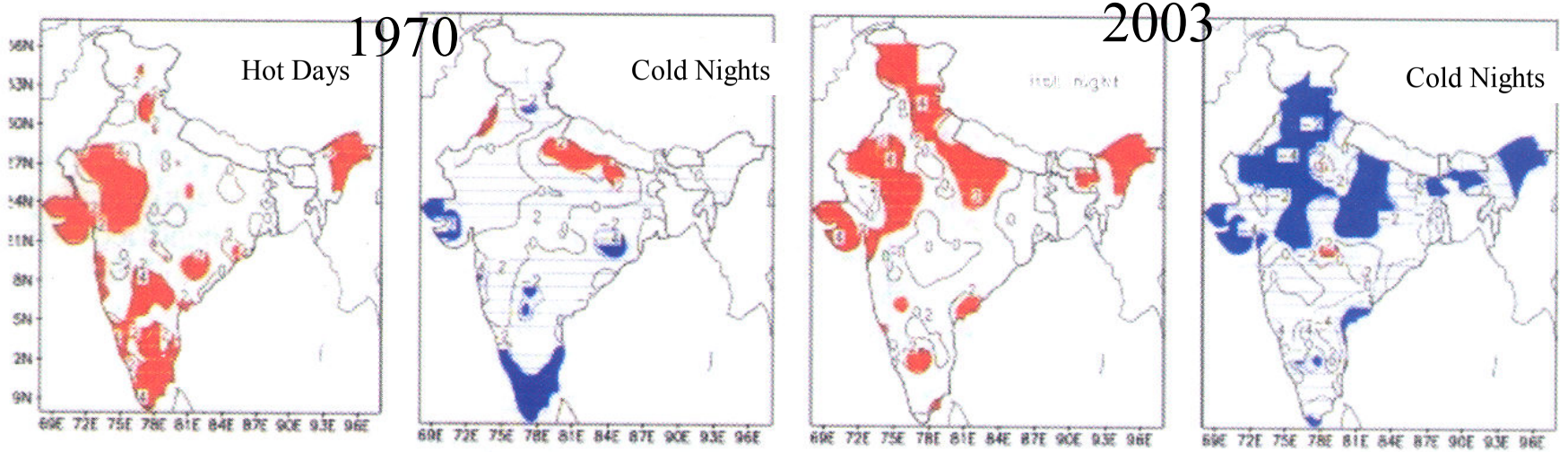


Fig. Mean diurnal anomalies (relative to daily mean) of JJAS 1998 (left) and 2002 (right) for 2-m air temperature (°C) at 0000, 0600, 1200 and 1800 UTC from NCEP-DOE reanalysis data sets.

Extreme Event Trends

Winter extreme event trend (days/decade)



Spring extreme event trend (days/decade)

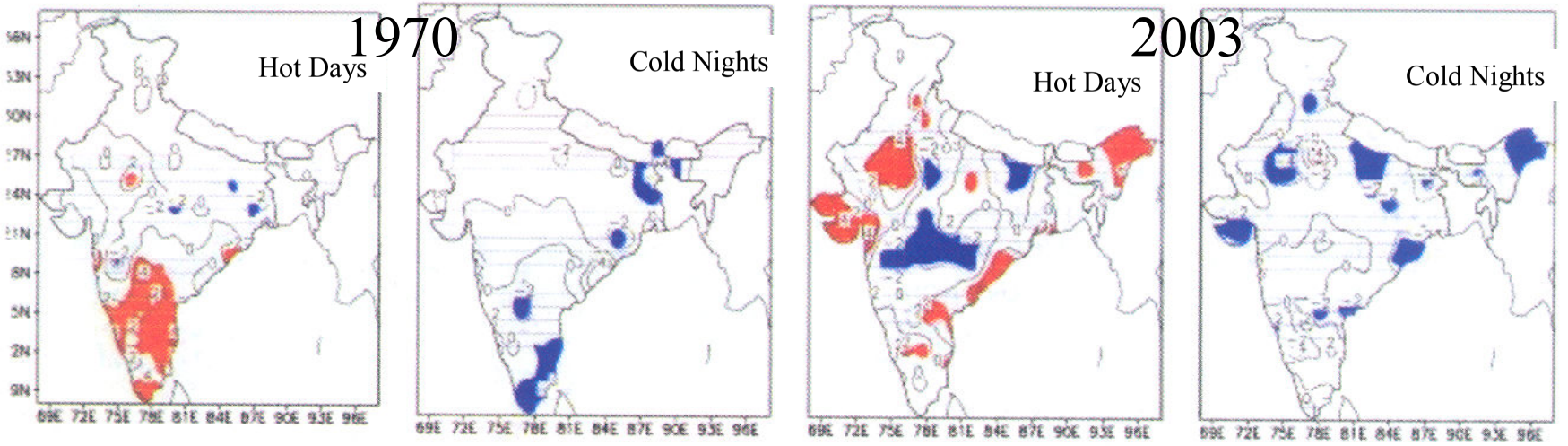
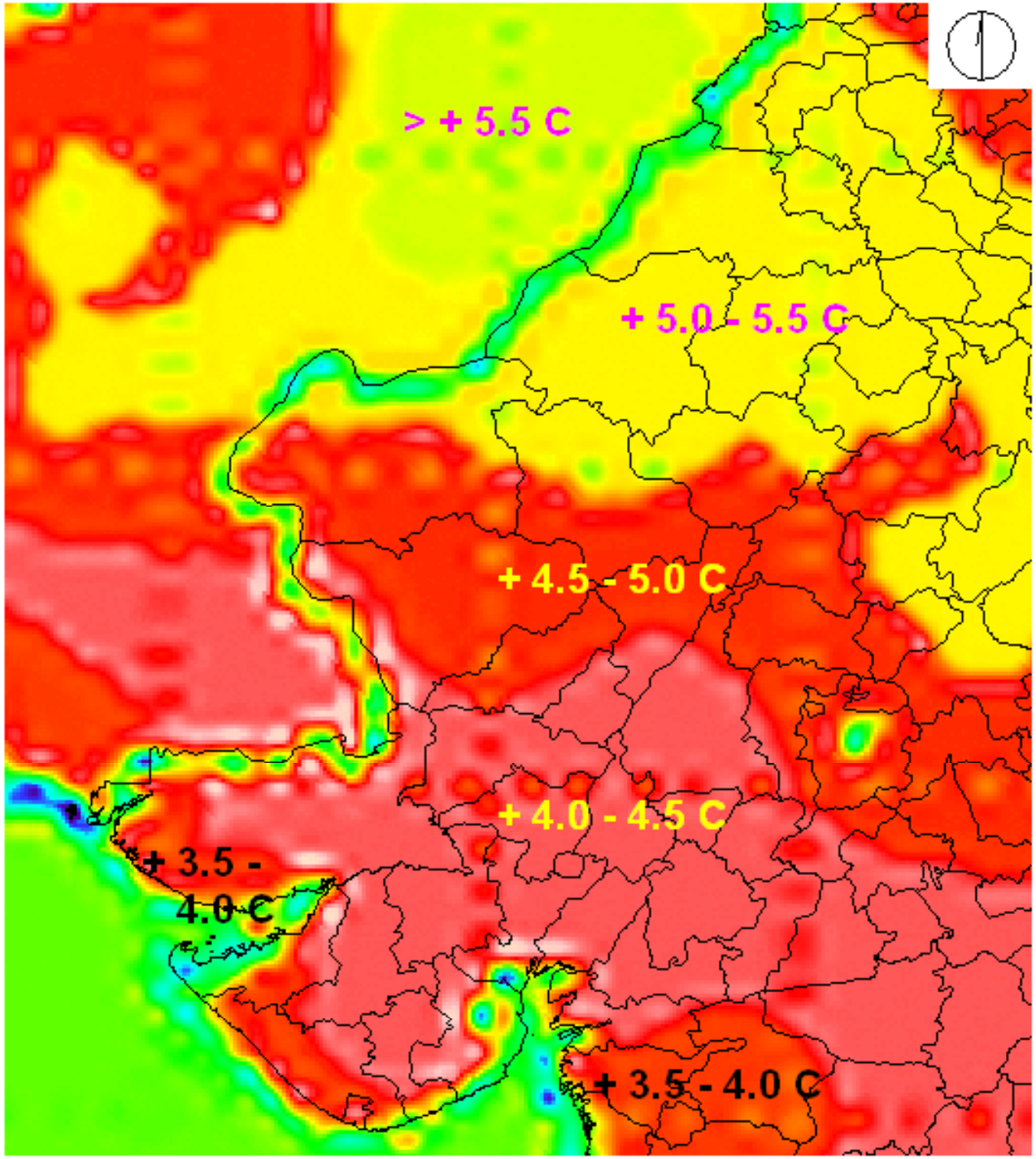


Fig. Spatial patterns of trends in seasonal extreme temperature events (shaded area indicates trend significant at 5% level, red for increasing and blue for decreasing, 1970 – 2003.



LIKELY CHANGES IN ANNUAL TEMPERATURE IN NORTHWEST INDIA BY YEAR 2071

USING PRECIS RCM FOR A2 SCENARIO

SOURCE:

