

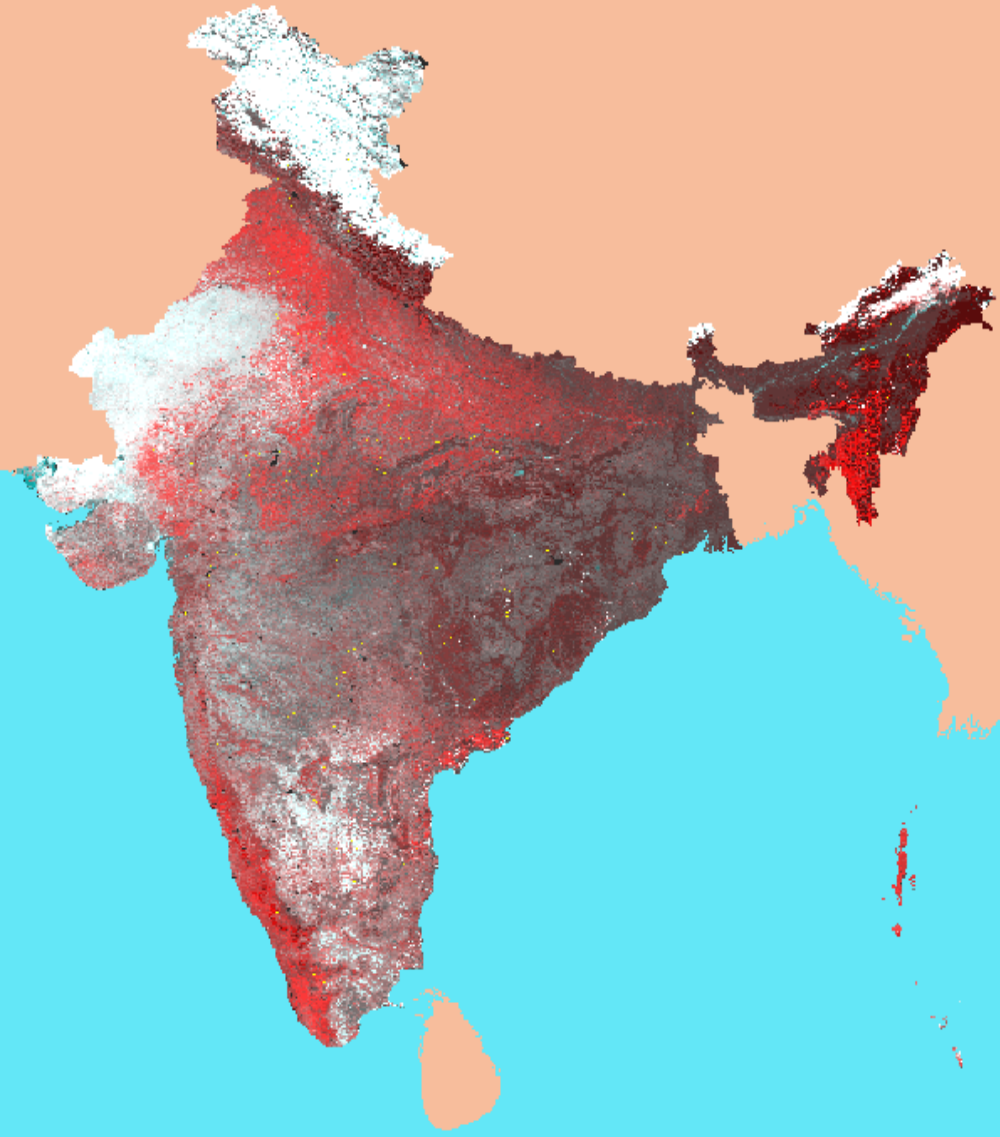
Evolution of ISRO's Remote Sensing Programme

Aishwarya Narain

Presented at the Colloquium, Space Studies, UND, Jan 12, 2009

<http://www.isro.org/programmes.htm>

NATURAL RESOURCES OF INDIA



GEOGRAPHICAL AREA : 329 Mha

AGRICULTURE

CULTIVABLE AREA :181 Mha

NET SOWN AREA : 142.22 Mha

NET IRRIGATED AREA : 53.51 Mha

FOREST

TOTAL AREA : 64 Mha

FAUNA : 65000 , FLORA : 45000

WATER

TOTAL WATER RESOURCES : 1,675,000 Mft³

GLACIERS : 33,000 sq km

REPLEN. GROUND WATER : 433100 Mm³ /Yr

WETLANDS : 4.05 Mha

MARINE

COAST LINE : 7500 km

CORAL REEFS : 960 sq km

MANGROVE : 4460 sq km

FISHERY CATCH 2.8-3 Mton/Yr

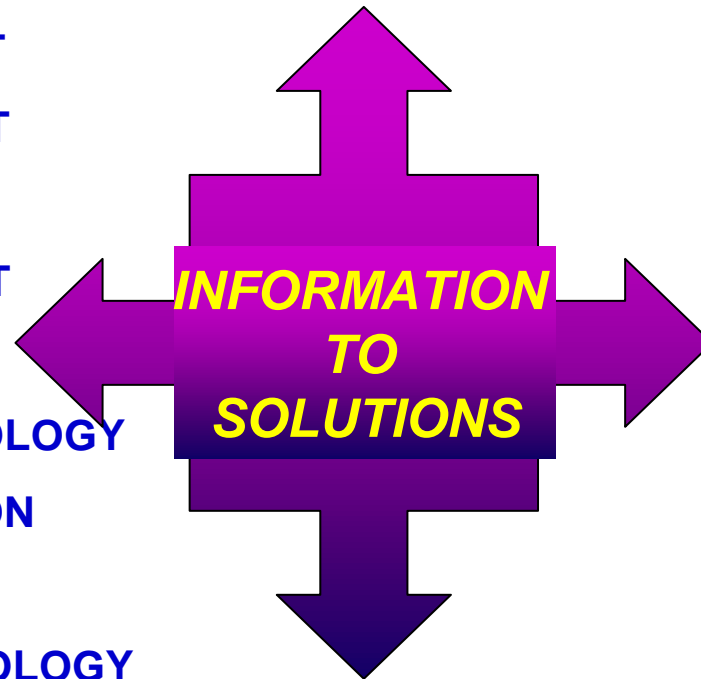
MINERALS(RECOVERABLE RESERVE) (Mton)

NATURAL GAS : 697. IRON ORE : 9754

REMOTE SENSING APPLICATIONS

• CENTRAL MINISTRIES/DEPARTMENT:

- AGRICULTURE
- ENVIRONMENT AND FORESTS
- RURAL DEVELOPMENT
- URBAN DEVELOPMENT
- WATER RESOURCES
- OCEAN DEVELOPMENT
- MINES
- SCIENCE AND TECHNOLOGY
- PLANNING COMMISSION
- BIOTECHNOLOGY
- INFORMATION TECHNOLOGY
- STATE GOVERNMENT AGENCIES
- PRIVATE SECTOR
- NGOs
- ACADEMIA/UNIVERSITIES



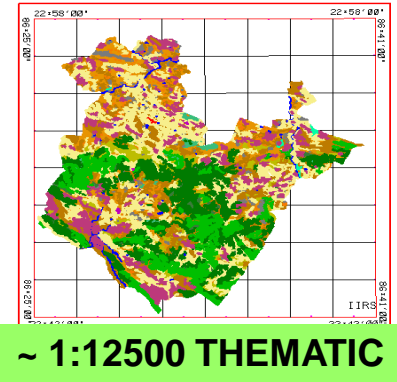
- AGRICULTURE
- FORESTS & ENVIRONMENT
- DISASTER MANAGEMENT
- WATER RESOURCES
- GEOLOGY
- MARINE RESOURCES
- METEOROLOGY
- OCEANOGRAPHY
- URBAN PLANNING
- MAPPING / DTM
- GLOBAL CHANGE
- STRATEGIC APPLICATIONS
- DEVELOPMENT PLANS
- NATURAL RESOURCES
INFORMATION SYSTEM

➤ IMAGES FOR DEVELOPMENTAL APPLICATIONS



PROCESSING AND ANALYSIS

MAPS

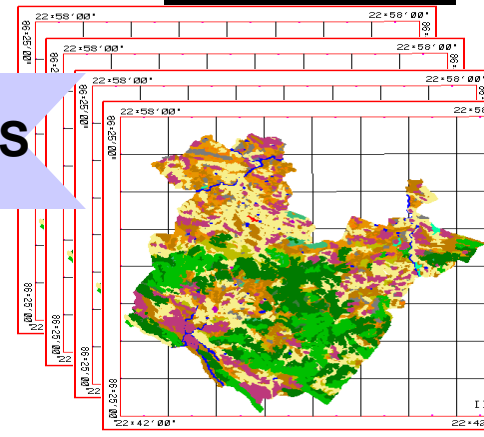


**TABLES/
REPORTS**

**GIS DATABASES
AND INTEGRATION**

MULTI-LAYER

DEV. SOLUTIONS



APPLICATIONS:

- CROP PRODUCTION
- FOREST MANAGEMENT
- URBAN PLANNING
- WASTELAND MAPPING
- LANDUSE MAPPING
- COASTAL ZONE REGN
- WATERSHED DEVELOPMENT
- DISASTER MANAGEMENT
- ENVIRONMENT
- MARINE RESOURCE SURVEY
- COMMAND AREA MANAGEMENT

..... MANY MORE

1995/1997



IRS-1C/1D LISS-3 (23/70M,
STEERABLE PAN (5.8 M);
WiFS (188M)

1999



INSAT-2E CCD
(1KM RESOLUTION;
EVERY 30 MiNUTES)

2001



RESOURCESAT-1
LISS3 - 23 M; 4 XS
LISS4 - 5.8 M; 3-XS
AWIFS - 70 M; 4-XS

1996



IRS-P3 (1996)
WiFS MOS
X-Ray,

1994



IRS-P2
LISS-2

1999



IRS-P4
OCEANSAT OCM, MSMR

2002



CARTOSAT - 1
PAN - 2.5M, 30 KM,
F/A

1988/91



IRS-1A & 1B LISS-1&2 (72/36M,
4 BANDS; VIS & NIR)

*Oceansat 2 +scatterometer

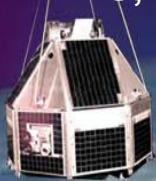
INDIAN REMOTE SENSING SYSTEMS

2003



CARTOSAT-2
PAN - 1M

1982



RS-D1

IMAGING IMPROVEMENTS

- ◆1KM TO < 1 M RESOLUTION
- +GLOBAL COVERAGE

*2008-09



MEGHA-TROPIQUES
SAPHIR
SCARAB &
MADRAS

*RISAT - radar imaging satellite

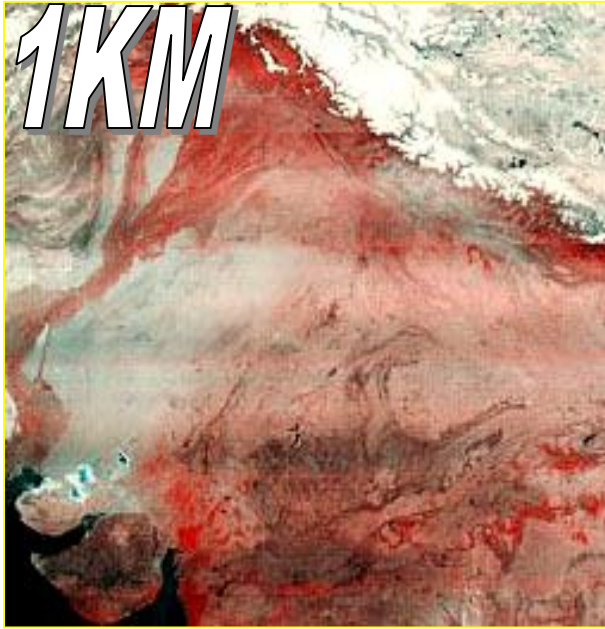
*CARTOSAT 3 (sub-meter)

* To be launched...

