

## Satellite Remote Sensing & GIS for Irrigation Management

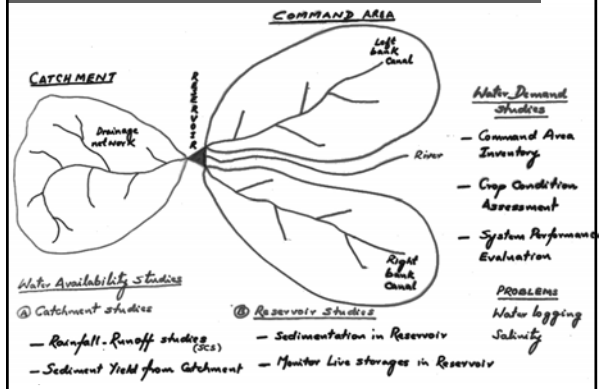
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## Remote Sensing for Command Area Management



## Remote Sensing for Command Area Management

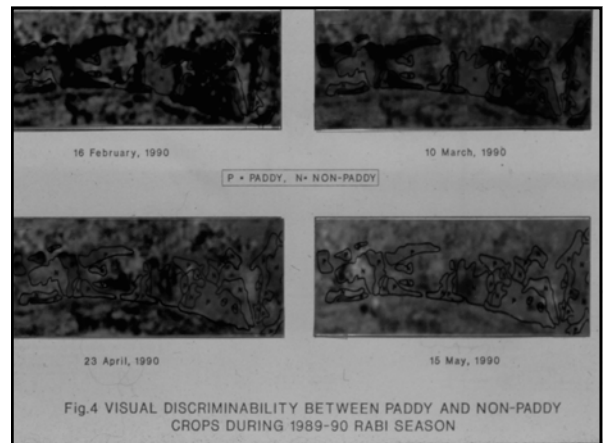
- Assessment of water availability in reservoirs for optimal management of water to meet the irrigation demand
- Identifying, inventorying and assessment of irrigated crops
- Determination of irrigation water demand over space and time
- Distinguishing lands irrigated by surface water bodies or by ground water withdrawals
- Estimation of crop yield

## Remote Sensing for Command Area Management (Contd..)

- Water logging and salinity problems in irrigated lands
- Irrigation scheduling based on water availability and water demand
- Evapotranspiration studies
- Irrigation system performance evaluation

## Spectral Signature of Major Crops

Crop Type	Growth Stage at the time of Satellite Data Acquisition	Possible signature on a Standard FCC
Paddy	2 to 3 weeks after transplantation	Greenish black to Reddish black
Paddy	Peak vegetative phase	Dark Red
Groundnut	Peak vegetative phase	Shades of bright red
Sugarcane	Peak vegetative phase	Light Pink to Pink
Cotton	Peak vegetative phase	Pink to Red



## Derivation of Bio-physical Parameters

Parameter	Accuracy	Need for field Data
Vegetation cover	High	None
Leaf area index	Good	None
Photosynthetically active radiation	Good	None
Surface roughness momentum	High	None
Surface roughness heat	Low	High
Surface albedo	Good	Low
Thermal infrared surface emissivity	Good	None
Surface temperature	Good	Low
Surface resistance	Good	None
Crop coefficients: tabulated	Moderate	None
Crop coefficients: analytical	Moderate	High
Transpiration coefficients	Good	None

## Derivation of Crop Parameters useful for Irrigation Management

Crop Parameter	Process	Purpose
Vegetation cover	Chlorophyll development, soil and canopy fluxes	Irrigation area
Leaf area index	Biomass, minimum canopy resistance, heat fluxes	Yield, water use, water needs
Photosynthetically active radiation	Photosynthesis	Yield
Surface roughness	Aerodynamic resistance	Water use water needs
Surface albedo	Net radiation	Water use water needs
Thermal infrared surface emissivity	Net radiation	Water use water needs
Surface temperature	Net radiation, surface resistance	Water use
Surface resistance	Soil moisture and salinity	Water use
Crop coefficients	Grass evapotranspiration	Water needs
Transpiration coefficients	Potential soil and crop evaporation	Water use water needs
Crop yield	Accumulated biomass	Production