HADLEY CENTRE, UK

Boundaries are approximate

GIS OVERLAYS BY A. KAR

CAZRI, JODHPUR

KAR CAZRI

Droughts and Floods

Future of Droughts

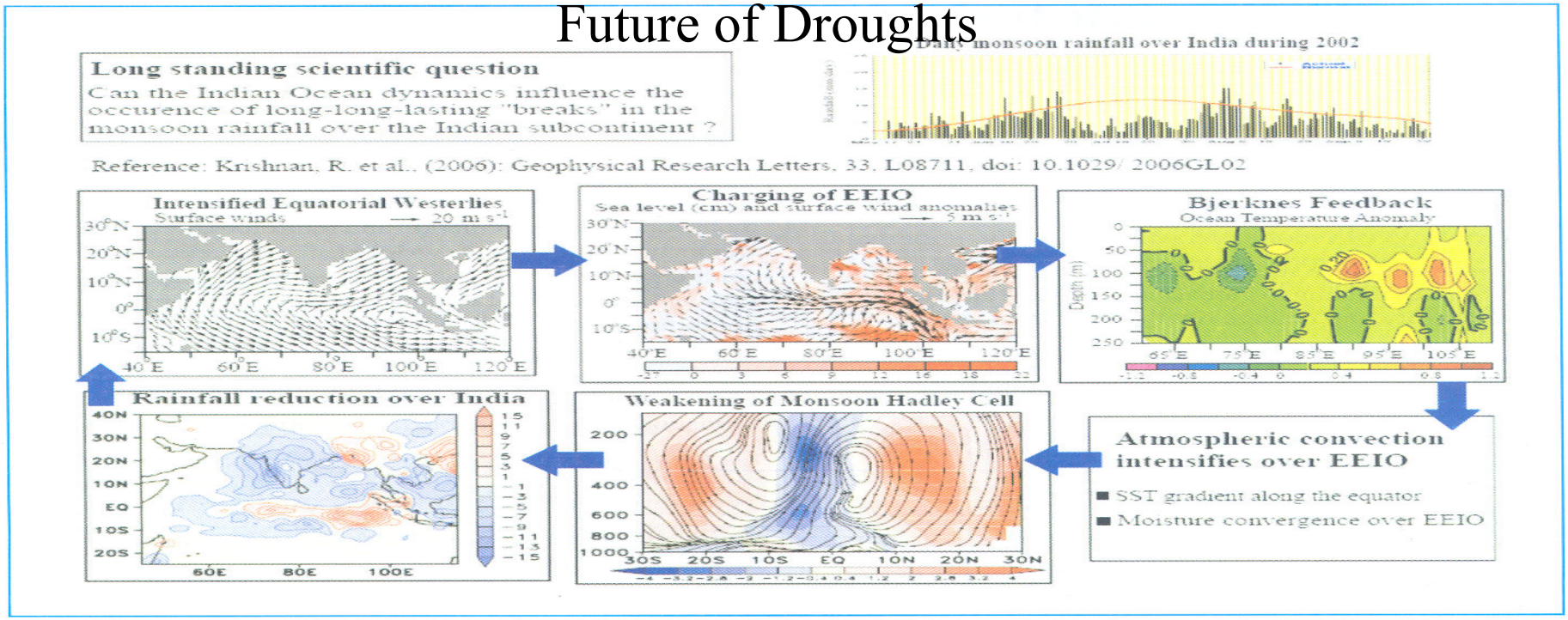


Fig. 50 : Indian Ocean Monsoon coupled interactions and droughts over India

Break in Monsoon Rainfall

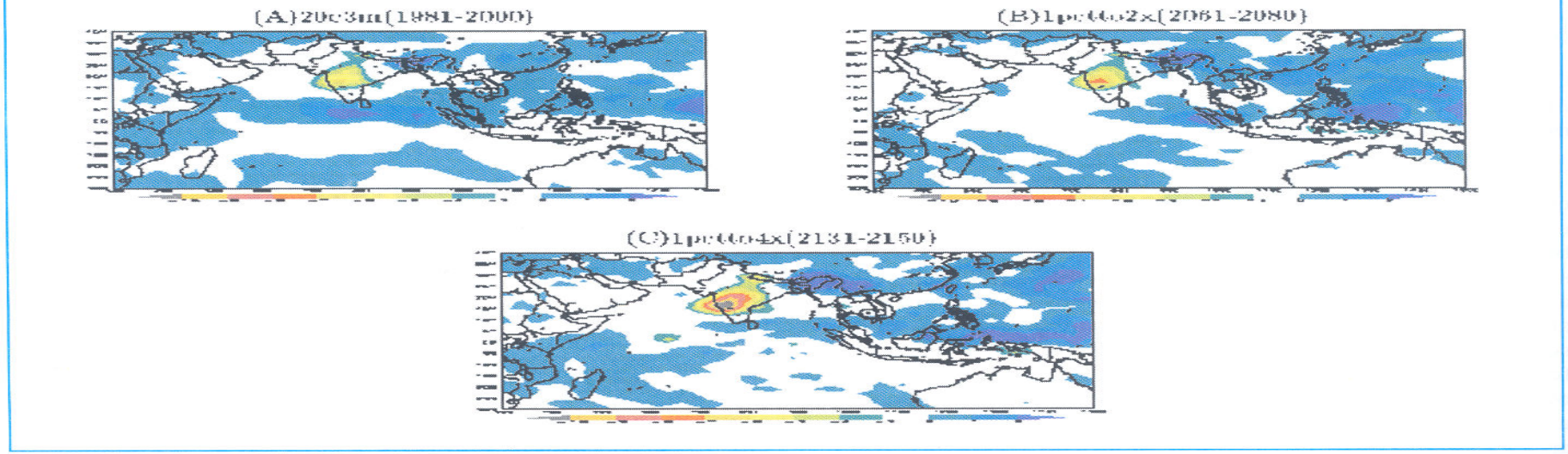


Fig.51: Simulation of break-monsoon rainfall anomaly in the present-day and global warming scenarios

Change in drought and flood risk from late 20th to late 21st century

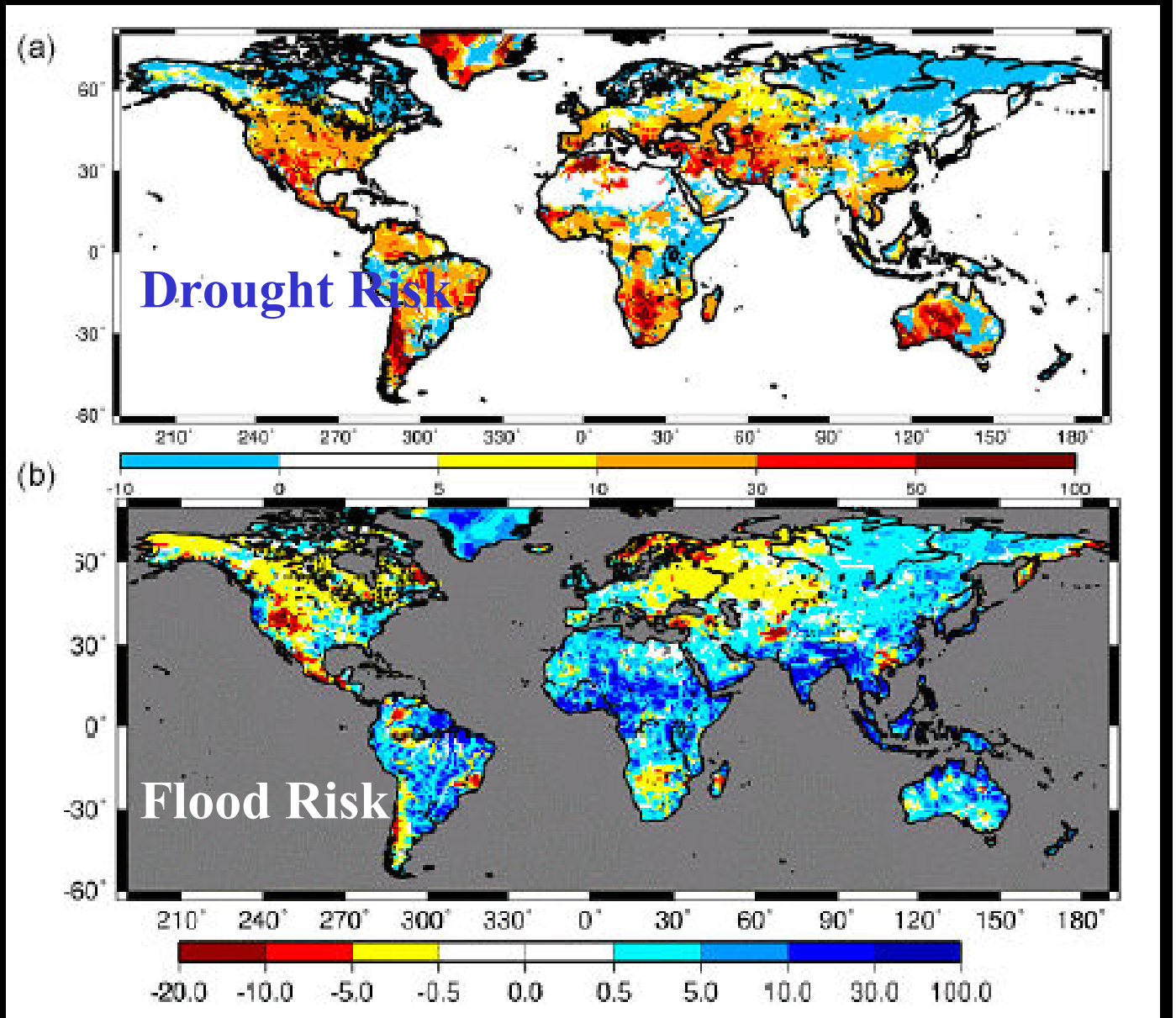
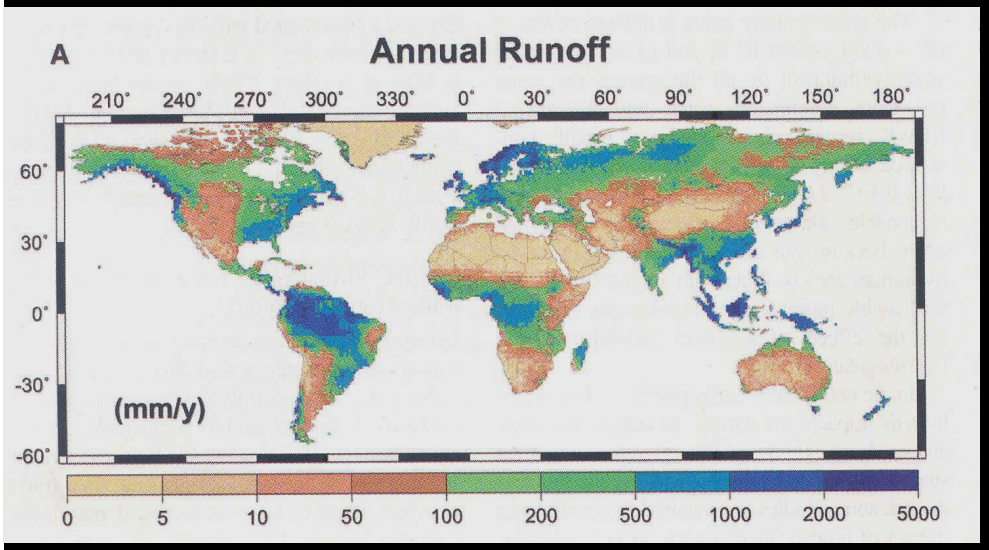
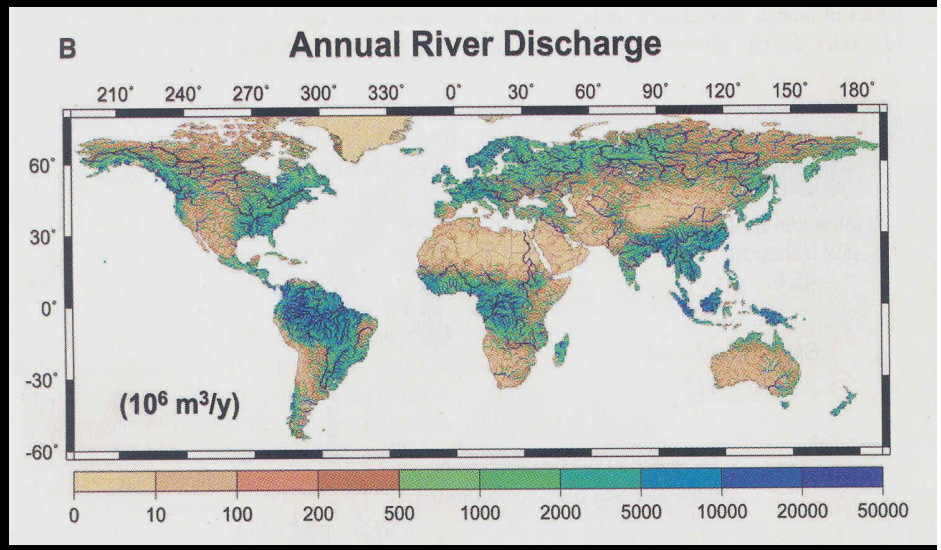


Fig. (a) Change in drought risk from the late 20th century to the late 21st century, with red showing increased risk, and (b) Change in flood risk from the whole 20th century to the whole 21st century, with blue showing increased risk, based on daily river discharge data simulated by the MIROC model. See text for the definition of the risk indices.