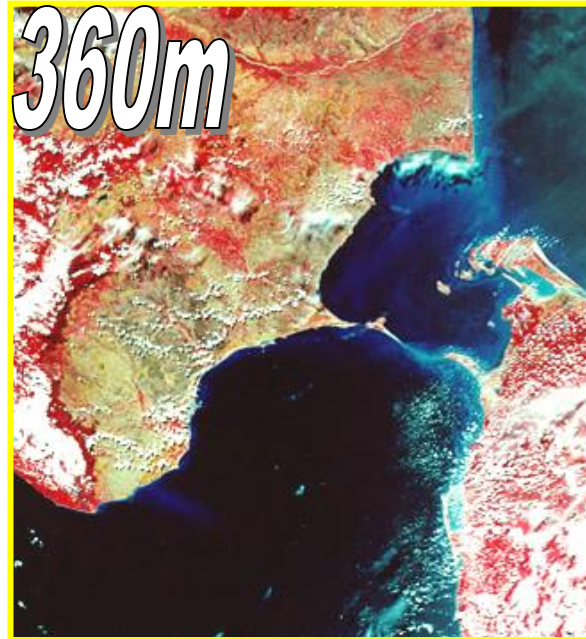
1979



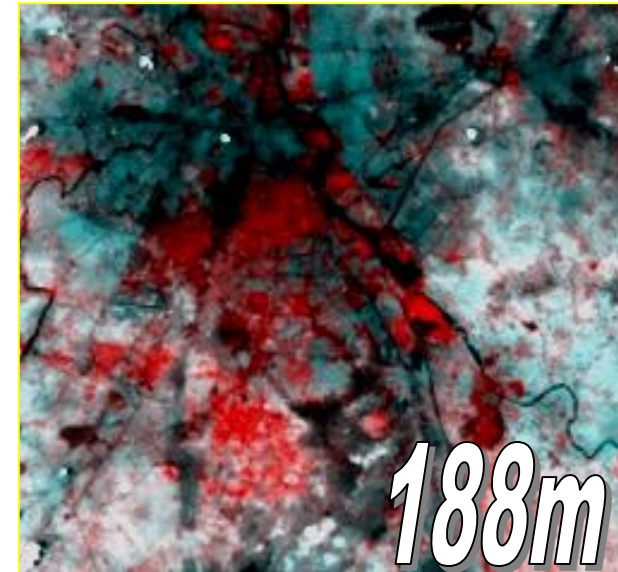
BHASKARA



- EVERY 30 MIN. IMAGING
- 1M+ SCALES
- CLIMATE/WEATHER



- EVERY 2 DAYS IMAGING
- 1:250K SCALES
- OCEAN APPLICATIONS



- EVERY 5 DAYS IMAGING
- 1:250K SCALES
- NATIONAL SURVEYS

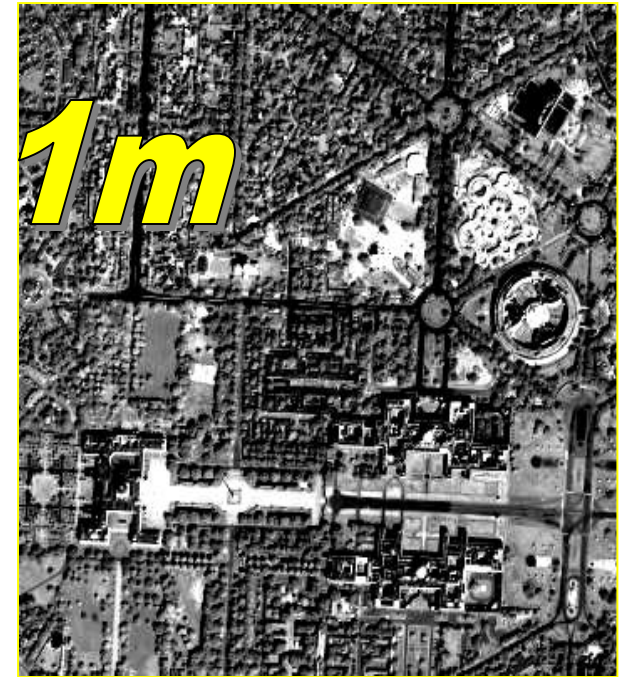
INDIAN IMAGING CAPABILITY



- EVERY 22 DAYS IMAGING
- 1:50K SCALES
- DETAILED RESOURCES SURVEY



- EVERY 5 DAYS IMAGING
- 1:12500 SCALES
- LARGE SCALE MAPPING
- STEREO CAPABILITY



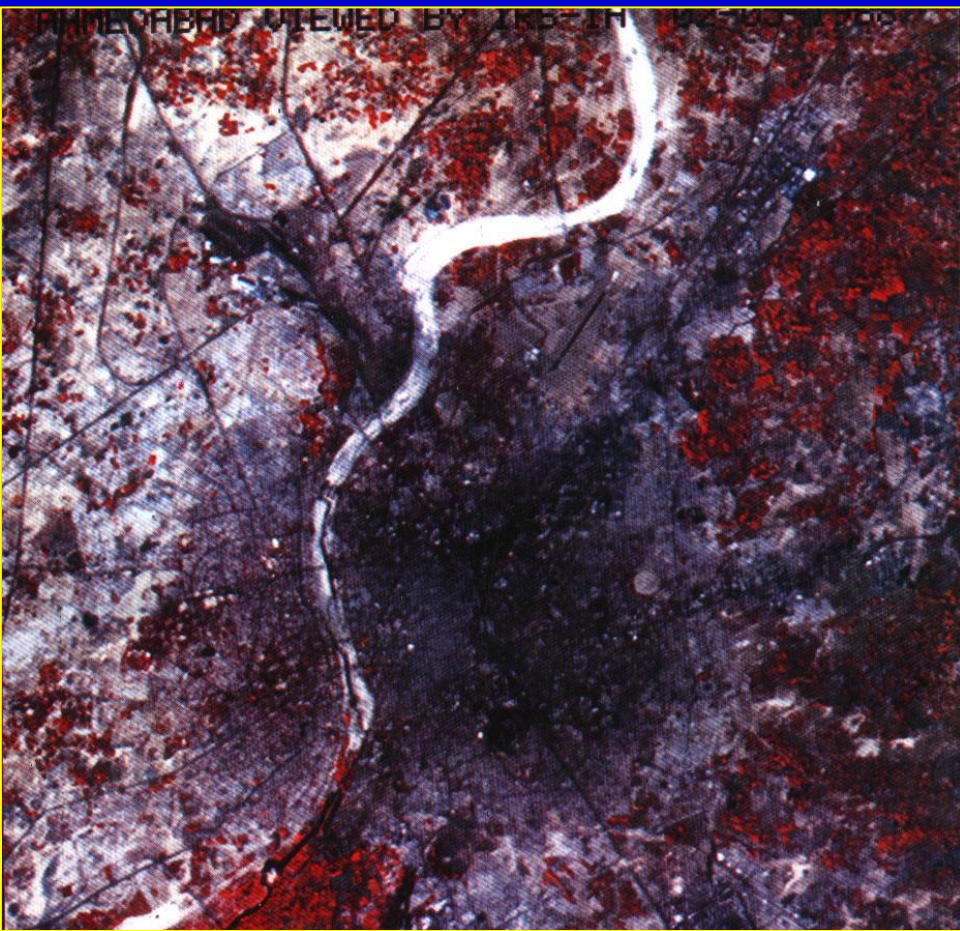
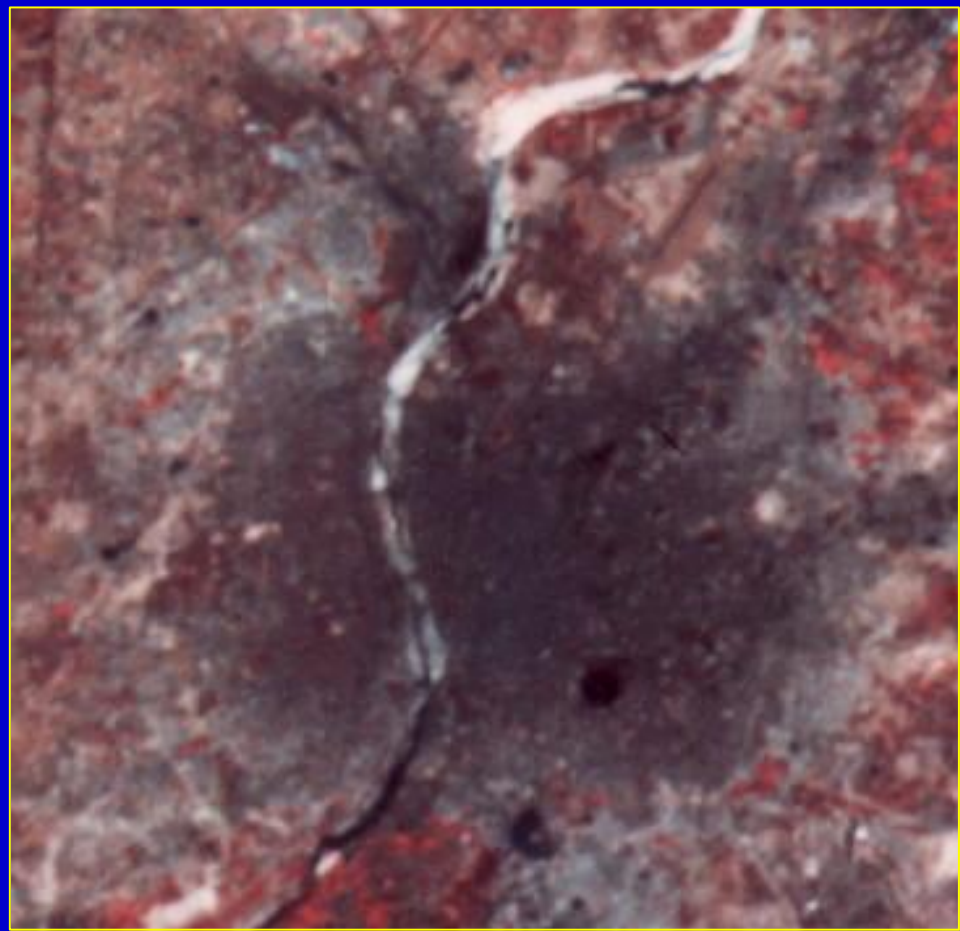
- LOCAL AREA IMAGING
- 1:2000/4000/1:8000 SCALES
- STEREO CAPABILITY

Future < 1 M)

SPATIAL RESOLUTION VIS-À-VIS SCALE

73m

36.5m



•1:250 K SCALES

•1:50 K SCALES

USE

➤ Regional Plan

➤ Perspective Plan



23M IRS LISS-III



5.8M IRS PAN



5.8M IRS MERGED

DETAILED PLANNING



1M TES PAN

1M TES MERGED



Agricultural Applications

- Operational Component
 - ❖ Crop Acreage & Production (Major Crops)
 - ❖ Inventory & Site suitability for Horticultural Crops

