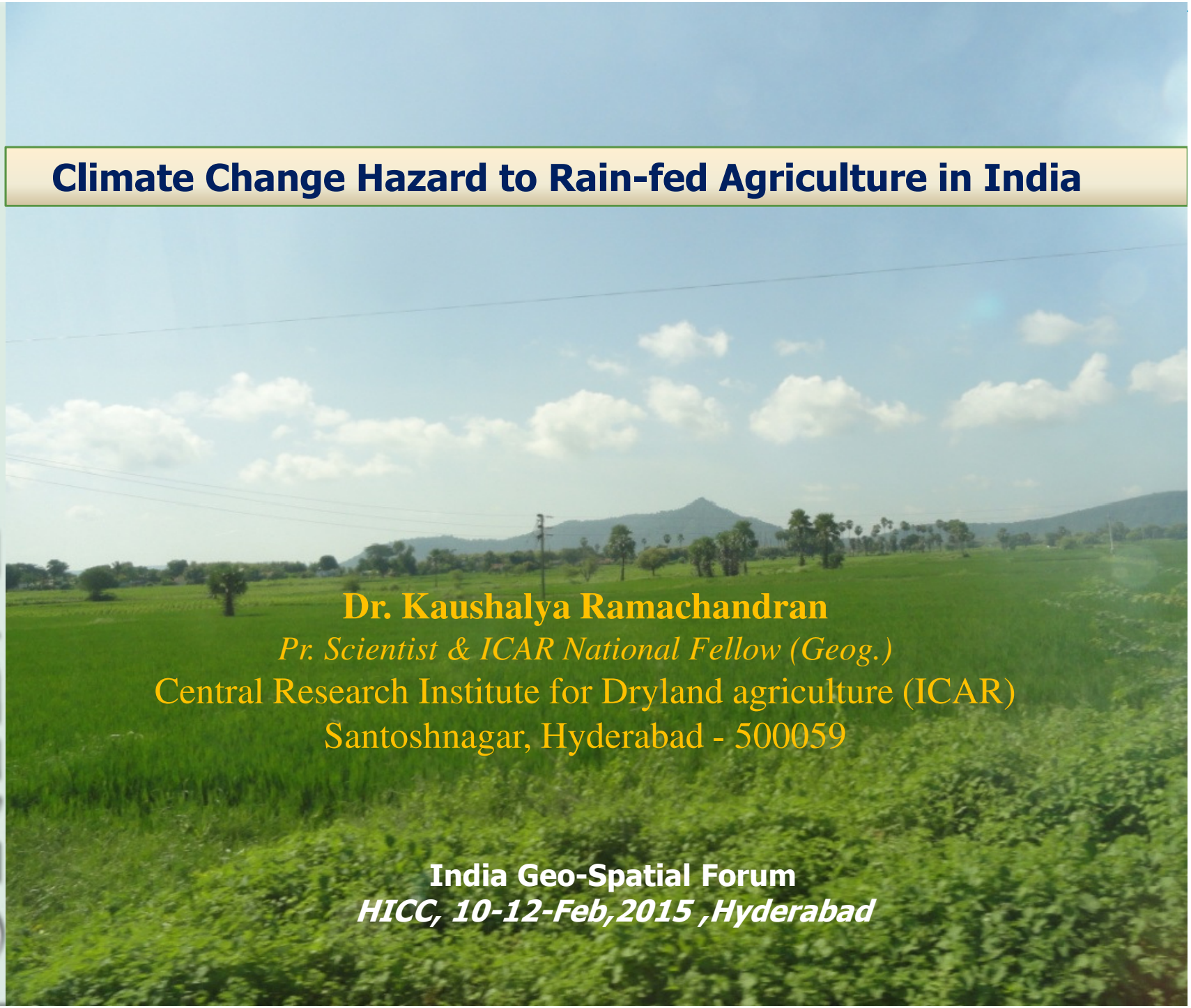
Climate Change Hazard to Rain-fed Agriculture in India



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India Geo-Spatial Forum
HICC, 10-12-Feb,2015 ,Hyderabad

Objectives

- **Identify sources of vulnerability to rainfed agriculture & estimation of extent of vulnerable regions at State, AESR & District levels in India**
- **Trend in variations in SPI, NDVI & LGP in vulnerable regions**
- **Typology of agriculturally vulnerability in India**
- **Identify strategies to mitigate, adapt and improve resilience of rainfed farming**

Use of NDVI to study Agricultural Vulnerability

- **NDVI derived from 2-band information (Red & Near-infra Red) of MSS imagery is contrast –stretch ratio calculated from Red & NIR bands from LANDSAT – TM; AVHRR; IRS-1B/1C/1D/P6 satellite based sensors LISS-2, LISS-3 / LISS-4; and MODIS besides others.**

- **NDVI derived from AVHRR & MODIS data with Red reflectance in Band 1 & NIR reflectance in Band 2 was calculated as follows:**

  ***band 2-band 1 / band 2 + band 1*.**

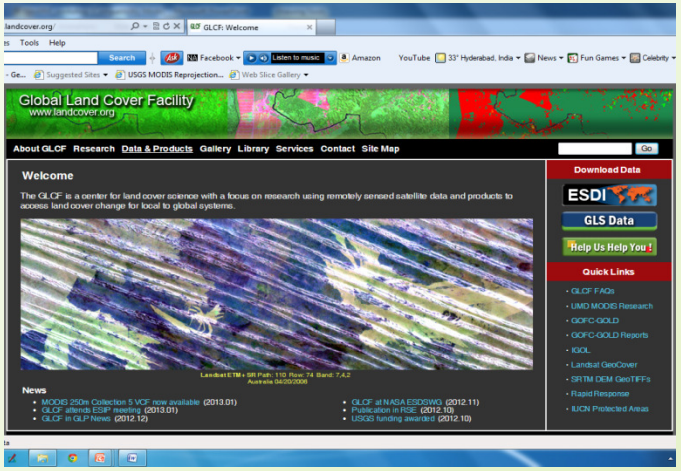
- **Land Use & Land Cover (LULC) study helps in identifying NDVI variations in agriculture, forest & open scrubland.**

- **Correlating rainfall pattern with NDVI time-series data indicates areas vulnerable to Climate Change .**

- **Use of NDVI is particularly advantageous in sub-tropical regions in Asia & Africa where dependence of agriculture is high & climate data is scarce. This helps in drawing strategies to manage & adapt to weather aberrations.**

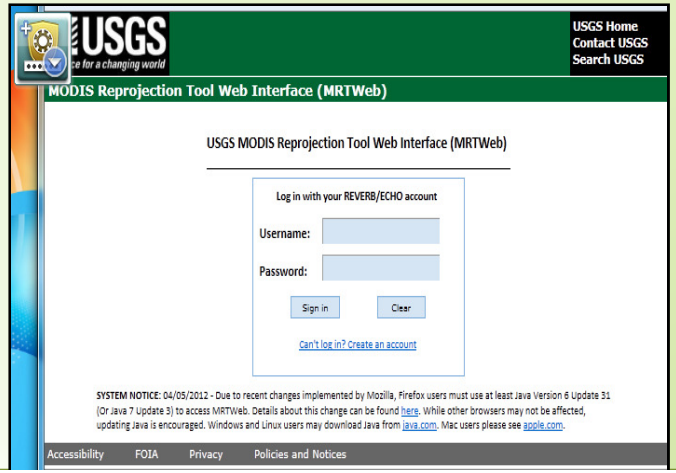
Dataset Used

NOAA- AVHRR dataset: Data was downloaded from Global Land Cover Facility (GLCF) website www.landcover.org (http://www.glcf.umd.edu/data/gimms/) as 15-day Maximum-Value Composite



TERRA – MODIS dataset

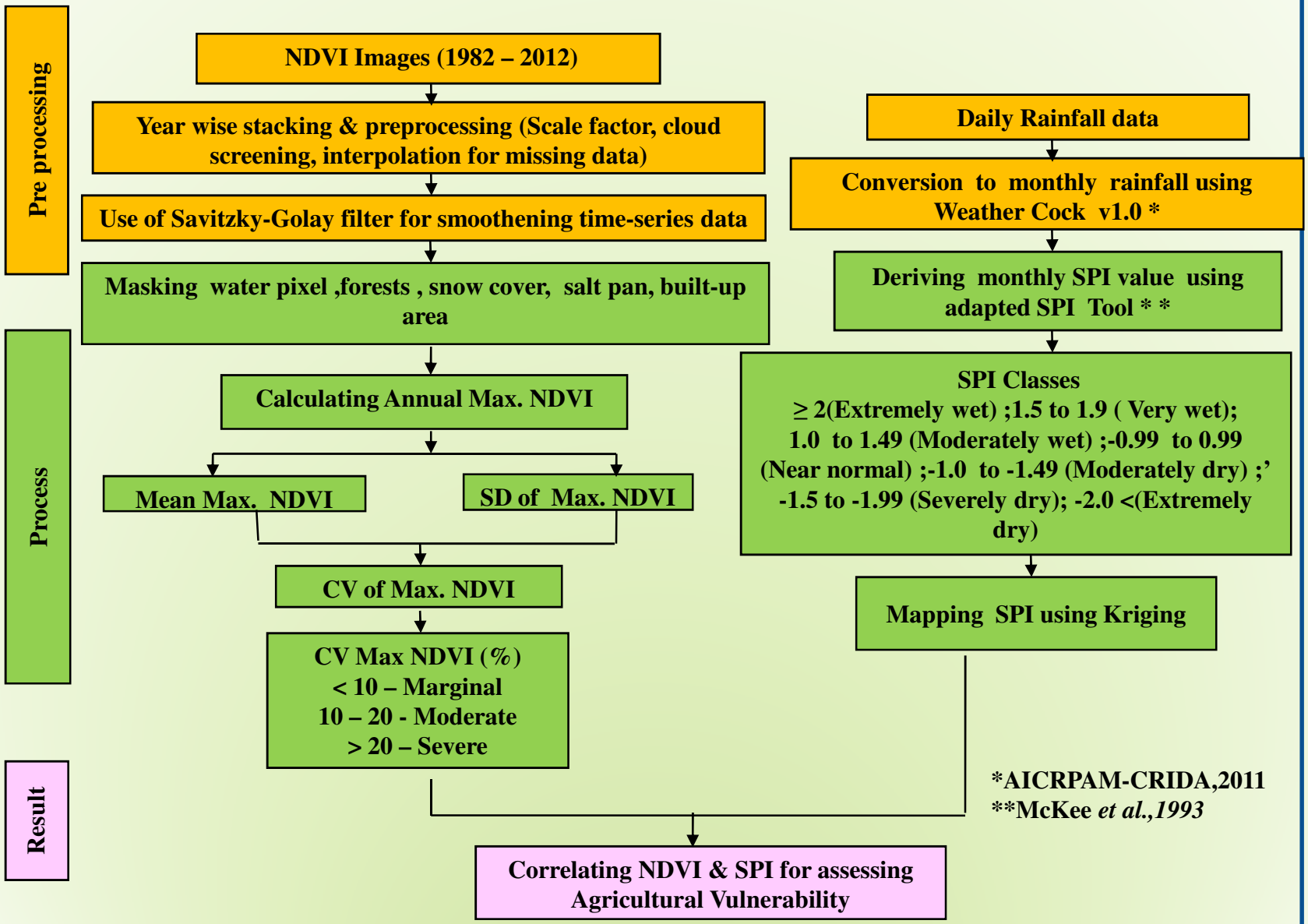
MODIS (250m) NDVI composite products freely available from *Land Processes - Distributed Active Archive Centre (LPDAAC)* website of USGS http://mrtweb.cr.usgs.gov/ wherein Indian sub-continent is covered in 13 tiles. Data is available from February 2000 onwards.