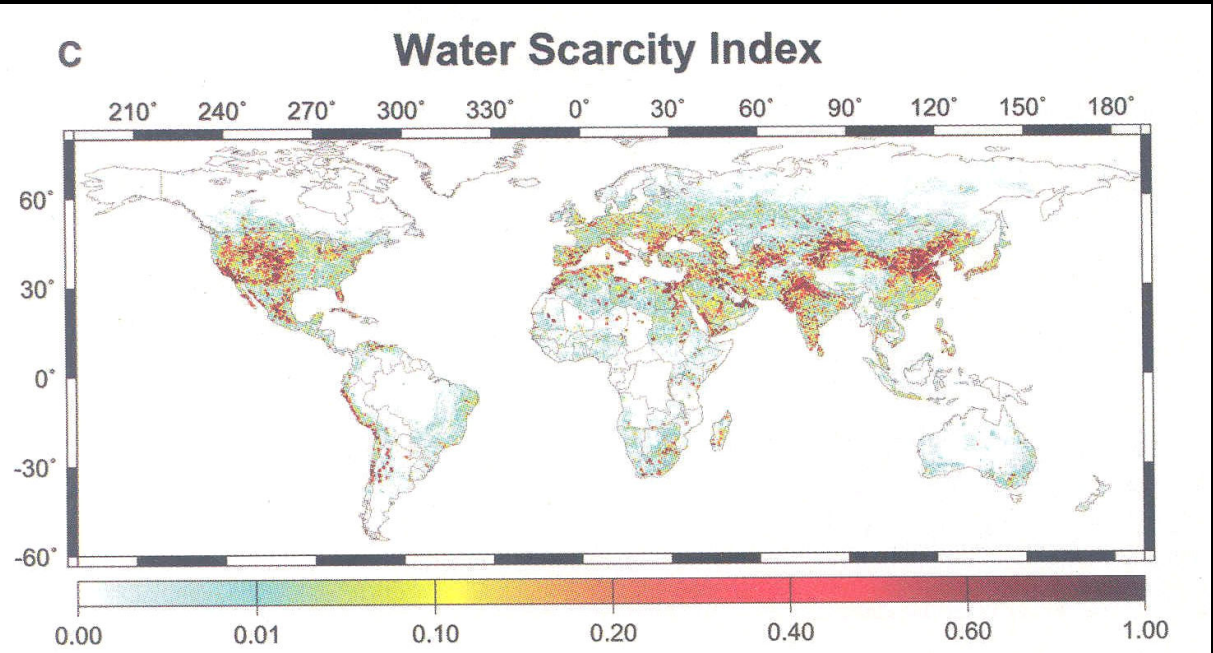
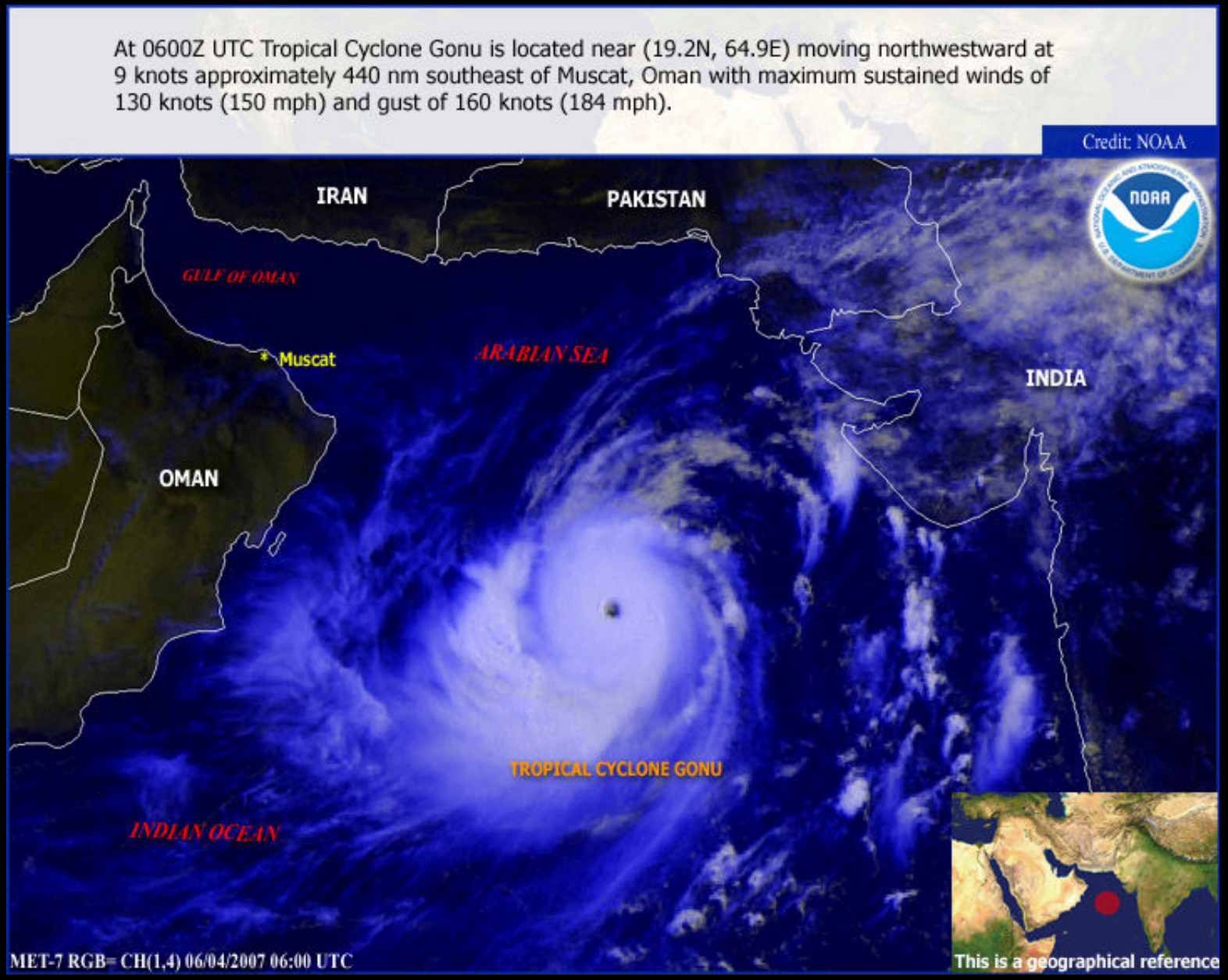


Fig. Global distribution of (**A**) mean annual runoff (mm/year), (**B**) mean annual discharge (million m^3/year), and (**C**) water scarcity index *Rws* (*3*, *11*). Water stress is higher for regions with larger *Rws*.

NOAA IMAGE OF A CYCLONE APPROACHING FROM THE ARABIAN SEA
05 JUNE 2007



HIMALAYAN GLACIERS ARE RETREATING FAST

SO, MAJOR STREAMS ARE EXPERIENCING EARLY PEAKS IN DISCHARGE

STREAMS TO ACCOMMODATE LARGER VOLUME OF WATER NOW, OR FLOOD MORE OFTEN

NEXT PHASE WILL SEE A MAJOR WATER CRISIS



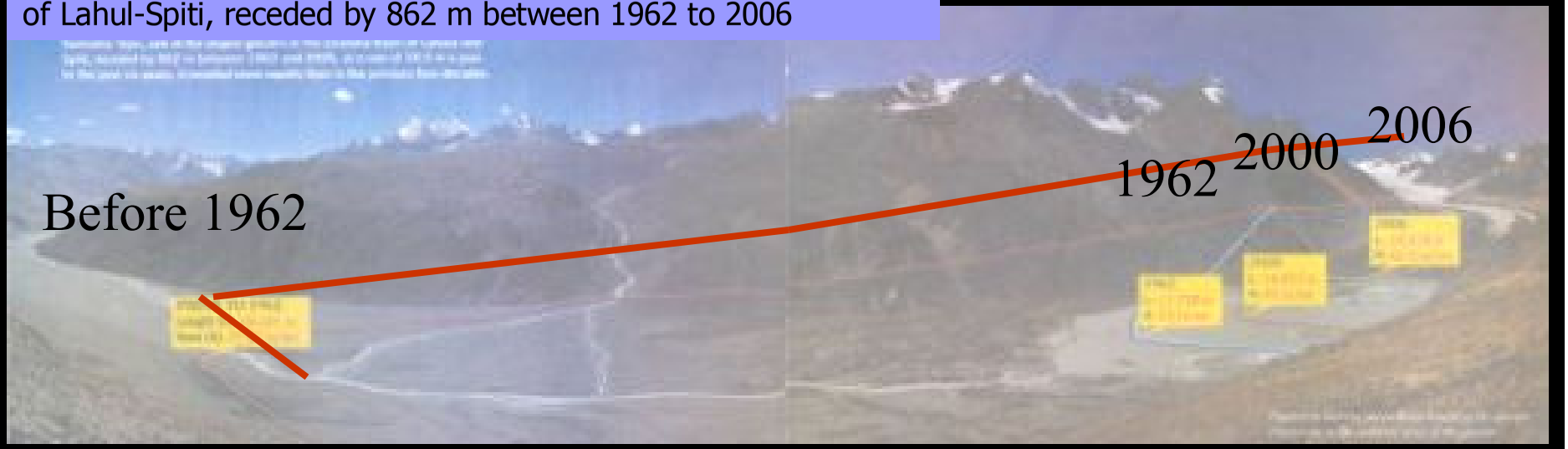
Retreat @ 34 m/year during last 3 decades

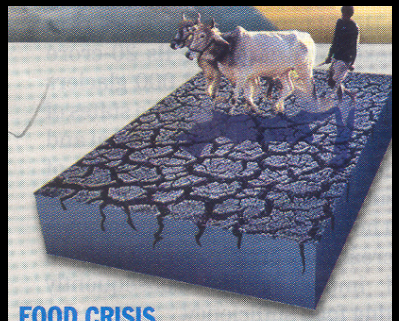
PEAK DISCHARGE ALONG THE GANGA MAY GRADUALLY INCREASE TO 120-133% OF THE PRESENT FOR ~2 DECADES; BY 6TH DECADE IT MAY SEE ~50% DECLINE. THE INDUS MAY SHOW 15-90% HIGER DISCHARGE, BUT DECLINE EXPECTED IN 10 DECADES.