- R&D Elements
 - Crop Rotation, Fallow Land Status, Resource Utilisation
 - ❖ Planning Sustainable Cropping System
 - ❖ Modelling for Energy and Water Balance and Crop Growth Simulation

Crop production

WHEAT PRODUCTION FORECAST (RABI 2000-2001)

	ACREAGE (000 ha)	PRODU. (000 t)
RS	166.8	693.6
BES	167.0	774.0
RD %	- 0.1	- 10.4
Date	April 10, 01	Dec. 01

LEGEND

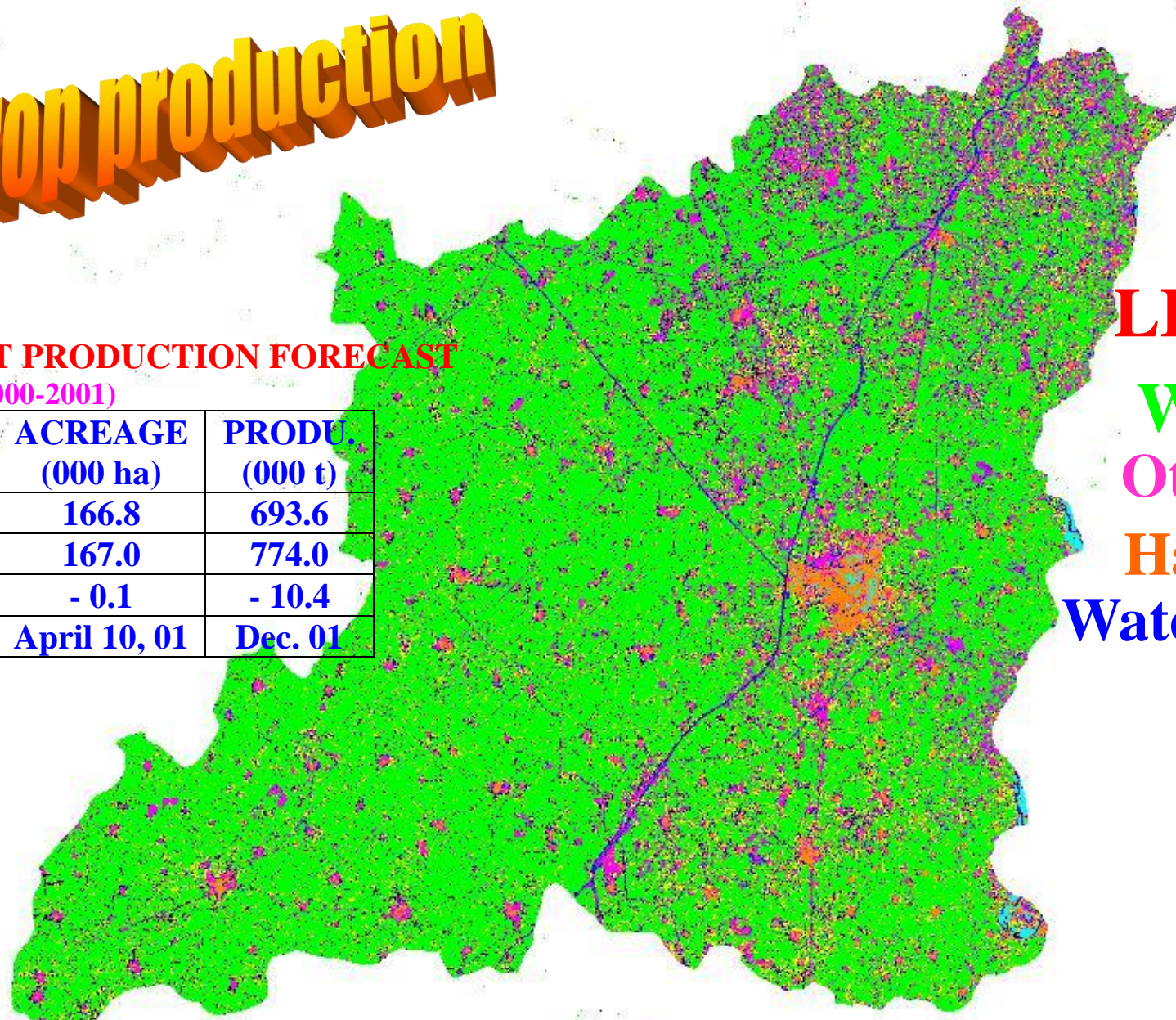
WHEAT

Other Veg.

Habitation

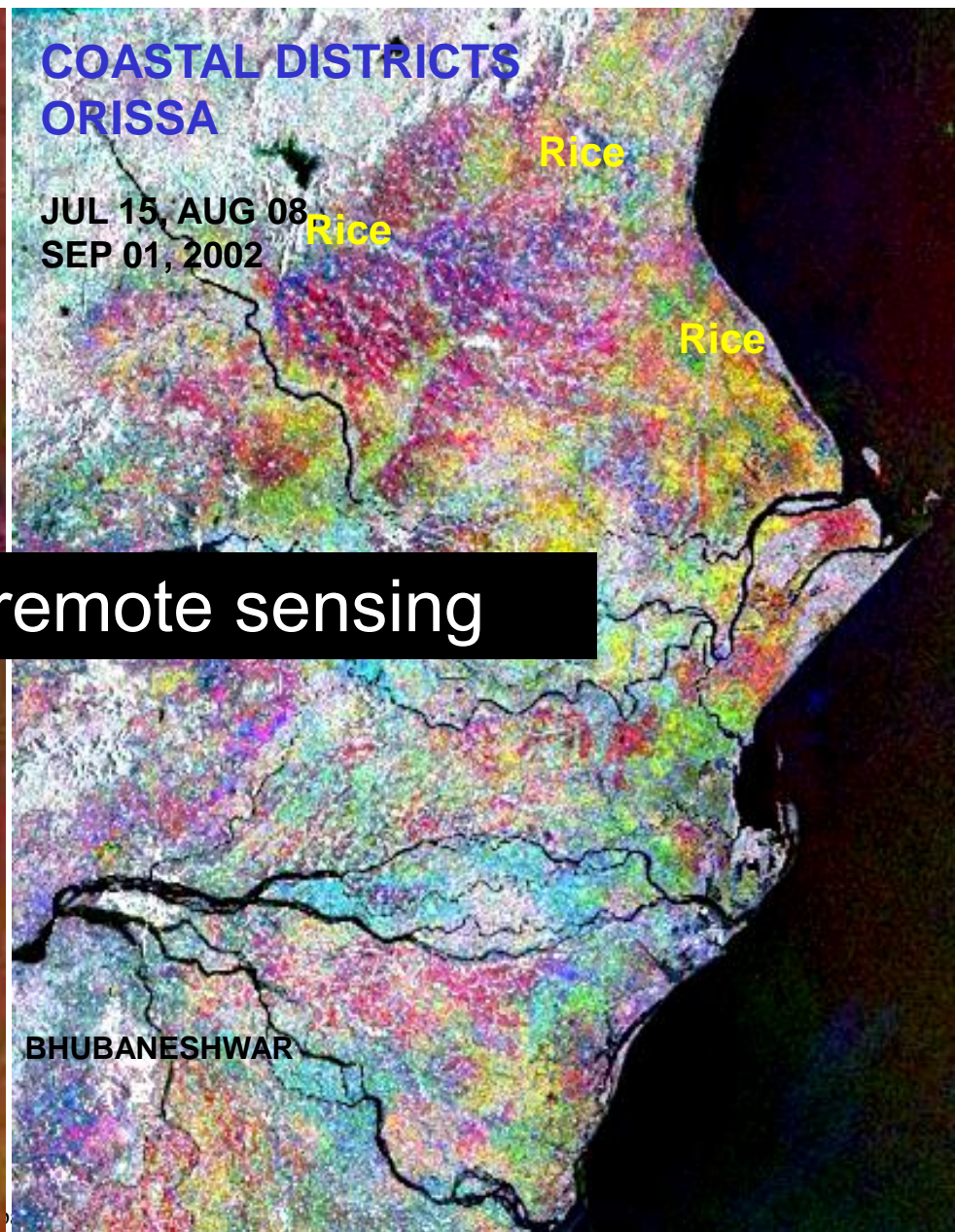
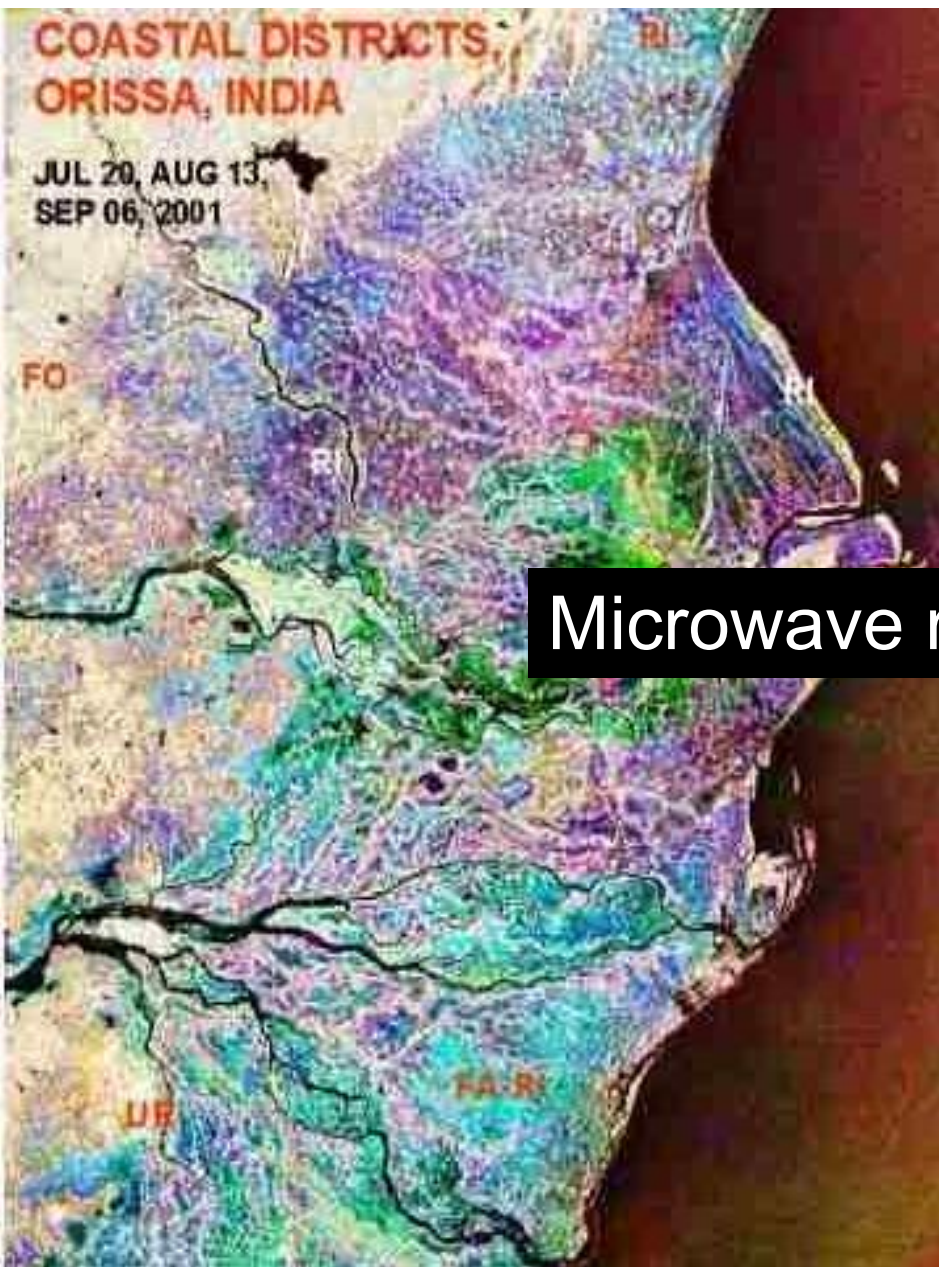
Water Bodies

