REMOTE SENSING & GIS APPLICATIONS IN WATERSHED MANAGEMENT

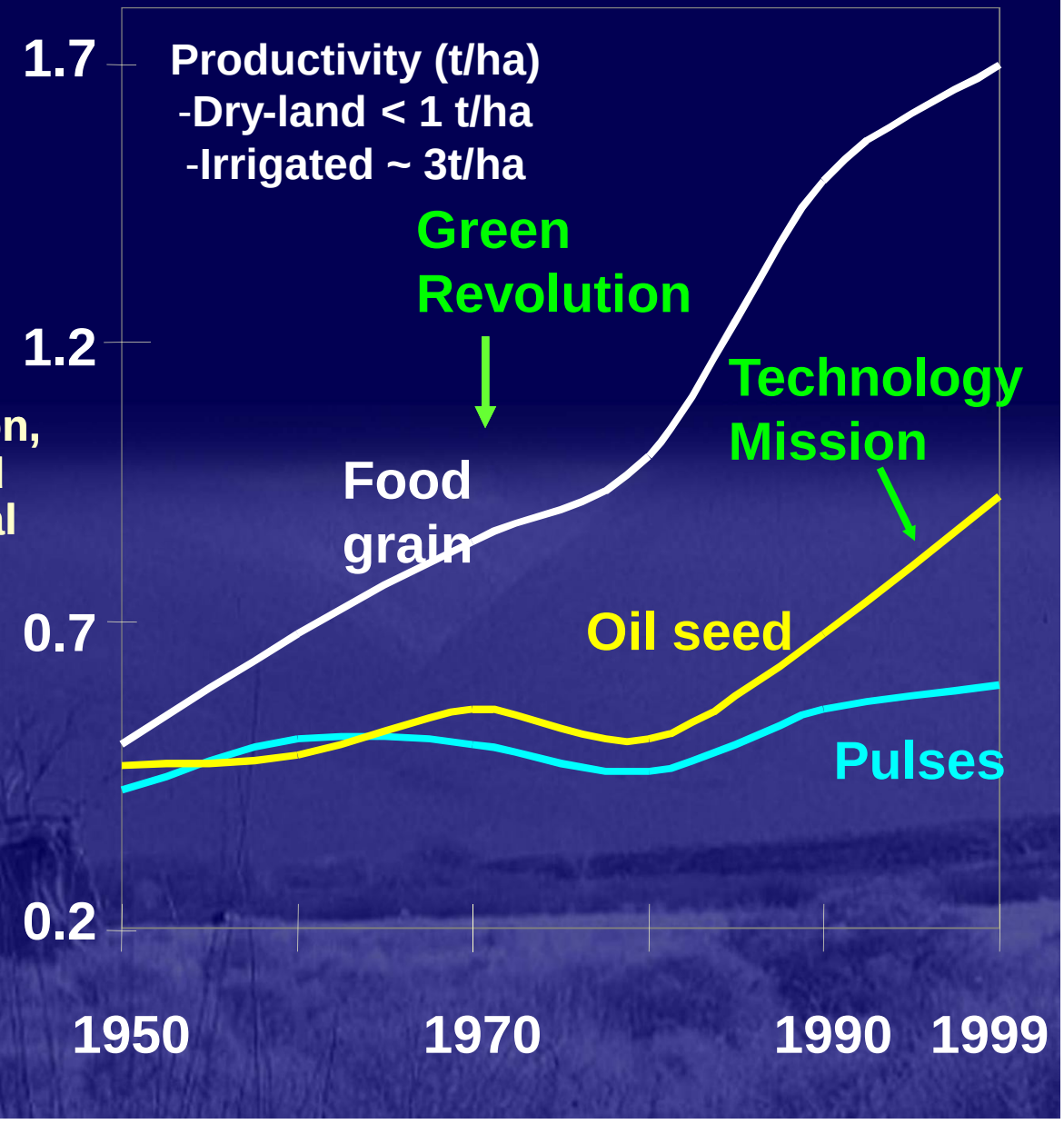
Dr. Y. V. N. Krishna Murthy

RURAL POVERTY : GENESIS

Impact of Green Revolution covered 40 Mha and benefited mostly rich farmers

100 Mha arable dry land of mostly to small & marginal farmers remained unaffected

With enhanced cost of cultivation, reduced marketable surplus and increased vulnerability to natural disasters, small & marginal farmers - poverty trap..



Production	Rainfed areas
Food grain	45
Oilseeds	75
Pulses	90

Contribution (%) of Dry-land Areas

WATER RESOURCES: SCARCITY & ABUNDANCE

Total Usage
51 Mham/
400 Mham
Water

Irrigation
35 Mham

Other Uses
16 Mham

Temporal Variability

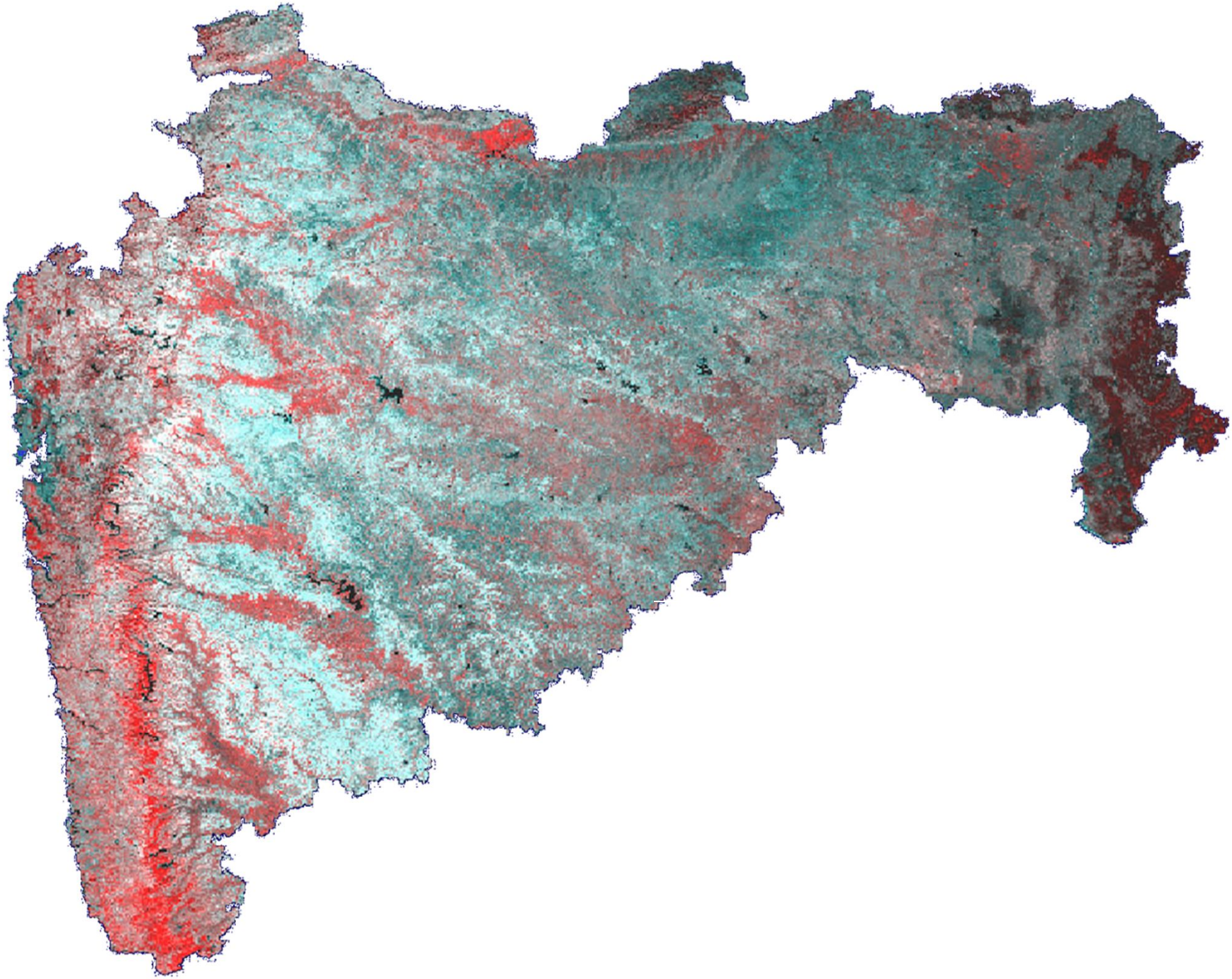
Season/Period	M ha m	%
Winter (Jan-Feb)	12	3
Pre-monsoon (Mar-May)	52	13
SW monsoon (Jun- Sep)	296	74
NE monsoon (Oct-Dec)	40	10
Total for the year	400	100

Spatial Variability

Rainfall zone (mm)	Geogr. Area (M ha)	Water avail. (M ha m)
100-500	52.07	15.62
500-750	40.26	25.16
750-1000	65.86	57.63
1000-2500	137.24	205.86
>2500	32.57	95.86
Total	328.00	400.00

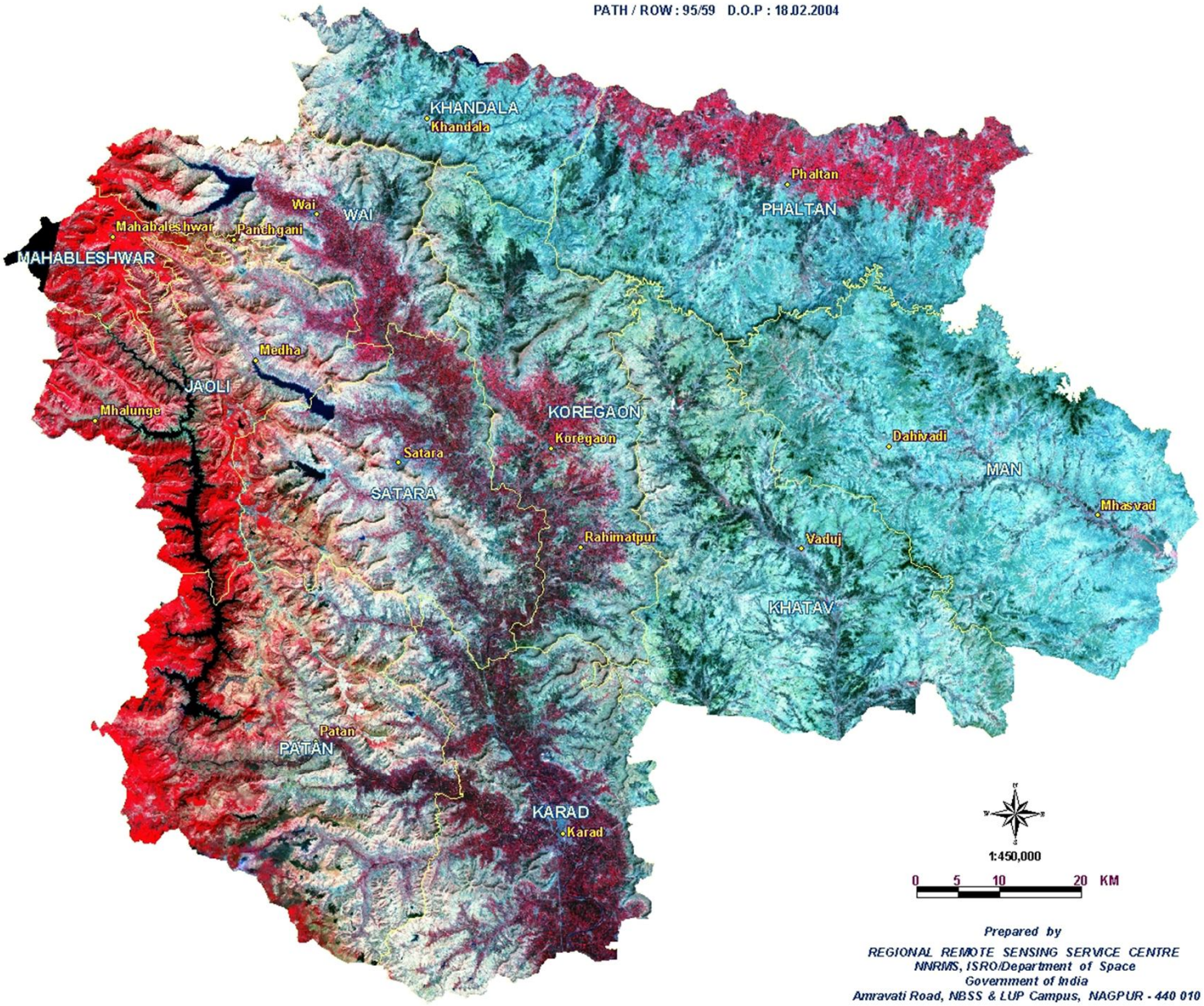
Need for :

- Water Harvesting
- Watershed Development
- Command Area Development
- Ground Water Targeting
- River Basin Development
- Inter-basin Linkages



IRS - P6 RESOURCESAT AWIFS IMAGERY OF SATARA DISTRICT, MAHARASHTRA

PATH / ROW : 95/59 D.O.P : 18.02.2004



Prepared by

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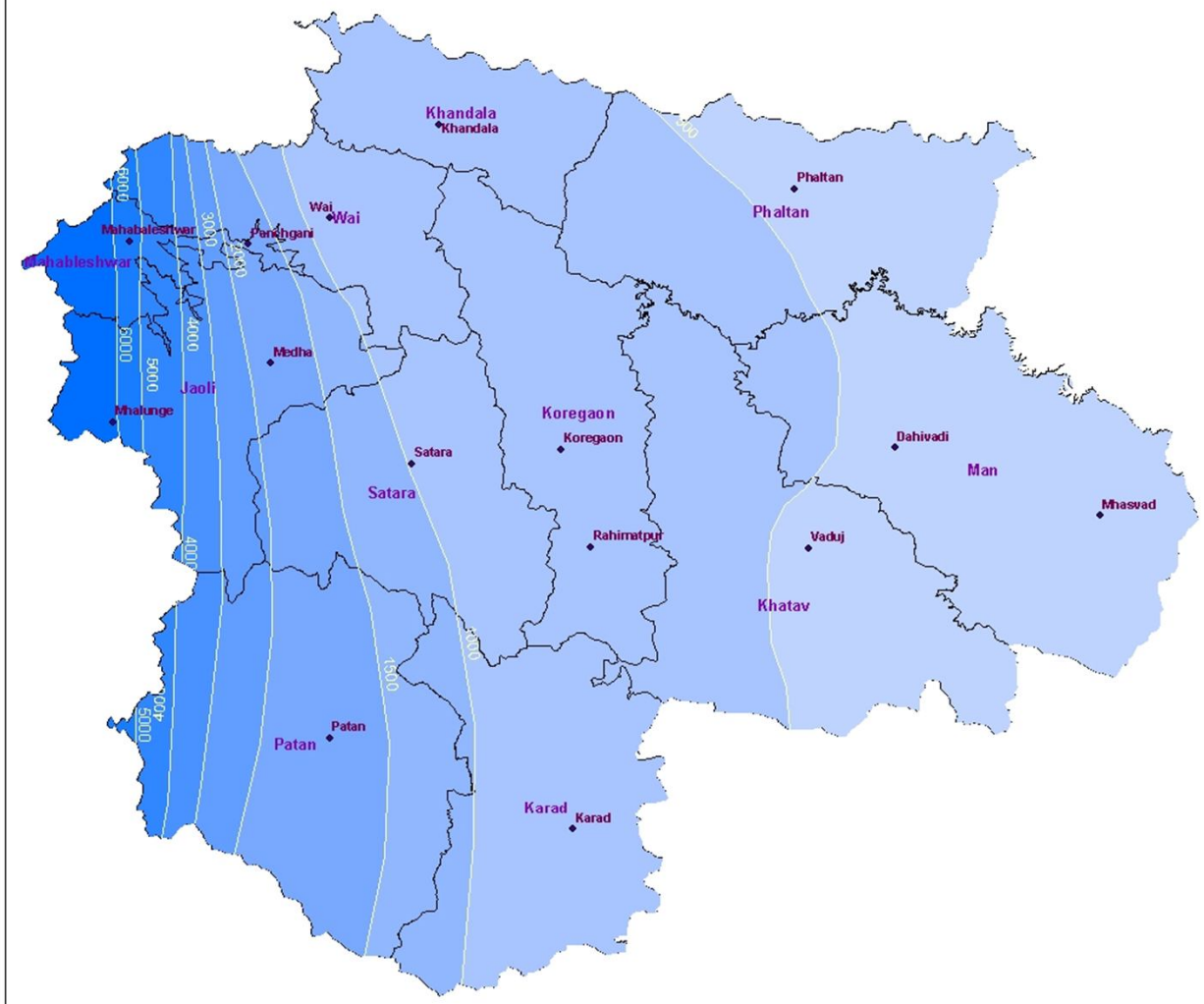
Amravati Road, NBSS & LUP Campus, NAGPUR - 440 010

RAINFALL MAP

SATARA DISTRICT, MAHARASHTRA

FOR OFFICIAL USE ONLY

SATARA



LEGEND

RAINFALL (mm)

6000

< 500

BASE MAP LEGEND

State Boundary
District Boundary
Tehsil Boundary
Block Boundary
Notified Forest Boundary (FSI/SFR)
Railways
Major Roads
River / Stream/Water body
Settlements

SOURCE :

* IMD data
* District database generated under NRIS
* Indian Remote Sensing Satellite (IRS P6) Resourcesat data.
* Existing maps and reports.
* Field information.

SCALE

0 16 0 Kilometers

1:550,000

LOCATION MAP

INDIA

MAHARASHTRA STATE

SATARA DISTRICT

MAP INDEX

District Digital Database Generated Under NRIS by

MAHARASHTRA REMOTE SENSING APPLICATIONS CENTRE
Government of Maharashtra
Nagpur - 440 010

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CURRENT SCENARIO - INDIA

- One of the most densely populated nation.
- Population : 16 % of world's population.
  Present > billion (342 million in 1947).
  Future > 1.43 billion by 2030
- Geographical area - 329 M ha (2.42 % of world's geog. area).
- Coast line - 7500 Km.
- Forests – 19 %
- Mangroves – 3 % of total forest area.
- Per capita arable land – 0.15 ha (0.09 ha by 2075)
- Rain-fed agriculture – 68 %
- Agr. production – 205 M tons (required 325 M tons by 2050)
- 17 % of world's cattle population.

PROBLEMS

- Increasing rate of degradation and depletion of resources.
- Deforestation, desertification, soil erosion, salinization, falling water tables.
- Degraded land – 175 M ha

  Soil erosion by wind & water – 150 M ha. Salt affected soils – 7.0 M ha

  Shifting cultivation – 4.36 M ha Water-logging – 6.0 M ha
- Heavy demand for fodder resulting in over grazing of forest and grass lands.
- Natural disasters: Drought (1/2 of the country is drought prone), Floods (40 M ha), landslides, cyclone, locust attack etc.

Drastic reduction in Biomass

Depleting Water Resources

Loss of productive Soil

Reduced carrying capacity of streams

Extinction of fauna & flora

NEED

- Scientific & rational Land and Water Resources management
- Striking balance between availability v/s needs
- Adoption of eco-friendly sustainable development and Determining alternatives for development.
- Peoples participation
- Adopting natural boundaries defined by river basins/ sub-basins as a planning unit.
- Integrated development approach.
- Regular monitoring to assess the status of development

INTEGRATED WATERSHED DEVELOPMENT PLANNING

Watershed

- is a natural hydrological unit

- Topographically delineated area drained by a stream system, from which runoff resulting from precipitation flow past from a point into single stream.

- Development is not confined just to agriculture lands but covers entire catchment's area.

- Watershed approach is holistic, linking upstream and downstream areas.

-Practical approach in planning, directed at preservation, conservation, development, management and exploitation of natural resources for the benefit of people.

INTEGRATED WATERSHED DEVELOPMENT PLANNING

Watershed Development Approach

- Integrated and multi-disciplinary approach.

- To suggest possible exploitation of resources within the limits of tolerance.

- Approach is Preventive, Progressive, Corrective & Curative.

- Objectives -
  - Conservation of Soil and Water
  - Improved ability of land to hold water
  - Maintaining adequate vegetative cover for controlling soil erosion
  - Rain water harvesting and ground water recharging.

- Benefits -
  - Promotes economic and social development of community
  - Employment generation and other income generation
  - Ecological balance

ROLE OF REMOTE SENSING

Useful for generating environmental indicators that can be integrated with collateral data and social indicators.

- **Synoptic view, Multi-resolution, multi-spectral, repetitive offers appropriate method for quick, unbiased mapping and monitoring of natural resources both in space and time domain.**

- **Timely and accurate information on spatial distribution – landuse, soil, vegetation density, forest, geology, water resources etc.**

- **RS data in conjunction with collateral data helps in delineation of ridge line, characterization, prioritization, erosion prone areas, etc.**

Capability of Remote Sensing for Watershed Attributes Information

Attribute	Attribute Parameter	Relevance
Size	Area	Available rainfall, run-off, sedimentation
Shape	Geometric form, shape index, form factor	Run-off & sedimentation
Physiography & slope	Mean elevation, av. Slope, relief length	Run-off & sedimentation
Drainage	Drainage pattern & density, stream order	Run-off & sedimentation
Geology	Rock types	Run-off & sedimentation
Soil	Texture, moisture, capability	land degradation, production potential, Run-off & sedimentation
Landuse	Present LU, wasteland, surface water	Run-off & sedimentation
Groundwater	Potential	Recharge & irrigation

ROLE OF GEOMATICS

- Integration of natural resources information in conjunction with socio-economic data.

- Generation of locale specific action plans for land and water resources.

-Analysis of SE / demographic data to assess developmental needs of the region.

- Assessment of the existing infrastructure to arrive at developmental schemes.

- Generation of variety of derived maps.

INTEGRATED WATERSHED DEVELOPMENT

OBJECTIVES

Economic Growth, Basic Needs, Ecological Balance

INFORMATION NEED

Natural Physical Resources	Contemporary technology	Socio-Economic & Demographic data
- SOIL - GEOLOGY - GEOMORPHOLOGY - GROUNDWATER - LANDUSE / LANDCOVER - RAINFALL AND CLIMATE - DRAINAGE & WATERSHED - SLOPE, ASPECT & ALTITUDE - TRANSPORT NETWORK AND SETTLEMENT	- AGRICULTURE - WATER MANAGEMENT - GROUNDWATER EXPLORATION - ANIMAL HUSBANDARY - FISHRIES - MINERAL EXPLORATION - HOUSING AND CONSTRUCTION - ENERGY & POWER ENGINEERING - HEALTH & SANITATION - WATER HARVESTING	SPATIAL ANALYSIS OF SOCIO ECONOMIC DATA - SOCIAL PROFILE - DEMOGRAPHIC PROFILE - CULTURAL PROFILE - ECONOMIC STATUS

THEMATIC MAP INFORMATION

INTEGRATION OF MULTI-THEMATIC INFORMATION
(Composite Land Development Unit)

NATURAL/PHYSICAL RESOURCE BASED DEVELOPMENT POSSIBILITY RESOURCES REGIONS

PEOPLES NEED & PROGRAMMES REGION IDENTIFICATION
- Socially backward Areas/People
- Economically backward Areas/People
- Areas lacking basic amenities

RESOURCES MANAGEMENT DECISIONS-SPECIFIC PLANS/PROJECTS

DEMONSTRATION OF TECHNOLOGY

IMPLEMENTATION

TRAINING/RETRAINING OF USERS

EVALUATION AND FEED BACK

WATERSHED DEMARCATION AND SELECTION

Method: Separation of the major drainage area; principal drainage basin and sub-basin; watershed

CATEGORIES DELINEATION SYSTEM

Region (6) …… 1.5-12 lakhs sq km

Basins (50) …… 0.3- 3.0 lakhs sq km

Catchment …… 0.1 - 0.5 lakhs sq km

Subcatchment ……. 2000 - 10000 sq km

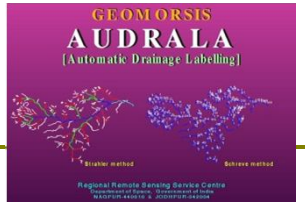
Watershed …… 500 - 2000 sq km

Sub-watershed …….. 50 - 500 sq km

Mini Wateshed ……. 10 - 50 sq km

Micro watershed …… 5 - 10 sq km

WATERSHED COVERAGE



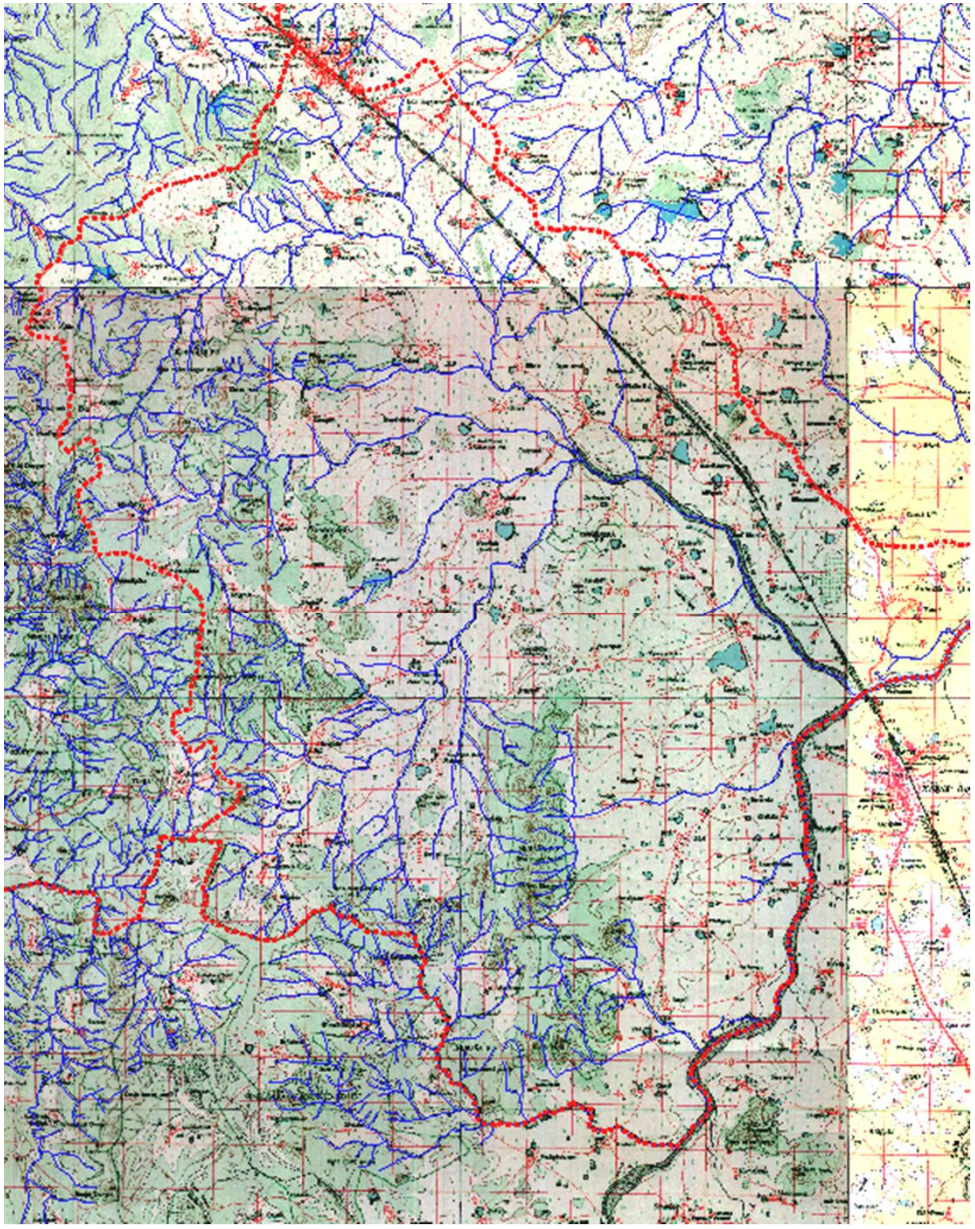
- **Watershed codification**

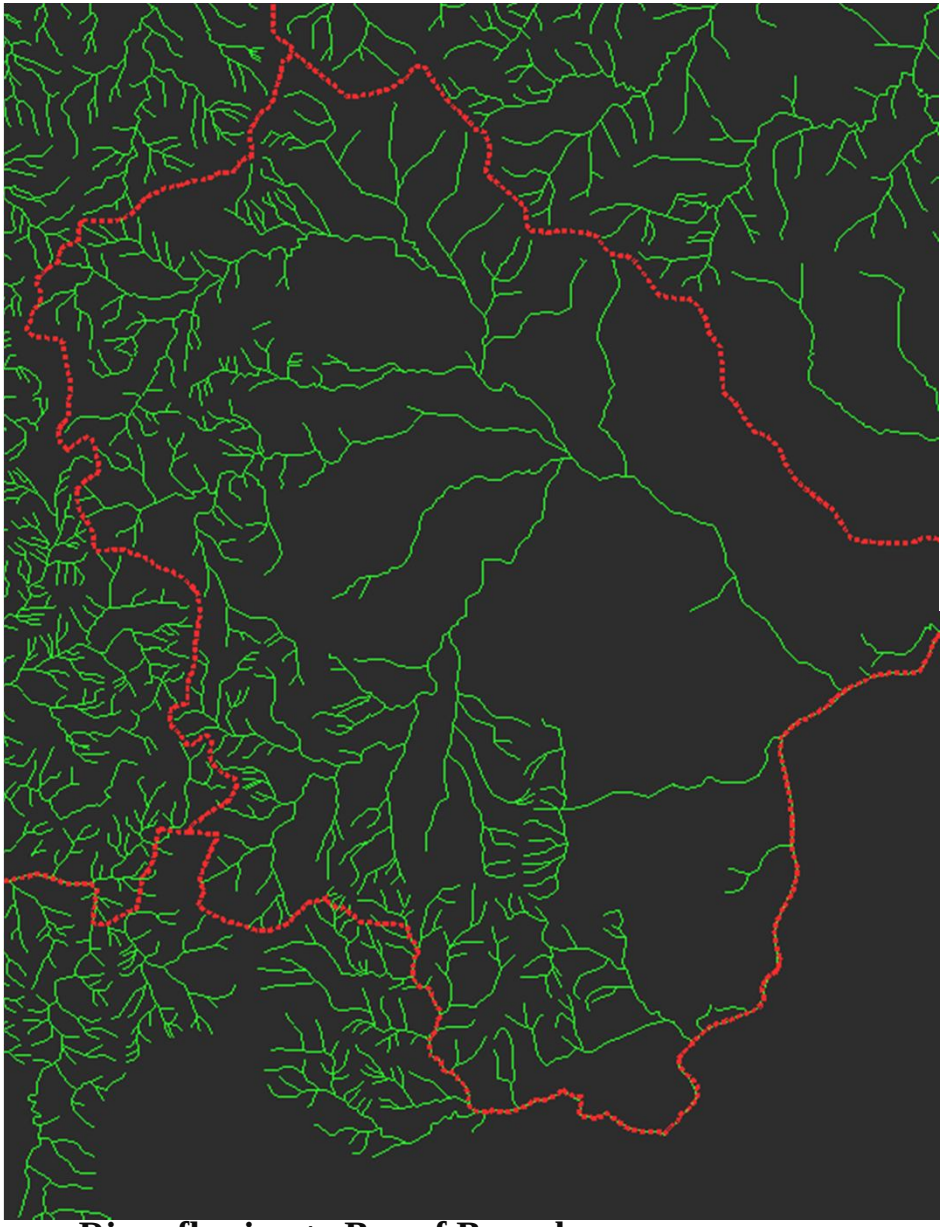
AIS & LUS codes

IMSD codes

REGION	– 4
BASIN	E 5
CATCHMENT	A 6
SUB-CATCHMENT	C 2
WATERSHED	a
SUB-WATERSHED	
MINI WATERSHED	
MICRO WATERSHED	

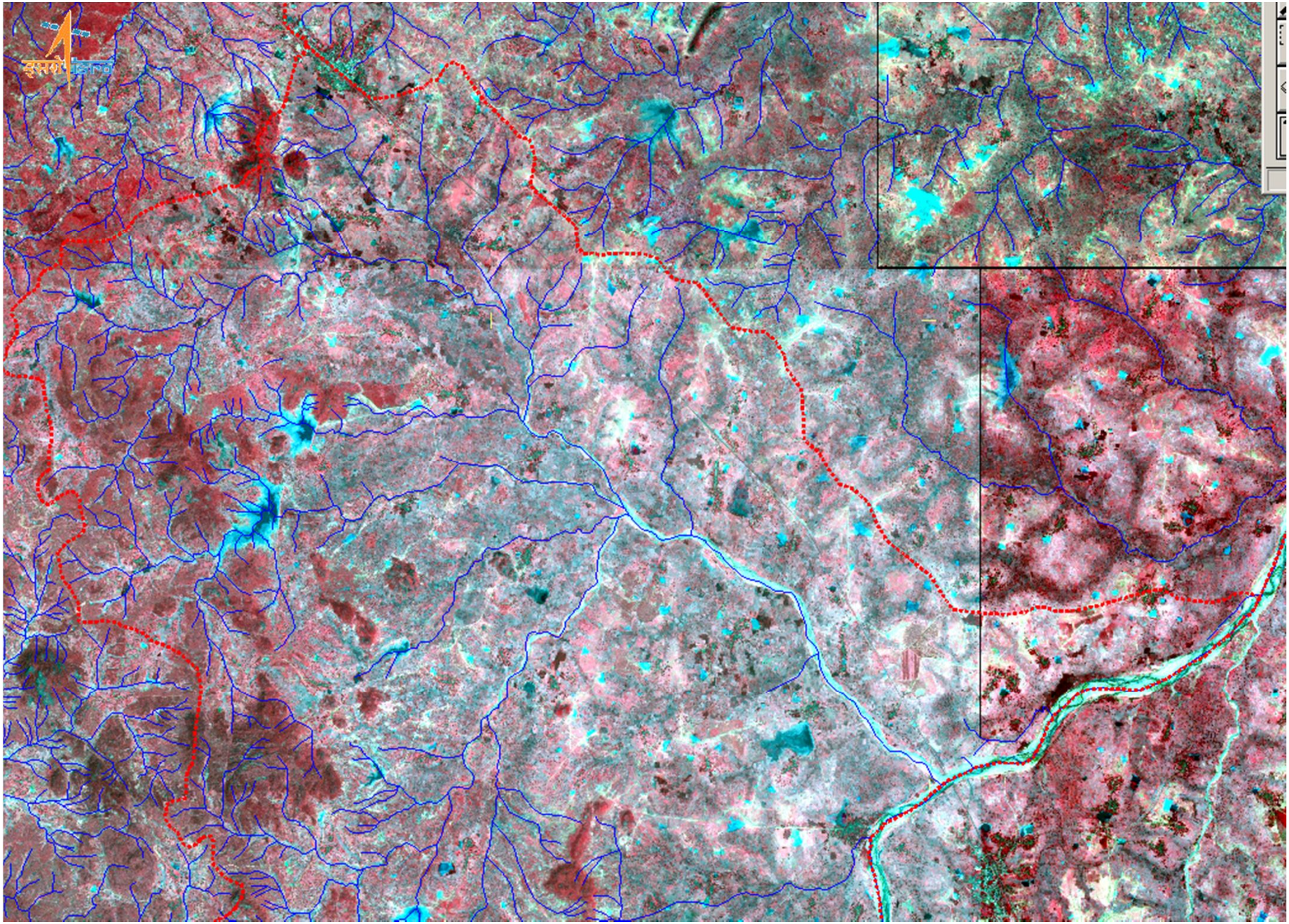
- **Watershed code items…** WSNAME (8,8,C)
  WSCODE (8,8,C)
  WSLCODE (16,16,C)