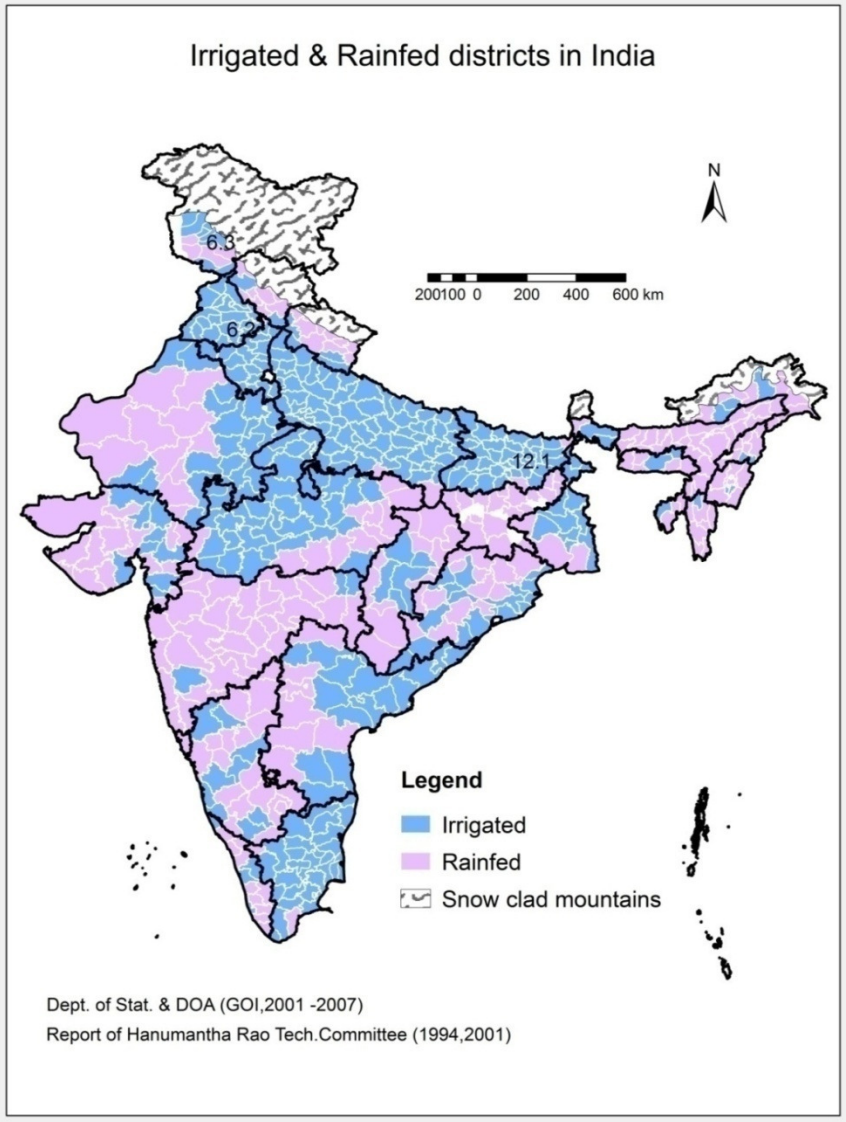


SPI Grid Tile

IMD provides daily rainfall data of >100 years for many stations from archives. Daily girded rainfall data for 1901–2007 for 1384 stations used by *Rajeevan et al 2008*). Girded rainfall data on regular grid of 1^0 x 1^0 was used to calculate SPI .

Methodology for Vulnerability Analysis using NDVI

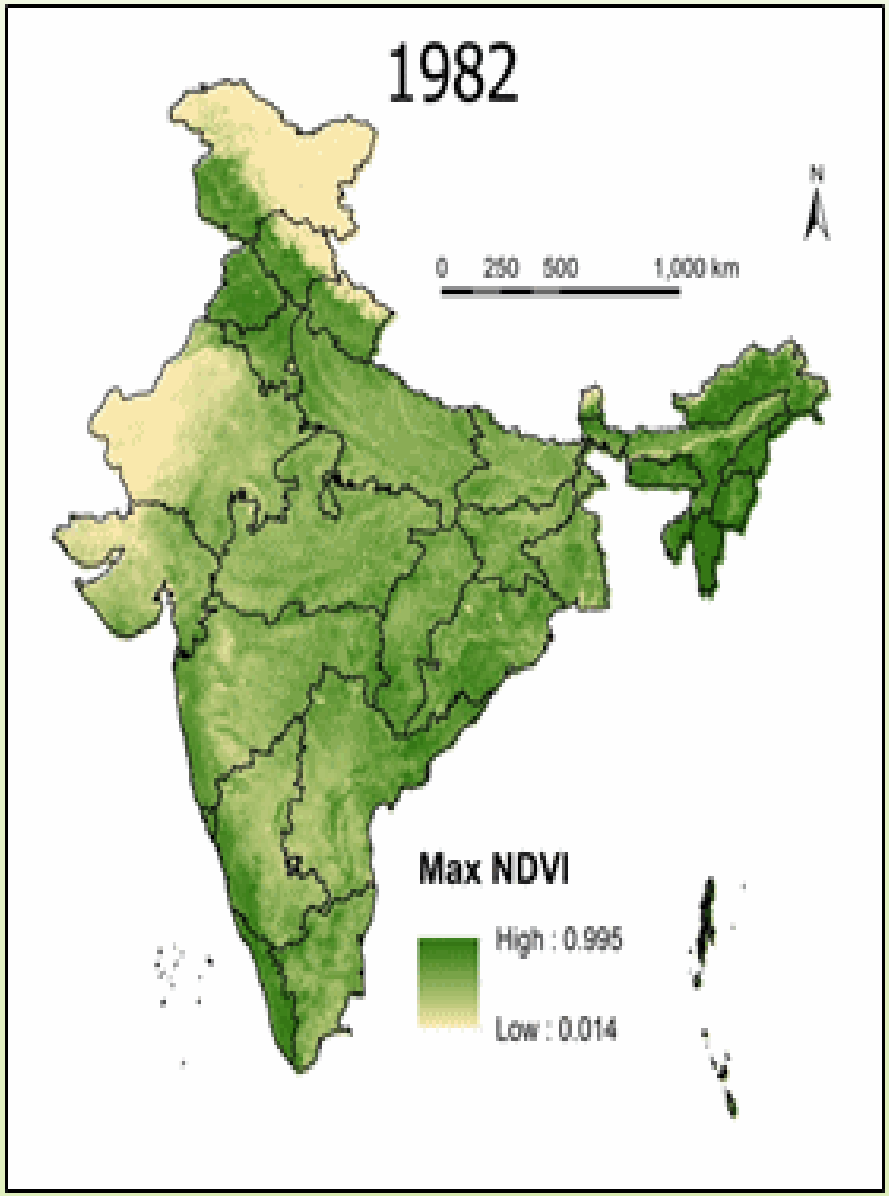




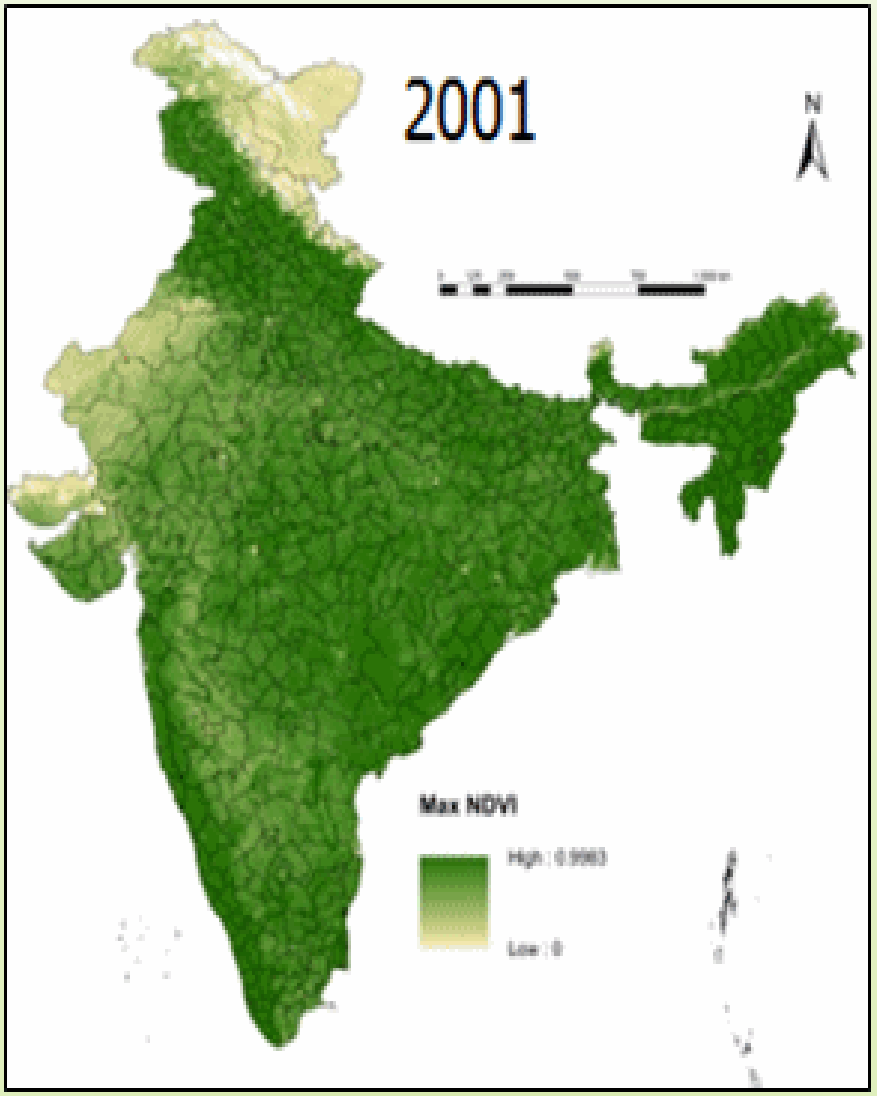
DOA classifies rainfed district as one that has <30% net sown area under irrigation (Hanumantha Rao committee's report on DDP, DPAP classification of districts in India)