## Water Management Information that can be Derived from Remote Sensing

Parameter	Accuracy	Need for field Data
Precipitation	Moderate	High
Surface runoff	Low	High
River discharge	Low	High
Potential evapotranspiration	Moderate to good	Low
Potential transpiration	Moderate	Low
Potential evaporation	Moderate	Low
Actual evapotranspiration	High	Low
Actual transpiration	Low	Moderate
Actual evaporation	Low	Moderate
Crop stress indicators	Good	Low
Crop yield	Good	Moderate
Relative yield	Moderate	Low
Topsoil moisture	Moderate	Moderate
Root-zone moisture	Low	High
Soil salinity	Low	High
Salt minerals	low	High

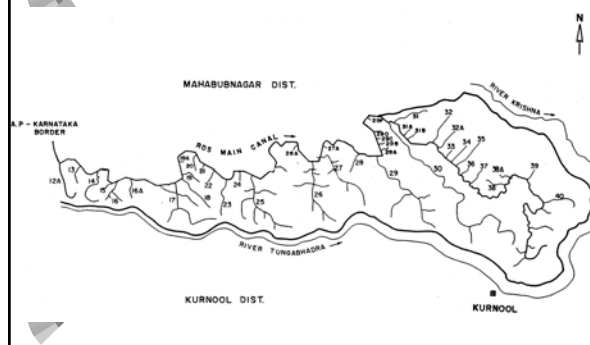
## Case Study –1

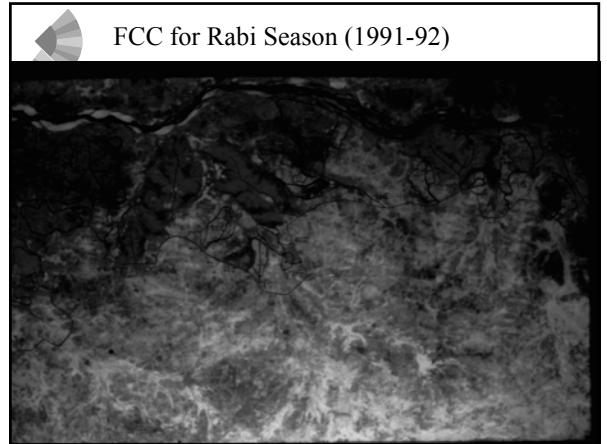
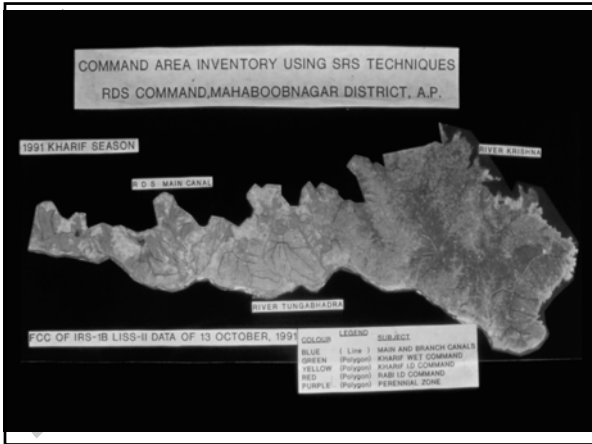
- Rajolibanda Diversion Scheme (RDS)
  - Inter state project between Karnataka and AP on Tungabhadra river in Krishna river basin upstream of Srisailem project.
  - 143 km long left bank main canal
  - Initial 42.6 km in Karnataka consisting of 12 distributaries
  - Distributaries 12A to 40 in AP
    - Ayacut of 35,410 ha
      - Kharif Season - 14,215 ha.
      - Rabi Season - 19,332 ha
      - Perennial Crops - 1,863 ha.

## Problems in RDS command

- Source of water supply is located in another state
- Result of water releases reducing in magnitude (annually)
  - Concentration of paddy in head reaches
  - Mid and tail end reaches receiving insufficient water supplies leading to violations of Command Area Development tenets
  - Due to insufficient water availability in the tail end stretches, reduced crop acreages are reported, with portions of ID crops subjected to moisture stress.