Roads



KARNAL DISTRICT: HARYANA

NATIONAL KHARIF RICE INVENTORY PROJECT



Microwave remote sensing

ORISSA 2001

ORISSA 2002

Land use, Forestry and Environmental Applications

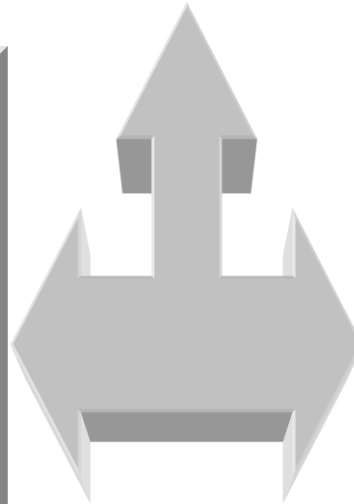
- **Urban land use**
- **Development plans: Land and Water**
- **Grassland mapping**
- **Biodiversity Characterisation**
- **Wetland Mapping & Monitoring**
- **Archaeological site identification**

INTEGRATED MISSION FOR SUSTAINABLE DEVELOPMENT

**SURFACE WATER HARVESTING
GROUND WATER EXPLORATION & RECHARGE
SOIL CONSERVATION
ALTERNATE LAND USE PRACTICES**

WATER RESOURCES DEVELOPMENT

**CHECK DAMS
PERCOLATION TANKS
NALA BUNDS
DYKES (BANDHARA)
SUB-SURFACE DYKES
FARM PONDS
VEGETATIVE BUNDS
RUBBLE CHECKS
GULLY PLUGS
ANICUTS
TANK DESILTATION
DUG/TUBE WELLS
LIFT IRRIGATION**



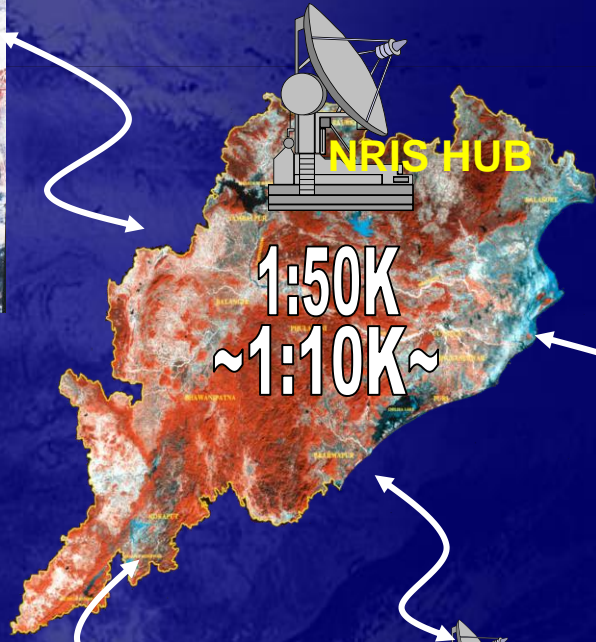
LAND RESOURCES DEVELOPMENT

**AGRO-HORTICULTURE
HORTICULTURE
AGRO-FORESTRY
DRY LAND AGRICULTURE
SILVIPASTURE
DOUBLE CROPPING
INTENSIVE AGRICULTURE
AFFORESTATION
FOREST ENRICHMENT
INTERFACE FORESTRY
PASTURE DEVELOPMENT
FUEL/FODDER PLANTATION**

NNRMS/ NRIS ACCESS AND SERVICES



SATELLITE IMAGES
~ 20 SPATIAL
~ 8 NON SPATIAL



VILLAGE INFORMATION KIOSK



VILLAGE INFORMATION KIOSK

SERVICES:

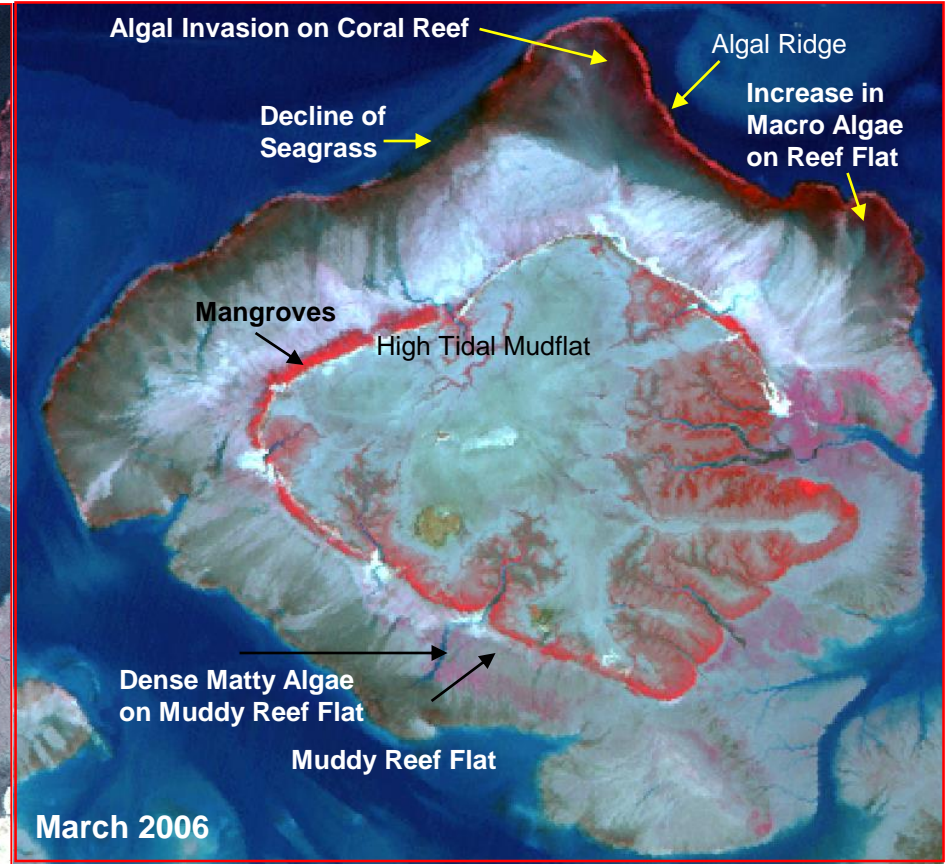
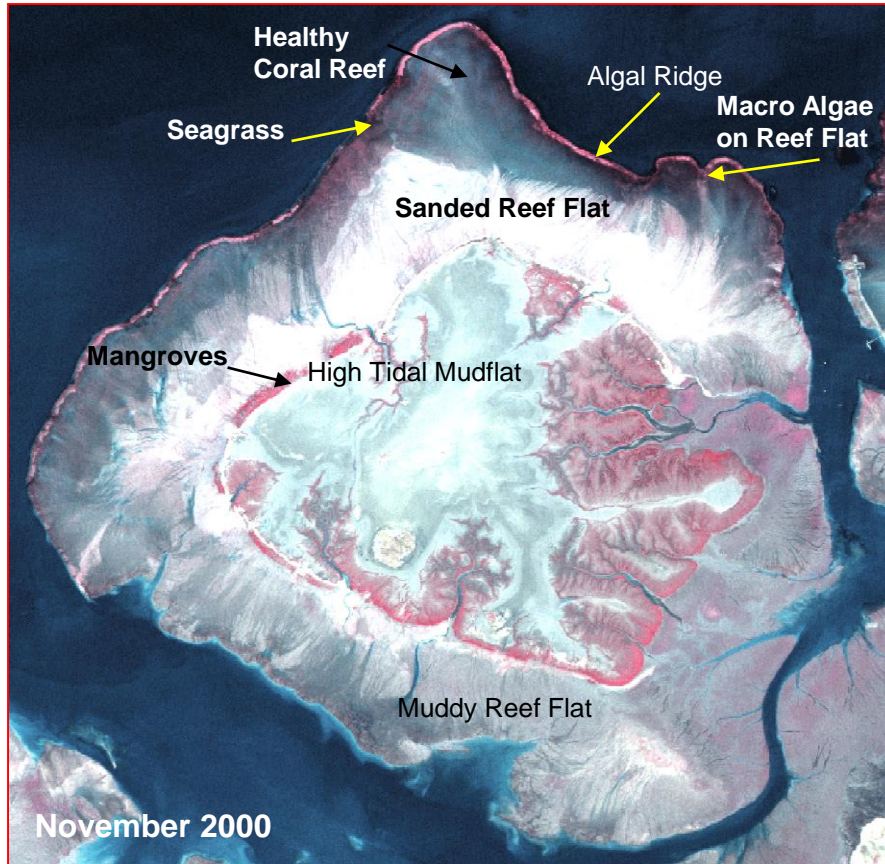
- AGR. ADVISORY
- PRECISION FARMING
- DISTRICT PLANS
- WATERSHED PLAN
- LAND USE CHANGE
- WASTELAND DEV PLAN
- GROUNDWATER
- IRRIGATION
- ROUTING
- DISASTER MGMT.
- INFRASTRUCTURE
- CONNECTIVITY
- GOVT. DEV. INFO