Shavariarpettai, Ramanathapuram, Tamilnadu Feb. 2013

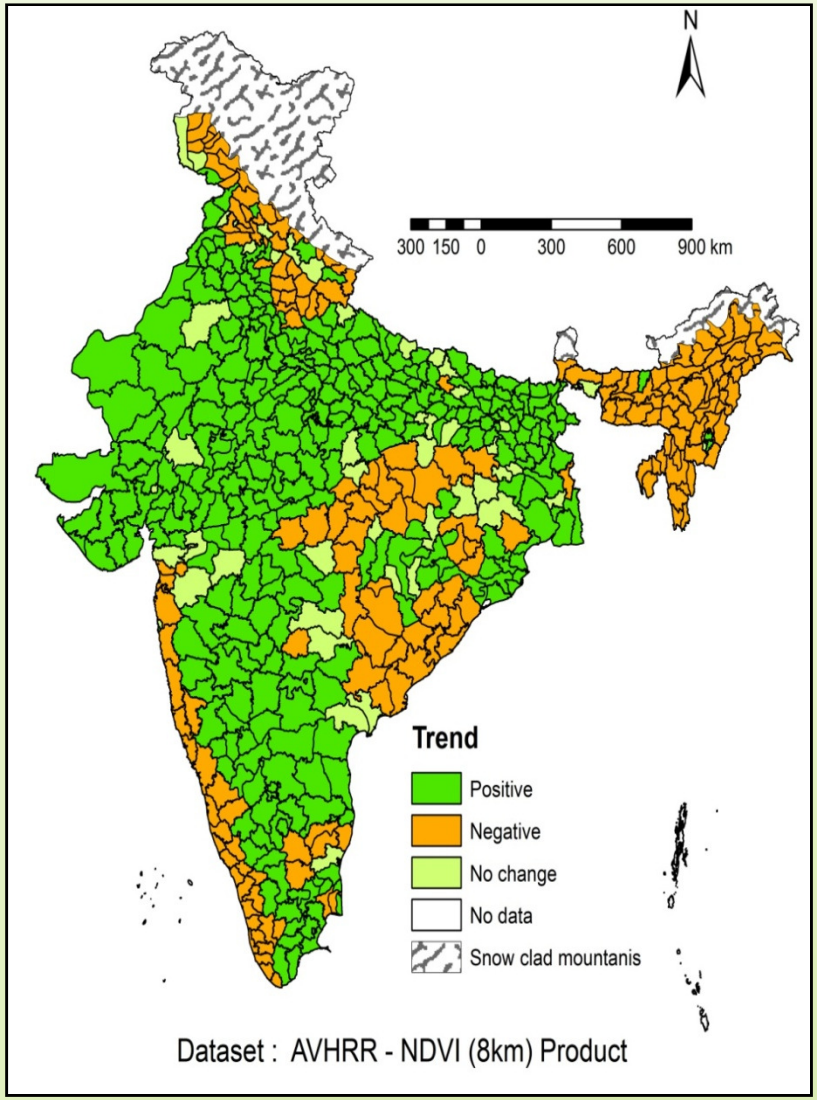
Temporal Variations in AVHRR-NDVI (1982 – 2006)



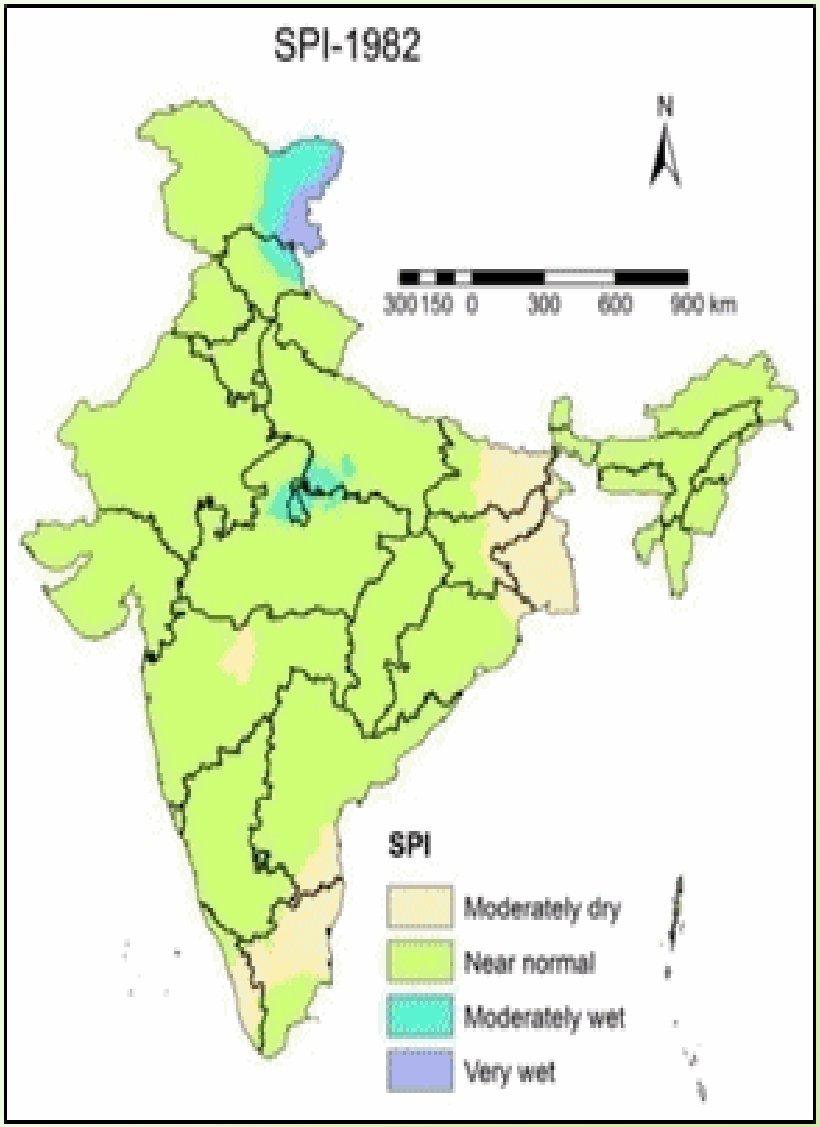
Temporal variations in MODIS-NDVI (2001-2011)



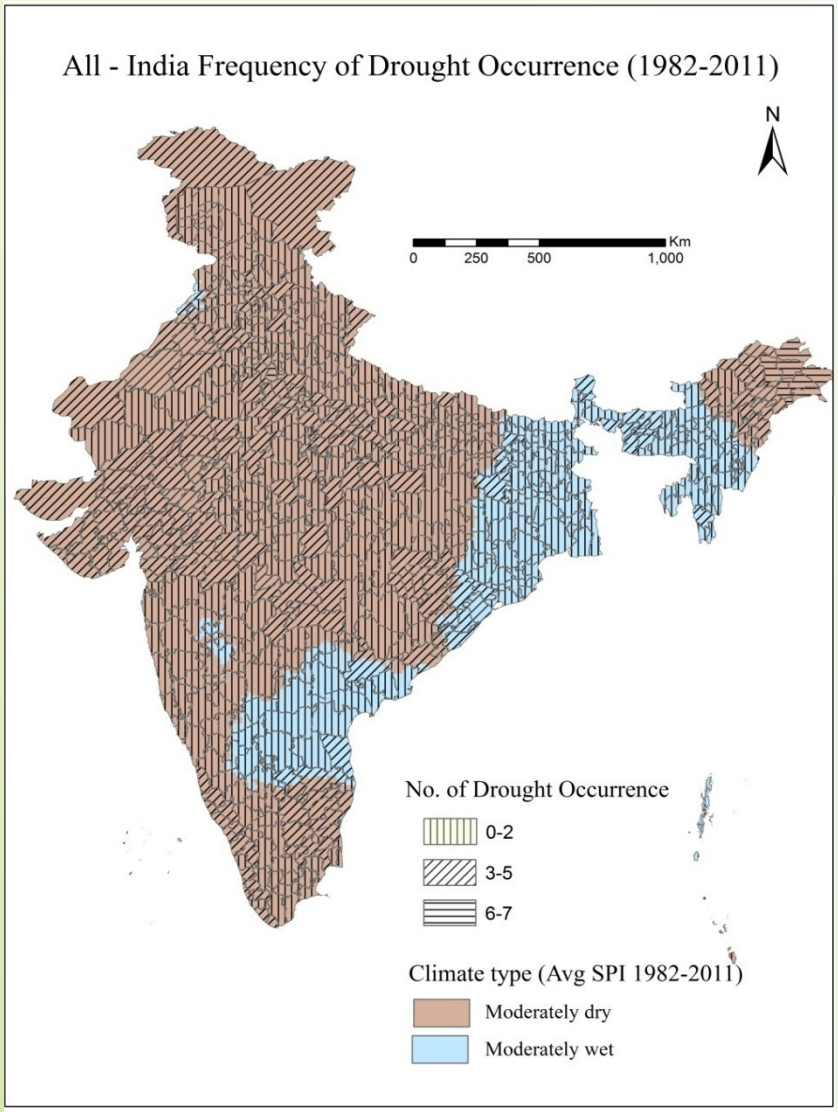
District-level Vulnerability based on CV Max NDVI of AVHRR data (1982-2006)



Variations in rainfall pattern based on SPI (1982 –2012)

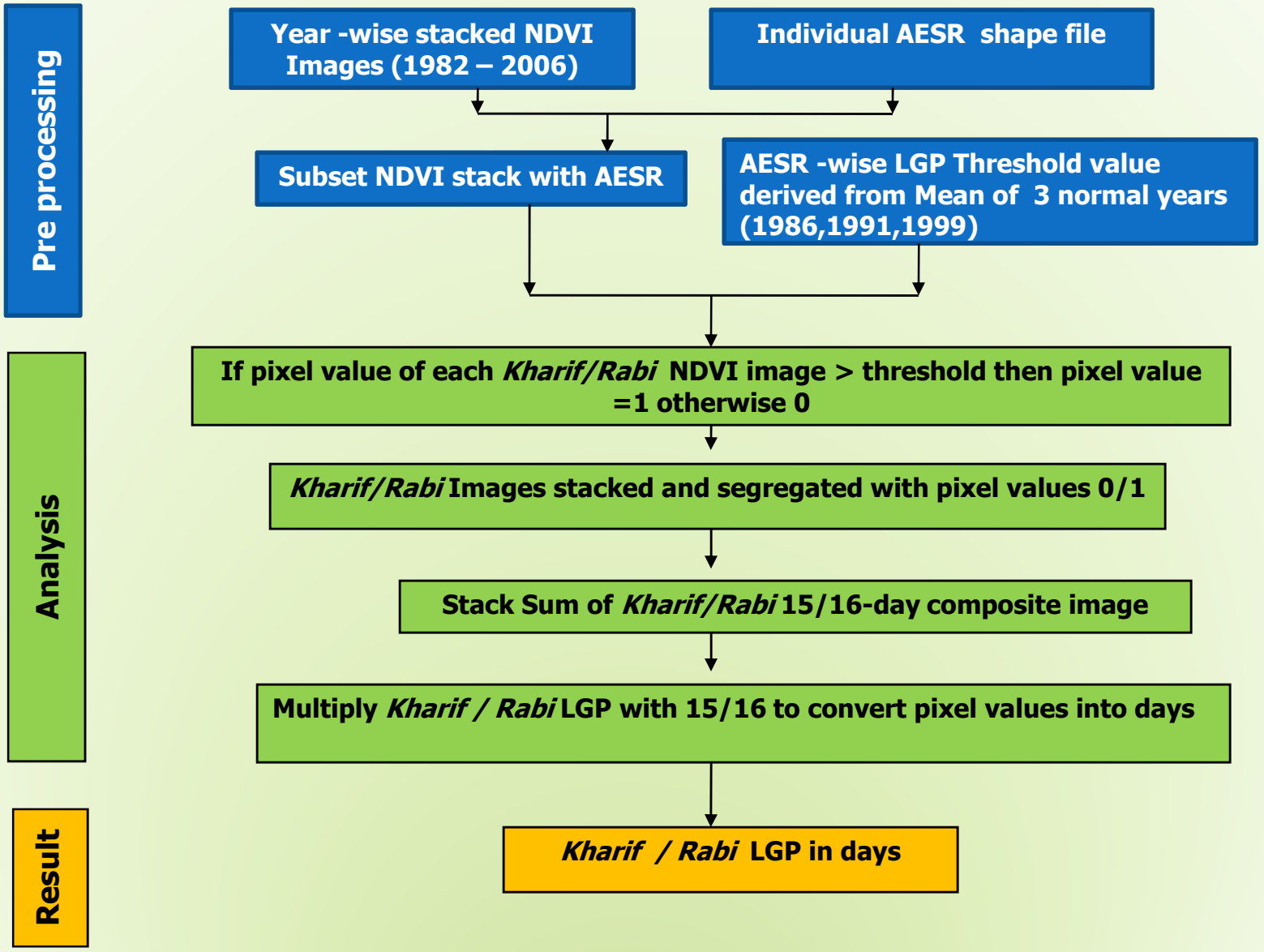


Drought Occurrence based on SPI (1982-2011)