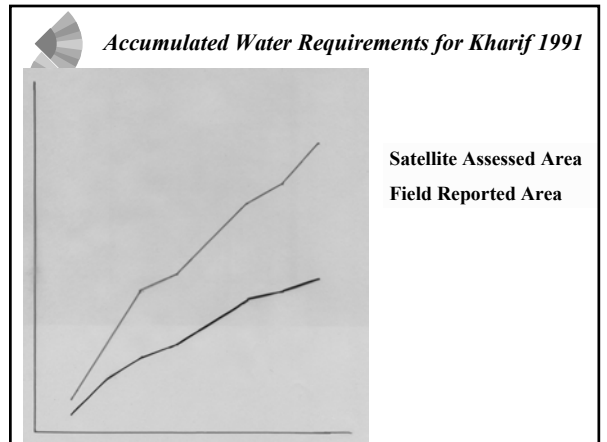
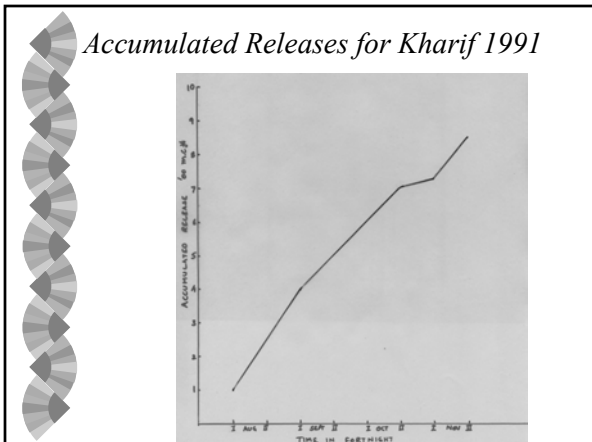
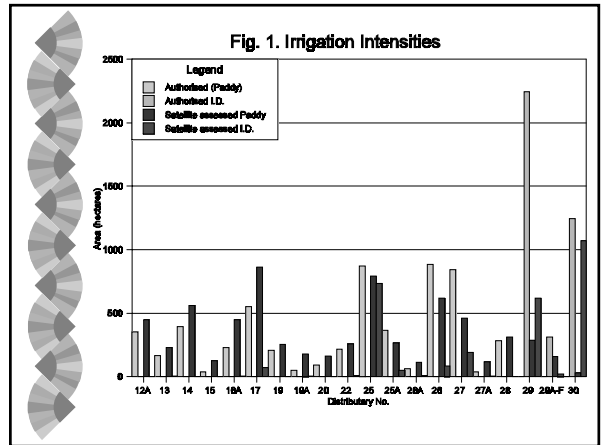
## Index Map of RDS



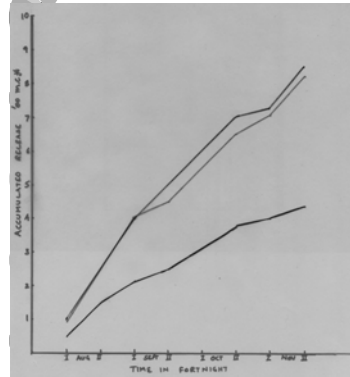


Distributary-wise Crop-group Areas (ha) during Kharif 1992

Distributary Number	Authorized areas		Field reported areas		Satellite assessed areas	
	Paddy	I.D.	Paddy	I.D.	Paddy	I.D.
12A	352	---	340	---	418	2
13	165	---	150	---	227	4
14	393	---	340	---	561	2
15	38	---	38	---	126	---
16A	227	---	215	---	449	6
17	552	---	600	---	865	73
19	208	---	138	70	255	---
19A	50	---	35	15	178	4
20	93	---	96	---	163	---
22	218	---	212	8	257	8
25	873	---	485	395	791	734
25A	367	---	482	102	266	50
26A	62	---	68	6	111	8
26	885	---	451	292	619	84
27	842	---	326	332	460	193
27A	37	---	32	---	117	6
28	284	---	105	69	310	1
29	---	2,243	283	1,194	285	618
29A-F	---	310	106	65	160	21
30	---	1,244	20	628	30	1,071