4G2E7 XXX

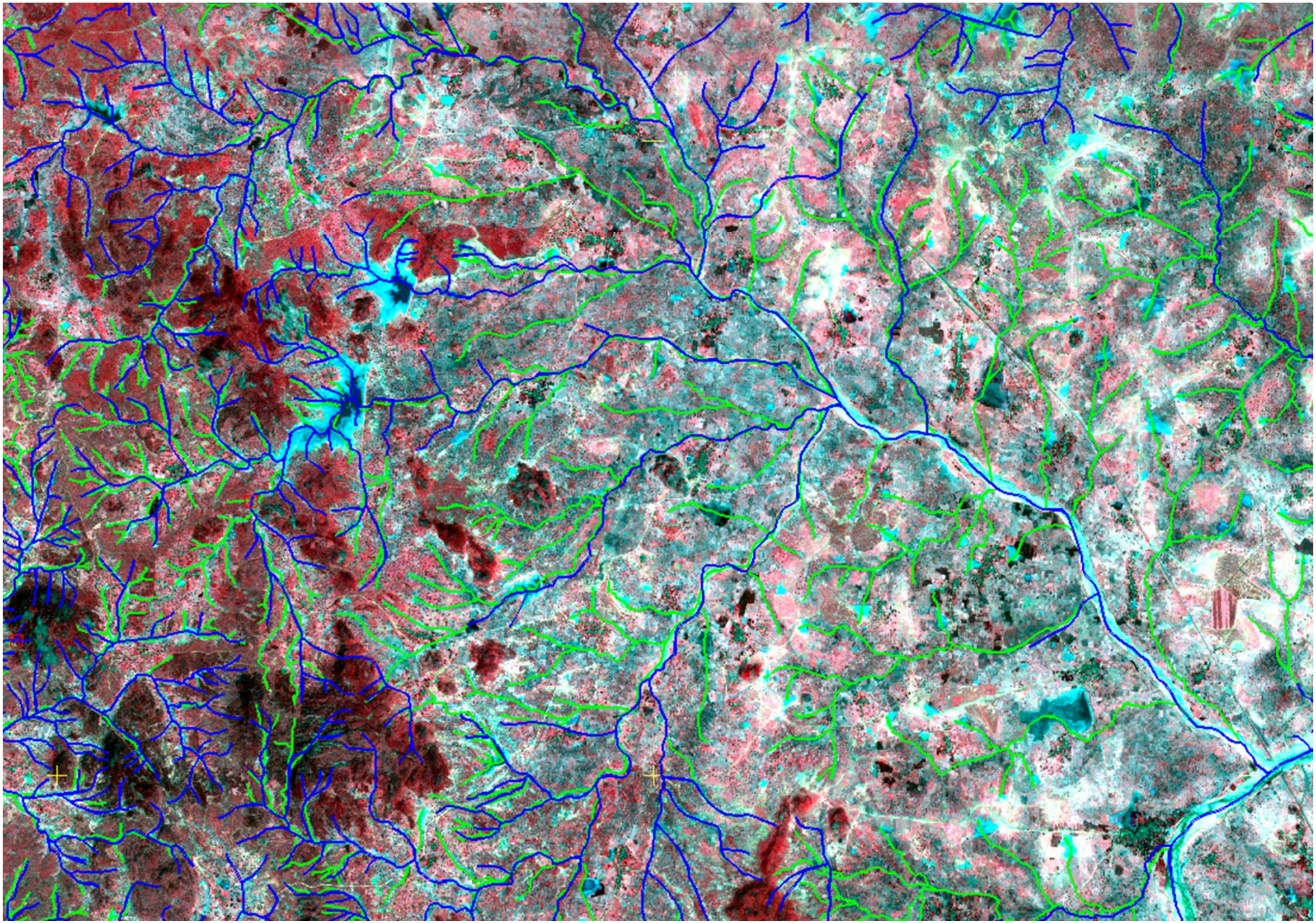
River flowing to Bay of Bengal
Mahanadi
Hirakund to confluence with Seonath
RB of Mahanadi - Hirakund to Jonk
Upper Jonk/Silda

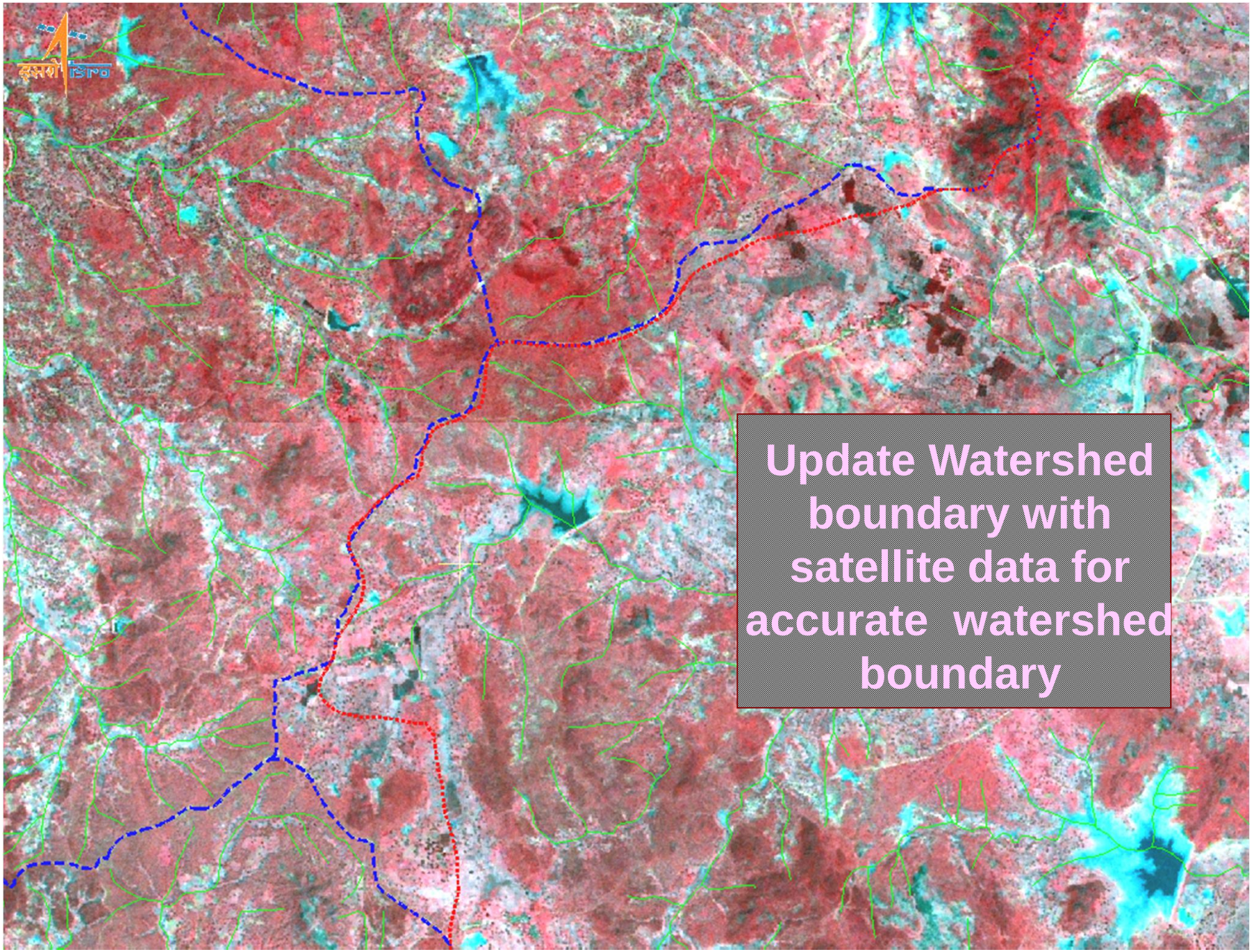


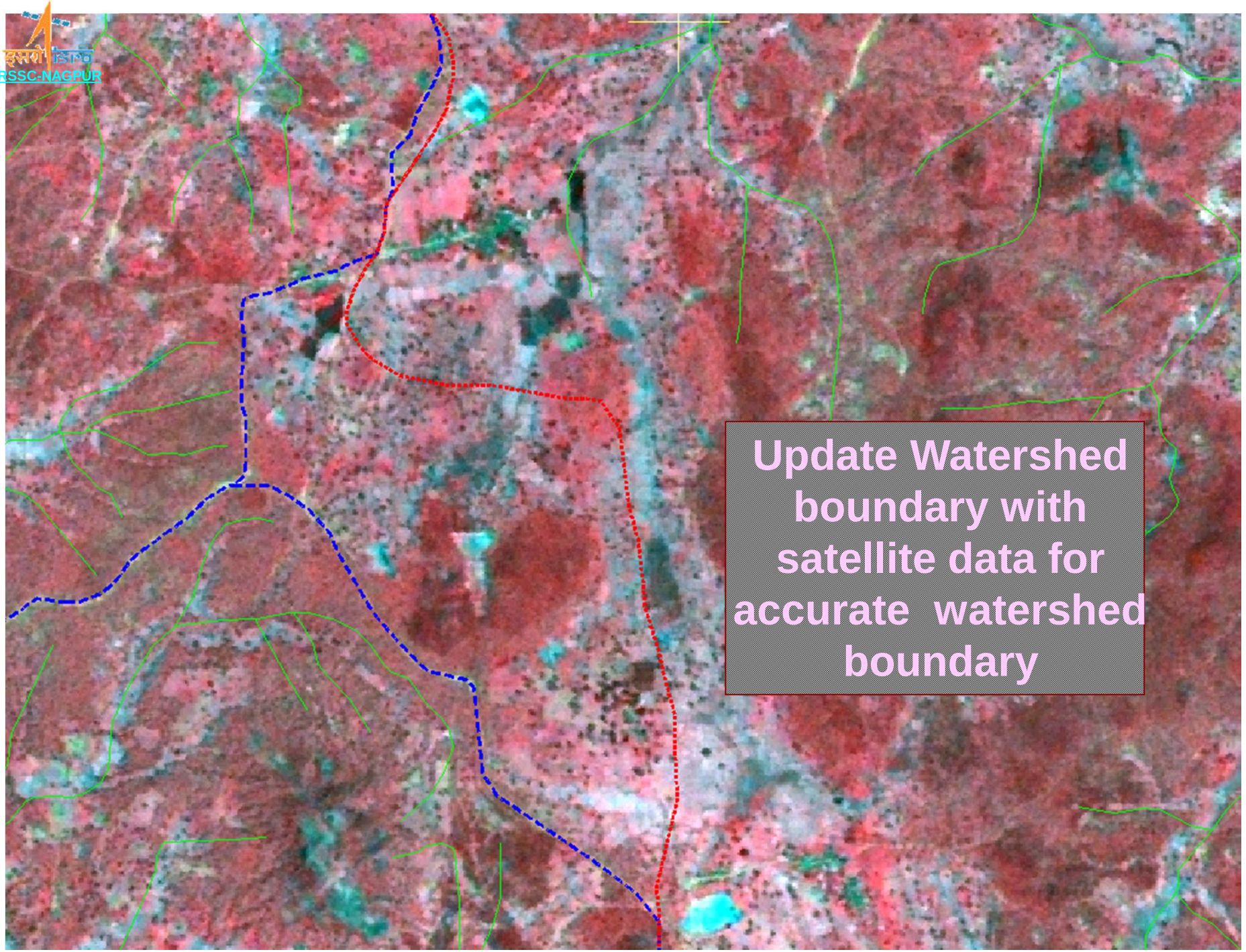
Drainages superimposed on satellite data

Existing drains

Extracted from Image




Update Watershed boundary with satellite data for accurate watershed boundary


RRSSC-NAGPUR
Update Watershed boundary with satellite data for accurate watershed boundary

WATERSHED CHARACTERIZATION

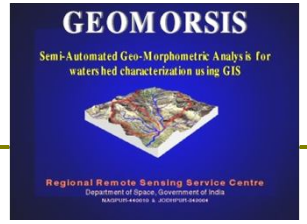
Components of watershed : Drainage and its order, watershed boundary, area, perimeter, area under various drainage order, length of the stream, etc.

Morphometric Analysis

Various laws of drainage

Calculation of various watershed characters

What is GEOMORSIS ?



GEOMORSIS is a semi-automatic geo-morphometric analysis package for quantitative analysis of watershed for watershed characterization using GIS

has SIX basic modules

- AUDRALA
- STMPARA
- RELIEF PARAMETE
- WATERSHED SELECTION
- BASGEO
- REPORT GENERATION

GEOMORSIS (ver 2.0)

GEOMORSIS

AUDRALA
(Auto ordering)

WATERSHED
SELECTION

STMPARA
&
BASGEO

RELIEF
PARAMETERS

REPORT
GENERATION

PREFERENCES

Quit

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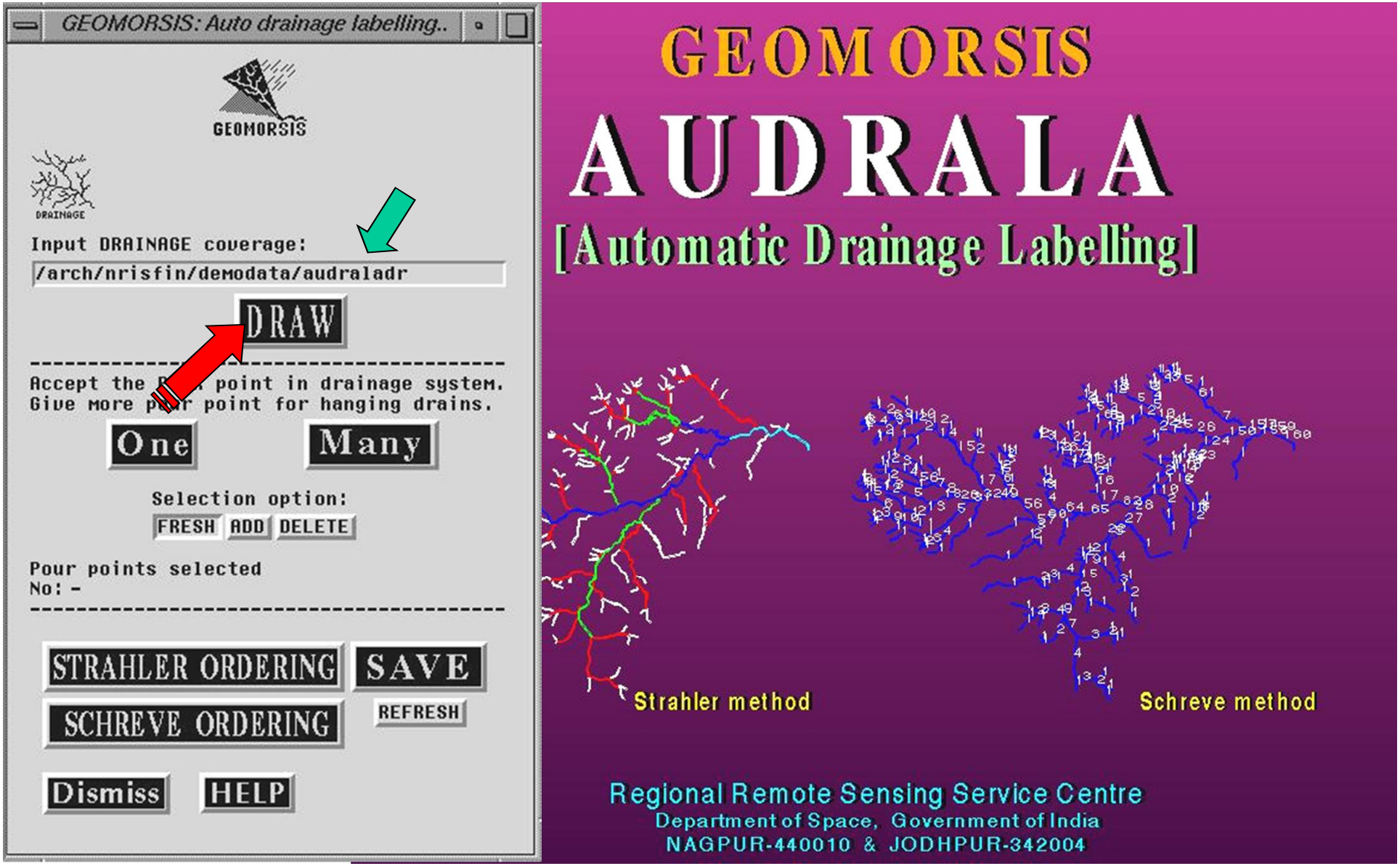
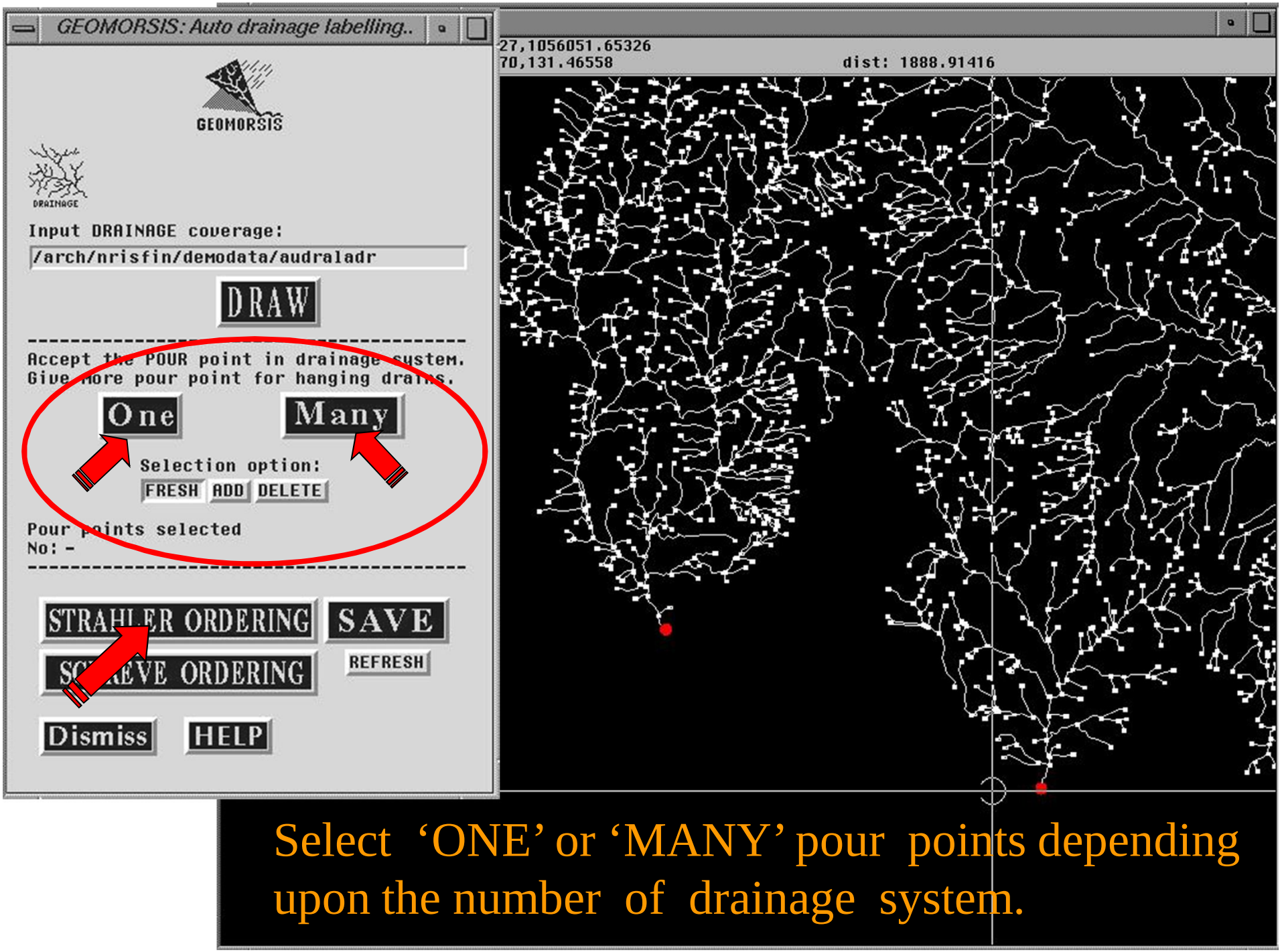
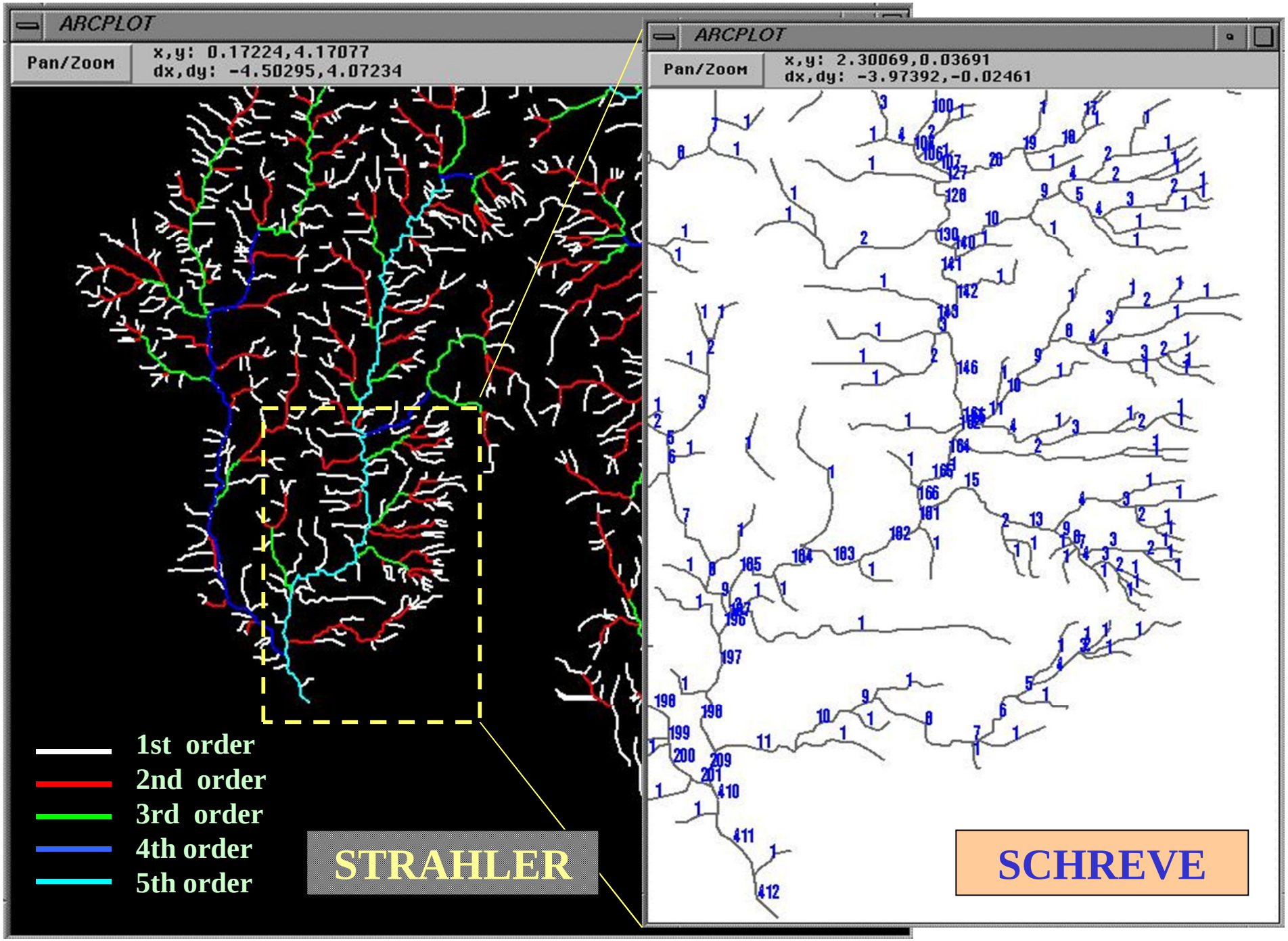


Ordering of the drainage coverage

DRAW displays the drainage coverage with nodes on which the pour points is to be selected



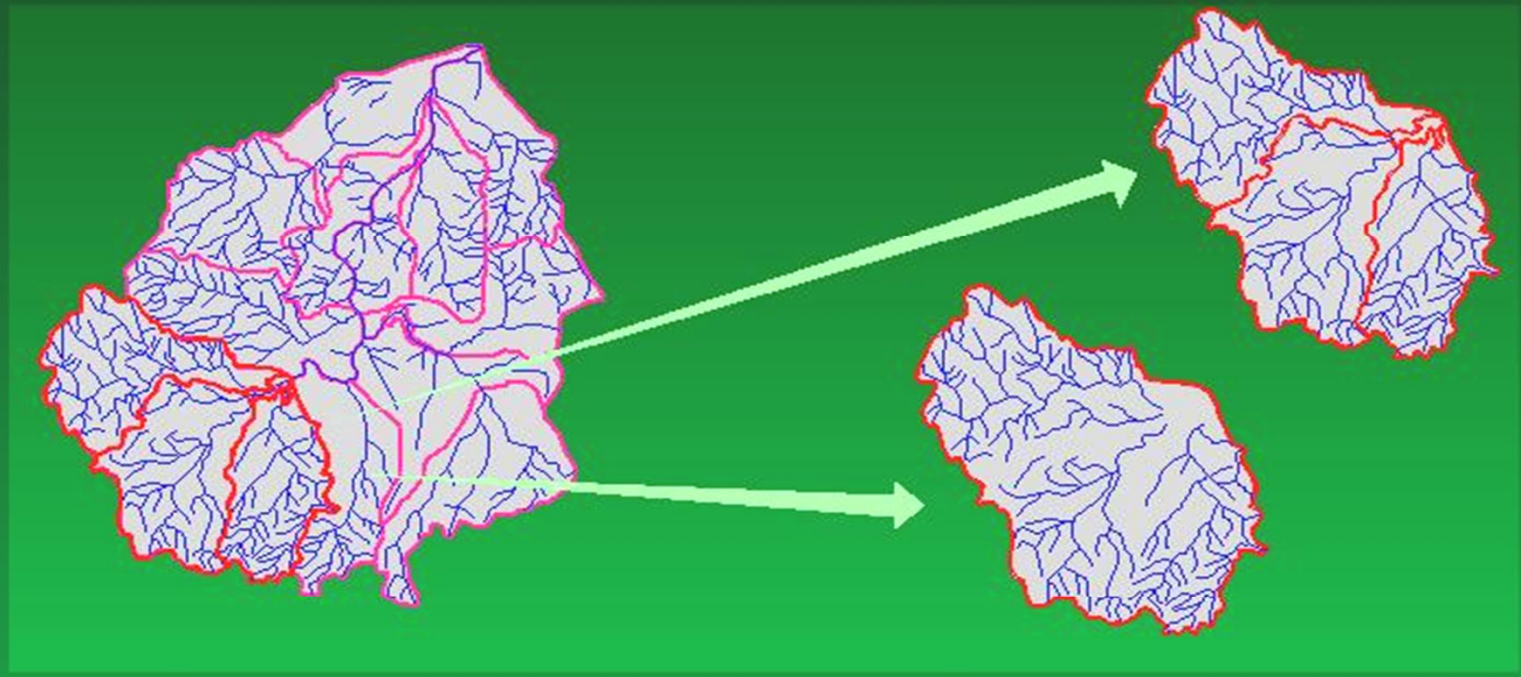
Select ‘ONE’ or ‘MANY’ pour points depending upon the number of drainage system.


ARCPLOT
Pan/Zoom
x,y: 0.17224,4.17077
dx,dy: -4.50295,4.07234
1st order
2nd order
3rd order
4th order
5th order
STRAHLER
ARCPLOT
Pan/Zoom
x,y: 2.30069,0.03691
dx,dy: -3.97392,-0.02461
SCHREVE

GEOMORSIS

WATERSHED SELECTION

[Watershed selection and appending module]



(Give the INPUTS and proceed)

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ORSIS

SELECTION

nd appending module]

GEOMORSIS: Watershed selection...

GEOMORSIS

WATERSHED

WATERSHED coverage(from which to select):

/arch/nrisfin/gmorsis/mordata/smlwshed

DRAINAGE

DRAINAGE coverage(for background view):

/arch/nrisfin/gmorsis/mordata/smldrn

SELECTION BY WATERSHED NAME ...

SELECT WATERSHED INTERACTIVELY...

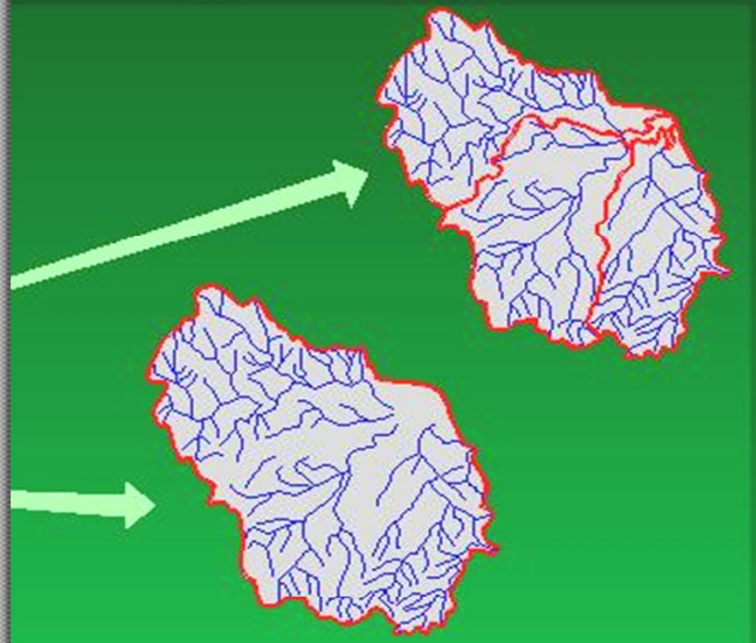
APPEND SELECTED WATERSHED COVERAGES ...

