Bharathidasan University

Tiruchirappalli – 620 023, Tamil Nadu

6 Yr. Int. **M.Tech. Geological Technology and Geoinformatics**

Course Code : **MTISC0206G**

INTRODUCTION TO GEOTECHNOLOGY

Unit-3 Natural Resources and Disasters

ISS, NASA track @ Spot the Station
https://spotthestation.nasa.gov/signup.cfm

Dr. K.Palanivel
Professor, Department of Remote Sensing

Course Objectives

- To know the content and familiarize the courses of this entire programme
- To study the basics and concepts of major disciplines in Geological Technology
- To understand the importance of Geoinformatics and its applications
- To learn the application of Geological Technology and Geoinformatics in natural resources mapping
- To learn the application of Geoinformatics in natural disaster mitigation.

MTISC-0206G - INTRODUCTION TO GEOTECHNOLOGY ---- 3 credits

1. Earth System Processes: 6hrs

Earth Sciences: Definition, Branches of Earth Sciences, Scope and importance of Earth Sciences

Earth System Processes: Origin, interior & age of the Earth – Plate tectonics – Formation of Continents & Oceans – Mountain building activities – origin of rivers – Physiography of the Earth.

2. Lithology, Structure, Geomorphology: 12hrs

Lithology: Rock forming minerals – Igneous, Sedimentary & Metamorphic Rocks – Stratigraphy.

Structure: Folds, faults, geotectonics and their significance.

Geomorphology: Various Geomorphic Processes – Regional Geomorphology of India – Geological Ecosystems.

3. Natural Resources and Disasters: 12hrs

Natural Resources: Mineral Provinces of India and exploration strategies – Hydrocarbon provinces of India and exploration strategies–Water Resources and exploration strategies. Soil, Forest & Biomass and Marine resources.

Natural Disasters: Geodynamic Processes and Natural Disasters (Seismicities – Landslides – Floods – Tsunami – Other Natural Disasters).

4. Remote Sensing Based Mapping: 12hrs

Aerial Remote Sensing – Satellite Remote Sensing Principles – Digital Image Processing concepts – GPS based mobile mapping principles – Image interpretation principles for Geotechnology.

5. Geoinformatics: 6hrs

Definition & Concepts – Input Sources (Satellite, Aerial & Ground based) - Computer based Geospatial data base generation – data modeling on Natural Resources, Eco Systems & Natural Disasters – Information Systems.

Course Outcomes

After the successful completion of this course, the students are able to:

- Create subject interest amongst the students joined in this programme and gain knowledge on variety of sub disciplines that they can choose for their future.
- Understand the scope and importance of the Geological Technology and Geoinformatics subjects.
- Provide a brief exposure to the course works of entire 6 year programme.
- Brief exposure to the advanced and computerized tools in Geoinformatics and their applications to Geology, Natural Resources and Natural Disasters.
- Understand the concepts of mapping using Remote Sensing Satellites, Aerial Photography and Digital Image Processing.
- Know the concepts of Geospatial / Geoinformatics Technology based database generation, modeling and information systems.

INTRODUCTION TO GEOTECHNOLOGY

Unit – III NATURAL RESOURCES AND DISASTERS

3. Natural Resources and Disasters: 12 hrs.

Natural Resources: Mineral Provinces of India and exploration strategies – Hydrocarbon provinces of India and exploration strategies–Water Resources and exploration strategies. Soil, Forest & Biomass and Marine resources.

Natural Disasters: Geodynamic Processes and Natural Disasters (Seismicities – Landslides – Floods – Tsunami – Other Natural Disasters).

NATURAL RESOURCES

- Naturally occurring materials which are playing major role as essential for life of human.

NATURAL RESOURCES

- MINERAL RESOURCES
- PETROLEUM & GAS – HYDROCARBON
- COAL RESOURCES
- WATER RESOURCES
- SOIL RESOURCES
- GEOTHERMAL RESOURCES
- OCEAN / MARINE RESOURCES
- FOREST RESOURCES
- BIOMASS – PLANTS & ANIMALS

Geological Resources

How were the Natural Resources utilised by our forefathers?