KAR
CAZRI

The glacial melt will adversely alter India's Fresh water balance

Samudra Tapu, one of the largest glaciers in the Chandra Basin of Lahul-Spiti, receded by 862 m between 1962 to 2006



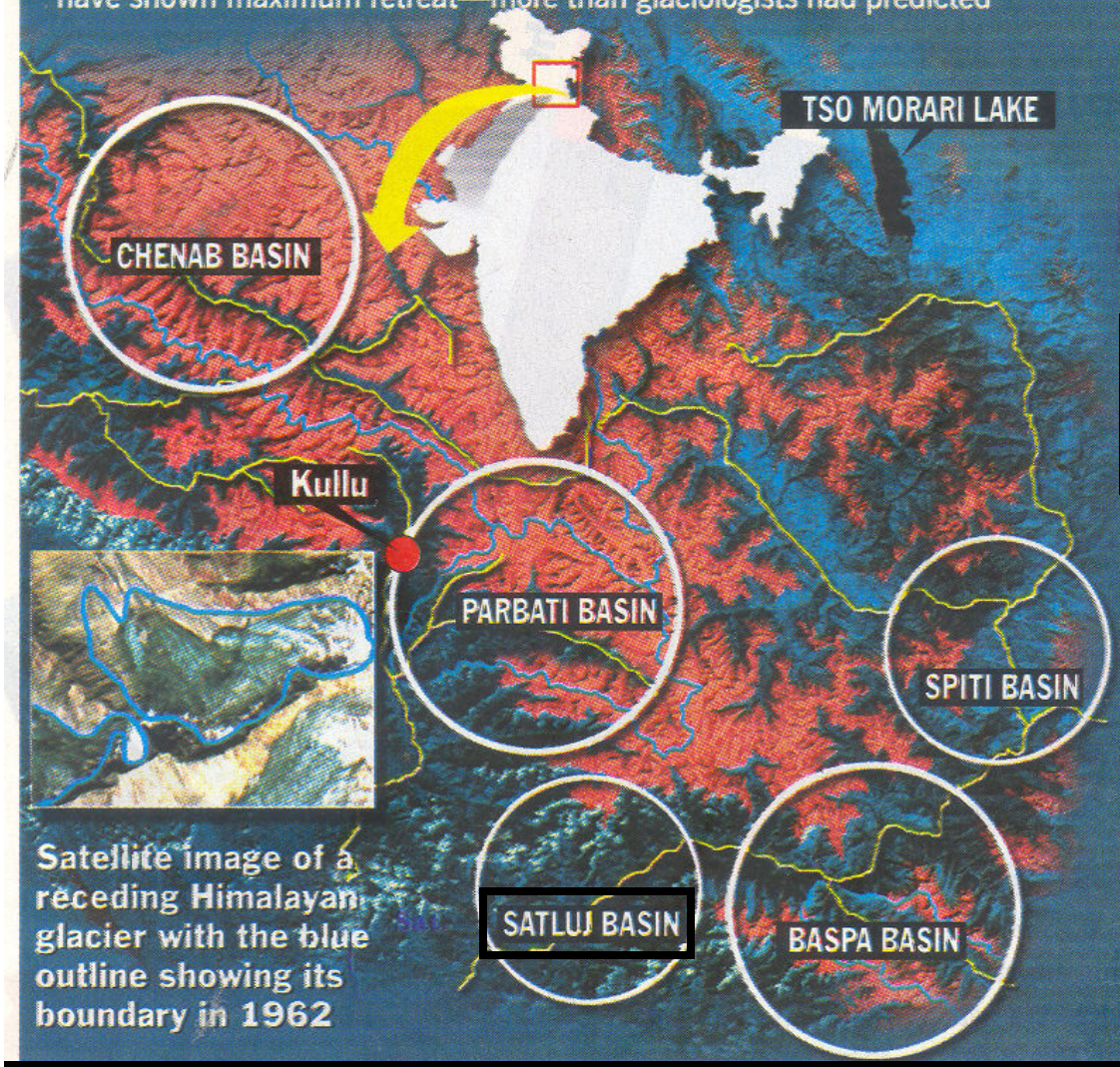


FOOD CRISIS
With climate patterns changing, the water balance is disrupted leading to droughts in traditionally fertile zones. Agricultural production, especially food grains, would be badly hit.

- In 40 years, key Himalayan glaciers have shrunk by 21%
- Weather conditions could be irrevocably altered
- Food crops will face catastrophic water shortage
- The hydro-power will be badly hit

VANISHING ACT

Even as the larger glaciers are getting fragmented, the smaller glaciers have shown maximum retreat—more than glaciologists had predicted



Satellite image of a receding Himalayan glacier with the blue outline showing its boundary in 1962

Basin	No. of glaciers	Loss percentage
Chenab	359	21%
Parbati	88	22%
Baspa	19	19%
TOTAL	466	21%

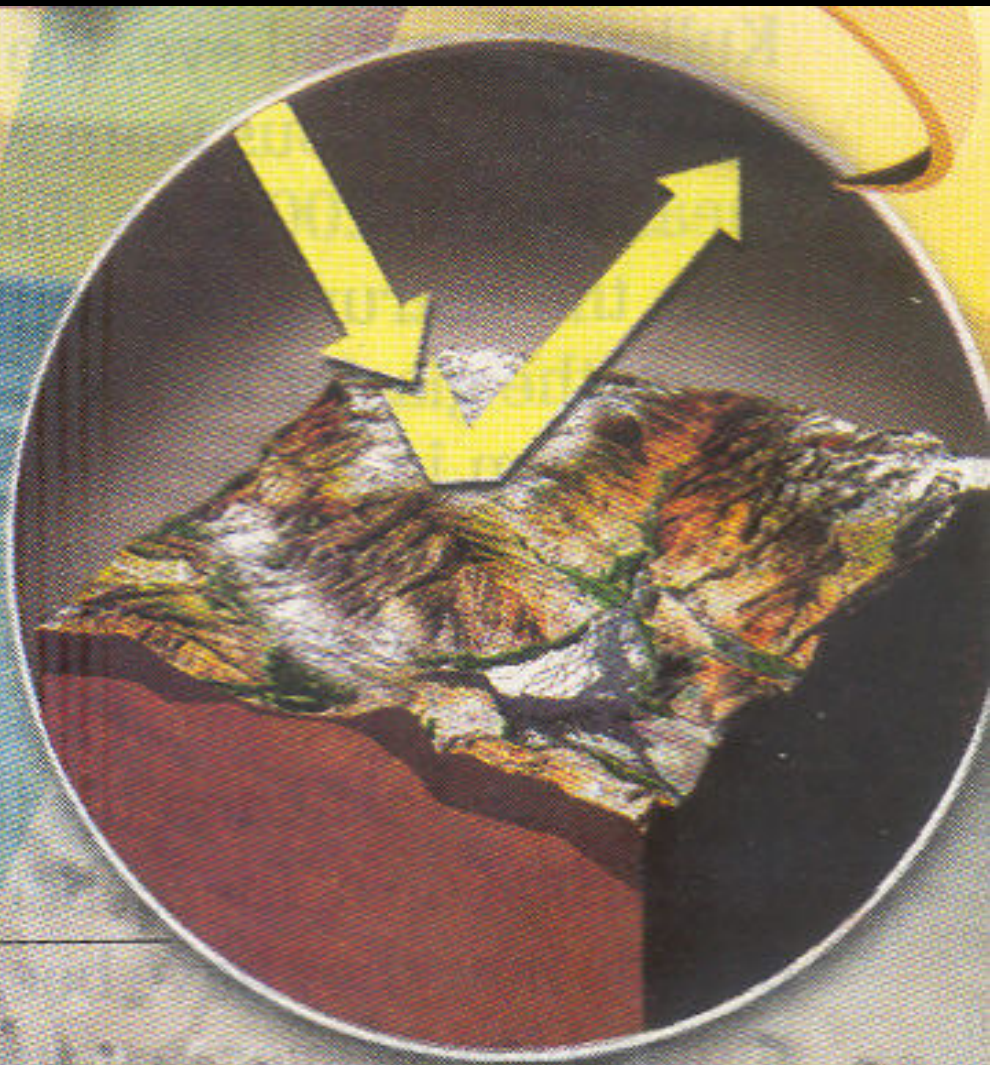
Glacier	Basin	Glacier area (sq km)	Retreat (metres) Total	Retreat (metres) Rate/yr
Miyar	Chenab	87.8	757	16.43
Shaune Garang	Satluj	8.8	923	26.4
Bilare Bange	Satluj	2.8	90	2.6
Parbati	Beas	48.44	6569	214
Samudra Tapu	Chenab	77.67	802	21
Chipa	Dhauliganga*	5.0	1050	26.92
Meola	Dhauliganga	14.0	1350	34.62
Jhulang	Dhauliganga	3.3	400	10.53
Gangotri	Ganga*	143	535	28.1
Dokariana Bamak	Ganga	5.8	585	16.7
Meru Bamak	Ganga	4.7	395	17.2

** Not shown in map.*

The figures are based on an average 30-year observation. Main study focussed on glaciers in Himachal Pradesh. Source: ISRO