DRAW

Dismiss

HELP

PREFERENCES



S and proceed)

sing Service Centre

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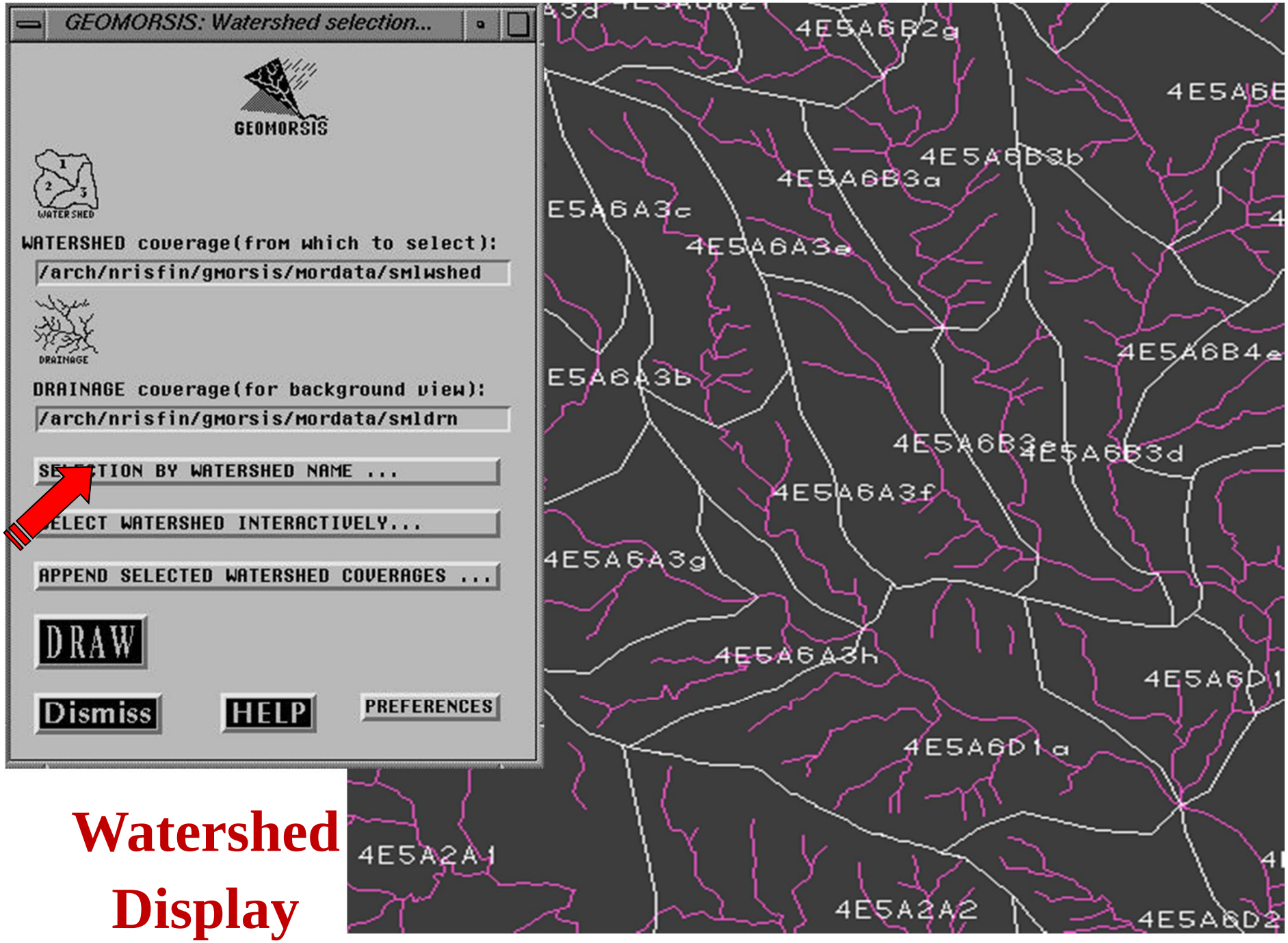
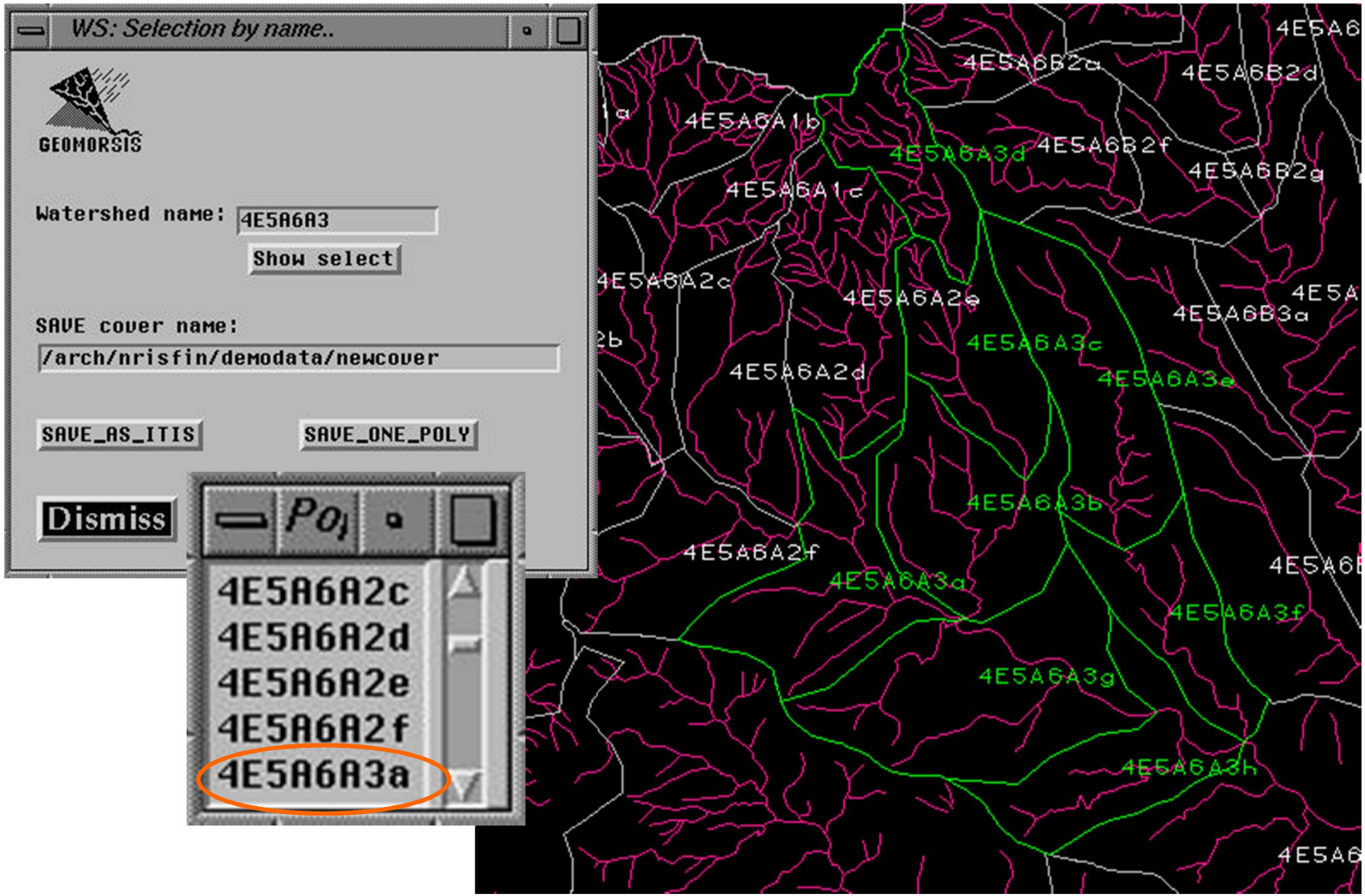


Watershed Display



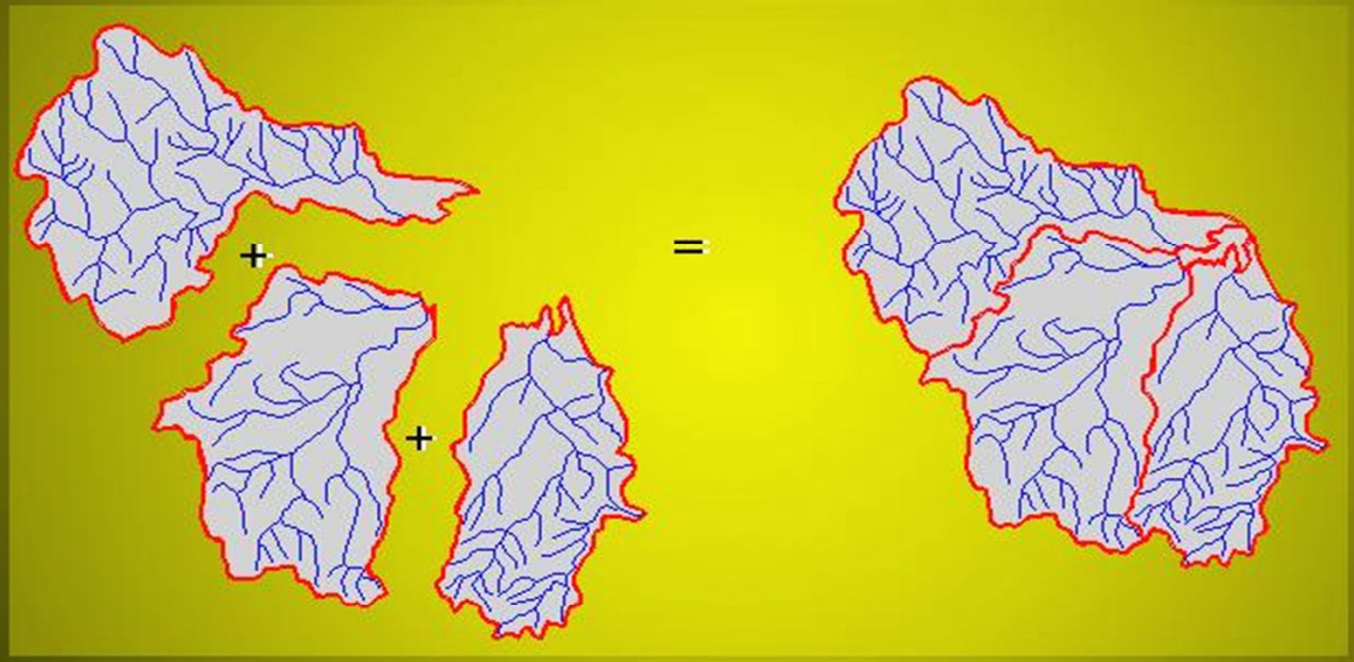
Watershed selection by-name

Watershed selection by-pointing

GEOMORSIS

APPEND COVERAGES

[Appending adjacent watershed module]



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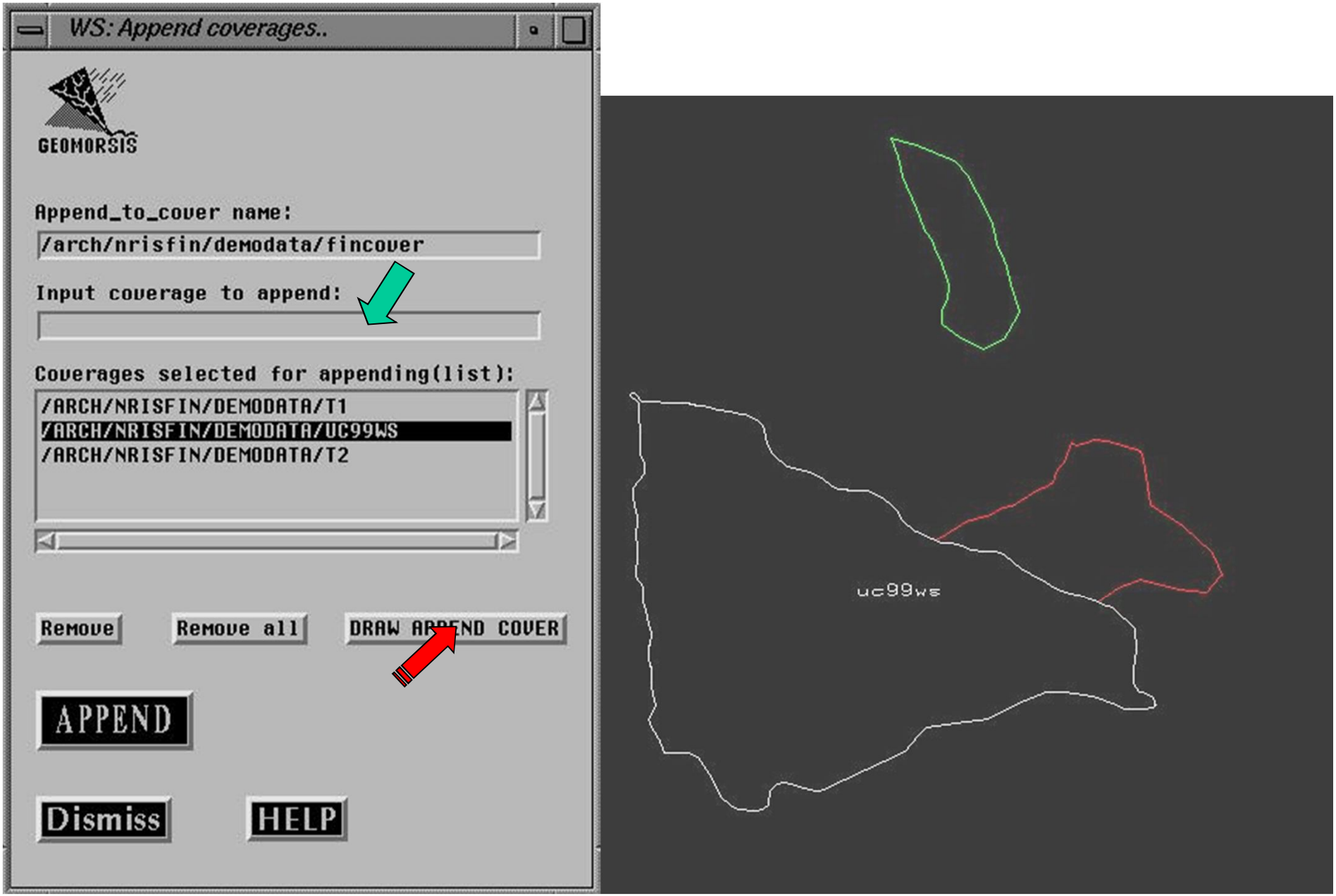

Watershed APPENDING

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GEOMORSIS

AUDRALA
(Auto ordering)

WATERSHED
SELECTION

STMPARA
&
BASGEO

RELIEF
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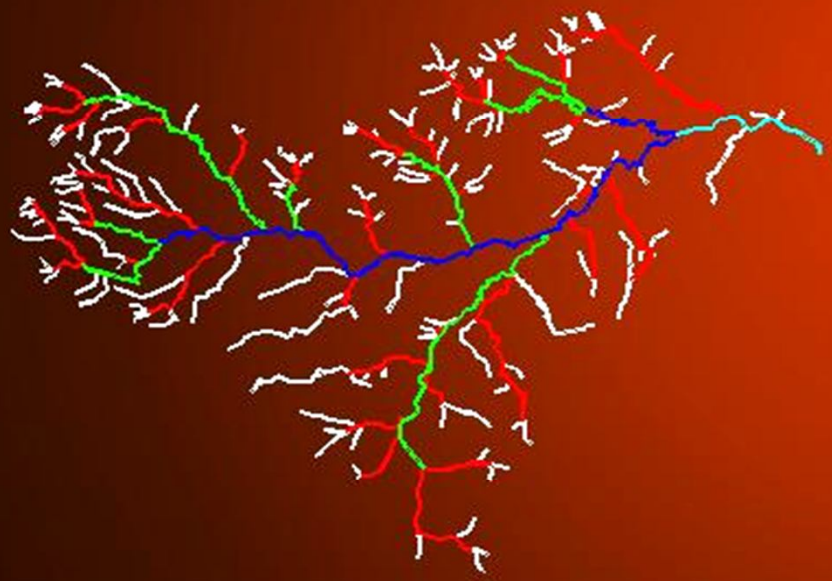
STMPARA

[Stream Parameters Analysis]



STATISTICS TABLE

Watershed name : 4E5A6E2b — Unit : km

Parameter	Value
1. Maximum order of watershed	2
2. Stream frequency (order 1)	15 nos.
3. Length of stream (order 1)	8.288 km
4. Stream frequency (order 2)	3 nos
5. Length of stream (order 2)	4.246 km
6. Total number of streams	18 nos
7. Total length of streams	12.534 km
8. Bifurcation ratio (order 1)	5.000
9. Bifurcation ratio (order 2)	3.000
10. Length ratio (between order 1-2)	2.561
11. Average length (order 1)	0.553 km
12. Average length (order 2)	1.415 km
13. Average Bifurcation ratio	4.000
14. Average length ratio	2.561

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GEOMORSIS

BASGEO

[Basin Geometry Analysis]

Press START to initiate

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GEOMORSIS

BASGEO

[Basin Geometry Analysis]

GEOMORSIS:BASGEO(Basin geometry a

GEOMORSIS

1 outof 1 WATERSHED to be processed

Processing the WATERSHED number: 2

PREVIOUS

START

NEXT

WATERSHED length VALUE(km)

--

DELETE

STREAM length

--

DELETE

OVERLAND-FLOW length

--

DELETE

PERFORM ANALYSIS

REFRESH

Dismiss

HELP

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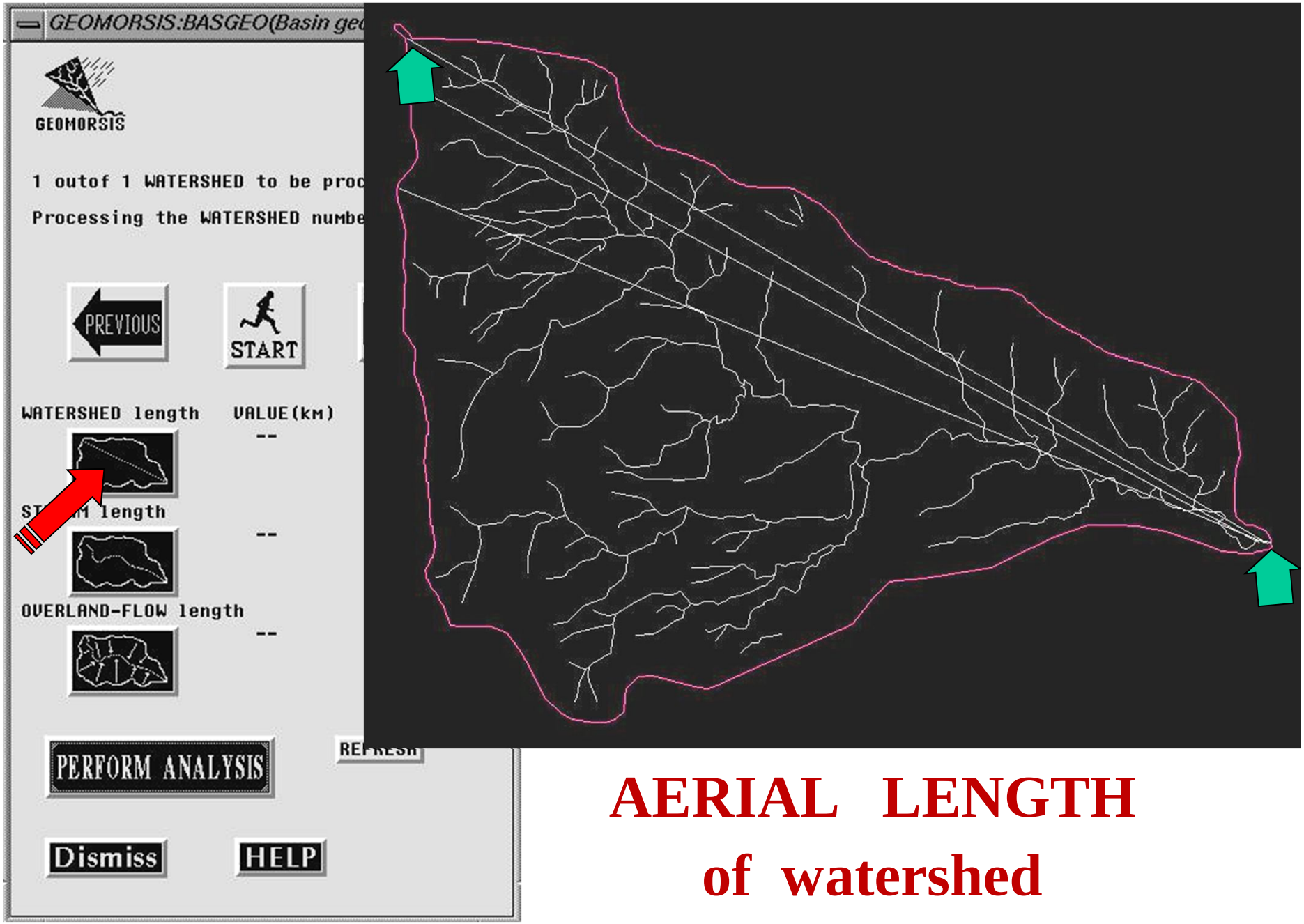
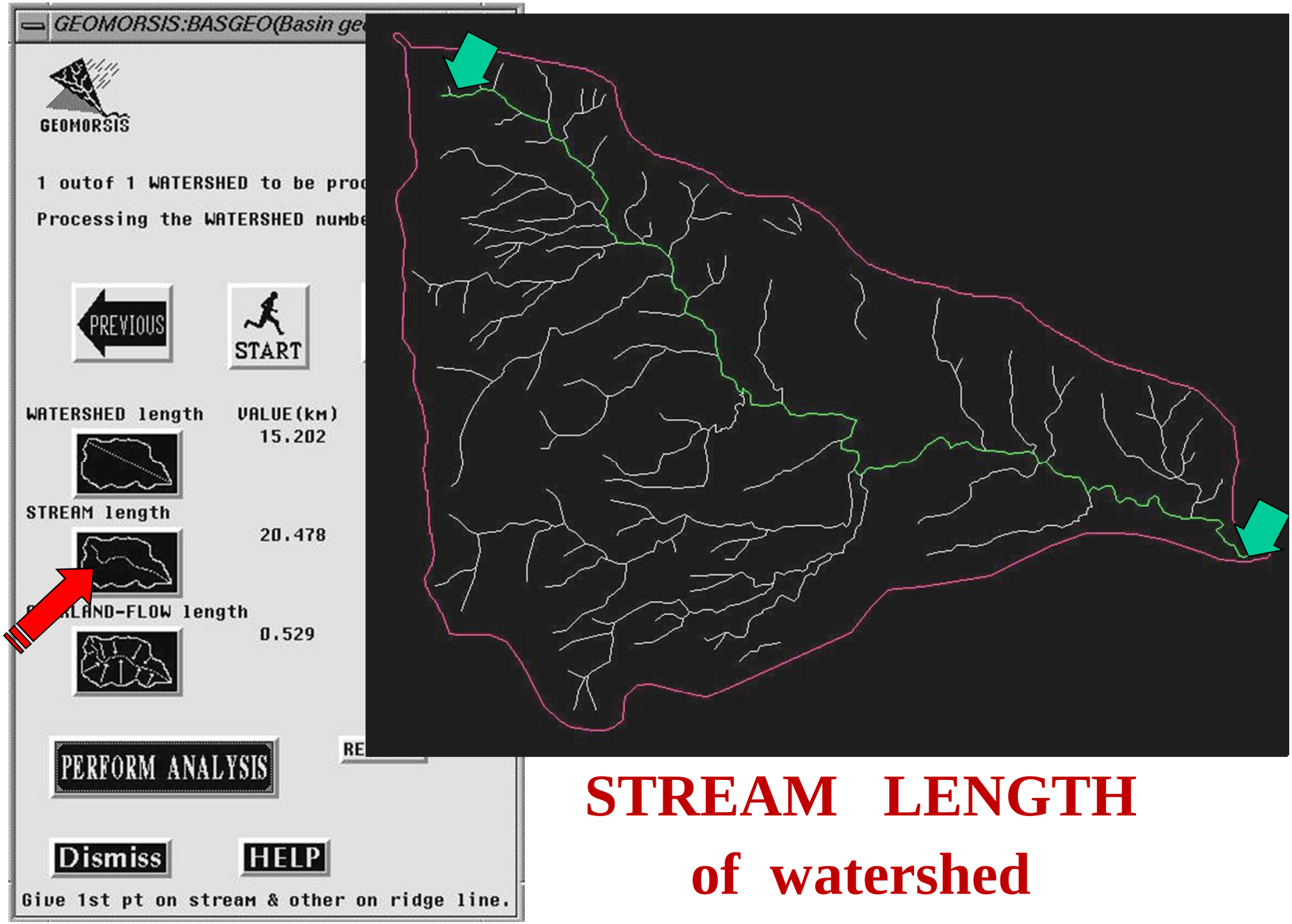
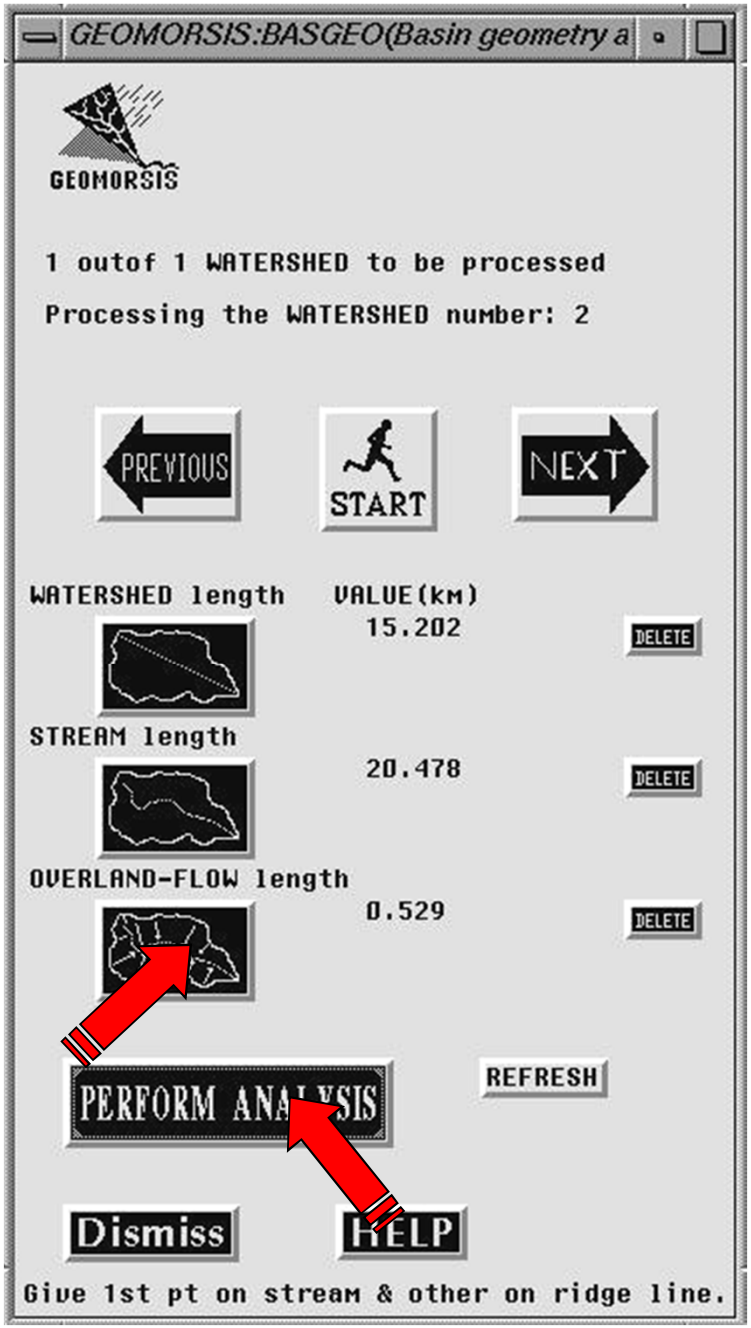


AERIAL LENGTH of watershed



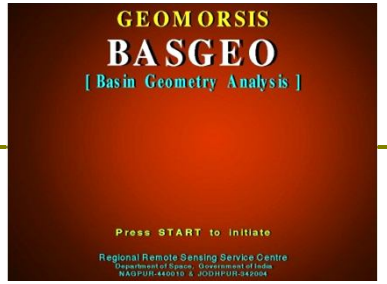
STREAM LENGTH of watershed



OVERLAND FLOW LENGTH

of watershed

BASIN GEOMETRY PARAMETERS

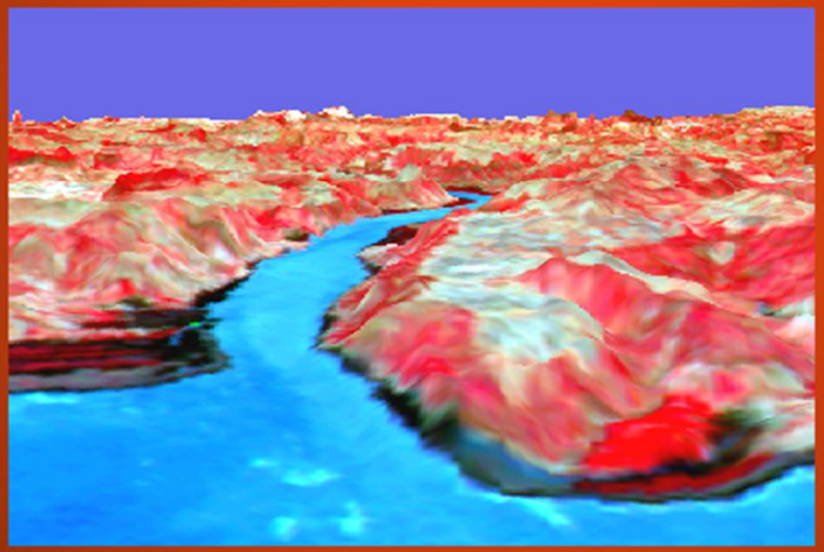


- **AREA and PERIMETER of watershed**
- **AERIAL, STREAM and OVERLAND - FLOW length of watershed**
- **ELONGATION RATIO**
- **BASIN CIRCULATORY RATIO**
- **FORM FACTOR**
- **COMPACTNESS COEFFICIENT**
- **RHODENTITY FACTOR**
- **DRAINAGE DENSITY**
- **STREAM FREQUENCY**
- **DRAINAGE TEXTURE**
- **TEXTURE RATIO**
- **LAMISCATE RATIO**

GEOMORSIS

RELIEF PARAMETERS

[Relief Parameters Analysis]



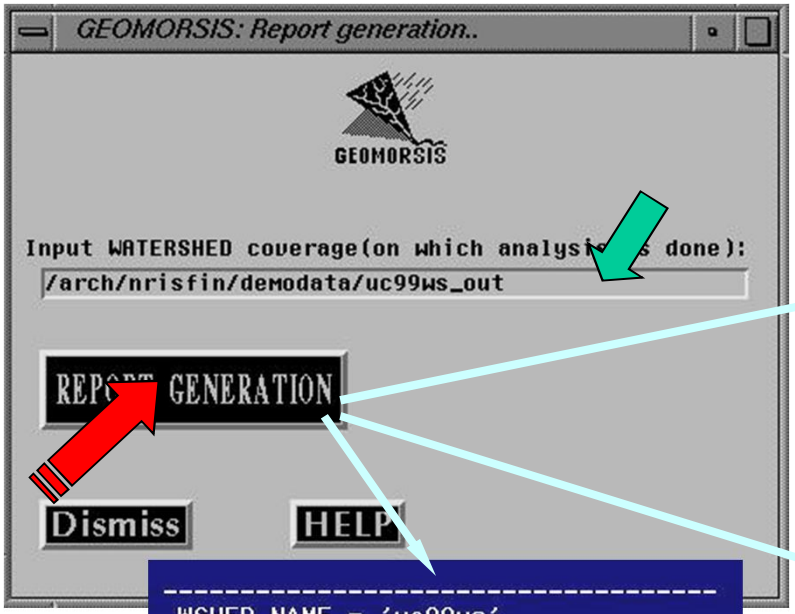
MAXIMUM ELEVATION, MINIMUM ELEVATION

RELIEF RATIO, RELATIVE RELIEF ,

RUGGEDNESS NUMBER

GEOMORSIS

RELIEF PARAMETERS




```
WSHD NAME    = 'uc99ws'
  UNITS      = km.
-----------------------------------
MAX_HT       =              380
MIN_HT       =              220
RE_REL       =              160
REL_RO       =           0.0105
RUG_NO       =           0.2522
```

<output w/s name>.rlf

```
WSHED NAME = 'uc99ws'
  UNITS    = km.
-----------------------------------
MXORD      =                4
FREQ 1     =               91
LEN 1      =           72.052
AVLEN 1    =            0.792
FREQ 2     =               24
LEN 2      =           36.320
AVLEN 2    =            1.513
FREQ 3     =                6
LEN 3      =           13.456
AVLEN 3    =            2.243
FREQ 4     =                1
LEN 4      =           16.277
AVLEN 4    =           16.277
TOTFREQ    =              122
TOTLEN     =          138.105
BIR 1      =            4.000
BIR 2      =            6.000
BIR 2      =            6.000
LENRA 2    =            7.258
LENRA 3    =            0.000
LENRA 4    =            0.000
AVBIR      =            4.597
AVLENR     =            3.550
~
```