How did they safeguarded themselves as well as Natural Resources from Natural Disasters/ Calamities?

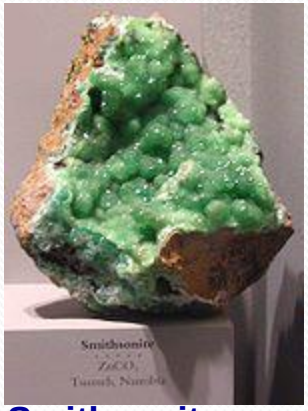
It is high time to recall / understand the methods adopted by our Ancestors in preventing destructions due to natural hazards to the Natural Resources and their infrastructures and utilize the Natural Resources sustainably.

NATURAL RESOURCE

Kyanite

- Recall from the first unit – Minerals – Importance of Geotechonology, etc.

Azurite



Smithsonite –
Botryoidal habit

Heamatite –
Brown streak

Aragonite

Chalcocite,
Copper ore

Garnet –
Dodecahderal habit

Diamond xal

Beryl

Quartz crystals

Satinspar – Silky Lustre

Obsidian – Volcanic Glass

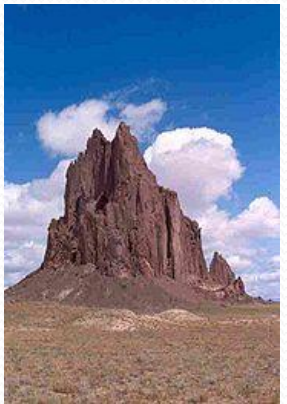
Orbicular Granite and Gabbro – Plutonic Igneous rocks

Pyrite – Metallic Lustre

Pillow Lava / Aa / Pahoehoe Lava / Volcanic Neck– Volcanic Igneous rocks

Pumice – Porous Volcanic rock

Basalt – Volcanic Igneous rock



Dykes & Laccolith– Intermediate / Hypabyssal Igneous rocks

Coal - Bituminous

Oil Shale

Mudstone-tilted

Current beddings

Breecia boulder

Ripple marks

Uprooted Sedi. Rock

Fossil rich

Top: Undisturbed but eroded;

Bottom: Carved

Gneiss – Highly Deformed

Quartzite

Marble

Slate

Slate Roof

Mylonite

Natural Resources – **Exploration, Exploitation, Conservation, Management**

Natural Disasters - **Mitigation, Forewarning, Management, Damage Assessment**

Geyser@Calistoga, California

All these activities are possible using Geomatics. How?

- By understanding the Formation / Origin & conditions of Occurrence about the Natural Resources
- By understanding the causative / inducing / /parameters of Natural Disasters
- By understanding the Earth system processes

Mineral Provinces of India & Tamil Nadu

- **Tamil Nadu**
  - Tiruchirappalli - Granite
  - Ariyalur – Limestone – fossiliferous, Phosphatic nodules, Gypsum
  - Cuddalore – Sandstone
  - Neyveli – Lignite, White clay, Red clay
  - Sivanganga – Graphite
  - Madurai – Granite varieties
  - Salem – BMQ Banded Magnetite Quartzite, Magnesite,
  - Yercaud – Bauxite (exploited)
  - Melur - Granite

INDIAN MINERAL PROVINCES

- BIHAR – Coal - Bituminus, Copper @ Mosabani, Uranium @ Jaduguda,
- RAJASTHAN – Marble, Rock Salt
- ORISSA, Kerala – Radioactive Placer Minerals – Illmenite
- MAHARASHTRA – Slate, Iron Ore @ Kudremukh
- MADHYAPRADESH – Diamond @ Panna
- ANHDHRAPRADESH – Barite, Asbestos, Mica, Quartz, Feldspar,
- KARNATAKA – Gold @ Kolar.
- ….

EXPLORATION STRATEGIES

- Preliminary survey – using remote sensing data
- Map favourable areas through different anomalies derived using remote sensing data
- Do local survey – Geophysical and Geochemical surveys
- Locate the exact targets
- Drill bore hole and do sampling & analysis
- Estimate the Quality and Quantum of resources and plan for exploitation and
- Tackle the problems posed due to ESPs, like excess hydrostatic pressures, groundwater seepage, high pressure, anaerobic situations, poisonous and flammable gaseous emanations, floods …in the working face of mines and quarries.