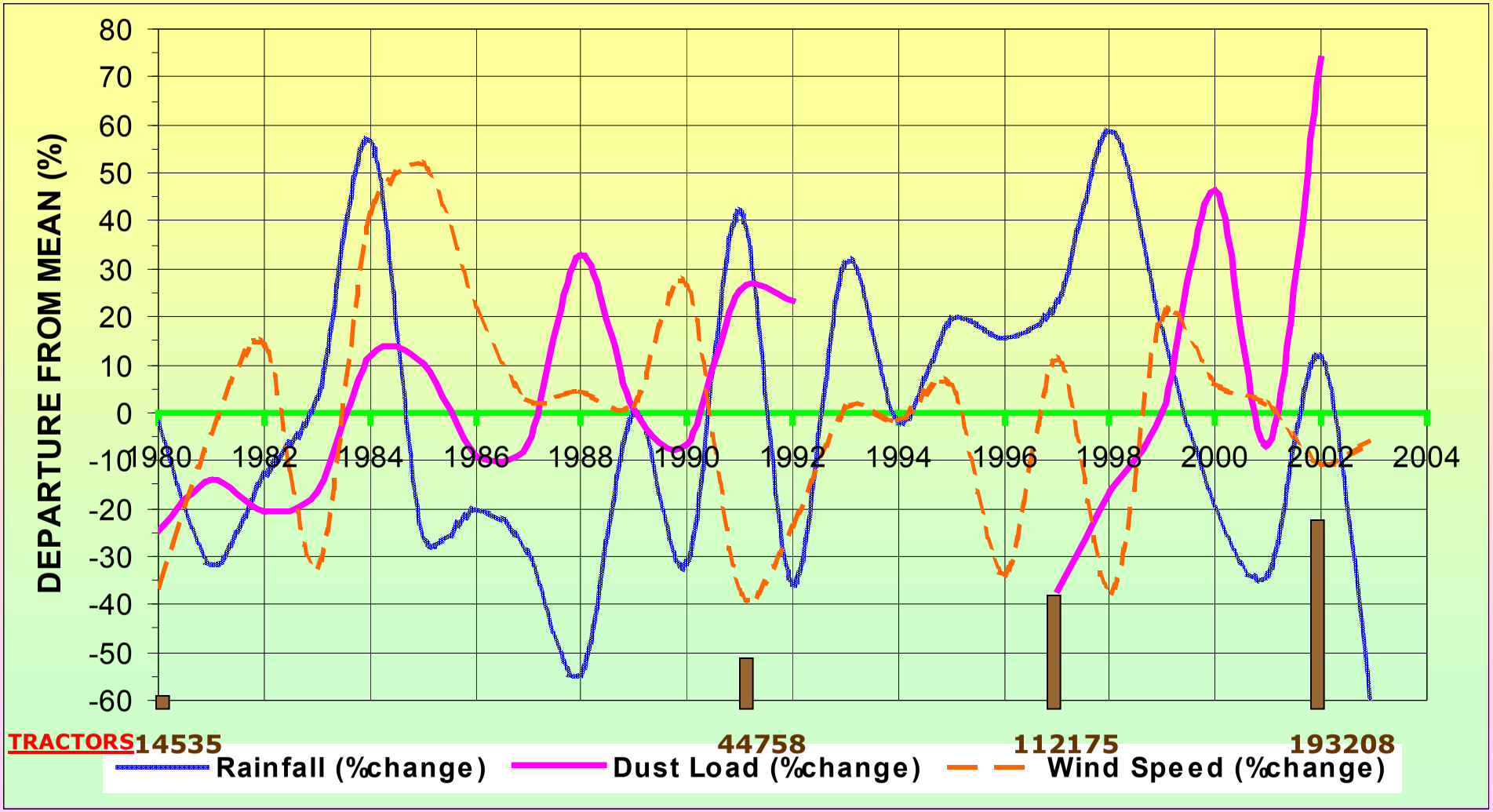
NO ICE SHIELD

Ice caps on mountains and glaciers to a large extent help deflect the heat of the sun. But with glaciers receding, the heat stays trapped close to the soil.