<output w/s name>.stm

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AREA_WS     =          87.62611
PERI_WS     =          45.23025
WSHD_LEN    =          15.20243
LEN_AWS     =          15.20243
LEN_STRM    =          20.47806
LEN_STOF    =          21.00719
BA_CIR      =           1.36276
FO_FA       =           0.37915
ELO_RO      =           0.69466
COM_CO      =           4.28297
RHO_RA      =           2.07232
DRA_DEN     =           1.57607
CAN_MAN     =           0.63449
STM_FREQ    =           1.39228
DRA_TEX     =           2.19433
TEX_RO      =           2.69731
LAM_RO      =           0.04337
```

<output w/s name>.bsg

WATERSHED PRIORITIZATION

Erosion - Major problem and forms the bases of prioritization

Factors - Rainfall, runoff, wind, soil, slope, plant cover and management practices.

Why assessment of erosion becomes so important ?

Identification of the eroded and erosion prone area through remote sensing (NDVI, SBI, PC)

Assessment of the Erosion Hazards :

Quantitative method - Universal soil loss equation;
Qualitative method - Sediment Yield Index

Runoff Rate
Vegetation Status
Socio-economic conditions

WATERSHED PRIORITIZATION - SYI Method

Climatic Factors : Total precipitation, its frequency and intensity

Geomorphic Factors : Landforms, Physiography, slope and drainage characteristics.

Soil Factor : Soil profile characteristics (texture, structure, OM content, swell-shrink potential, porosity, hydraulic, soil depth & clay mineralogy

Surface Cover Factor : Vegetation cover pattern governing flow hydraulics.

Management Factors : Cultivation, bunding, multching, etc.

WATERSHED PRIORITIZATION - SYI Method

Framework through systematic delineation & codification

↓

Mapping/Reconnaisance surveys for map indicating erosion-intensity mapping units

↓

Assignment of weightages values to various mapping units based on relative silt yield/run-off potential (0.35 to 0.95)

↓

Assignment of maximum delivery ratios to various erosion intensity and adjusted delivery ratios (measure of transportability) for different watersheds.

↓

Computation of Silt Yield Index (SYI)/ Potential Run-off Index (PRI) for individual watershed/subwatershed

$$SYI = \frac{\sum (Ai * Wi * Di)}{Aw} * 100, \quad i = 1 \text{ to } n$$

$$RPI = \frac{\sum (Ai * Wi)}{Aw} * 100, \quad i = 1 \text{ to } n$$

Sediment Yield Index

Run-off Potential Index

Ai = Area of the ith unit (EIMU)

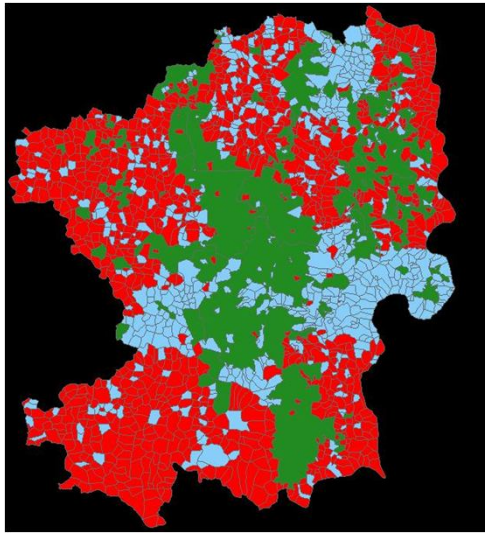
Wi = Weightages value of ith mapping unit

Di = Adjusted delivery ratio assigned to ith mapping unit

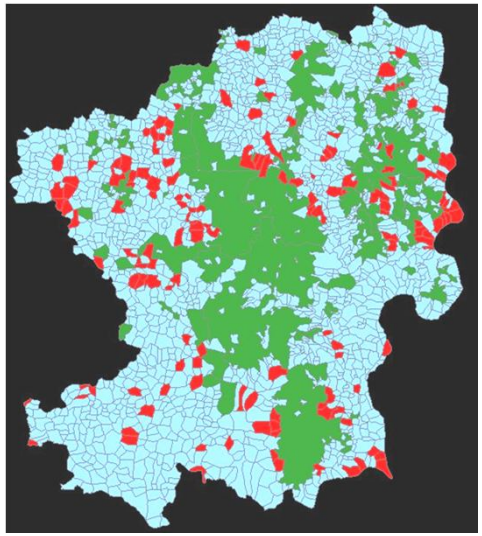
N = No. of mapping unit ; Aw = Total area of watershed

↓

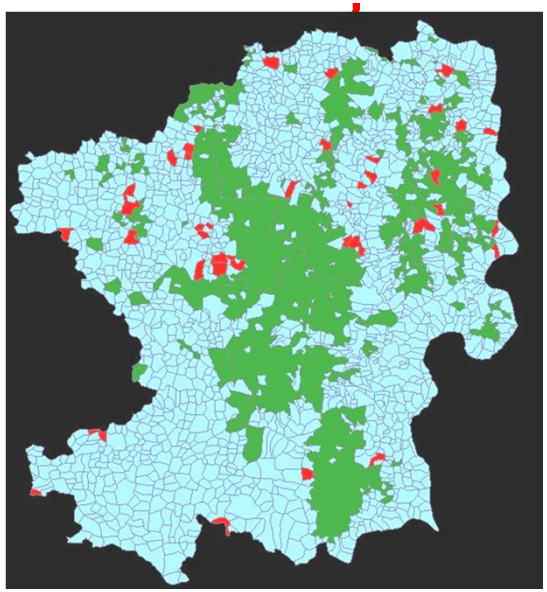
CATEGORIZATION & GRADATION of Subwatershed



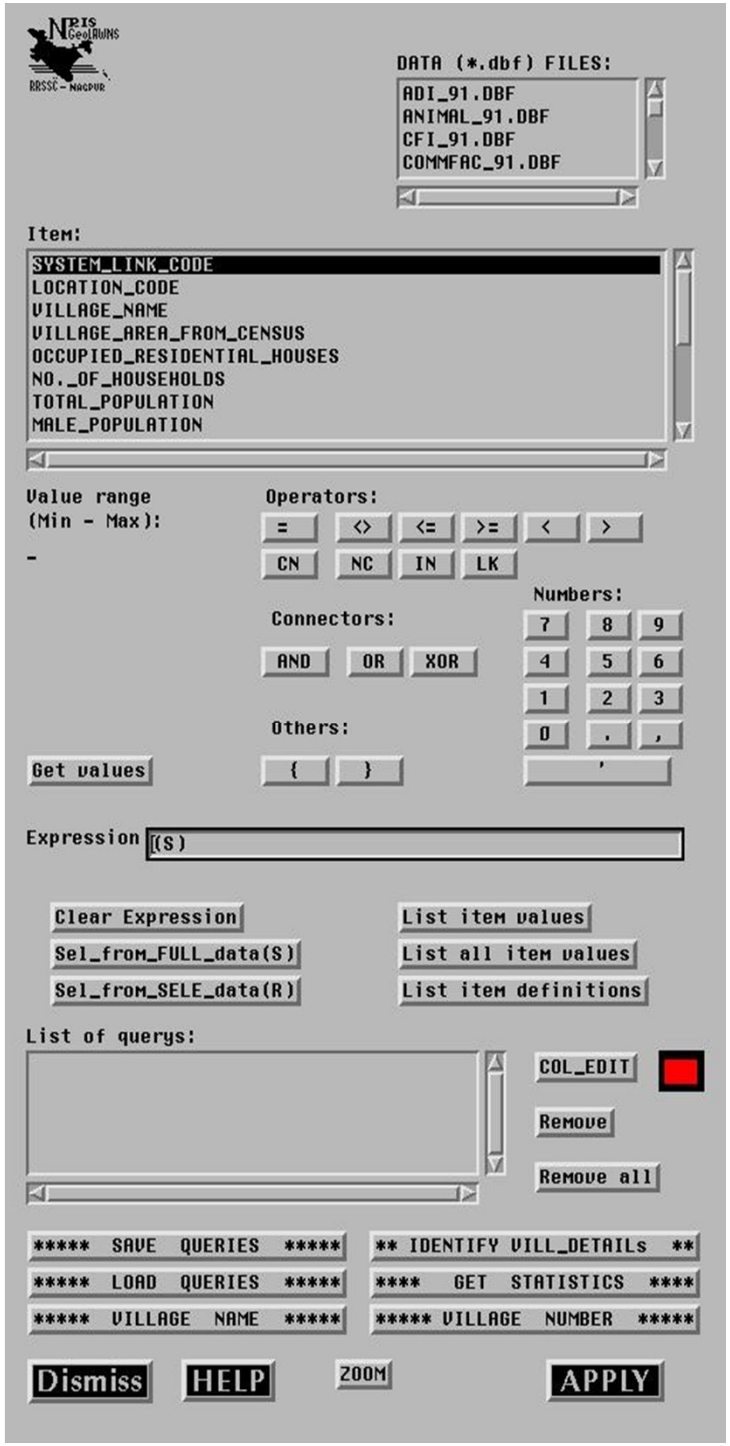
Fodder status < 0



Fodder status < 0
(+) Wasteland > 50



Fodder status < 0 (+) Wasteland > 50 ha (+) Below Poverty level > 40 %

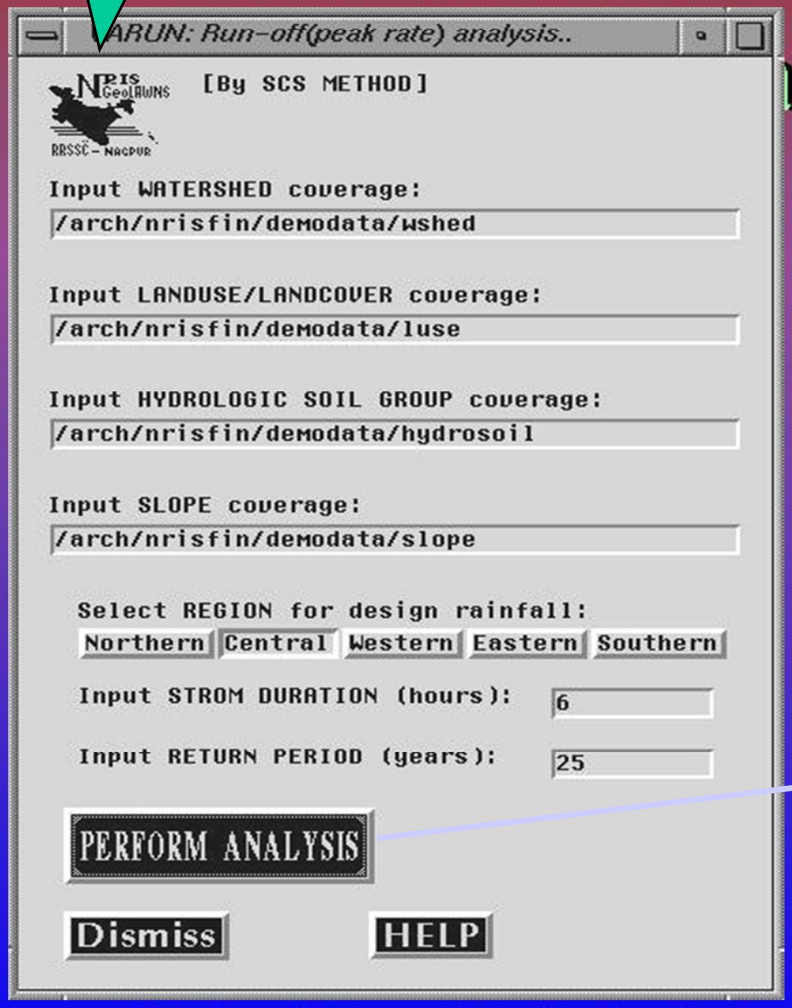


VARUN

RUNOFF ANALYSIS

Run-off (Peak rate)

te for design rainfall]



OUTPUT

```
**********************************************
                  VARUN
   (Value Added Rainfall-rUnoff aNalysis)
      PEAK RUNOFF RATE FOR DESIGN RAINFALL
**********************************************

REGION                  =   CENTRAL
STORM DURATION          =        6 hr
RETURN PERIOD           =       25 years
RAINFALL                = 124.2884 mm
DIRECT RUNOFF DEPTH     =  62.8429 mm
AREA OF WATERSHED       = 11.225884 sq km
AVERAGE SLOPE           =   6.6000 %
TIME OF CONCENTRATION   =   1.9101 hr
TIME TO PEAK            =   2.5281 hr
PEAK RUNOFF RATE        =  58.0414 cumec
**********************************************
     THESE CALCULATIONS ARE FOR AMC II
```

Regional Remote Sensing Service Centre, Department of Space, Government of India

Run-off (Rainfall event)

VARUN

RUNOFF ANALYSIS

e for design rainfall]

OUTPUT

VARUN: Run-off analysis(rainfall event)..

[By SCS METHOD]

Input WATERSHED coverage:

/arch/nrisfin/demodata/wshed

Input LANDUSE/LANDCOVER coverage:

/arch/nrisfin/demodata/luse

Input HYDROLOGIC SOIL GROUP coverage:

/arch/nrisfin/demodata/hydrosoil

Input SLOPE coverage:

/arch/nrisfin/demodata/slope

Input RAINFALL for a event(mm): 150

PERFORM ANALYSIS

Dismiss HELP

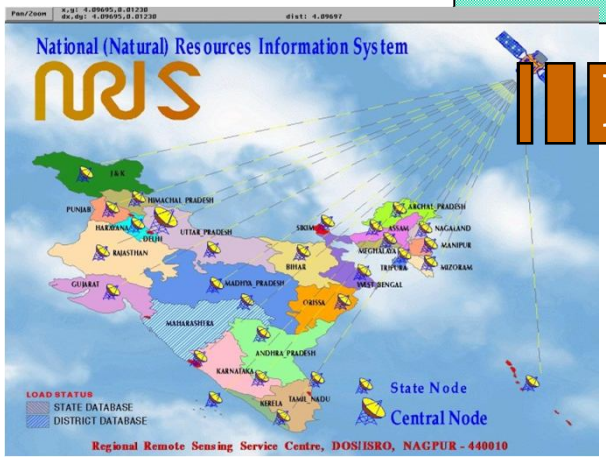
```
*******************************************
                VARUN
   (Value Added Rainfall-rUnoff aNalysis)