## Comparison



Satellite Assessed Area  
Field Reported Area

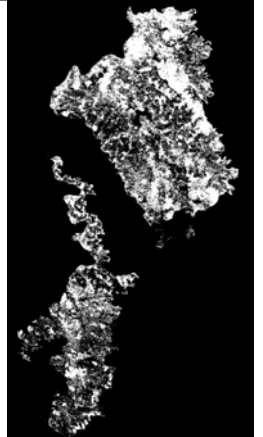
## Case Study - 2

- Irrigation Management in Bhadra Project Command Area, Karnataka
  - Bhadra Dam - in Chickmagalur District
  - Bhadravati, Malebennur & Davangere Div.
  - Paddy & Non Paddy Crops in Rabi Season
- National Water Management Plan (NWMP)
  - Pre NWMP Vs Post NWMP (after 1988)
- IRS LISS-I data (Path-row: 27-58 & 27-59)

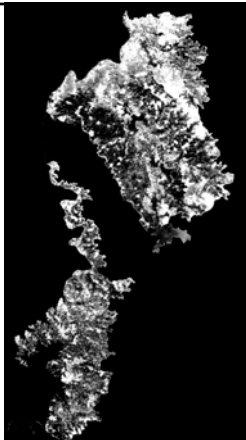
Location map of  
Bhadra Command Area



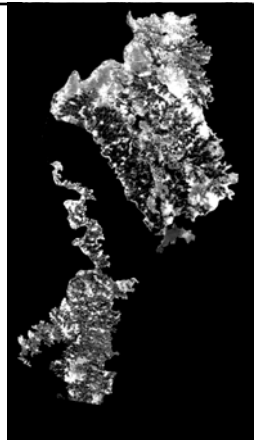
False Color Composite Image  
of Bhadra Command area of  
20 Feb 1993

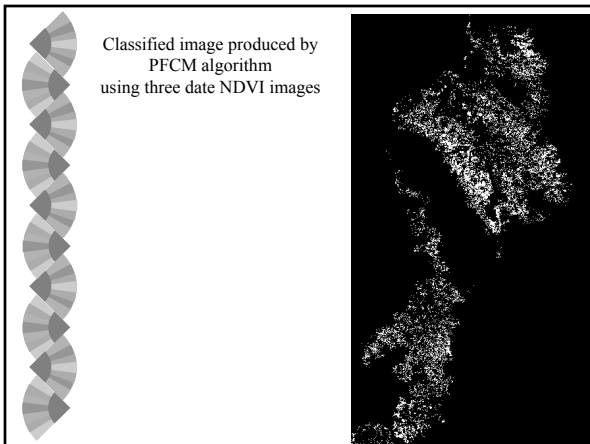
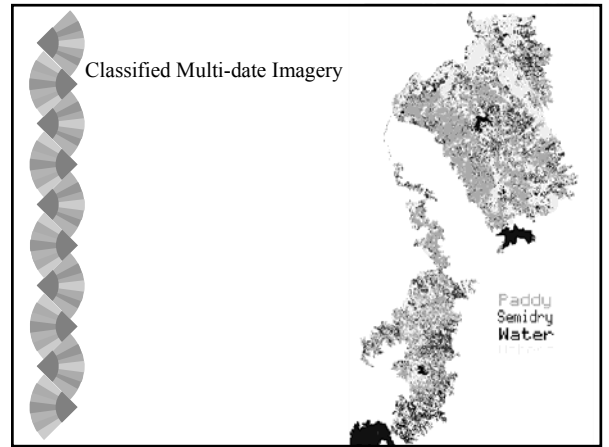
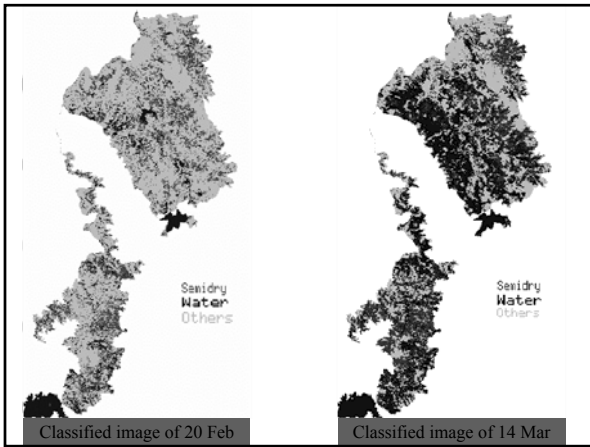
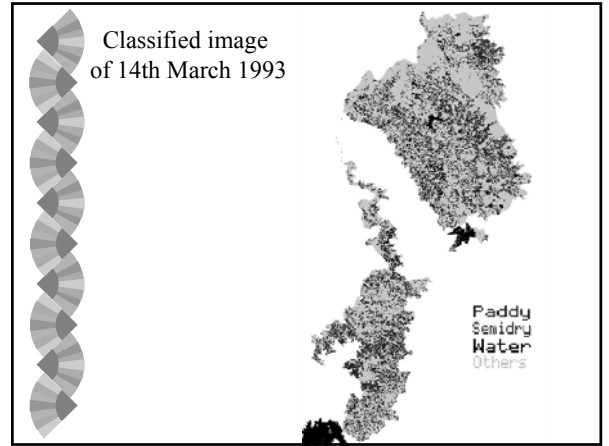
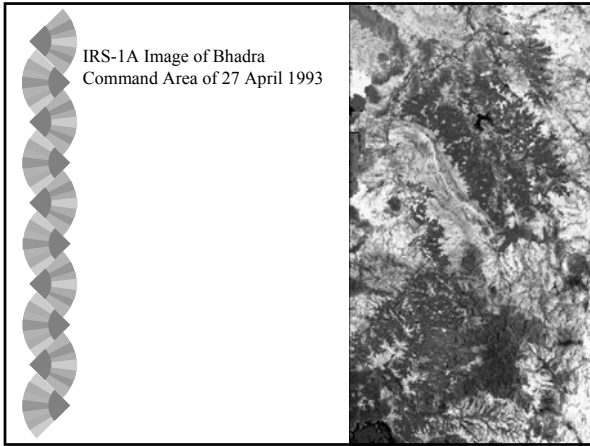