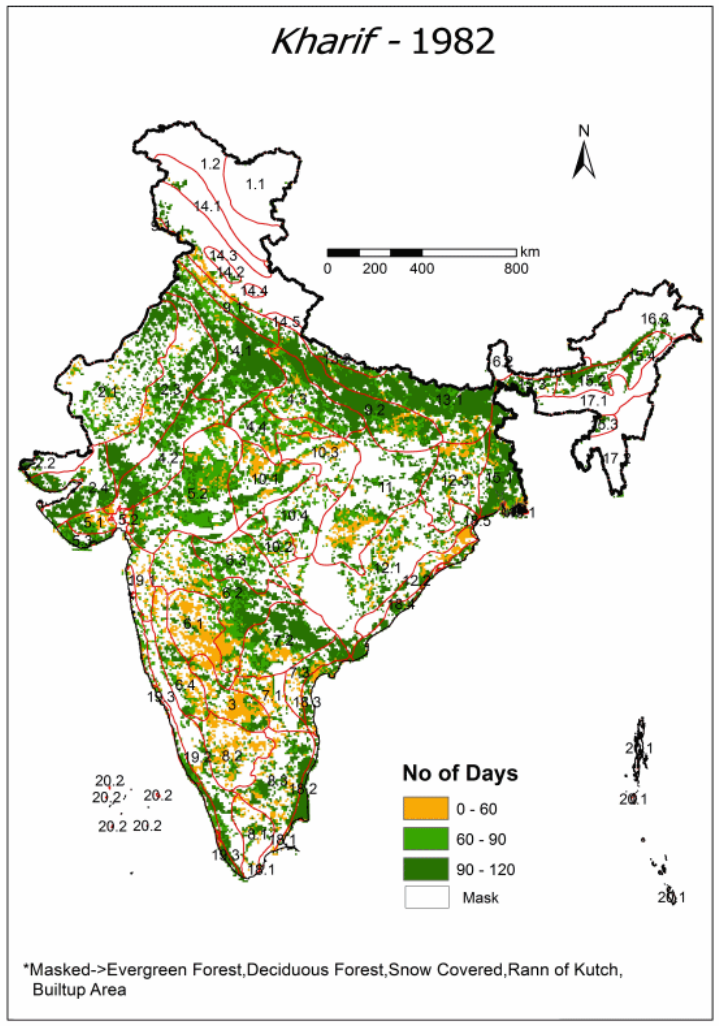


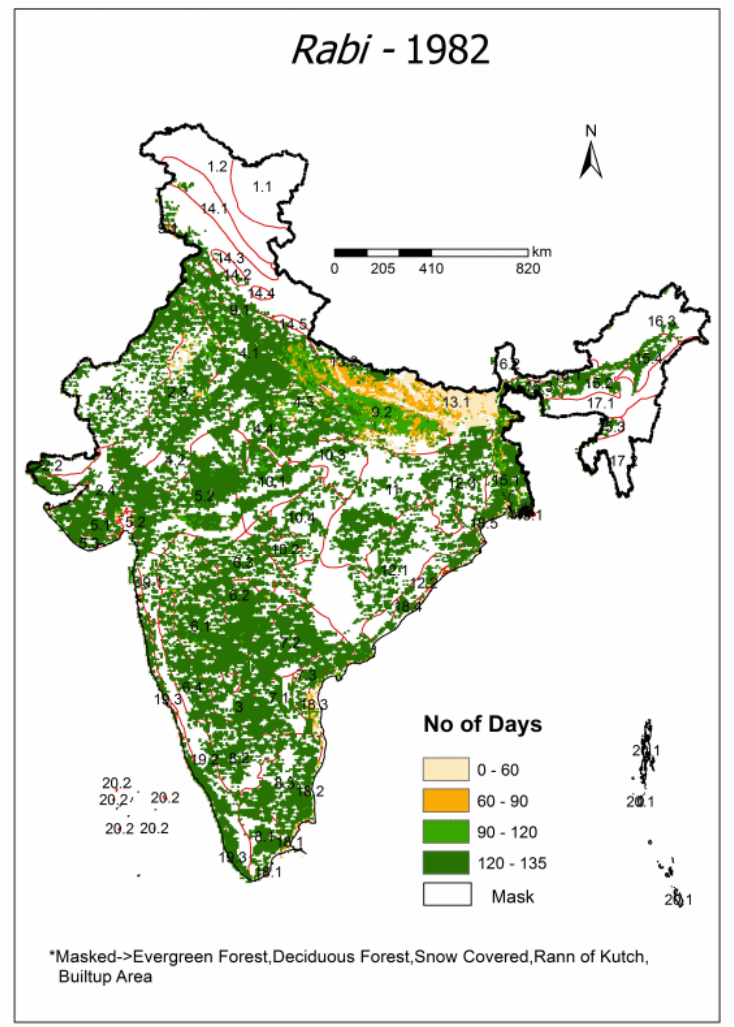
Drought in Ramanathapuram, Tamilnadu, Feb 2012

Methodology for Estimating LGP using NDVI



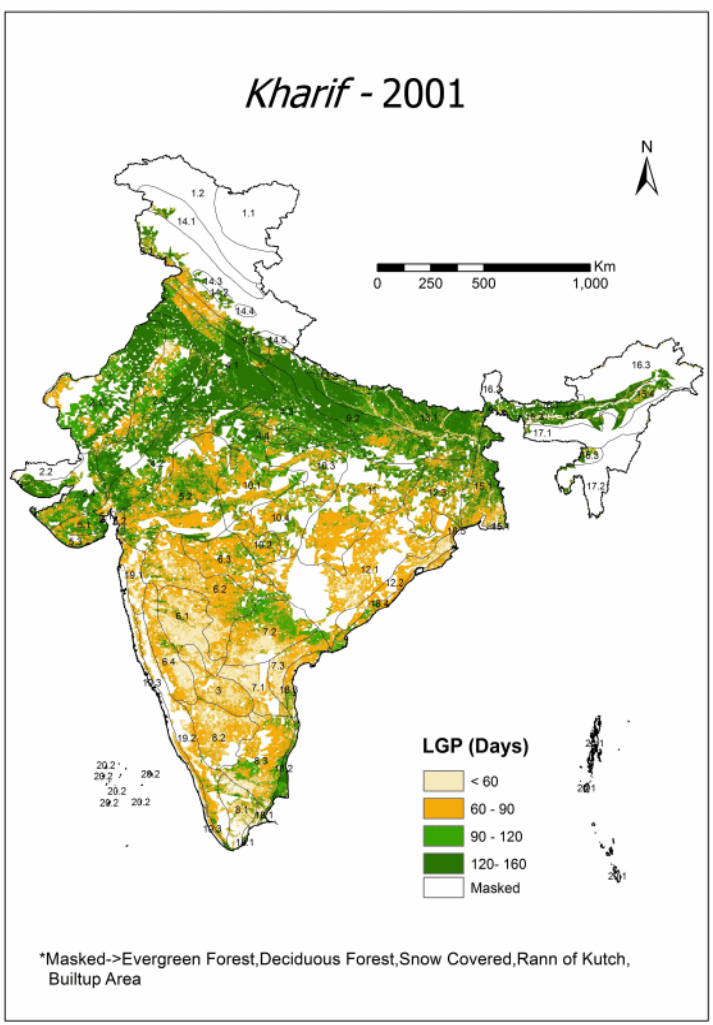
Temporal variation in *Kharif* & *Rabi* LGP based on AVHRR (1982-2006)

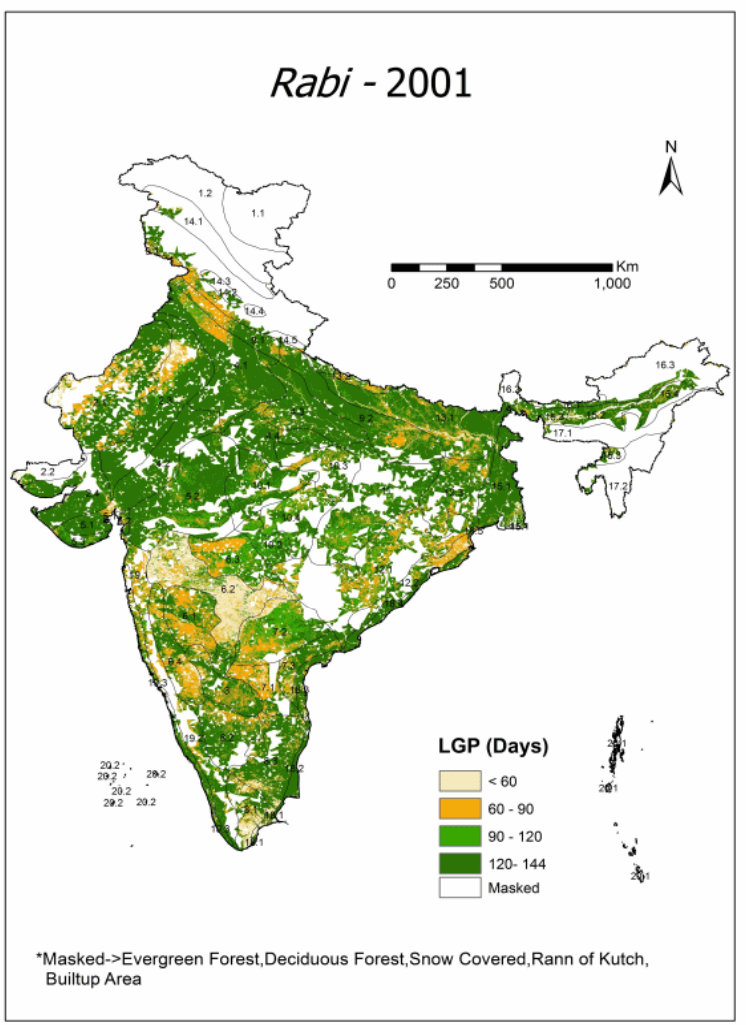




- **Variability in LGP was high in regions with <60 days & in areas with 120-150 days of LGP.**
- **Variations was least in zones having 90-120 days LGP.**
- **Pixel resolution affected identification of Start - of - Season & End- of – Season of LGP. (AVHRR indicated 135 days of LGP while MODIS indicated 160 days of LGP based on NDVI .**

Temporal variations in *Kharif* & *Rabi* LGP based on MODIS (2001-2012)

