Use of Remote Sensing / GIS in Monitoring and Evaluation

By

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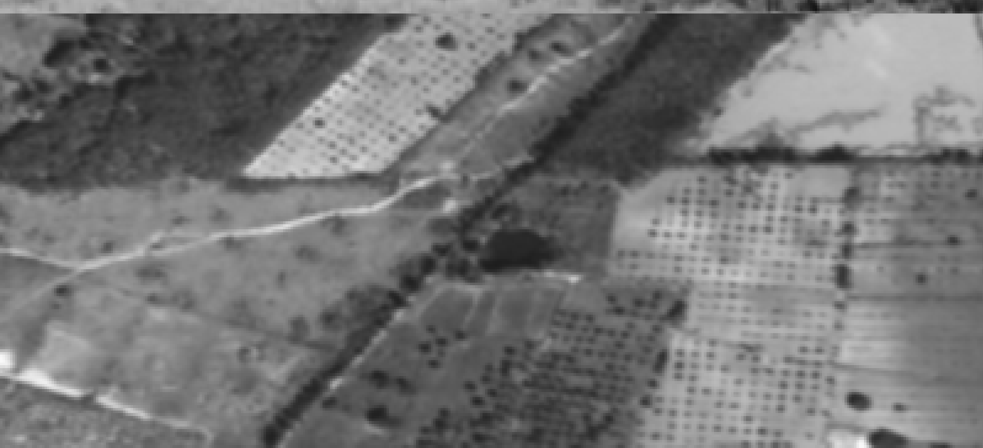


SASAR Monitoring and Evaluation Workshop, World Bank, New Delhi

Monitoring and Evaluation

A management and motivational tool

Essential for * Tracking the progress & Performance
* Streamlining the Interventions
* Assessing the impact of the project

Traditional M&E

Physical & Financial

Transformation →

Present Context

Concurrent monitoring

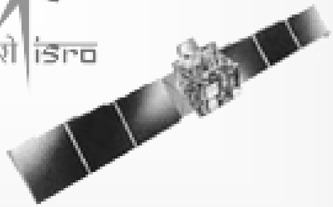
Participatory

Forward looking

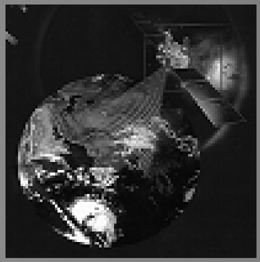
Learning

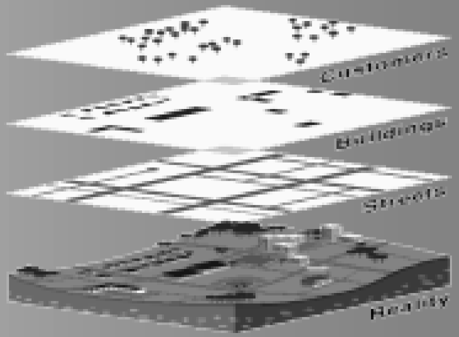
Capacity Building

Empowerment



Remote Sensing,
GIS
GPS
SATCOM





Remote Sensing

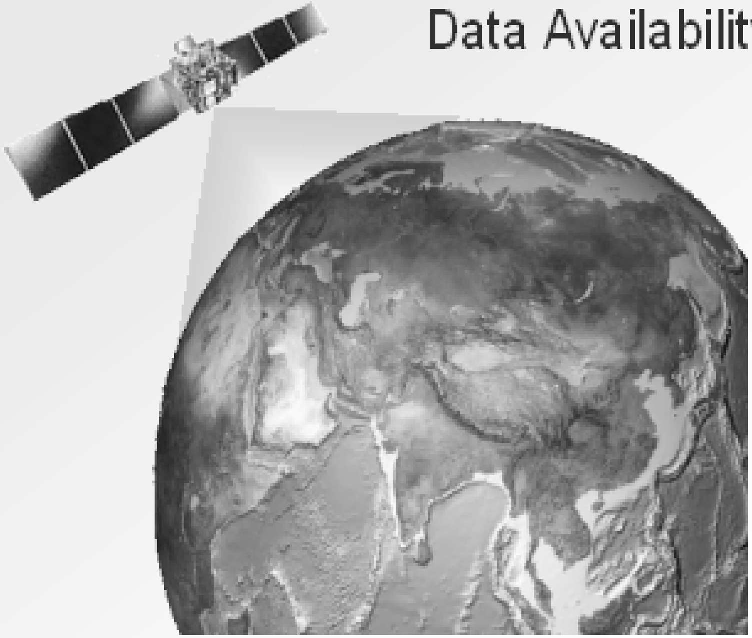
A tool for Mapping, Monitoring & Management of Natural resources

Applications of GIS

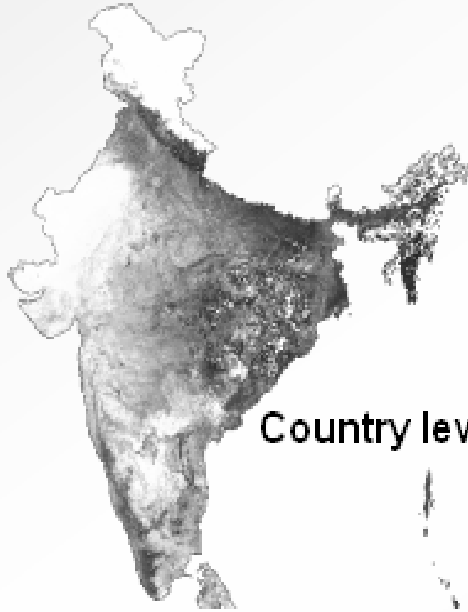
- As an information database
- As an Analytical Tool
- As a Decision support system

Tool to integrate spatial & non-Spatial data

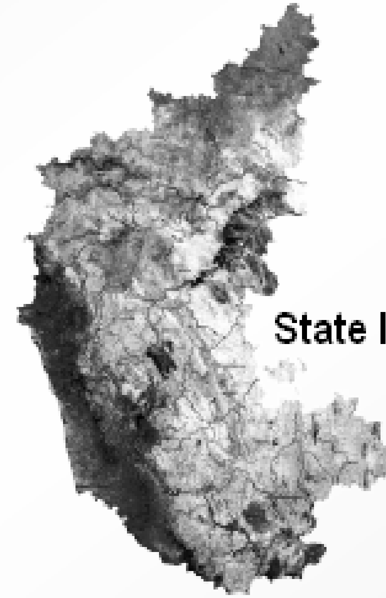
Data Availability



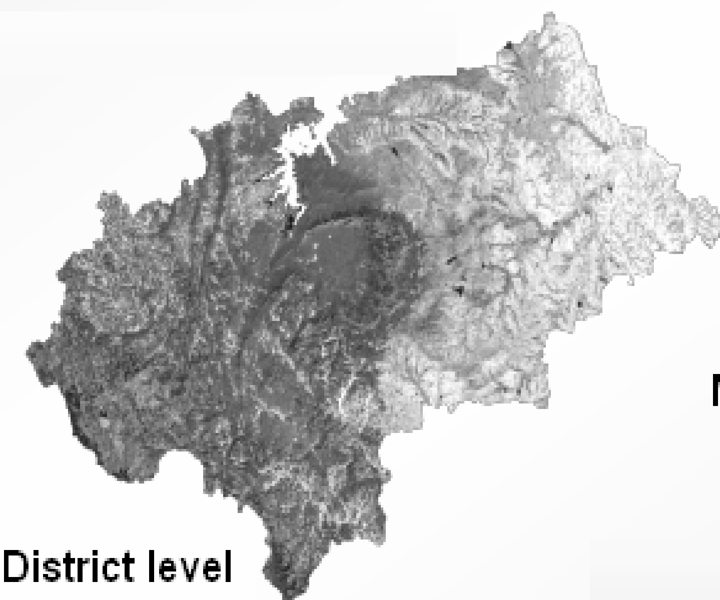
Global level



Country level



State level



District level

Micro level

MONITORING CHANGES USING SATELLITE DATA

THE REPETITIVE NATURE OF THE SATELLITE PROVIDES AN EXCELLENT OPPORTUNITY

TO MONITOR THE LAND USE / LAND COVER CHANGES

EVALUATE ITS IMPACT ON THE ENVIRONMENT

THROUGH COMPARISON OF IMAGES ACQUIRED FOR THE SAME AREA AT DIFFERENT TIMES

CHANGES :

LONG TERM, SHORT TERM, NEAR REAL TIME

NATURE OF CHANGES :

AFFORESTATION / DEFORESTATION, CROPPED AREA, CROPPING INTENSITY,

LANDSLIDES, FLOODS, DROUGHT, FOREST FIRE, WATER SPREAD,

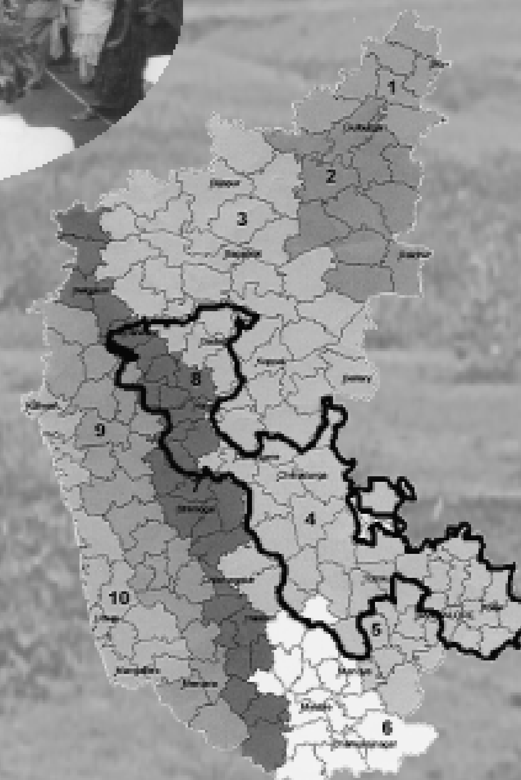
BIO-DIVERSITY, MINING, ENCROACHMENTS, Etc.,

Karnataka Watershed Development Project (Sujala)

Objective: Improve productive potential of degraded watersheds and poverty alleviation

Towards Improving

* The quality of life
* Natural Resource Assets
* Productivity
* livelihood support
* Empowering the vulnerable



Project Profile

No. of Micro Watersheds	854
Treatment Area	5.1 Lakh Ha.
Household benefited	3.5 Lakh
No. of Taluks	38
No. of Districts	Five
Budget	678 Crores

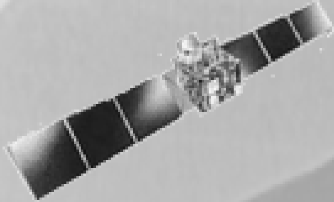
Monitoring	Implementation	Funding
Antrix Corporation, ISRO	Watershed Dept., Govt. of Karnataka	The World Bank

Unique features of Sujala Project

- Community driven, Participatory, Holistic & Bottom up approach
- Integrated – Agriculture, Horticulture, Forestry, livestock, IGA
- Science and Technology tools integrated into developmental processes
- Communities involved in Planning, Implementation & Monitoring,
- NGO's & Government act as facilitators, M&E by an Independent Agency

Role and Responsibilities of M E & L system

- Provide timely, reliable & relevant information on progress and performance
- Reflect the actual status and propose corrective measures
- Measure and evaluate short term and long term impacts
- Dissemination of field observations and develop feedback mechanism
- Facilitate timely Data flow through MIS for decision making
- Carryout specific Thematic / Evaluation studies as prioritised by the project
- Identify, document and share the best practices and lessons learnt
- Enable mid-course correction, to mitigate negative impact, if any.

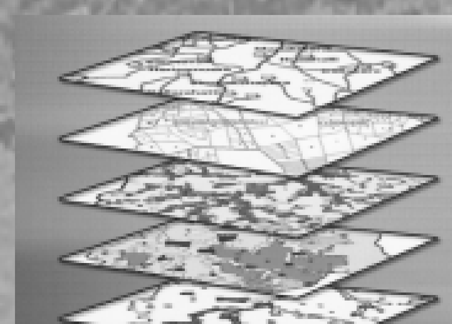


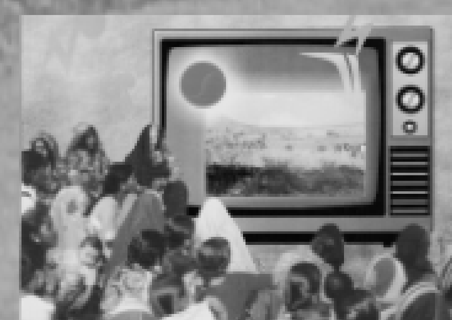
Sujala Watershed Development Project

Space Technology
- Remote Sensing
- Geographical Information System
- Management Information System
- SATCOM

Optimally used for

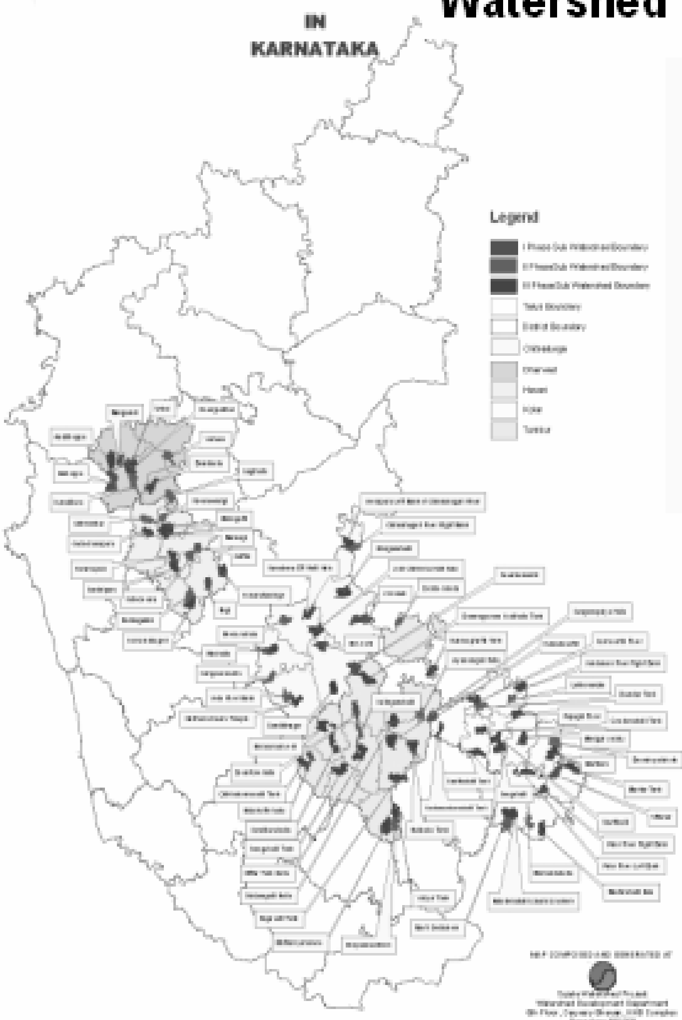
- Capacity Building
- Planning
- Implementation
- Monitoring & Evaluation
- Impact Assessment





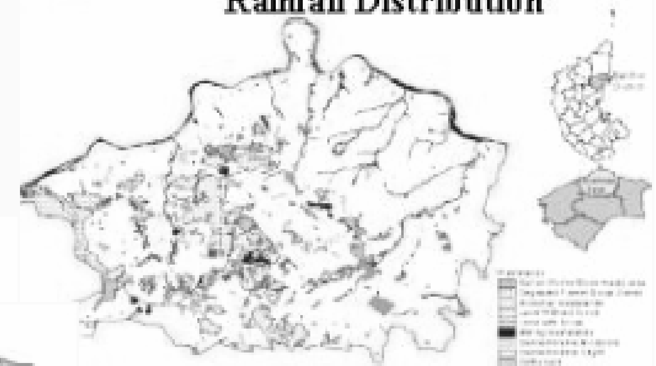
Space inputs used for Planning

Watershed Delineation and Prioritisation

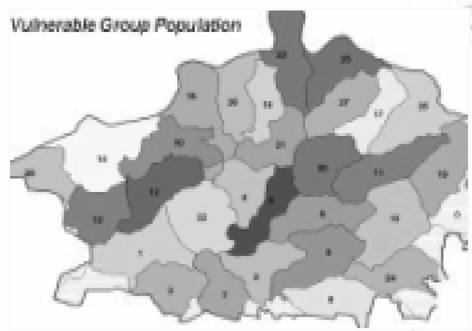


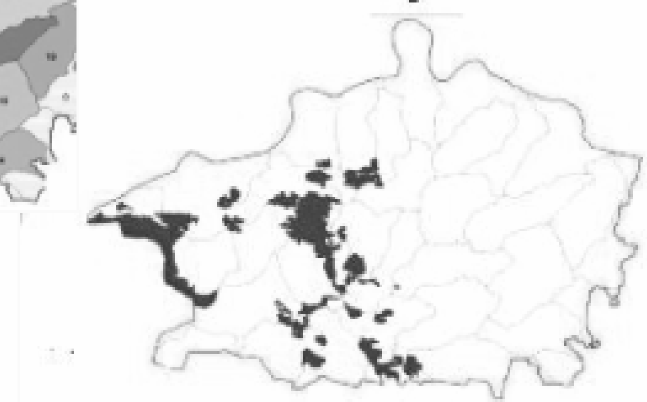
Parameters	Weightage
Silt Yield Index –	*20*
SC/ST Population-	*20*
Wasteland -	*20*
Agri Laborers. -	*10*
Rainfall -	*10*
Forest Area -	*10*
Irrigated Area -	*10*

Rainfall Distribution



Wasteland Map

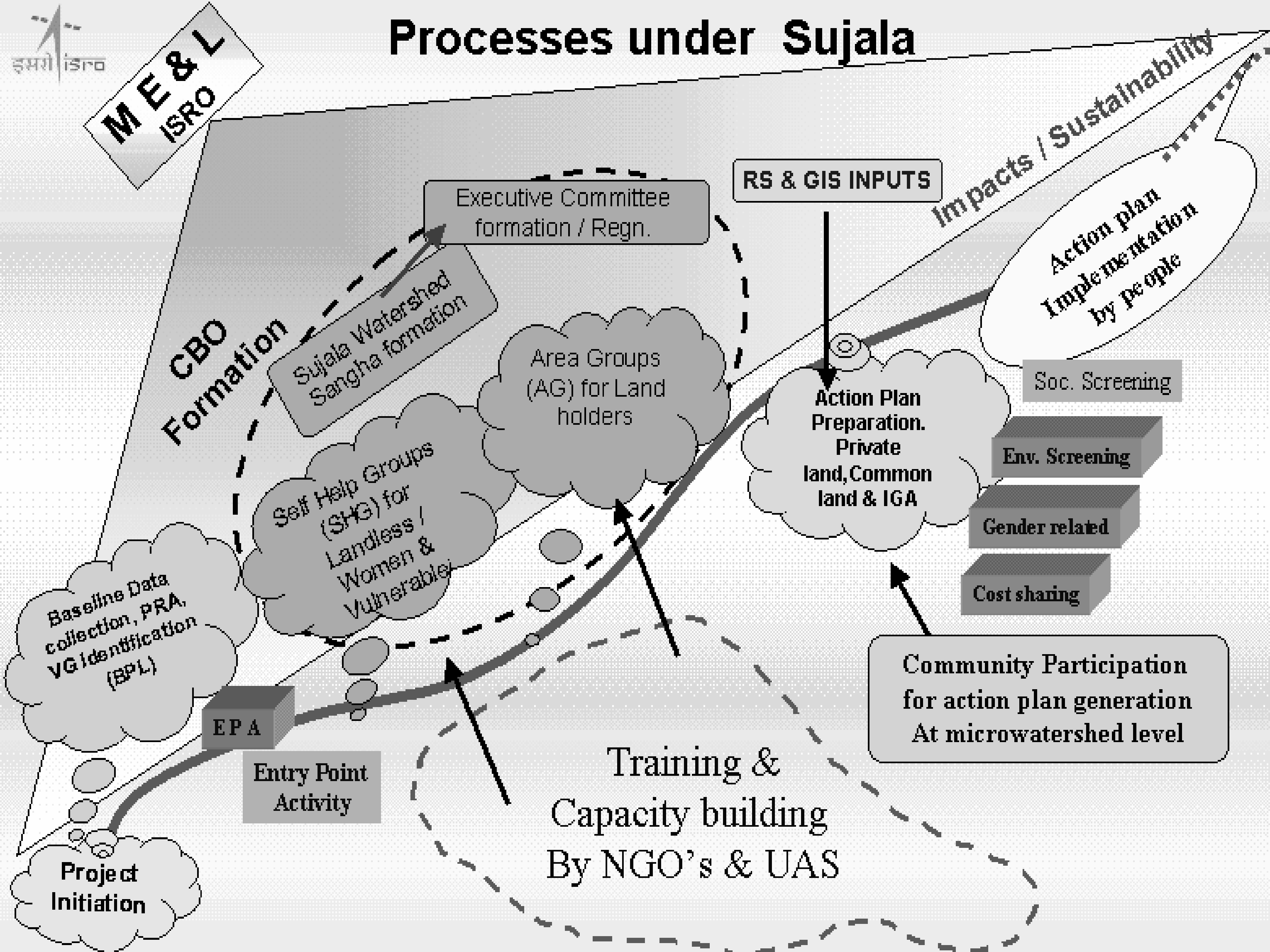




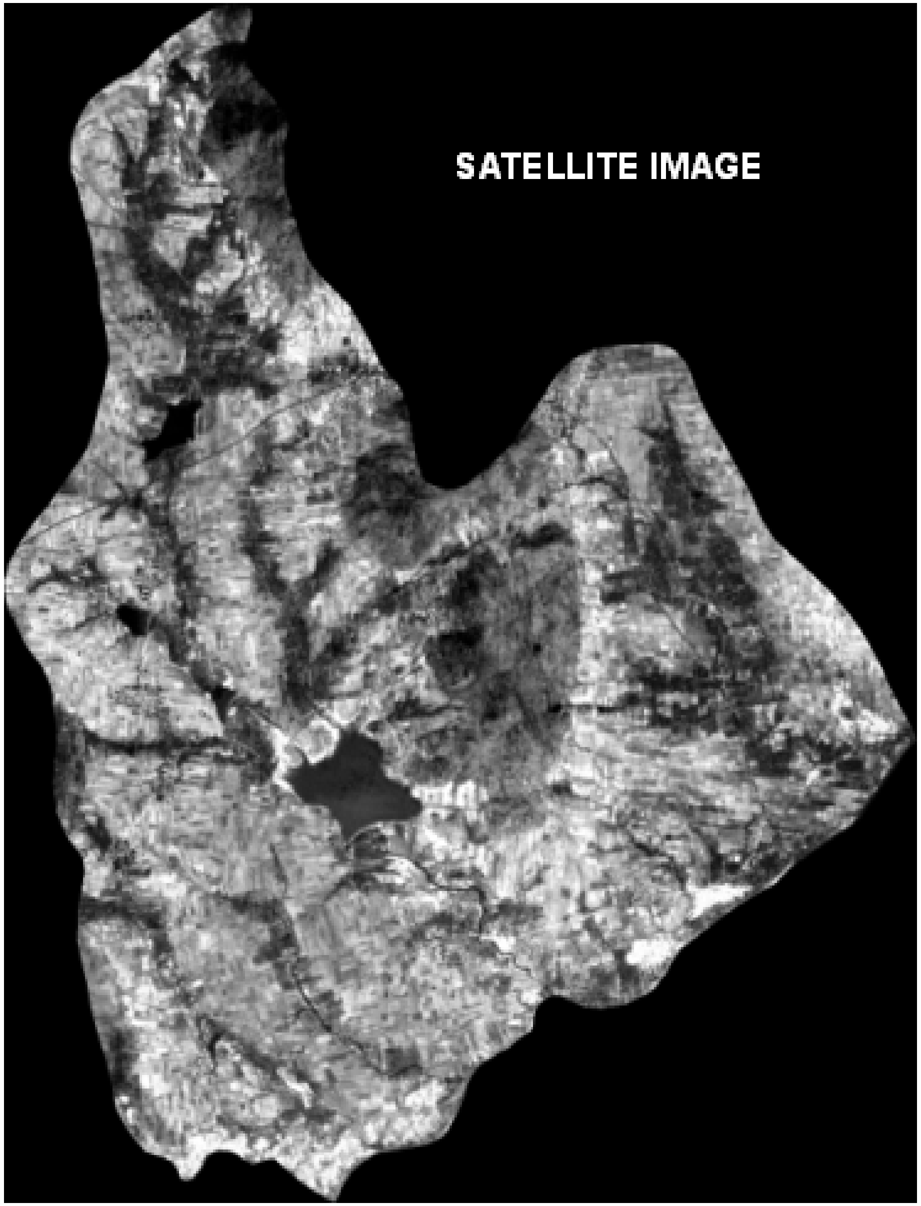
Vegetation Map

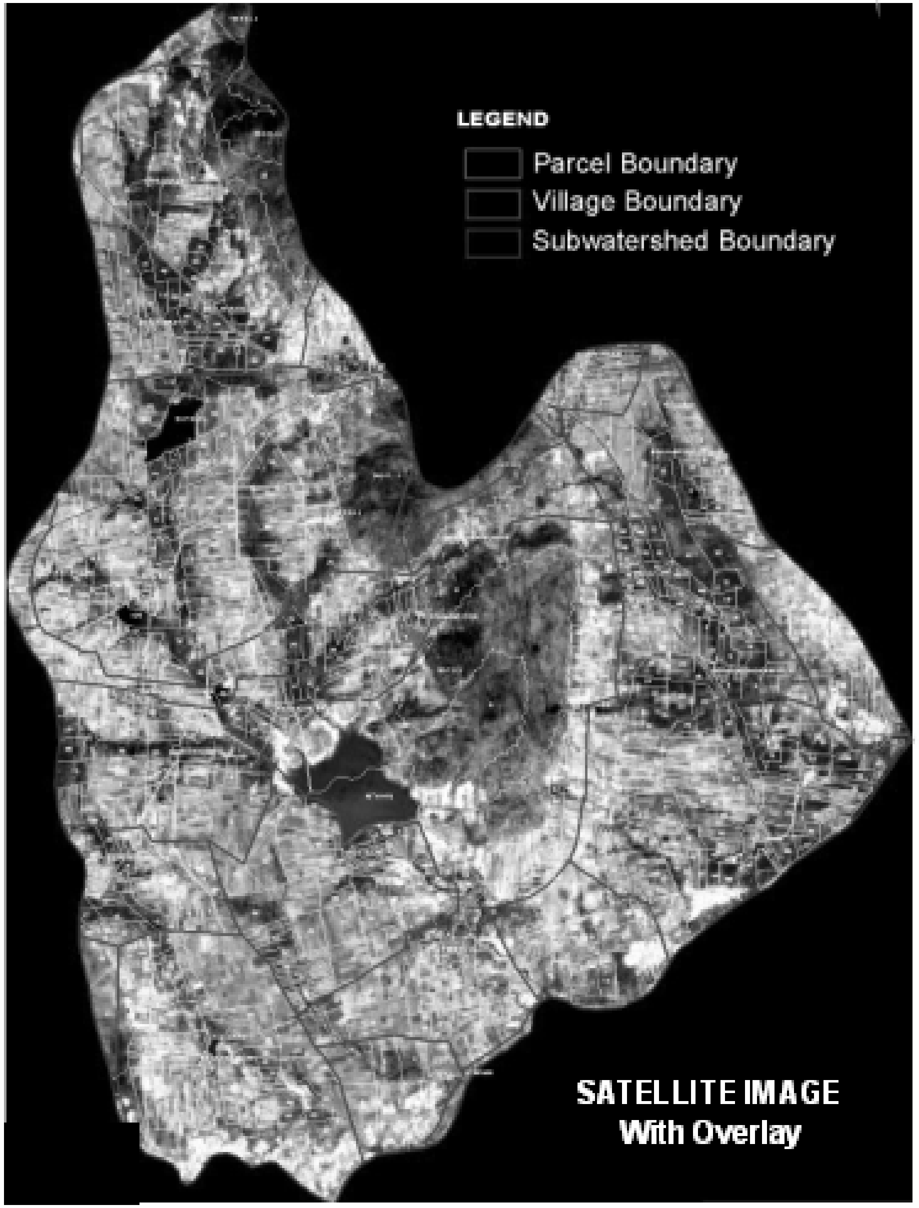
Watersheds Prioritised for implementation

Processes under Sujala

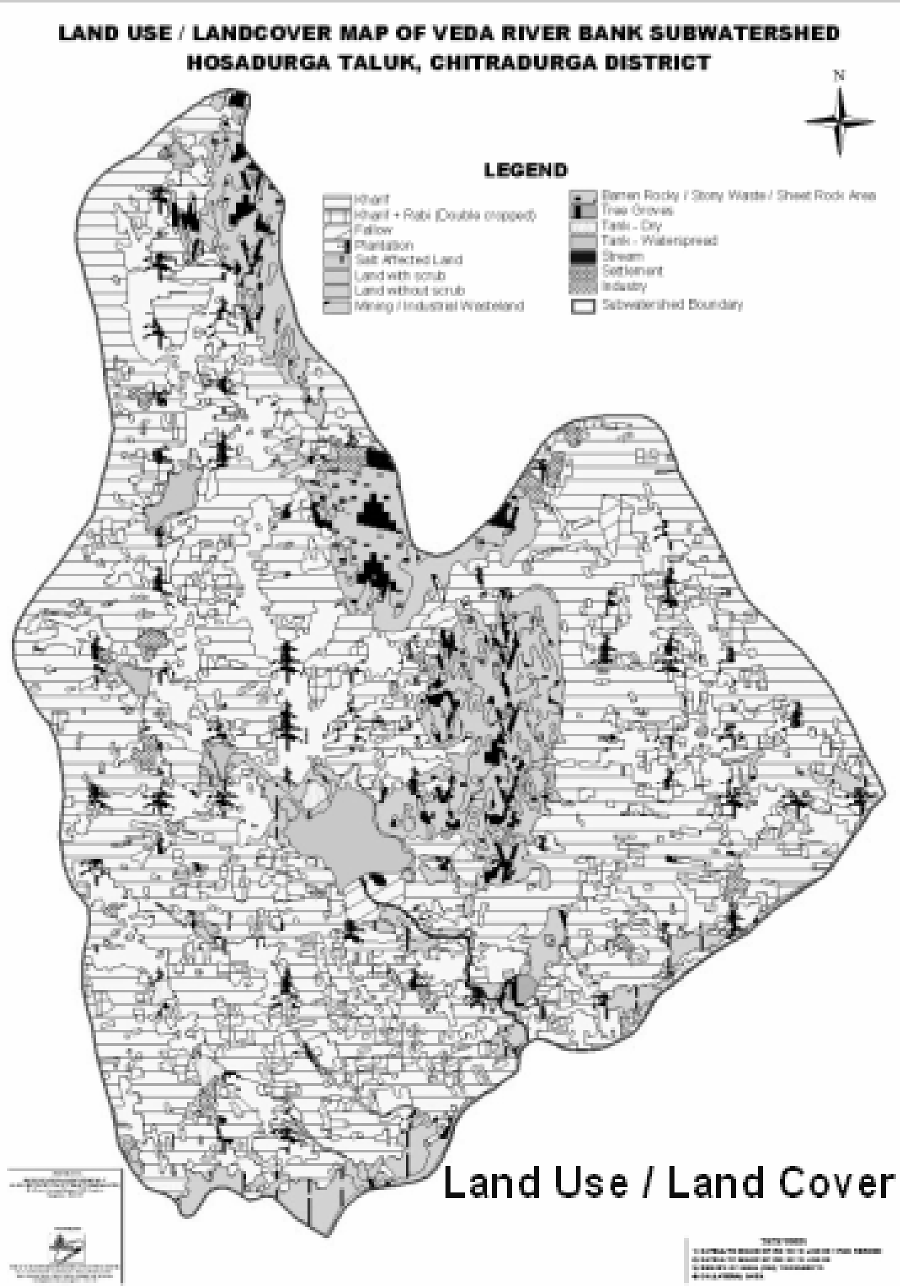


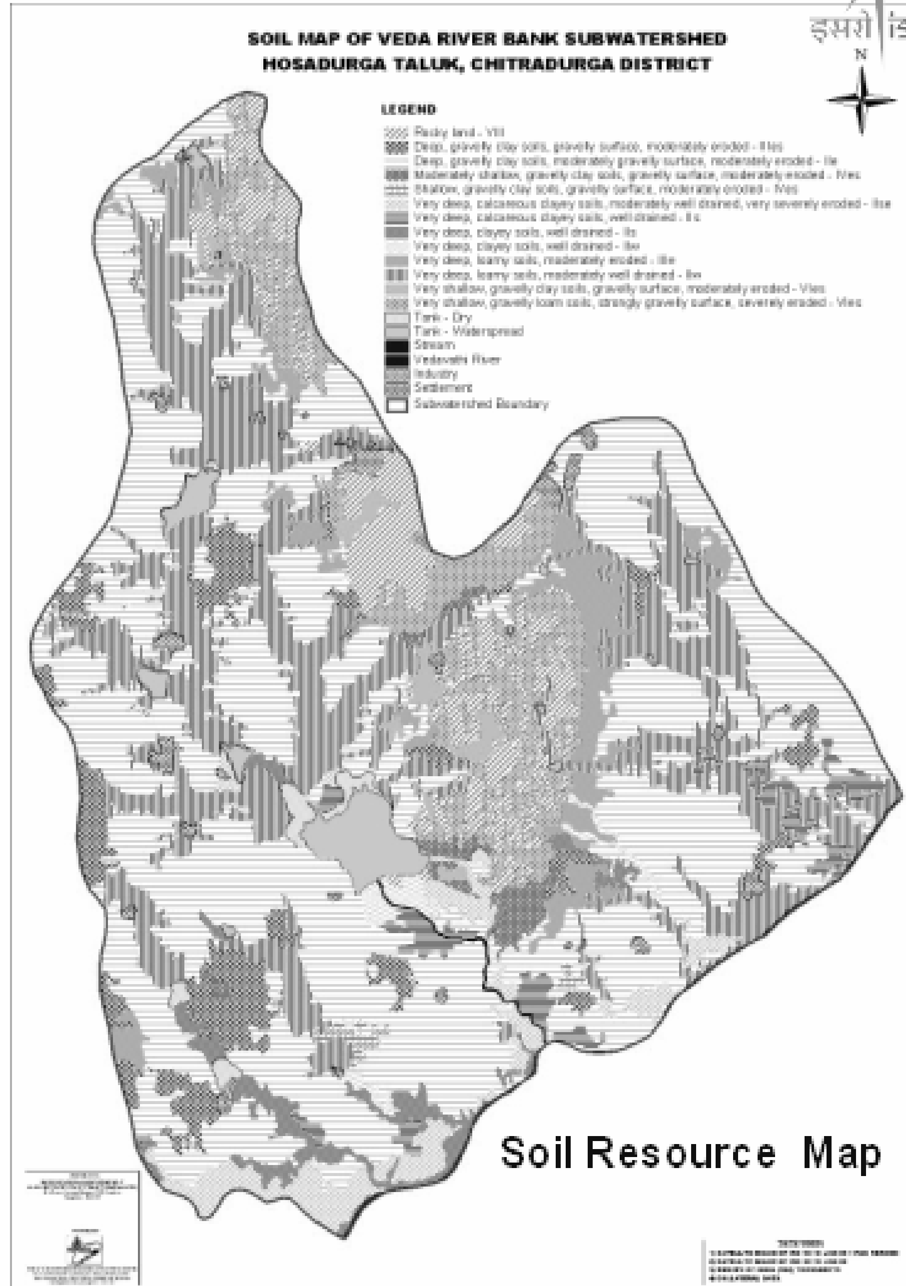
Veda River Right Bank Sub-Watershed, Chitradurga