- GOVERNMENT
- PRIVATE/NGOs
- VILLAGE COMMUNITY
- INDIVIDUALS

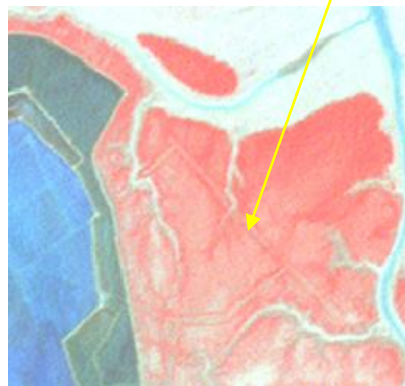
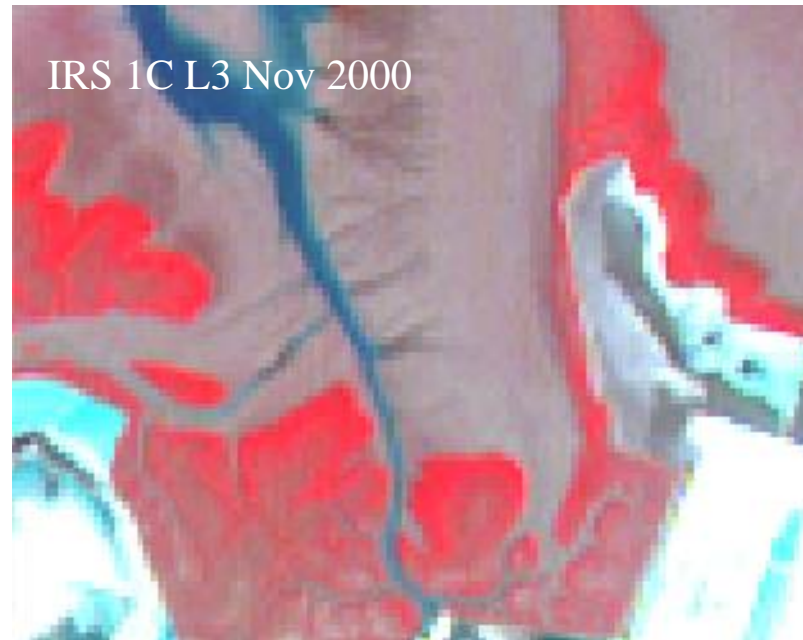
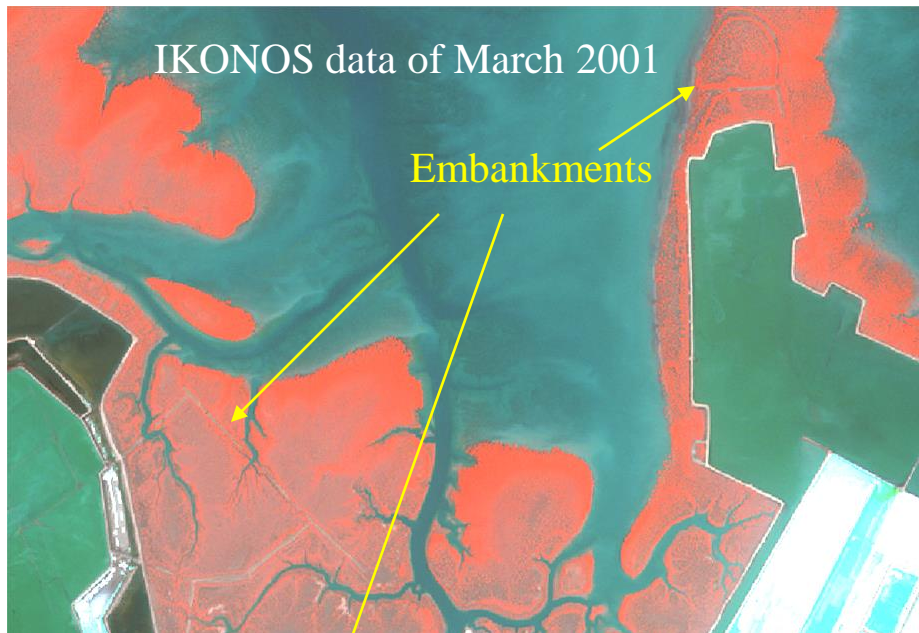
Coastal ZONE

- Habitat Status (coral reefs/ mangrove)
- Shoreline change (zone of accretion/ erosion)
- Coastal Regulation zoning (coastal land use)
- Information System (data base/ query shell)

Coral Reef, Gulf of Kachchh) using IRS Data



Status of Mangroves in the Core Marine National Park, Gulf of Kachchh

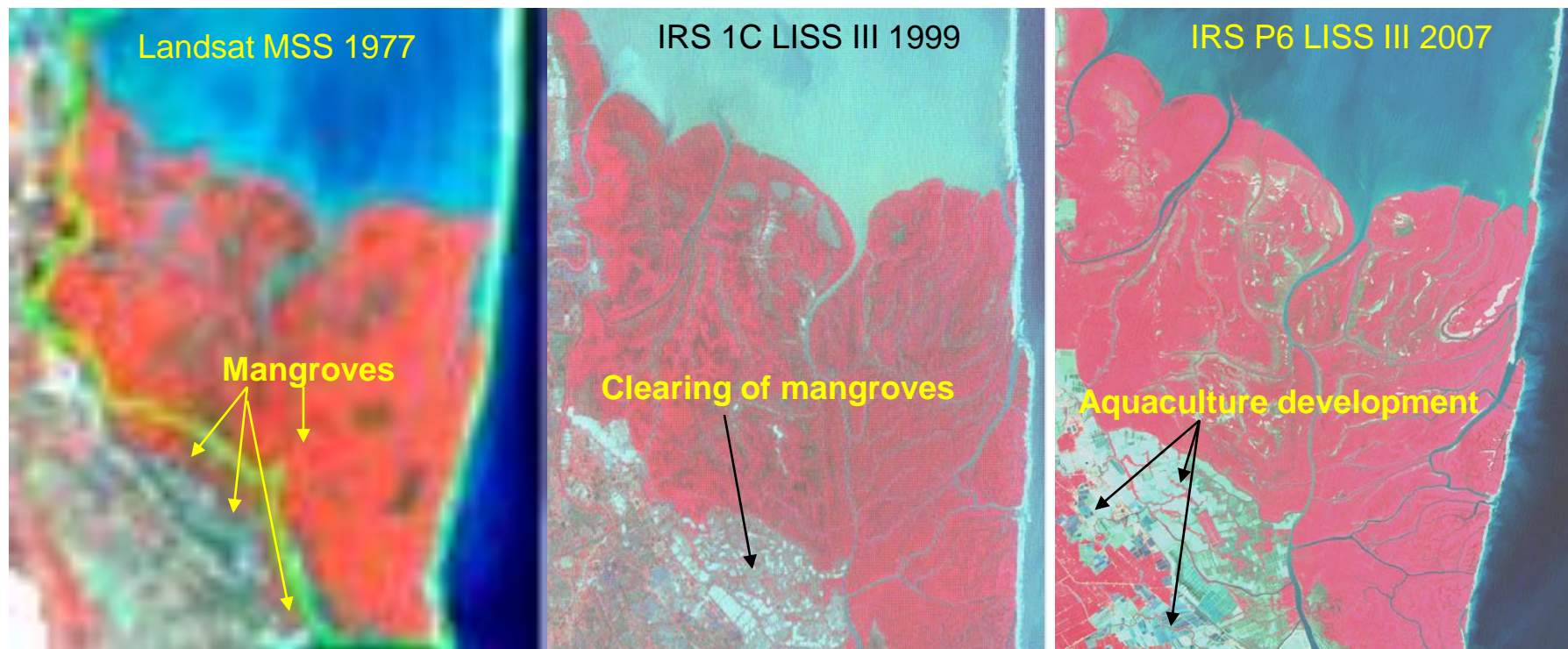


- **Creation of Bund/ embankment within mangroves resulted in degradation.**
- **Satellite images were shown to the Marine National Park Authorities in 2005.**
- **Embankment was destroyed by the Authorities and mangroves have started improving**

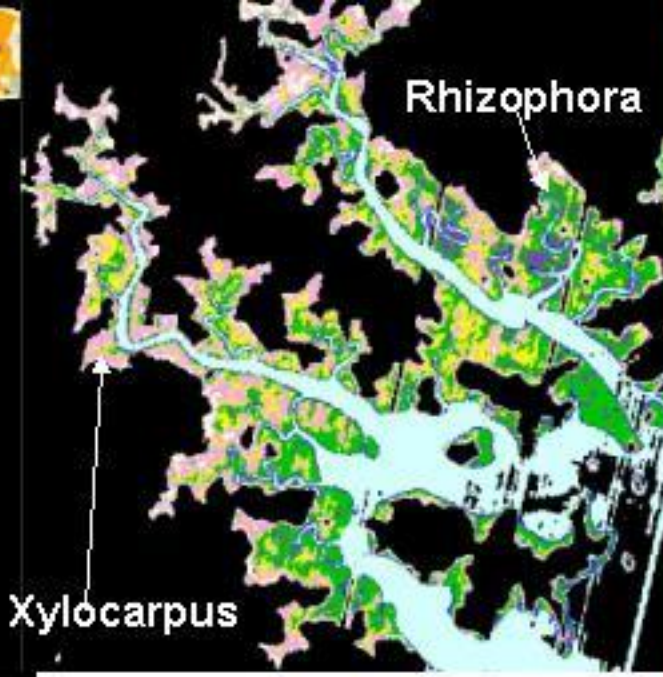
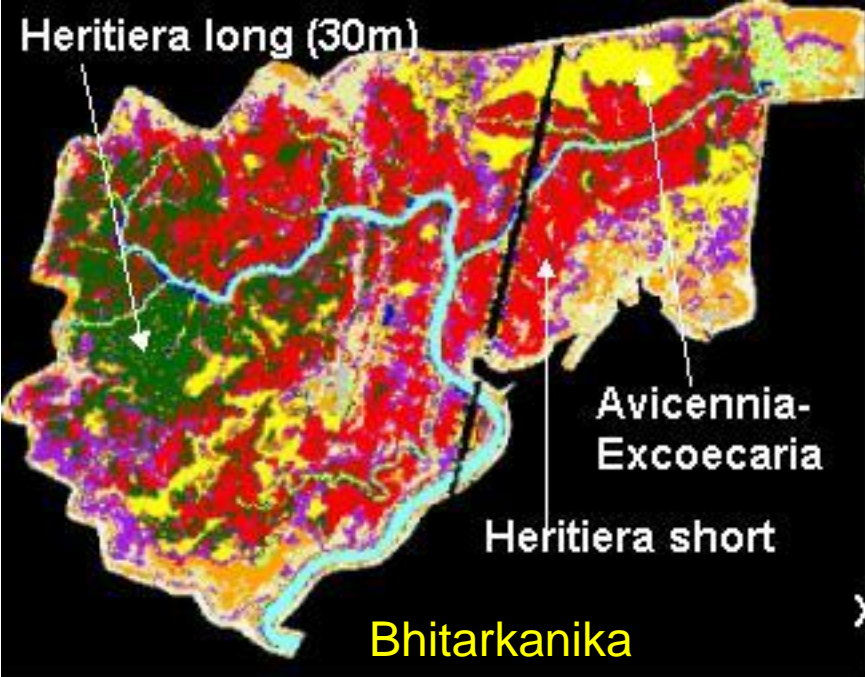
12 January 2009

Degradation of Mangroves due to Reclamation for Aquaculture Development

Coringa Mangroves Reserve Forest, Andhra Pradesh

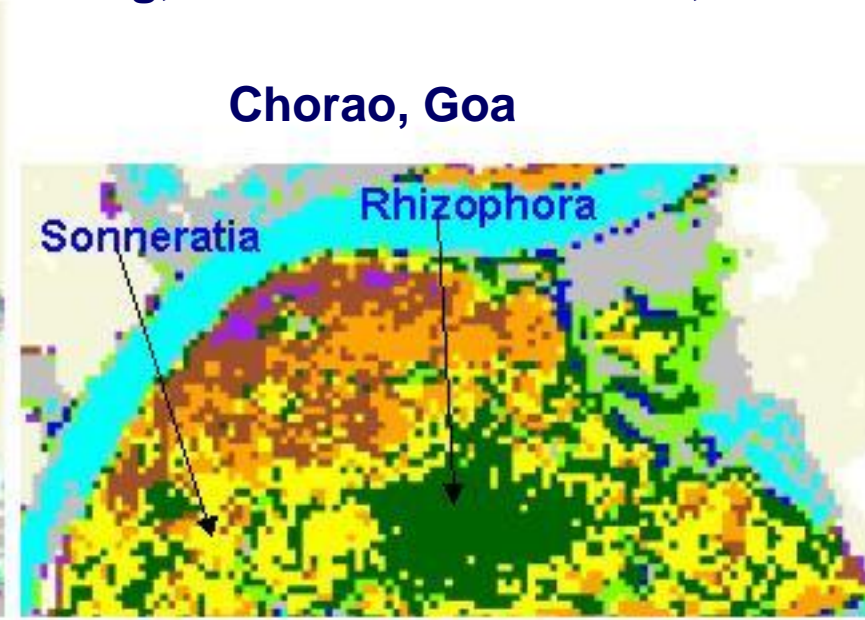
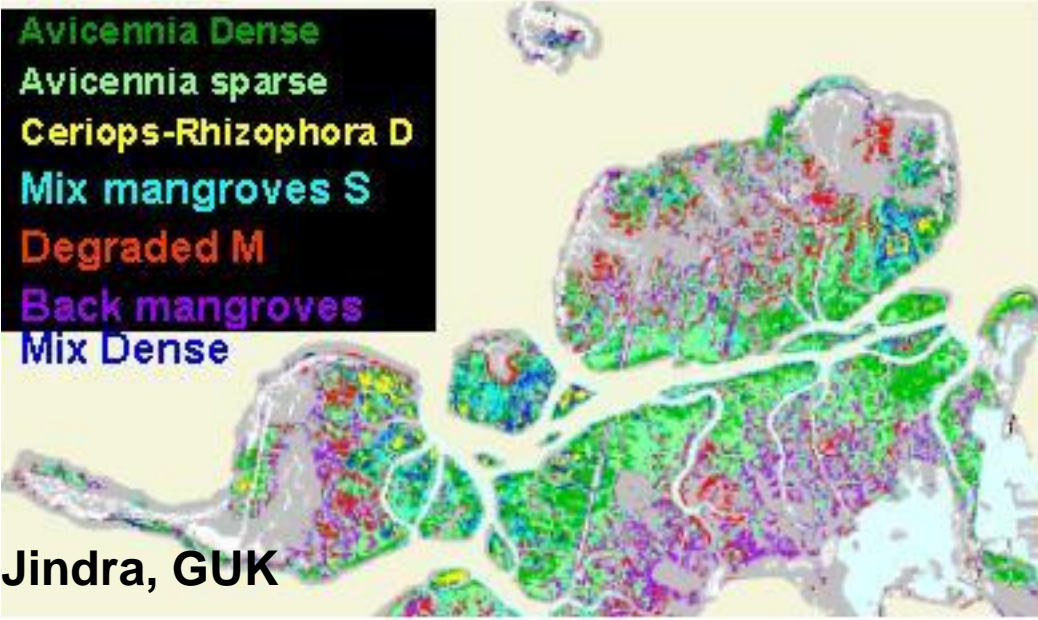