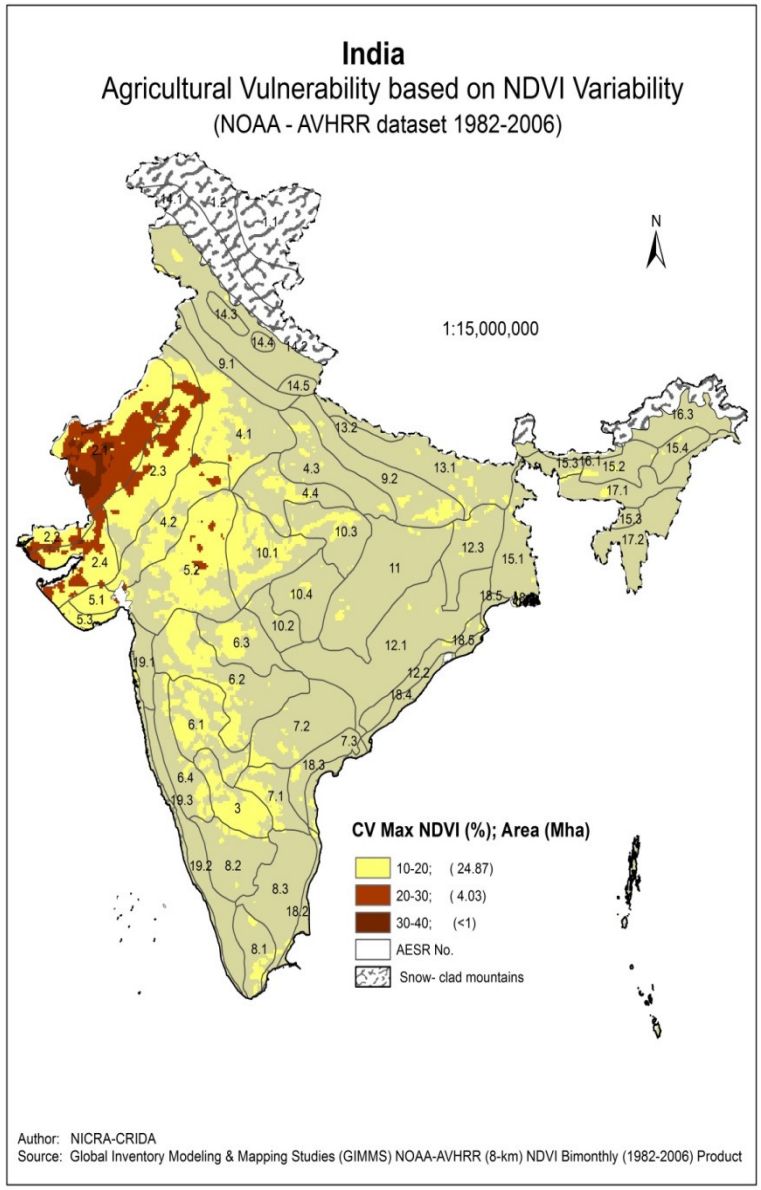


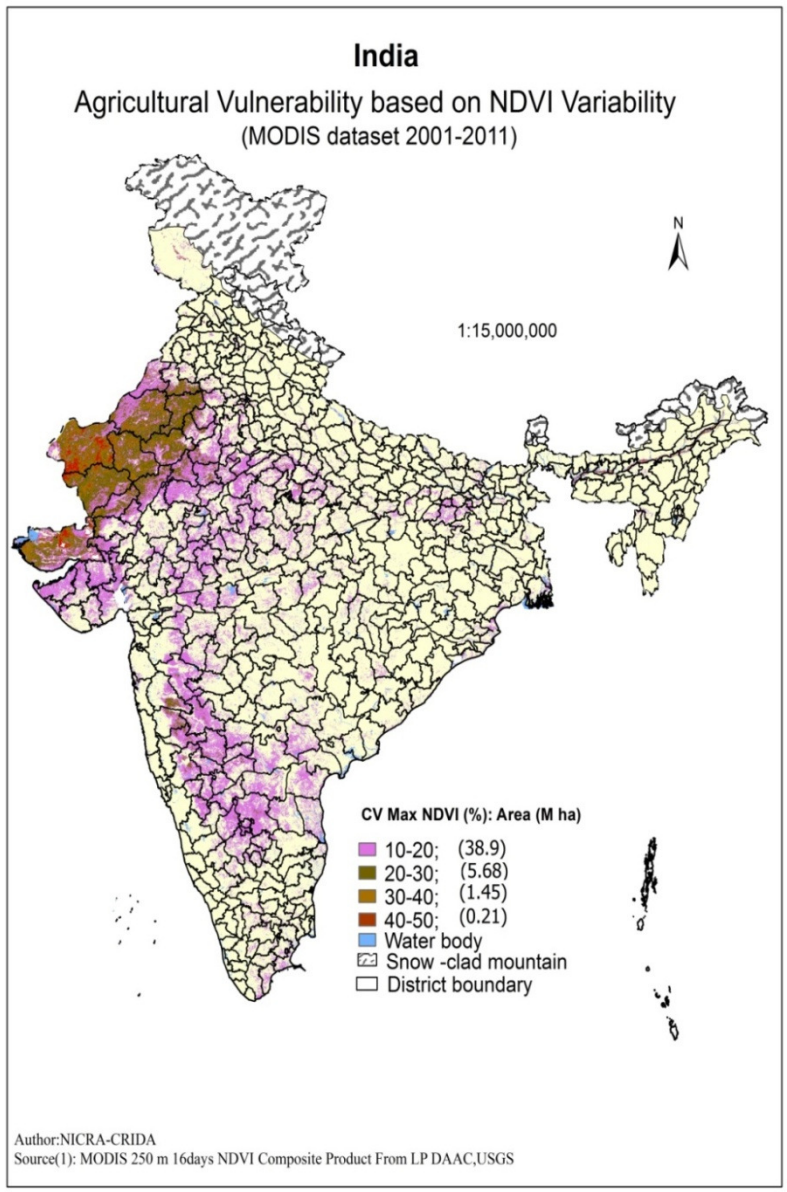


- **Observed that during *Kharif* AESR 4.3 region covering Ganga –Yamuna Doab in central UP experienced increase in LGP from 100 to 140 days.**
- **Similarly AESR 4.4 (Central India Plateau), 8.2 (Central Karnataka), 8.3(TN Uplands), 13.1 (Northern Bihar), 16.3 (Aruanchal Pradesh) experienced increase in LGP from 90 to 120 days.**
- **Decline in NDVI during 1982-2000 with an increase during 2001-2010.**
- **Reduction in LGP Green-up phase during *Rabi* season was significant.**

Estimation of Extent of Agricultural Vulnerability in India

Extent of Agricultural Vulnerability in India



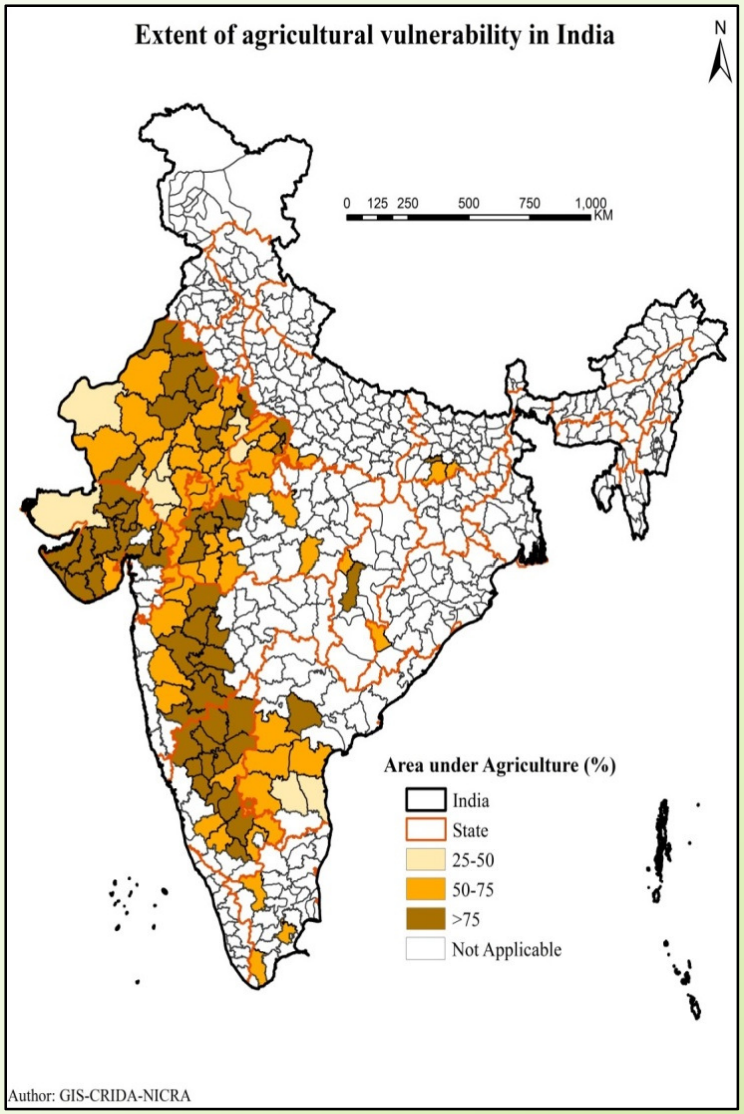


- **Study indicates that over 47 mha of Net Sown Area was vulnerable to Climate Change (MODIS-TERRA). NOAA-AVHRR indicated 29 mha as vulnerable to it. This translates to 20.4 to 33.1% of Net Sown Area in the country as under risk.**

Basis for Typology of Agriculturally Vulnerability

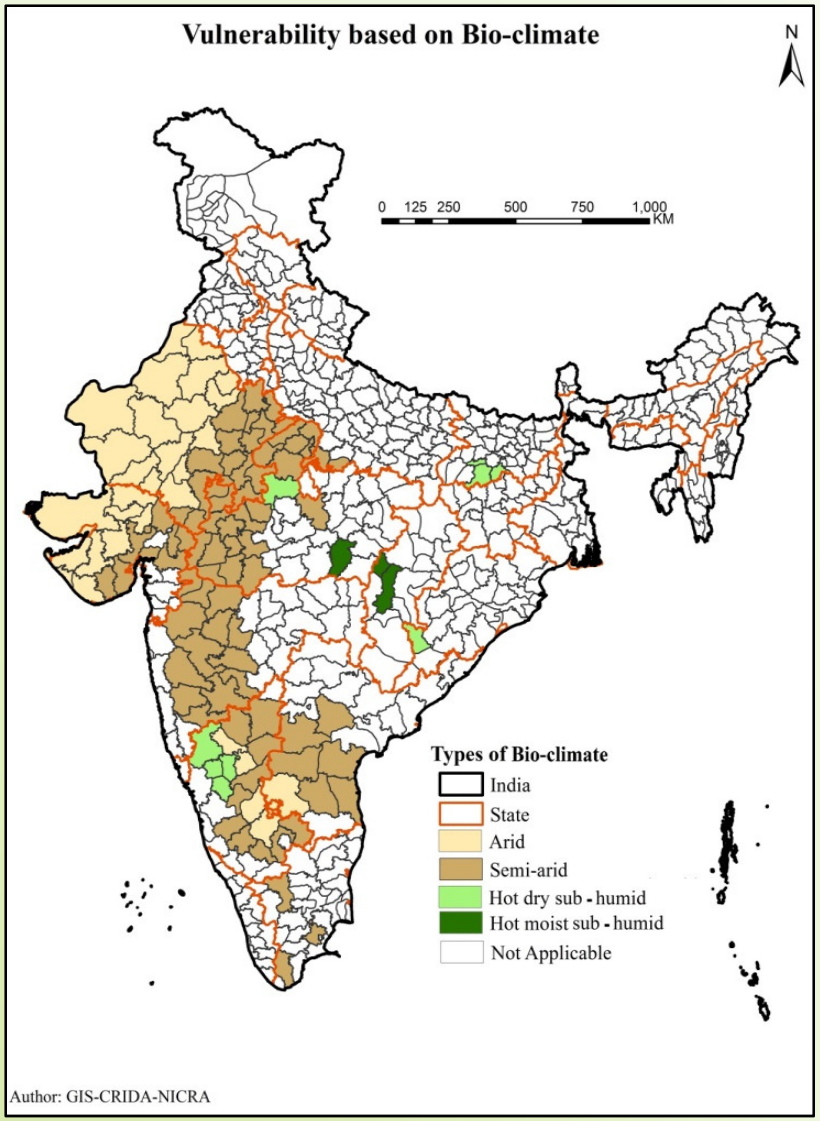
- ***Based on actual area under agriculture in each vulnerable district***
- ***Based on bio-climate of the district*** *(Thornthwaite Moisture Index)*
- ***Based on normal LGP estimated based on Water Balance (FAO, 1981)***
- ***Based on LGP derived from NDVI estimated from AVHRR and MODIS time-series datasets***
- ***Based on major cropping systems across vulnerable districts***