     USER SPECIFIED RAINFALL EVENT
*******************************************

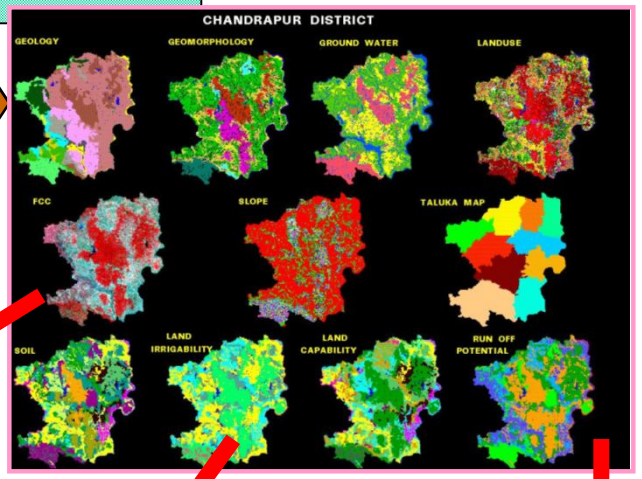
RAINFALL                = 150.0000 mm
DIRECT RUNOFF DEPTH     =  84.5494 mm
AREA OF WATERSHED       = 11.225884 sq km
RUNOFF VOLUME           = 94.914230 ha m
AVERAGE SLOPE           =   6.6000 %
TIME OF CONCENTRATION   =   1.9101 hr
TIME TO PEAK            =   2.5281 hr
PEAK RUNOFF RATE        =  78.0895 cumec
*******************************************
     THESE CALCULATIONS ARE FOR AMC II
```

Regional Remote Sensing Service Centre, Department of Space, Government of India

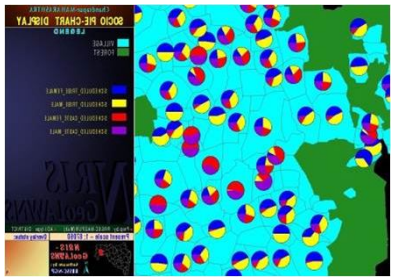
NRIS - GeoLAWNS

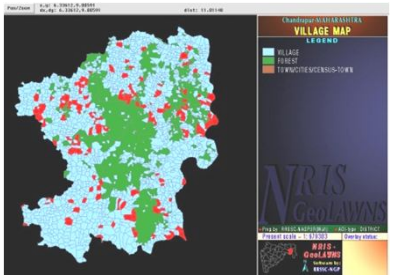


Database

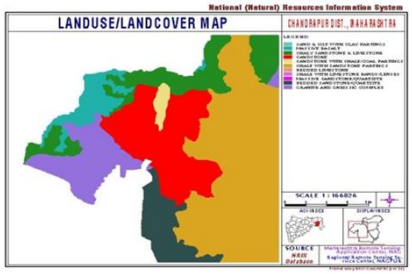


Display & Query

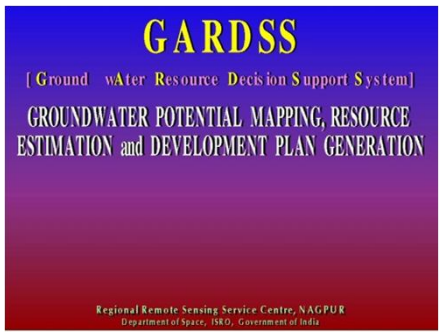


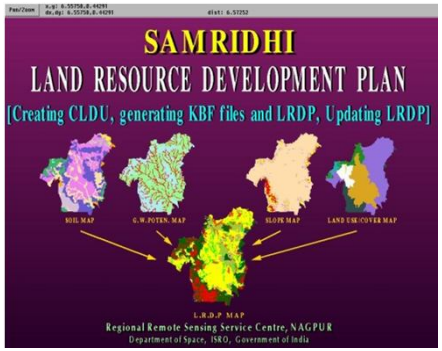


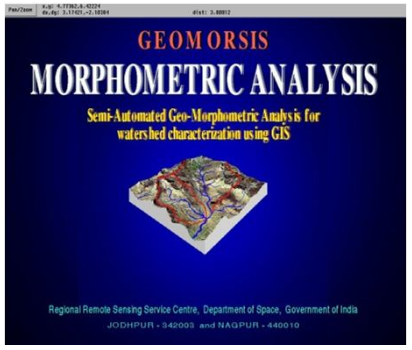
Output

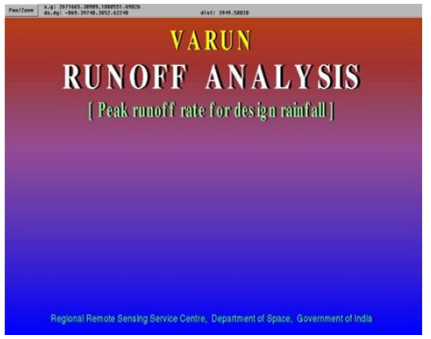


Analysis









INTEGRATED WATERSHED DEVELOPMENT

OBJECTIVES

Economic Growth, Basic Needs, Ecological Balance

INFORMATION NEED

Natural Physical Resources	Contemporary technology	Socio-Economic & Demographic data
- SOIL - GEOLOGY - GEOMORPHOLOGY - GROUNDWATER - LANDUSE / LANDCOVER - RAINFALL AND CLIMATE - DRAINAGE & WATERSHED - SLOPE, ASPECT & ALTITUDE - TRANSPORT NETWORK AND SETTLEMENT	- AGRICULTURE - WATER MANAGEMENT - GROUNDWATER EXPLORATION - ANIMAL HUSBANDARY - FISHRIES - MINERAL EXPLORATION - HOUSING AND CONSTRUCTION - ENERGY & POWER ENGINEERING - HEALTH & SANITATION - WATER HARVESTING	SPATIAL ANALYSIS OF SOCIO ECONOMIC DATA - SOCIAL PROFILE - DEMOGRAPHIC PROFILE - CULTURAL PROFILE - ECONOMIC STATUS

THEMATIC MAP INFORMATION

INTEGRATION OF MULTI-THEMATIC INFORMATION
(Composite Land Development Unit)

NATURAL/PHYSICAL RESOURCE BASED DEVELOPMENT POSSIBILITY RESOURCES REGIONS

PEOPLES NEED & PROGRAMMES REGION IDENTIFICATION
- Socially backward Areas/People
- Economically backward Areas/People
- Areas lacking basic amenities

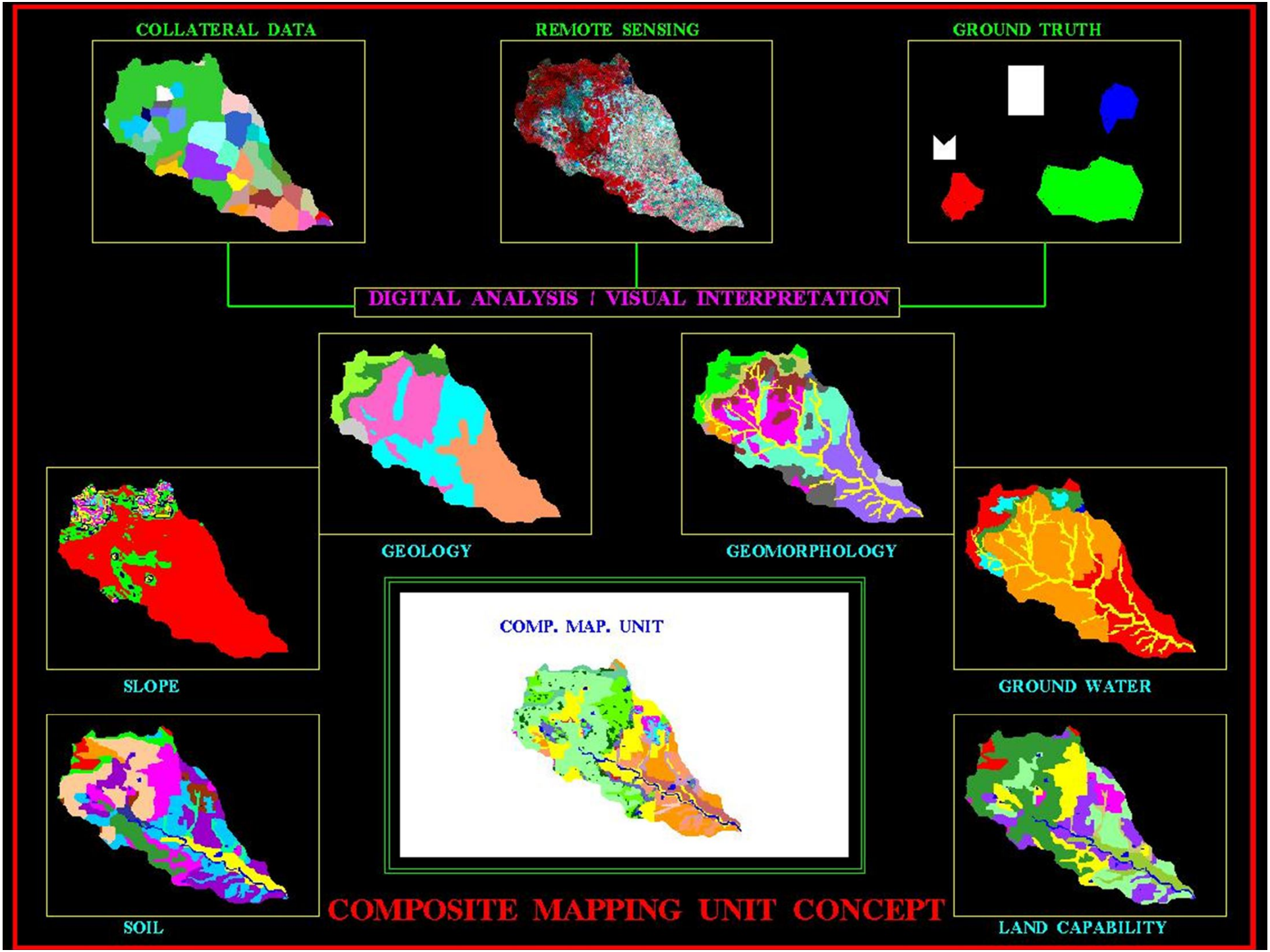
RESOURCES MANAGEMENT DECISIONS-SPECIFIC PLANS/PROJECTS

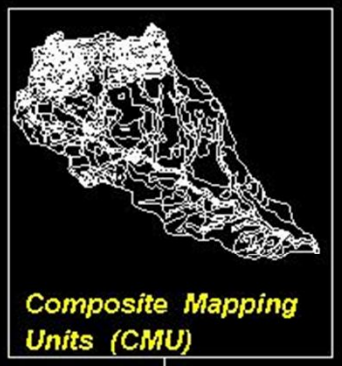
DEMONSTRATION OF TECHNOLOGY

IMPLEMENTATION

TRAINING/RETRAINING OF USERS

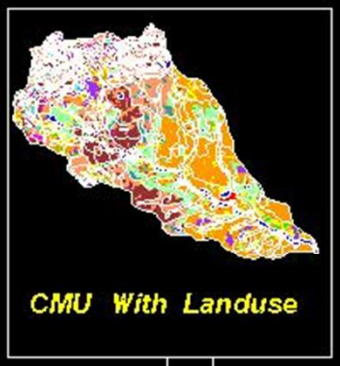
EVALUATION AND FEED BACK


COLLATERAL DATA
REMOTE SENSING
GROUND TRUTH
DIGITAL ANALYSIS / VISUAL INTERPRETATION
GEOLOGY
GEOMORPHOLOGY
SLOPE
GROUND WATER
COMP. MAP. UNIT
SOIL
LAND CAPABILITY
COMPOSITE MAPPING UNIT CONCEPT



Composite Mapping Units (CMU)

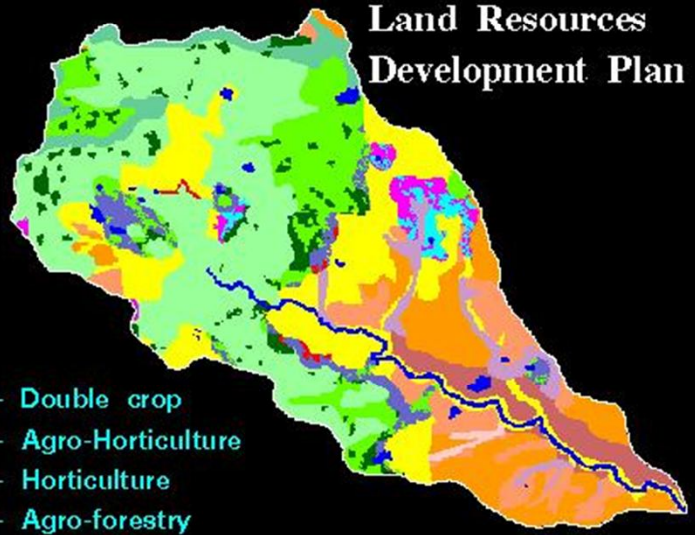
Landuse Map



CMU With Landuse

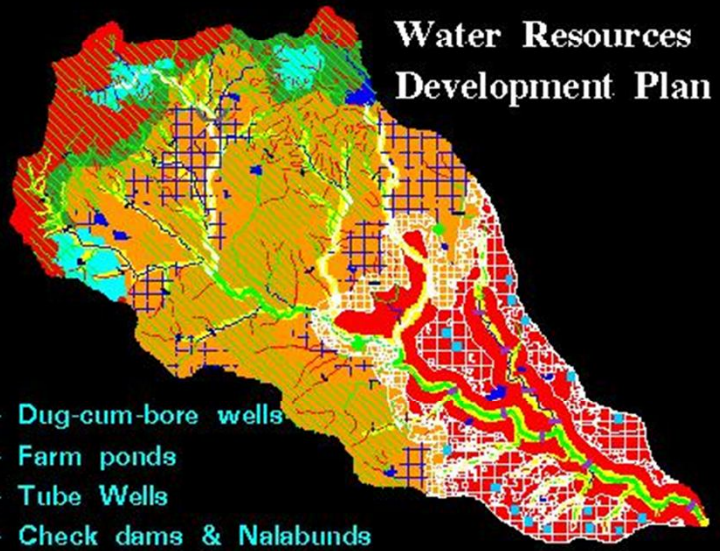
Socio-Economic And Institutional Facilities

ANALYSIS OF CMU FOR PLANNING DECISIONS



Land Resources Development Plan

- Double crop
- Agro-Horticulture
- Horticulture
- Agro-forestry
- Silvipasture
- Fuel/Fodder
- Afforestation
- Forest Development & Management



Water Resources Development Plan

- Dug-cum-bore wells
- Farm ponds
- Tube Wells
- Check dams & Nalabunds
- Bhandaras
- Underground Bhandaras

WATER HARVESTING

- Water harvesting is capturing and storing of runoff for later water requirements of drinking, irrigation, domestic and industrial use.

OBJECTIVES

- Store excessive run off for future use
- Augment percolation /recharge to aquifers
- Checking of floods
- Checking of land erosion

APPROPRIATE LOCATION

Location of water harvesting structures at appropriate places is important for effectiveness of these structures.

NEED FOR RECHARGING GROUND WATER

- Recharging is necessary in view of depleting GW table.
- Deteriorating water quality from the aquifers.
- Increasing demand for drinking water and irrigation.
- The excess runoff can be used for recharging the aquifers.
- Deep water table increases the cost per unit yield.
- To improve the GW supplies for longer durations.
- Checking of floods and land erosion.
- Right utilization of the excess water from cities and canals.

Some Important Points

- Water harvesting measures must be implemented on a watershed basis to get maximum recharge to aquifer occurring at depth.

- Type of structures depend on topography, drainage pattern, geology / structures, geomorphology and soil cover of a watershed.

- Structures for storage purpose must be located on impervious base while those for recharge on pervious base.

Cont……

- **Recharge structures need porous geological materials for percolation of water down to aquifers.**

- **Weak zones are preferred for recharging, viz.,**

✓FRACTURED ZONES

✓SHEAR ZONES

✓ROCK CONTACTS

✓LINEAMENT/ LINEAMENT INTERSECTIONS

✓BRECCIATED AREAS

✓WEATHERED ZONES

✓TOPOGRAPHIC TROUGHS

✓MAJOR VALLEYS

METHODS OF RECHARGE / WATER HARVESTING

Obstruction	Check dam, nalabund, gully plugs, khadin, contour bunds.
Storing	Percolation tanks, farm ponds, K.T. Weirs, recharge pits.
Spreading	Recharge basins, flooding.
Injection	Inverted / recharge wells.

PARAMETERS IMPORTANT FOR RECHARGING OF AQUIFERS

- Nature of subsurface soil, rock, extent of weathering and thickness of hydrogeological units.
- Water bearing capacity and hydraulic conductivity of aquifer materials.
- Geological structures (Lineaments).
- Topography, slope and drainage characteristics.
- Land use /land cover in the area.
- Quality of water and evaporation.
- Locations of recharge /discharge areas, water levels and water budget.
- Rainfall & runoff

Water Harvesting Structures

Farm Ponds

- Made by either by constructing an embankment across a water course or by excavating a pit, usually provided within individual farms.
- To provide water storage for life saving irrigation.
- Provide drinking water for livestock and human beings in arid areas.
- Site conditions: Areas having flat topography and locations with rocks and soils of low permeability, free from structures such as faults, joints/fractures.

Water Harvesting Structures

Minor Irrigation Tanks

- **Created across streams for creating water reservoirs for providing irrigation to the crops at critical periods and to facilitate groundwater recharge.**

- **<u>Site conditions</u>:**

--Preferably narrow gorges/ valleys for making the dam in order to reduce the ratio of earth work to storage as minimum.

--Availability of sufficient catchment area in the upstream side.

--Geologically and structurally favourable sites to avoid loss of water.

Check Dams

- **Proposed where water table fluctuation is very high and the stream is influent. Av. Catchment area of 25 ha.**

- **Main Objective:**

--To reduce runoff velocity thereby minimizing erosion.

--Increasing recharge to the wells located down stream.

- **Site conditions:**

--Areas having medium slope.

--Constructed on lower order streams (generally up to third order).

-- Favourable soils and lithology and structures for allowing percolation of water.

-- Availability of irrigation wells downstream of proposed structures.

Masanary Bandhara / KT Weir

- Structures similar to minor irrigation tanks except that they do not have extensive canal system and their command area is limited to fields downstream.

- Main Objective:

--to collect and impound surface runoff during during monsoon rains and facilitate infiltration to raise groundwater level.

--to facilitate irrigation in the fields lying in the close proximity of the structure.

- Site conditions:

--Located in moderately permeable strata and soils to facilitate recharge and also short term storage.

--Availability of good cultivated land at the downstream of the structure to reap the benefits of the water stored.

--Availability of good quality soil for bundhi construction.

Nala Bunds and Percolation Tanks

- Relatively structures of smaller dimension across nalas.
- Main Objective:

--to impound surface runoff coming from the catchment and to facilitate percolation of stored water.

--to hold the silt flow.

- Site conditions:

-- Site should be in relatively flatter nala reaches, the slope of the nala should not be more than two percent.