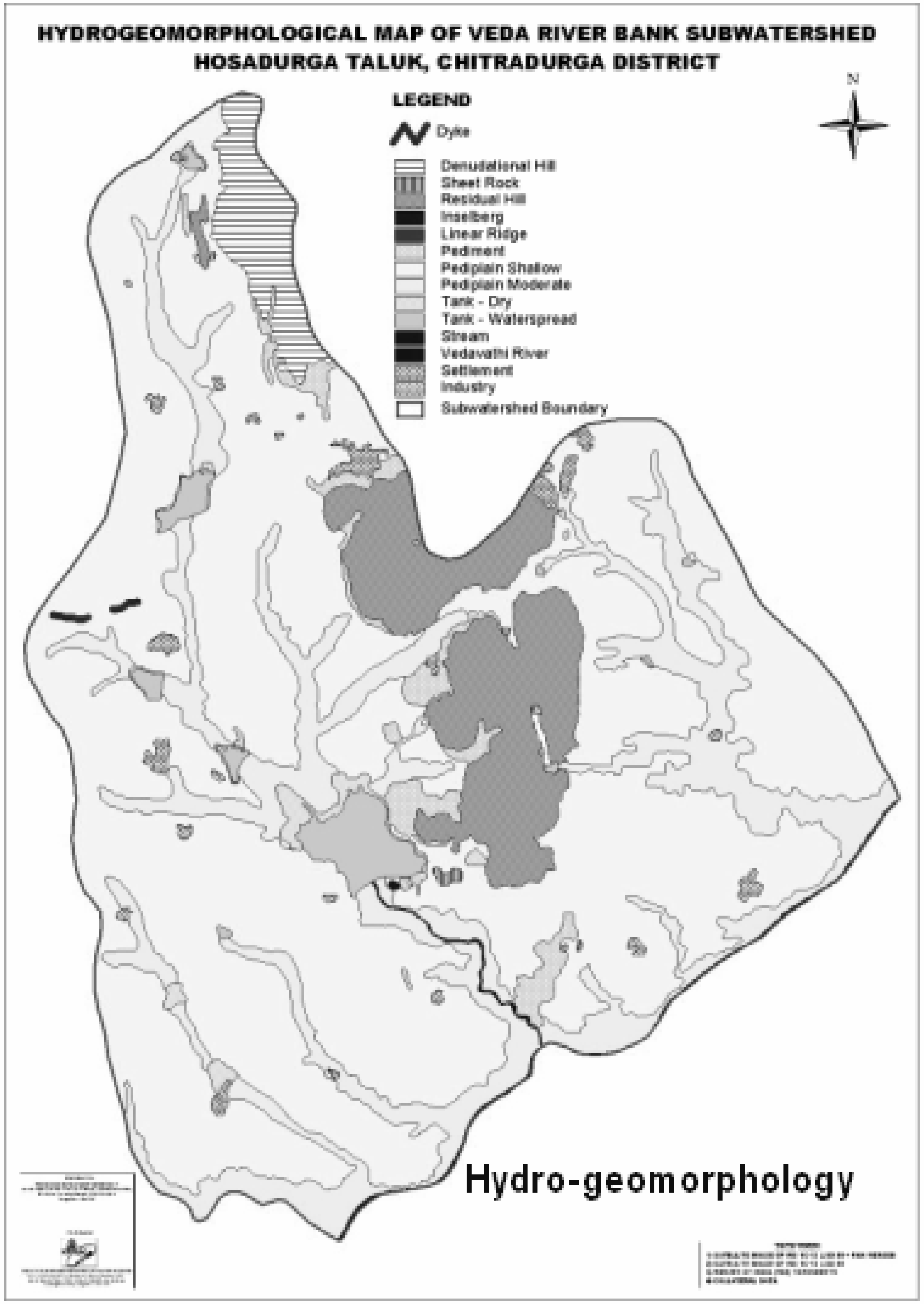


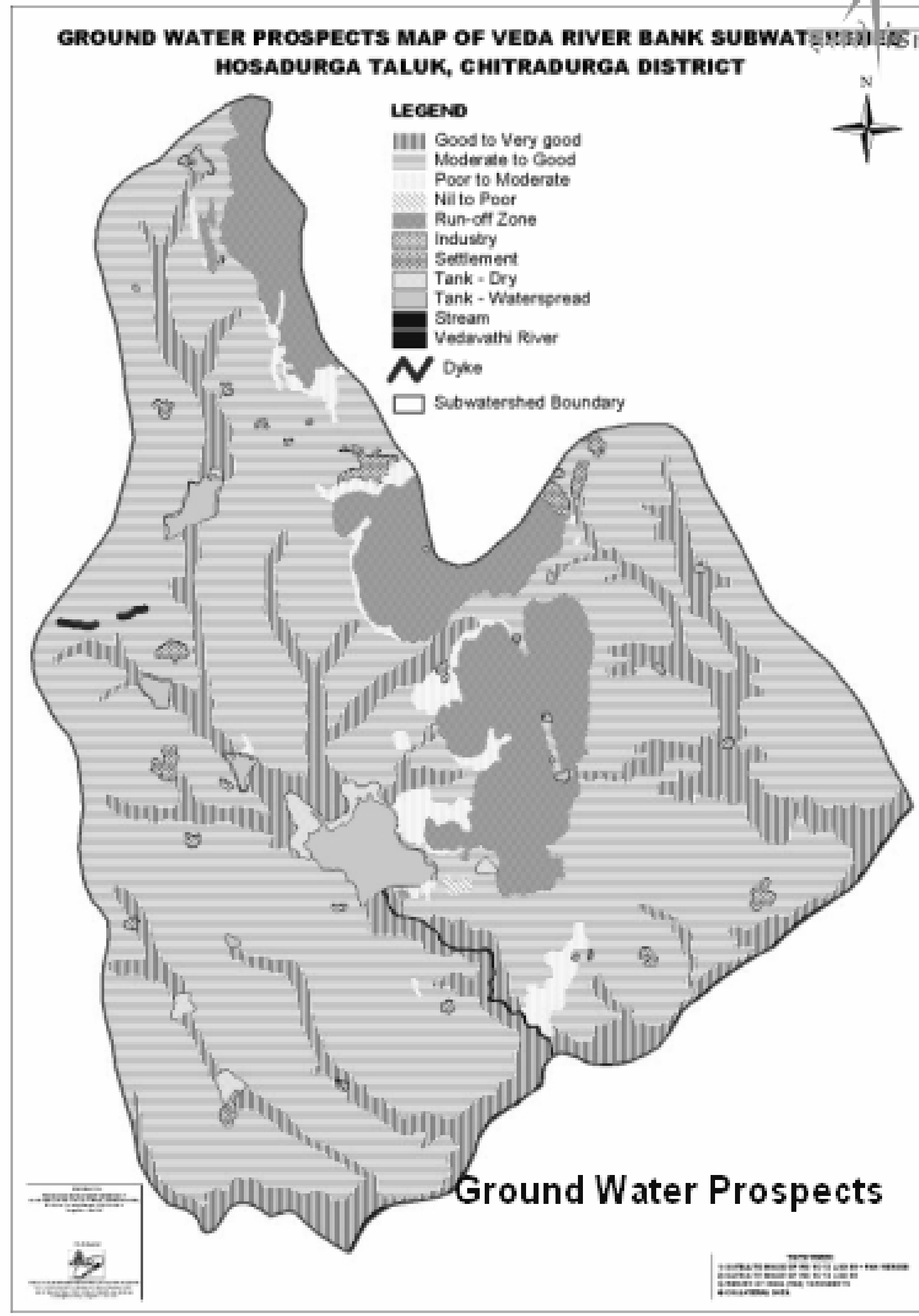


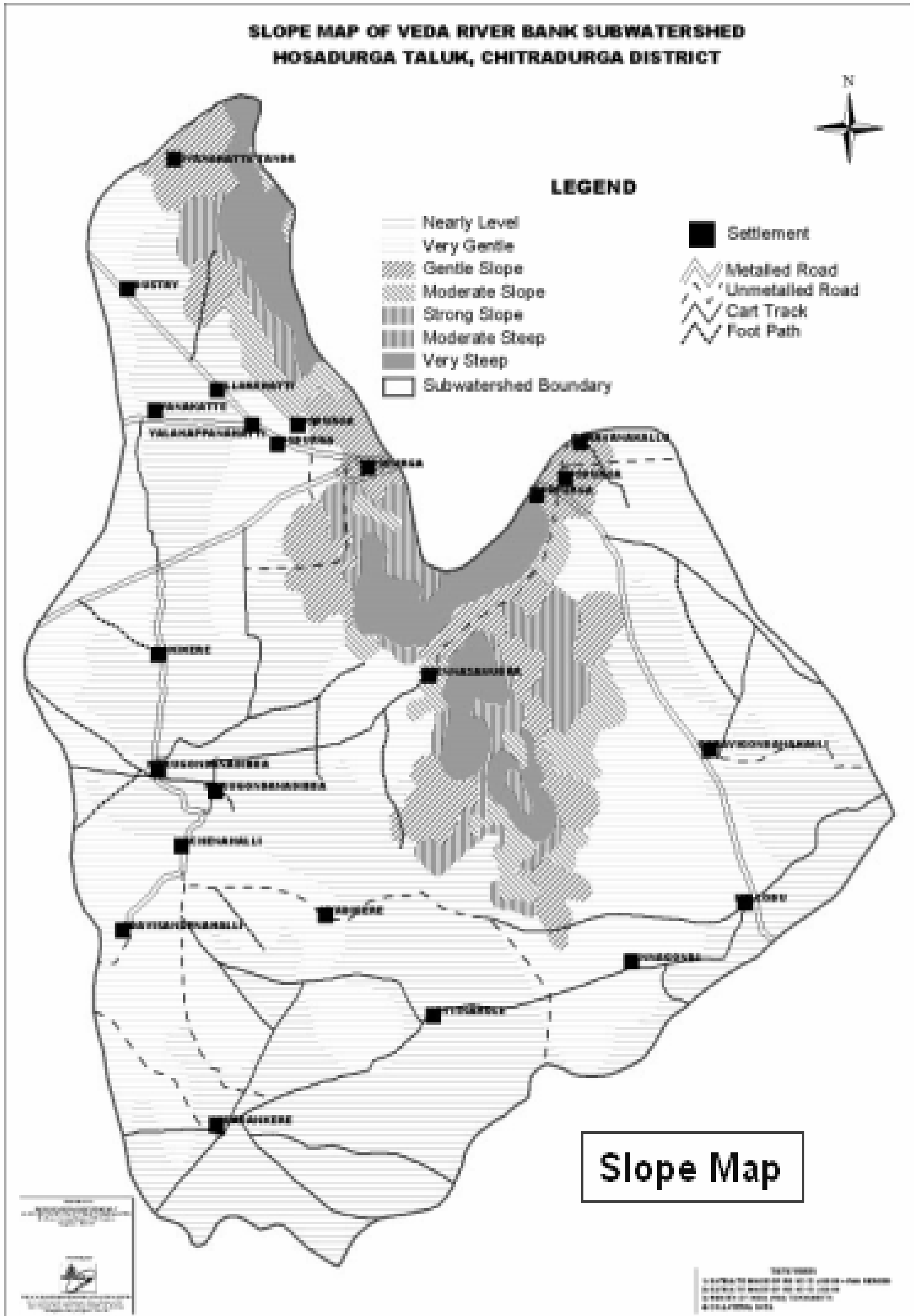
High Resolution Satellite Data

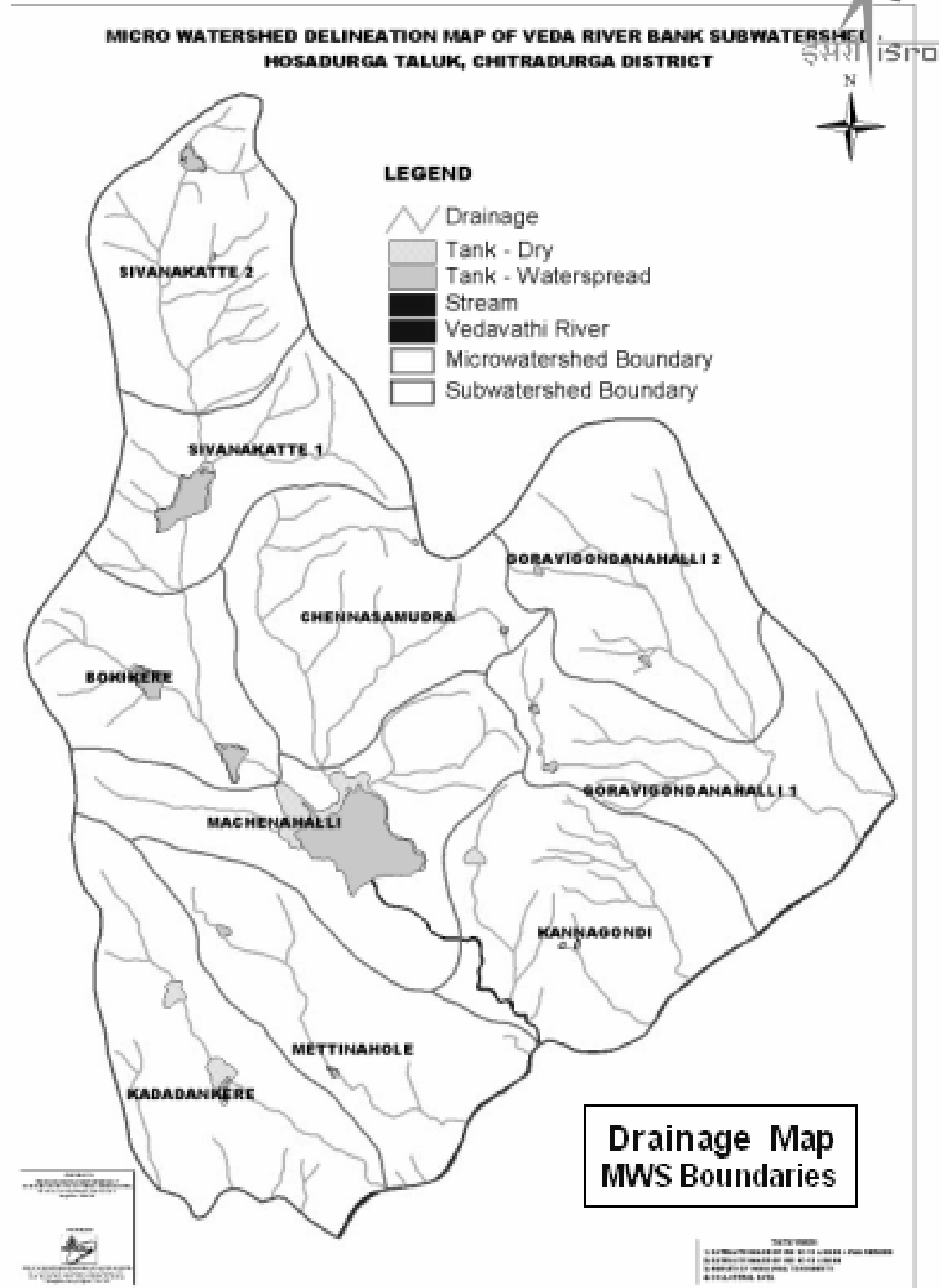

LAND USE / LANDCOVER MAP OF VEDA RIVER BANK SUBWATERSHED
HOSADURGA TALUK, CHITRADURGA DISTRICT
N
LEGEND
Kharif
Kharif + Rabi (Double cropped)
Fallow
Plantation
Salt Affected Land
Land with scrub
Land without scrub
Mining / Industrial Wasteland
Barren Rocky / Stony Waste / Sheet Rock Area
Tree Groves
Tank - Dry
Tank - Waterspread
Stream
Settlement
Industry
Subwatershed Boundary
Land Use / Land Cover

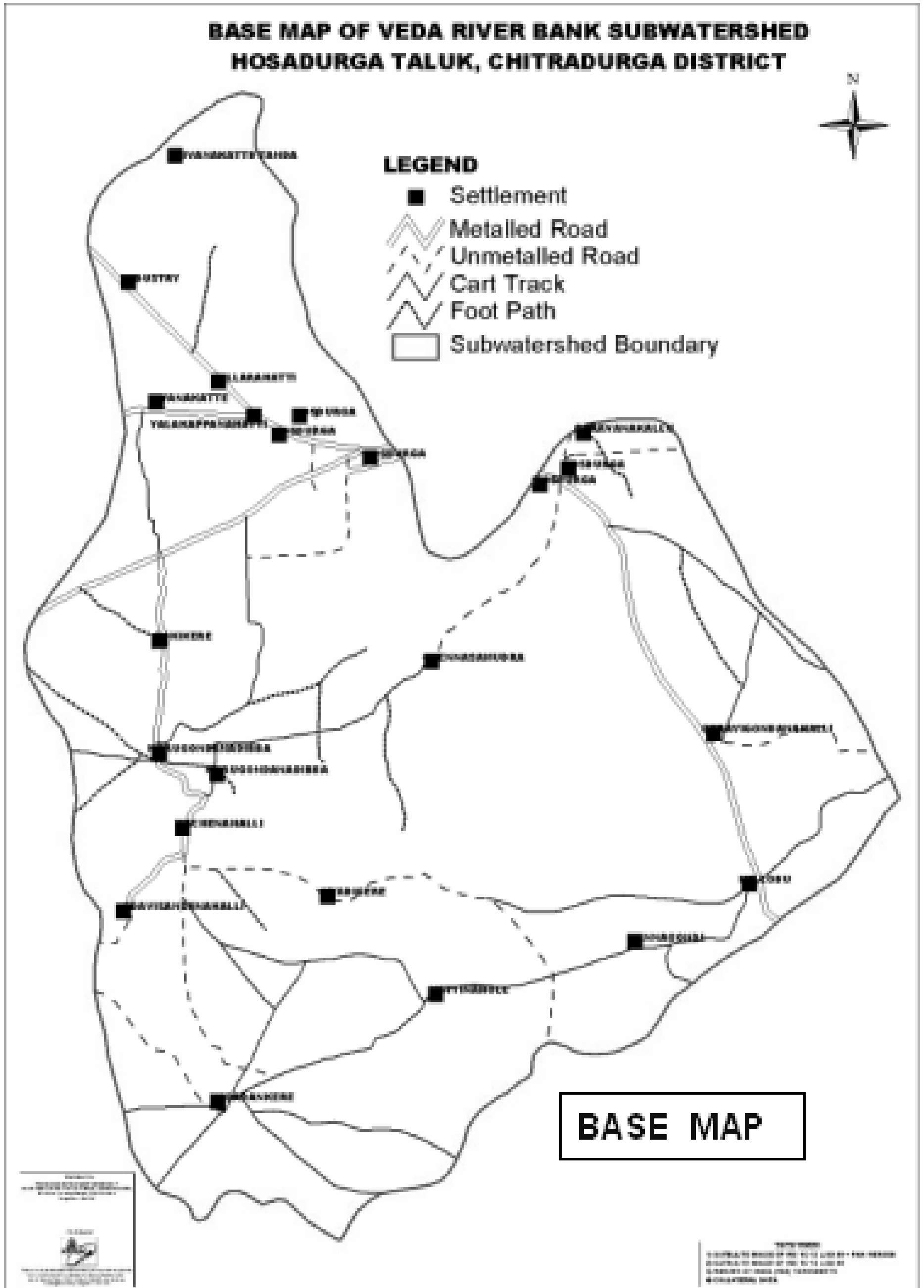

SOIL MAP OF VEDA RIVER BANK SUBWATERSHED
HOSADURGA TALUK, CHITRADURGA DISTRICT
N
LEGEND
Rocky land - VIII
Deep, gravelly clay soils, gravelly surface, moderately eroded - IIIes
Deep, gravelly clay soils, moderately gravelly surface, moderately eroded - IIIe
Moderately shallow, gravelly clay soils, gravelly surface, moderately eroded - IVes
Shallow, gravelly clay soils, gravelly surface, moderately eroded - IVes
Very deep, calcareous clayey soils, moderately well drained, very severely eroded - IIIse
Very deep, calcareous clayey soils, well drained - IIs
Very deep, clayey soils, well drained - IIs
Very deep, clayey soils, well drained - IIw
Very deep, loamy soils, moderately eroded - IIIe
Very deep, loamy soils, moderately well drained - IIw
Very shallow, gravelly clay soils, gravelly surface, moderately eroded - VIes
Very shallow, gravelly loam soils, strongly gravelly surface, severely eroded - VIes
Tank - Dry
Tank - Waterspread
Stream
Vedavathi River
Industry
Settlement
Subwatershed Boundary
Soil Resource Map

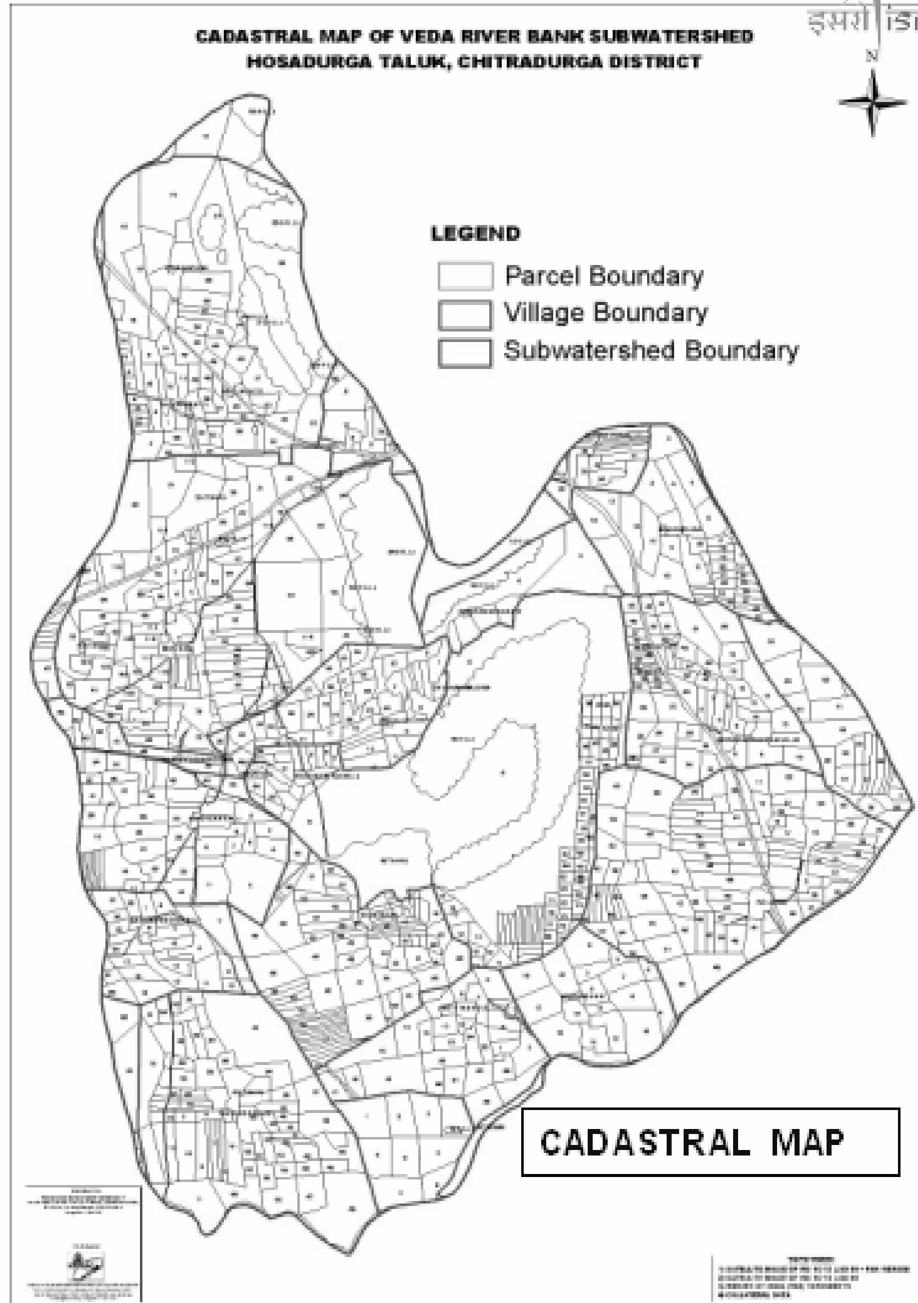

HYDROGEOMORPHOLOGICAL MAP OF VEDA RIVER BANK SUBWATERSHED
HOSADURGA TALUK, CHITRADURGA DISTRICT
LEGEND
Dyke
Denudational Hill
Sheet Rock
Residual Hill
Inselberg
Linear Ridge
Pediment
Pediplain Shallow
Pediplain Moderate
Tank - Dry
Tank - Waterspread
Stream
Vedavathi River
Settlement
Industry
Subwatershed Boundary
N
Hydro-geomorphology


GROUND WATER PROSPECTS MAP OF VEDA RIVER BANK SUBWATERSHED
HOSADURGA TALUK, CHITRADURGA DISTRICT
LEGEND
Good to Very good
Moderate to Good
Poor to Moderate
Nil to Poor
Run-off Zone
Industry
Settlement
Tank - Dry
Tank - Waterspread
Stream
Vedavathi River
Dyke
Subwatershed Boundary
N
Ground Water Prospects


SLOPE MAP OF VEDA RIVER BANK SUBWATERSHED
HOSADURGA TALUK, CHITRADURGA DISTRICT
N
LEGEND
Nearly Level
Very Gentle
Gentle Slope
Moderate Slope
Strong Slope
Moderate Steep
Very Steep
Subwatershed Boundary
Settlement
Metalled Road
Unmetalled Road
Cart Track
Foot Path
Slope Map


MICRO WATERSHED DELINEATION MAP OF VEDA RIVER BANK SUBWATERSHED
HOSADURGA TALUK, CHITRADURGA DISTRICT
N
LEGEND
Drainage
Tank - Dry
Tank - Waterspread
Stream
Vedavathi River
Microwatershed Boundary
Subwatershed Boundary
SIVANAKATTE 2
SIVANAKATTE 1
CHENNASAMUDRA
GORAVIGONDANAHALLI 2
GORAVIGONDANAHALLI 1
MACHENAHALLI
KANNAGONDI
METTINAHOLE
KADADANKERE
Drainage Map
MWS Boundaries

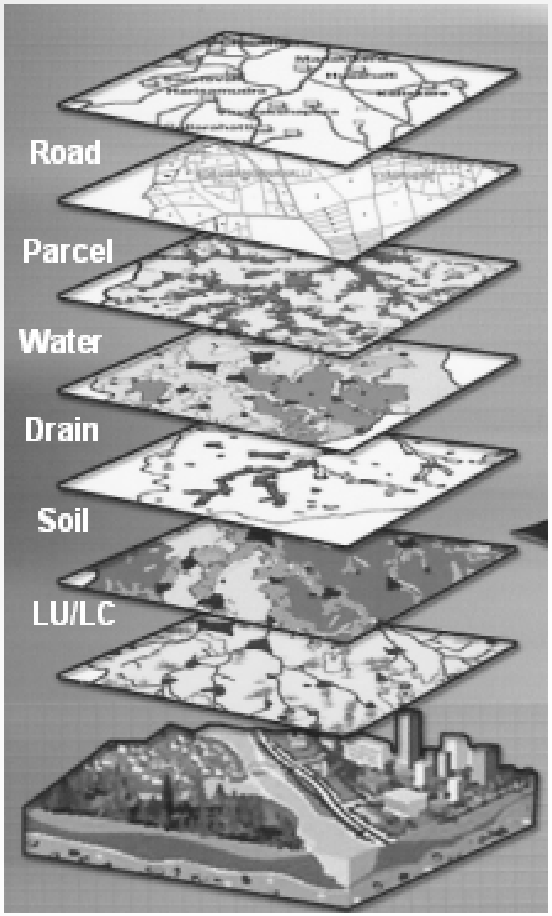

BASE MAP OF VEDA RIVER BANK SUBWATERSHED
HOSADURGA TALUK, CHITRADURGA DISTRICT
N
LEGEND
Settlement
Metalled Road
Unmetalled Road
Cart Track
Foot Path
Subwatershed Boundary
BASE MAP


CADASTRAL MAP OF VEDA RIVER BANK SUBWATERSHED
HOSADURGA TALUK, CHITRADURGA DISTRICT
N
LEGEND
Parcel Boundary
Village Boundary
Subwatershed Boundary
CADASTRAL MAP

Cadastral Overlay on High Resolution Imagery

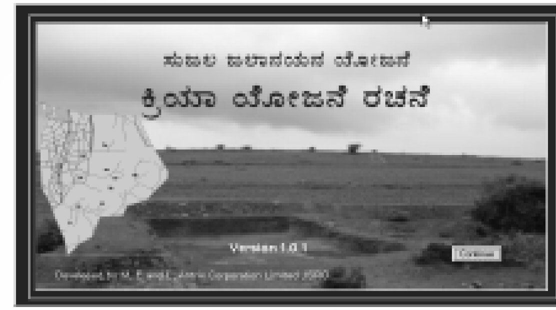
LANDUSE / LANDCOVER

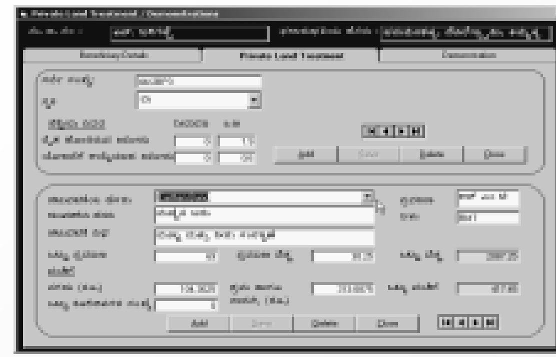
Participatory Action Plan Preparation

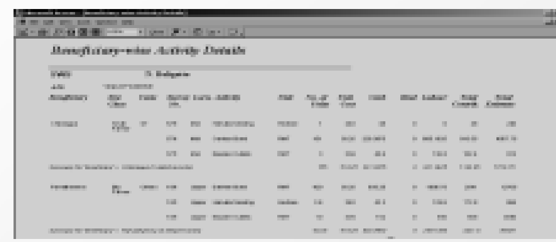


Satellite Inputs
(Resource Maps)

Community Aspirations
(Stake holder needs)