Typology based on agriculture vulnerability



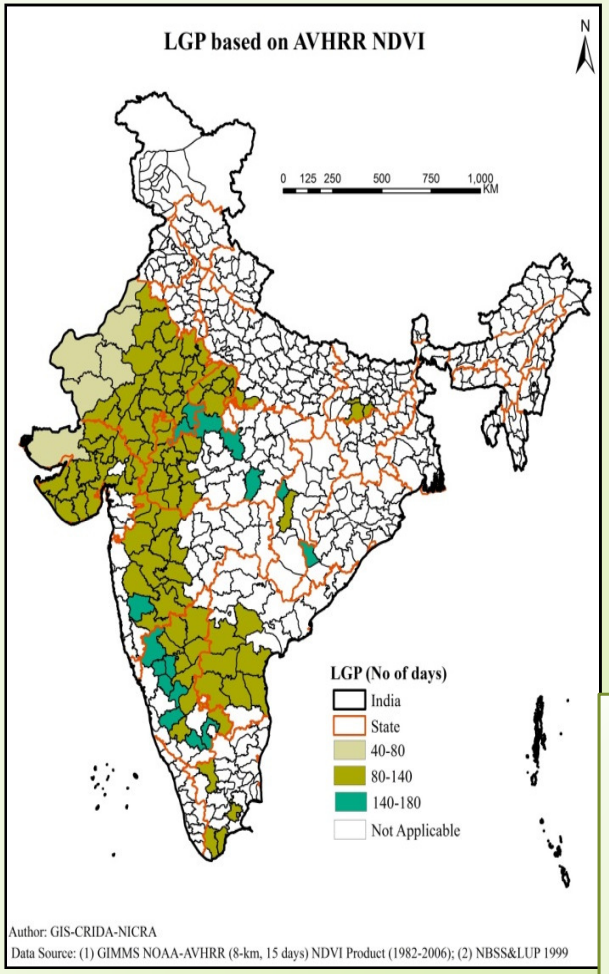
• **Of the 122 vulnerable districts, 10 had <50 % area under agriculture, 57 had 50-75 % and 55 had >75 % area under agriculture indicating relative importance in district economy.**

Typology based on prevalent bio-climate in the region

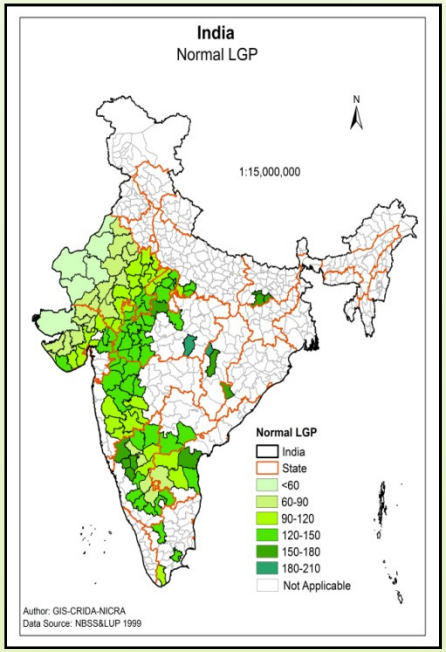


• **30 vulnerable districts located in arid region, 80 districts in semi-arid, 10 in hot dry sub-humid & 2 in hot moist sub- humid bio-climate (MI).**

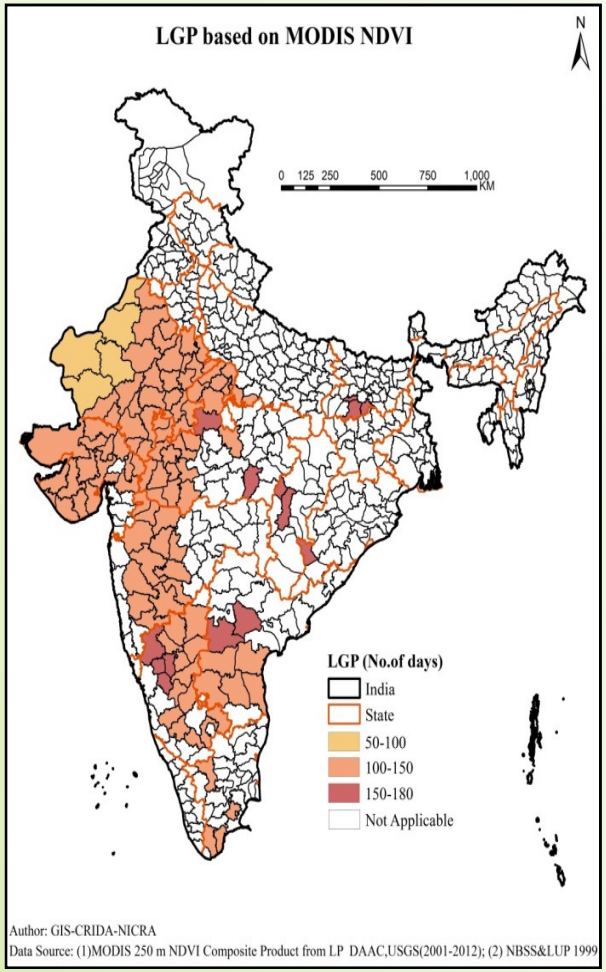
Typology based on LGP



- **LGP derived based on AVHRR-NDVI indicated decrease in length. 7 districts experienced LGP of 40-80 days, 99 districts 80-140 days & 16 districts had 140-180 days LGP.**

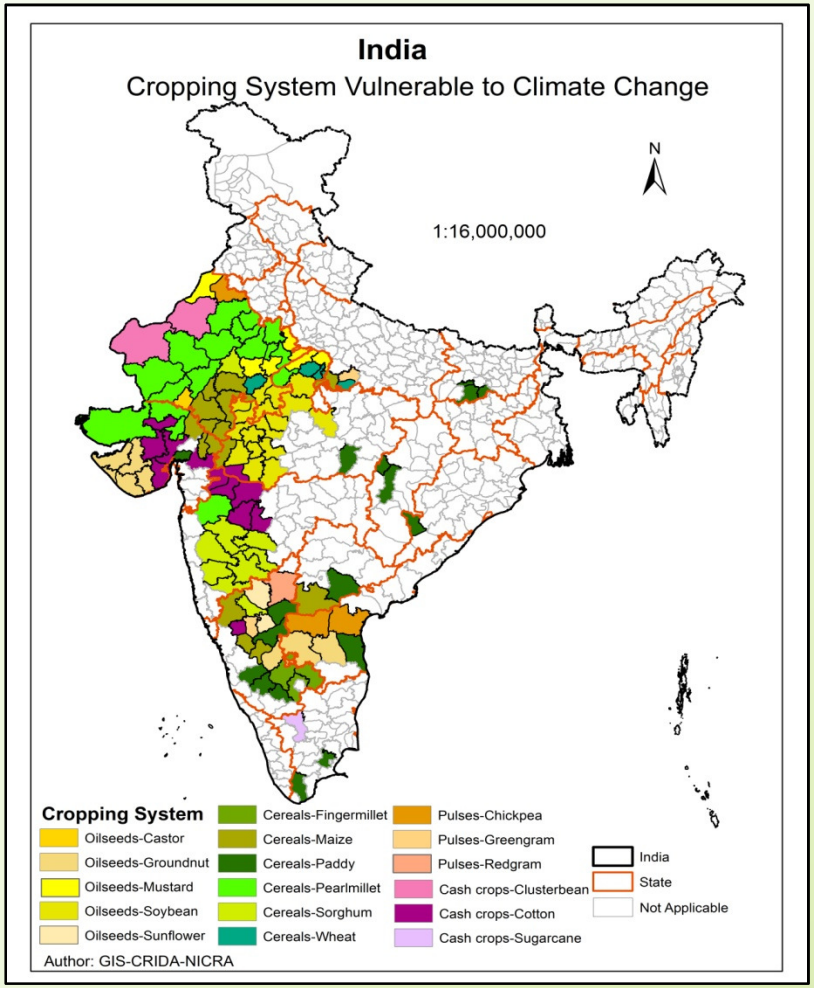


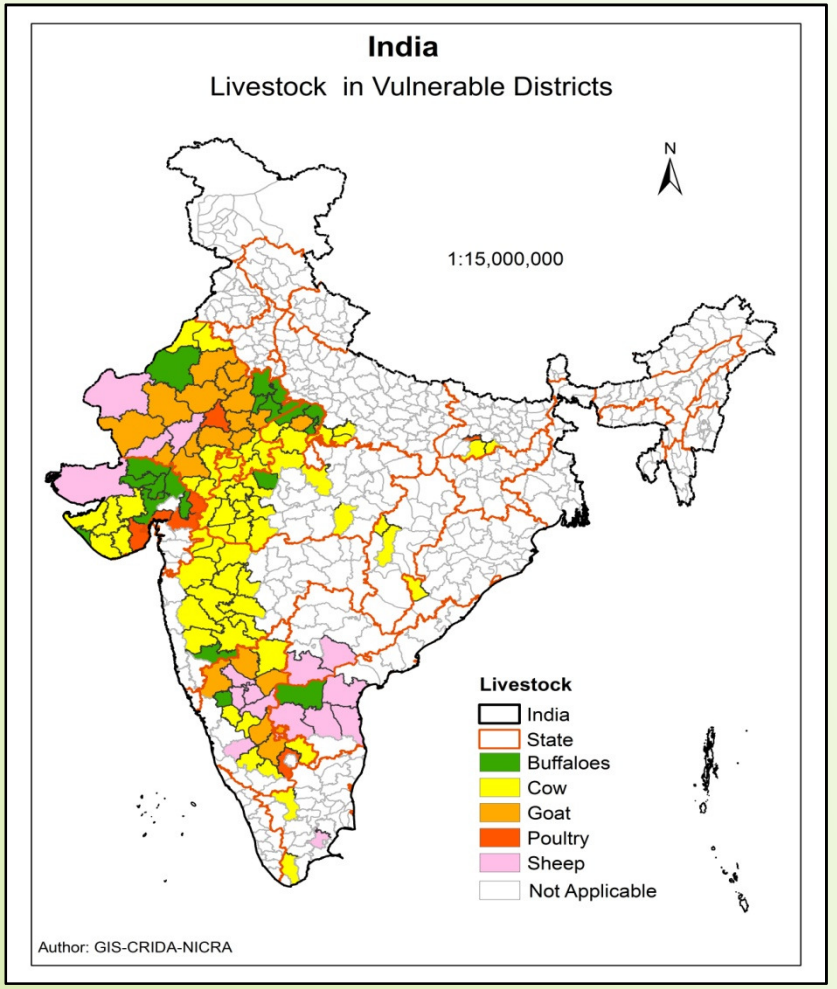
- **Based on FAO water balance model vulnerable districts identified in India could be grouped under six classes. 6 districts were under LGP category <60 days; 23 in semi-arid region under 60-90; 34 in 90-120 days; 46 under 120-150 days; in 11 in 150-180 days & LGP class of 180-210 days was prevalent in 2 districts.**