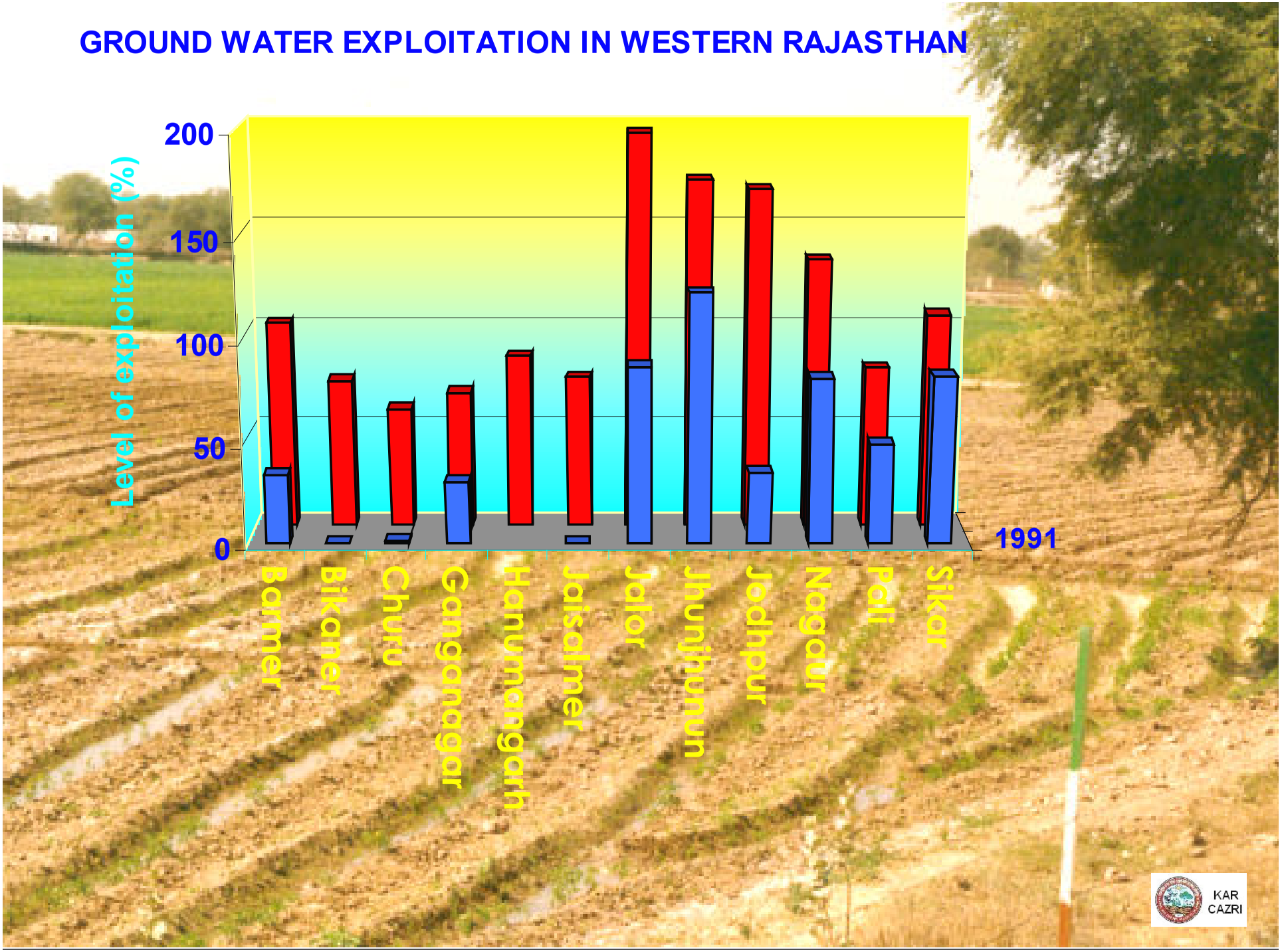
Anthropogenic Activities

ATMOSPHERIC DUST LOAD IN RELATION TO JUNE WIND SPEED, ANNUAL RAINFALL AND TRACTOR USE IN WESTERN RAJASTHAN

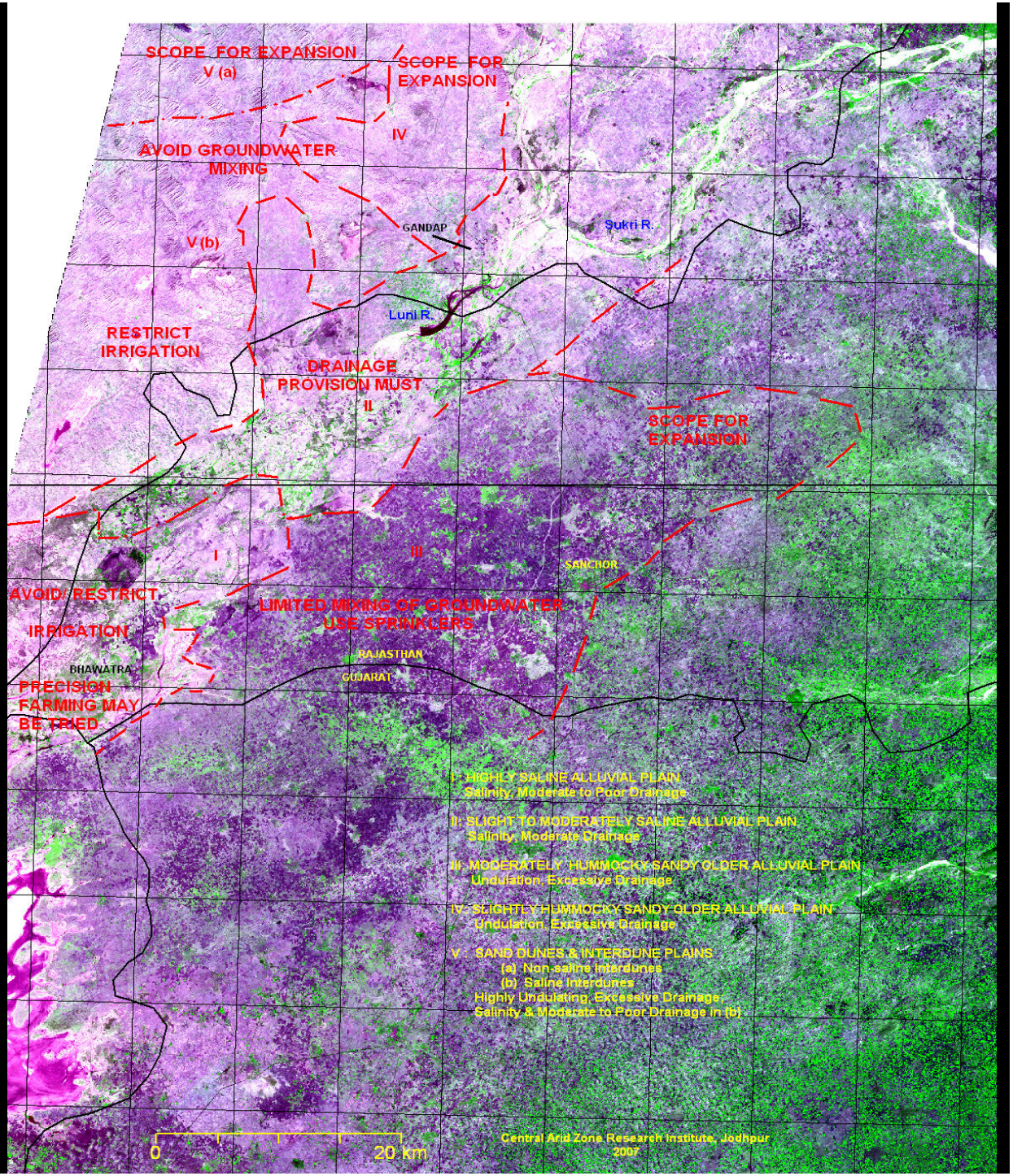


KAR/ CAZRI

GROUND WATER EXPLOITATION IN WESTERN RAJASTHAN



Advise to Government of Rajasthan on Irrigation from River Narmada



Distribution of Ozone boundary

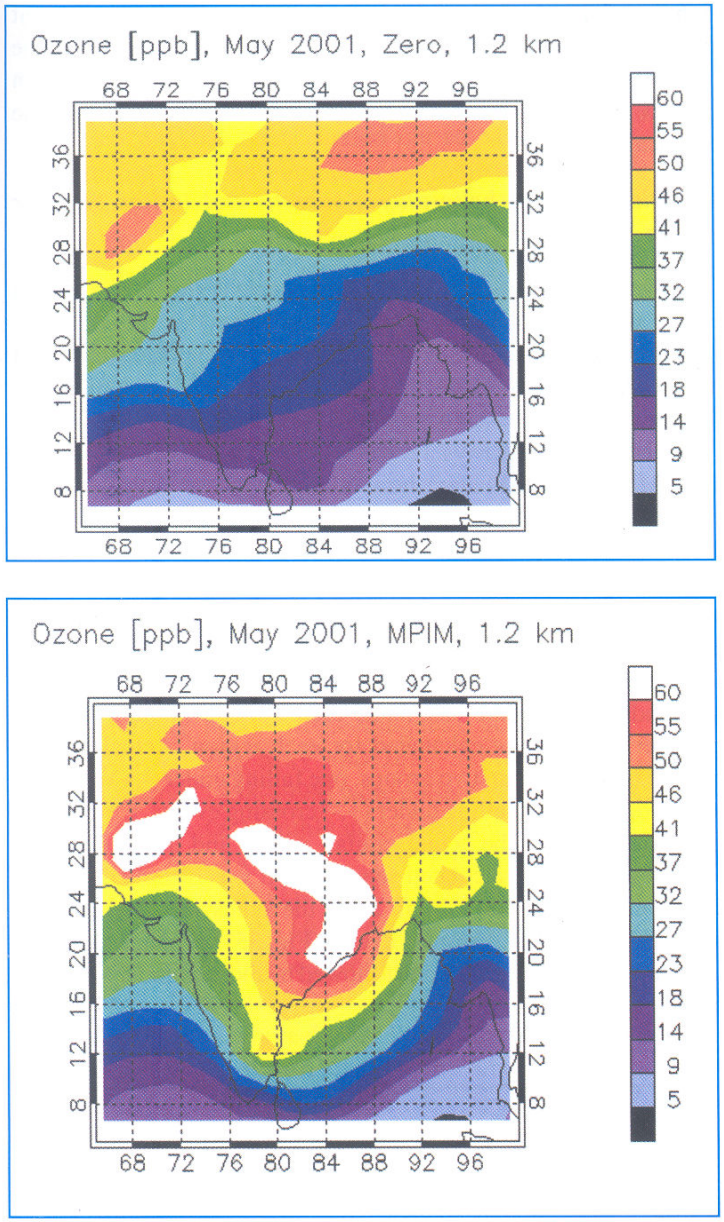


Fig. 34 : Distribution of ozone near the boundary layer over the Indian geographical regions (A) when Indian emissions from local resources are considered as zero, which is attributed as the impact of south Asian emissions (long range transport) on the distribution of ozone over India; (B) Normal distribution of ozone over the Indian geographical region (reference level) for comparison.

Effect of South Asian Emissions

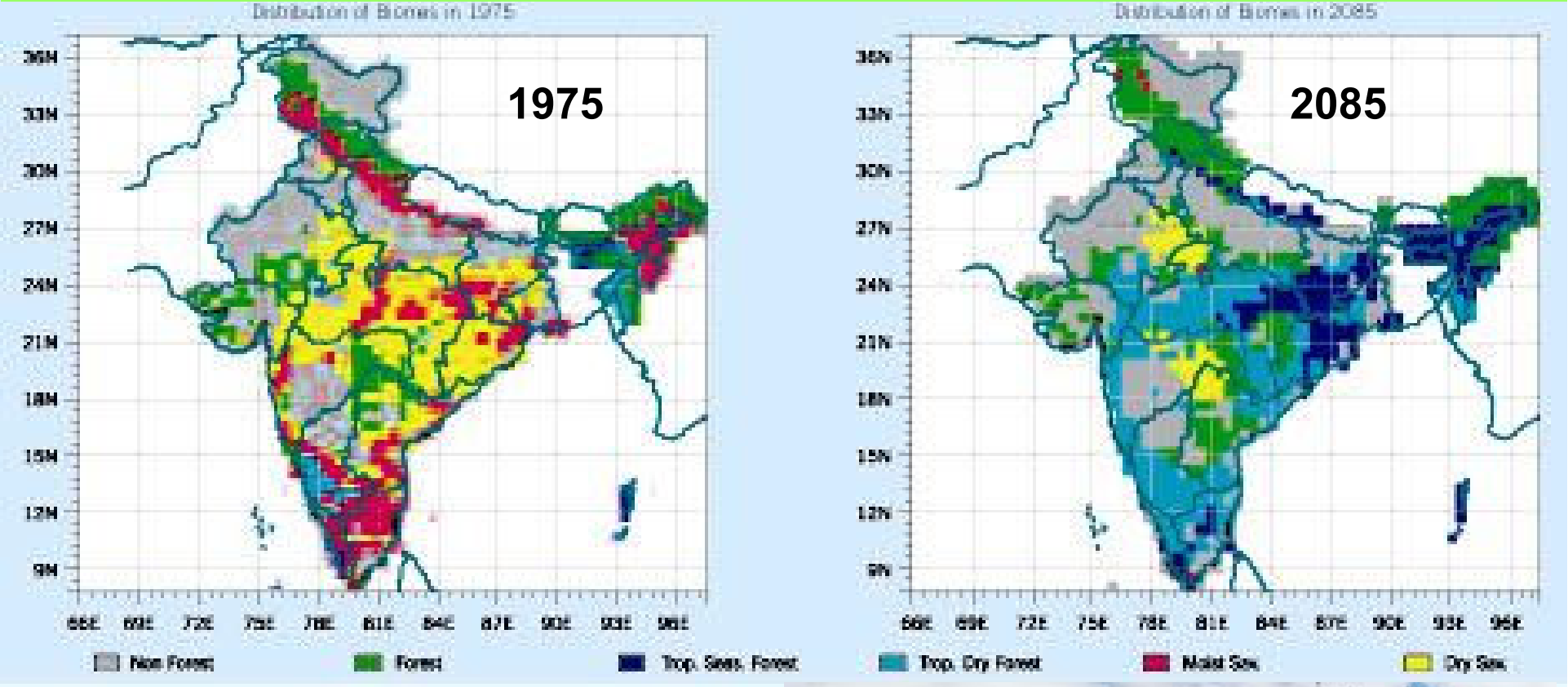
Normal

Humans have transformed the earth in the last 50 years



Courtesy :A. K. Gupta, NCMRWF

LIKELY CHANGES IN FOREST TYPES IN INDIA BY THE END OF 21ST CENTURY



NOT INCLUDING THE IMPACT OF DIFFERENT RATES OF FOREST COVER EXPLOITATION




INDUSTRIAL EMISSION
Carbon emission from burning coal in industrial operations add to the greenhouse effect.
DISAPPEARING GREENS
Trees are carbon sinks and deforestation upsets the balance. With less green cover, soils retain more heat and droughts soon follow.

What if……

Climate change, thus can be summarized

- Mean diurnal temp is on increase at 0600 &1200 hrs (1998 to 2002)

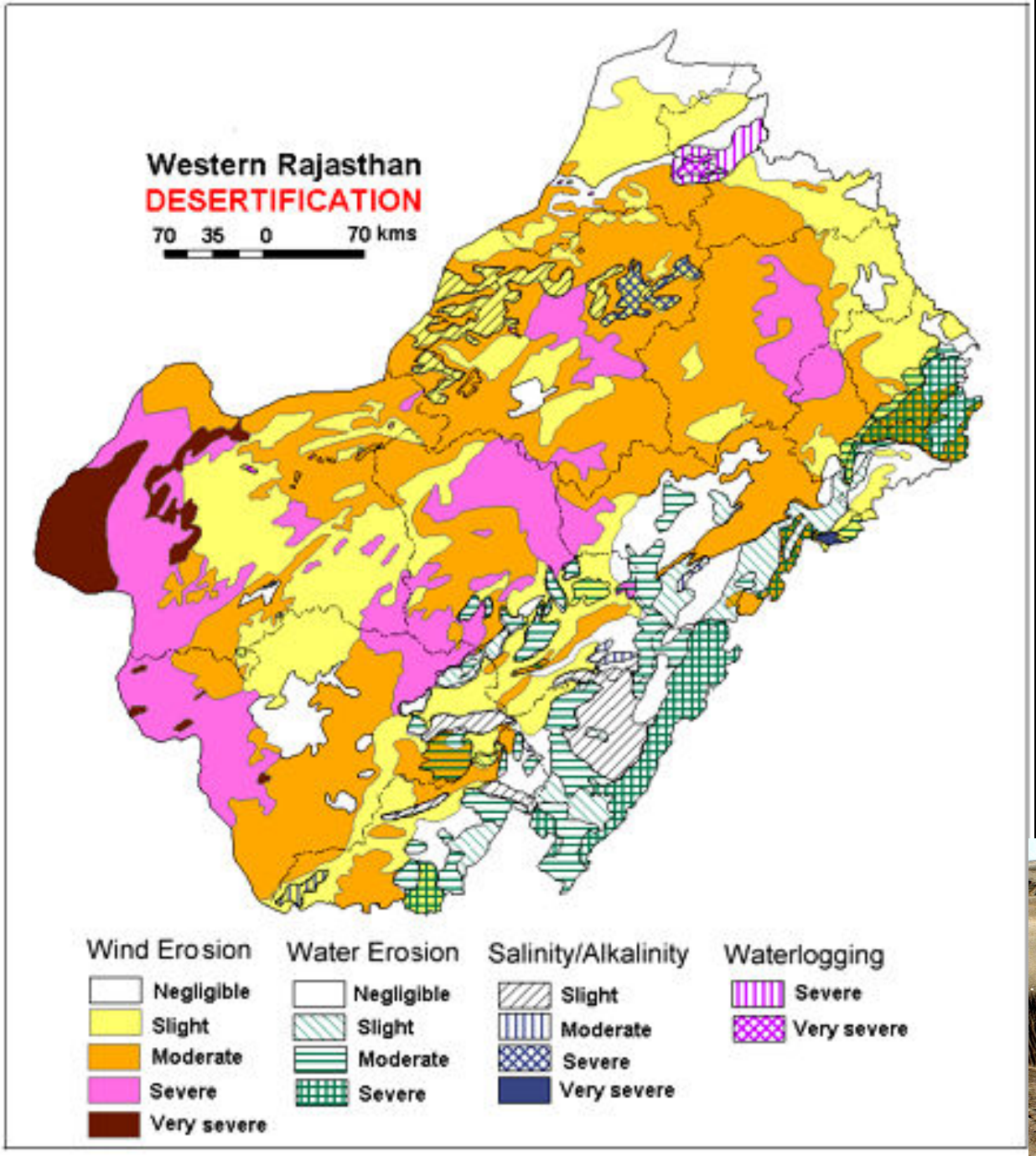
- Extreme events
  - Hot days increased
  - Cold nights decreased
  - Ozone is highest at >60 ppb

Future trends -
  - Increase in highest maximum temperature
  - Increase in lowest minimum temperature
  - Breaks in monsoon in central India is on increase
  - Glaciers are tracking backwards

There is significant regional variation in the impacts from a +2.0°C rise in mean temperature and a +7% increase in mean precipitation levels.