EXPLORATION STRATEGIES – Problems in Mining – Area- & Resource-Specific

- Lignite – Being Mined by NLC – During exploration phase, they were able to determine, some natural problems that could cause serious disaster in series such as,
  - the huge amount of hydrostatic pressure of the subsurface Artesian Aquifer can **explode the working face** while mining lignite at any stage and **subside by flooding** the entire working area
  - The mixture of phosphates and sulfides poses **fire** problems during summer as well as **acid mine drainage**
  - The access benches to the working face, made of Loose unconsolidated sediments may pose problem like **bench slope failure, soil erosion, soil slip, landslides**.

HYDROCARBON PROVINCES

- In India, Gulf of Cambay, Offshore Mumbai
- Dispur, Angaleshwar @ Assam
- Cauvery Delta-Bhuvanagiri
- Krishna-Godavari Delta
- Moreover, possible occurrences at Ganga Basin, Cudappah Basin, Deccan Synclise, etc., are studied & possibilities are proved.

WATER RESOURCES

- Surface water – tanks, reservoirs, lakes, rivers and canals
- Groundwater – sedimentary aquifers, hard rock / crystalline aquifers, Alluvial Aquifers of all the Indian river basins & Coastal aquifers are yielding good amount of groundwater
- By understanding the regional phenomena like, tectonic arching and deepening, types of faults, lineaments, fractures / cracks that are formed, flooding, soil erosion and siltation phenomena, other related natural calamity vulnerabilities… land subsidence,

- By understanding the local phenomena like groundwater level changes, natural recharge and water quality modifications, groundwater movement…..
- Thus, some of the exploration strategies are:
  - Remote Sensing based rapid mapping – This avoids time consuming, expensive and more human power involving tedious conventional geological field surveys
  - RS needs only a limited / fewer Ground truth / Geological surveys – wherever necessary and accessible
  - GIS based database generation, manipulation, integration, modeling, quantification, quality estimation, budgeting and sustainable planning
  - Identify GW targets and suggest suitable Artificial Recharge Schemes to improve the aquifers and their health.

SW & GW PROVINCES IN INDIA

- Ganges, Brahmaputra, Narmada, Tapti, Krishna, Godavari, Cauvery, Vaigai, Tambraparni are some of the major river basins in India
- Several major reservoirs, colonies / swarms of tanks are also available
- Hot water springs in Deccan, Himalayas, etc., are also attracting attention
- Major river basins are also having their own alluvial aquifers – very good Groundwater provinces
- Sedimentary-glacial, Gondwana – coastal aquifers and hardrock aquifers are good provinces for g.w.

Natural resources in India – Some facts

- India's total renewable water resources are estimated at 1,907.8 km3/year.
- Its annual supply of usable and replenishable groundwater amounts to 350 billion cubic meters.
- Only 35% of groundwater resources are being utilized.
- About 44 million tonns of cargo is moved annually through the country's major rivers and waterways.
- Groundwater supplies 40% of water in India's irrigation canals.
- 56% of the land is arable and used for agriculture.
- Black soils are moisture-retentive and are preferred for dry farming and growing cotton, linseed, etc.
- Forest soils are used for tea and coffee plantations. Red soil have a wide diffusion of iron content.
- Most of India's estimated 5.4 billion barrels (860,000,000 m^3) in oil reserves are located in the Mumbai High, upper Assam, Cambay, the Krishna-Godavari and Cauvery basins.
- India possesses about seventeen trillion cubic feet of natural gas in Andhra Pradesh, Gujarat and Orissa.