- **MODIS NDVI dataset indicated 5 districts under 50-100 days LGP category, 103 under 100-150 days & 14 under 150-180 days LGP.**

Cropping Systems and Livestock in Vulnerable districts



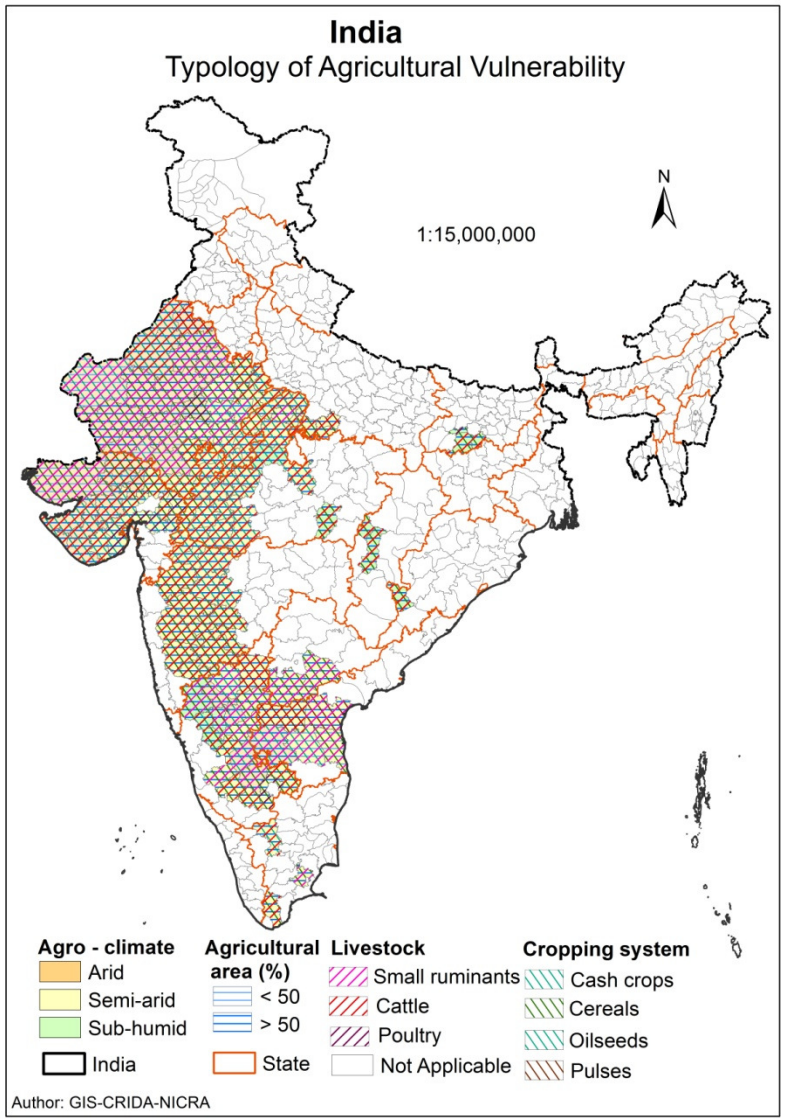


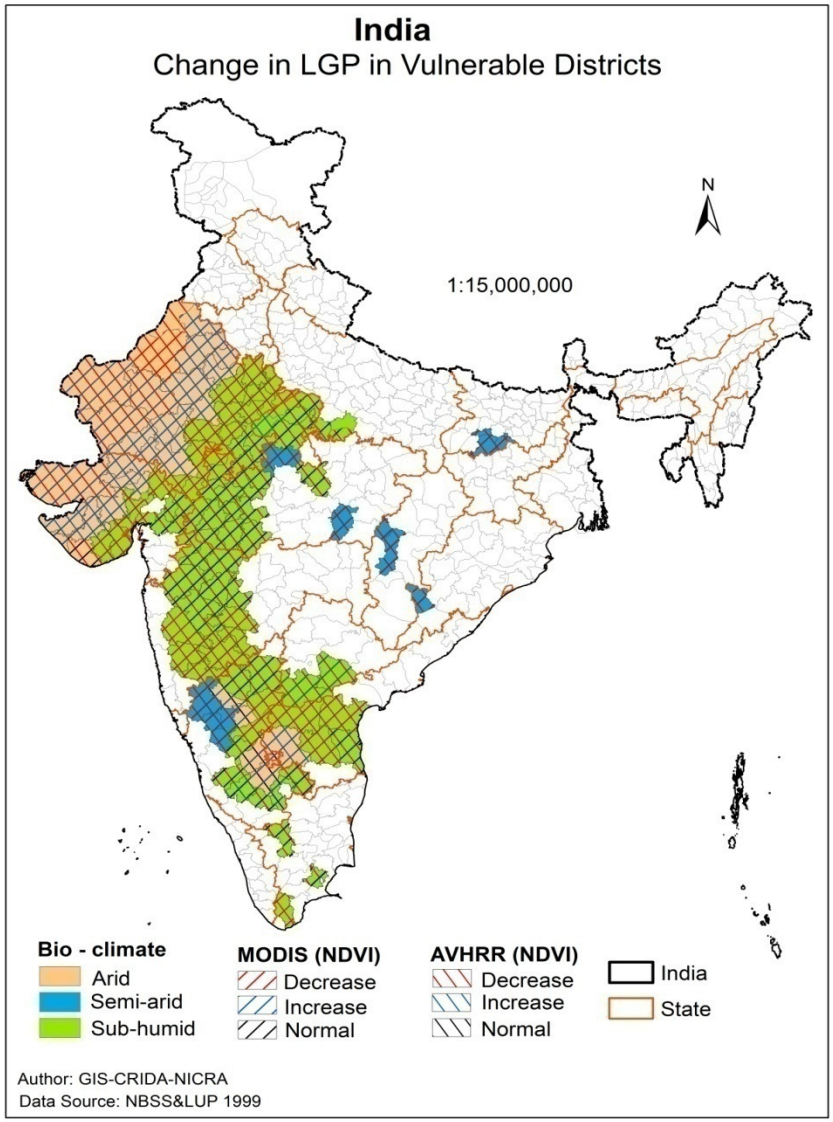
Predominant cropping systems viz., cereals-, oilseeds-,pulses-, cash crop were analyzed for developing typology to identify vulnerable crops due to decrease in LGP. 35 oilseed-based, 66 cereal-based, 6 pulses and 15 cash crop based districts were vulnerable to decrease in LGP.

16 districts had predominantly buffalo population, 51 milch cattle, 3 with poultry, & 36 with small ruminants; rest had mixed livestock.

Typology of Agricultural Vulnerability in India

Composite Typology of Agricultural Vulnerability in India

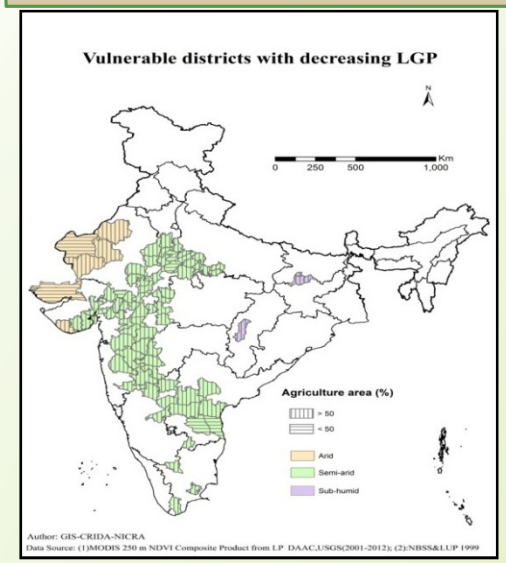




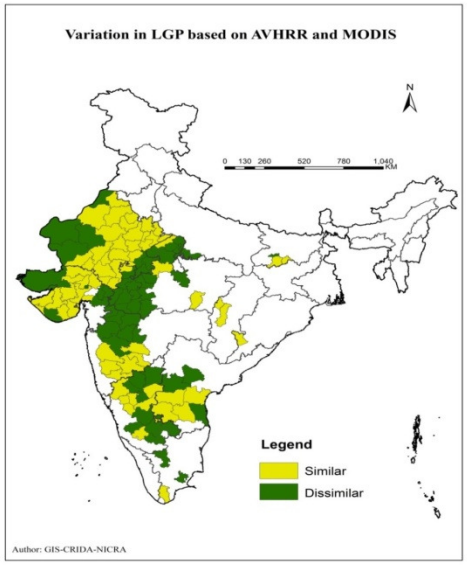
Typology of composite vulnerability of districts based on bio-climate, cropping system, livestock & area under agriculture

LGP derived from MODIS & AVHRR were compared

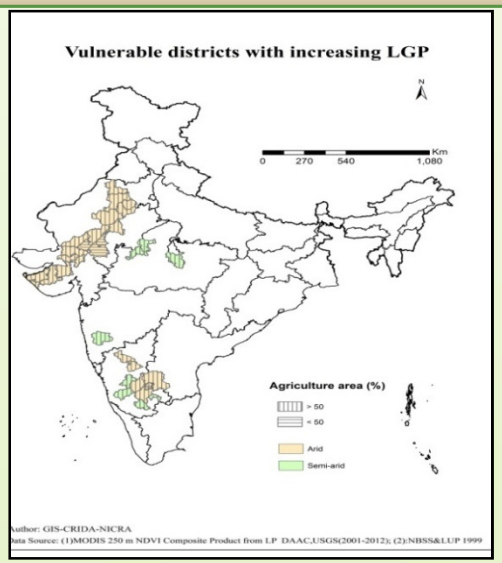
Typology of Agricultural Vulnerability based on LGP variability



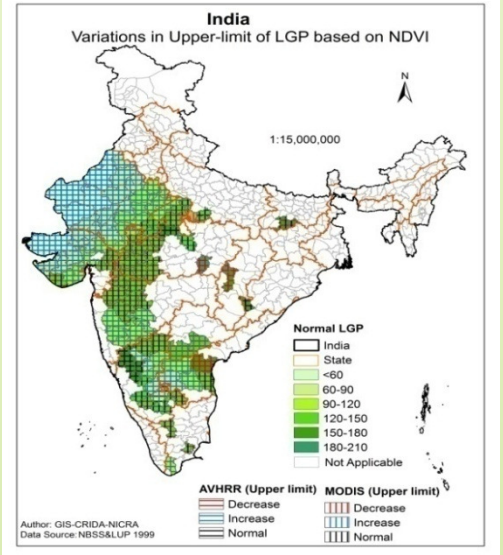
• 80 districts with >50% Net Sown Area (NSA) indicated decrease in LGP (6 in arid, 70 in semi-arid & 4 in sub-humid), accounting for 0.83 mha under paddy, 0.26 mha under cotton & sugarcane & 0.48 mha under oilseeds .



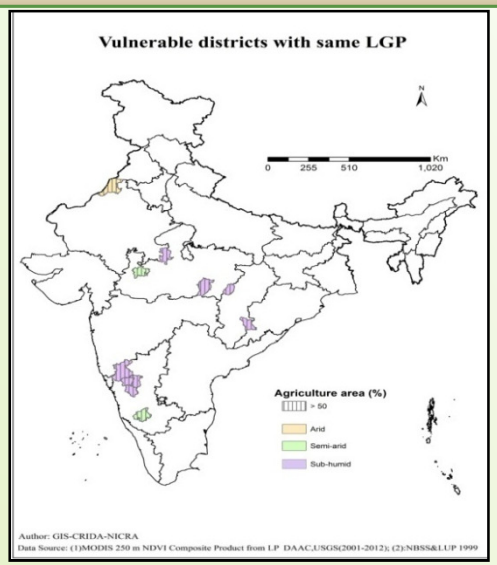
MODIS & AVHRR datasets indicated similar trend in 68 districts in semi-arid & arid regions. 54 districts had dissimilar trend.