--The catchment area of the nala bund should not be less than 40 ha.

--the nala bed should have soils with adequate permeability and good fracture development to facilitate good groundwater recharge.

Sub-surface dykes

- Structures to arrest lateral groundwater flow (base flow in stream) in the alluvial area.

- Main Parameters to be considered:

--thickness of sand/alluvium

--degree and extent of weathering

--depth to bedrock.

- Site conditions:

--Thickness of weathered mantle should be about 2-5 m.

--The structure should be constructed up to the bedrock, therefore depth to bedrock should not be very high.

Other Structures

Inverted /Recharge/ Wells/Recharge Pits/ Trenches

Where top layer is impervious. Dug perpendicular to fractures. Pits~10m, Trenches~3-4m.

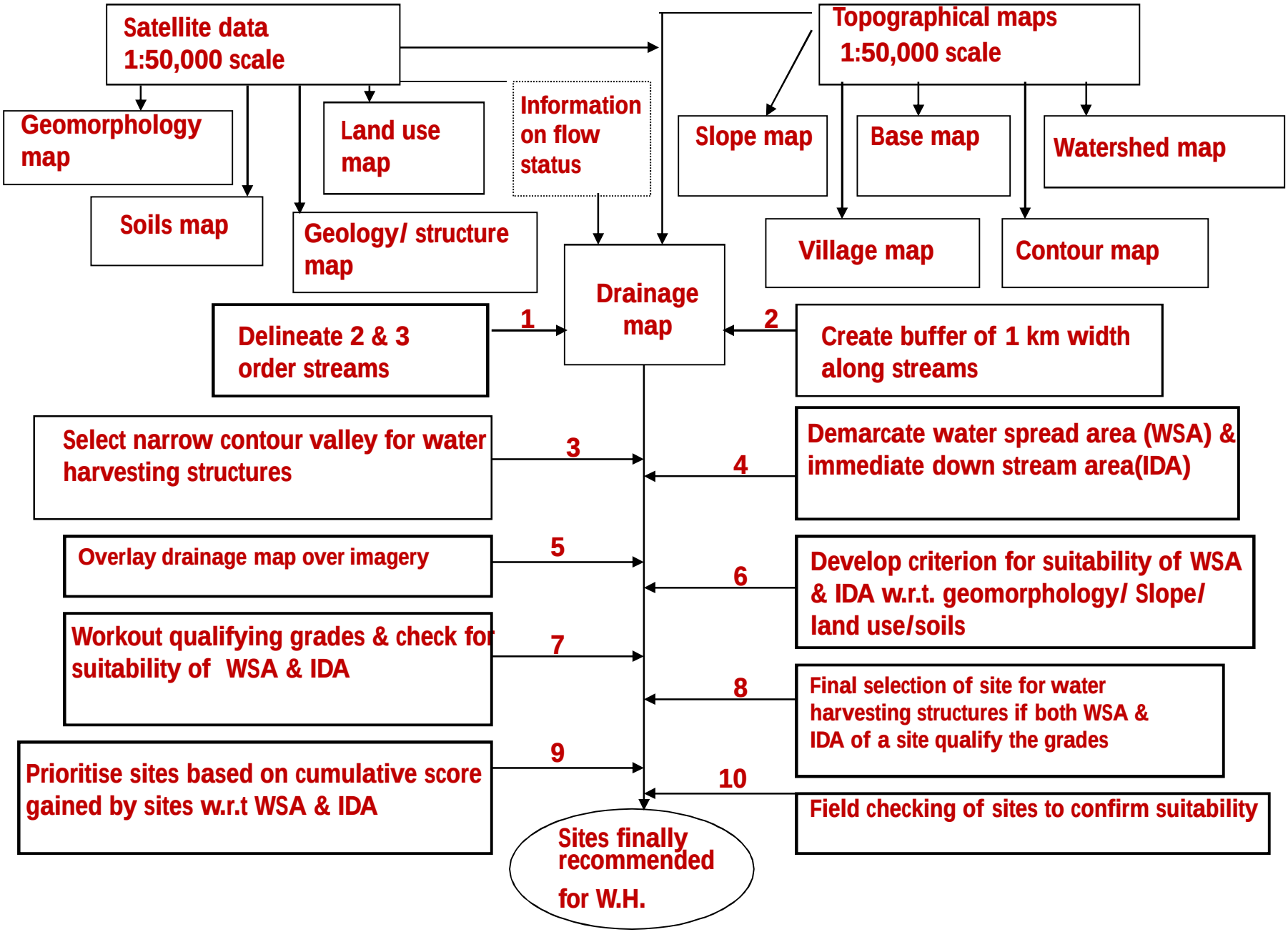
Contour Bunds/ Trenches

In higher slope areas, for stopping soil erosion.

Tankas

Covered underground tanks for individual family use 20-200 cu.m in arid zones.

Methodology for locating water harvesting sites using remote sensing and GIS



Scales of data

- 1:50,000 for delineation of water harvesting sites at block/taluk/watershed level
- 1:25,000 for detailed study at watershed level
- 1:12,500 for suitability study of individual sites

Details of the satellite data

- 1:50,000 scale study IRS LISS-III data 23.5 m Resolution
- 1:25,000 Scale study IRS LISS-III & PAN 5.8 m Merged Data
- 1:12,500 Scale study pan data (5.8m) Resolution and LISS-III+PAN merged FCC data products

Sample Criteria for Site Selection

	Drainage Order	Buffer Dist. m	HSG	LU/LC	SLP	Geomorphology
Check Dam	1	100	C, D	WL, F	10-15%	Pediplain /Pediments/VF
Nala Bund	1	200	C,D	WL	5-10%	Pediplain/VF
Cement Nala Bund	2	200	C,D	WL	5-10%	Pediplain /Pediments/VF
Percolation Tank	>4	500	B,C,D	WL	0-10 %	Pediplain /AP/VF
KT Weir	>4	300	C,D	WL,F	0-5%	Pediments
UGB	2,3	100	A,B	WL,F	0-5%	Pediplain /VF

Note : For all the structures, Nala Bed Slope should be used for further design (X-Section & L-Section)

GIS CONCEPT

BASE MAP

SLOPE

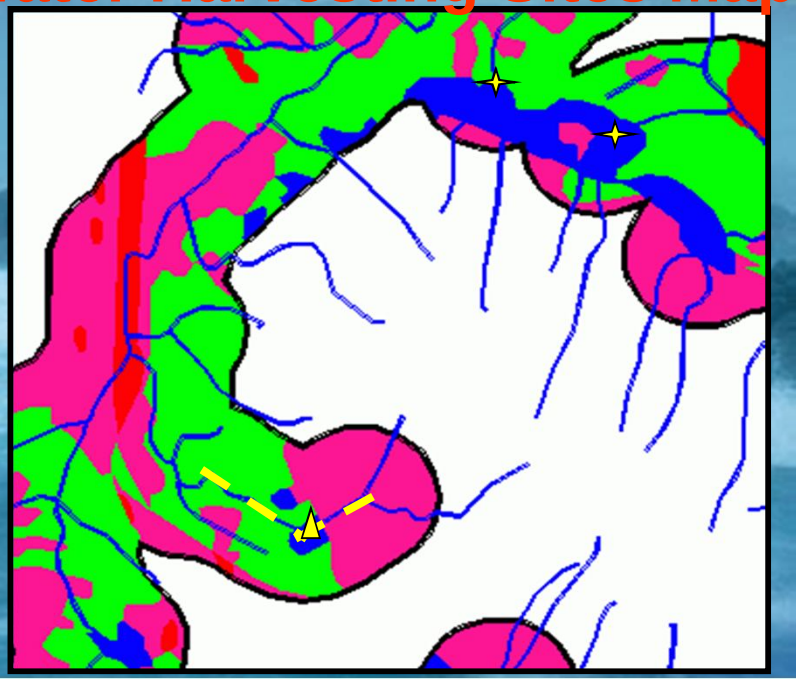
LANDUSE

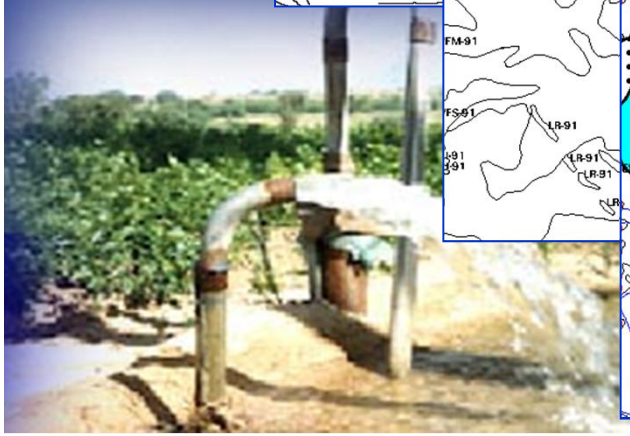
GEOLOGY & STRUCTURAL FEATURES

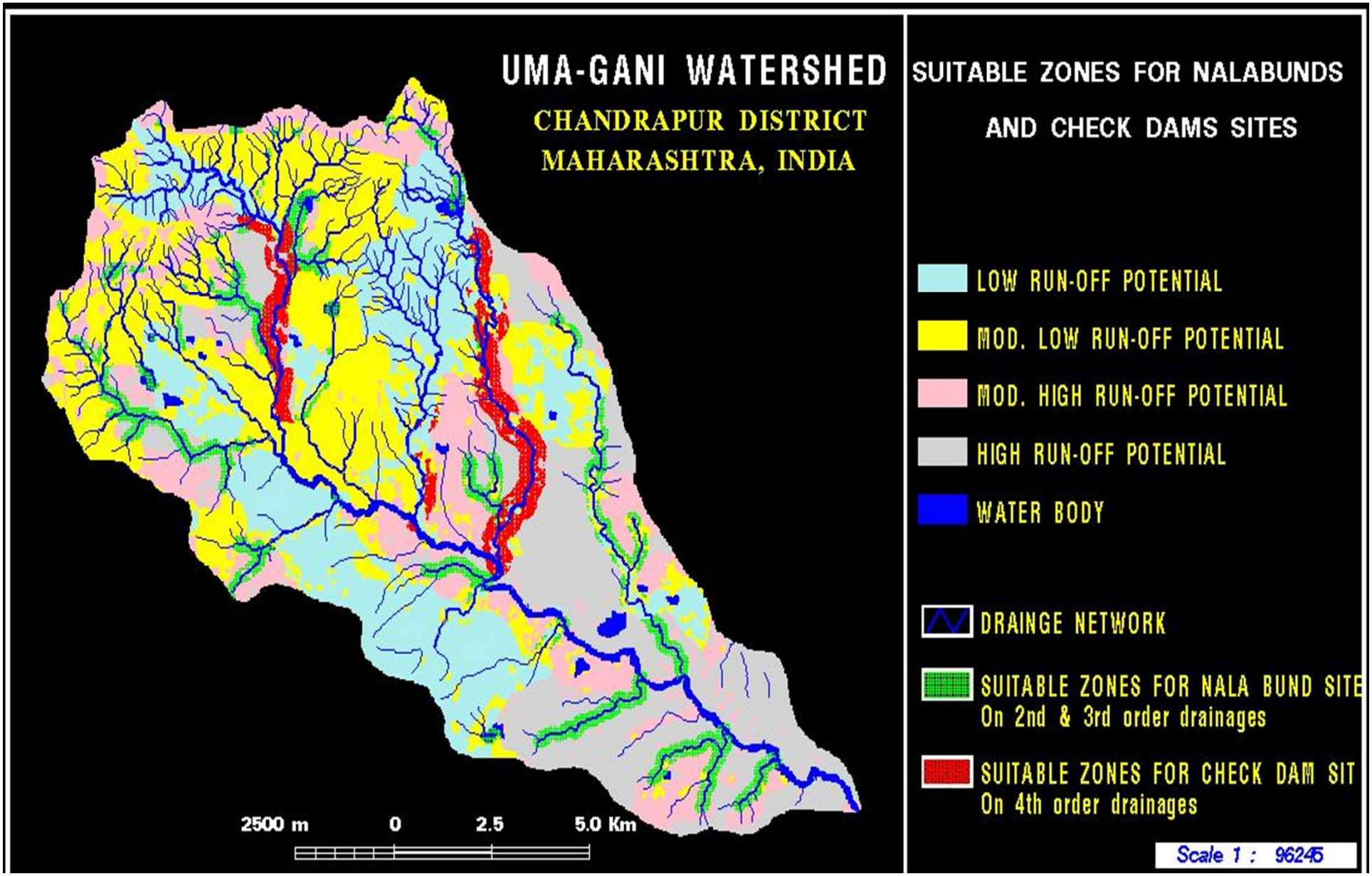
GEOMORPHO-LOGICAL MAP

HYDROLOGICAL MAP

Water Harvesting Sites Map



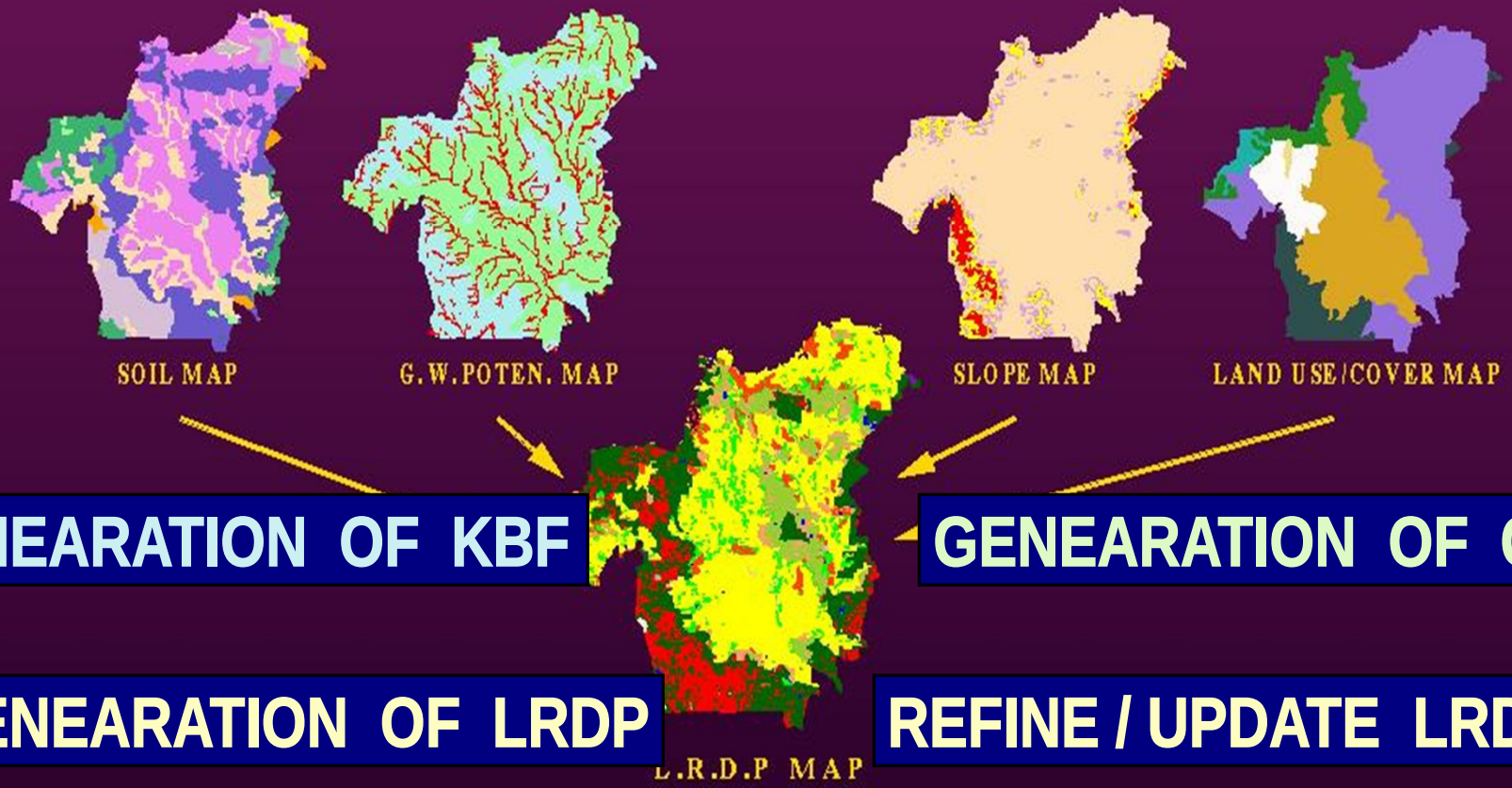



UMA-GANI WATERSHED
CHANDRAPUR DISTRICT
MAHARASHTRA, INDIA
SUITABLE ZONES FOR NALABUNDS
AND CHECK DAMS SITES
LOW RUN-OFF POTENTIAL
MOD. LOW RUN-OFF POTENTIAL
MOD. HIGH RUN-OFF POTENTIAL
HIGH RUN-OFF POTENTIAL
WATER BODY
DRAINGE NETWORK
SUITABLE ZONES FOR NALA BUND SITE
On 2nd & 3rd order drainages
SUITABLE ZONES FOR CHECK DAM SIT
On 4th order drainages
2500 m
0
2.5
5.0 Km
Scale 1 : 96245

SAMRIDHI

LAND RESOURCE DEVELOPMENT PLAN

[Creating CLDU, generating KBF files and LRDP, Updating LRDP]



GENEARATION OF KBF

GENEARATION OF CLDU

GENEARATION OF LRDP

REFINE / UPDATE LRDP

Regional Remote Sensing Service Centre, NAGPUR
Department of Space, ISRO, Government of India

SAMRUDHI (ver 2.0)

D I M
DATABASE INTEGRATION MODULE

Display Query MODULE

Generate CLDU

Generate KBF

Generate LRDP

Refine/ Update LRDP

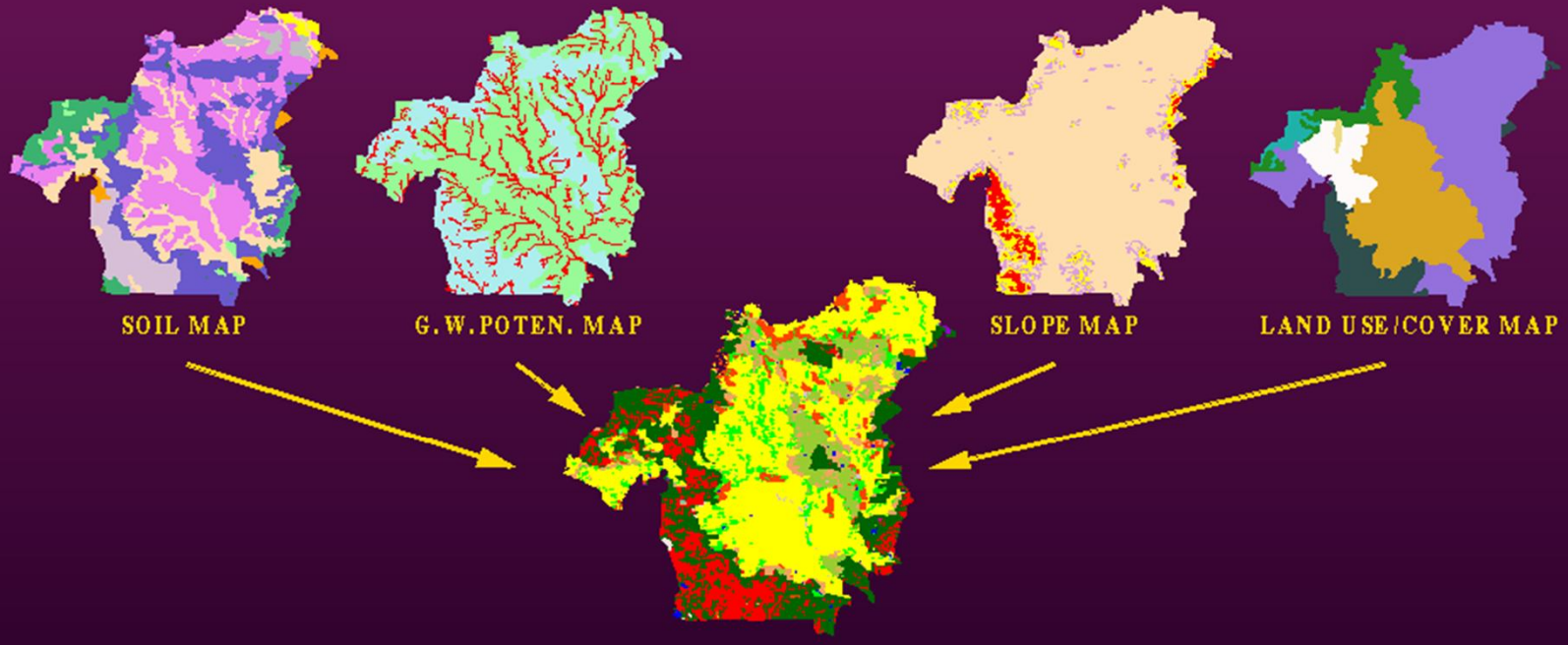
Quit

HELP

SAMRIDHI

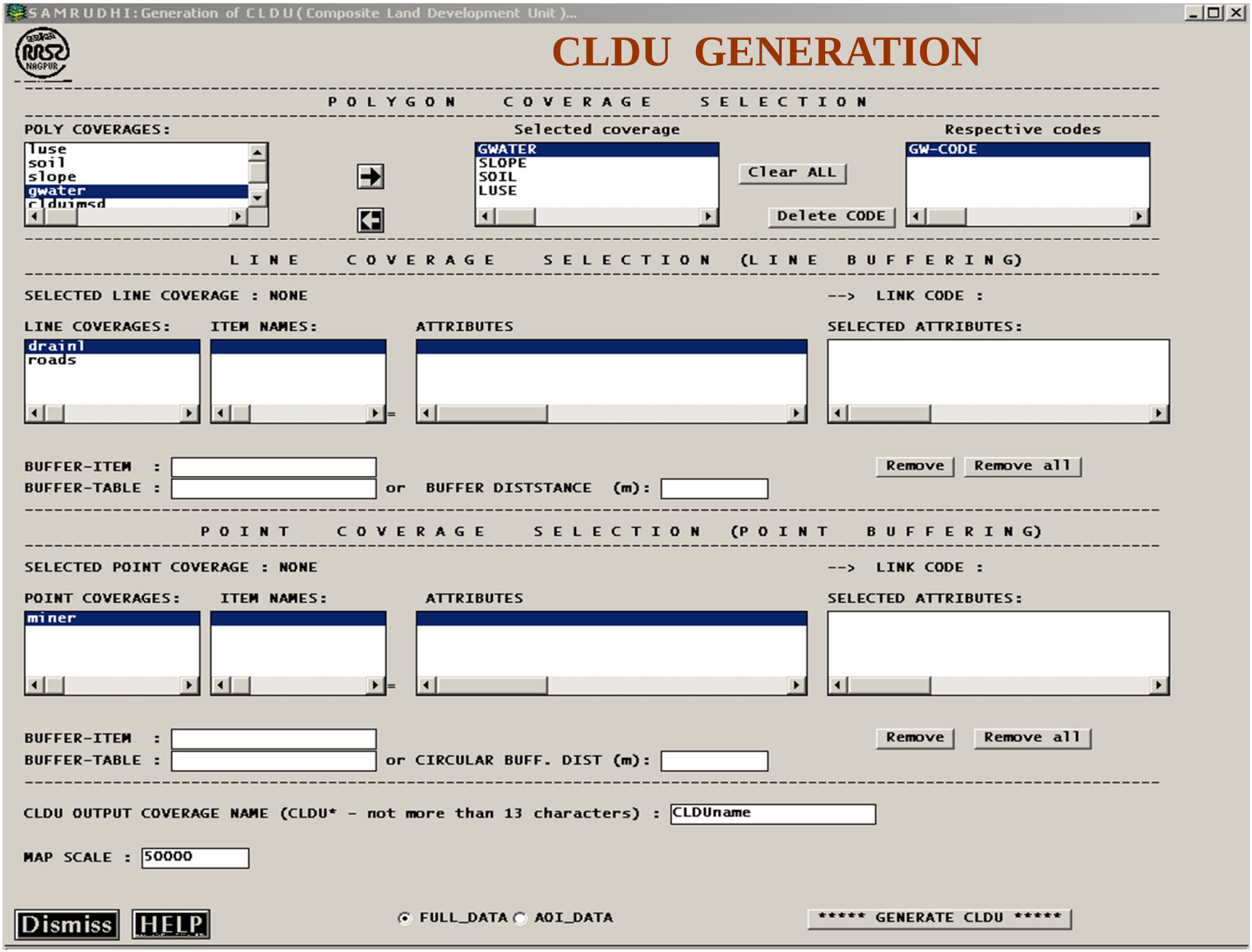
LAND RESOURCE DEVELOPMENT PLAN

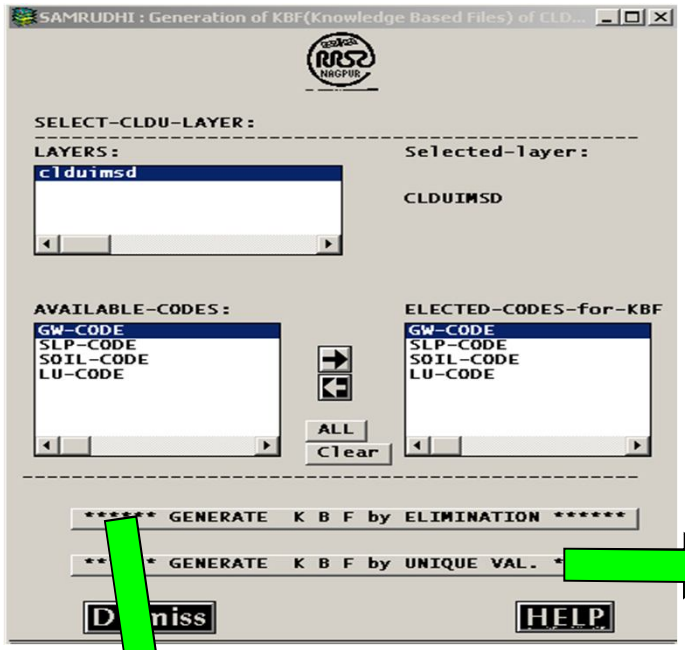
[Creating CLDU, generating KBF files and LRDP, Updating LRDP]

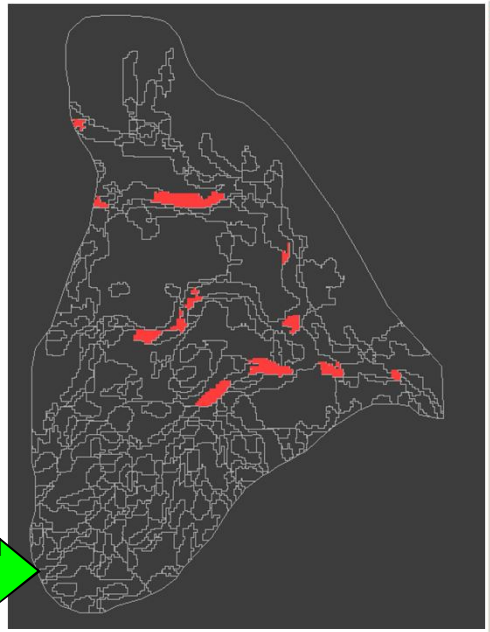


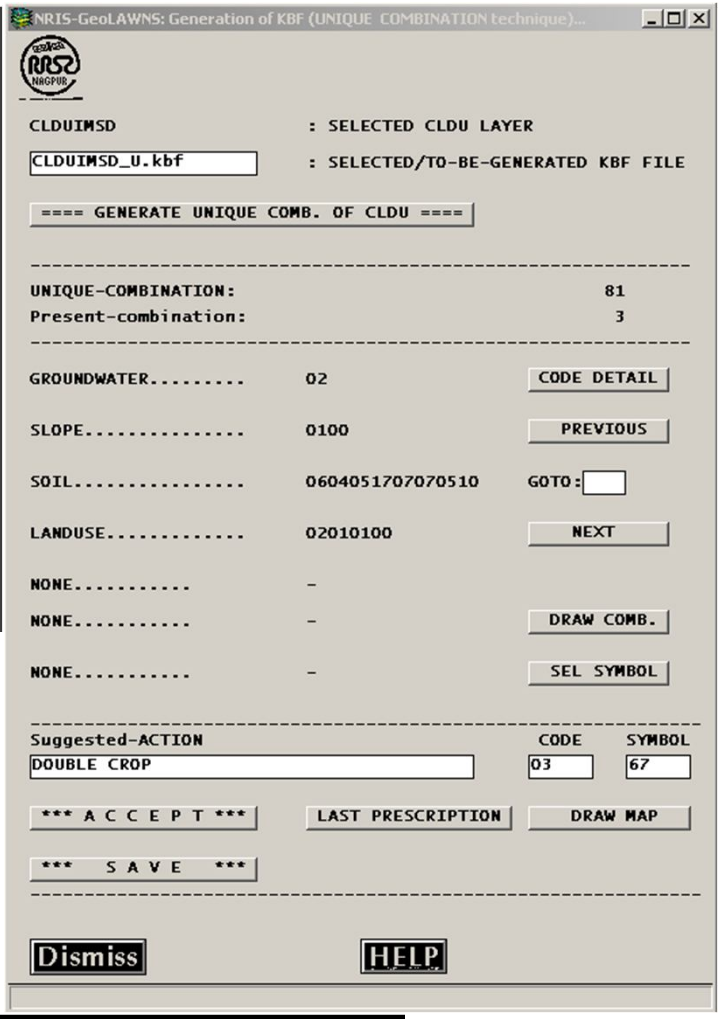
Regional Remote Sensing Service Centre, NAGPUR

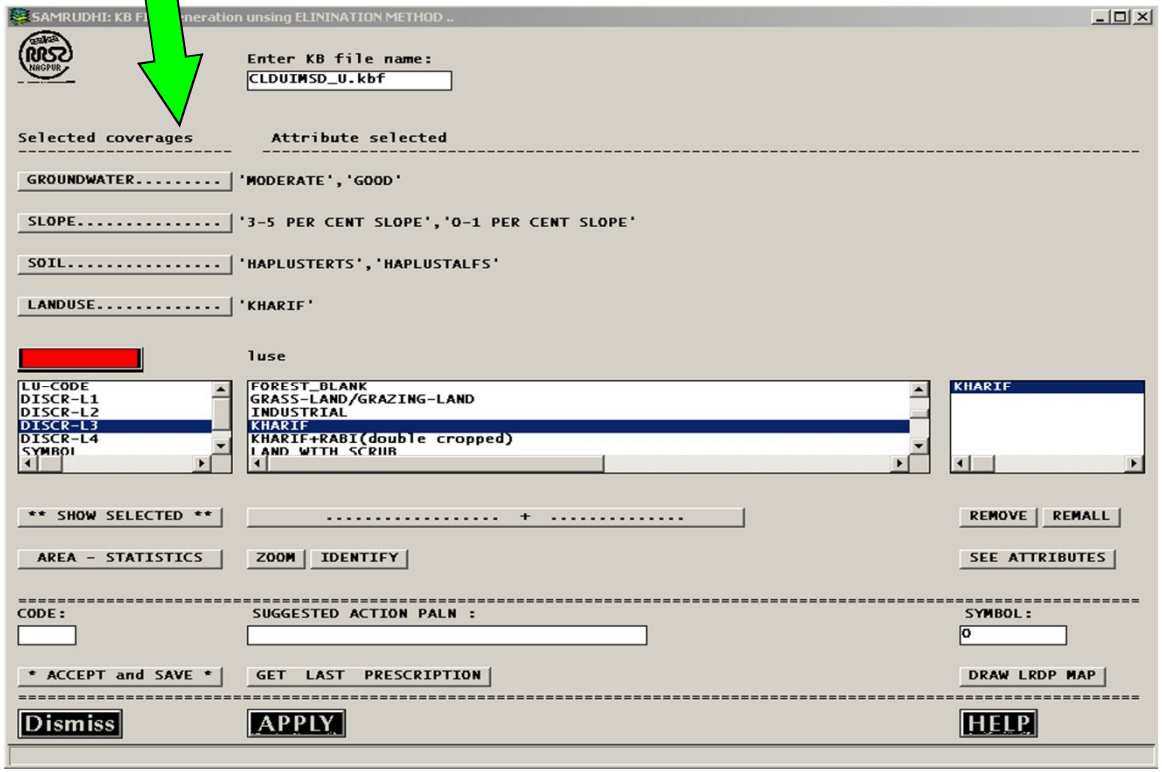
Department of Space, ISRO, Government of India


SAMRUDHI:Generation of CLDU(Composite Land Development Unit)...
CLDU GENERATION
POLYGON COVERAGE SELECTION
POLY COVERAGES:
luse
soil
slope
gwater
clduimsd
Selected coverage
GWATER
SLOPE
SOIL
LUSE
Clear ALL
Delete CODE
Respective codes
GW-CODE
LINE COVERAGE SELECTION (LINE BUFFERING)
SELECTED LINE COVERAGE : NONE
--> LINK CODE :
LINE COVERAGES:
ITEM NAMES:
ATTRIBUTES
SELECTED ATTRIBUTES:
drainl
roads
BUFFER-ITEM :
BUFFER-TABLE :
or BUFFER DISTSTANCE (m):
Remove
Remove all
POINT COVERAGE SELECTION (POINT BUFFERING)
SELECTED POINT COVERAGE : NONE
--> LINK CODE :
POINT COVERAGES:
ITEM NAMES:
ATTRIBUTES
SELECTED ATTRIBUTES:
miner
BUFFER-ITEM :
BUFFER-TABLE :
or CIRCULAR BUFF. DIST (m):
Remove
Remove all
CLDU OUTPUT COVERAGE NAME (CLDU* - not more than 13 characters) :
CLDUname
MAP SCALE :
50000
Dismiss
HELP
FULL_DATA
AOI_DATA
***** GENERATE CLDU *****

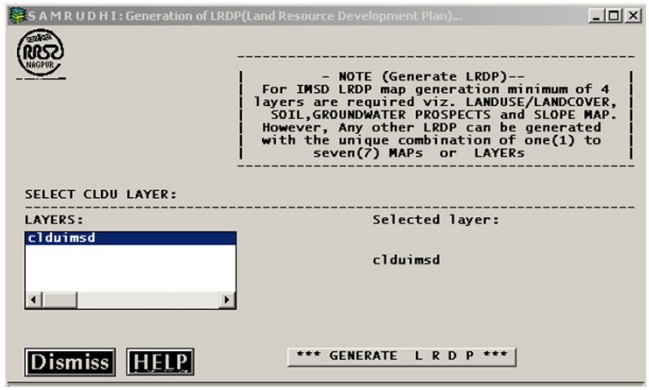


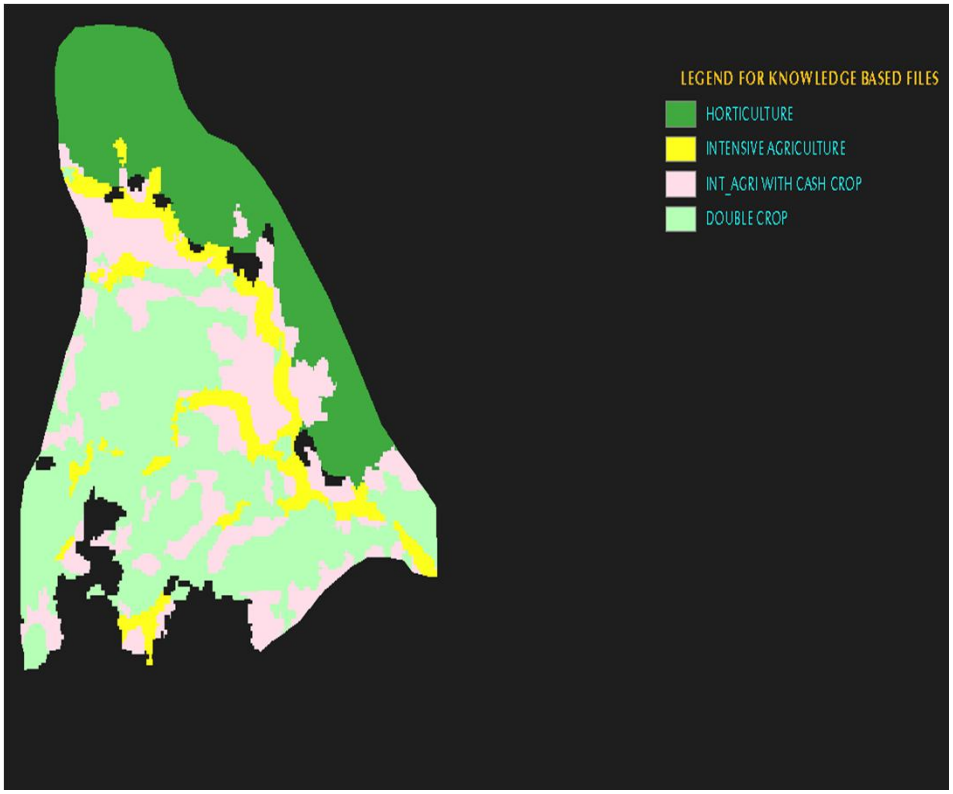




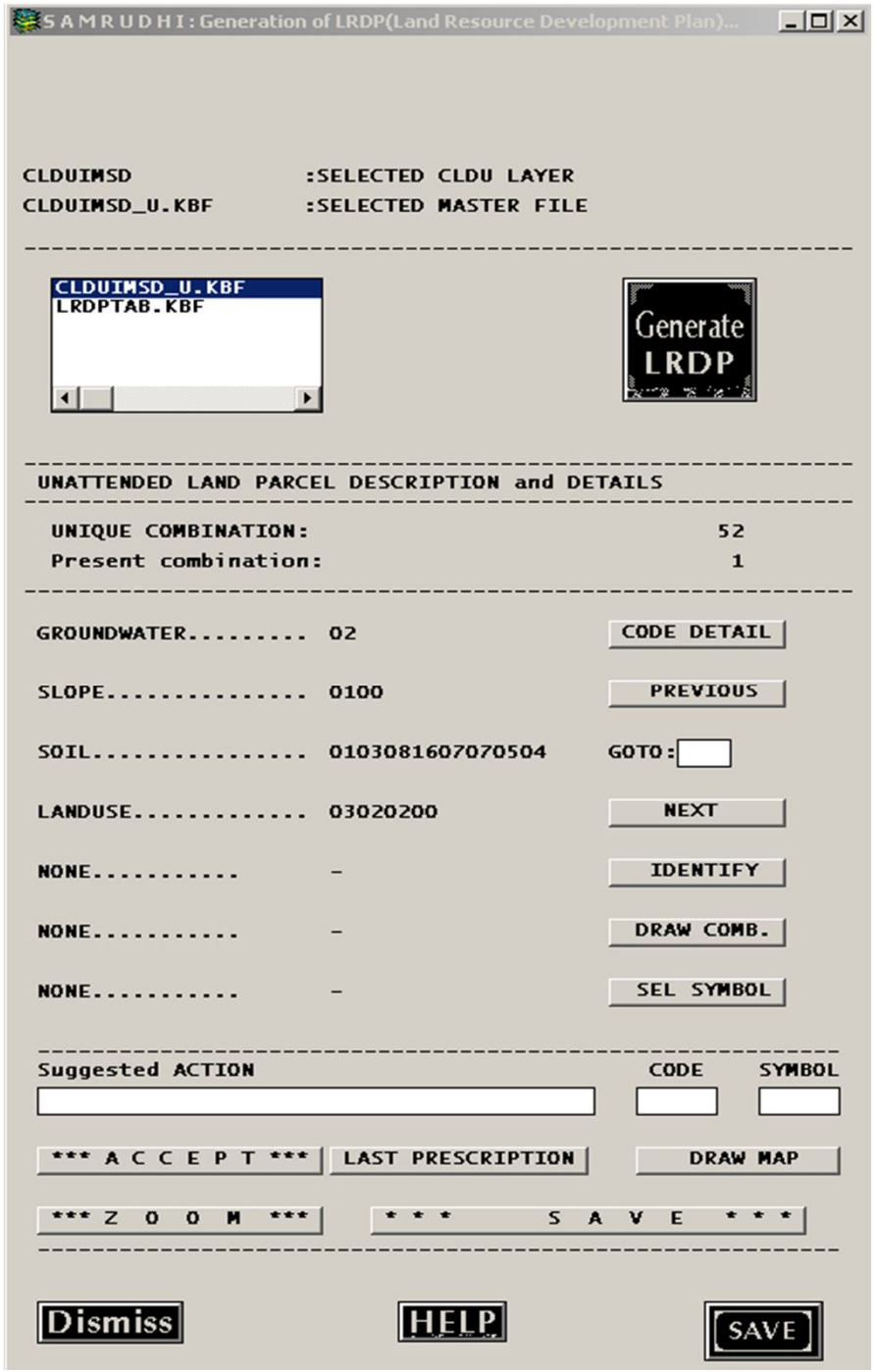


KBF generation

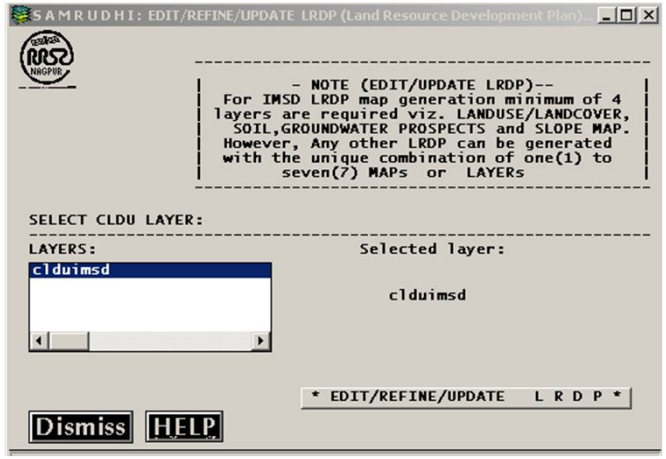


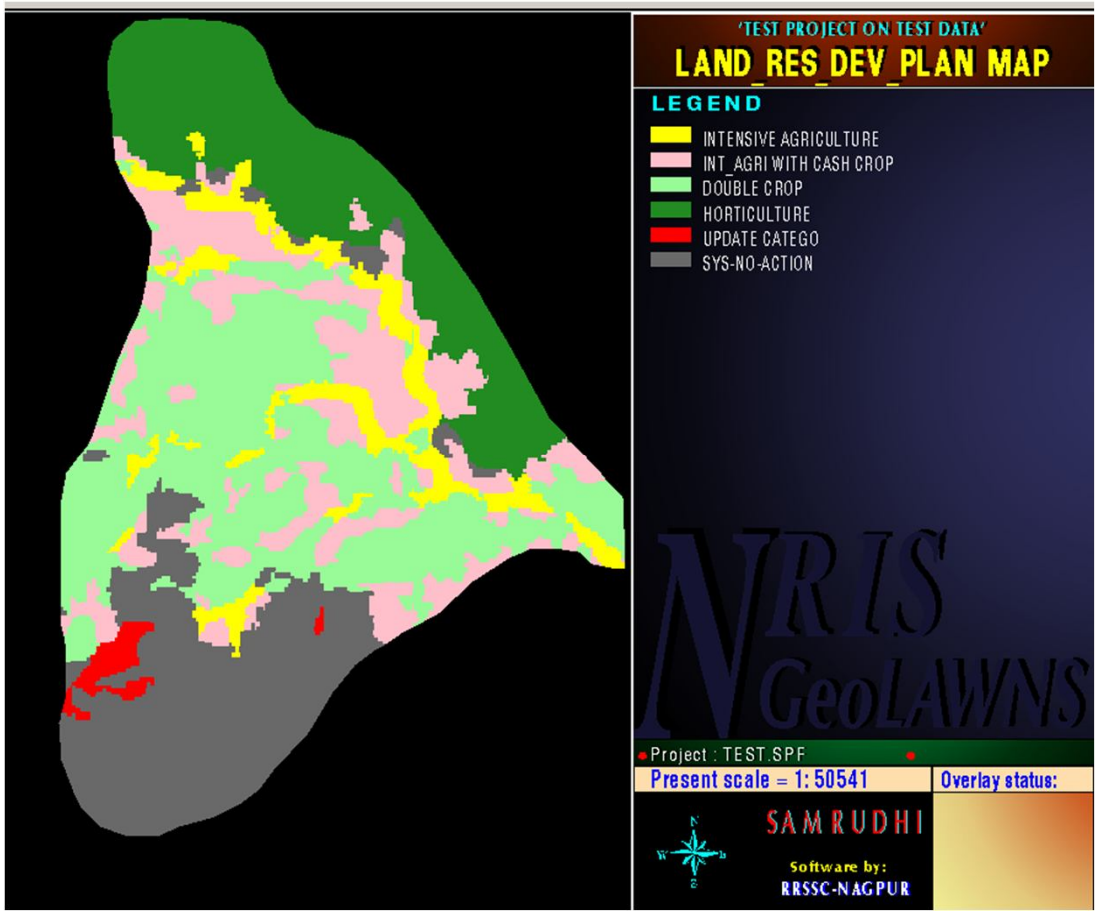


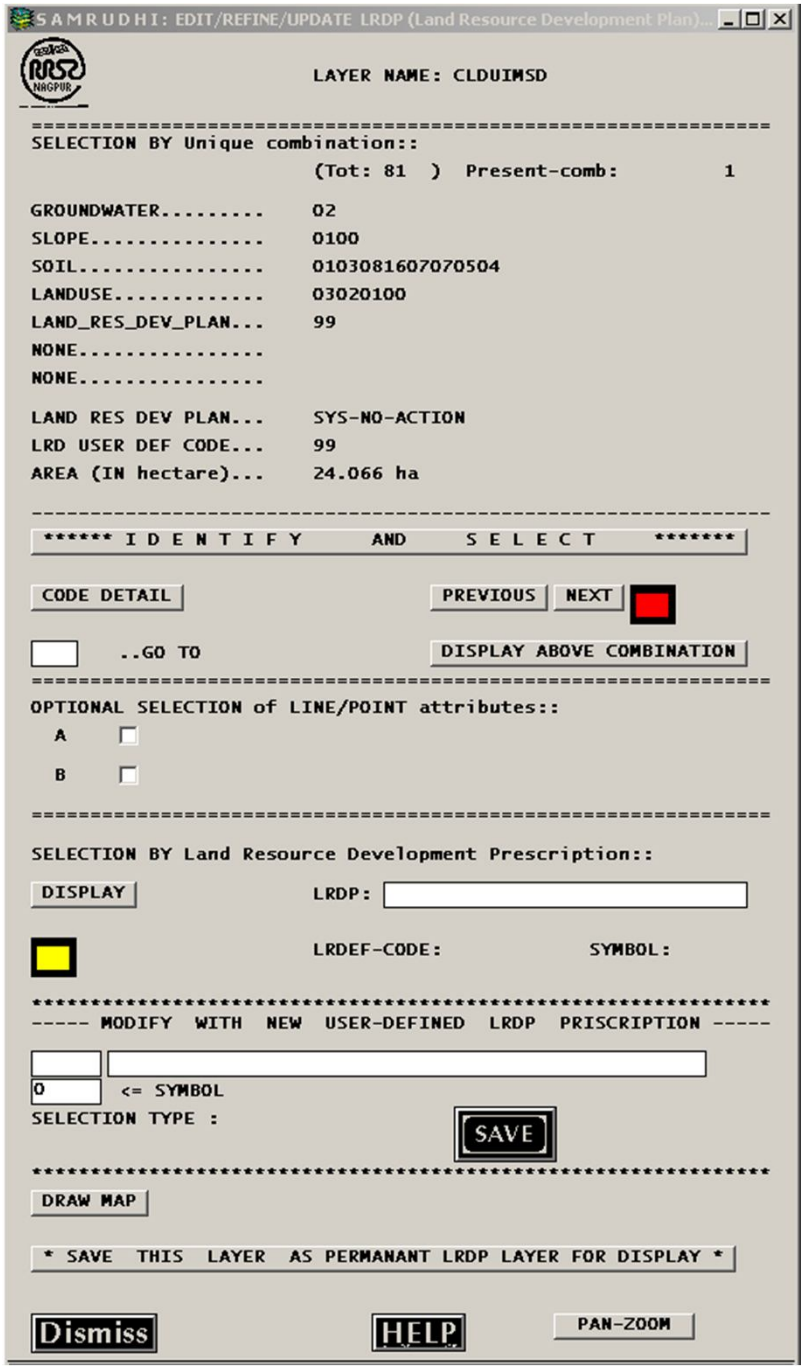
LRDP GENERATION

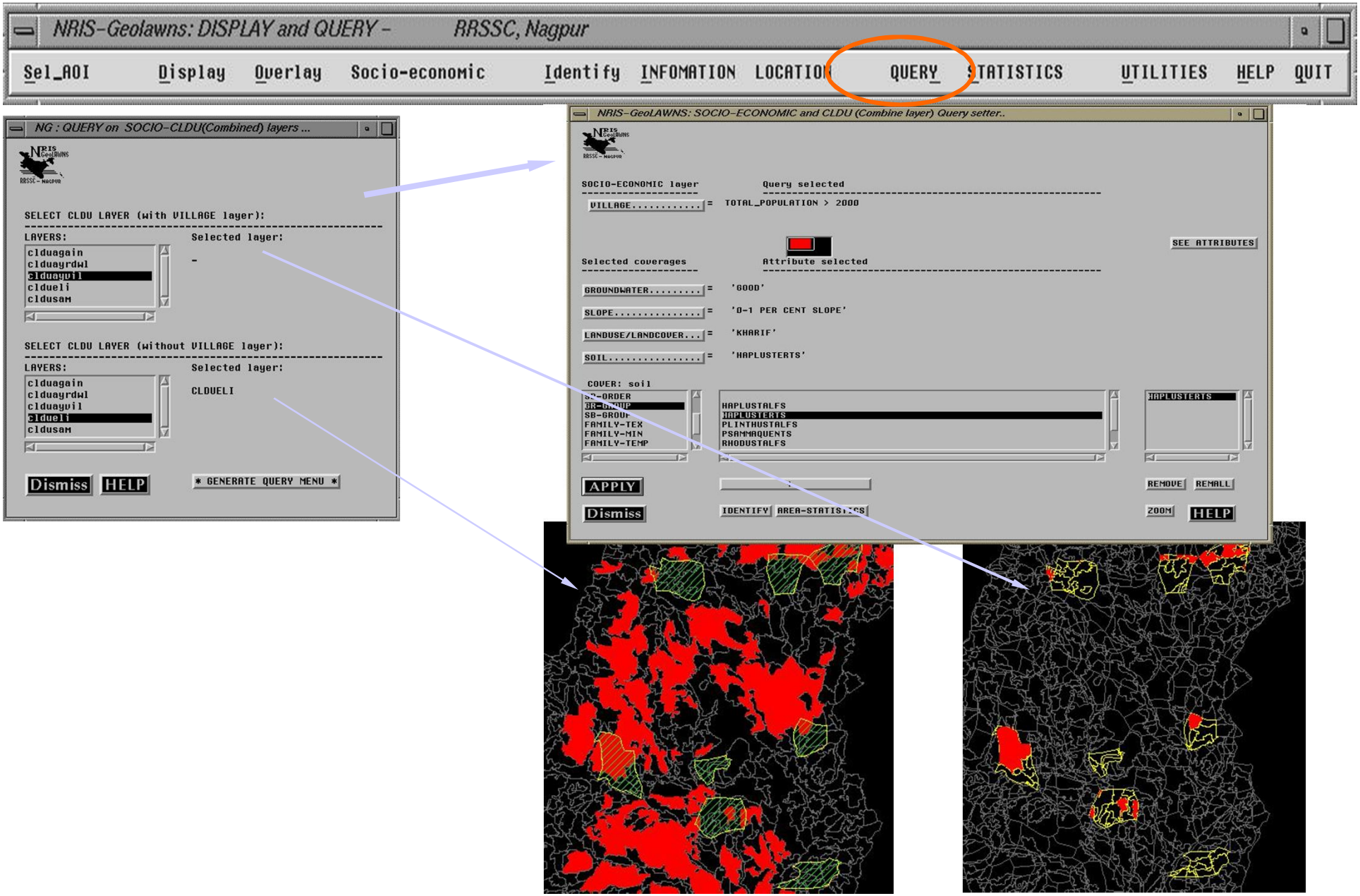


LRDP REFINE & UPDATE

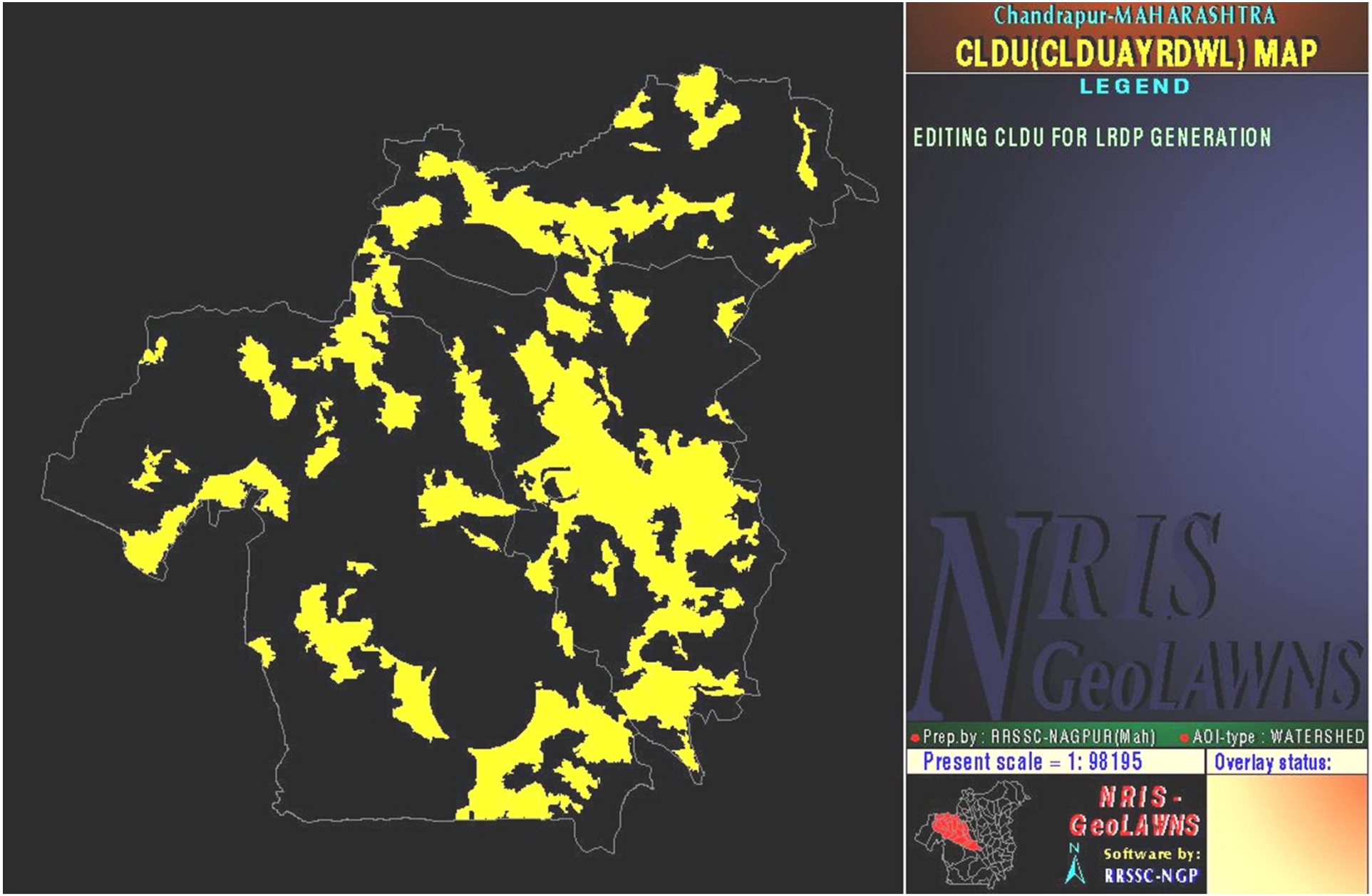




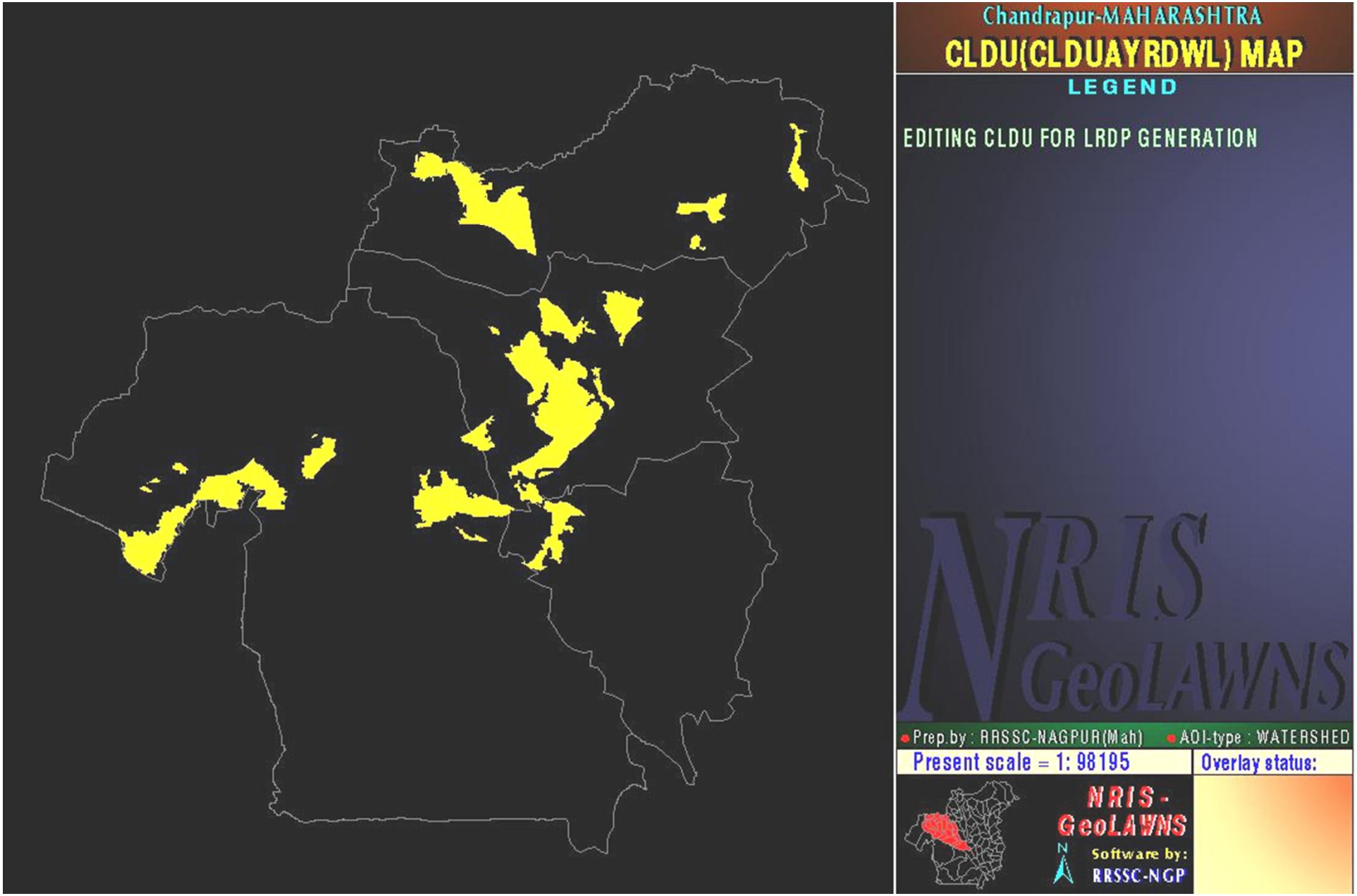




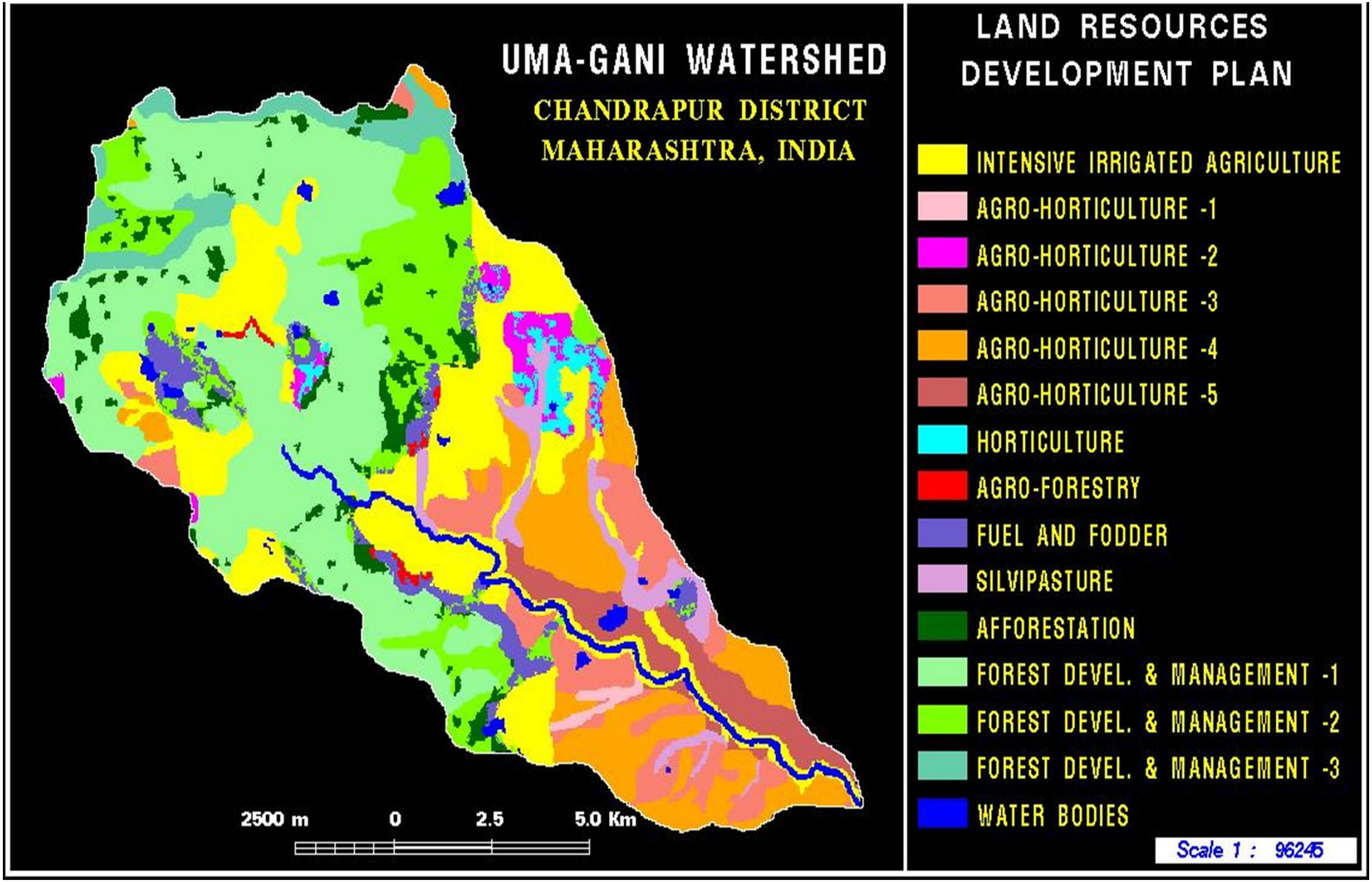
CLDU WITHOUT VILLAGE **CLDU WITH VILLAGE**



- LRDP = AGRO-HORTICULTURE



- LRDP =AGRO-HORTI along 2km BUFFER OF MAIN Rd.



LRDP MAP OUTPUT

ADMINISTRATIVE MAP

MAN TALUK, SATARA DISTRICT, MAHARASHTRA

FOR OFFICIAL USE ONLY

MAN TALUK

LEGEND

- TALUK BOUNDARY
- Metalled - Black topped (BT) or Bitumen roads
- RAIL
- SETTLEMENT

BASE MAP LEGEND

State Boundary
District Boundary
Tehsil Boundary
Block Boundary
Notified Forest Boundary (RS FP)
Railways
Major Roads
River / Stream/Water body
Settlements

SOURCE :

- District database generated under NRIS
- Indian Remote Sensing Satellite (IRS-P6) Resourcesat data.
- Existing maps and reports.
- Field information.

SCALE

1 0 6 0 1 Kilometers

1:225,000

LOCATION MAP

INDIA

MAHARASHTRA STATE

SATARA DISTRICT

MAP INDEX

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Government of Maharashtra
Nagpur - 440 010

Map Prepared by

REGIONAL REMOTE SENSING SERVICE CENTRE
NNRMS, LS.R.O./Department of Space
Government of India
Amravati Road, NBSS & LUP Campus, NAGPUR - 440 010

VILLAGE MAP

MAN TALUK, SATARA DISTRICT, MAHARASHTRA

FOR OFFICIAL USE ONLY

MAN TALUK

LEGEND

ROADS

RAIL

SETTLEMENT

BASE MAP LEGEND

State Boundary
District Boundary
Tahsil Boundary
Block Boundary
Railroad
Major Roads
River / Stream/Water body
Settlements

SOURCE :

- District database generated under NRIS
- Indian Remote Sensing Satellite (IRS P6) Resourcesat data.
- Existing maps and reports.
- Field information.

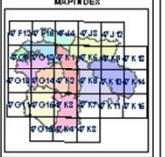
SCALE

10 0 10 Kilometers

1:225,000

LOCATION MAP

MAP INDEX



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DRAINAGE MAP

MAN TALUK, SATARA DISTRICT, MAHARASHTRA

FOR OFFICIAL USE ONLY

MAN TALUK

LEGEND

- Dry
- Perennial
- Waterbody

BASE MAP LEGEND

- State Boundary
- District Boundary
- Tahsil Boundary
- Block Boundary
- Notified Forest Boundary (RS FP)
- Railways
- Major Roads
- River / Stream/Water body
- Settlements

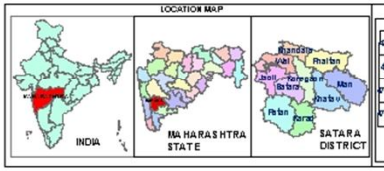
SOURCE :

- District database generated under NRIS
- Indian Remote Sensing Satellite (IRS P6) Resourcesat data.
- Existing maps and reports.
- Field information.

SCALE

1:225,000

LOCATION MAP



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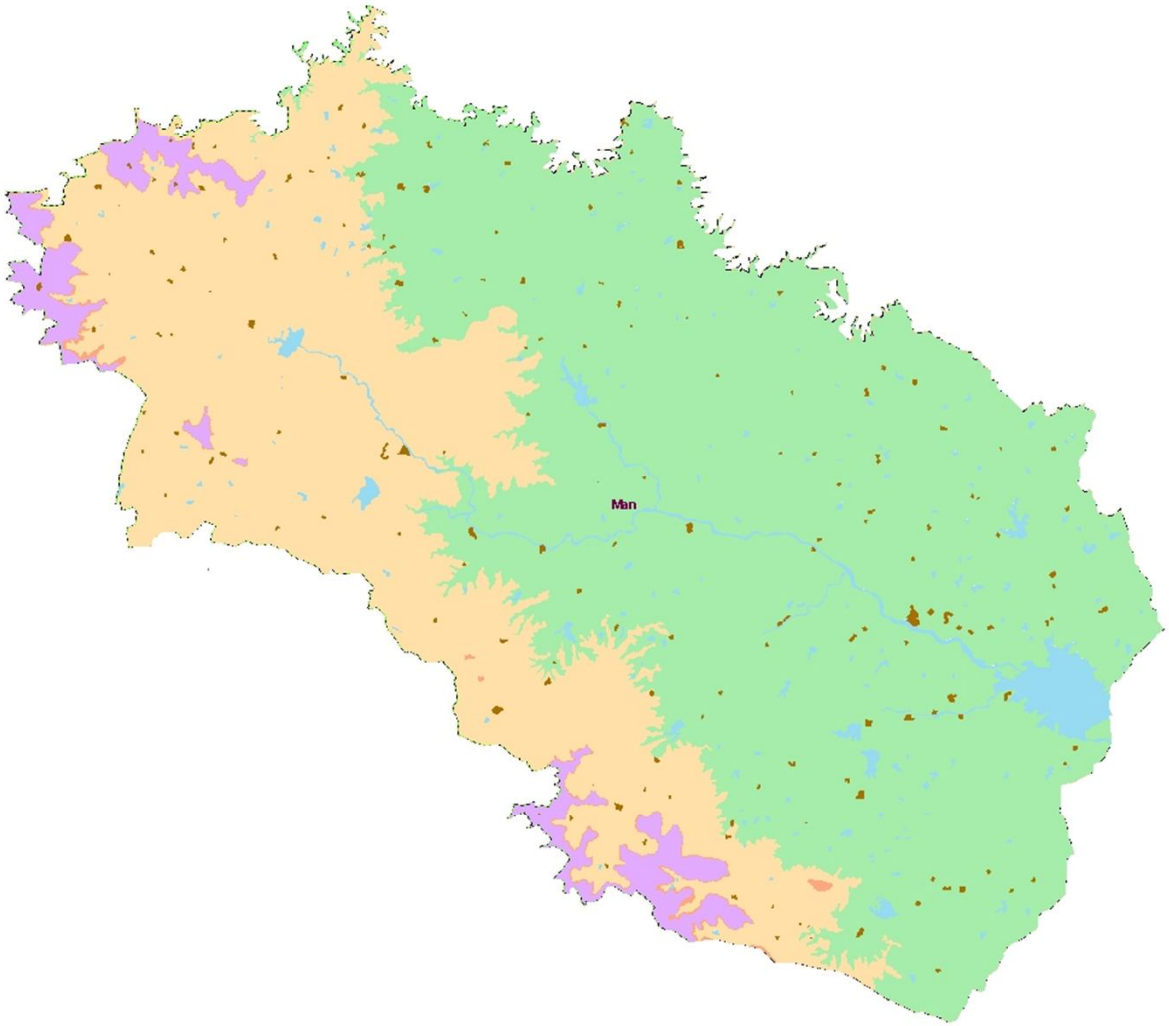
LITHOLOGY MAP

MAN TEHSIL, SATARA DISTRICT, MAHARASHTRA

FOR OFFICIAL USE ONLY

MAN



LEGEND

Lithological Units

- Laterite (Ferricrete)
- Basalt : aa pahoehoe mixed flows
- Basalt : aa simple flows
- Basalt : Megacryst flow (30 Mt)
- Basalt : aa flows
- Water body

BASE MAP LEGEND

State Boundary
District Boundary
Tahsil Boundary
Block Boundary
Reserved Forest Boundary (FSI/PI)
Railways
Major Roads
River / Stream/Water body
Settlements

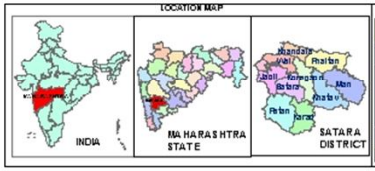
SOURCE :

- District database generated under NRIS
- Indian Remote Sensing Satellite (IRS-P6) Resourcesat data.
- Existing maps and reports.
- Field information.

SCALE

1:225,000