FCC Image of Bhadra Command  
area of 14 March 1993



FCC Image of Bhadra Command  
Area of 16 April 1993





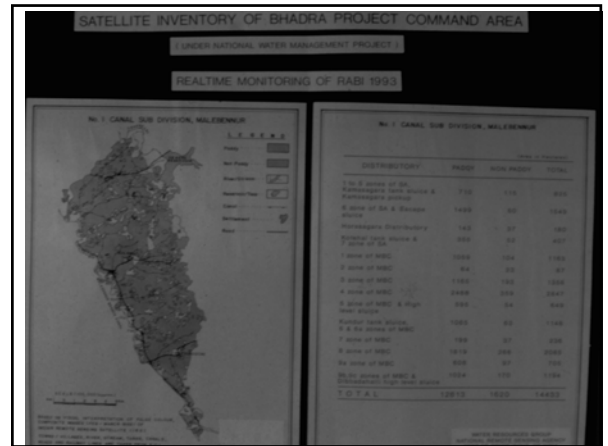
**Increase in Crop Area (in Hectares) after NWMP**

DIVISION	1988	1989	1990
Davengere	15,848	32,222	34,205
Malabennur	12,677	18,868	28,240
<b>Total</b>	<b>28,525</b>	<b>51,090</b>	<b>62,445</b>

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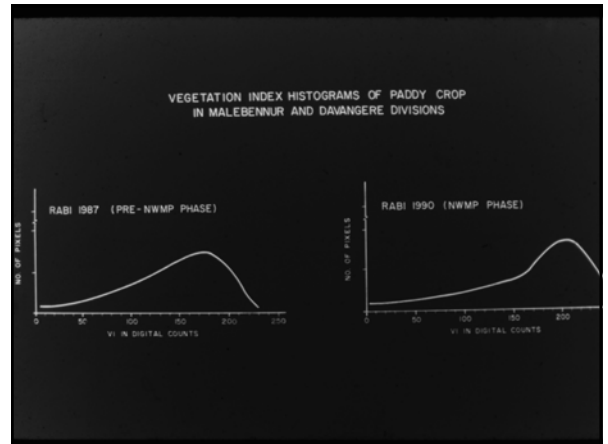
## Satellite Derived Cropping Pattern for Rabi 1992-93 Season (in Hectares)