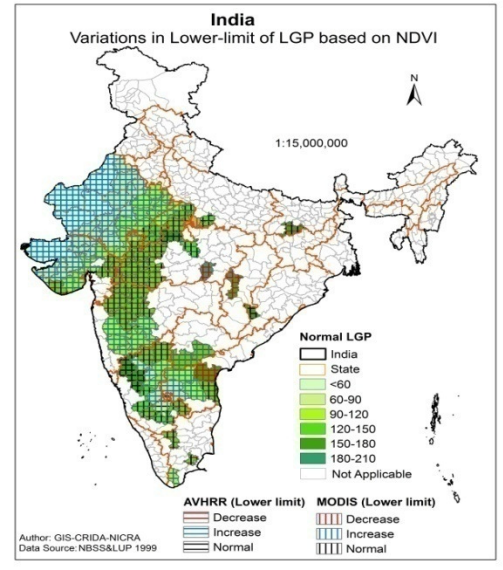
• 31 districts with >50% NSA indicated increase in LGP (23 in arid & 8 in semi-arid), accounting for 0.64 mha under pearl millet, pulses and groundnut.



AVHRR NDVI dataset indicated decrease in upper-limit of LGP 44 districts, increase in 70 districts & no change in 8 districts. MODIS NDVI indicated decrease in 4, increase in 65 & same in 53 districts



• 11 districts with >50% NSA indicated no change in LGP (1 in arid, 2 in semi-arid & 8 in sub-humid).



Change in lower-limit of LGP based on AVHRR- NDVI indicated decrease in 92 , increase in 28 , & no change in 2 districts. MODIS-NDVI indicated a decline in 53, increase in 60 districts& no change in 9 .

Conclusions

•NOAA – AVHRR (8km, 15 days) time- series NDVI composite data (1981-2006) was found suitable for state/ AESR –level study. TERRA-MODIS (250m 16-day) NDVI composite was suitable for district -level study, although available since 2000.

•To extend district-level analysis, AVHRR (1-km) resolution data required. This would involve study of 56,917 scenes to cover whole of India from 1982 till 2012.

•Study helped to estimate extent of agricultural vulnerability in India. Over 74 mha in 26 AESR in 12 states in India would be adversely affected by climate change which would require strategies for risk management & crop contingency planning in rainfed areas.

•122 districts in 12 states including 10 districts with <50% net sown area and 112 with >50% net sown area would be affected by climate change.

• There was a difference in extent of vulnerable region identified using AVHRR (8km, 15 days) and MODIS (250m, 16 days) NDVI composite data products. While AVHRR indicated 29mha NSA, MODIS indicated 47mha NSA as vulnerable. Difference was essentially due to variation in ground resolution of both datasets.

• Methodology was developed to derive LGP from NDVI datasets. Threshold Value (TV) for Start of Season (SOS) & End Of Season(EOS) were derived for each AESR based on NDVI of three normal years.

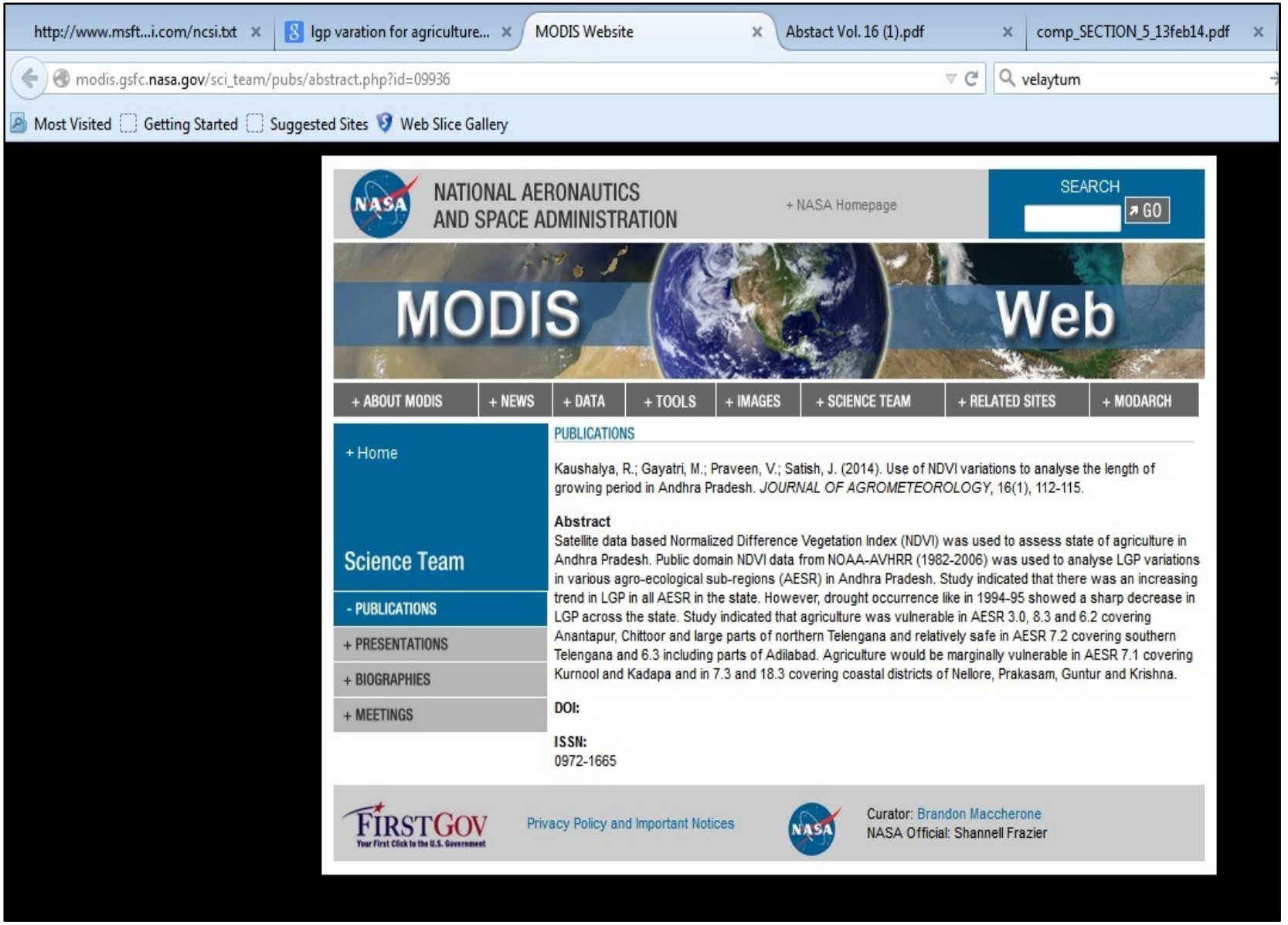
Cont……

- Study of LGP variations indicated a decline in moist semi-arid Gangetic Plains, sub-humid Central India, southern Plateau and Coastal region that forms an important agricultural region. While LGP derived from AVHRR and MODIS datasets were similar, it varied in case of arid ecosystems in Rajasthan and Gujarat.

- Cropping systems based on paddy, maize, soybean and cotton faced climate hazard while ecosystems with large buffalos and cattle population could face fodder shortage. Land use in typical vulnerable district was analysed to identify strategies for improving adaptive capacity of farmer.

- Trend in SPI indicated a decline in rainfall in large parts in India.

- Decline in NDVI was seen during first 2 decades with an increase in previous decade. Study of NDVI variations in snow-clad Himalayas was not undertaken.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modis.gsfc.nasa.gov/sci_team/pubs/abstract.php?id=09936
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+ ABOUT MODIS
+ NEWS
+ DATA
+ TOOLS
+ IMAGES
+ SCIENCE TEAM
+ RELATED SITES
+ MODARCH
+ Home
Science Team
- PUBLICATIONS
+ PRESENTATIONS
+ BIOGRAPHIES
+ MEETINGS
PUBLICATIONS
Kaushalya, R.; Gayatri, M.; Praveen, V.; Satish, J. (2014). Use of NDVI variations to analyse the length of growing period in Andhra Pradesh. JOURNAL OF AGROMETEOROLOGY, 16(1), 112-115.
Abstract
Satellite data based Normalized Difference Vegetation Index (NDVI) was used to assess state of agriculture in Andhra Pradesh. Public domain NDVI data from NOAA-AVHRR (1982-2006) was used to analyse LGP variations in various agro-ecological sub-regions (AESR) in Andhra Pradesh. Study indicated that there was an increasing trend in LGP in all AESR in the state. However, drought occurrence like in 1994-95 showed a sharp decrease in LGP across the state. Study indicated that agriculture was vulnerable in AESR 3.0, 8.3 and 6.2 covering Anantapur, Chittoor and large parts of northern Telengana and relatively safe in AESR 7.2 covering southern Telengana and 6.3 including parts of Adilabad. Agriculture would be marginally vulnerable in AESR 7.1 covering Kurnool and Kadapa and in 7.3 and 18.3 covering coastal districts of Nellore, Prakasam, Guntur and Krishna.
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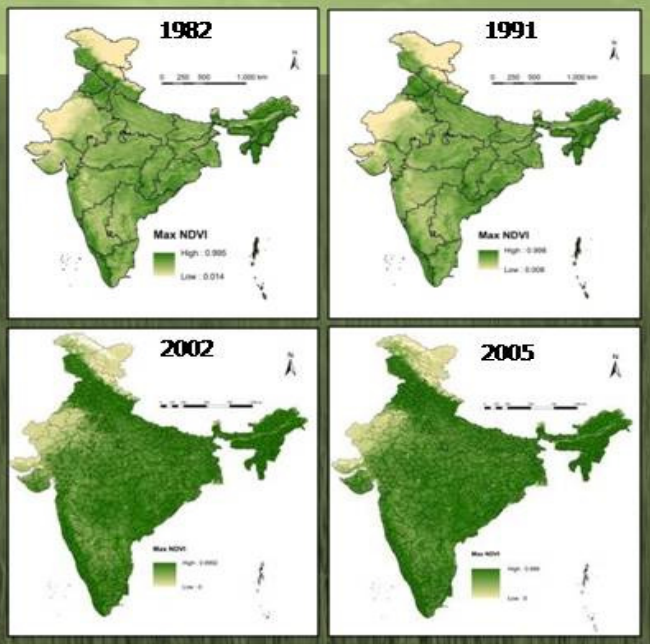
NASA Official: Shannell Frazier

National Initiative on Climate Resilient Agriculture

Spatial Vulnerability Assessment using Satellite based NDVI for Rainfed Agriculture in India



Kaushalya Ramachandran, C.A. Rama Rao, B.M.K. Raju, V.U.M. Rao, A.V.M. Subba Rao, K.V. Rao, D.B.V. Ramana, K. Nagasree, K. Ravi Shankar, M. Maheswari, Ch. Srinivas Rao , B. Venkateshwarlu & A.K. Sikka

CRIDA - NICRA- ICAR, Hyderabad

February 2015

Asia Geospatial Excellence Award

for

Assessing Agricultural Vulnerability using Satellite Data to Improve Adaptive Capacity of Rainfed Farmers in India

Award conferred on 25 Nov 2014
at Jakarta, Indonesia at
Asia Geospatial Forum

Thank you