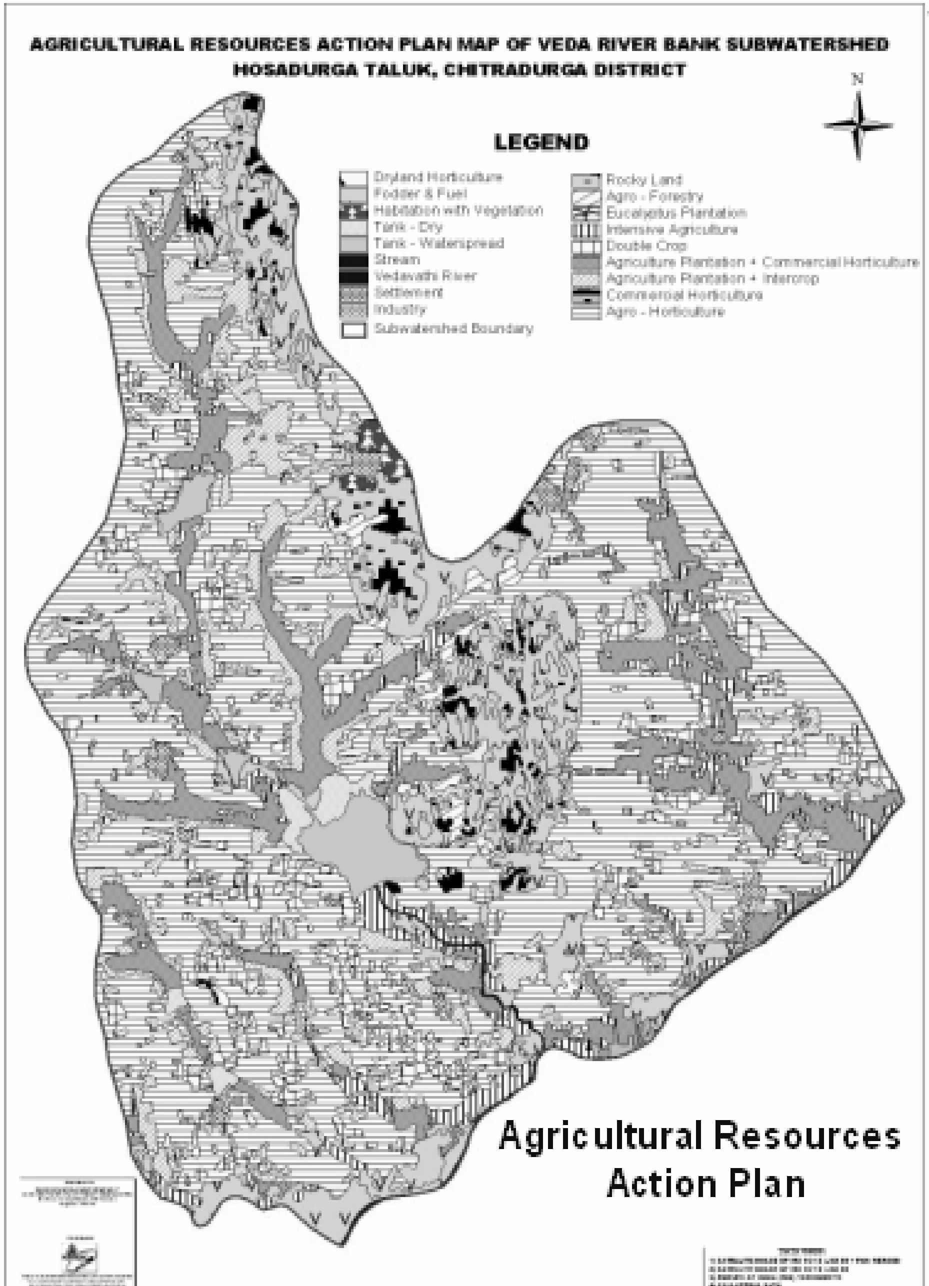


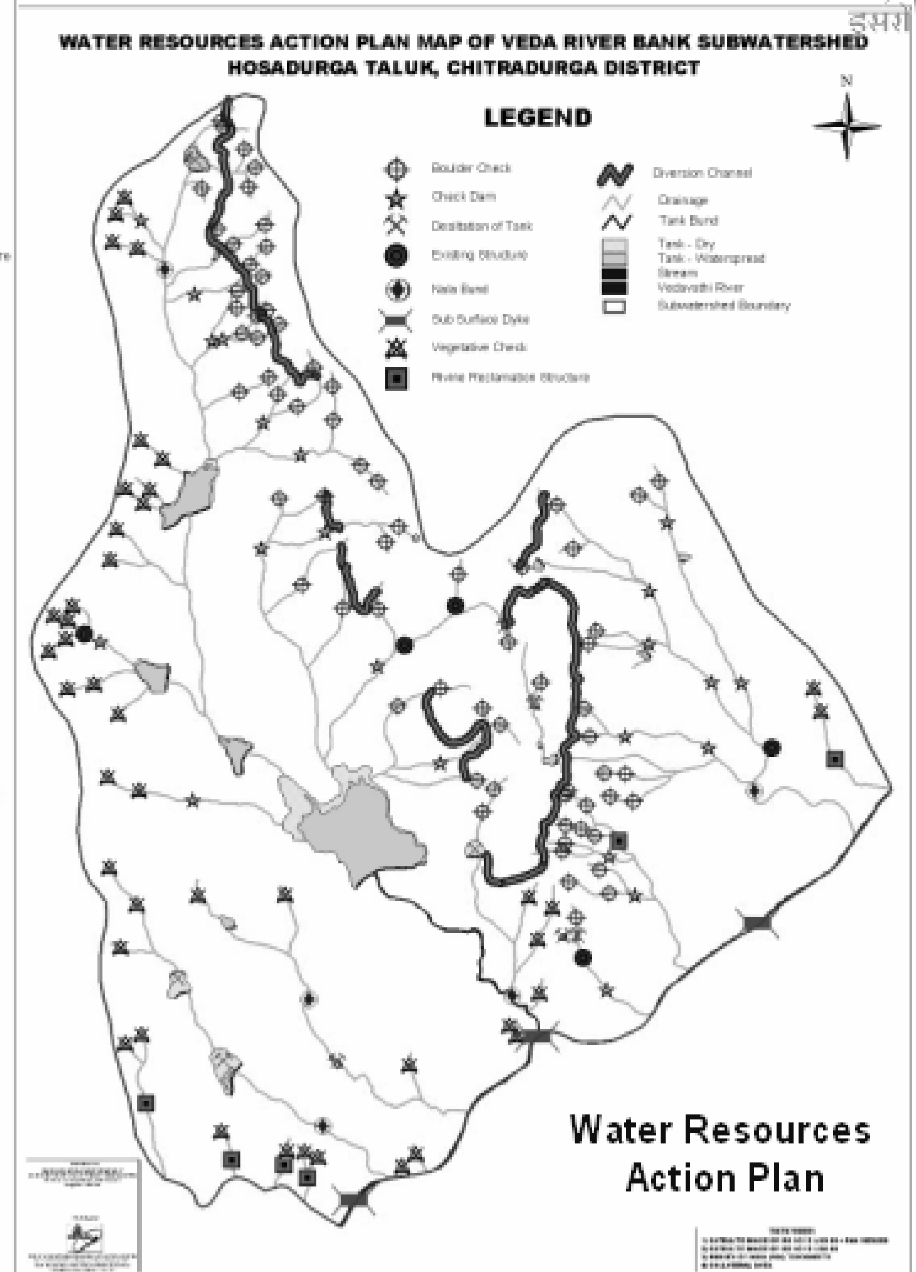




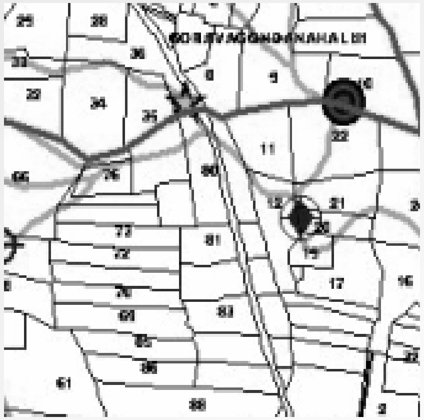
GIS Inputs
(Beneficiary wise details)

ACTION PLAN

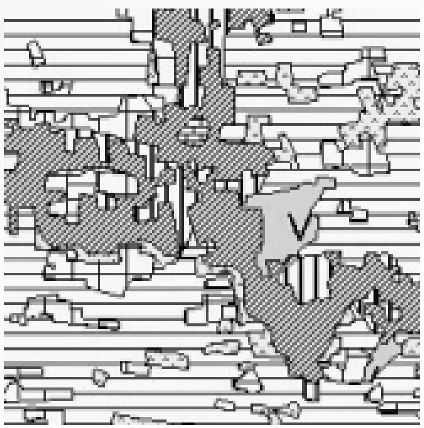

AGRICULTURAL RESOURCES ACTION PLAN MAP OF VEDA RIVER BANK SUBWATERSHED
HOSADURGA TALUK, CHITRADURGA DISTRICT
N
LEGEND
Dryland Horticulture
Fodder & Fuel
Habitation with Vegetation
Tank - Dry
Tank - Waterspread
Stream
Vedavathi River
Settlement
Industry
Subwatershed Boundary
Rocky Land
Agro - Forestry
Eucalyptus Plantation
Intensive Agriculture
Double Crop
Agriculture Plantation + Commercial Horticulture
Agriculture Plantation + Intercrop
Commercial Horticulture
Agro - Horticulture
Agricultural Resources
Action Plan


WATER RESOURCES ACTION PLAN MAP OF VEDA RIVER BANK SUBWATERSHED
HOSADURGA TALUK, CHITRADURGA DISTRICT
N
LEGEND
Boulder Check
Check Dam
Desiltation of Tank
Existing Structure
Nala Bund
Sub Surface Dyke
Vegetative Check
Ravine Reclamation Structure
Diversion Channel
Drainage
Tank Bund
Tank - Dry
Tank - Waterspread
Stream
Vedavathi River
Subwatershed Boundary
Water Resources
Action Plan

Action Plan Implementation



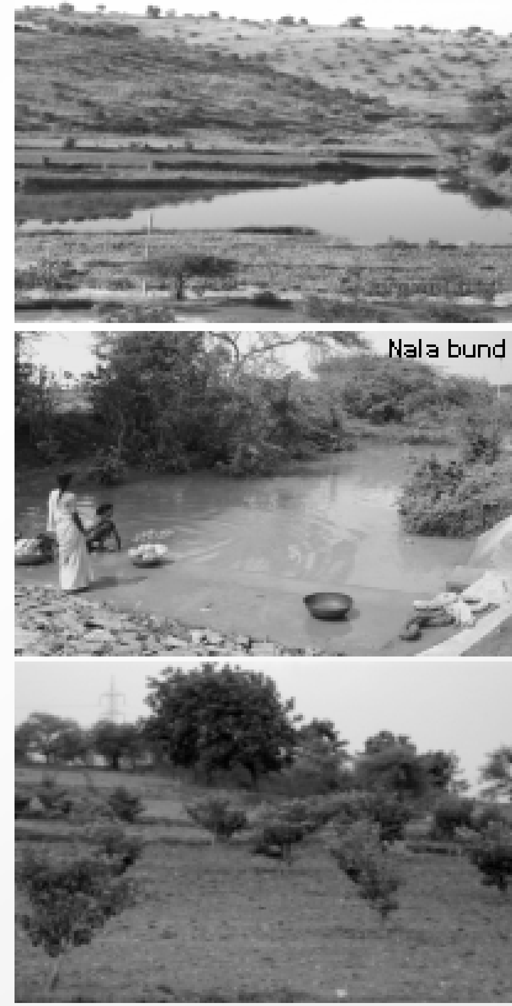
Water Resources
Action Plan



Land Resources
Action Plan

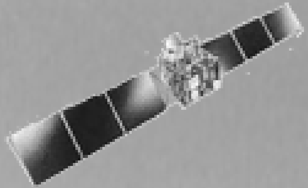
Watershed Community

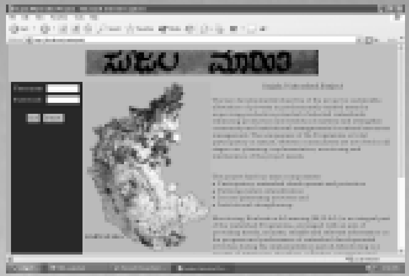
Participatory Implementation



Out Come

……. towards Social Equity, Economic Productivity and Sustainability.





Sujala Mahithi - MIS

Satellite based monitoring

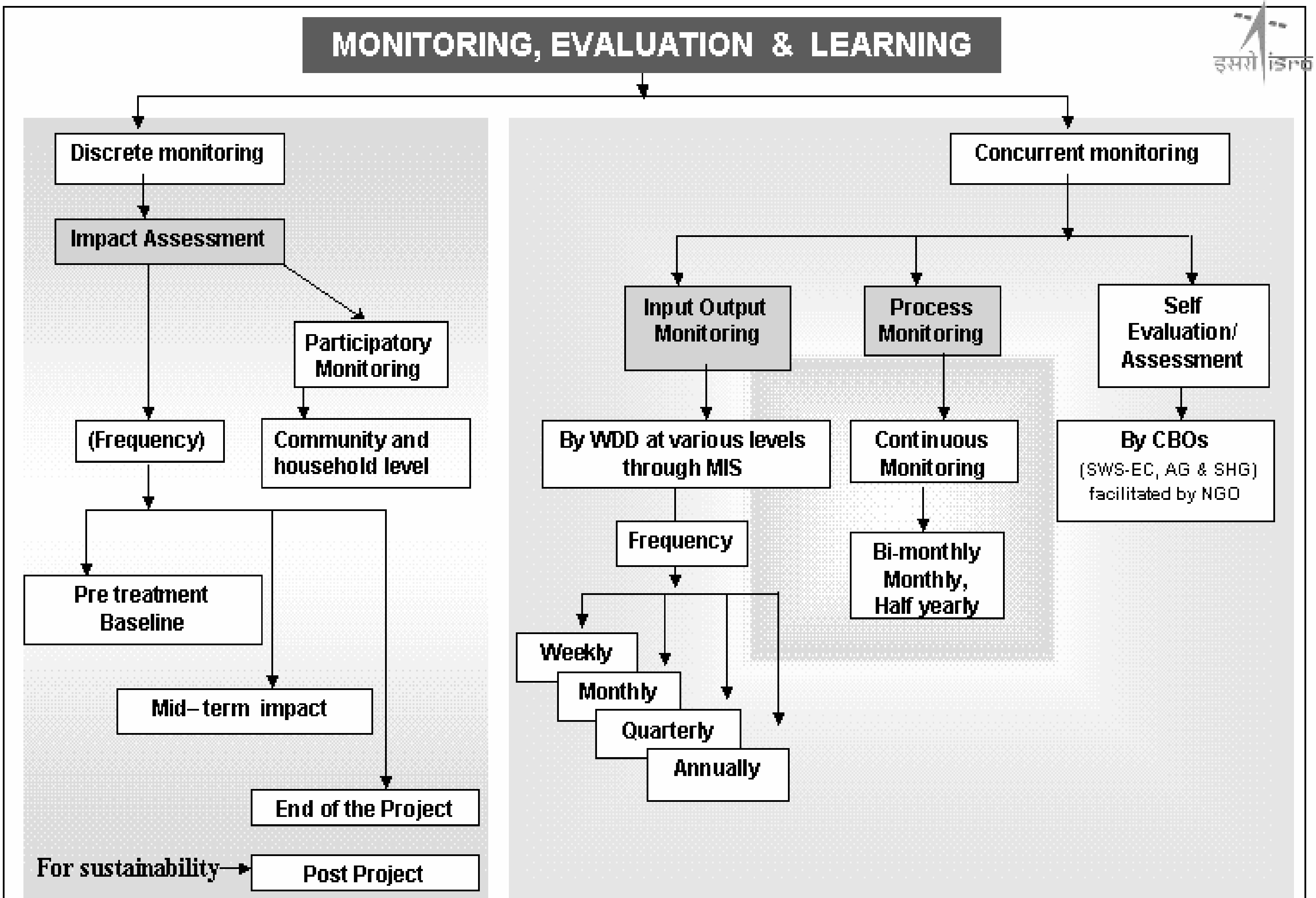
Ground based monitoring

CBO Assessment

Monitoring and Evaluation

Satellite, Ground and MIS / GIS data used for

- **Process Monitoring**
- **Implementation Monitoring**
- **Physical & Financial Monitoring**
- **Short term & Long Term Impacts**



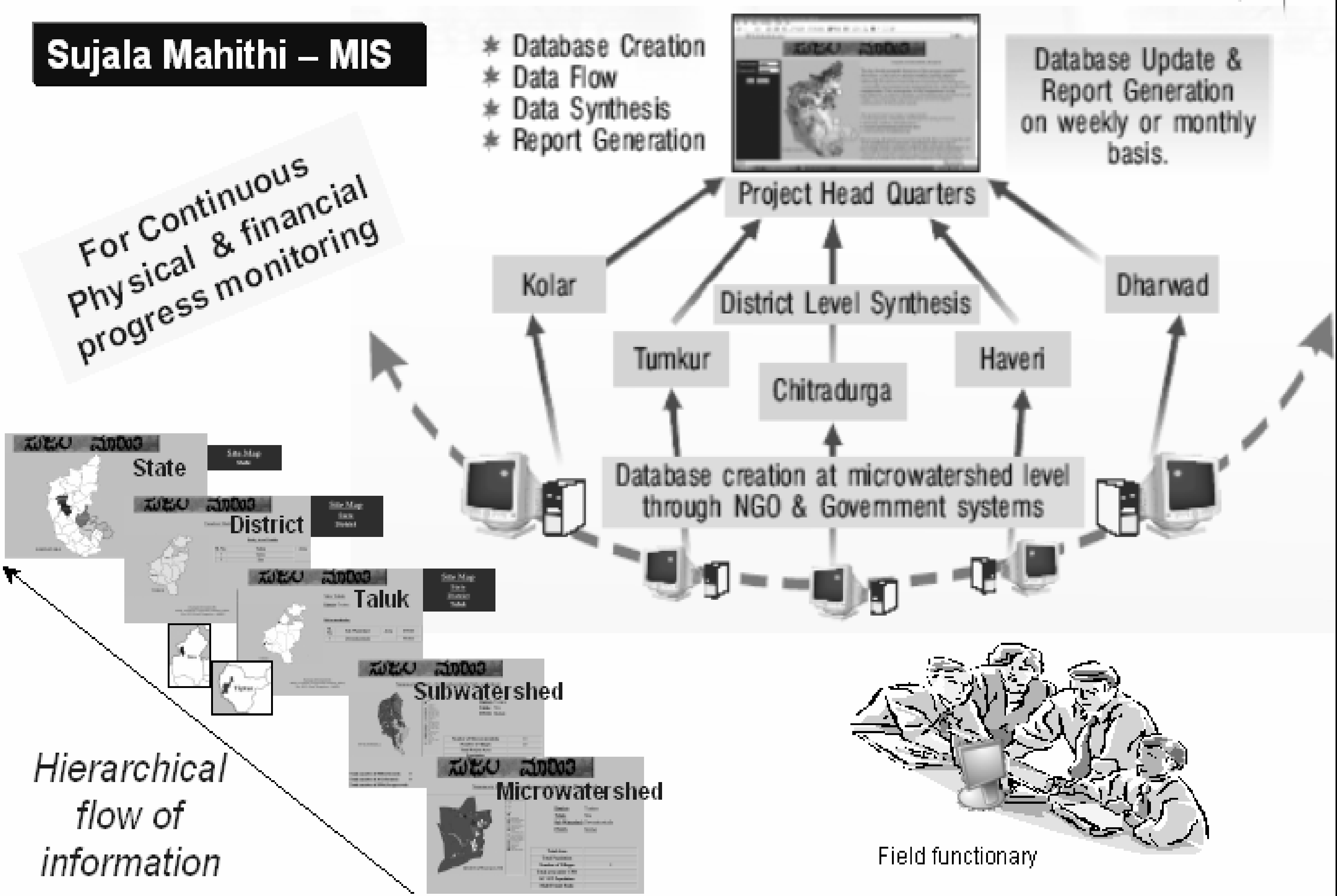
Schematic representation of M & E in Sujala Project

Data Collection Approaches

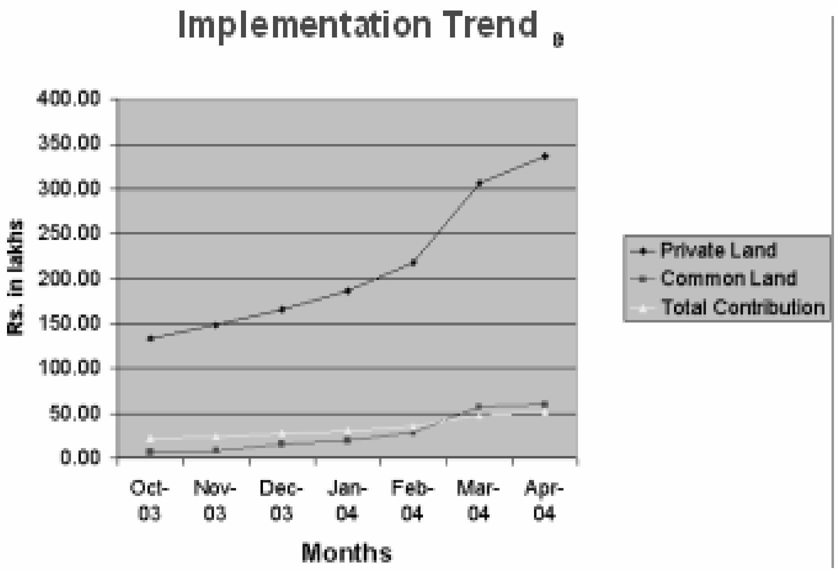
Blend of both conventional & satellite based monitoring system

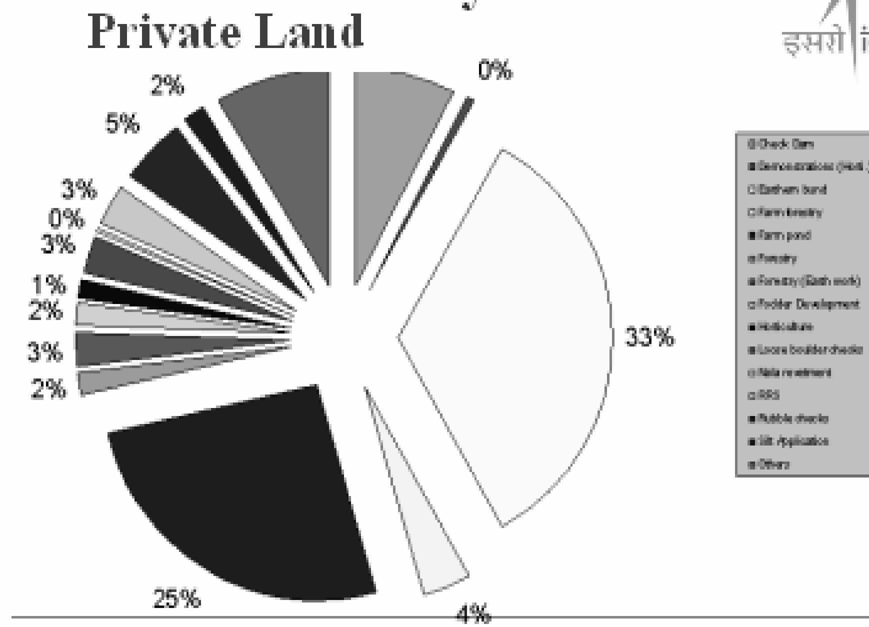
Impact Assessment	Input – Output Monitoring	Process Monitoring
Remote Sensing **GIS analysis** **Houshold survey & analysis** • *Thematic Studies* • *Case Studies* • *Self assessment*	• MIS / GIS for progress monitoring • SWAP: Action Plan preparation • GIS based plan Preparation & monitoring	• Participatory Observations • Focus Group Discussions • Transect Walks • Files, Records, Documents • Informal discussions • Expert judgement

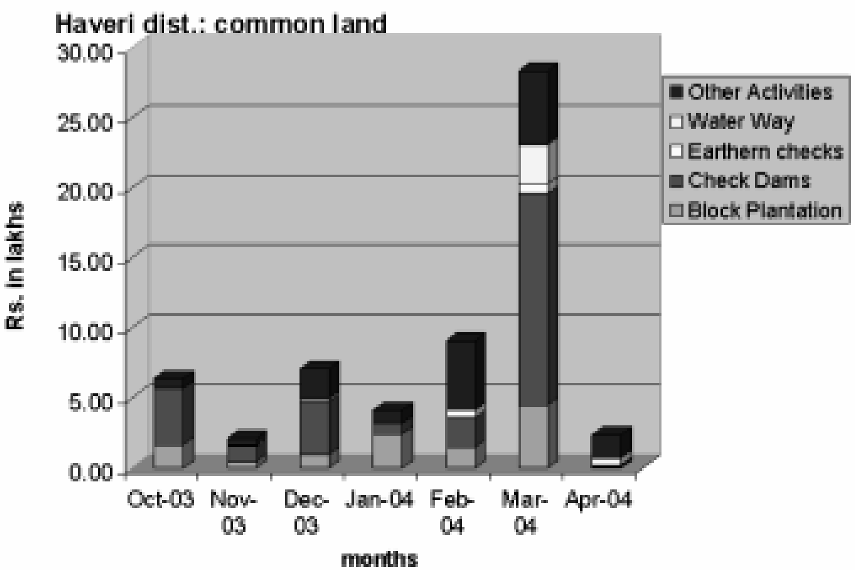
MIS / GIS Package in SUJALA

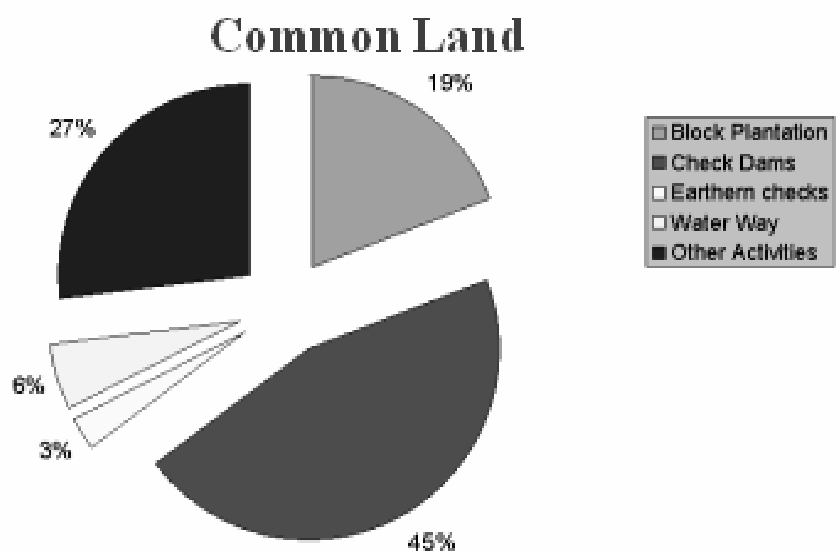


Haveri District: Land treatment Analysis



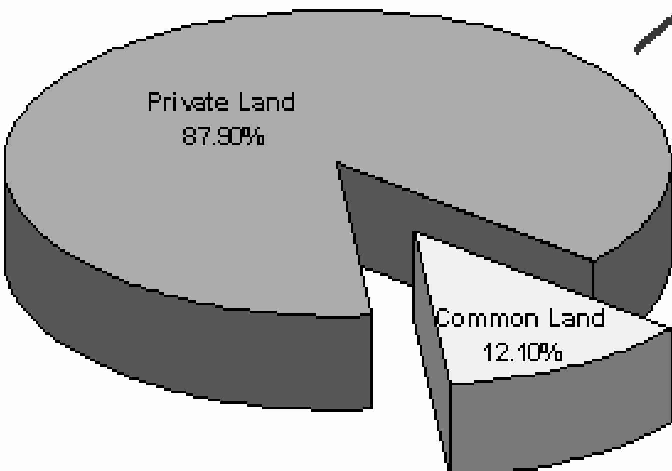




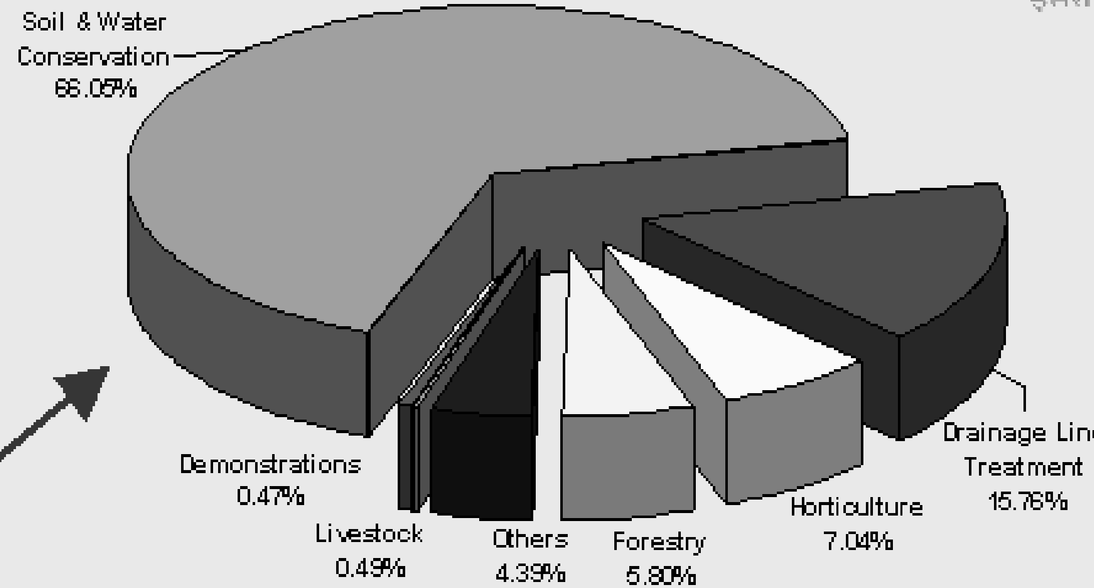


Phase – 1 Implementation Details

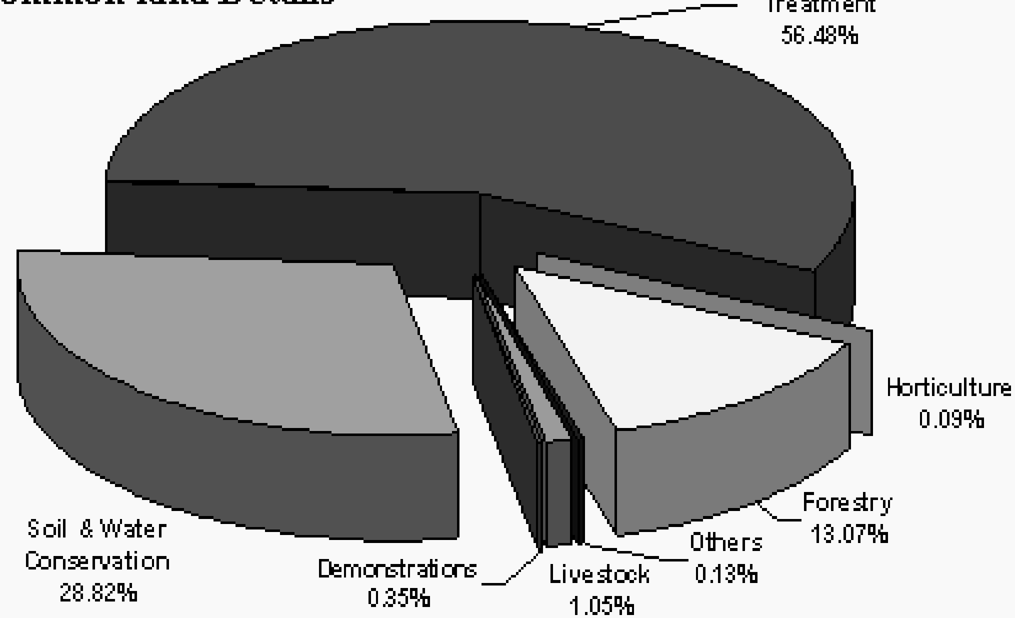
Implementation Breakup



Private land Details

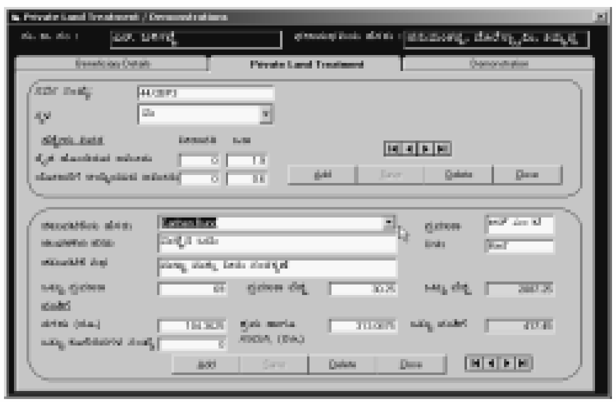


Common land Details



Kriya Yojane

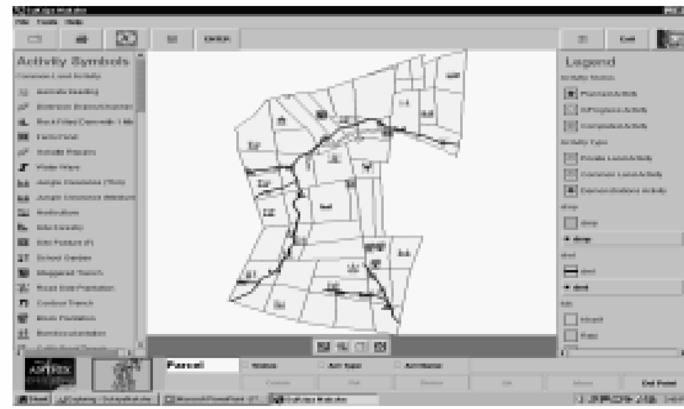
Bilingual package for participatory action plan preparation & implementation



Beneficiary wise details

Sukriya Nakshe

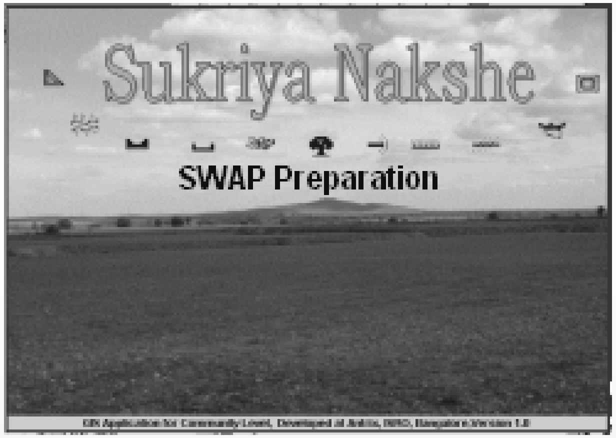
GIS enabled package for monitoring the implementation progress at cadastral level



Interventions implemented Survey no. wise

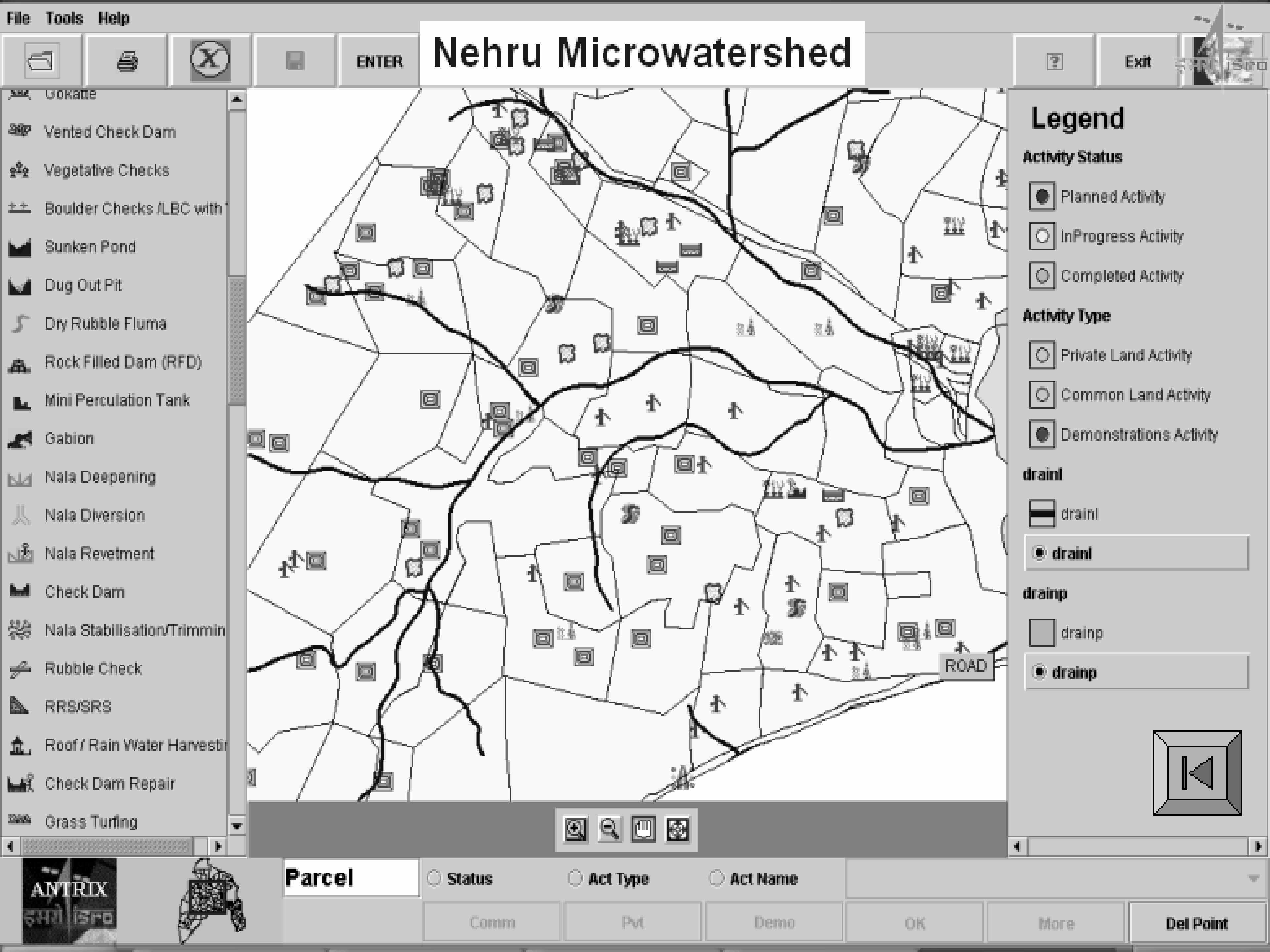
SuKriya package

- Systematic database creation with respect to private/common land treatments.
- Depicts information related where, what, when on the cadastral map in a user friendly manner.
- Allows about 150 different types of activities to be depicted at micro-watershed level
- Helps in SWAP preparation, implementation and monitoring.
- Customized user-friendly package