DIVISION	Paddy	Non Paddy	Total
Bhadravathi	9,290 (58%)	7,330 (42%)	17,250
Malabennur	25,604 (81%)	6,134 (19%)	31,738
Davengere	25,869 (66%)	13,567 (34%)	39,436

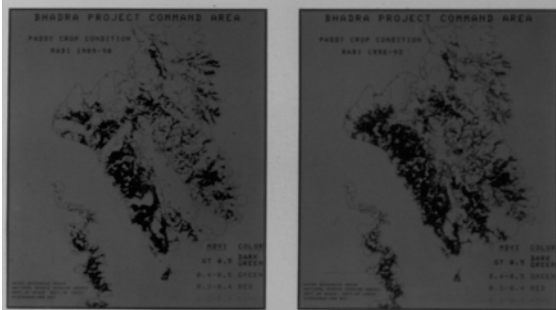


## Estimation of Yield

- NDVI Image
  - Normalised Difference Vegetation Index
    - $(\text{Reflectance in NIR} - \text{Red}) / (\text{Ref. in NIR} + \text{Red})$
    - $(\text{Band 4} - \text{Band 3}) / (\text{Band 4} + \text{Band 3})$
  - $\text{NDVI} = \text{imdivide}(\text{insubtract}(14, 13), \text{imadd}(14, 13));$
- Regression Analysis
  - $\text{Yield} = - 5.89 + 0.234 \text{ NDVI}$  (S.E.: 0.037)
- Paddy Yield : 61.70 to 62.21 quintals/ha



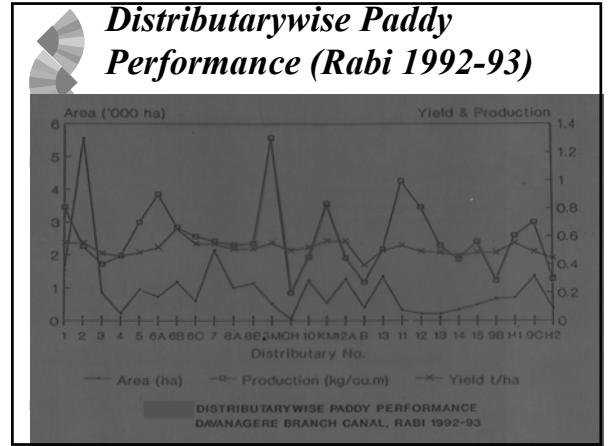
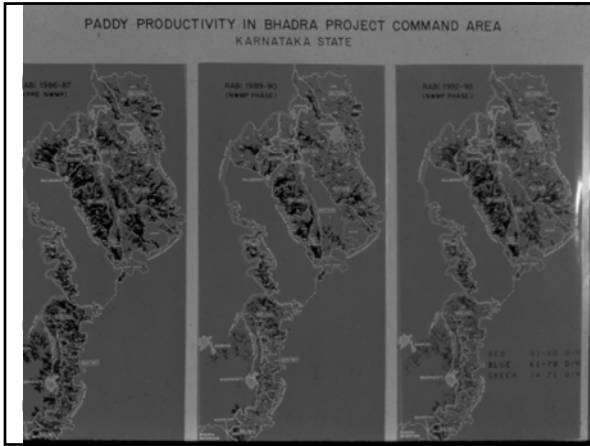
## BHADRA PROJECT COMMAND AREA (MALEBENNUR AND DAVANGERE DIVISIONS) KARNATAKA STATE



DECREASE IN PADDY PRODUCTIVITY (INDICATED BY DECREASE IN NORMALISED DIFFERENCE VEGETATION INDEX i.e. FROM DARK GREEN TO GREEN) DURING RABI: 1992-93 COULD BE DUE TO LARGER AREA UNDER IRRIGATION IN THIS YEAR COMPARED TO RABI: 1989-90 WHERE

## Estimation of Yield Contd..

- Paddy Yield (quintals/ha)
  - Malabennur Division 61.70 to 62.21
  - Davangere Division 51.66 to 52.14



**Summary**

- ◆ Satellite Remote Sensing can be Effectively used for Irrigation Management

**Thank You**