Mangroves beyond the Sanctuary boundary (in yellow) have been removed and land reclaimed for aquaculture. The sequential images show mangroves in the region, their clearing and subsequent aquaculture development.



Porlob Jig, A&N

Lothian, W.B



Chorao, Goa

Dominant mangrove community zonation

Marine Applications

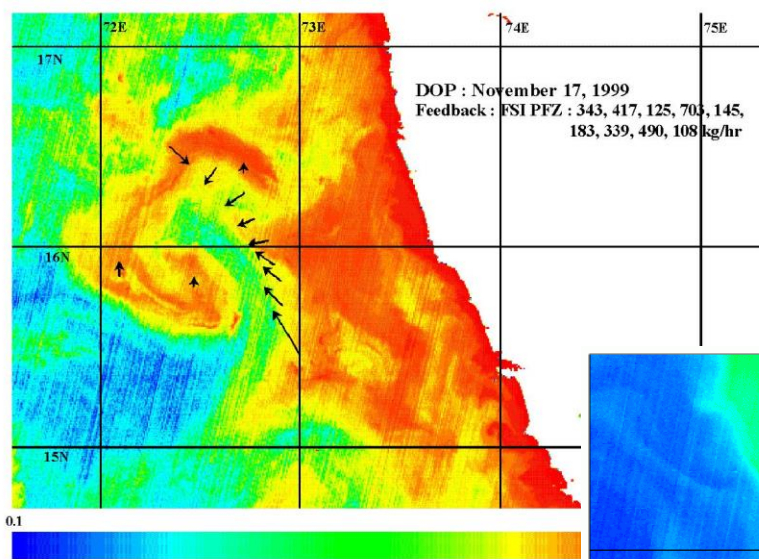
- ❖ OPERATIONAL

 - Fishery forecast (colour & SST)

- ❖ Modelling of primary productivity (colour)

- ❖ Spatial and temporal variability of chlorophyll and SST AS (NOAA AVHRR & OCM)

Fishery Forecast



← FEED BACK PHASE I

(1999-2000)

www.incois.gov

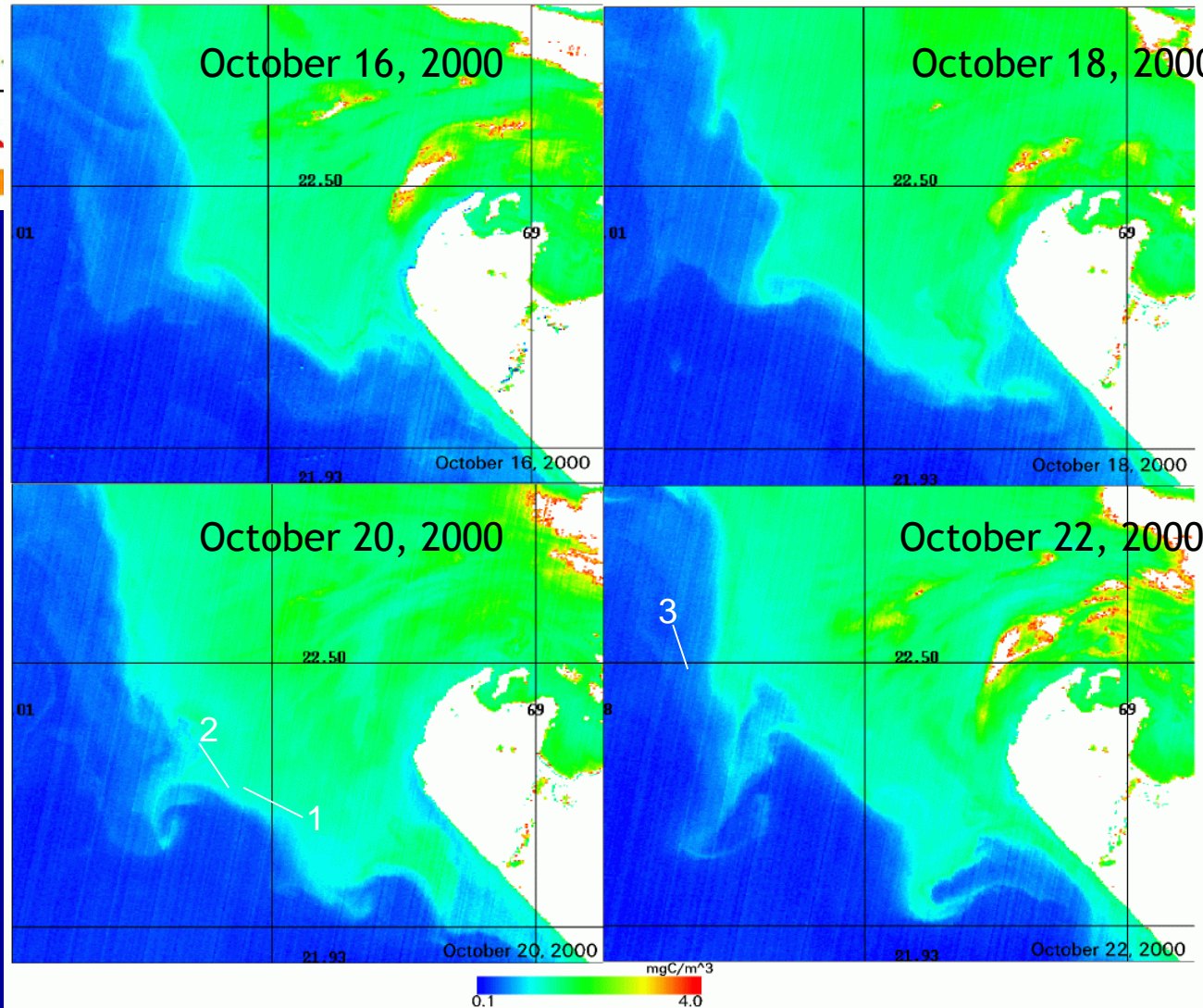
(Source : FSI)

↓ FEED BACK PHASE III
(2000-2001)

Mean = 124 kg / hr
mean + SD = 84

Track No.	DOF	DOP	Catch (kg)
1	21 Oct	20 Oct	237(H)
2	21 Oct	20 Oct	236(H)
3	22 Oct	20 Oct	116

Track No	DOF	Chlorophyll (mg/m ³)	
		18 Oct	20 Oct
1	21 Oct	0.46	0.52
2	21 Oct	1.7	1.9
3	22 Oct	0.53	0.67

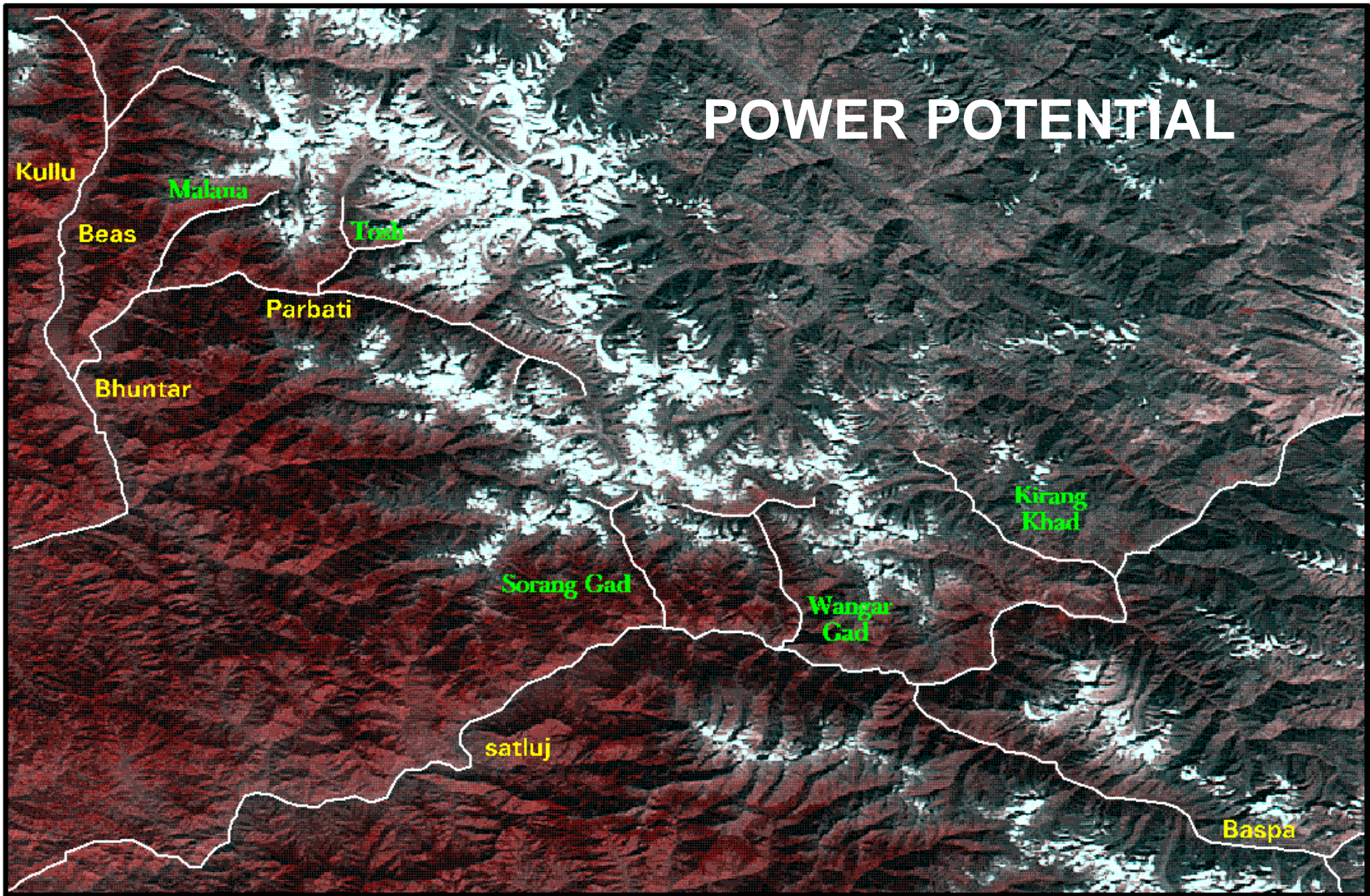


12 January 2009

Snow and Glaciers

- Glacier inventory
- Mass balance (accumulation vs. ablation)
- Snow melt run-off (sites for power generation)
- Moraine dammed –lakes
(inventory and associated hazard)