GIS tool enables

- **Input and update beneficiary-wise activity status**
- **Activity- wise Segregation and depiction**
- **Zoom / Pan / Text display and legending capabilities**
- **Input to Satellite data interpretation**



File
Tools
Help
ENTER
Nehru Microwatershed
Exit
Vented Check Dam
Vegetative Checks
Boulder Checks /LBC with
Sunken Pond
Dug Out Pit
Dry Rubble Fluma
Rock Filled Dam (RFD)
Mini Perculation Tank
Gabion
Nala Deepening
Nala Diversion
Nala Revetment
Check Dam
Nala Stabilisation/Trimmin
Rubble Check
RRS/SRS
Roof / Rain Water Harvesti
Check Dam Repair
Grass Turfing
ROAD
Legend
Activity Status
Planned Activity
InProgress Activity
Completed Activity
Activity Type
Private Land Activity
Common Land Activity
Demonstrations Activity
drainl
drainl
drainl
drainp
drainp
drainp
ANTRIX
Parcel
Status
Act Type
Act Name
Comm
Pvt
Demo
OK
More
Del Point

PROCESS MONITORING

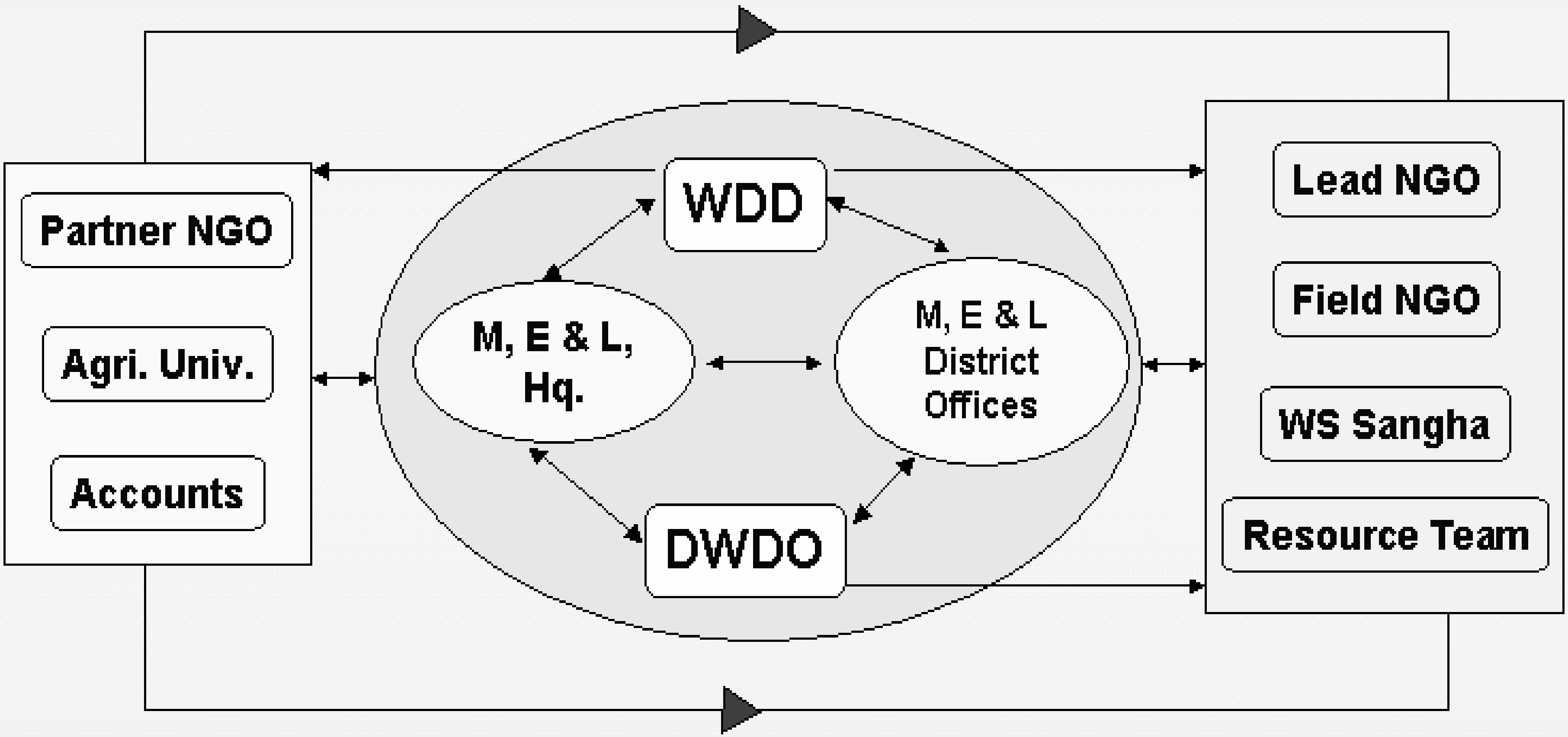
To capture near real time information on key processes

- Awareness & Sensitisation
- Entry point activity
- Formation & functioning of CBO's
- Capacity building
- Swap preparation
- Swap Implementation
- Income generating Activities
- Farm demonstrations
- Operation & Maintenance

DISSEMINATION

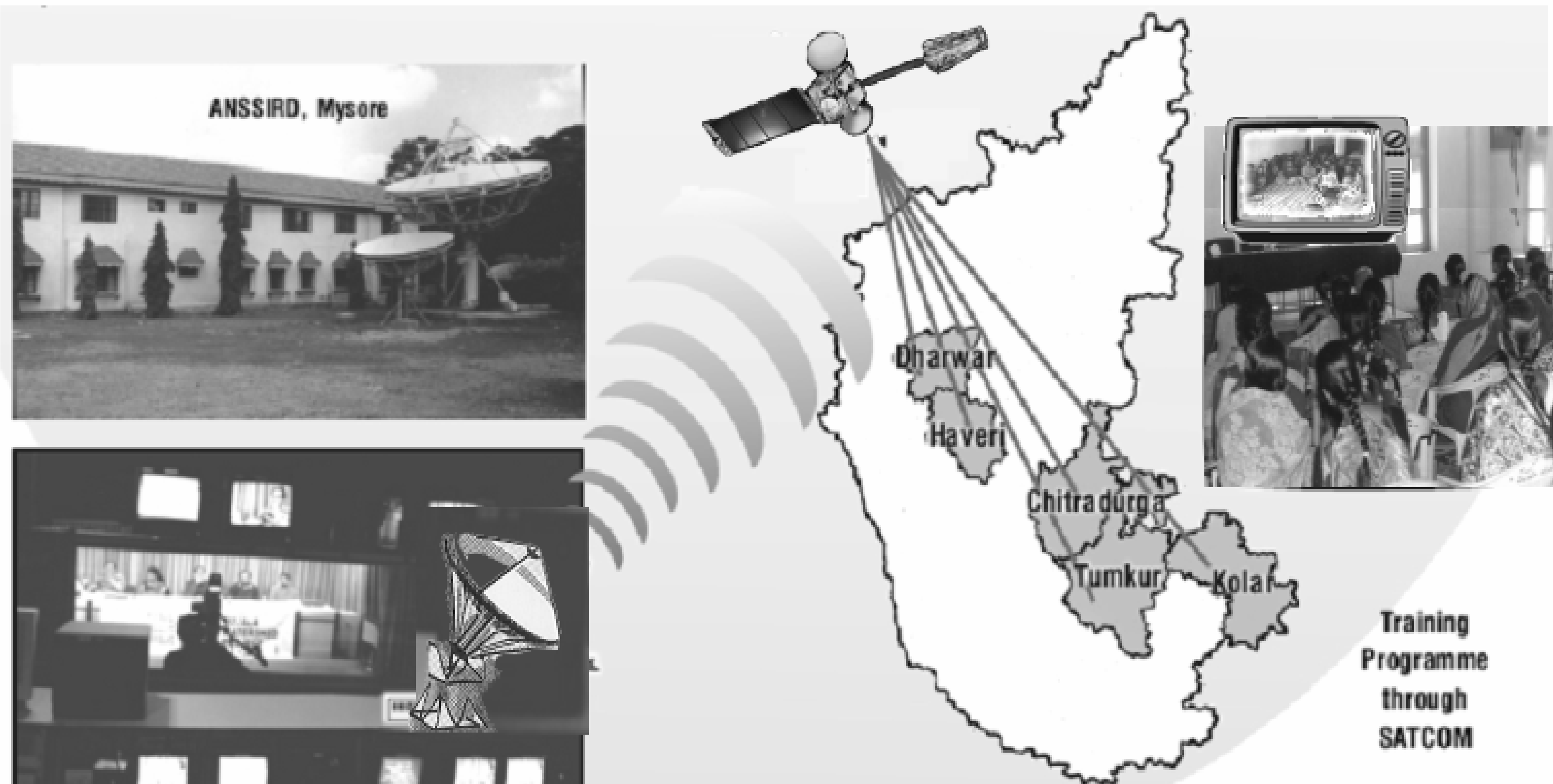
- *Weekly / Monthly Reports*
- *District / Field level interaction*
- *Compliance / Learning*

Information Feedback / Dissemination Network



Capacity Building of Rural Community
through SATCOM programme

Self Help Groups, Area Groups, NGO's, Gram Panchayat, Dept. offficials in 38 Taluks of Karnataka State



Empowerment through Technology

IMPACT ASSESSMENT

To address the overall impact on Environment & Socio-Economic indicators

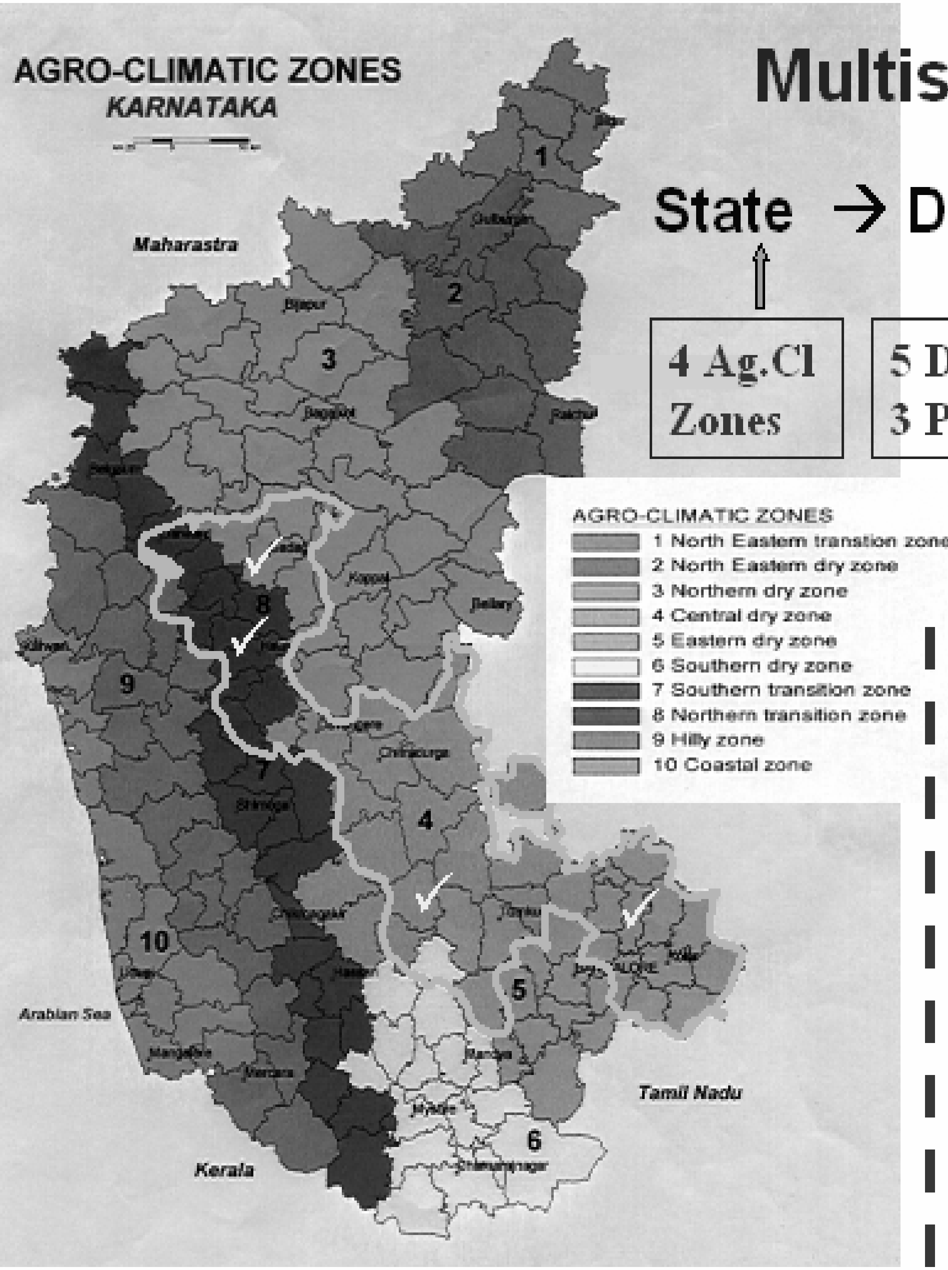
IMPACT → SHORT TERM / LONG TERM → HOUSEHOLD LEVEL / COMMUNITY / VILLAGE / MICRO / SUB-WATERSHED

IMPACT ↓

* BEFORE (BASELINE)
* DURING (MID-TERM)
* END OF THE PROJECT

APPROACH → BEFORE AND AFTER / WITH AND WITHOUT

Multistage sampling criteria



State → District → SWS → MWS → HH

State	4 Ag.Cl Zones
District	5 Dists. & 3 Phases
SWS	SRS, 33% in 3 Phases
MWS	StRS, 10% in 3 phases
HH	PPS within each strata 11.6% in 3 phases

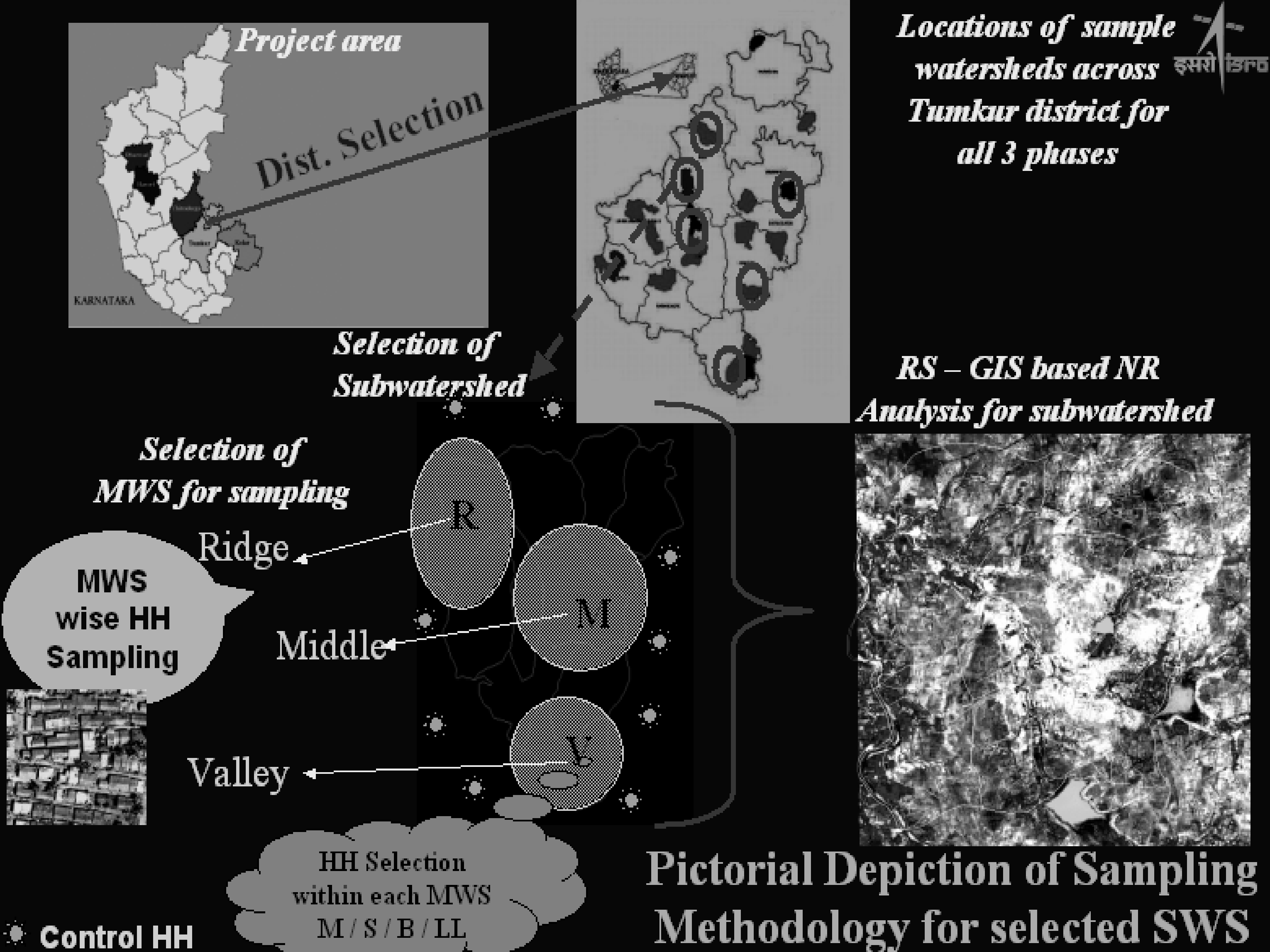
State Level	Agro-climatic zones across study area
Phase wise sampling in 5 Districts	Distribution of SWS in project area
Subwatershed level	MWS in Ridge, Middle and Valley
RS & GIS to cover entire area for NR	10% sampling of HH in R, M, V
Adaptation of SRS, StRS, PPS & Area based sampling	Control HH outside the project area

No. of SubWS : 77

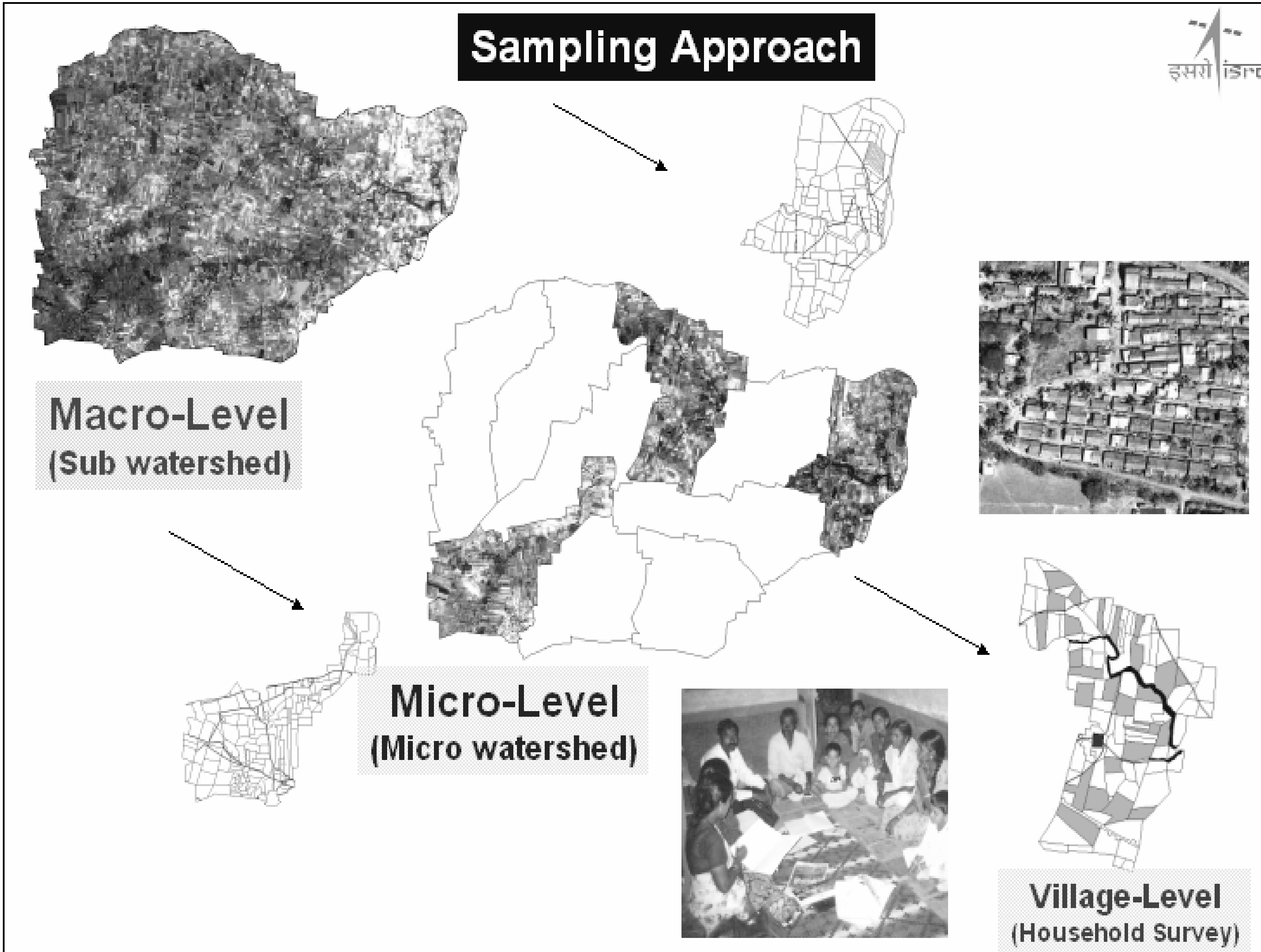
No. of Districts : 5

No. of Agro-CZ : 4

Sample Size: 10 %



Project area
Dist. Selection
KARNATAKA
Locations of sample watersheds across Tumkur district for all 3 phases
Selection of Subwatershed
RS – GIS based NR Analysis for subwatershed
Selection of MWS for sampling
R
Ridge
M
Middle
V
Valley
MWS wise HH Sampling
HH Selection within each MWS M / S / B / LL
Control HH
Pictorial Depiction of Sampling Methodology for selected SWS


Sampling Approach
इसरो isro
Macro-Level
(Sub watershed)
Micro-Level
(Micro watershed)
Village-Level
(Household Survey)

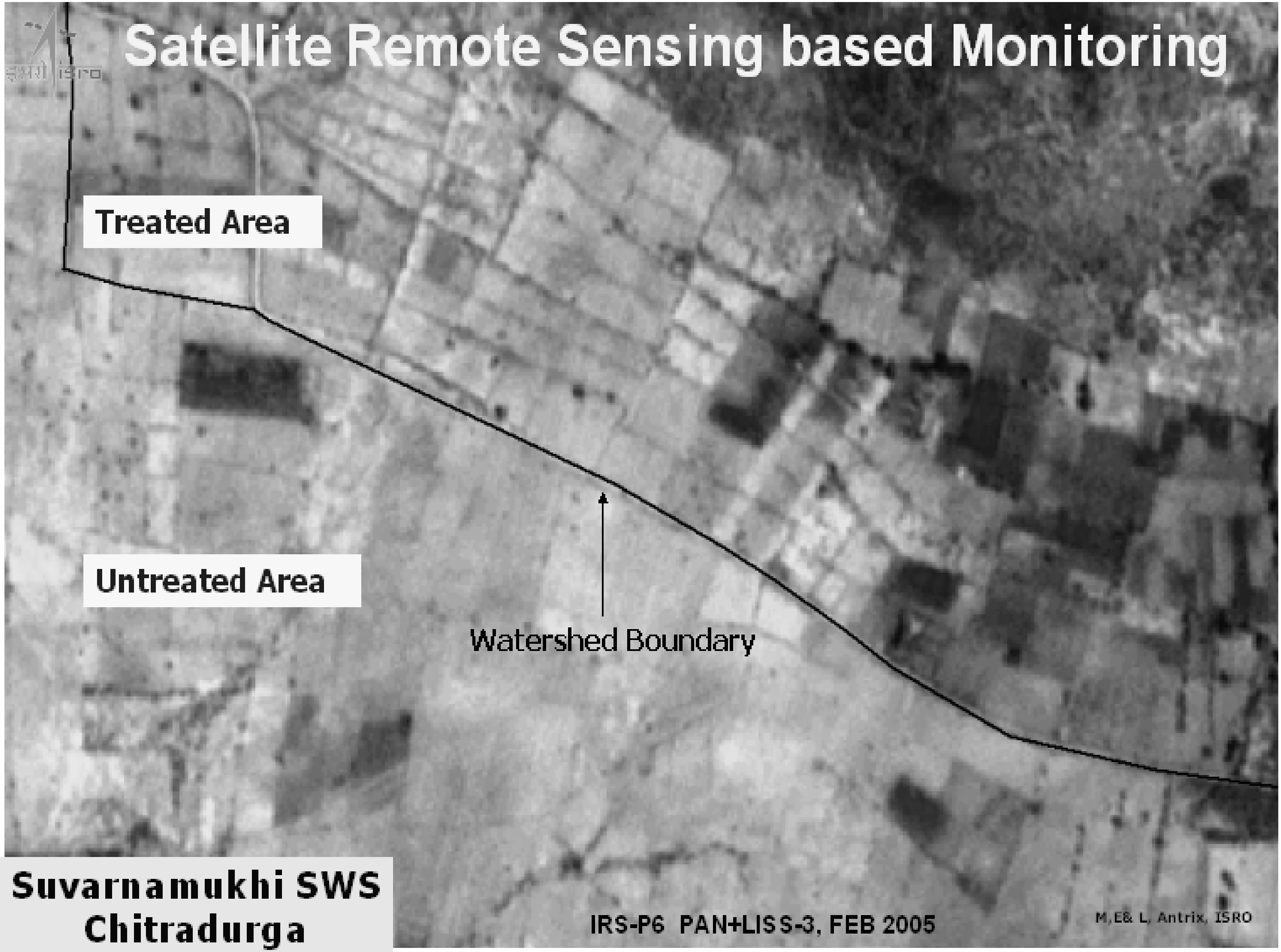
INDICATORS

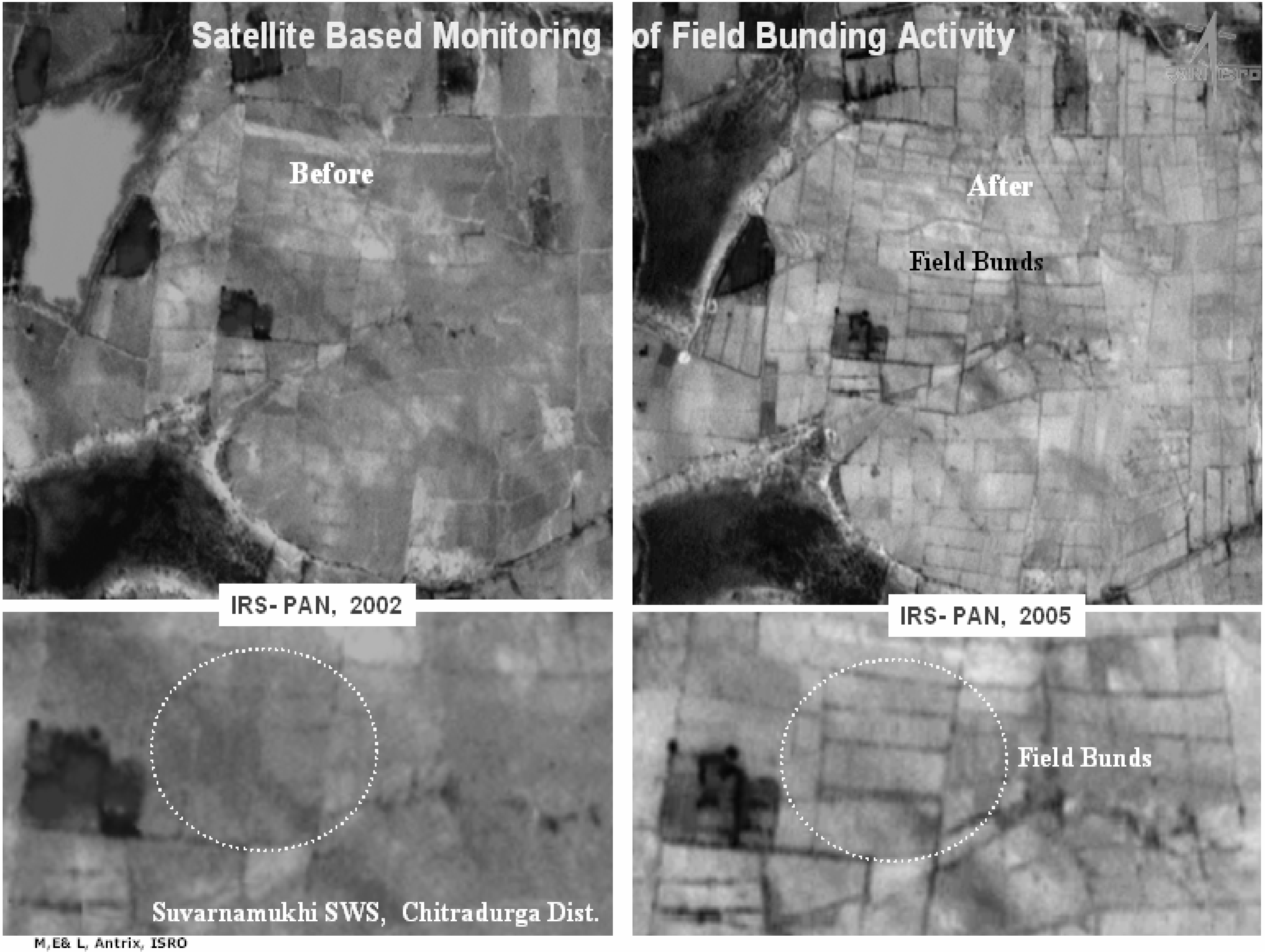
Natural Resource

- Land use / Land cover
- Agricultural productivity
- Cropping Intensity
- Cropping Pattern
- Horticulture / Forestry
- Wasteland Extent
- Ground water level/Yield
- Biomass

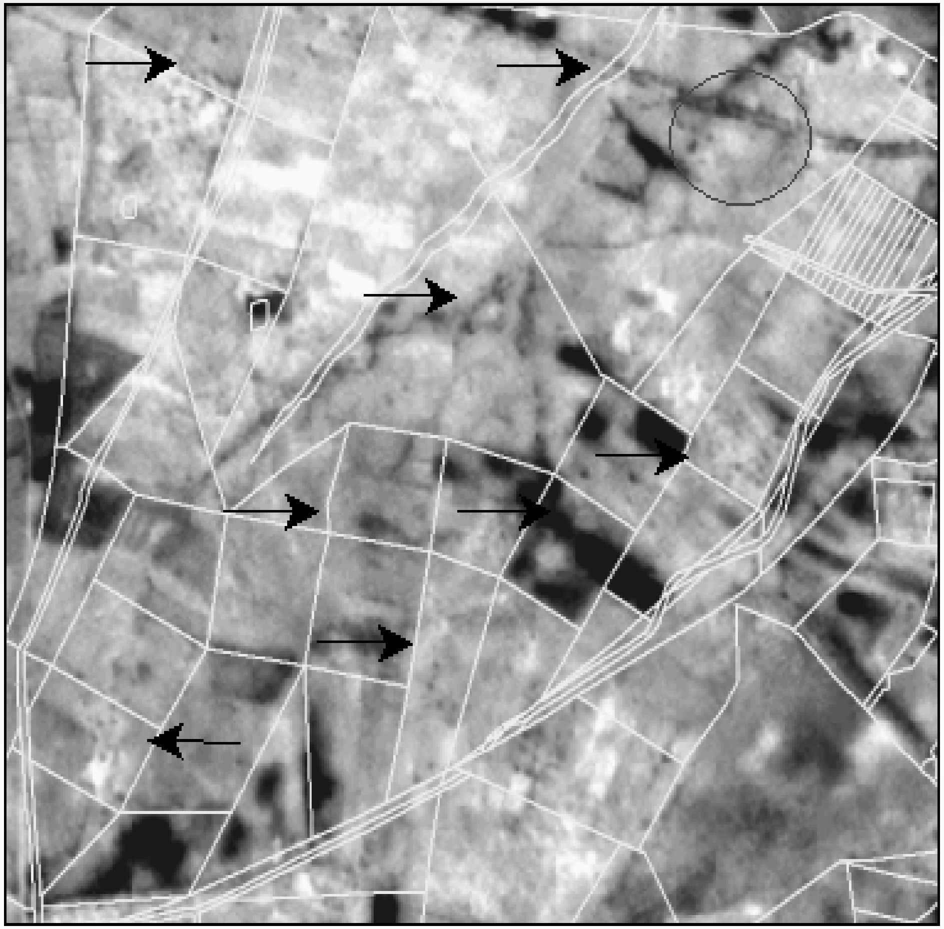
Socio-Economic

- Household Income
- Livestock Population
- Fodder and Fuel Wood
- Assets and Liabilities
- Migration
- Milk Yield
- Employment Opportunity


Satellite Remote Sensing based Monitoring
Treated Area
Untreated Area
Watershed Boundary
Suvarnamukhi SWS
Chitradurga
IRS-P6 PAN+LISS-3, FEB 2005
M,E& L, Antrix, ISRO