LOCATION MAP



MAP INDEX

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GEOMORPHIC UNIT MAP

MAN TEHSIL, SATARA DISTRICT, MAHARASHTRA

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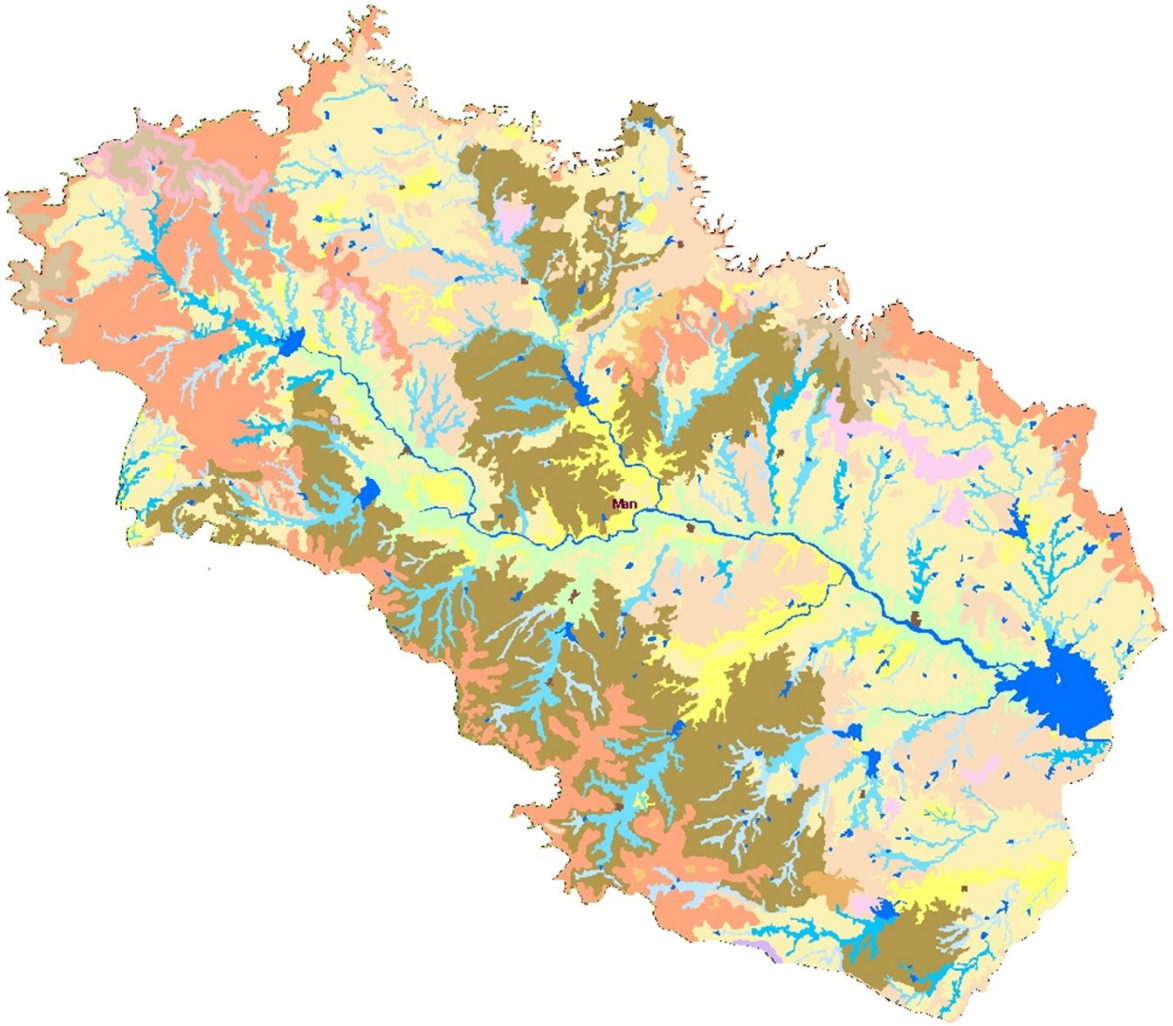
MAN



LEGEND

Geomorphic Units

- Linear Ridge/Dyke Ridge
- Mesa/Butte
- Massivetype Residual Hills
- Highly Dissected Upper Plateau
- Moderately Dissected Upper Plateau
- Denudational Slopes
- Plateau Top
- Plateau Top-Weathered
- Valley
- Upper Bajada-Moderate
- Pediment
- Inselberg
- Pediment Inselberg Complex
- Shallow Weathered Pediplain
- Eroded/Gullied Pediplain-Moderate Basement
- Moderately Weathered Pediplain
- Deeply Weathered Pediplain
- Valley Fill-Shallow
- Valley Fill-Moderate
- Valley Fill-Deep
- Deep Alluvial Plain (Upper)
- Deep Alluvial Plain (Lower)
- Point Bar
- Water Body
- Habitation Mask

BASE MAP LEGEND

State Boundary
District Boundary
Tehsil Boundary
Block Boundary
National Forest Boundary (RF/PF)
Railways
Major Roads
River / Stream/Water body
Settlements

SOURCE :

- District database generated under NRIS.
- Indian Remote Sensing Satellite (IRS-1D) Panmux data.
- Existing maps and reports.
- Field information.

N

SCALE

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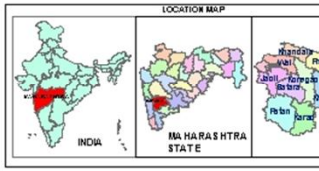
LOCATION MAP



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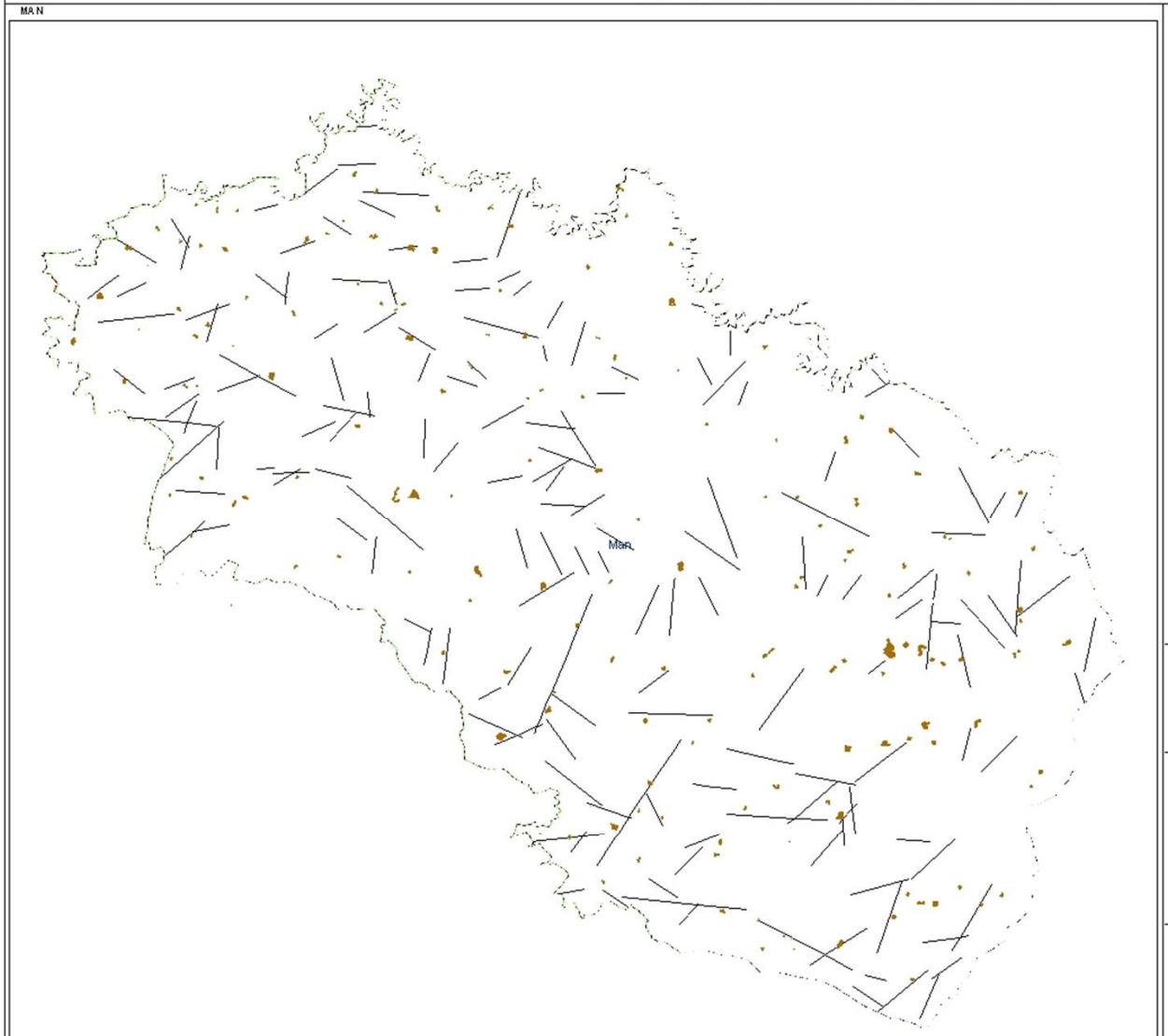
GEOLOGICAL STRUCTURES MAP
MAN TEHSIL, SATARA DISTRICT, MAHARASHTRA

FOR OFFICIAL USE ONLY



LEGEND

Geological Structurs

- Lineament
- Valleys formed along fractures/faults
- Escarpment
- Dyke

BASE MAP LEGEND

State Boundary
District Boundary
Tehsil Boundary
Block Boundary
Notified Forest Boundary (FSI/IFP)
Railways
Major Roads
River / Stream/Water body
Settlements

SOURCE :

- District database generated under NRIS
- Indian Remote Sensing Satellite (IRS P6) Resourcesat data.
- Existing maps and reports.
- Field information.

SCALE

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LOCATION MAP

MAP INDEX

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GROUND WATER PROSPECTS MAP

MAN TEHSIL, SATARA DISTRICT, MAHARASHTRA

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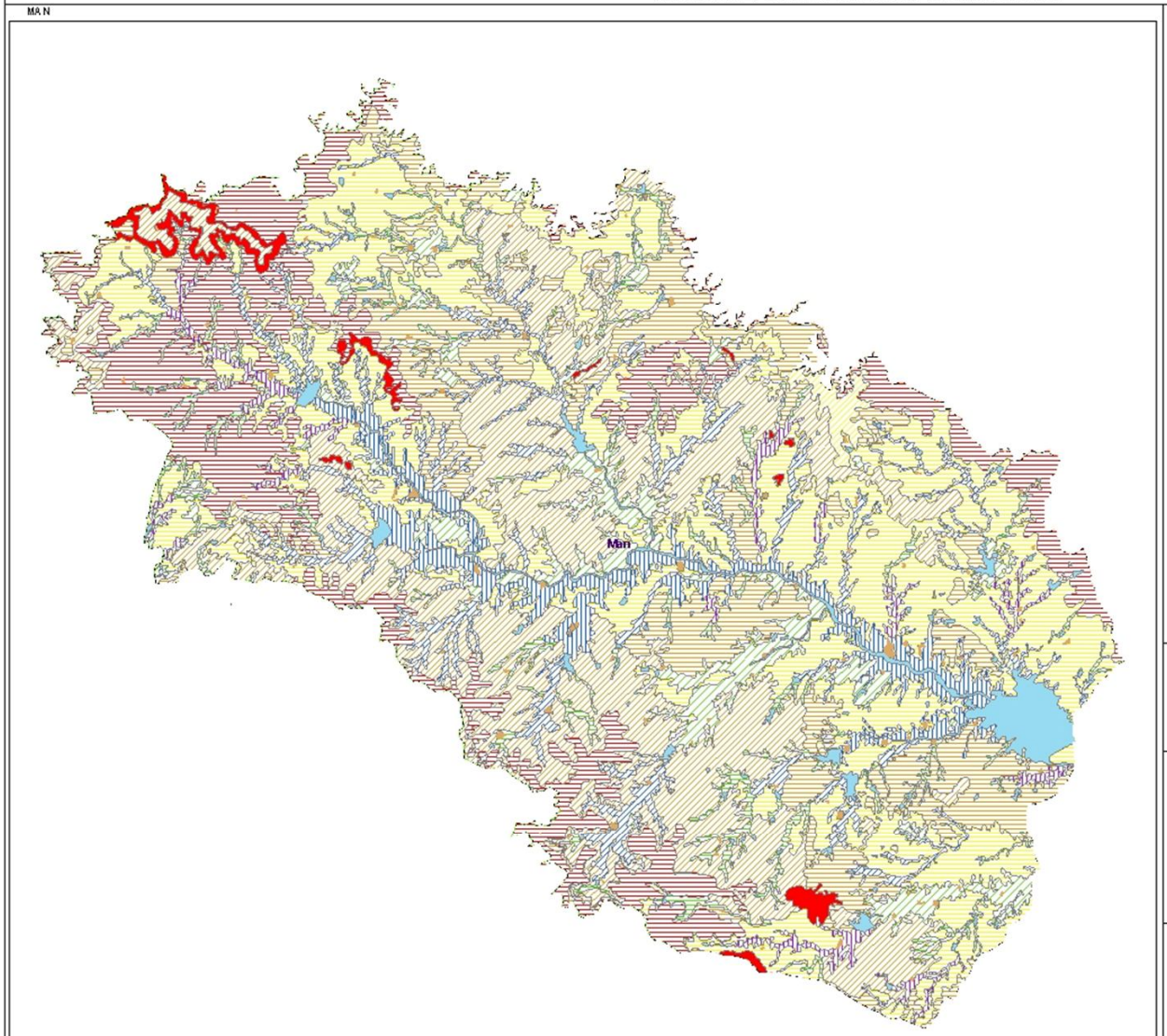

LEGEND

Ground Water Prospect Units

- 400-800 LPM -- Shallow Depth
- 400-800 LPM -- Deep
- 200-400 LPM -- Moderate Depth
- 200-400 LPM -- Deep
- 100-200 LPM -- Shallow Depth
- 100-200 LPM -- Moderate Depth
- 100-200 LPM -- Deep
- 50-100 LPM -- Shallow Depth
- 50-100 LPM -- Moderate Depth
- 10-50 LPM -- Shallow Depth
- 10-50 LPM -- Moderate Depth
- Run-off Zone -- Prospects along Valleys only
- Run-off Zone
- Settlement
- Water Body

BASE MAP LEGEND

State Boundary
District Boundary
Tehsil Boundary
Block Boundary
Notified Forest Boundary (FSI/FP)
Railways
Major Roads
River / Stream/Water body
Settlements

SOURCE :

- District database generated under NRIS
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- Field information.

SCALE

1:225,000

LOCATION MAP

INDIA

MAHARASHTRA STATE

SATARA DISTRICT

MAP INDEX

47 K/6 47 K/10 47 K/14
47 K/7 47 K/11 47 K/15

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WATER RESOURCES DEVELOPMENT PLAN

MAN TALUK, SATARA DISTRICT, MAHARASHTRA

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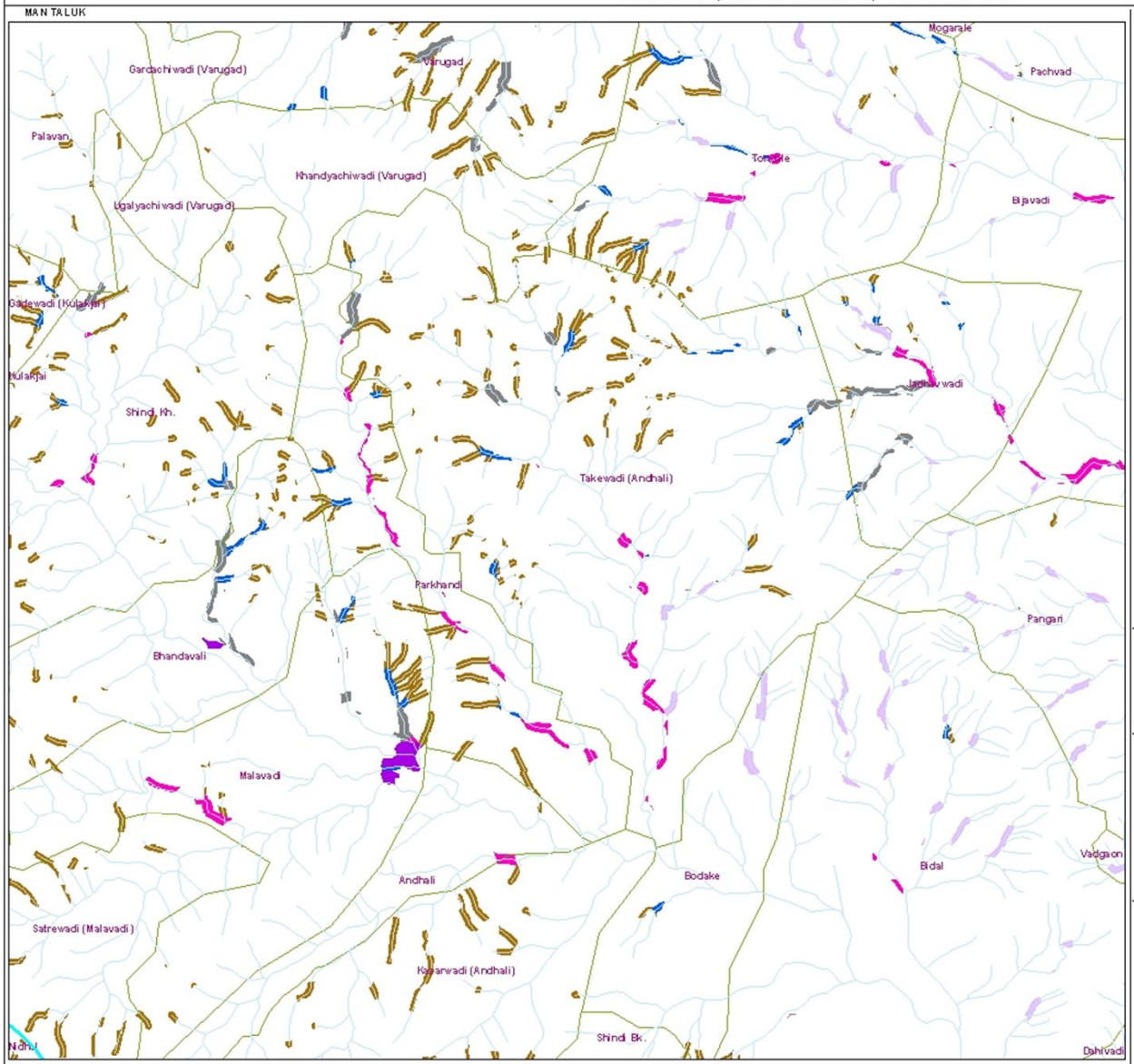

LEGEND

WATER RESOURCES DEVELOPMENT PLAN ZONES SUITABLE FOR STRUCTURES

- Check Dam
- Cement Check Dam
- Nalla bund
- Underground Bandhara
- KT Weir (Priority 1)
- KT Weir (Priority 2)
- Village Boundary
- Drain

BASE MAP LEGEND

- State Boundary
- District Boundary
- Tahsil Boundary
- Block Boundary
- Reserved Forest Boundary (FSI/PI)
- Railways
- Major Roads
- River / Stream/Water body
- Settlements

SOURCE :

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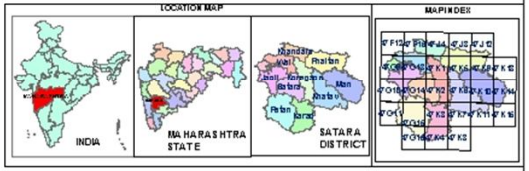
- Field information.

SCALE

1:50,000

LOCATION MAP



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WATER RESOURCES DEVELOPMENT PLAN

KARAD TALUK, SATARA DISTRICT, MAHARASHTRA

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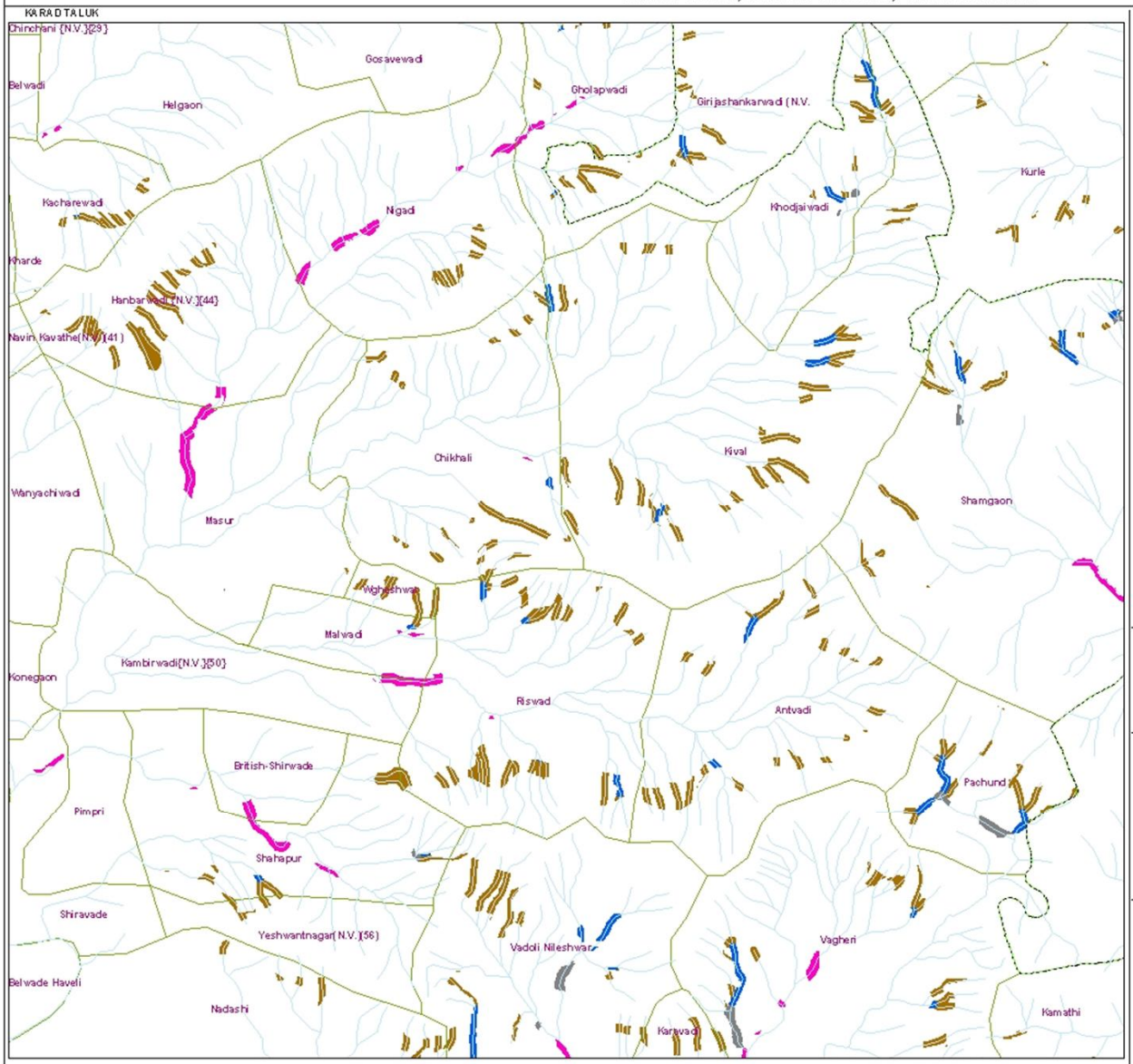

LEGEND

WATER RESOURCES DEVELOPMENT PLAN SUITABLE FOR STRUCTURES

- Check Dam
- Cement Check Dam
- Nalla bund
- Underground Bandhara
- KT Weir (Priority 1)
- KT Weir (Priority 2)
- Village Boundary
- Drain

BASE MAP LEGEND

SOURCE :

SCALE 1:50,000

LOCATION MAP

INDIA

MAHARASHTRA STATE

SATARA DISTRICT

MAP INDEX

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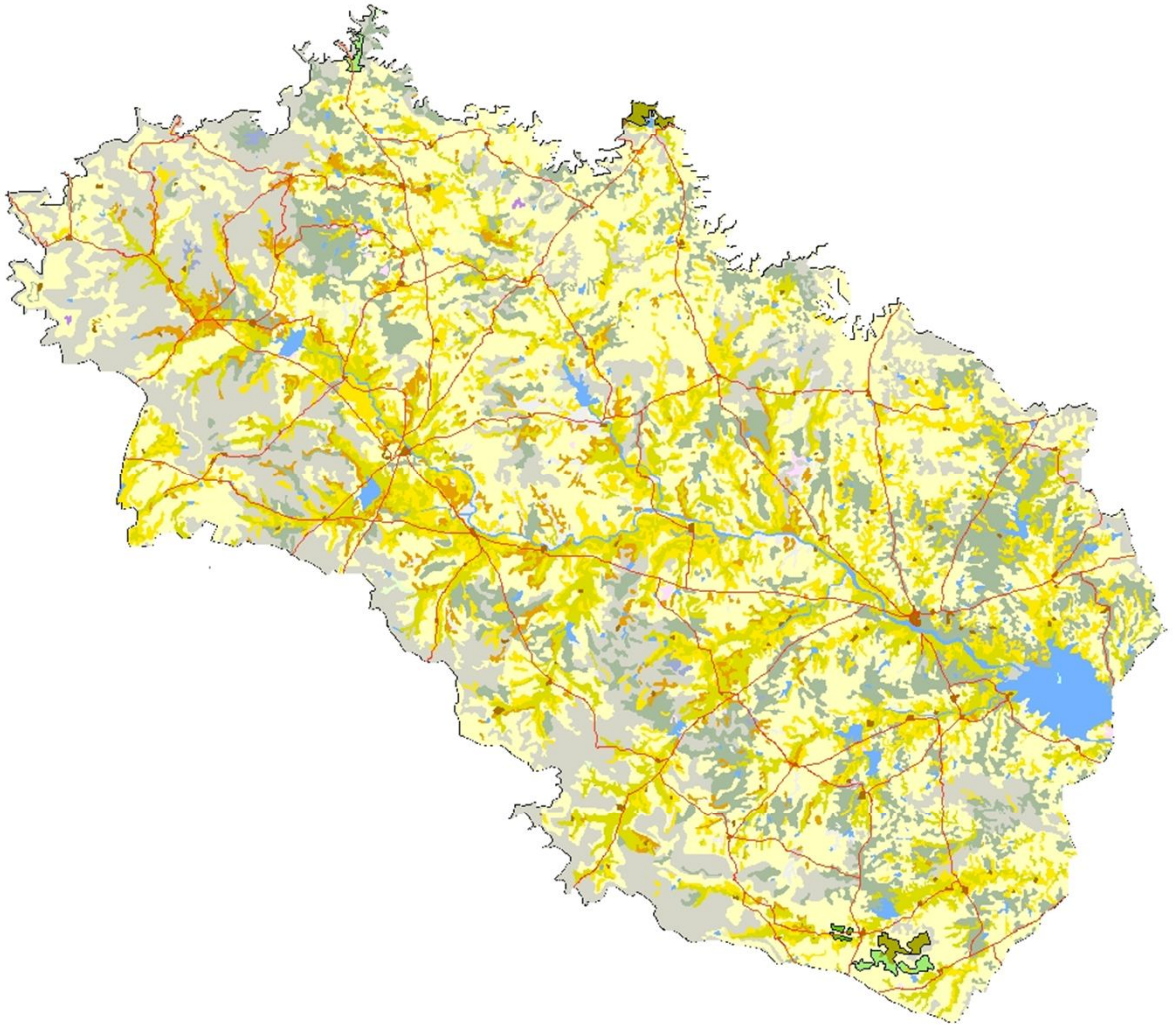
LAND USE / LAND COVER MAP
MAN TALUK, SATARA DISTRICT, MAHARASHTRA

FOR OFFICIAL USE ONLY

MAN TALUK



LEGEND

Land use /Land cover Units of Man Taluk

	LEVEL-I	LEVEL-II	LEVEL-III
	BUILT-UP LAND	RESIDENTIAL	URBAN
			RURAL
	AGRICULTURE LAND	CROP LAND	KHARIF CROP
			RABI CROP
			KHARIF + RABI
			KHARIF + RABI + SUMMER
			ZAID
			KHARIF + SUMMER
			RABI + SUMMER
		FALLOW	
		PLANTATIONS	
		HORTICULTURE	
	FOREST	DECIDUOUS	DENSE
			OPEN
		SCRUB FOREST	
		FOREST BLANKS	
		FOREST PLANTATIONS	
		AGRICULTURE IN FOREST	
	WASTELANDS	GULLIED / RAVINOUS LAND	
		LAND WITH SCRUB	
		LAND WITHOUT SCRUB	
		BARREN ROCKY/ STONY WASTE	
		MINING/INDUSTRIAL WASTE	
	WATER	WATER BODY / RIVER	
		RIVER SAND	

BASE MAP LEGEND

State Boundary
District Boundary
Tahsil Boundary
Block Boundary
Notified Forest Boundary (RF/PF)
Railways
Major Roads
River / Stream/Water body
Settlements

SOURCE :

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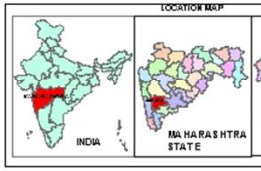
- Field information.

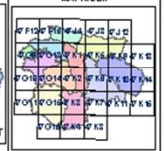
SCALE

1:225,000

LOCATION MAP



MAP INDEX



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SOIL MAP

MAN TALUK, SATARA DISTRICT, MAHARASHTRA

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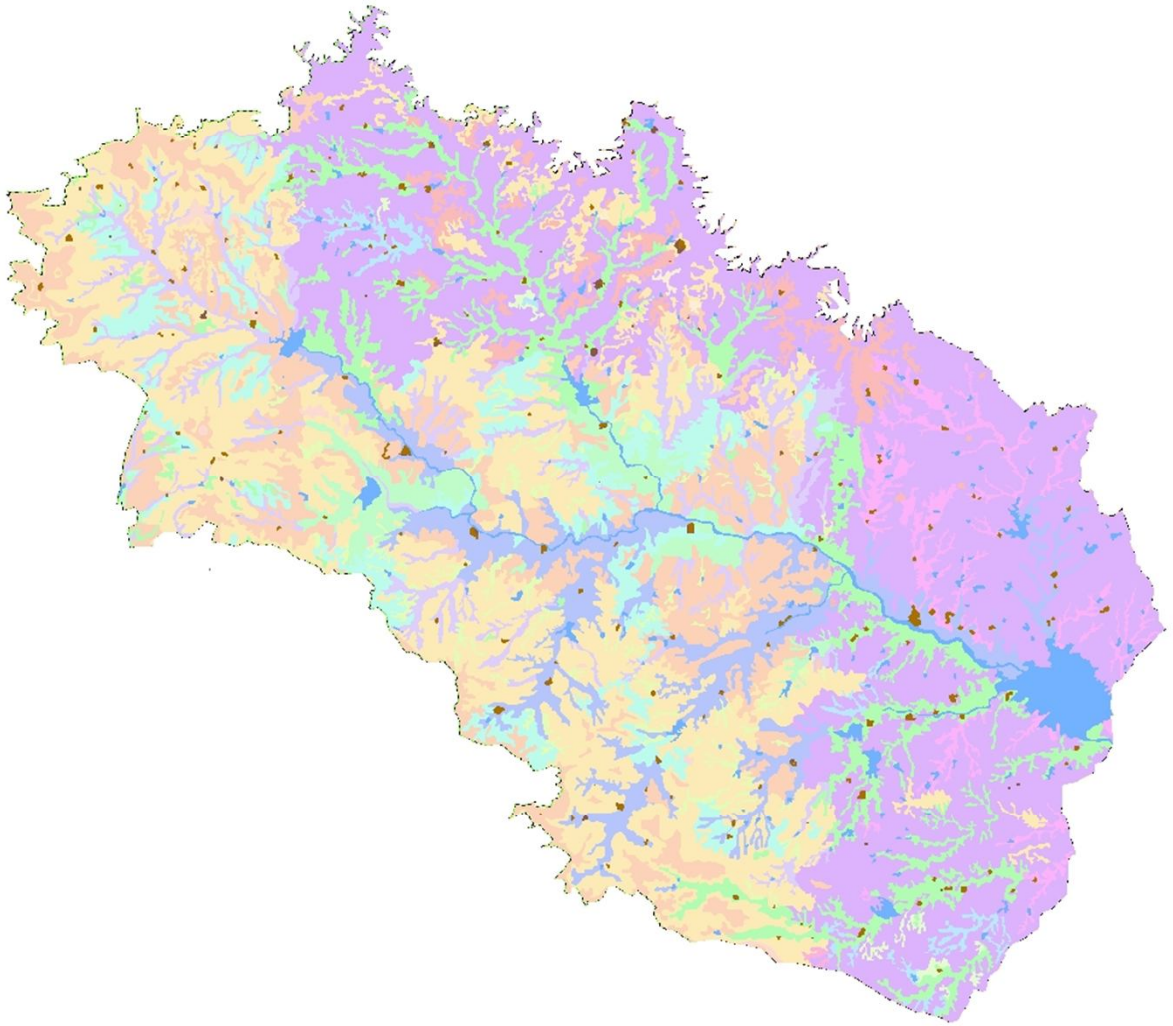
MAN TALUK



LEGEND

	Description
	Rocky
	Fine Mixed Isohyperthermic Vertic Ustifluvents Clayey;, Deep, Moderately eroded, Gently Sloping
	Loamy Mixed Isohyperthermic Typic Ustifluvents Loamy;, Deep, Moderately eroded, Gently Sloping
	Fine Loamy Mixed Isohyperthermic Lithic Ustorthents Fine loamy;, Shallow, Moderate to Severly eroded, Gently Sloping
	Fine Loamy Mixed Isohyperthermic Typic Ustorthents Fine loamy;, Deep, Moderately eroded, Gently Sloping
	Fine Mixed Isohyperthermic Typic Ustorthents(ed Clayey;, Moderately deep, Moderately eroded, Gently Sloping
	Very Fine Mixed Isohyperthermic, Fluventic Ustorthent Clayey;, Deep, Moderately eroded, Gently Sloping
	Fine, Mixed,Isohyperthermic,Vertic Haloquepts Clayey;, Deep, Very Gently Sloping
	Fine, Montmorillonitic,Isohyperthermic,Vertic Ustochrepts Clayey;, Very Deep, Slightly eroded, Gently Sloping
	Fine loamy;,Kaolinitic,Isohyperthermic,Dystric Ustochrepts Fine loamy;, Deep, Moderately eroded, Gently Sloping
	Fine, Mixed,Isohyperthermic,Typic Ustochrepts Clayey;, Deep, Moderately eroded, Gently Sloping
	Fine, Mixed,Isohyperthermic,Typic Ustochrepts(ed Clayey;, Deep, Moderately eroded, Gently Sloping
	Clayey;,Mixed, Isohyperthermic,Typic Haplustepts Clayey;, Deep, Moderately eroded, Gently Sloping
	Fine, Montmorillonitic,Isohyperthermic,Vertic Haplustepts Clayey;, Very Deep, Slightly eroded, Very Gently Sloping
	Loamy;,Mixed, Isohyperthermic,Fluventic Haplustept Loamy;, Moderately deep, Moderately eroded,
	Loamy Skeletal,Mixed, Isohyperthermic,Typic Calciustepts Loamy;, Shallow, Severly eroded,
	Clayey;,Montmorillonitic,Isohyperthermic,Vertic Calciustepts Clayey;, Deep, Moderately eroded, Gently Sloping
	Very Fine, Montmorillonitic,Isohyperthermic,Leptic Haplusterts Clayey;, Deep, Very Gently Sloping
	Fine, Montmorillonitic,Isohyperthermic,Typic Haplusterts Clayey;, Very Deep, Very Gently Sloping
	Fine, Montmorillonitic,Isohyperthermic, Vertic Ustorthents Clayey;, Deep, Moderately eroded, Gently Sloping
	Habitation
	Waterbodies

BASE MAP LEGEND

State Boundary
District Boundary
Tahsil Boundary
Block Boundary