POWER POTENTIAL



Location map of Basins (green) where Hydropower potential is estimated
(IRS-1C WiFS imagery of dated October 26, 01)

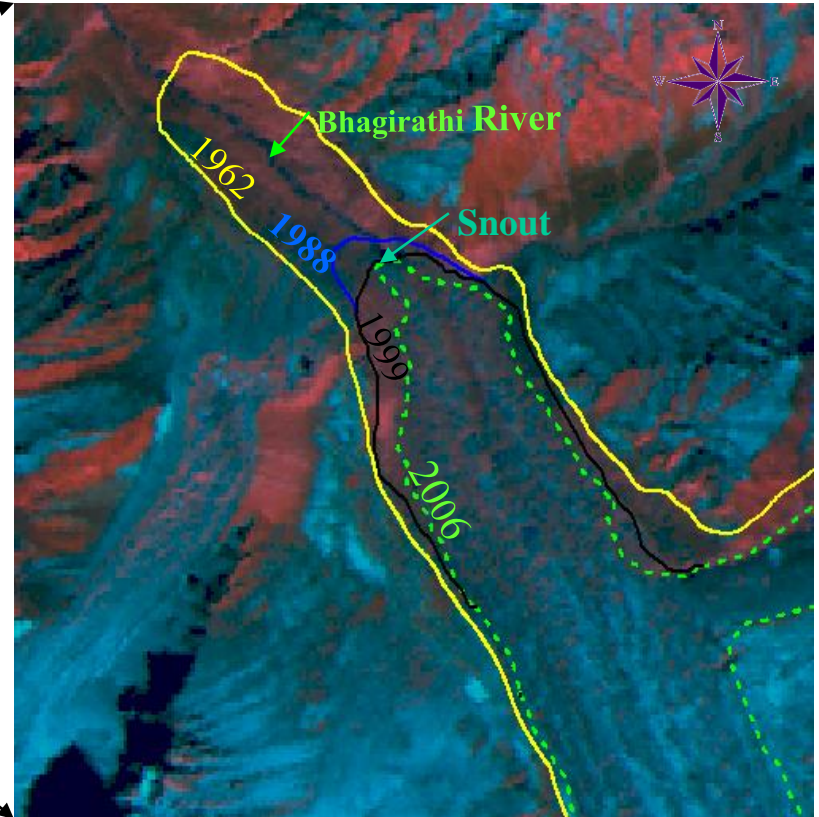
RETREAT OF GANGOTRI GLACIER

Full view of Gangotri Glacier



IRS LISS-III SEP 1999

Shift in snout during 1962-2006



IRS LISS-III SEP 2006

Management of Disasters

❖ LAND:

1. PRECURSORS TO EARTHQUAKE:
2. EXTREME RAINFALL EVENTS <FLASH FLOODS>
3. Forest Fire
4. FLOODS/ DROUGHT
5. Urban Environment: Carrying Capacity

❖ OCEAN/ LAND INTERFACE:

5. CYCLONE TRACKING AND LAND FALL
6. COASTAL EROSION

Resolving R& D ISSUES

- Scientific knowledge available globally but not adopted
- Knowledge upgradation and adoption (new sensor evaluation, newer concepts and modelling approaches)

CARRYING CAPACITY

A sustainable approach essentially needs such a criteria. In recent times, a concept based on the ‘**ecological footprint**’ has proved to be a good measure of sustainability (Rees 1996). It is defined as the use of a given resource whether terrestrial, aquatic or oceanic to produce certain output for sustenance of a given population and keeping provision for assimilation of the waste produced in such an activity.

Table: The Ecological Footprint calculation for Ahmedabad (AUDA), and Hyderabad (HUDA) and National Level as compared to that of Netherlands and United States

Region/Unit	Ecological* Productive Land (In ha)	Population Census (2001)	Ecological Productive Land per capita (in ha)	Deficit per capita	
				d=foot- print-c (In ha)	e= d/c (In %)
Assuming a 2 ha Footprint					
India*	169000000	1027015247	0.164	1.836	1119
Ahmedabad* (AUDA)	60223	5497962	0.011	1.989	18081
Hyderabad* (HUDA)	57238	6400000	0.009	1.991	22122
Assuming a 3 ha Footprint (source: Rees, 1996)**					
Netherlands**	2,300,000	15,500,000	0.15	2.85	1900
Assuming a 5 ha Footprint					
US**	725643000	258,000,000	2.81	2.28	80

*DES, GOI; **Rees, 1996



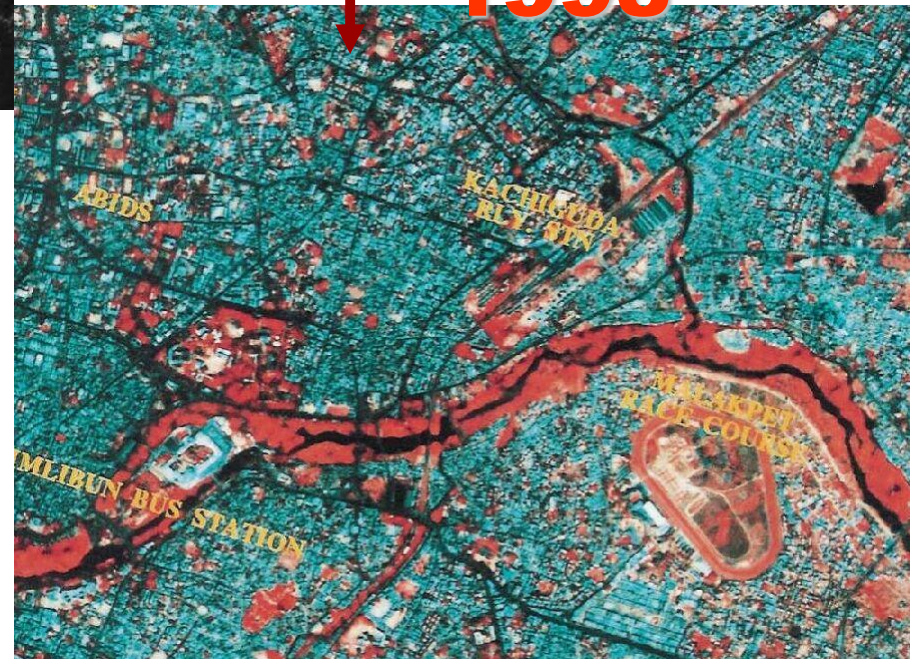
1967

A part of
Hyderabad city

Loss of Carrying Capacity:

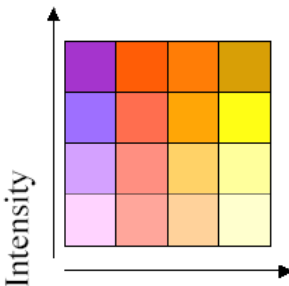
- *loss of open land
- *choked drainage

1998



OCEAN/ LAND (interface)

Population Density hab/Km2



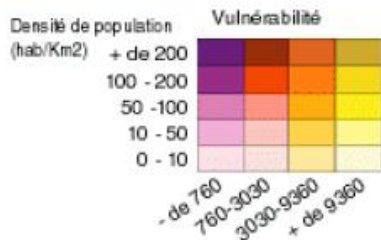
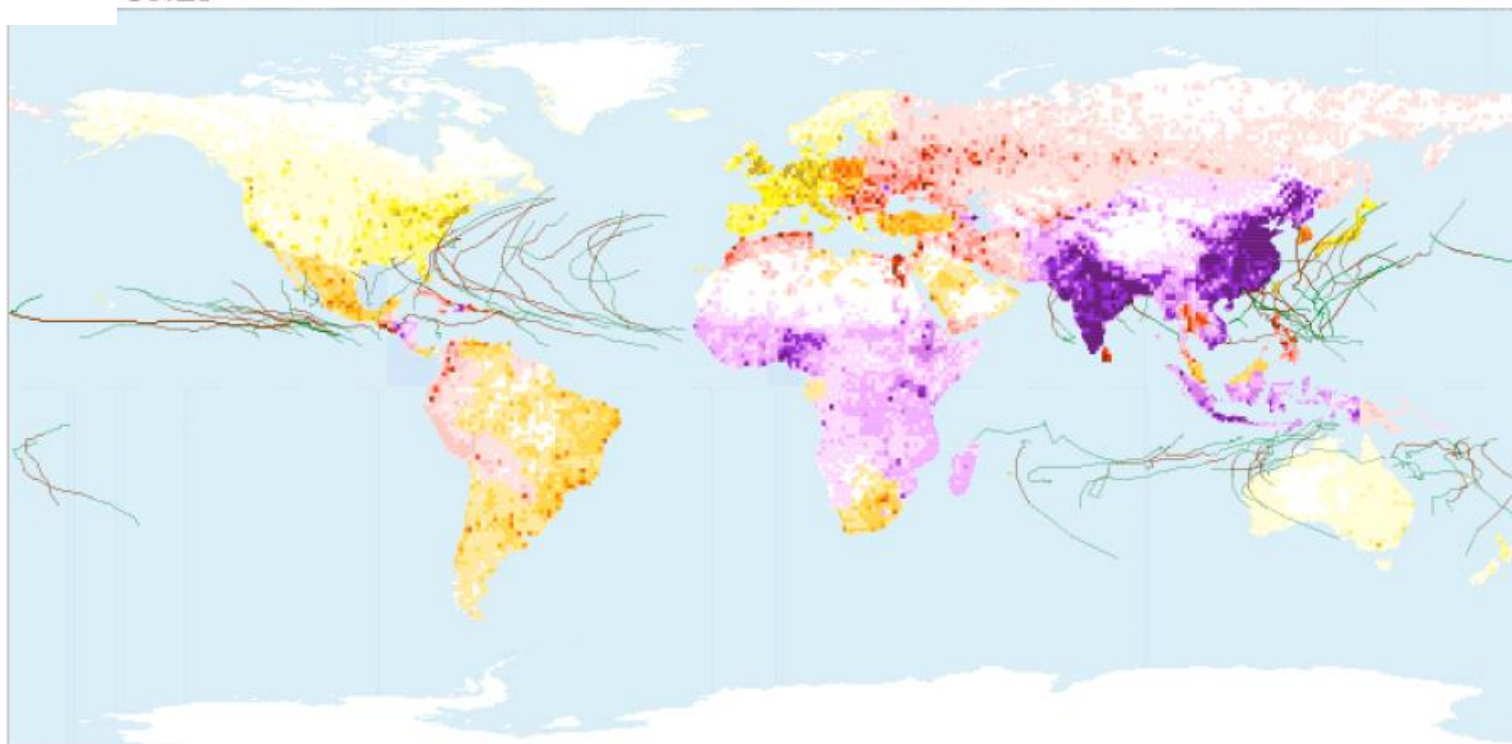
GDP