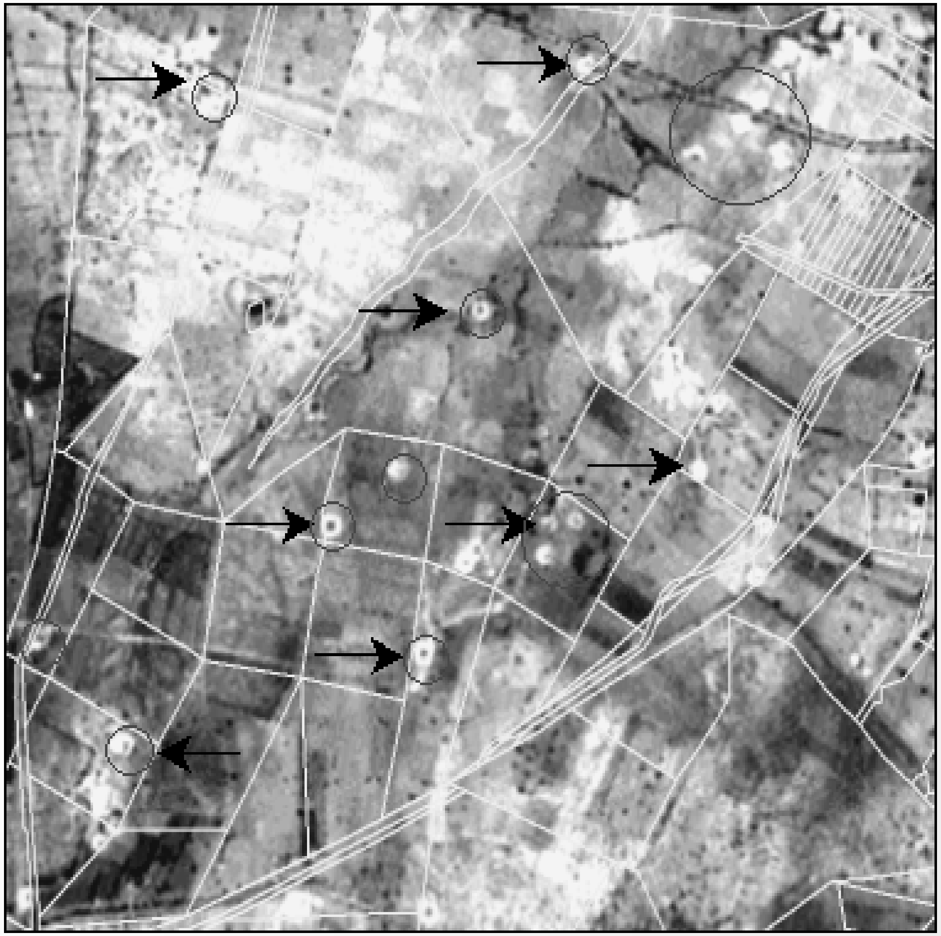

Satellite Based Monitoring of Field Bunding Activity
Before
After
Field Bunds
IRS- PAN, 2002
IRS- PAN, 2005
Field Bunds
Suvarnamukhi SWS, Chitradurga Dist.
M,E& L, Antrix, ISRO

Satellite Based Monitoring of Farm Pond Implementation



Before Treatment

IRS- 1D,PAN FEB 2002

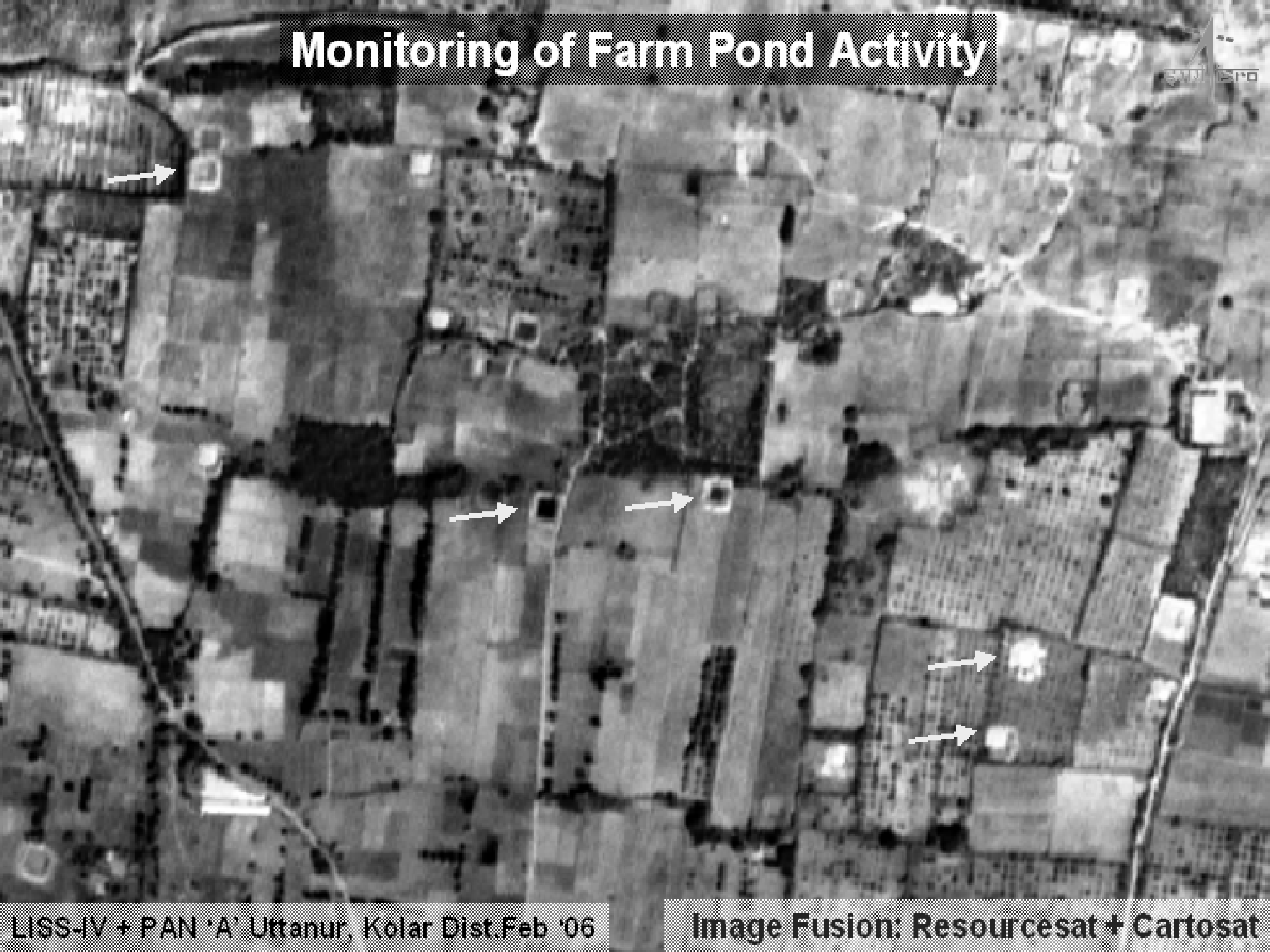


After Treatment

IRS- P6,PAN FEB, 2005

Kumudavathi SWS, Kurudi MWS, Kolar Dist

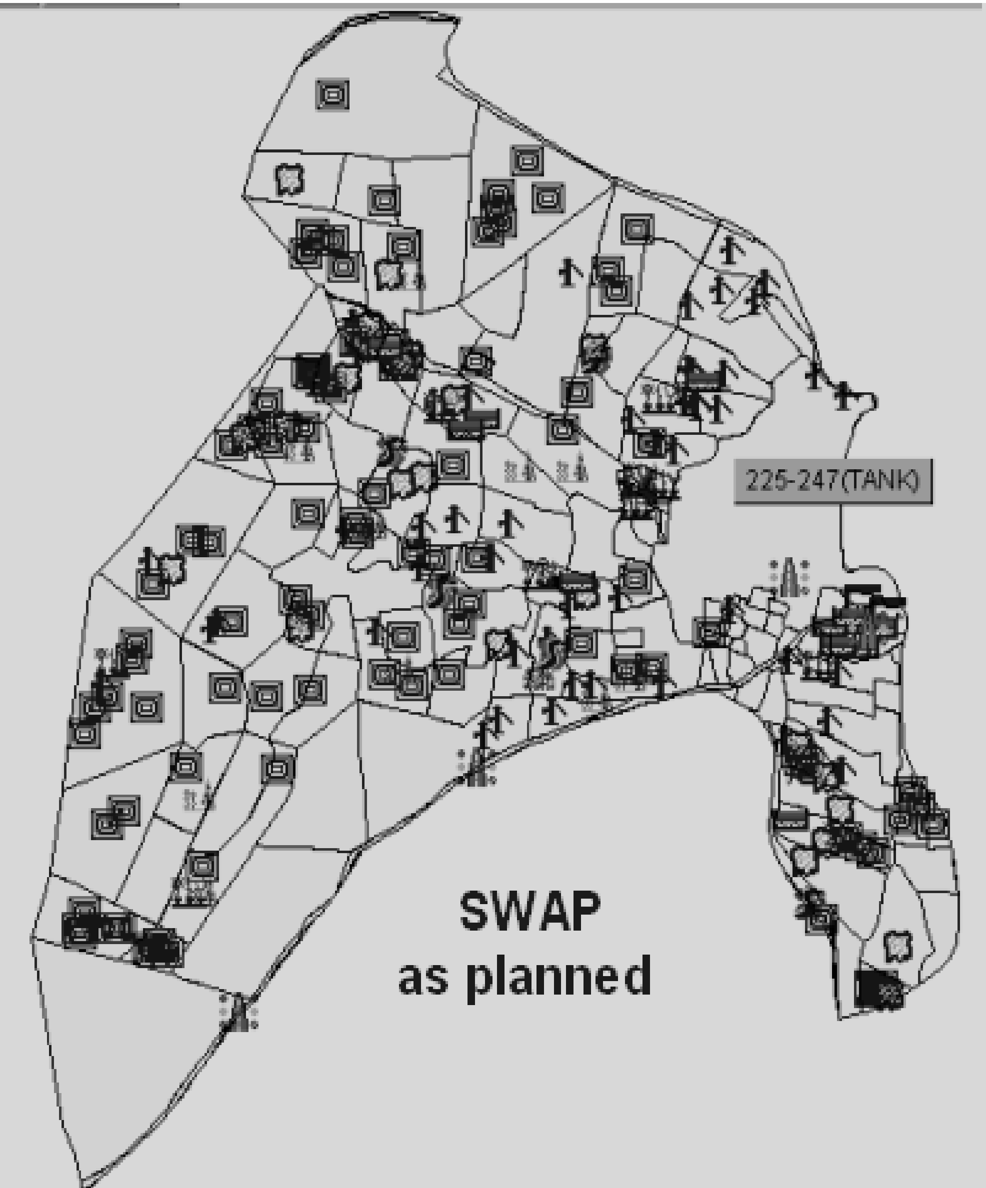
Monitoring of Farm Pond Activity

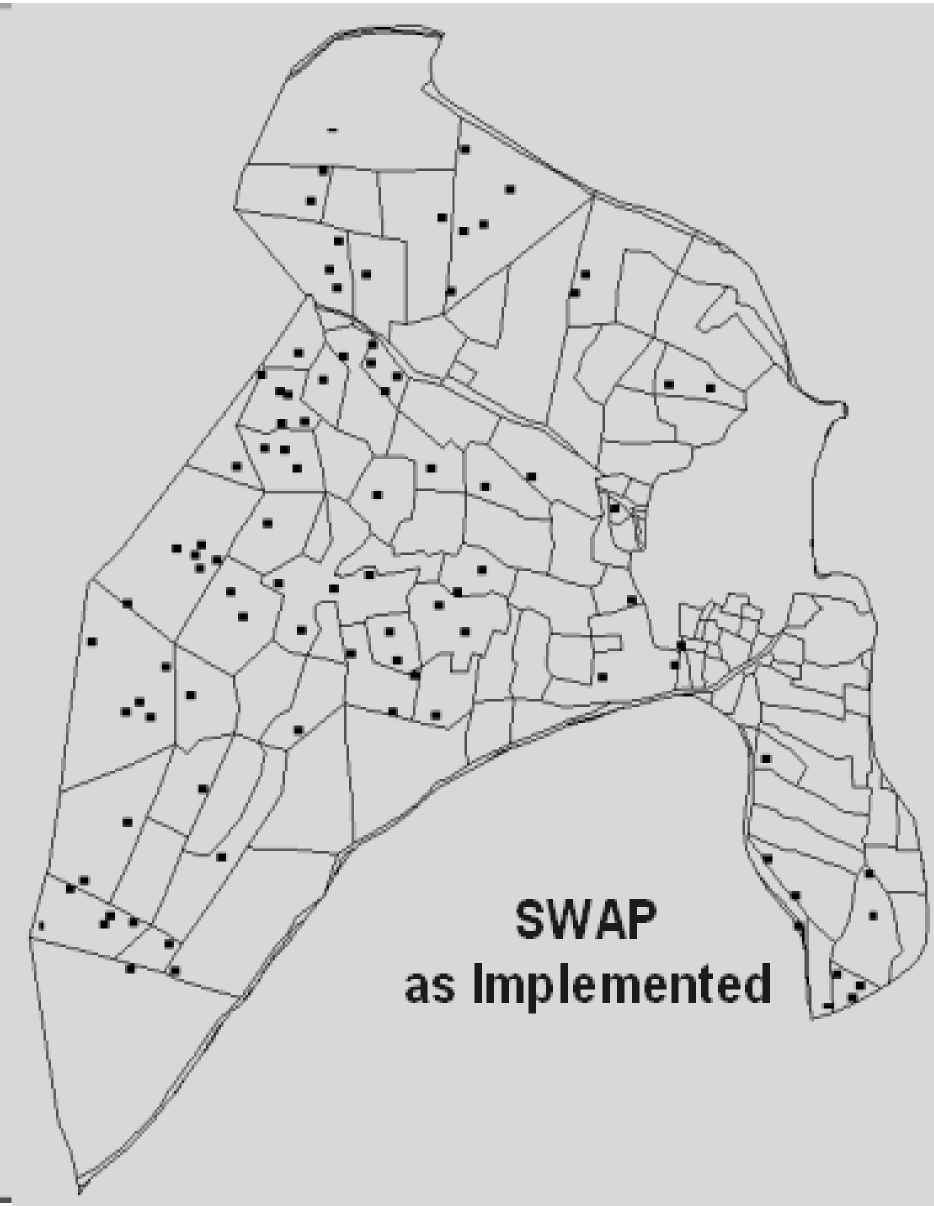


LISS-IV + PAN 'A' Uttanur, Kolar Dist.Feb '06

Image Fusion: Resourcesat + Cartosat

Mapping / Monitoring of Farm Ponds implementation – Sukriya Nakshe





Nehru MWS, Kumudvathi SWS, Kolar

Plan v/s Actual implementation

Shift from Agriculture to Agro-Horticulture

Uttanur SWS, Kolar Dist

IRS- 1D,PAN+LISS-3, FEB 2002

Pits made for Planting

Mango
Planted

IRS- P6,PAN+LISS-3, FEB, 2005

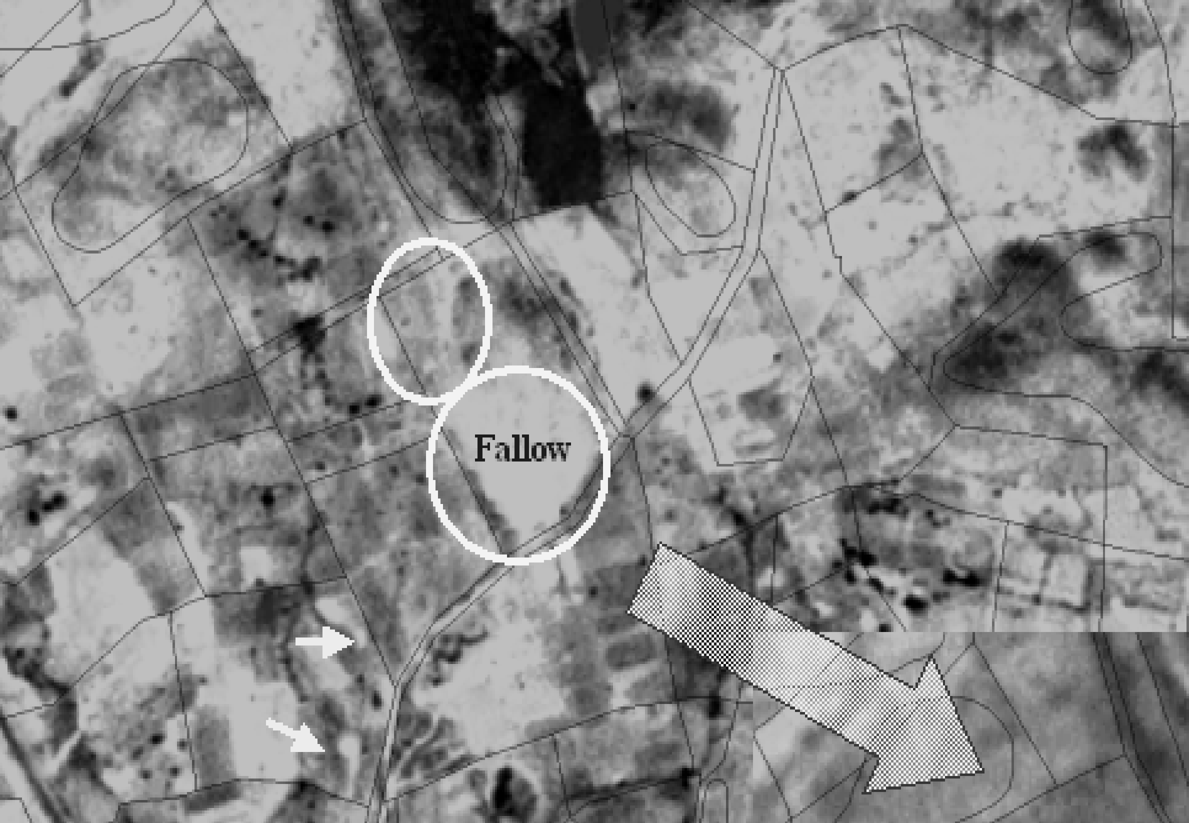
M,E& L, Antrix, ISRO


Monitoring of Horticultural Activities
LISS-IV + PAN 'A' Uttanur, Kolar Dist.Feb '06
Image Fusion: Resourcesat + Cartosat

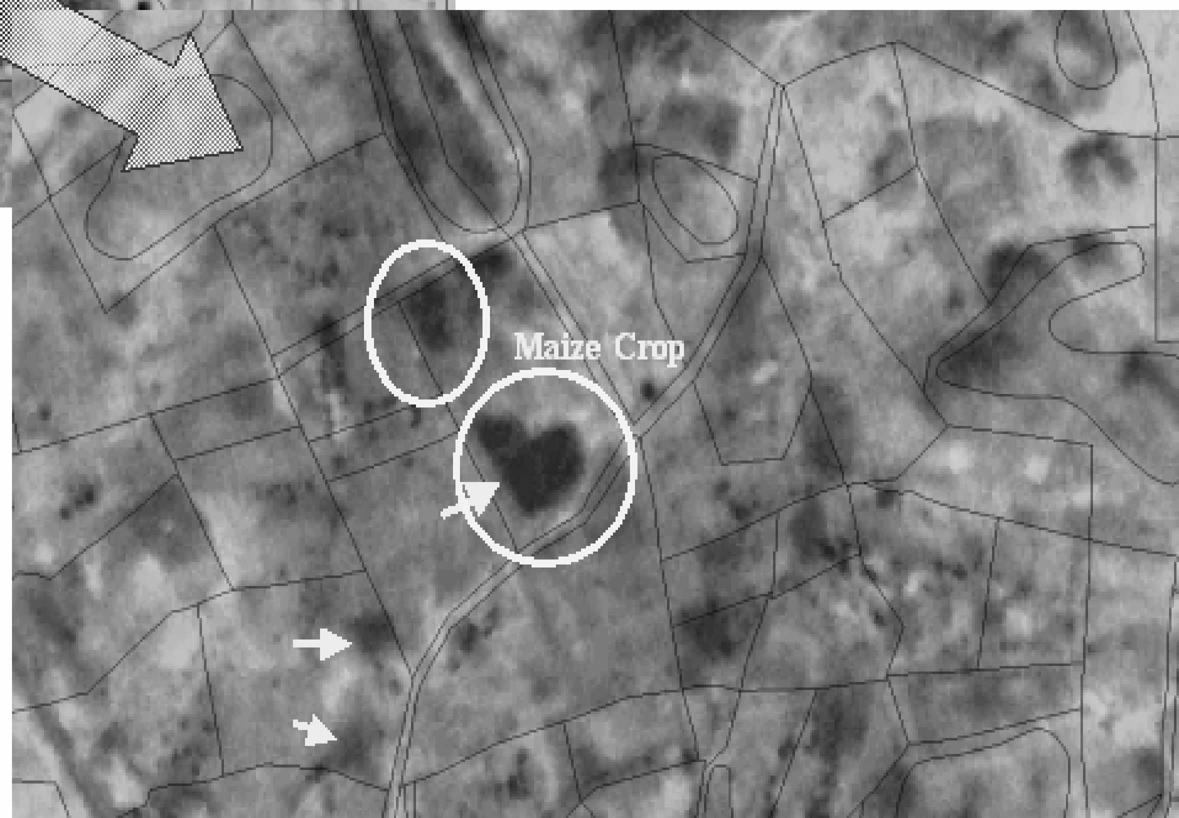
Monitoring Land use Changes

Managundi SWS, Dharwar Dist.

Improvement in Crop productivity through increased water availability



IRS- 1D,PAN+LISS-3, FEB 2002



IRS- 1D,PAN+LISS-3, MAR, 2005

Cropping Intensity has increased from 106 % to 128 %

Survey No.: 95
Beneficiary: Fakirappa. K. Naiker

COMMUNITY FORESTRY

- Community Participation in Development, Protection, Management and Utilisation activities
  - Stability of Forest Eco-system
  - Improve Land productivity / Canopy cover
  - Optimise Land use Pattern
  - Equity in Benefit Sharing
  - Improve the Welfare of Livelihoods
  - Promote IGA related to Forest Products

RS & GIS Provide inputs to the Processes, Programme & Institution of Community Forestry

Afforestation – Common Land

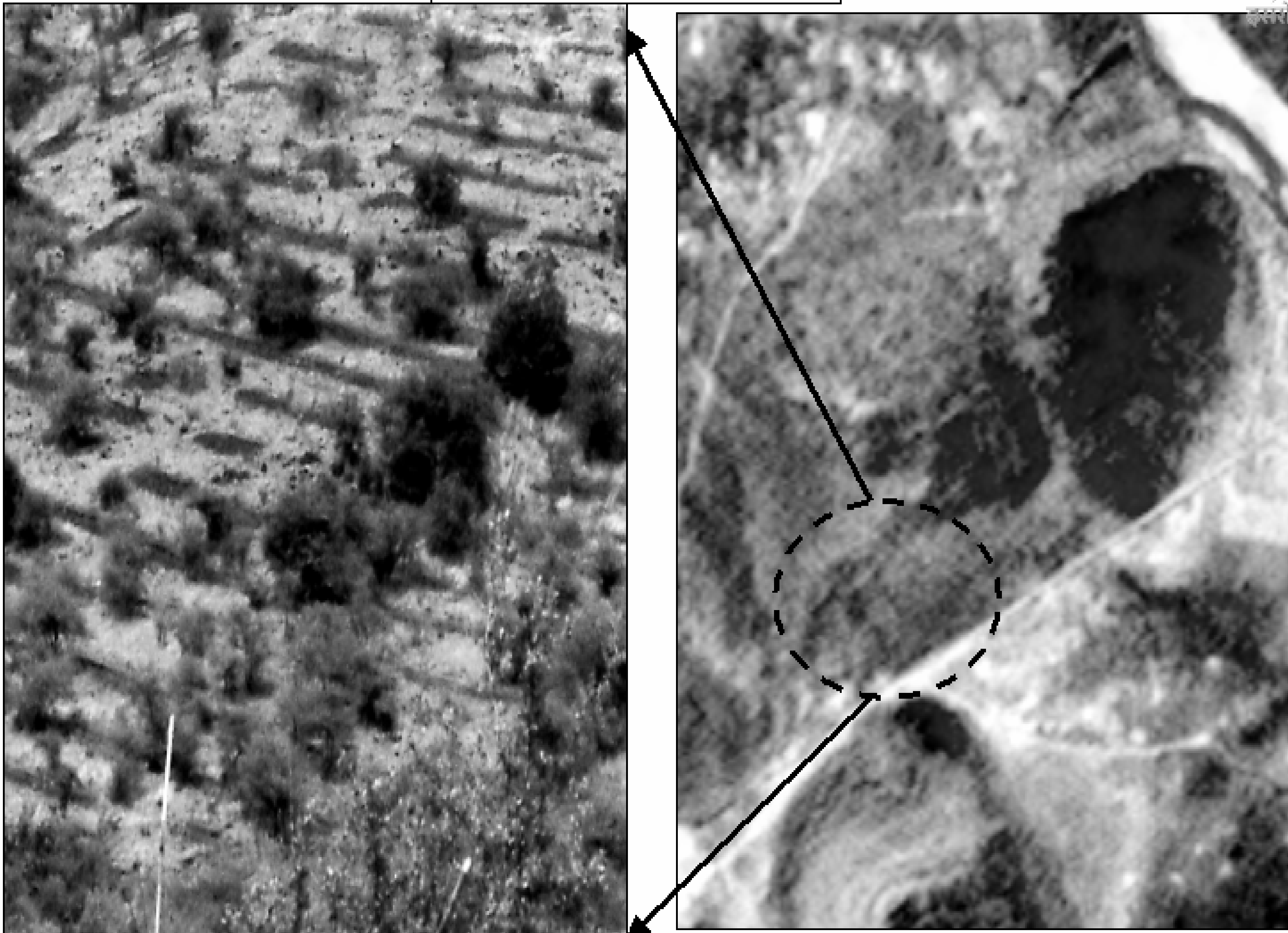








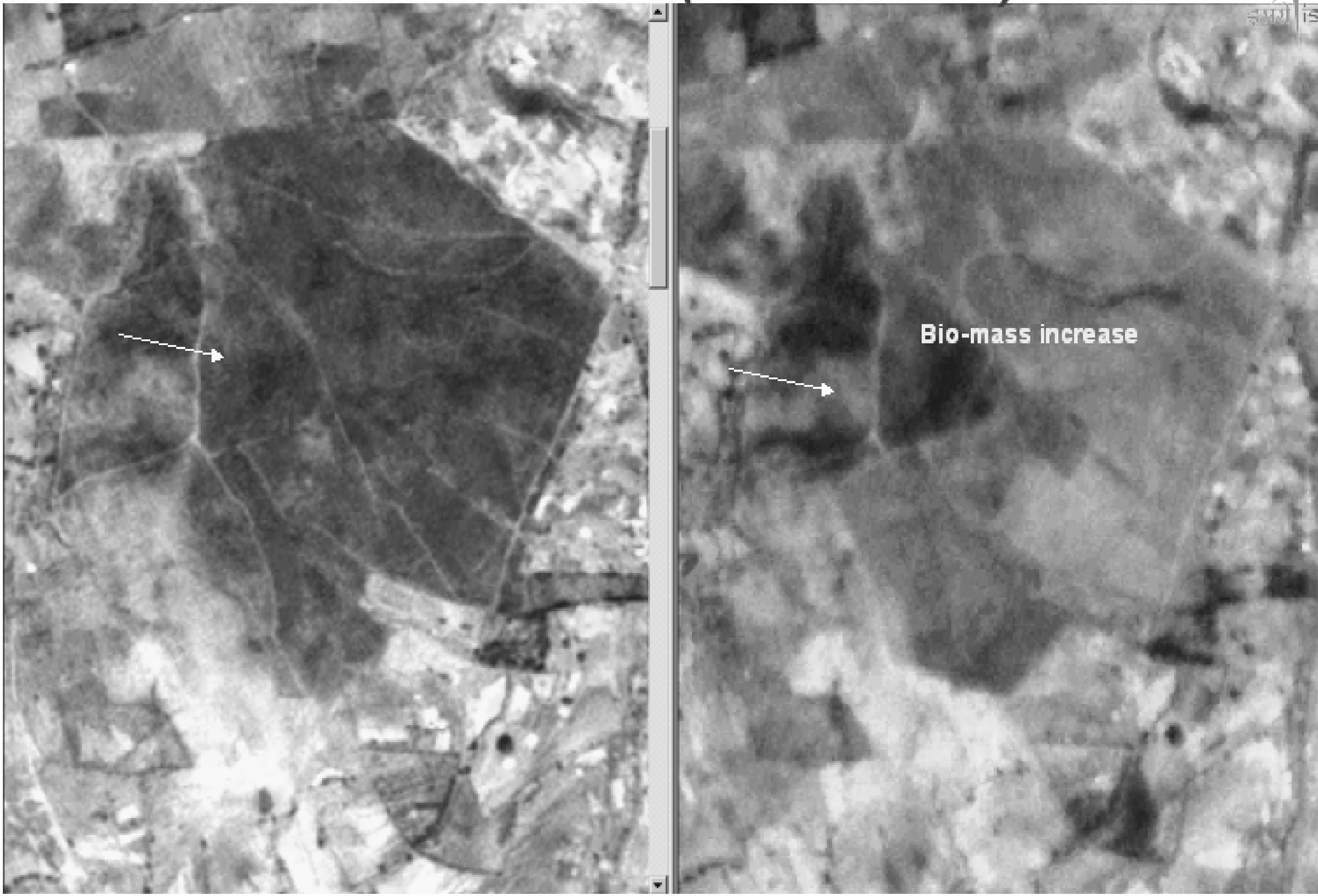
Afforestation Monitoring



Ground Photograph

Satellite Image

CPR Treatment (Afforestation)



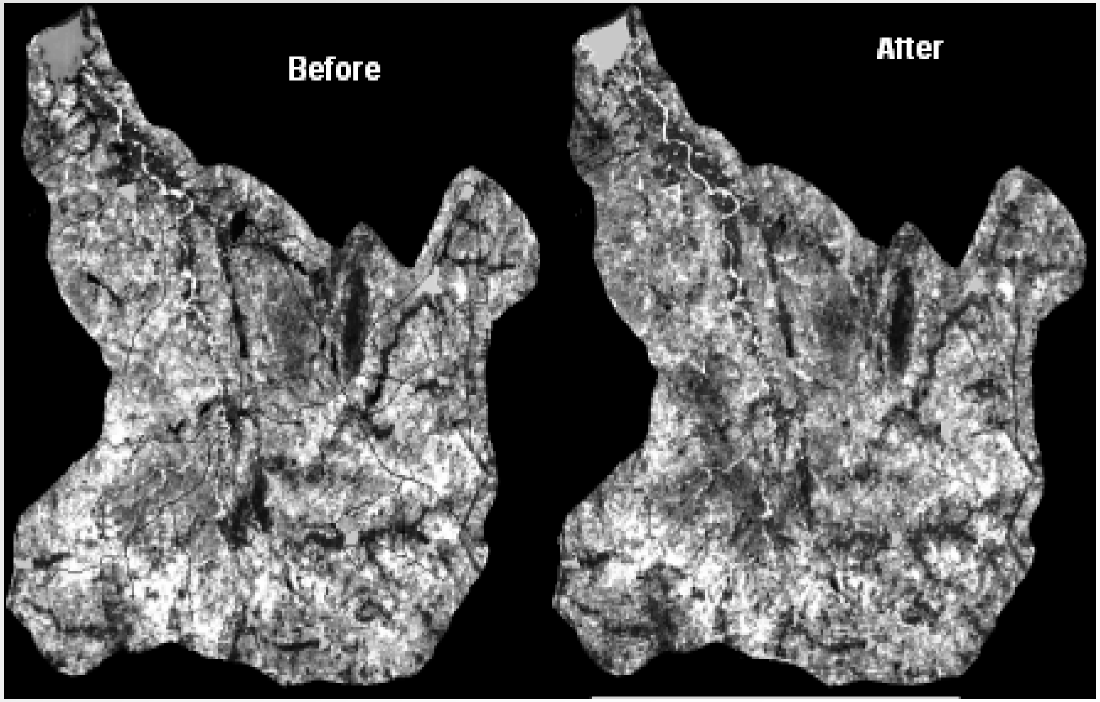
Before

After

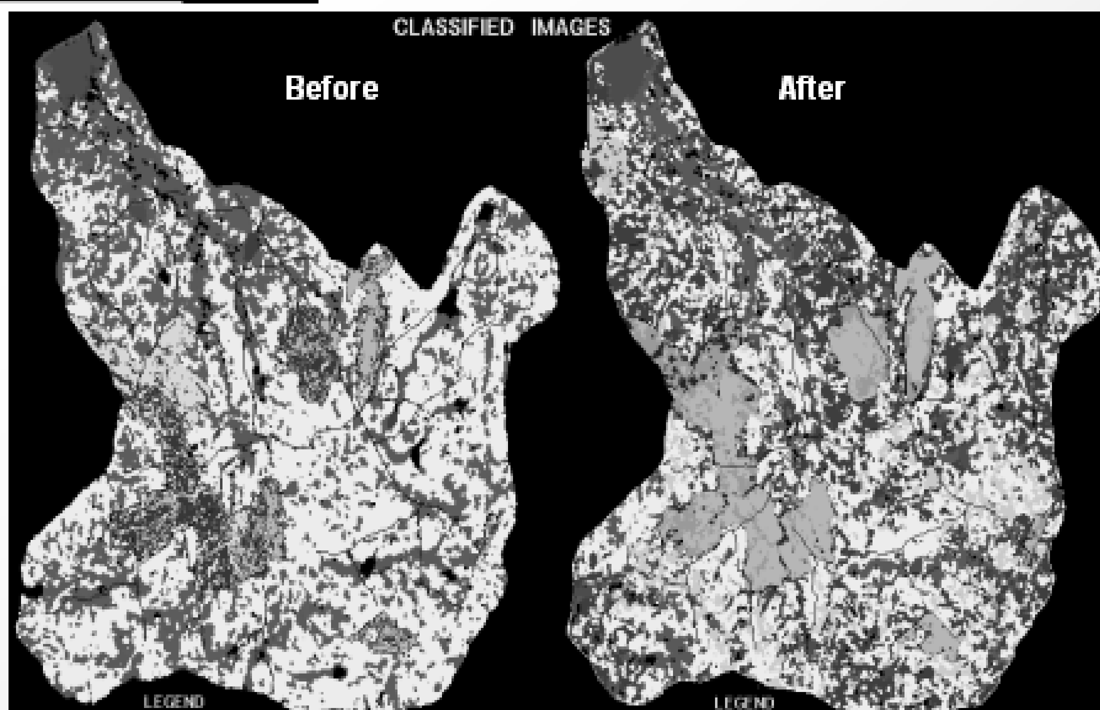
Managundi SWS, Dharwad District

IMPACT ASSESSMENT

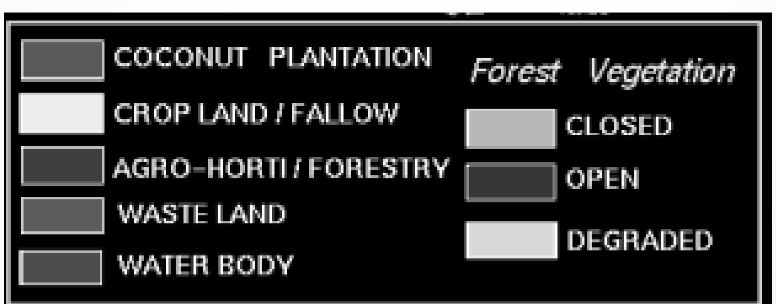
Land use / Land cover changes



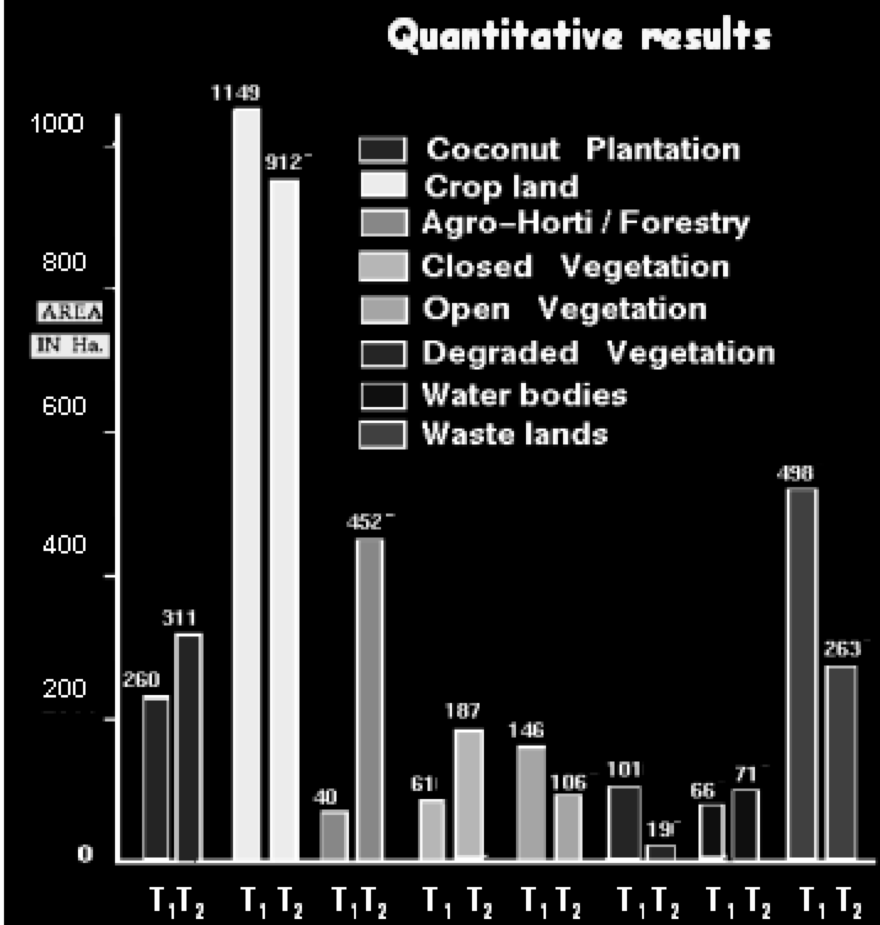
Satellite Images of
pre and post treatment periods