Agriculturally low-value, hot and dry districts of Rajasthan and Central India are negatively impacted.

Gujarat is most-negatively affected. High value agricultural regions of Punjab and Haryana show a small loss. Agriculture will shift to potentially more valuable summer crop.



AREAS AFFECTED

Percentage of Total Mapped

WIND EROSION 75.0

WATER EROSION 11.0

WATERLOGGING 0.7

SALINIZATION 05.0



Some Wayward Thoughts

Presently –
SRI in rice by regulated irrigation

15-20 years

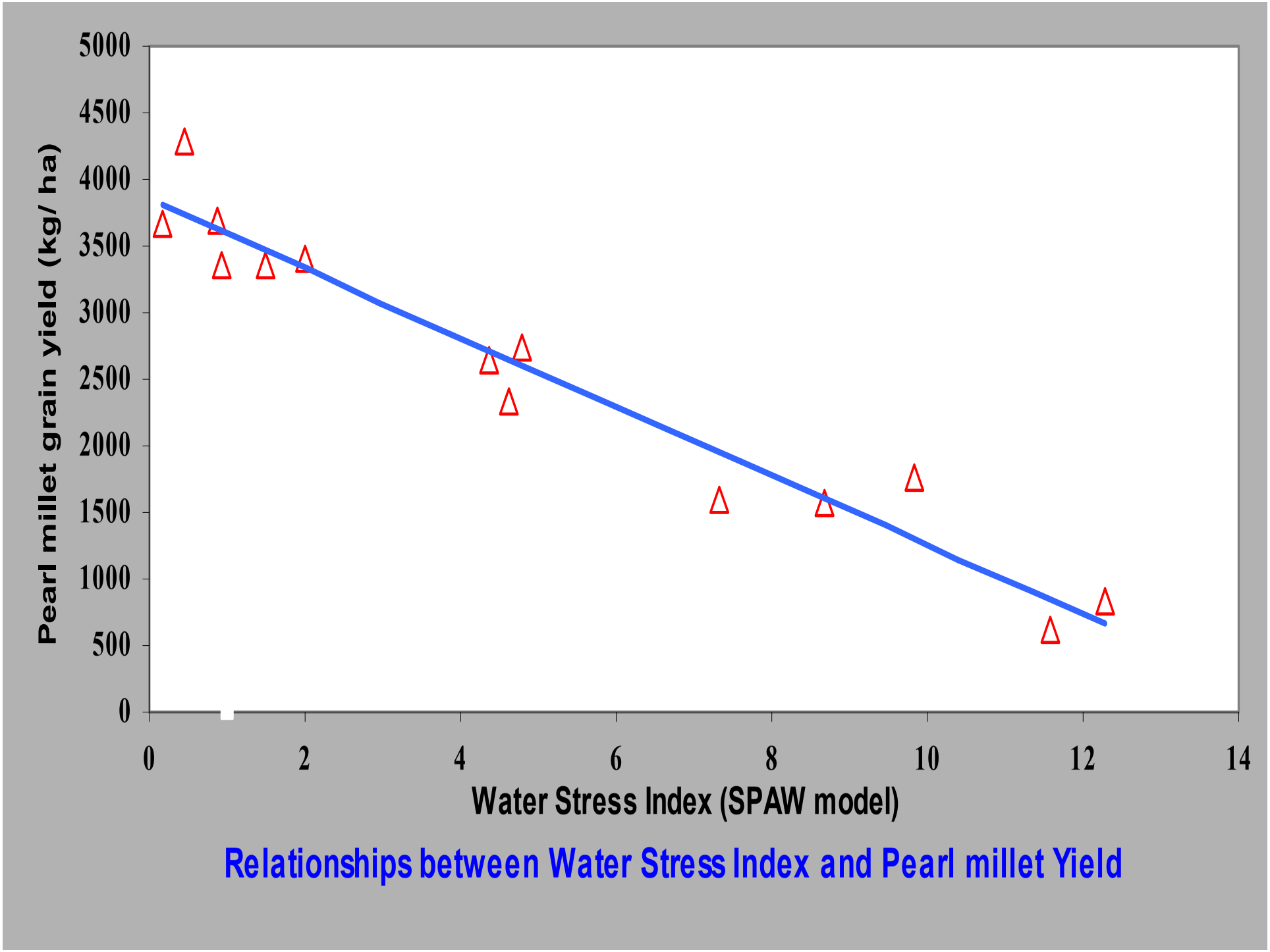
Land Care –
Bring back livestock based rangeland management (50-90%)
+ High tech glass/green house agriculture (15-20%)

30-50 years

Water care –
Storing excess melts/ floods in underground tanks
+ charging aquifers at feasible points

75-100 years

Last Resort –
Canalization of water through closed conduits +
Recycling of ET by condensation



Relationships between Water Stress Index and Pearl millet Yield



Technology

- Protect from biotic interferences
- Create micro-wind breaks
- Plant suitable trees and grasses

(adopted in ~4 lakh ha)

Production

Fuel wood: 30t/ha (after 10 yrs)

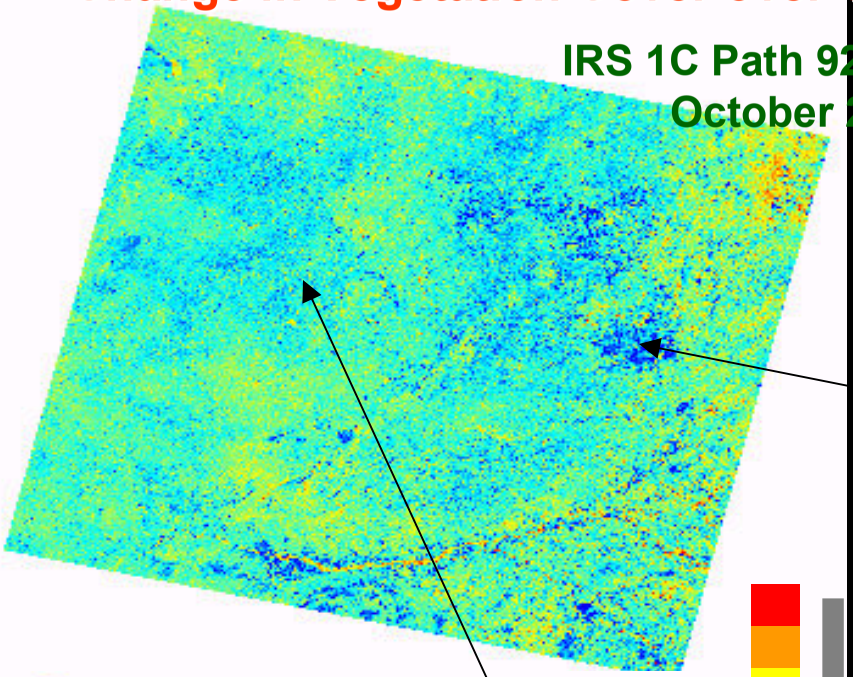
Grass: 5-8 q/ha/yr (after 3 yrs)

Benefit : Cost ratio 2.6

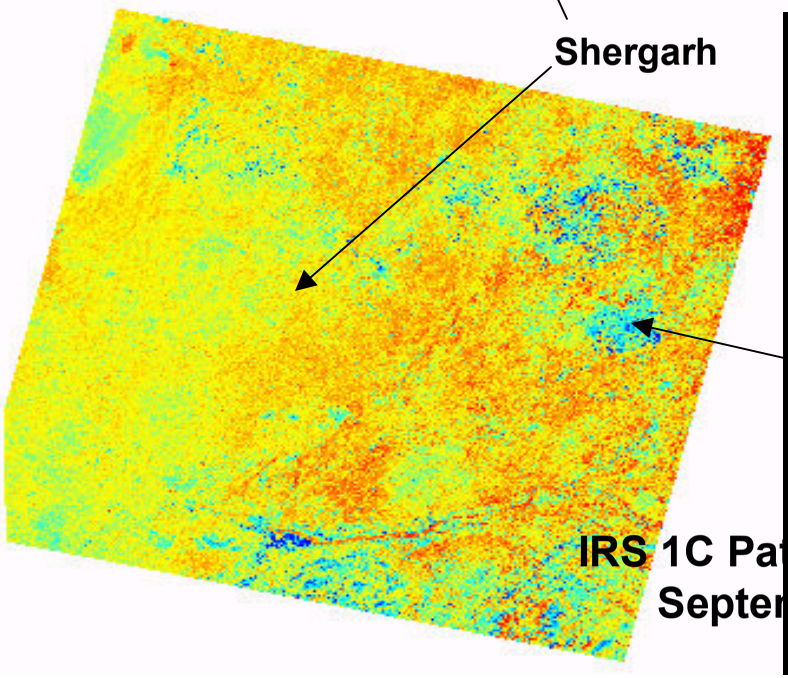
Sand Dune Stabilization

Change in Vegetation Cover over Time

IRS 1C Path 92, Row 53
October 2001



Shergarh



IRS 1C Pat
Septer







NEW INVASSIONS



COMMENSAL SPECIES (effect of urbanisation)

- *Mus Musculus*
- *Rattus rattus*

SUB-MESIC SPECIES (effect of change in land use pattern)

- *Golunda ellioti*
- *Mus booduga*
- *Rattus meltada*

Kuis/Beris

Found in western Rajasthan, these are 10-12 m deep pits dug near tanks to collect the seepage.

Kuis can also be used to harvest rainwater in areas with meagre rainfall.

The mouth of the pit is usually made very narrow. This prevents the collected water from evaporating.

The pit gets wider as it burrows under the ground, so that water can seep in into a large surface area.

The openings of these entirely *kuchcha* (earthen) structures are generally covered with planks of wood, or put under lock and key.