Hue UNEP

TROPICAL CYCLONES

Trajectoires des Cyclones Tropicaux en 1998-1999 en relation avec la Vulnérabilité de la Population



PNB (US\$ par habitant)

- Cyclones tropicaux
- Tempêtes et Dépressions Tropicales

Sources:
 Données météo:
 Unisys Weather, Australian Severe Weather
 Données population:
 Banque Mondiale (PNB 1998)
 GRID-Sioux Falls (Population 1990 1' x 1')



12 Janu

Key Issues in Tropical Cyclone Monitoring & Prediction

Correct Geolocation



Correct Intensity Estimation



Correct Intensity Change Detection



Correct Track Change Detection

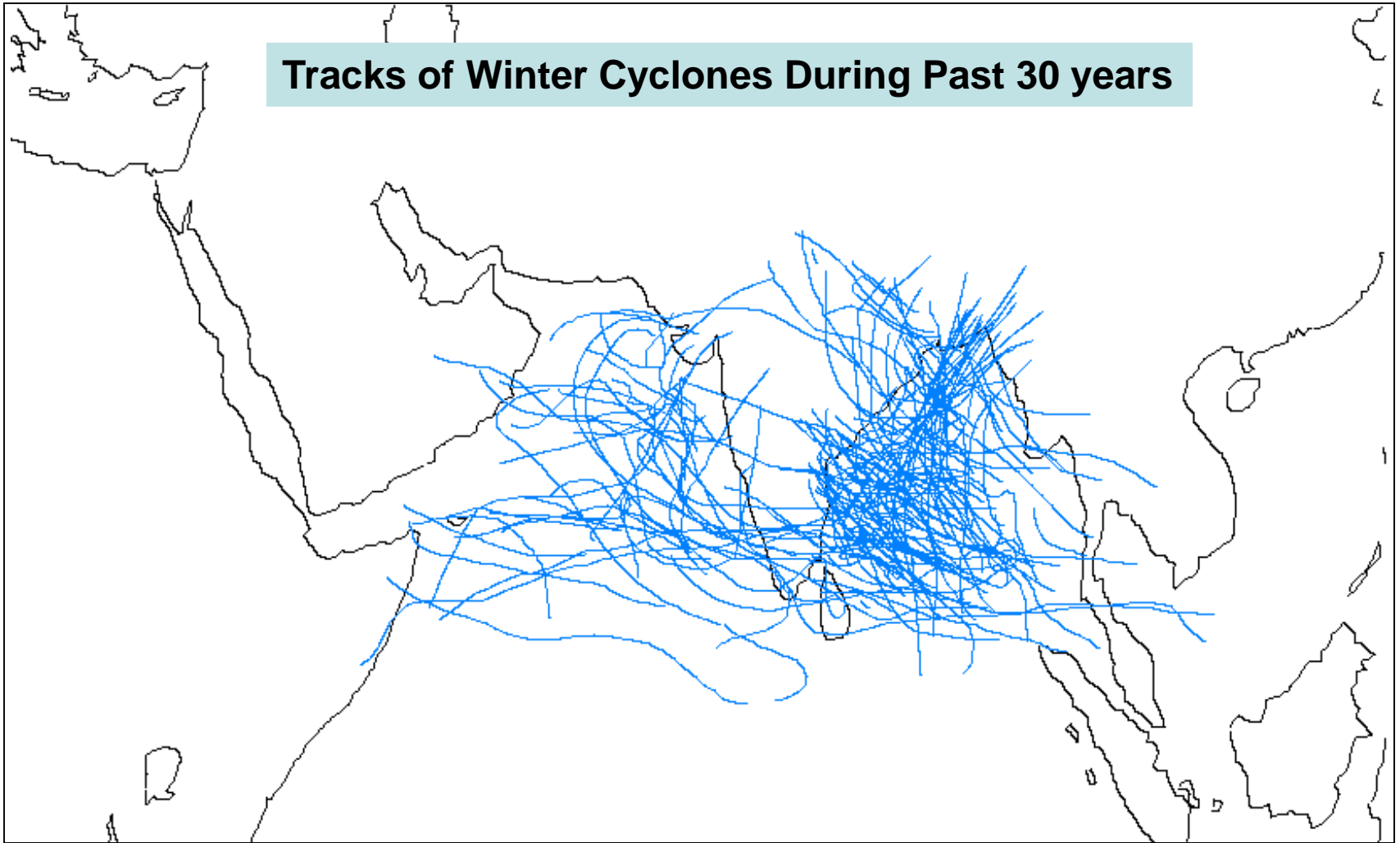


Courtesy: Dr CM Kishtwal, SAC, ISRO

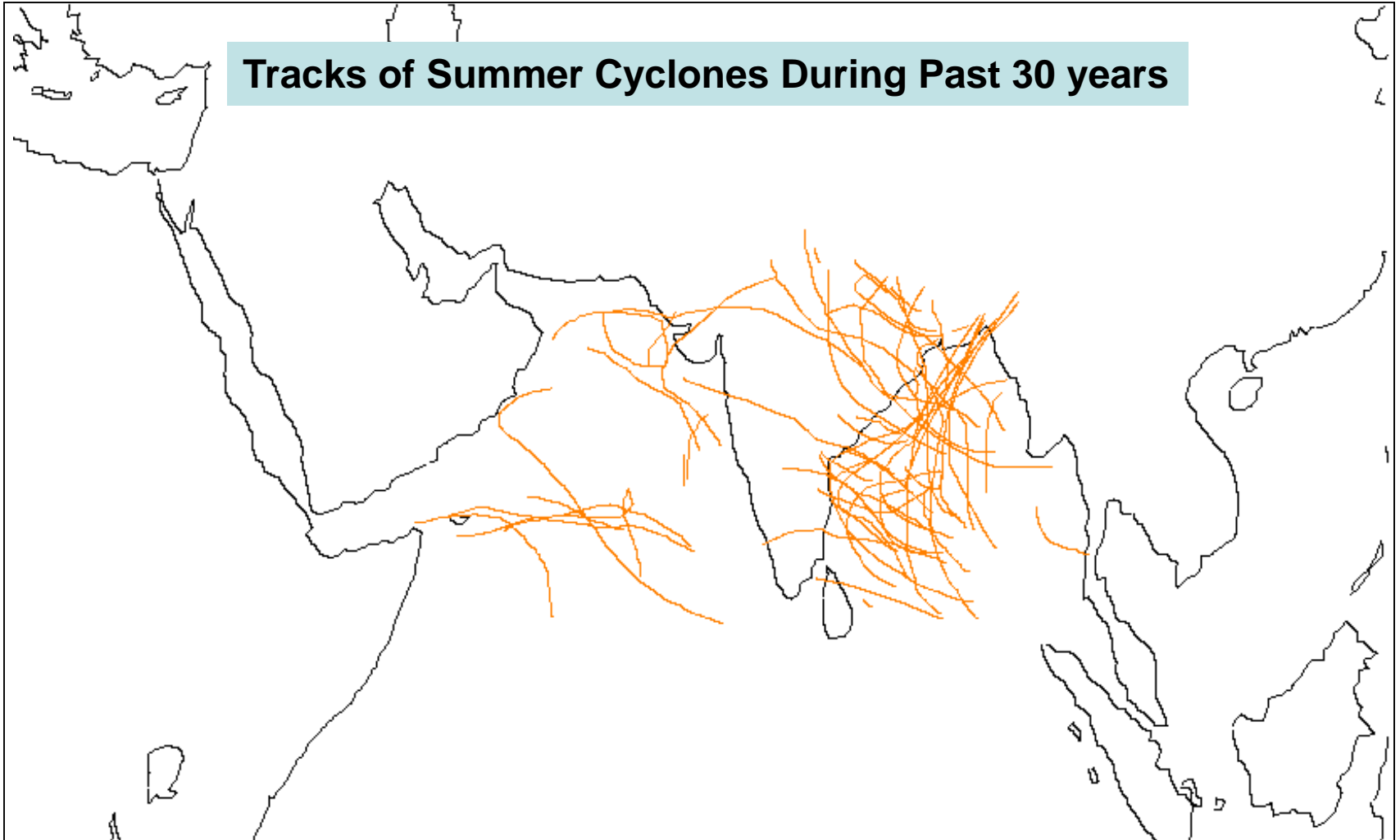
12 January 2009

Colloquium, Space Studies, UND

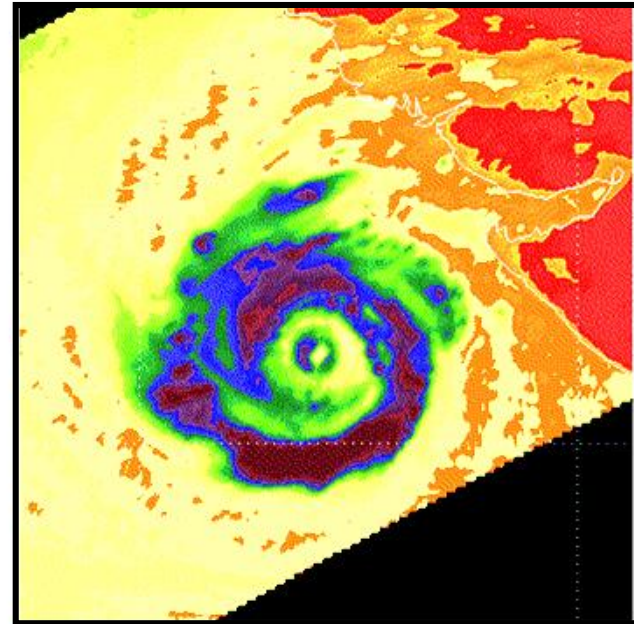
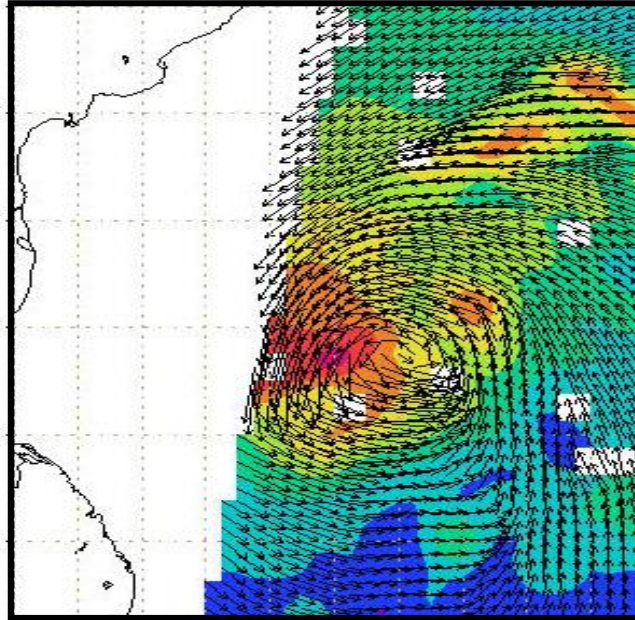
Tracks of Winter Cyclones During Past 30 years



Tracks of Summer Cyclones During Past 30 years



Tropical Cyclones



Visible/IR Images

- 24-h Track prediction using past positions of TC
- Diurnal Variation of TC intensity

Wind Scatterometer

- Method developed for TC Center determination with accuracy of approx. 20 km.

Microwave Radiometer

- Method developed automatic TC intensity estimation with accuracy of ~ 11 kt.
- Method developed for TC intensity change in next 24 hours with accuracy of ~ 7 kt.