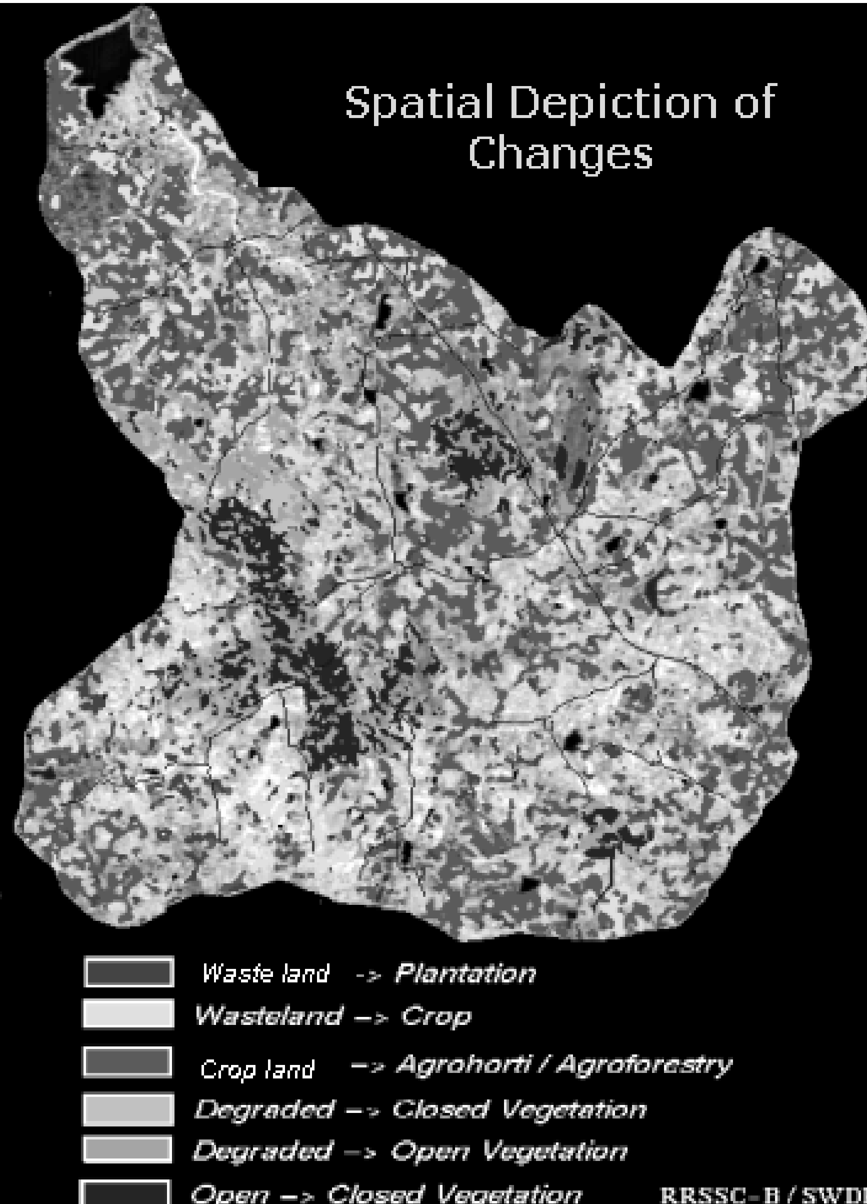
Classified Images of
pre and post treatment periods
depicting Land use/Land cover status



CHANGE IMAGE



Graph showing Land use / Land cover Status
Before and After the Treatment



BKR / KMN

RRSSC-B / SWDP

Visible Impacts

- Quality of life improved.
- Household income increased by 30%.
- Cropping intensity (%) increased - 106 to 124.
- Crop yield increase by 24%.
- Improved crop diversity from 2-4 to 3-6.
- Employment -15000 to 20000 man days/mws.
- Migration Reduced by about 70 to 80%.
- Wastelands / CPRs reclaimed - 50 to 60%.
- Improved Livestock and Milk production.
- Ground water yield increased by 250 gal/hr.

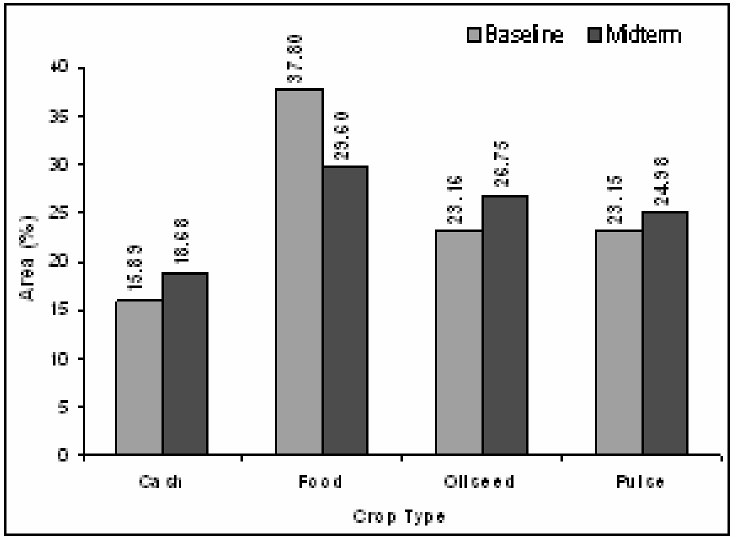




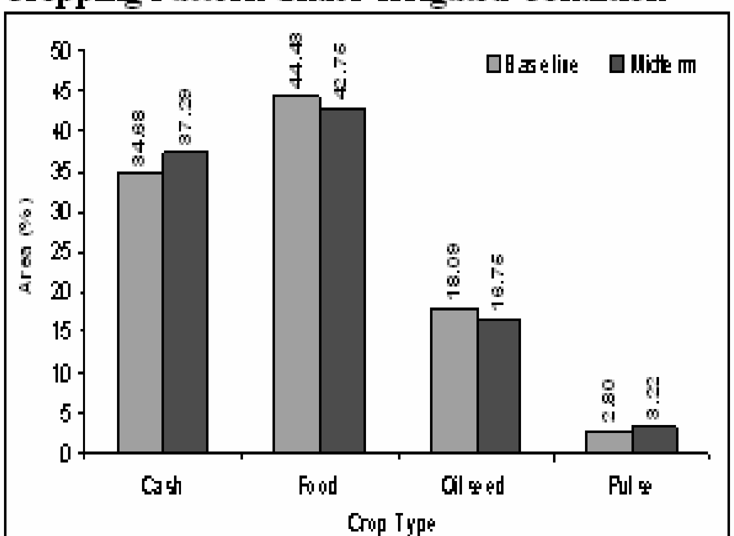



CROP DIVERSIFICATION

Cropping Pattern Under Rainfed Condition



Cropping Pattern Under Irrigated Condition



Visible Changes

Mono to Mixed Crop

Food to Cash Crops

Food to Oil Seeds

Food crops to Pulse

Crop Diversity

Baseline – 2 / 5 crops

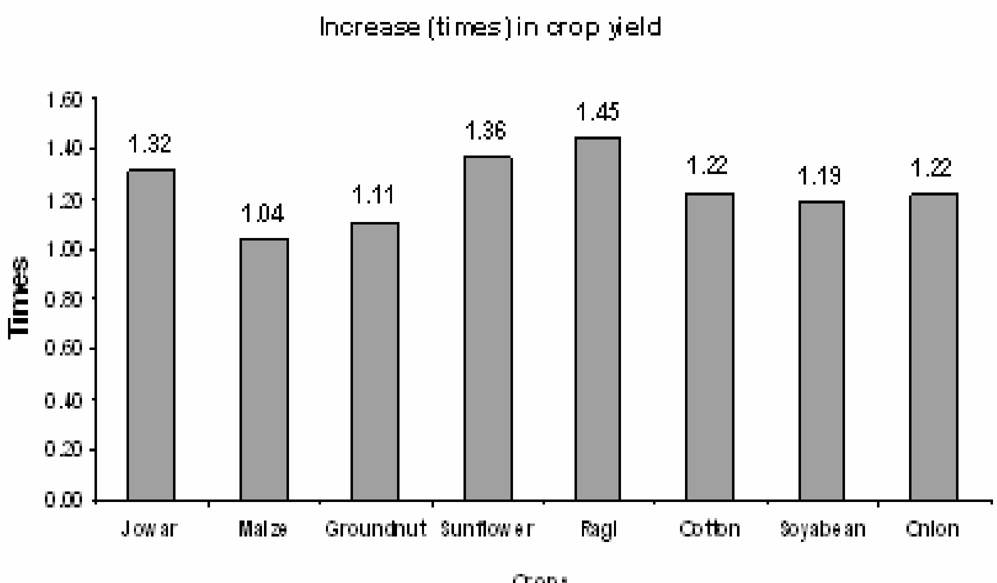
Midterm – 4 / 9 crops

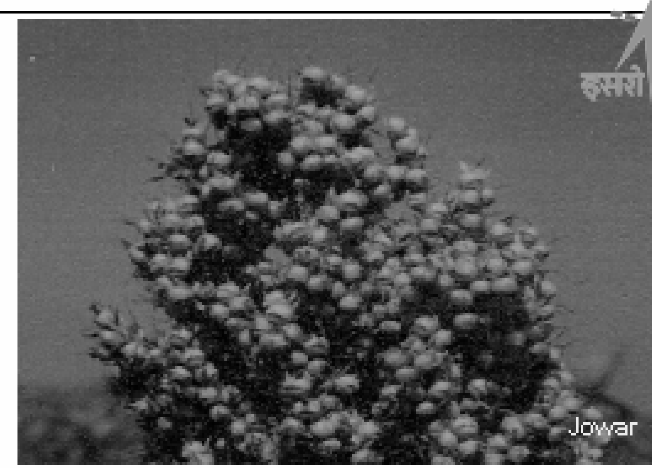
CROP YIELD

Improvement in Crop Yield (q/ac) observed

(under similar Agronomic practices)

Crop	Baseline	Midterm
Jowar	4.01	5.28
Maize	12.5	13
Groundnut	3.51	3.88
Sunflower	3.25	4.43
Ragi	3.04	4.4
Cotton	2.25	2.75
Soyabean	3.26	3.88
Onion	16.25	19.85



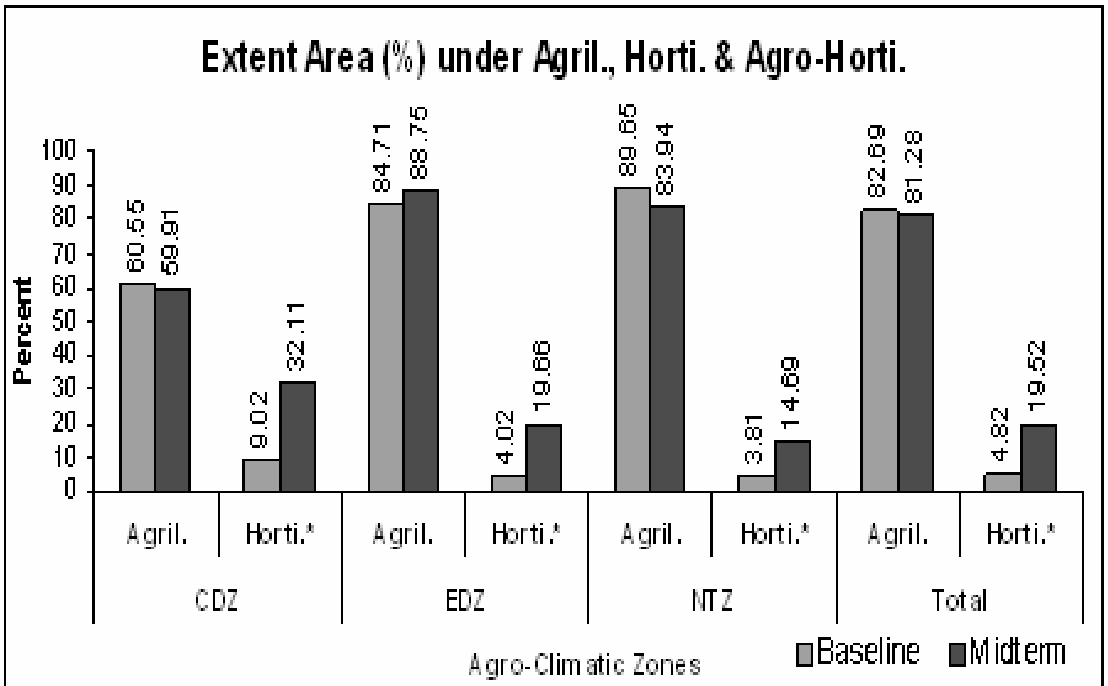


SHIFT TOWARDS AGRO-HORTICULTURE

District	Shift to Ag. Horti Actual Area (ha)	% of Total treated Area
Kolar	1294	6.69
Tumkur	865	6.61
Chitradurga	459	4.99
Haveri	329	2.47
Dharwad	771	5.43
Total	3719	5.38

Species grown
Mango, Sapota, Tamarind, Orange, Pomogranate

Survival rate
70 to 80%



GROUND WATER

A Few visible changes

Increase in Ground Water level (ft)
Dug / Open Well – 1.5 to 2.5 ft
Bore Well - 3 to 5 ft

Improved Ground water Discharge
Increase by 250 to 275 gallons / hr (1 gallon = 3.85 lts)

Period of Water Availability
Baseline - 3 to 4 months
Midterm – 4 to 6 months

Area Irrigated
Open / Dug Well – by 5 to 8 %
Bore well - by 10 to 20%

Improvement observed in
Crop Yield – 6 – 15 %
Cropping Intensity – 10 to 15 %
Crop Diversification – Food to Vegetable Crops

SOCIAL MOBILIZATION

Community Based Organizations (CBO's)

No. of CBOs formed

Self Help Groups (SHG)	–	909
Area Groups (AG)	-	498
SWS – Exe. Committee	-	80

CBO Functioning

SHG > 70 % - Good Performance

AG > 60 % - Moderate – Low Performance

SWS – EC > 70 % - Good Performance

Savings Mobilized

SHG – 163 . 0 Lakhs
AG - 12 . 9 Lakhs

SHG meeting

Area Group meeting

Executive Committee meeting

CAPACITY BUILDING

- Training programs
- Exposure visits
- Tele-conferences

Item	SHG	AG	EC
Trainings (No.)	5741	4475	853
Participants (No.)	74856	118351	9836

IMPACT	SHG	AG	EC
Increased awareness and skills	Moderate	Moderate -Low	Moderate
Improved Participation	Good	Moderate	Good
Increased self confidence	Good	Good	Good
Increased decision making capability	Moderate	Moderate	Moderate - Good
Increased environmental awareness	Low	Moderate	Moderate
Capable to undertake IGA/ME	Good	Moderate	Good


Executive Committee Training


SHG Training


Area Group Training

EMPOWERMENT OF WOMEN

IMPACT	SHG	AG	EC
Participation	Good	Low	Moderate
Decision making ability	Good	Low	Moderate
Financial management	Good	Low	Low
Self esteem and Confidence	Good	Moderate	Good
Access to employment opportunities	Good	Moderate	Good
Economic empowerment	Good	Moderate	Good
Reduced vulnerability	Moderate	Moderate	Good
Access to basic resources	Moderate	Moderate	Good


Financial Management


Group Decision Making

INCOME GENERATING ACTIVITIES (IGA)

Status of IGA

Activities	Number	Budget(Lakhs)
EDP Training	7272	104
Skill Training	903	80
Micro enterprises	5197	280

Districts	Agency	Trained	Activity Started
Kolar	IDF	1661	1115
Tumkur	Awake	1800	1157
Chitradurga	RUDSETI	1335	956
Dharwad	CEDOK	1377	1058
Haveri	IDF	1099	753

Major Activities Undertaken

- Cow / Buffalo rearing
- Sheep / Goat rearing
- Petty shop
- Tailoring
- Coconut business
- Broomstick Business
- Vegetable Business
- Kirana shop

IMPACT : Income increased, better livelihood, Improved Social Status


Tailoring


Hotel


Condiments

EMPLOYMENT GENERATION AND MIGRATION

Increased employment opportunities

- 15,000 – 20,000 man days / MWS

Increased income

– between Rs. 4,000 to 6,000 / person

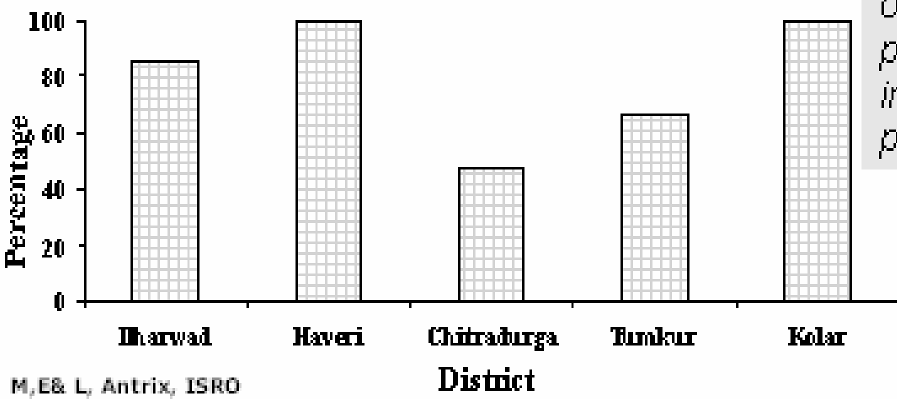
Major Employment Generating Activities

Bunding, Horticulture / Forestry, Farmpond, Boulder / Rubble Check

Impact

- **Increased employment due to IGA**
- **Reduced seasonal migration**
- **Change in migratory period & season**
- **Increase in the Household income**

Percent of Migrating Population Benefited



Slight increase in migration due to reduced employment opportunities in post implementation period

HOUSEHOLD INCOME

Increase in income due to
- **Employment**
- **Income Generating Activity**
- **Agri. Productivity**

Change in household income – 1.3 – 1.9 times

Baseline – Rs.10300 to 13000
Midterm – Rs.15000 to 25000

Central Dry Zone

LH-class	Baseline	Midterm	Increase
LL	5320.00	9053.33	1.70
MF	7750.00	11625.00	1.50
SF	11463.64	18759.09	1.64
BF	16796.67	27160.00	1.62

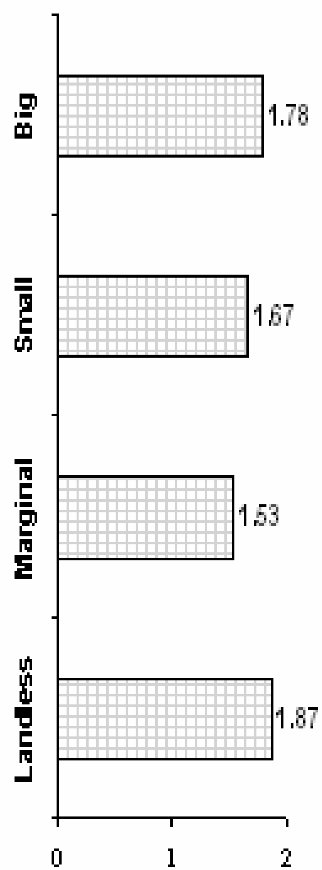
Eastern Dry Zone

LH-class	Baseline	Midterm	Increase
LL	4752.07	9296.55	1.96
MF	10003.33	13460.42	1.35
SF	14795.95	21022.97	1.42
BF	20326.32	37515.09	1.85

Northern Transition Zone

LH-class	Baseline	Midterm	Increase
LL	7570.00	14836.67	1.96
MF	10750.00	18970.00	1.76
SF	14944.57	29106.18	1.95
BF	21507.15	40604.31	1.89

Overall Increase



PARTICIPATORY MONITORING & EVALUATION

Community Level

- Implementation
- Impacts (Social, Environmental)
- Protection & Maintenance
- Sharing of Benefits
- Quality of Works

Reports

- Monthly Observation Reports
- Assessment reports
- Feedback reports
- Evaluation reports
- Thematic reports
- Input - Output reports
- Software User Manuals
- Special reports

Thematic Studies

- Investment Pattern
- Social Inclusion
- Women Empowerment
- Capacity Building
- Equity Issues
- Live stock
- Income Generating Activities
- Short term Impacts
- Ground water recharge
- Case Studies

GAPS OBSERVED / LESSONS LEARNT

- Ridge to valley concept – lesser adoption
- Holistic approach - Lacking. (Integration of different sectors)
- Land treatment – Preference to private land in comparison to Common property resources
- Usage of machinery - reduces employment opportunities
- Delay in initiating IGA's – Created frustration among SHG's
- Reserve forest within the watersheds - Not treated
- Common land treatment – More of soil and water conservation activity than afforestation
- Resentment to make use of MIS at the field level.
- IGA Revolving fund is less – needs enhancement to ensure better equity
- Capacity building was less effective initially. Subsequently remodeled to improve quality & participation
- NGO technical capability – good in social mobilization. Low with respect to WS development.
- SWAP preparation – Lack of clarity affected the quality of SWAP. Revised 4-5 times in Phase-I
- Witnessed lot of R&D resulting in improvement and hence revising the procedures / policy
- Initial delay in manpower positioning at Sujala HQ and subsequent changes in organizational structure
- Finalization of SR rates / payments, cost sharing & implementation – affected pace of the project
- Integration of livestock activities into the project - delayed (Gopal mitra, vet care, LEA, etc)
- Audio conference & SATCOM programs –effective in monitoring the progress & capacity building
- Participatory Research & Demonstrations initiated at the fag end of I phase
- Monthly open house meetings – Towards more transparency – yet to be stream lined
- Post project management of assets - yet to be operationalised at community level

These learning's are addressed and refined by Implementing Agency (WDD), ensuring better realisation of the project objectives & goals.

Integrated approach of M E & L has brought in Transparency, Accountability and Discipline in the project

Estimation of Runoff using RS and GIS using SCS - Curve Number method

Runoff - draining off of precipitation from a catchment through a surface channel.

Curve Number Method - US Soil Conservation Society (1972)
Also known as 'Hydrologic Soil Cover Complex Method'.
A land's runoff producing capability expressed b/n 0 - 100.

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \frac{25400}{CN} - 254$$

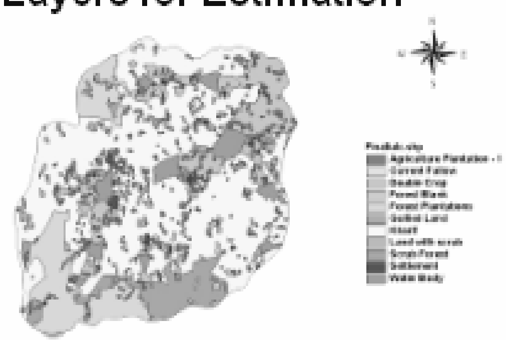
Where, Q = Runoff depth (mm);
P = Rainfall (mm); S = Infiltration (mm)
& CN = Weighted curve number

Why Estimate Runoff?

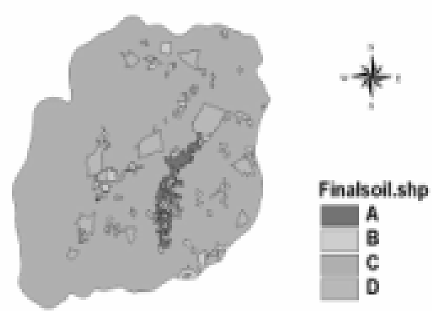
- Control of soil erosion
- Construction of CDs, NBs
- Water budgeting
- Cropping system intensification
- Crop diversification &
- Precision agriculture

Satellite Data – Land Use / Land Cover & Soil map; GIS – Creation, Integration and Analysis of thematic data

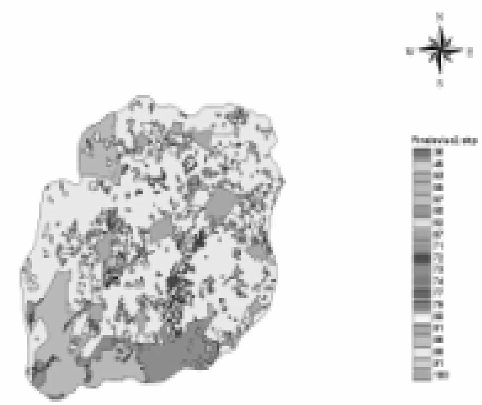
Basic Layers for Estimation



Land Use / Land Cover



Hydrologic Soil Group

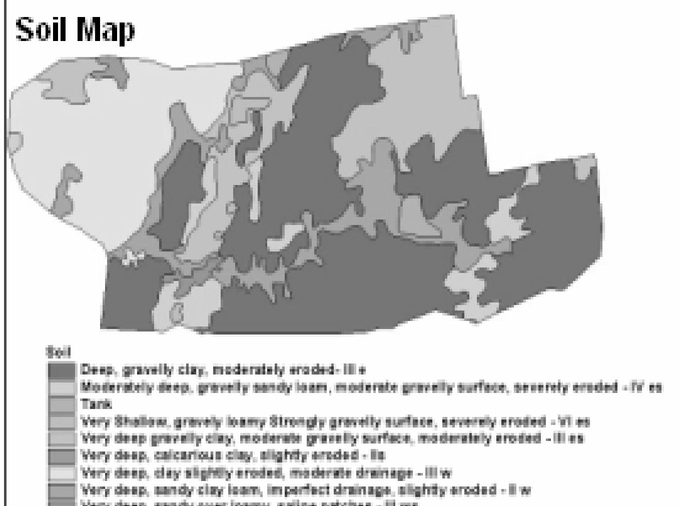


Soil Veg. Complex

Case Study - VK Gudda MWS, Suvarnamukhi SWS, C'Durga

Land Use / Land Cover Map

Soil Map



Soil Grouping

Soil group	Soil characteristics
Group A	Deep sand and aggregated soils
Group B	Shallow losses and sandy loam
Group C	Clay loam, shallow sandy loam
Group D	Plastic clays and saline soils

Soil – Vegetation – CN Matrix

Land use	Hydrologic soil group			
	A	B	C	D
Agricultural land without conservation (Kharif)	72	81	88	91
Agricultural land with conservation (bunding)	67	75	81	83
Double crop	62	71	88	91
Agriculture Plantation	45	53	67	72
Land with scrub	36	60	73	79

Major Observations

Wt. Average CN – Reduced to 77.59 from 82.87

Infiltration (mm) – increased to 73.38 from 52.50

Run-off depth (mm) – decreased to 493.47 from 514.48

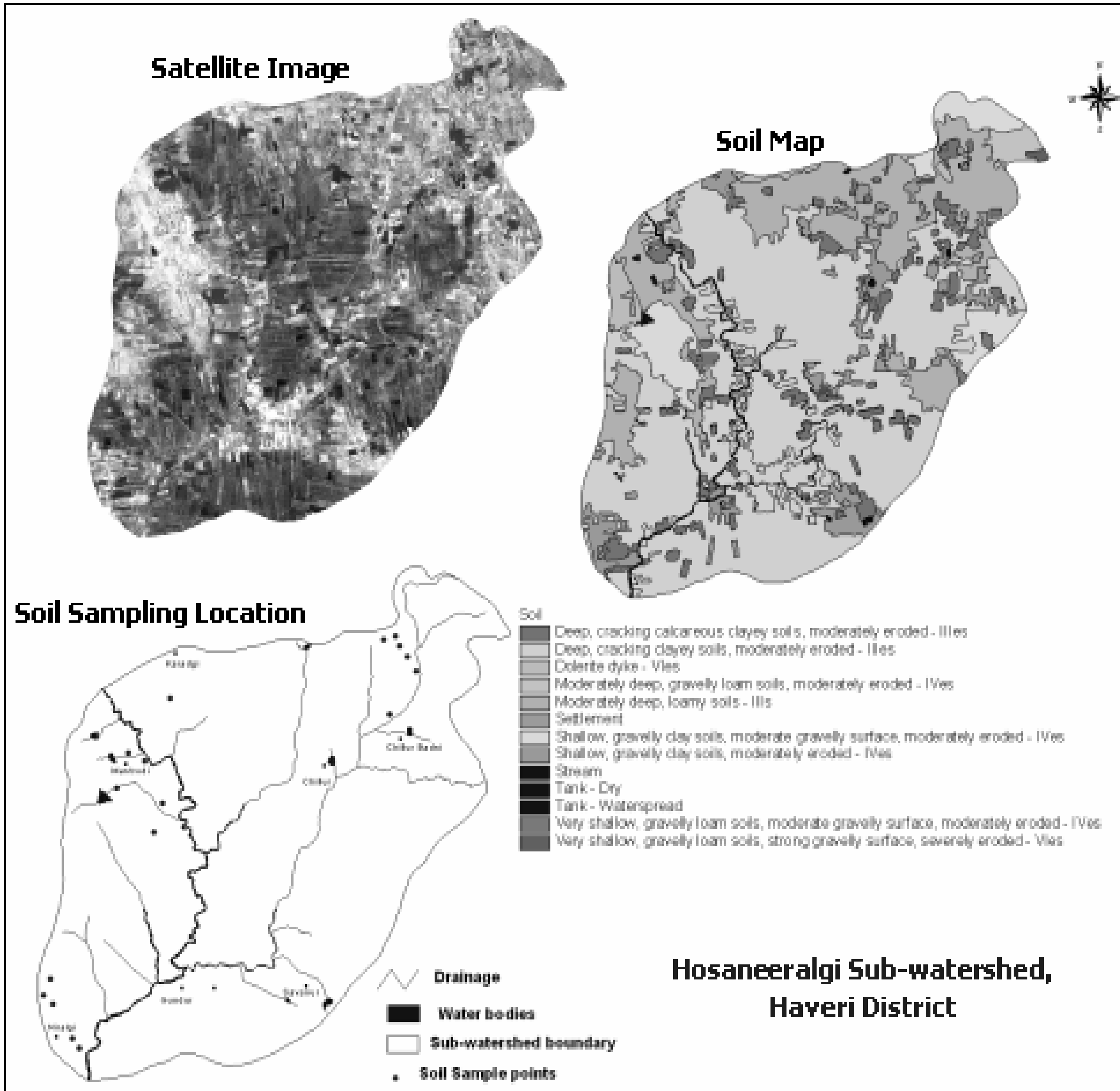
Run-off vol. (cu.m) – decreased by 210 units/ha

Soil Fertility Analysis

Objectives
Assess the soil quality
Benchmark nutrient content
Quantify Water Holding Capacity

Parameters Considered
Macro-Nutrients (NPK)
Micro-Nutrients (Zn, Fe, Mn, Cu)
Organic Carbon, pH, EC
Moisture Holding Capacity

Mid-Term Results
- Increased Organic Carbon content
- Improved moisture holding capacity



M,E& L, Antrix, ISRO

Assessing Agro-biodiversity & Cropping Pattern in a treated watershed of Karnataka

- Biodiversity - sustaining force for all living processes on earth
- Bio-diversity encompasses Genes to Ecosystems
- Agro-biodiversity has a unique place within bio-diversity
- Essential to satisfy human needs - food and livelihood security

Objective

- Characterize the Agro-biodiversity
- Changes in Cropping Pattern and Intensity
- Impact on Crop diversity and dominance

Location

14° 30′ - 14° 36′ N

75° 37′ - 75° 41′E

Period

Baseline (2003 – 04)

Midterm (2004 – 05)

Study Area

Itagi sub-watershed, Haveri district

Part of North Transition Zone

Annual Precipitation : 600 – 650 mm

Soil – Black Cotton / Red Lateritic

Data Used

Household survey – 90 HH

Field observations / visits

Transect-walks

Focused group discussions

High Resolution Satellite Image

Cropping Intensity

Multiple Cropping Index (MCI) = Σ ai *100 / A

Cropping Diversity

Area Diversity Index (DI) = $1 / \Sigma (ai/A)^2$

Shanon-Weiner Index (H') = $-\Sigma (ai/A) * \log 10 (ai/A)$

Crop Dominance

Simpson's Dominace (D) = $\Sigma (ai/A)^2$

where, ai = area occupied by i^{th} grp. & "A" = total cultivated land.