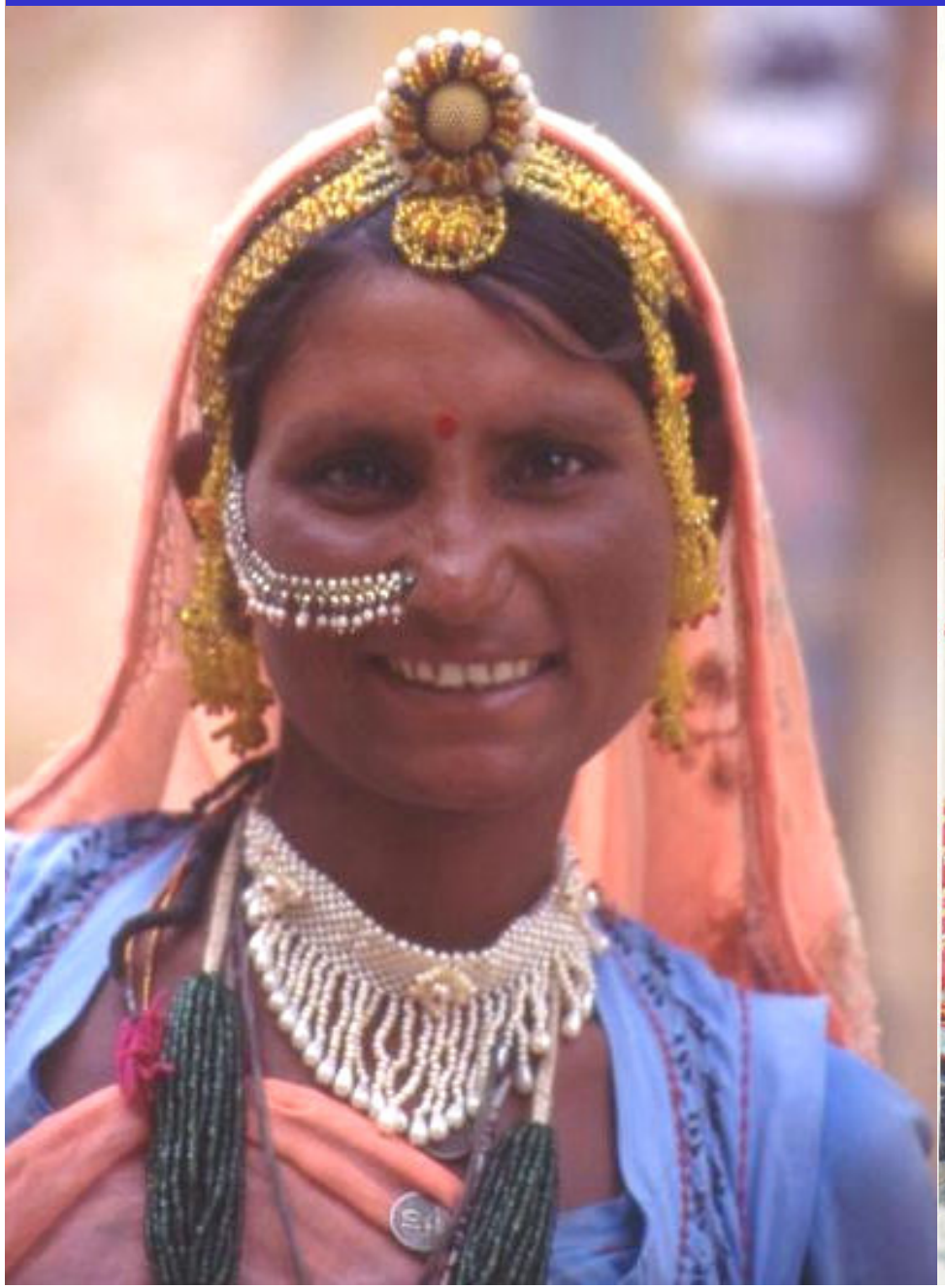
The water is used sparingly, as a last resource in crisis situations.

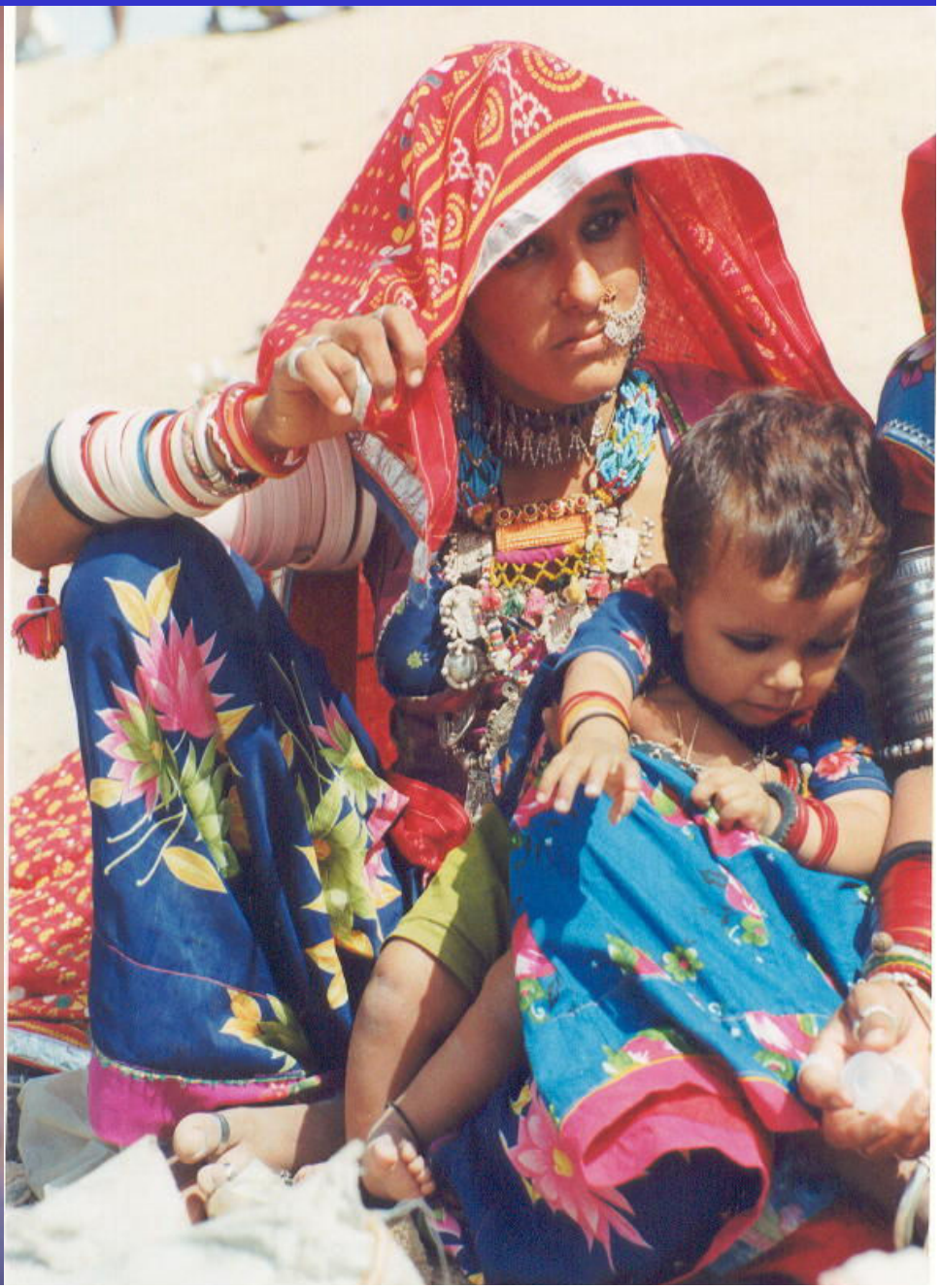


Beri



Traditional Ornaments

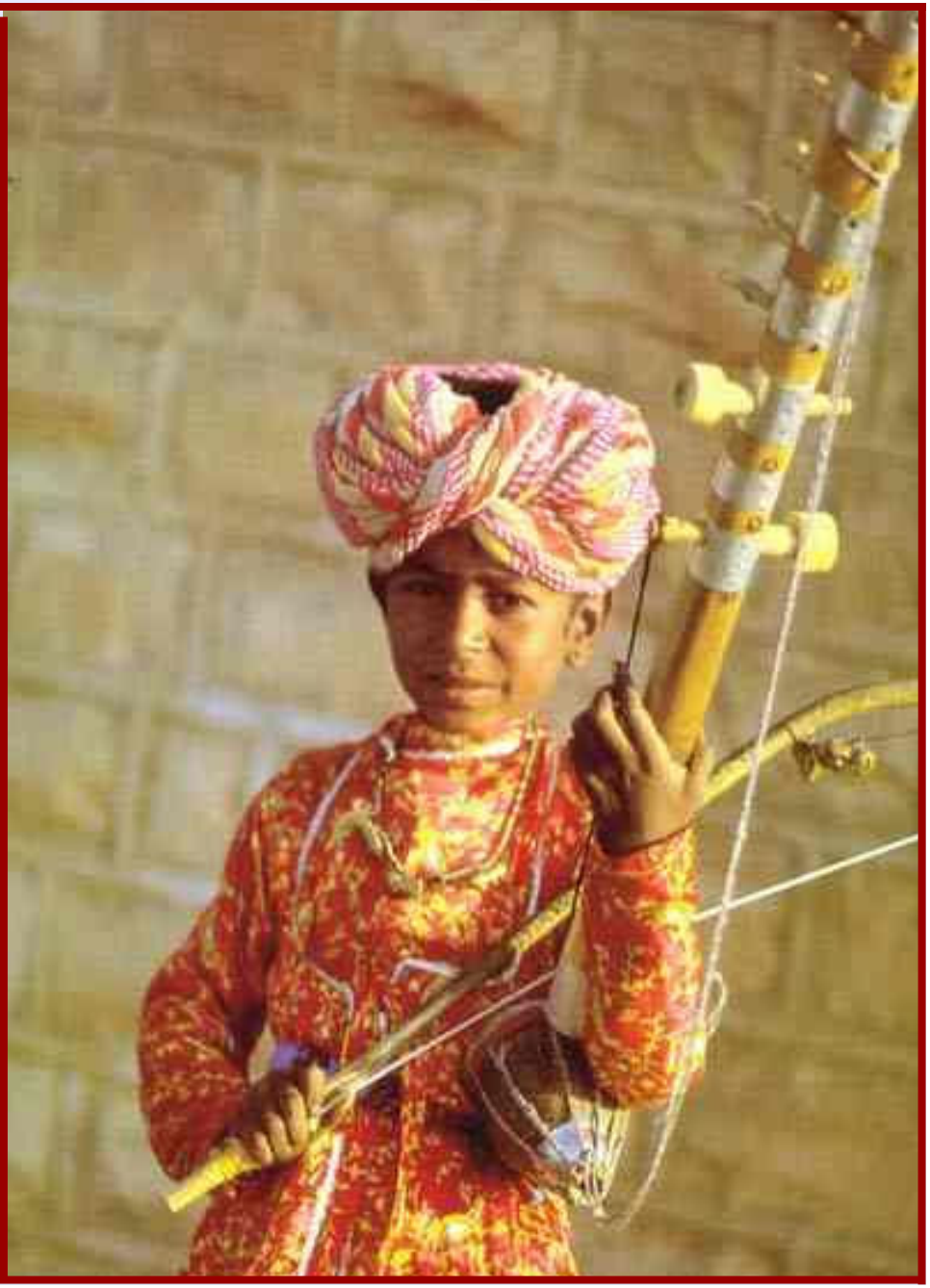




Soothing Desert Music







Cultural Heritage



Folk Dances



Bhavai



Gair



Kalbalia


THANKS