Notified Forest Boundary (FSI/SFR)
Railways
Major Roads
River / Stream/Water body
Settlements

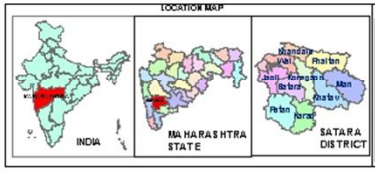
SOURCE :

- District database generated under NRIS
- Indian Remote Sensing Satellite (IRS-P6) Resourcesat data.
- Existing maps and reports.
- Field information.

SCALE

1:225,000

LOCATION MAP



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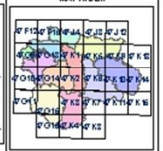

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Government of Maharashtra
Nagpur - 440 010

Map Prepared by

REGIONAL REMOTE SENSING SERVICE CENTRE
NNRMS, I.S.R.O./Department of Space
Government of India
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LAND CAPABILITY MAP

MAN TALUK, SATARA DISTRICT, MAHARASHTRA

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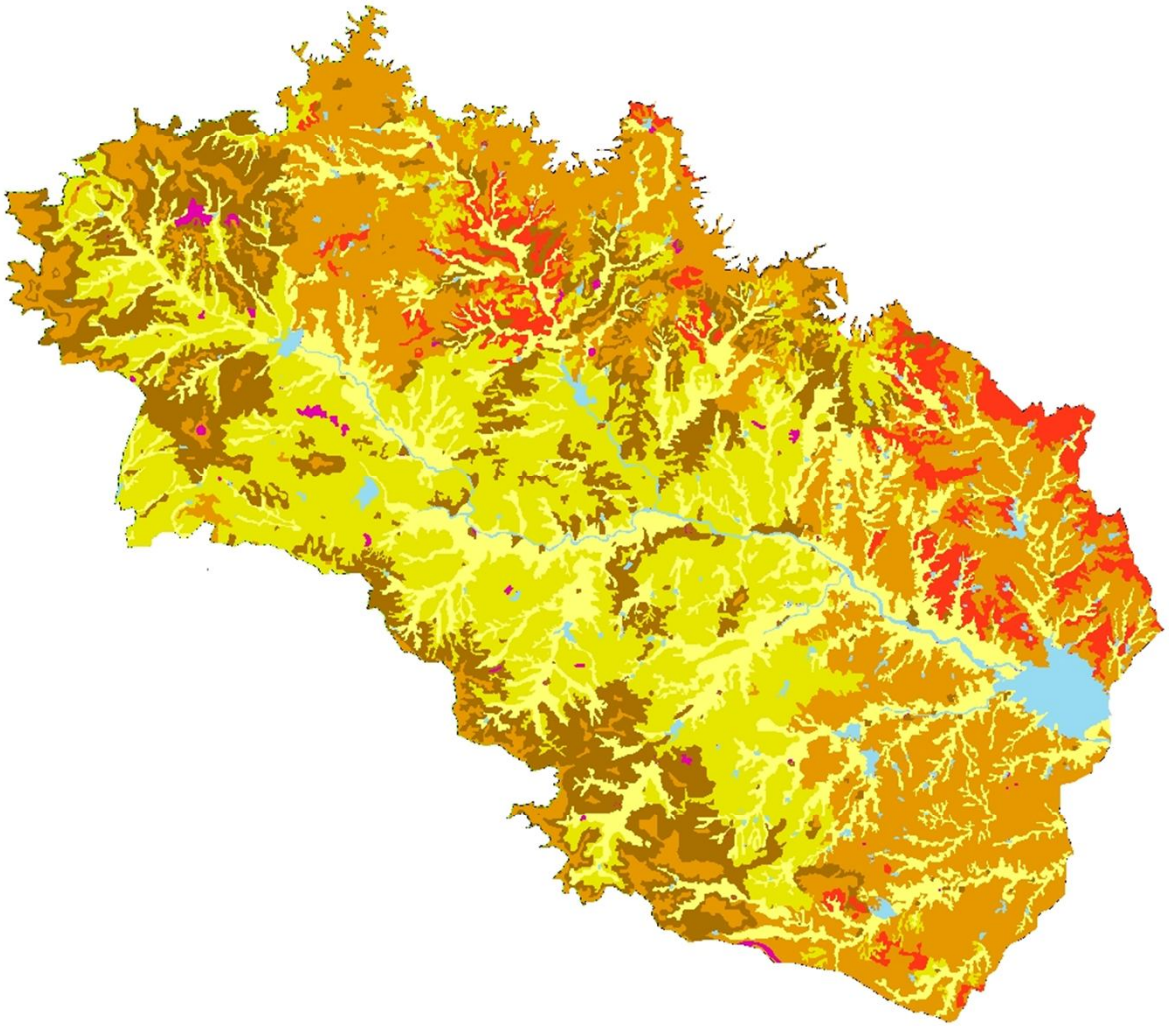
MAN TALUK



Legend

	LAND CAPABILITY CLASS	DESCRIPTION
	II	FEWER LIMITATIONS FOR AGRICULTURE
	III	LESSER LIMITATIONS FOR AGRICULTURE
	IV	MODERATE LIMITATIONS FOR AGRICULTURE
	VI	HIGH LIMITATIONS FOR AGRICULTURE
	VII	SEVERE LIMITATIONS FOR AGRICULTURE
	VIII	NOT SUITABLE FOR AGRICULTURE

BASE MAP LEGEND

State Boundary
District Boundary
Tahsil Boundary
Block Boundary
Notified Forest Boundary (FSI/SFD)
Railways
Major Roads
River / Stream/Water body
Settlements

SOURCE :

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SCALE

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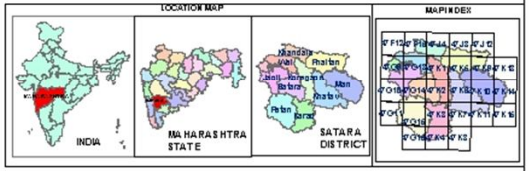
LOCATION MAP



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LAND IRRIGABILITY MAP

MAN TALUK, SATARA DISTRICT, MAHARASHTRA

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MAN TALUK

LEGEND

- FEW LIMITATIONS FOR SUSTAINED USE UNDER IRRIGATION
- MODERATE LIMITATIONS FOR SUSTAINED USE UNDER IRRIGATION
- SEVERE LIMITATIONS FOR SUSTAINED USE UNDER IRRIGATION
- VERY SEVERE LIMITATIONS, MARGINAL FOR SUSTAINED USE UNDER IRRIGATION
- NOT SUITED FOR USE UNDER IRRIGATION, ALSO NOT ARABLE
- WATERBODY
- SETTLEMENT

BASE MAP LEGEND

State Boundary
District Boundary
Tehsil Boundary
Block Boundary
Notified Forest Boundary (FSI/FP)
Railways
Major Roads
River / Stream/Water body
Settlements

SOURCE :

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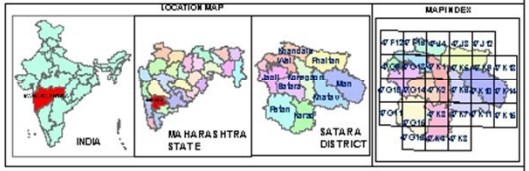
- Field information.

SCALE

1:225,000

LOCATION MAP



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SLOPE MAP

MAN TALUK, SATARA DISTRICT, MAHARASHTRA

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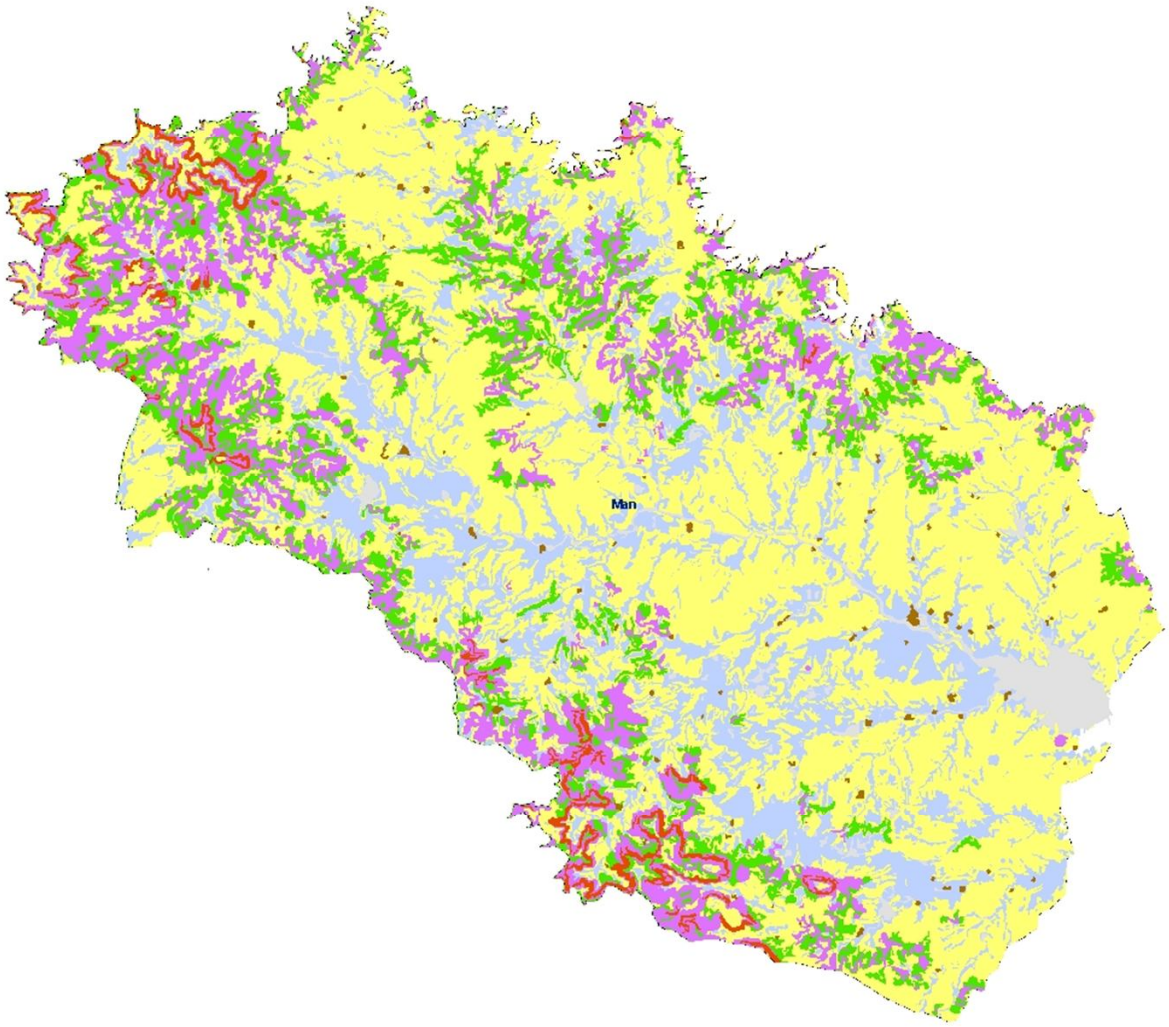
MAN TALUK



LEGEND

- 0-1 PER CENT SLOPE
- 1-3 PER CENT SLOPE
- 3-5 PER CENT SLOPE
- 5-10 PER CENT SLOPE
- 10-15 PER CENT SLOPE
- 15 - 35 PER CENT SLOPE
- 35 - 50 PER CENT SLOPE
- 50 - 70 PER CENT SLOPE
- > 70 PER CENT SLOPE

BASE MAP LEGEND

State Boundary
District Boundary
Tahsil Boundary
Block Boundary
Notified Forest Boundary (RFR)
Railways
Major Roads
River / Stream/Water body
Settlements

SOURCE :

- District database generated under NRIS
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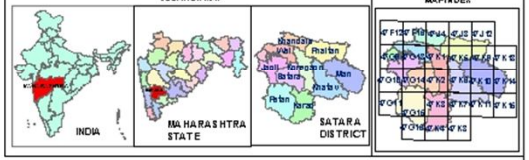
SCALE

1:225,000

LOCATION MAP



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LAND RESOURCES DEVELOPMENT PLAN
MAN TALUK, SATARA DISTRICT, MAHARASHTRA

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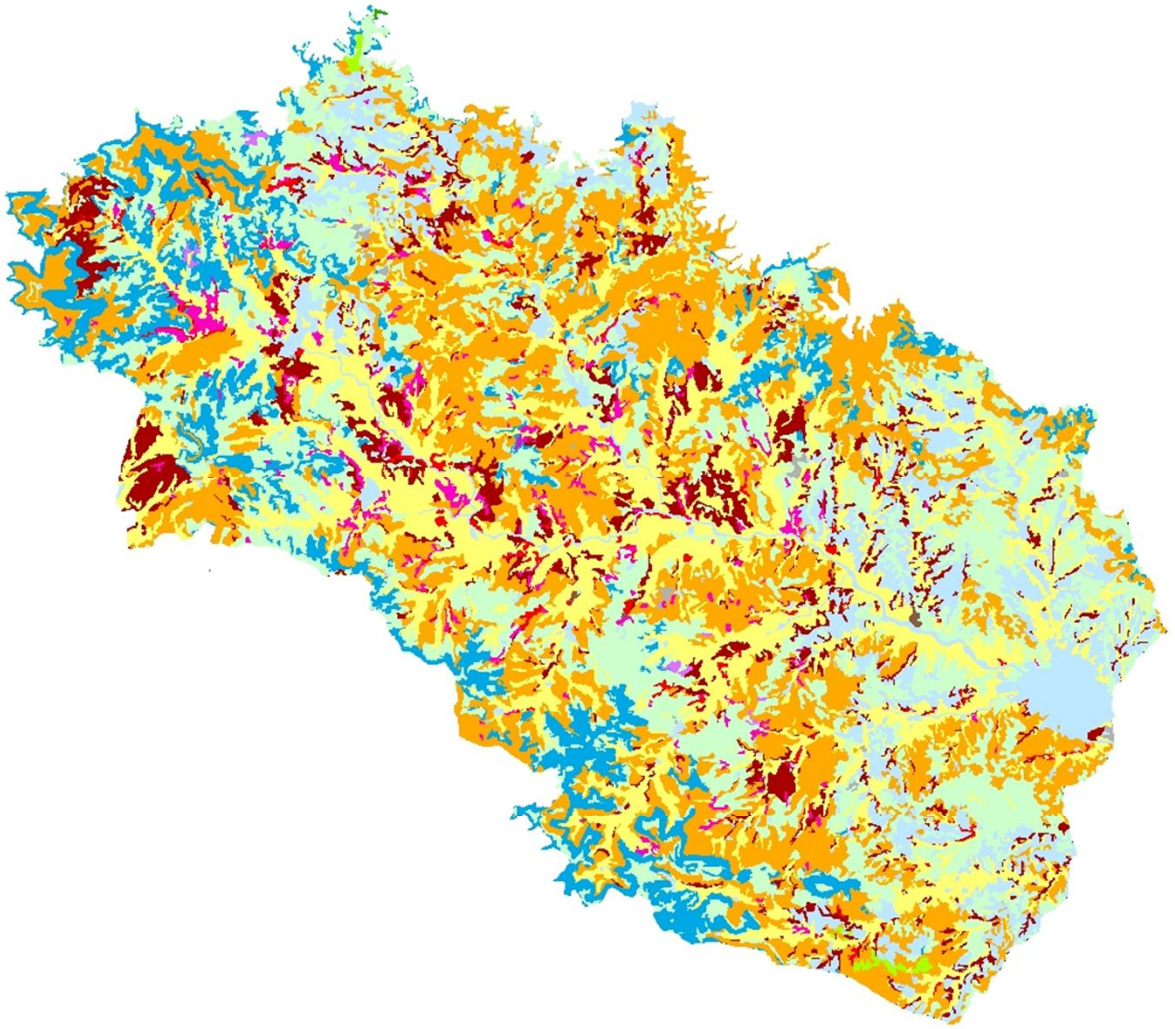
MAN TALUK



LEGEND

LAND RESOURCES DEVELOPMENT PLAN PRESCRIPTIONS

- AGRO-FORESTRY
- AGRO-HORTICULTURE
- DOUBLE CROP
- INTENSIVE AGRICULTURE
- HORTICULTURE
- AFFORESTATION WITH FAST GROWING TREES
- PLANTATION WORK PLAN
- PROTECTION WORKING PLAN AND FIRELINE
- SOIL CONSERVATION AND REGENERATION - WORKPLAN
- AFFORESTATION OF DEGRADED FOREST - WORK PLAN
- SOIL CONSERVATION - FUEL/FODDERWOOD
- SOIL CONSERVATION - SILVIPASTURE
- URBAN / RESIDENTIAL
- RECREATION
- WATERBODY / NO CHANGE

BASE MAP LEGEND

State Boundary
District Boundary
Tahsil Boundary
Block Boundary
Notified Forest Boundary (RFI/PF)
Railways
Major Roads
River / Stream/Water body
Settlements

SOURCE :

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SCALE

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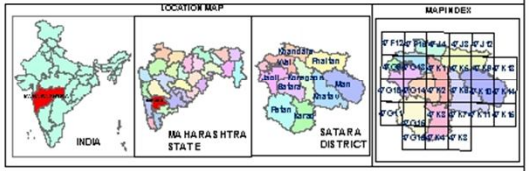
LOCATION MAP



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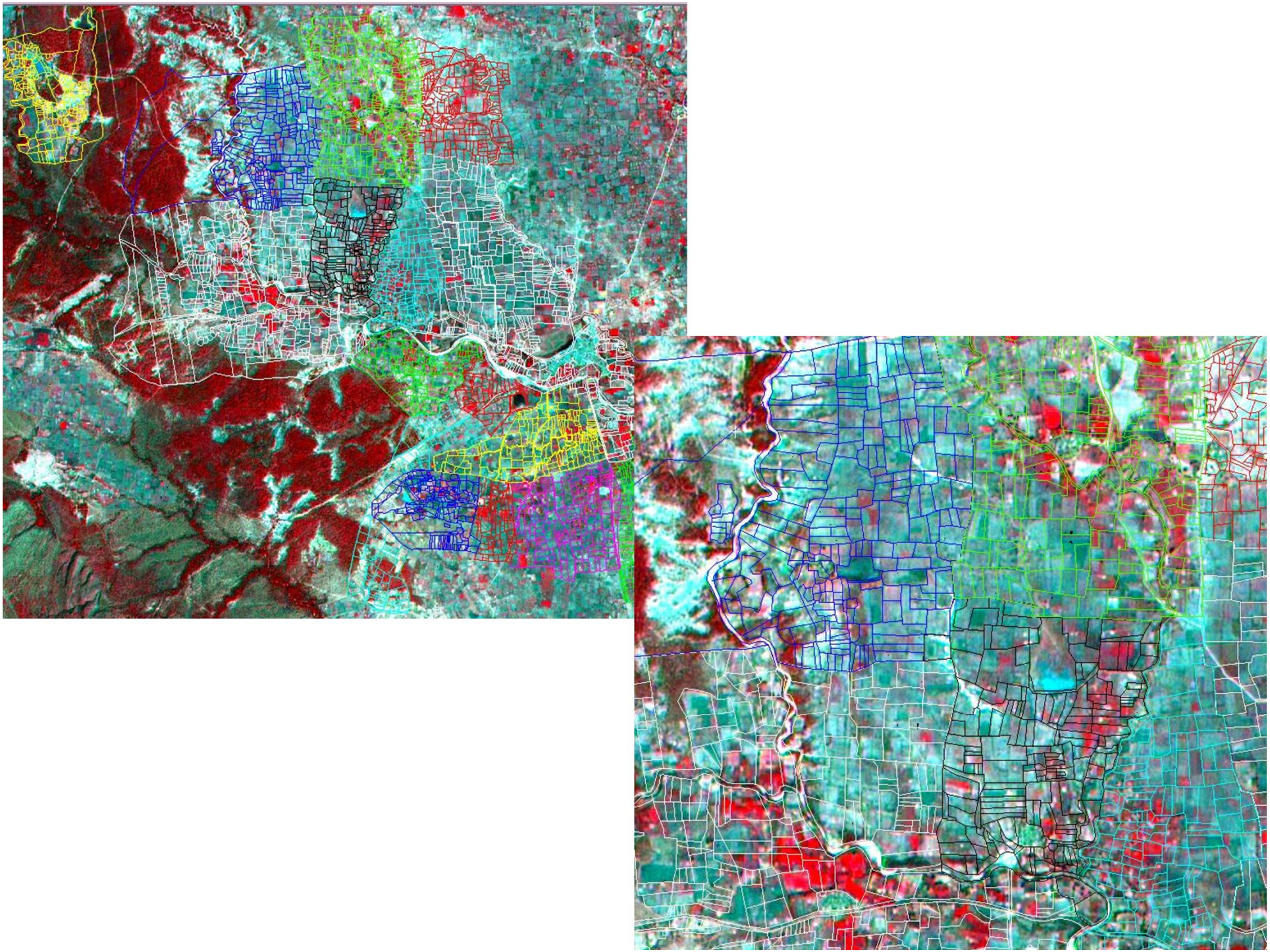
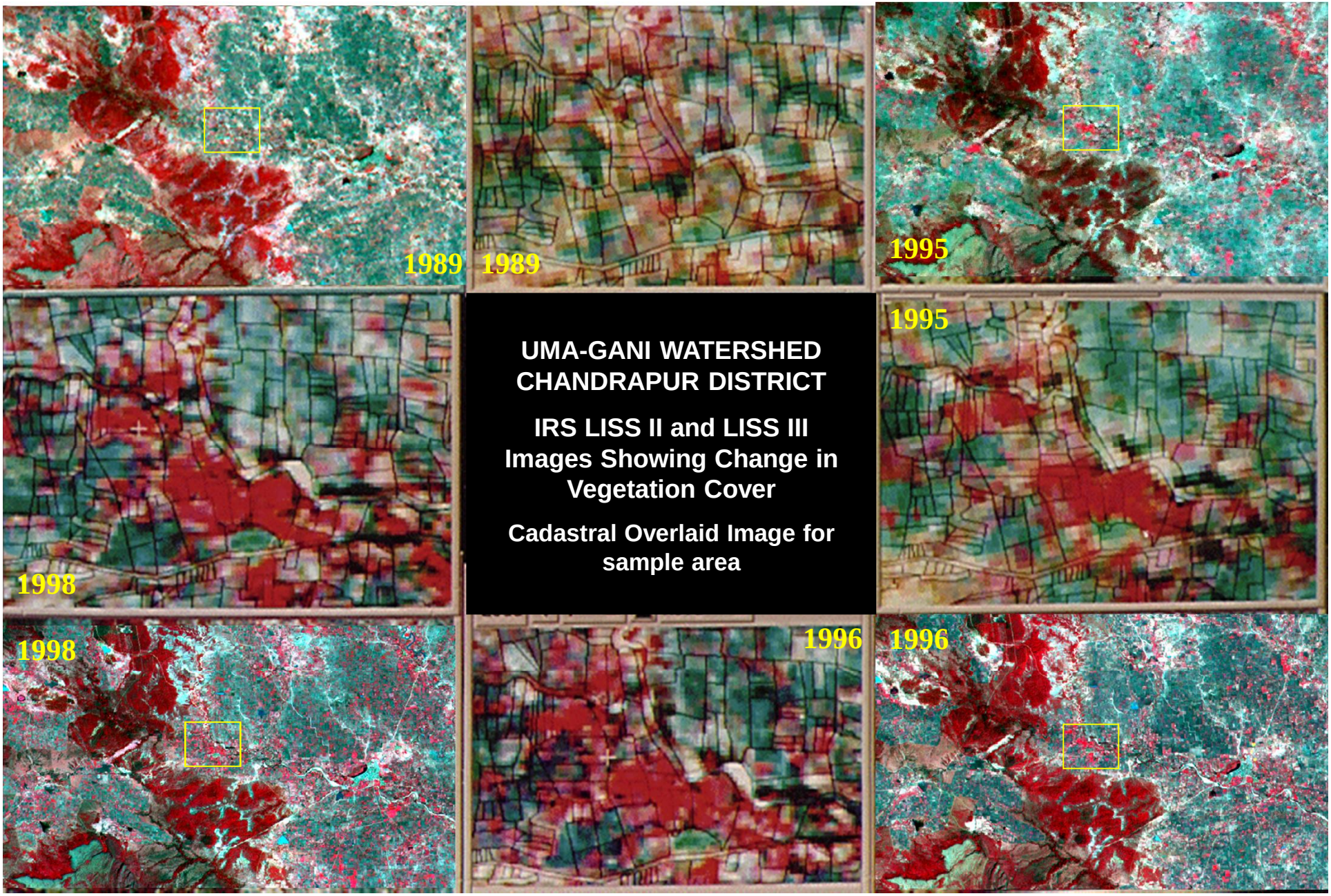


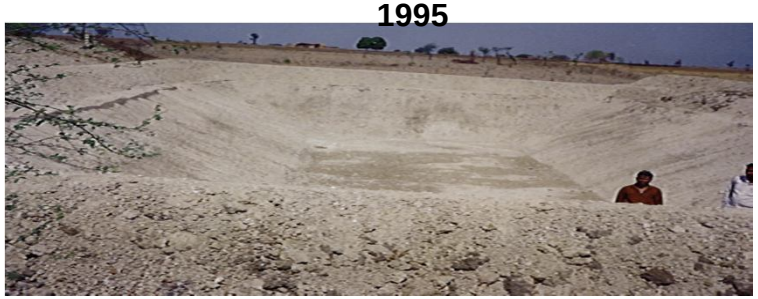
VILLAGE MEETING TO DISCUSS PROBLEMS & SOLUTIONS

Local elected bodies
&
Water users associations


1989
1989
1995
1998
UMA-GANI WATERSHED
CHANDRAPUR DISTRICT
IRS LISS II and LISS III
Images Showing Change in
Vegetation Cover
Cadastral Overlaid Image for
sample area
1995
1998
1996
1996

BEFORE IMPLEMENTATION
1989

AFTER IMPLEMENTATION
1995



Where ground water prospects are poor, such area 'traditional bodi's' have been converted to farm ponds with minimal cost due to impervious material, where lining of bunds is not required.

IMPACT ANALYSIS

ACTIVITY : Farm pond (Rs 18,000/-)

VILLAGE : Tirkhura

Farmer's name : Kishore Chandrasekar Ghadge

Survey no. -138, Area -3.6 ha

BEFORE IMPLEMENTATION			AFTER IMPLEMENTATION		
S.bean..	15q	15,000 /-	S.bean ..	10 q	10,000 /-
			Urad dal.	5q	6,000 /-
			Wheat ..	40 q	28,000 /-
			Jowar…	3 q	2,000 /-
INCOME ……		Rs 15,000 /-			46,000 /-

However while reaping the benefits, the same farmer increased the area under farm ponds. This will have negative impact in the adjoining fields in terms of land degradation by increase in salt concentration. Hence monitoring at micro level is imperative where high resolution satellite data will be useful.

Improvement has been made by simple clay grouting in the stream bed alluvium (commonly called as underground bandara) (1).

The underground bandara restricts the subsurface flow, whereas the surface flow of the stream is not affected, thereby retaining the soil moisture upstream.

This conservation measure not only survive the vegetative cover, but also improve the ground water recharge in the wells upstream of the bandhara(2).

Such underground bandharas are constructed across Uma-gani Nadi giving benefits to the farmers within the 500 m buffer on either side of the stream and a distance of 1-1.5 km upstream.(3)

Sudden run-off in areas with less slope creates lateral erosion by streams with entrenched meanders encroaching on to good agriculture lands.

Text-book examples is to straighten and deepen the stream and protect the stream banks with vegetative cover.

In practice, the vegetation perishes due to extreme heat in summer months and in course of time the treatment measure fails.

IMPACT ANALYSIS

VILLAGE : Shedegaon, Farmer's name : Abdul Shakil,
Survey no. -17, Area -2.5 ha

ACTIVITY : Provision of motor pump (Rs 15,000/-)

BEFORE IMPLEMENTATION		AFTER IMPLEMENTATION	
Cotton ...5 q	11,000 /-	Paddy .. 40 q	25,000 /-
Jowar .. 10 q	5,000 /-	S.bean.. 5q	5,000 /-
Tur..... 2 q	3,000 /-	Wheat .. 10 q	7,000 /-
		Chilli... 4 q	11,000 /-
INCOME ...	Rs 19,000 /-		Rs 47,000 /-

Activities : Construction of BANDHARA (Rs 1,25,000/-)

Provision of motor pump (Rs 15,000/-) for farmers on either side of river within 500 meter buffer of the river (upstream)

Provision of large diameter dug wells (25000/-)

Unlined wells will recharge better.

IMPACT ANALYSIS

ACTIVITY : Large diameter Dug well upstream of Bandhara - (Rs 25,000/-)

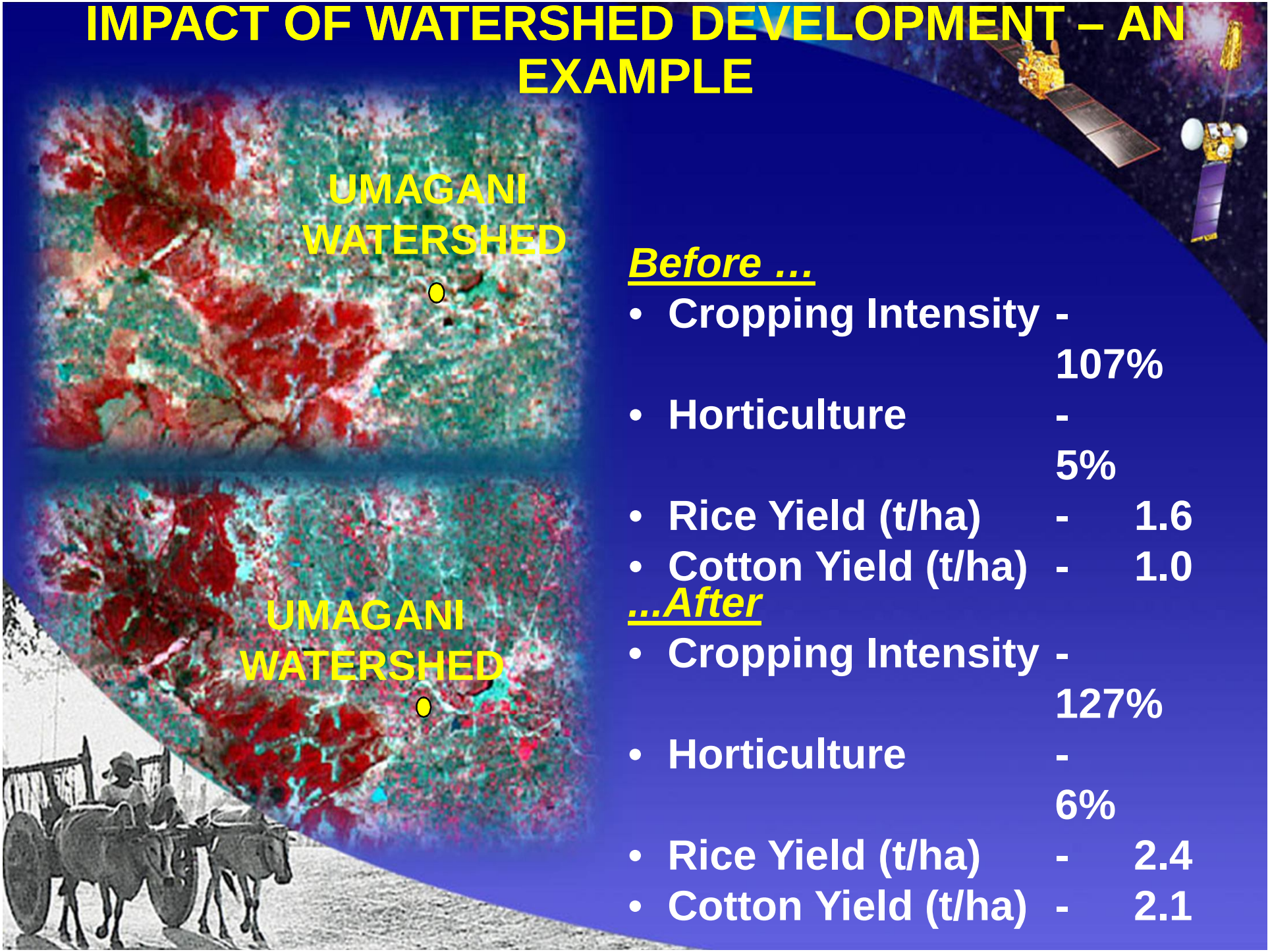
VILLAGE : Shedegaon

Farmer's name :

Natthu Aadku Raut,
Survey no. -4, Area -1.5 ha

BEFORE IMPLEMENTATION			AFTER IMPLEMENTATION	
Wheat	**2 q**	**1,500 /-**	**Hort.(orange)..**	**50,000 /-**
Jowar	**2 q**	**1,000 /-**	**S.bean..**	**2,000 /-**
			Wheat ..	**1,000 /-**
			Chilli...	**2,000 /-**
INCOME		**Rs 2,500 /-**		**Rs 55,000 /-**

IMPACT OF WATERSHED DEVELOPMENT – AN EXAMPLE



Before …

- Cropping Intensity - 107%
- Horticulture - 5%
- Rice Yield (t/ha) - 1.6
- Cotton Yield (t/ha) - 1.0

…After

- Cropping Intensity - 127%
- Horticulture - 6%
- Rice Yield (t/ha) - 2.4
- Cotton Yield (t/ha) - 2.1