M,E& L, Antrix, ISRO

Impact on Agricultural Land use

- Shift towards Agro-forestry and Horticulture
- Area under agriculture has reduced by about 15%.
- Horticulture increased to 63.35 ac from 20.5 ac.
- 71.5 ac brought under agro-forestry.

Impact on Cropping Pattern

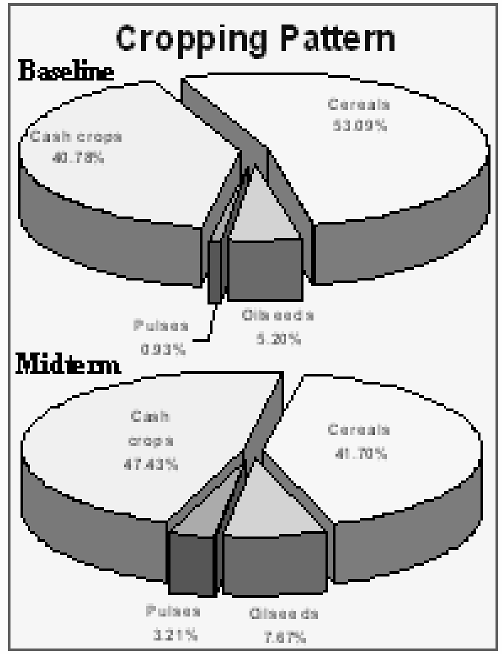
- Shift from low value to high value crops.
- Increased area of Cash crops, Oil seeds & Pulses
- Adoption of mixed cropping system
- Greater Increase in dry land horticulture

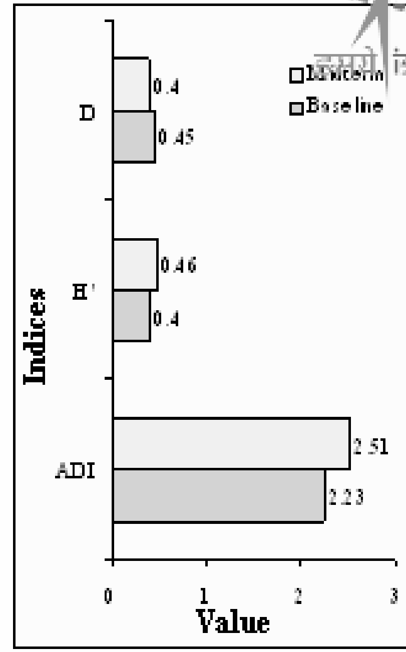
Impact on Crop Diversity

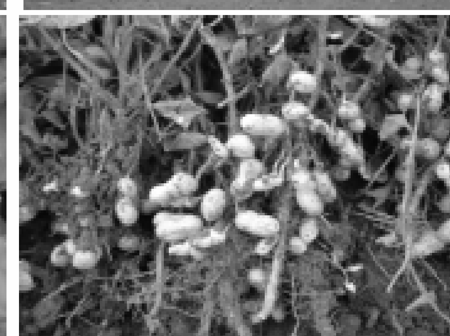
- Increased number of Cereals & Pulses
- Horticulture – Only Intensification, no diversification
- Diverse Agro-forestry activity.
- Forestry – Teak/Silver oak /Tamarind/Neem /Pongamia

Impact on Cropping Intensity & Dominance

- Cropping Intensity increased by 21%
- Increased Cropping Diversity
- Reduced Crop dominance



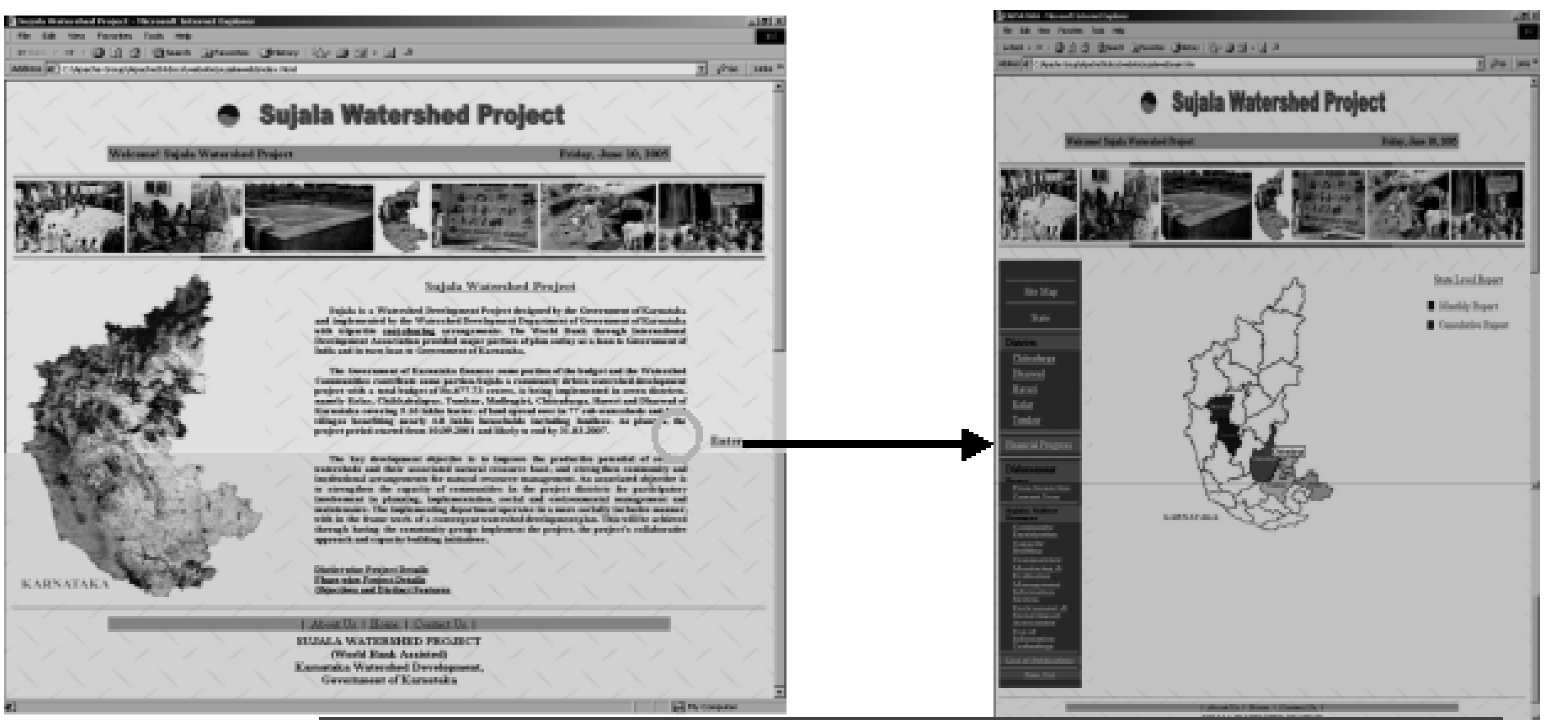




M,E& L, Antrix, ISRO

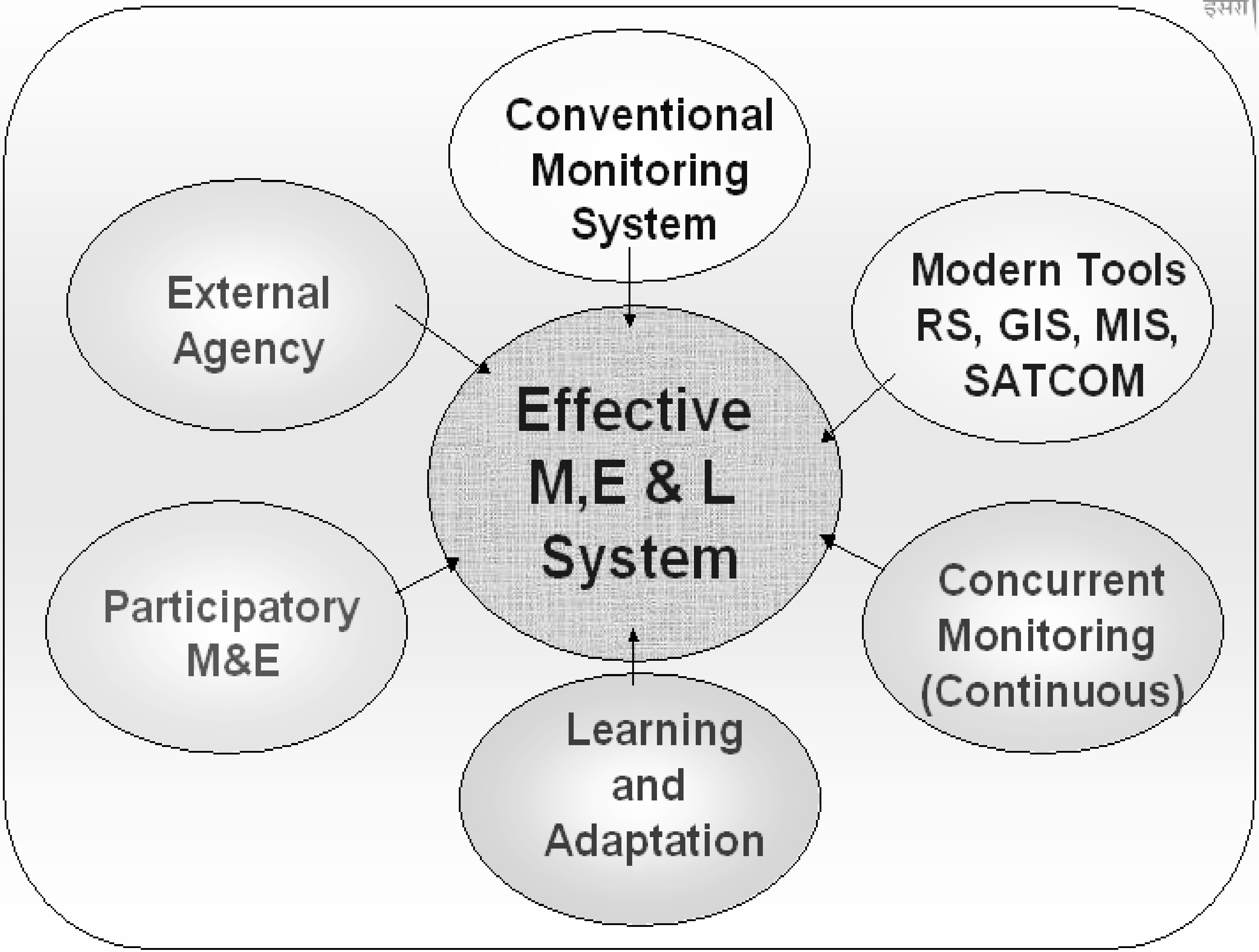
Website of Sujala Project

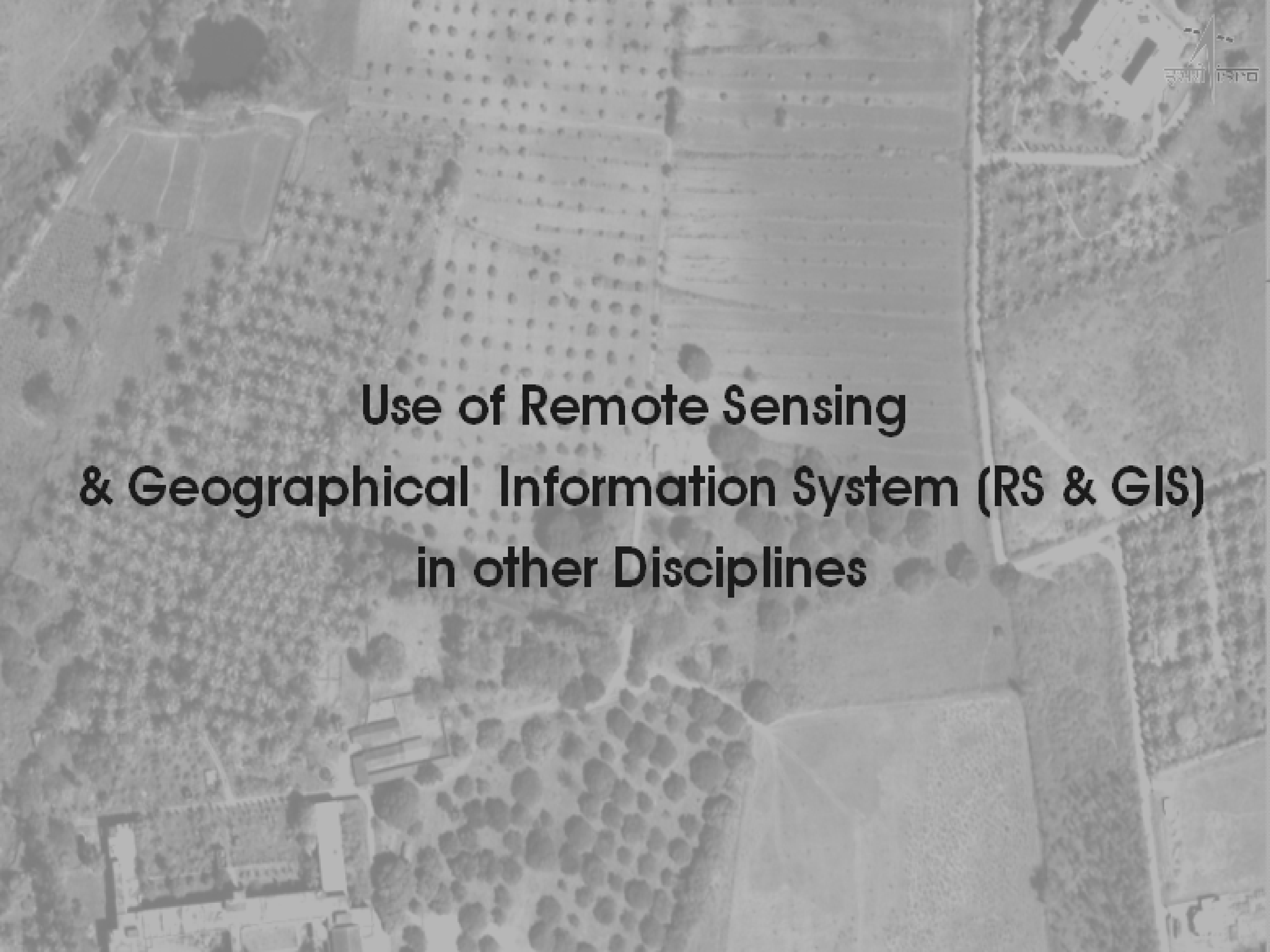
- **Salient Features**
  - Basic information on Sujala project objectives and area
  - Map clicks for navigation, query and information extraction
  - Important softcopy documents available for browse and download
  - Implementation status Reports at State,District and Sub Watershed level
  - **Phase wise reports update on monthly basis**



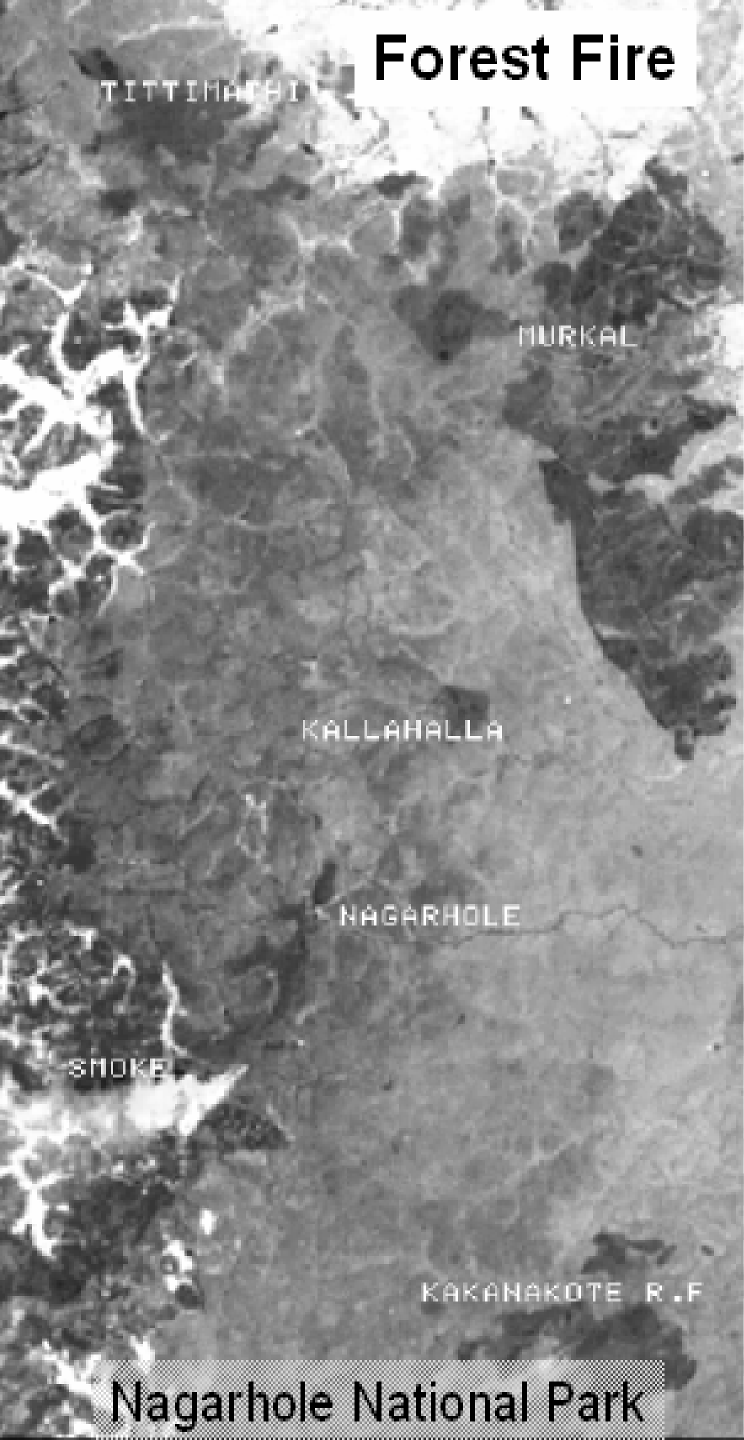
Plz. Visit: http://www.kar.nic.in/watershed/sujala

An Ideal M E & L System

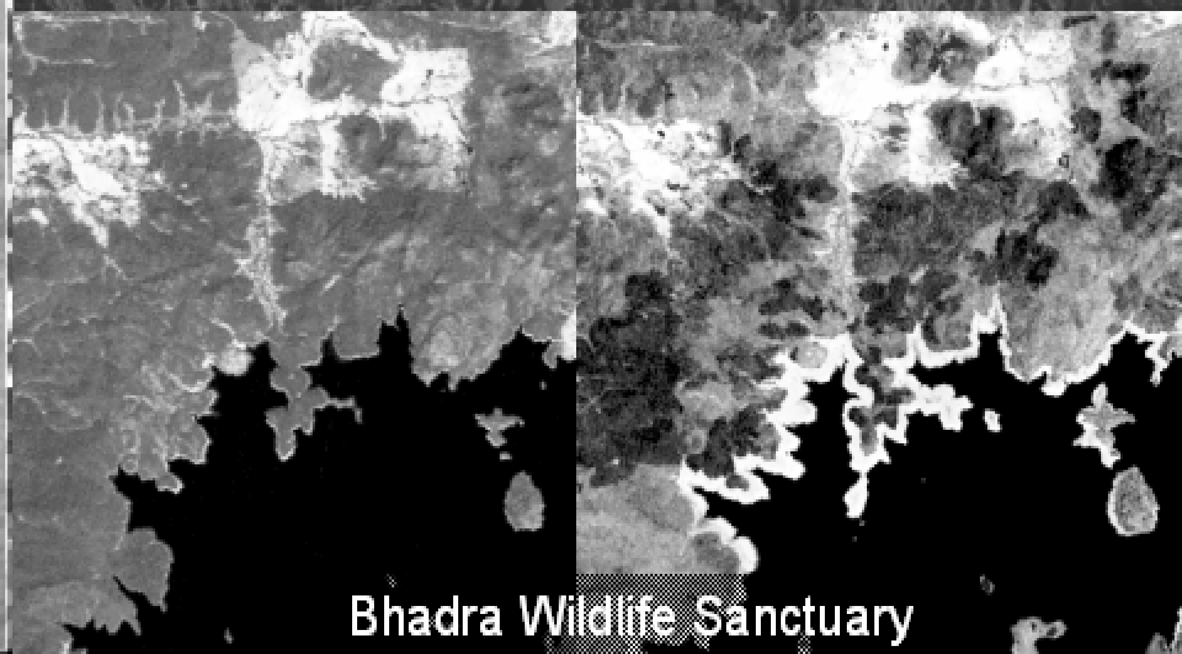




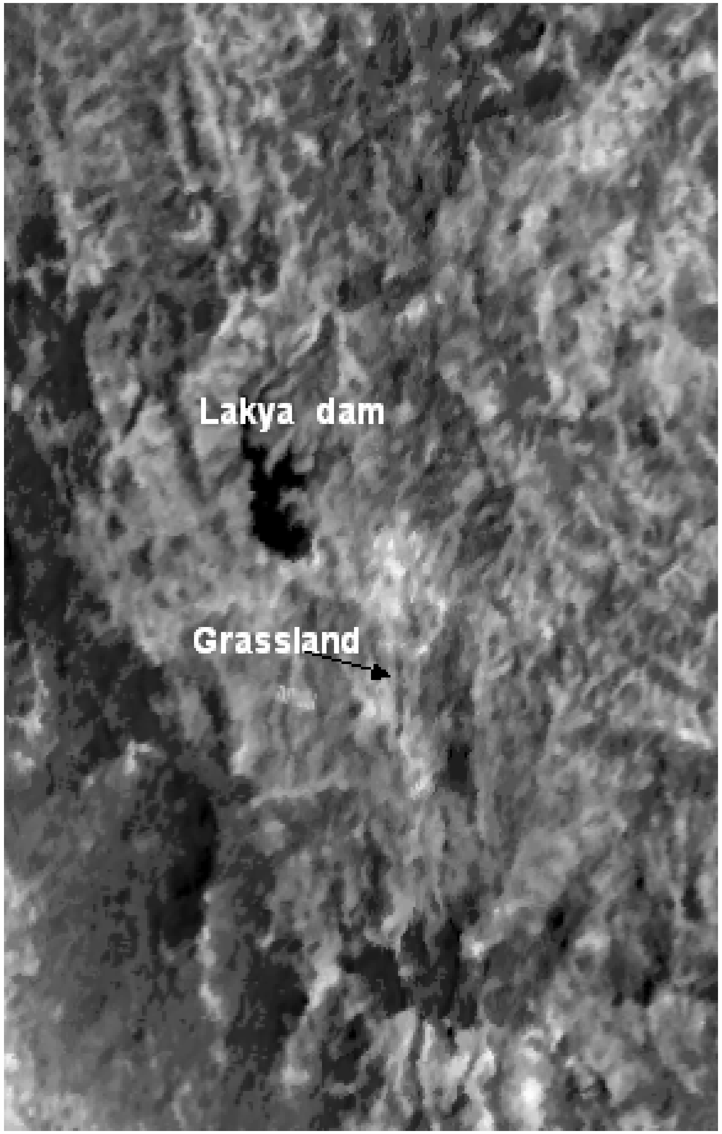
Use of Remote Sensing & Geographical Information System (RS & GIS) in other Disciplines

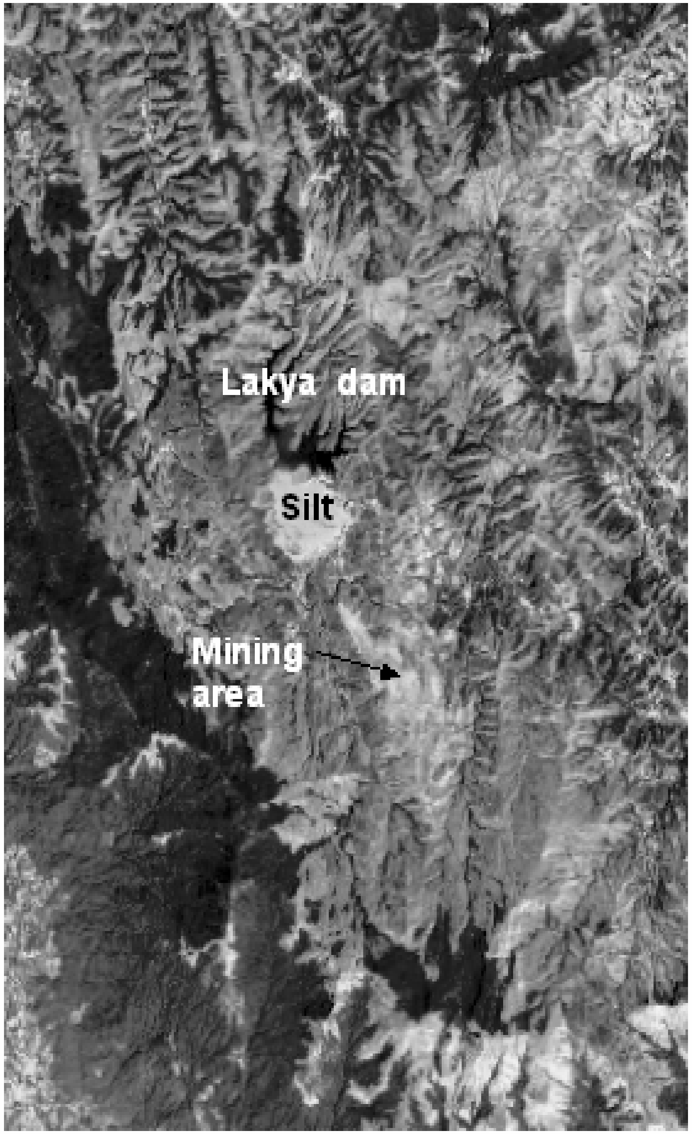

Forest Fire
TITTIMATHI
MURKAL
KALLAHALLA
NAGARHOLE
SMOKE
KAKANAKOTE R.F
Nagarhole National Park


Community Participation in
Conservation & Protection (Buffer Zones of NP and WLS)


Bhadra Wildlife Sanctuary

MINING ACTIVITY

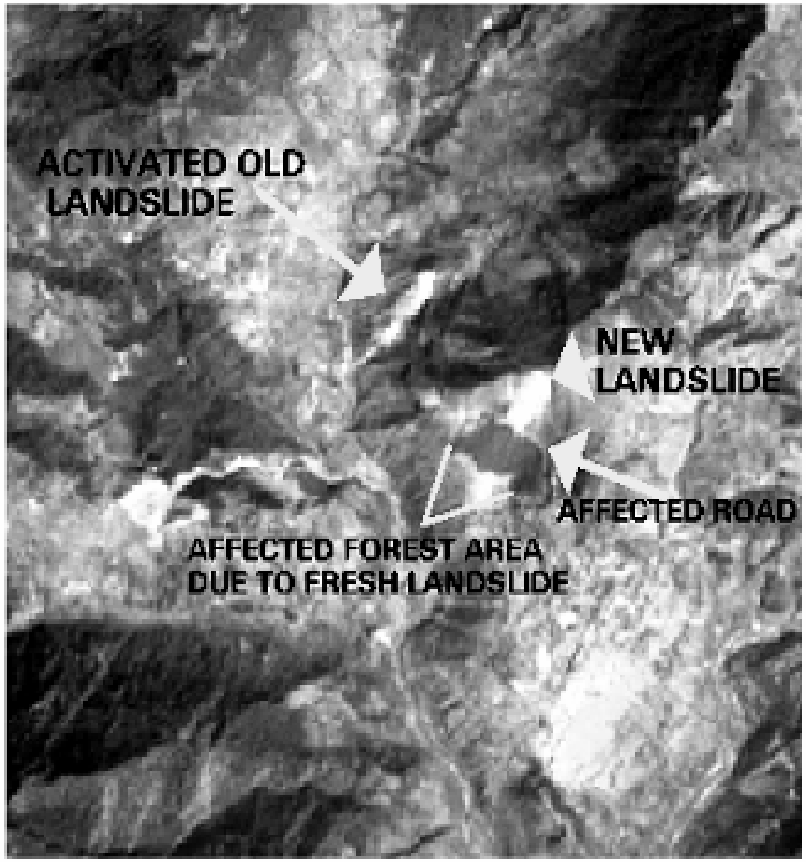




1983 Kudremukh area 1999

EARTHQUAKE INDUCED LANDSLIDES

PRE-EARTHQUAKE: 26-03-99
IRS-1C, LISS-III DATA



POST-EARTHQUAKE: 30-03-99
IRS-1C, LISS-III DATA

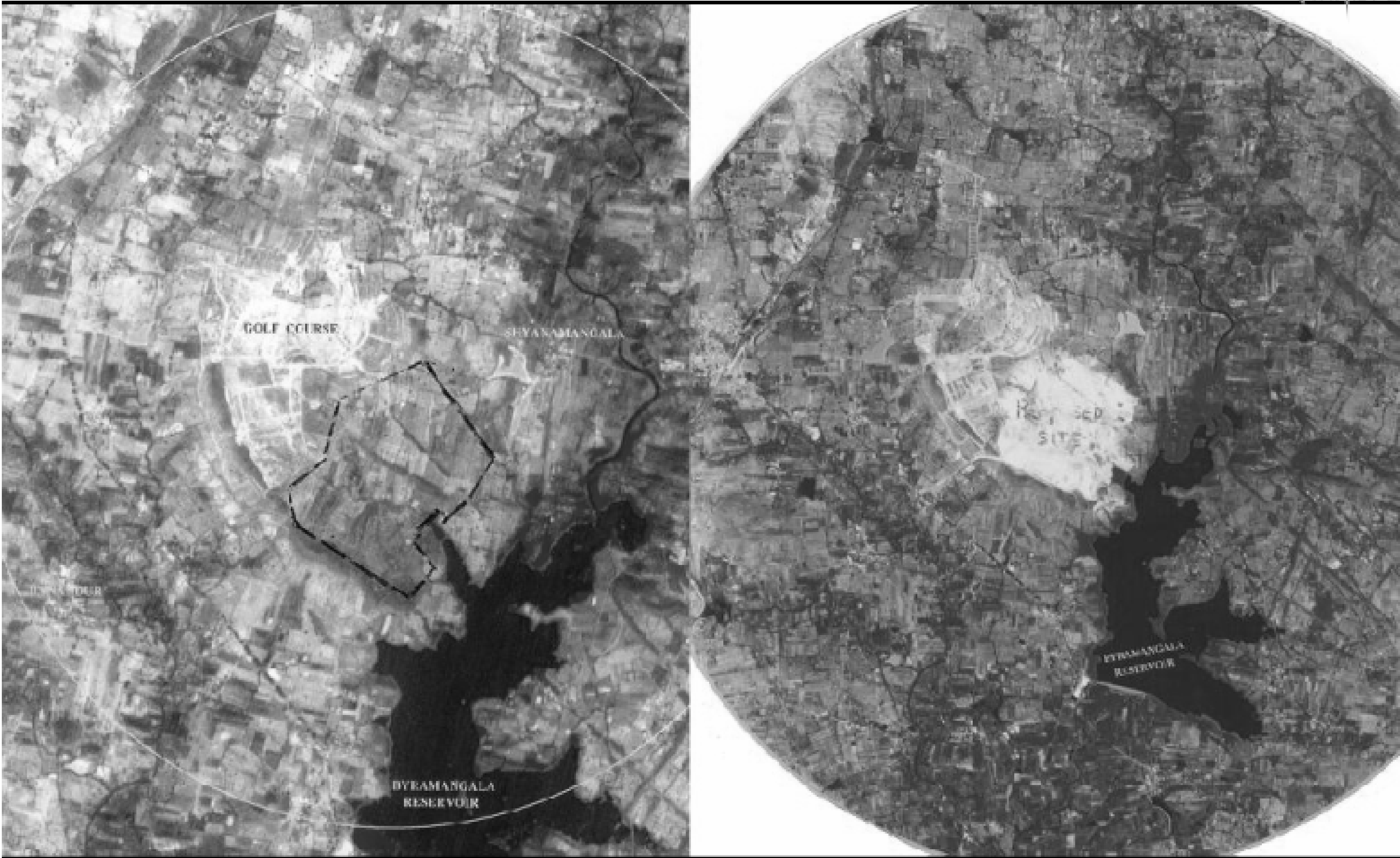
STUDY AREA: NEAR GOPESHWAR, CHAMOLI DISTRICT

NRSA/ISRO

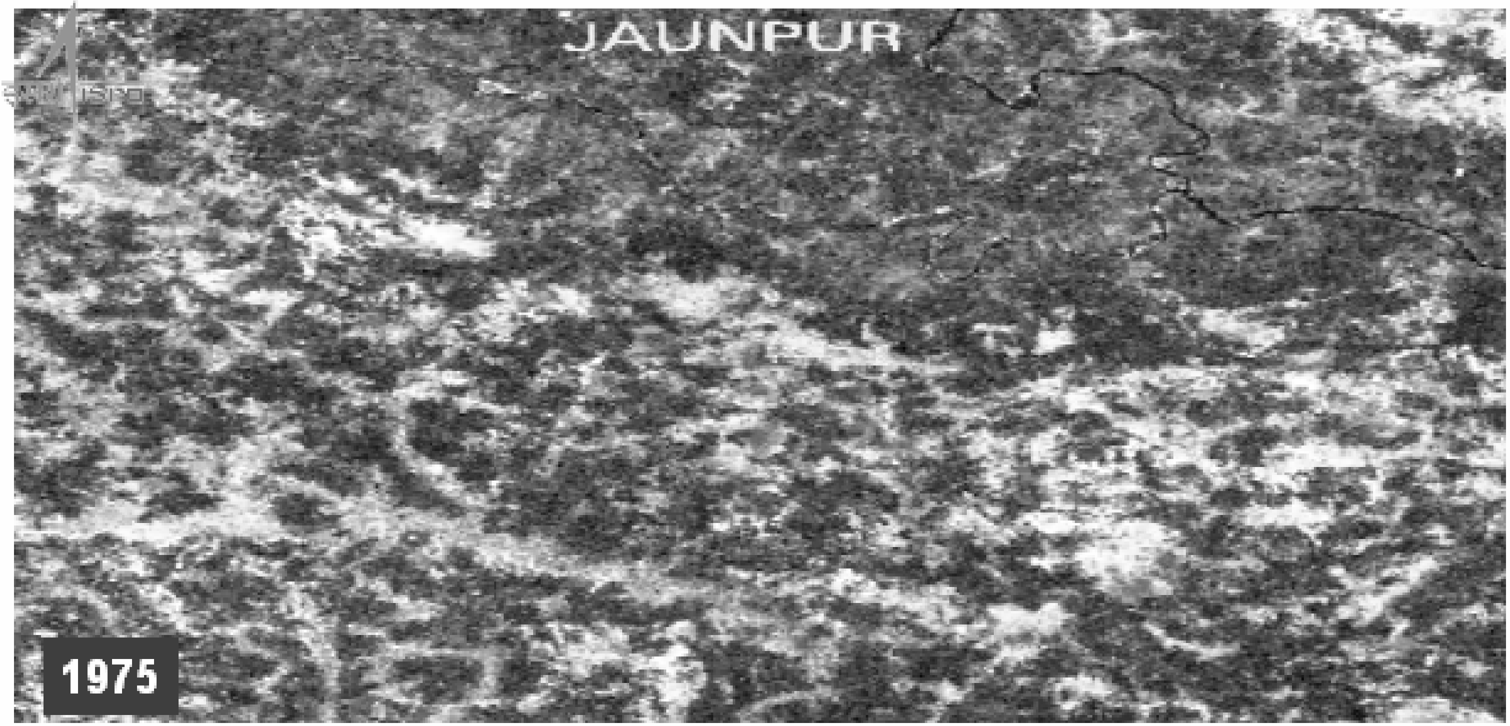
IRS -1D IMAGE OF PART OF SANGUEM TALUK, GOA

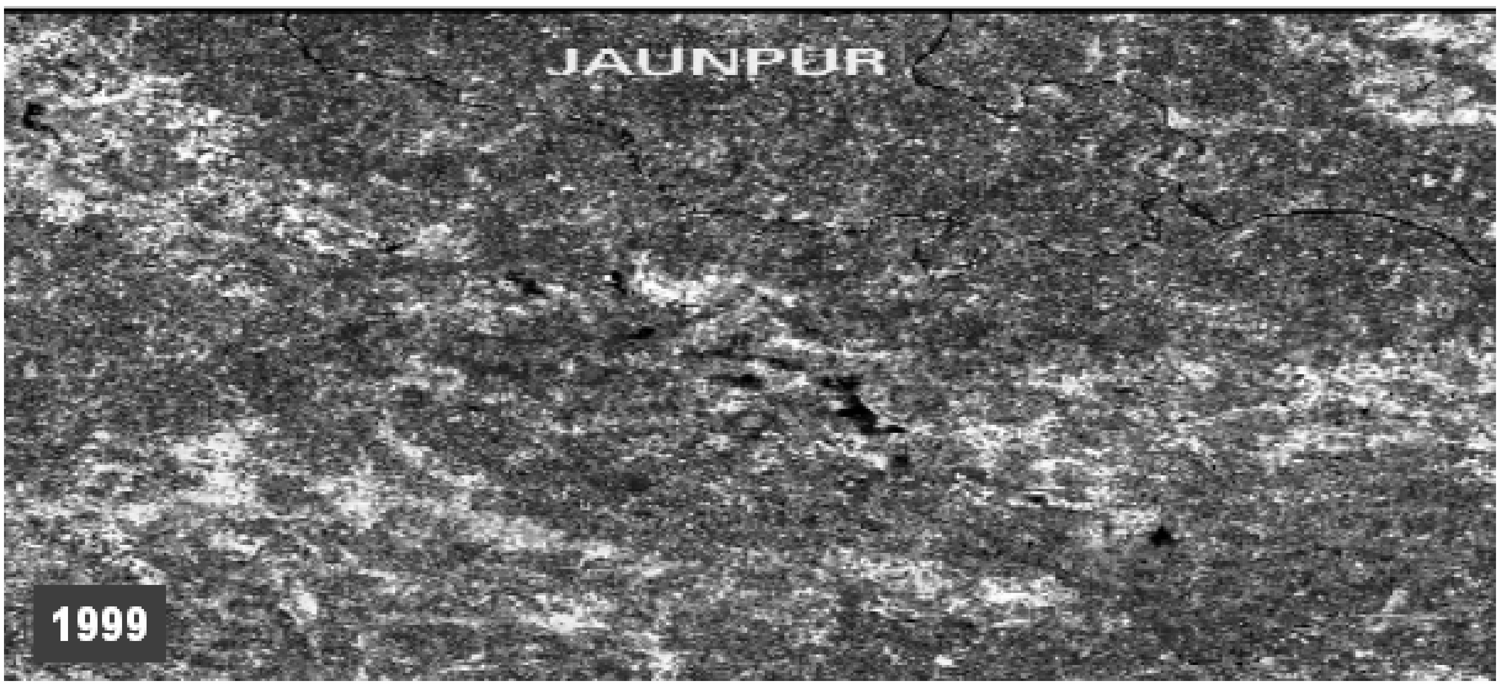
MINING ACTIVITY IN NETRAVATHY WILDLIFE SANTUARY

EIA and EMP inputs for industrial sites



Bangalore Rural District, Karnataka





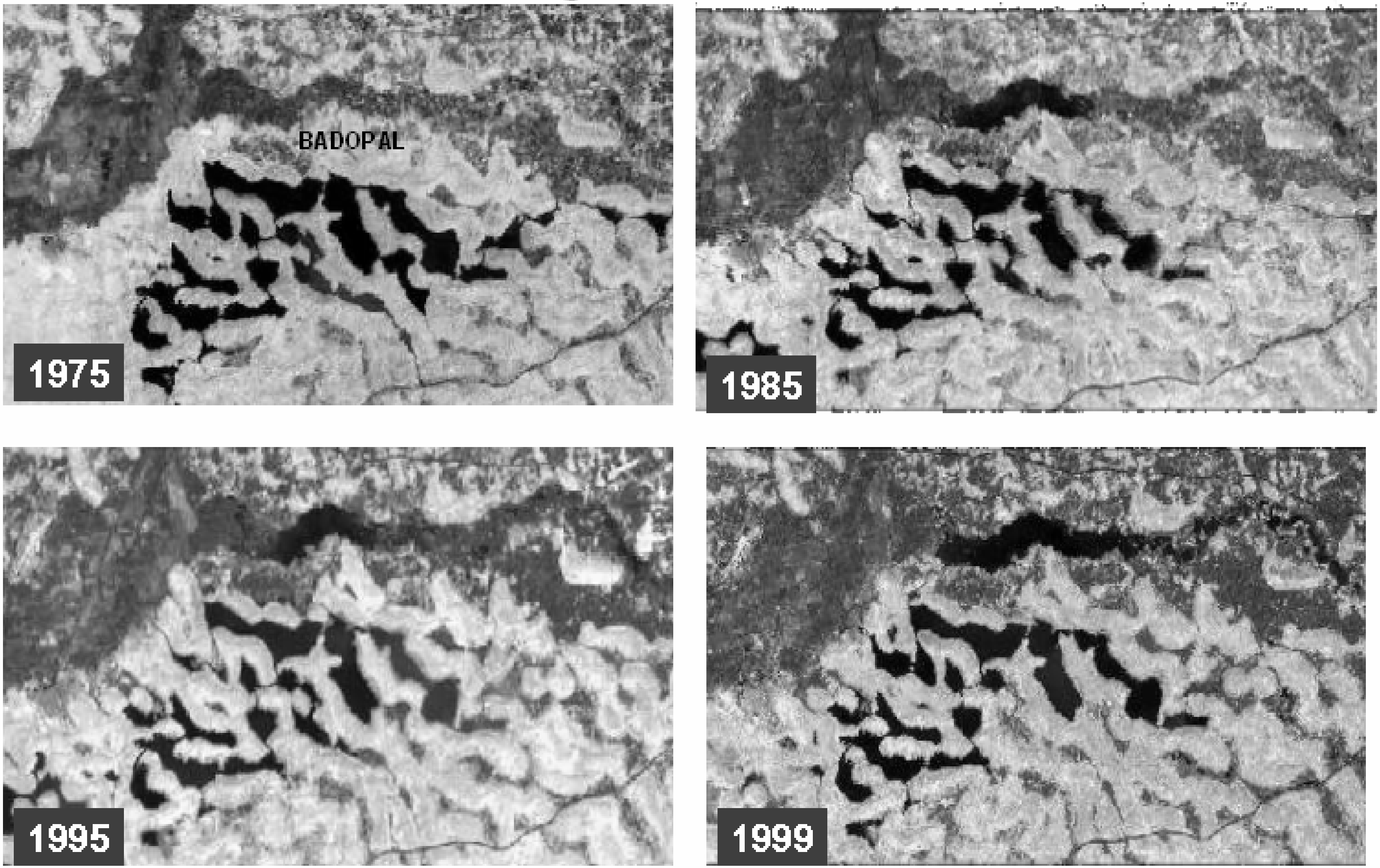
Monitoring of soils affected by Salinity / Alkalinity

Part Of Sharda Sahayak Command Area (Indo-Gangetic Plains), Jaunpur (UP)

1975 – 46,029 ha

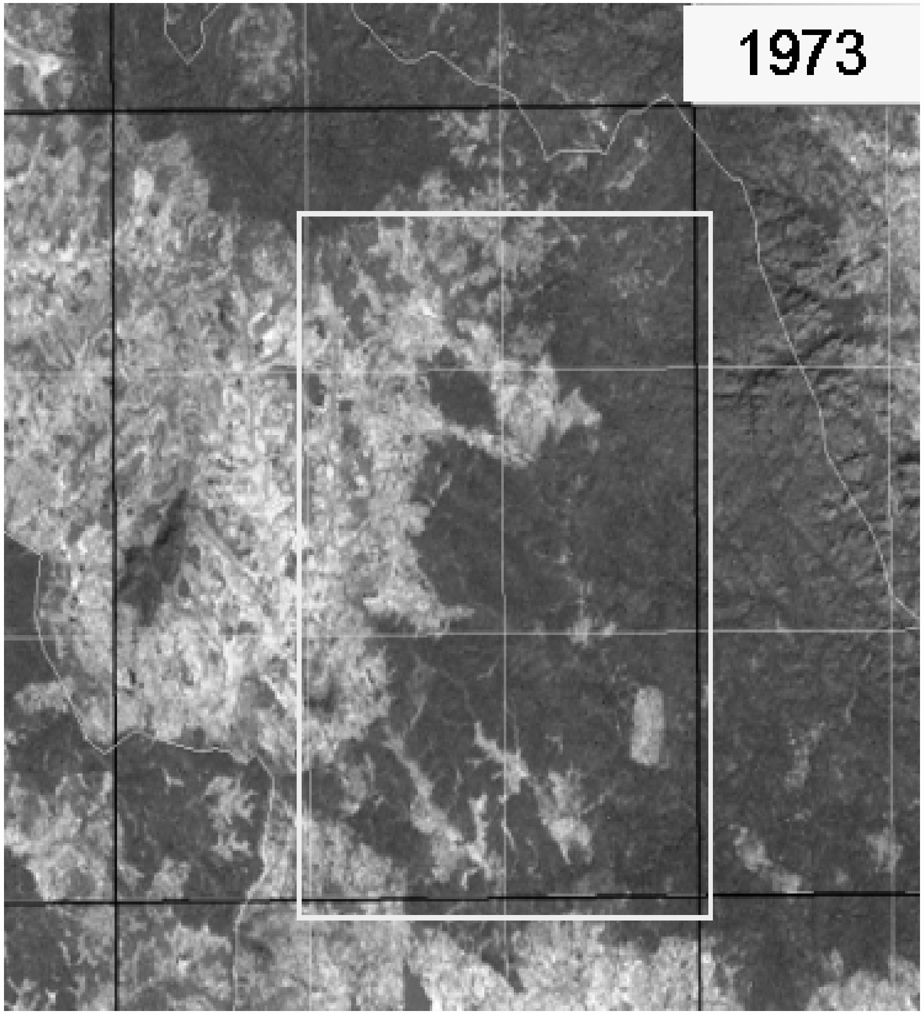
1999 – 28,749 ha

Monitoring of Command Area

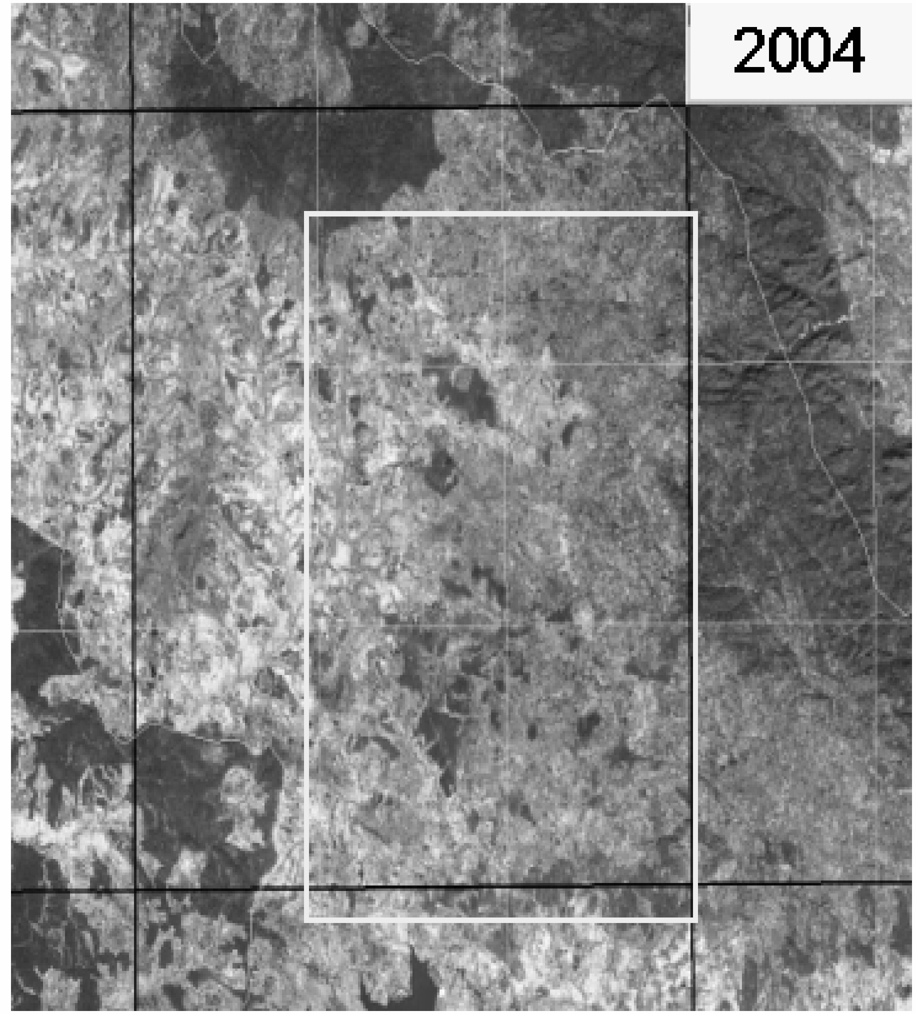


Part of Indira Gandhi Canal Command Area (Badopal, Gaganagar, Rajasthan)

Deforestation Monitoring



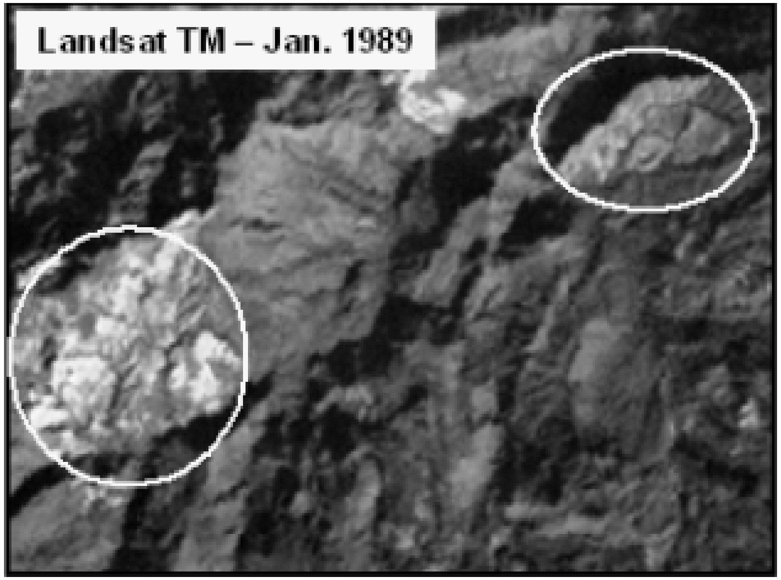
FCC of MSS image, January 1973

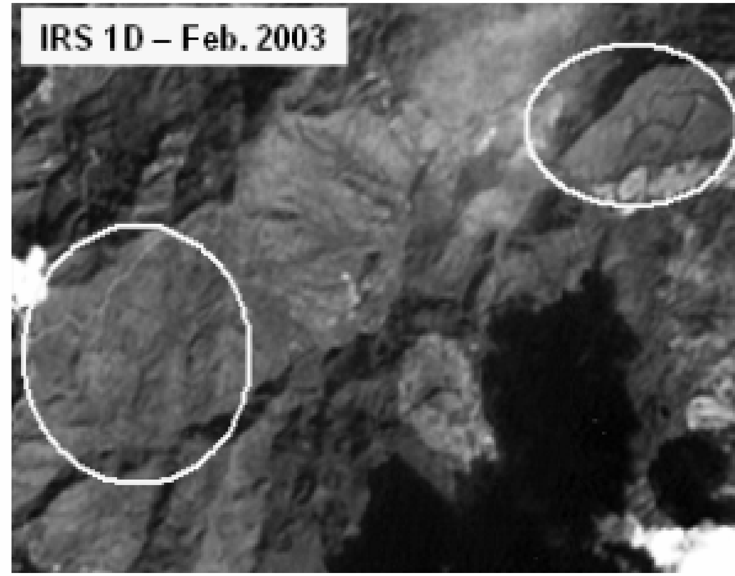


FCC of IRS P6 LISS III image, January 2004

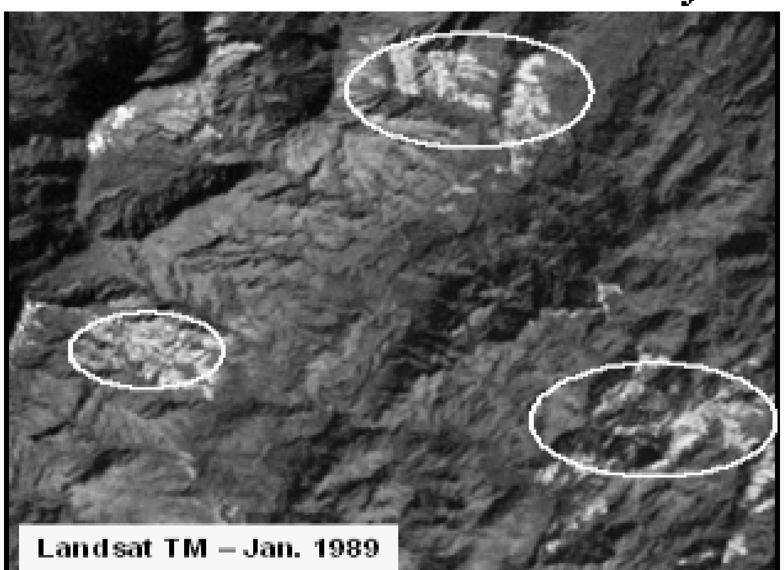
Clear felling and logging in Orissa

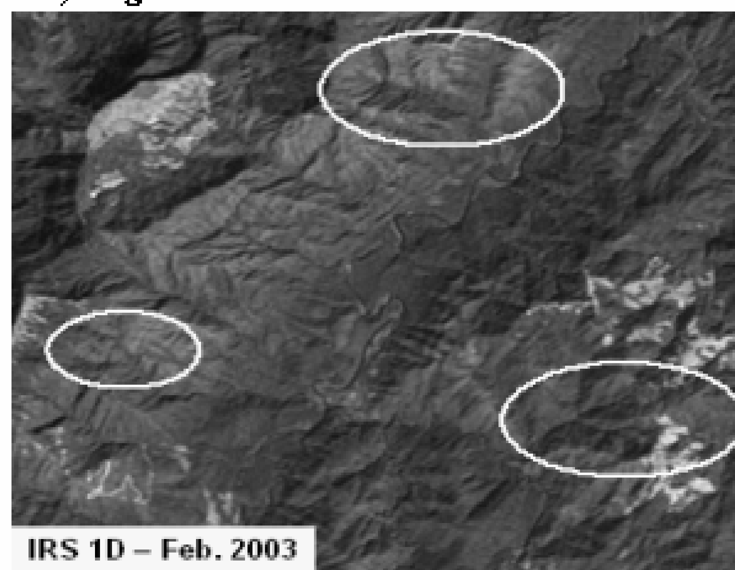
Monitoring of Jhum Cultivation





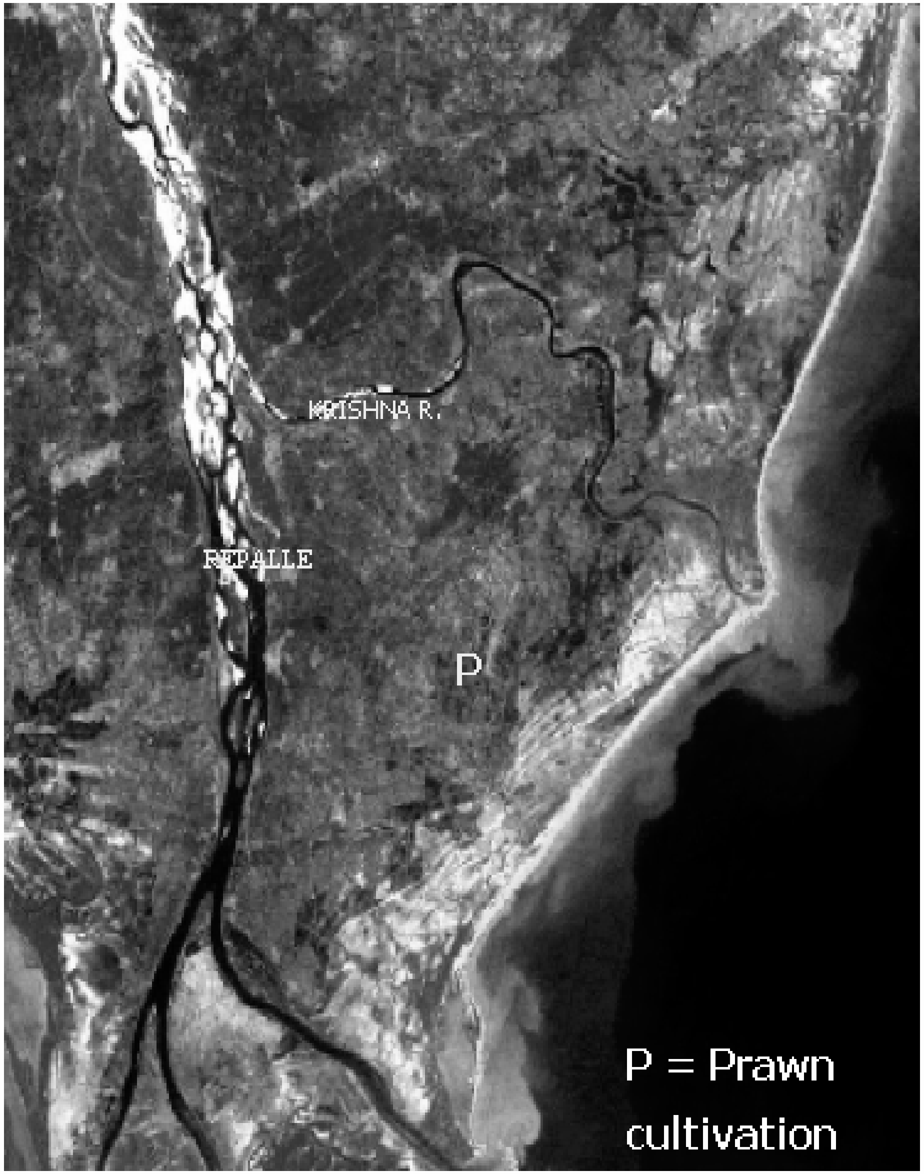
Part of Wokha District, Nagaland





Part of Mokokchung District, Nagaland

Land cover Transformation in Coastal Areas



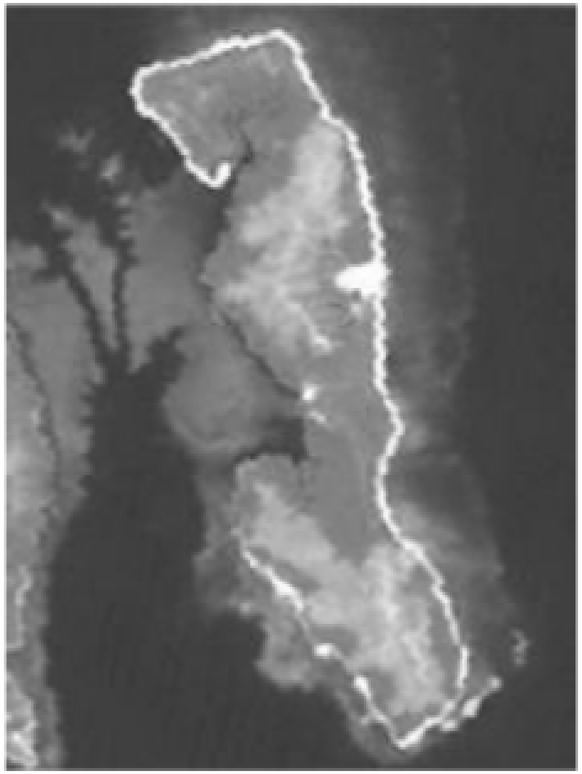
IRS-1B LISS-I 1992

IRS-1C LISS-III 2000

Aquaculture

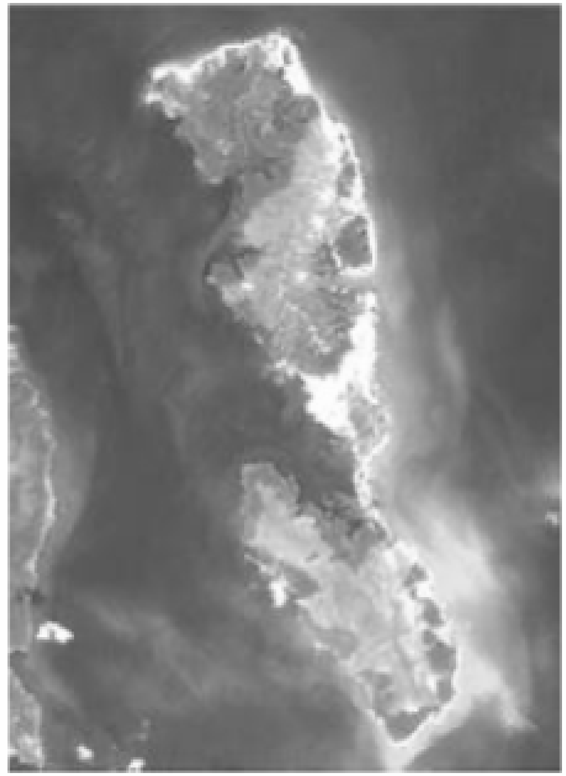
IMPACT OF TSUNAMI

IRS-P6 AWiFS 21-Dec-04



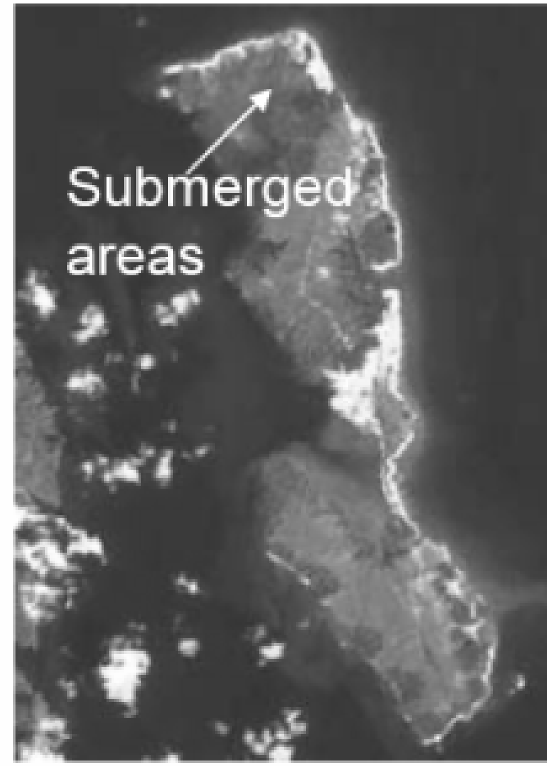
Pre-Tsunami

IRS-P6 LISS-III 04-Jan-05



Post-Tsunami

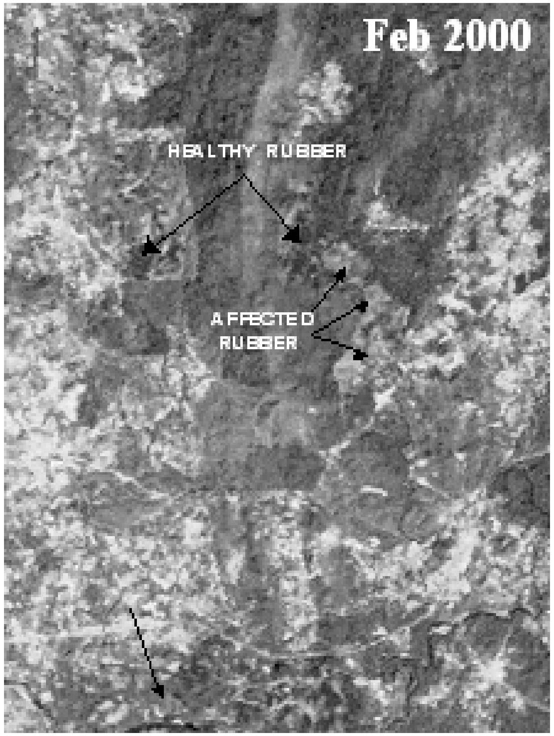
IRS-P6 LISS-III 06-Feb-05

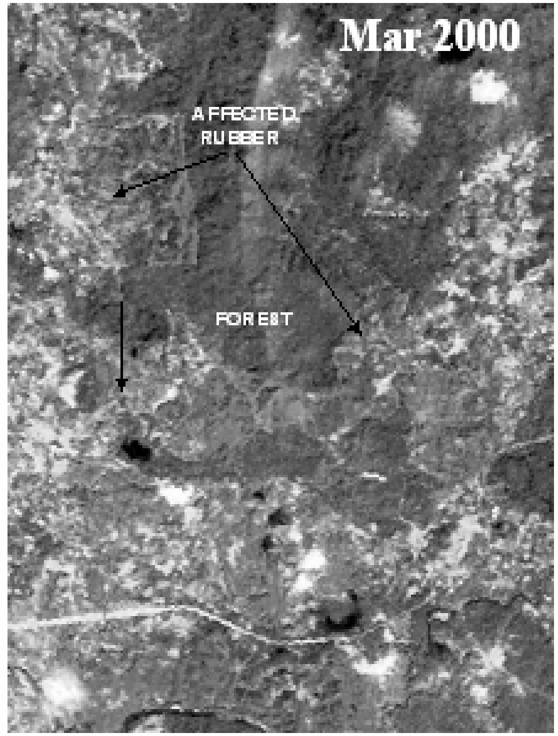


Post-Tsunami

Trinkat Island, Andaman and Nicobar Islands

Identification of Diseased Rubber Plantations

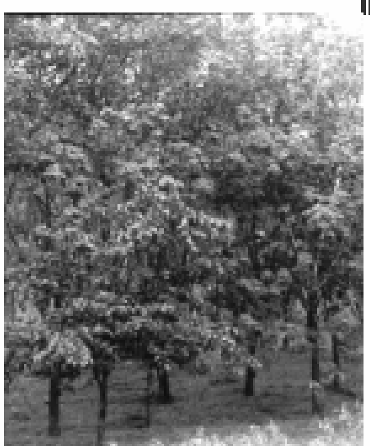




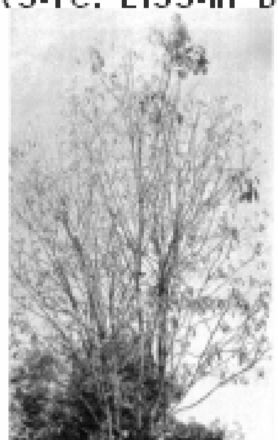
IRS-1C, LISS-III DATA

Study Area

Puttur & Sulya Tq.
Dakshina Kannada

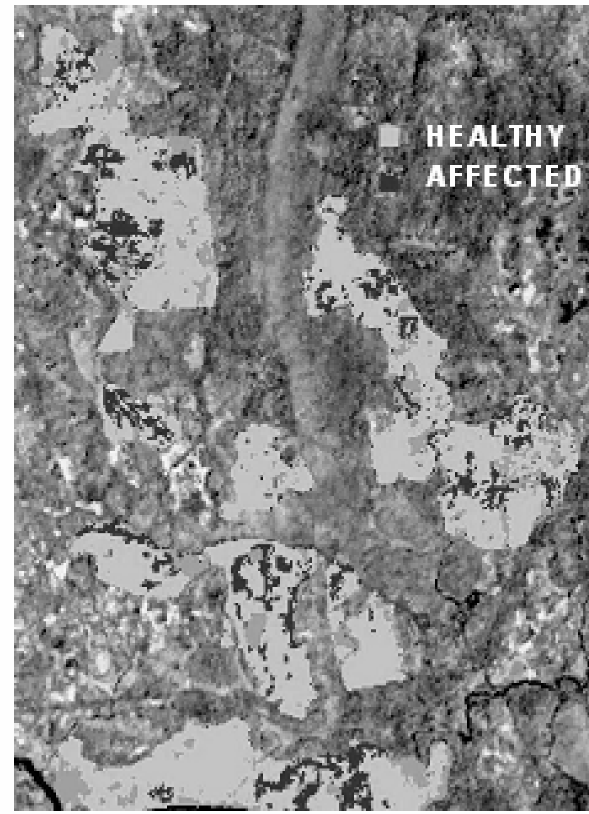


Healthy Ptn.



Affected tree

Infected leaves



Classified Image

High Resolution Satellite Data

THANK YOU