- **Uranium is mined in Andhra Pradesh, Bihar-Jduguda.**
- **India has 400 medium-to-high enthalpy thermal springs for producing geothermal energy in seven "provinces" — the Himalayas, Sohana, Cambay, the Narmada-Tapti delta, the Godavari delta and the Andaman and Nicobar Islands (specifically the volcanic Barren Island.)**
- **India is the world's biggest producer of mica blocks and mica splittings.**
- **India ranks second amongst the world's largest producers of barites and chromites.**
- **The Pleistocene system is rich in minerals. India is the third-largest coal producer in the world and ranks fourth in the production of iron ore.**
- **It is the fifth-largest producer of bauxite and crude steel, the seventh-largest of manganese ore and the eighth-largest of aluminium.**
- **India has significant sources of titanium ore, diamonds and limestone. India possesses 24% of the world's known and economically-viable thorium, which is mined along shores of Kerala.**
- **Gold was mined in the now-defunct**

Kolar Gold Fields in Karnataka.

Indian coal production is the 3rd highest in the world according to the 2008 Indian Ministry of Mines estimates. Photo: Coal mine in Jharkhand.

GEOHAZARDS & NATURAL DISASTERS

- **Geohazards** are Geological phenomenon / processes vulnerable to the human's and other living being's life, their property as well as environment.

- **Natural disasters** are extreme events within the earth's system
- that results in massive destruction, i.e., death or injury to humans, and damage or loss of valuable goods…,
- …such as buildings, communication systems, agricultural land, forest, natural environment, etc.

GEODYNAMIC PROCESSESS & TYPES OF NATURAL DISASTERS

GEOLOGICAL & CLIMATE RELATED GEOHAZARDS ARE:

- **Volcanoes** – hill, plain & ocean
- **Landslides** – hill & submarine
- **Soil erosion** – Slow occurring along hills, foot hill & undulating plains
- **Flood** – down stream slopes & plains
- **Tsunami** - coast
- **Land subsidence** – plains – Eg. Kolkatta city
- **Earth quake** – hill, plain, & ocean
- **Cyclone** – coast & adjacent plains
- **Drought** – (Slow Occurring) desertic plains, ice deserts.

Classification of Natural Disasters

Based on the time taken to happen in an area:

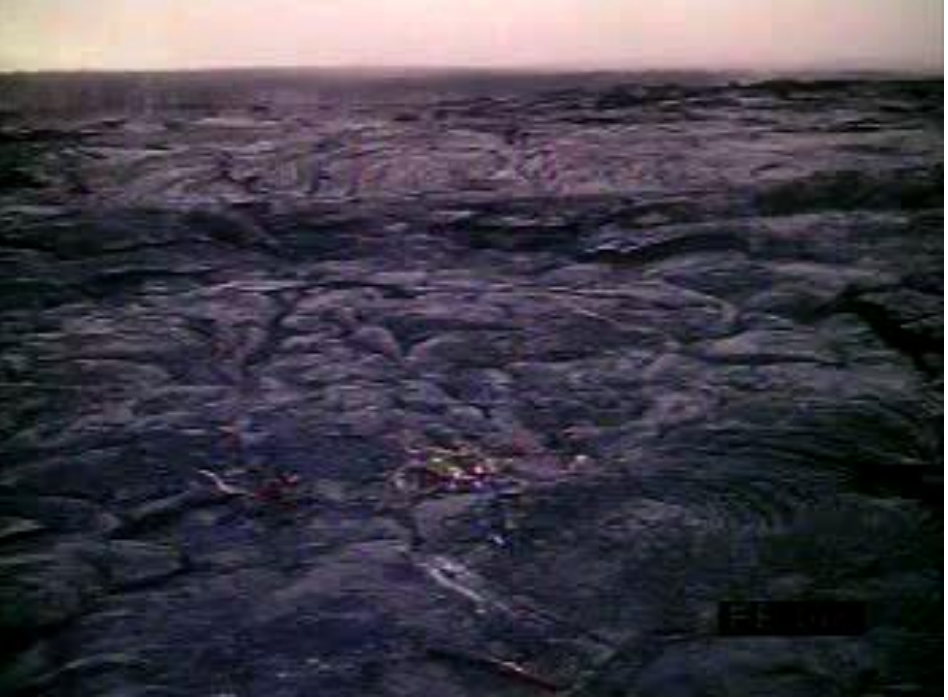
- **Rapid Occurring Disasters** – Causes Immediate destruction, e.g. Earthquakes, Landslides…

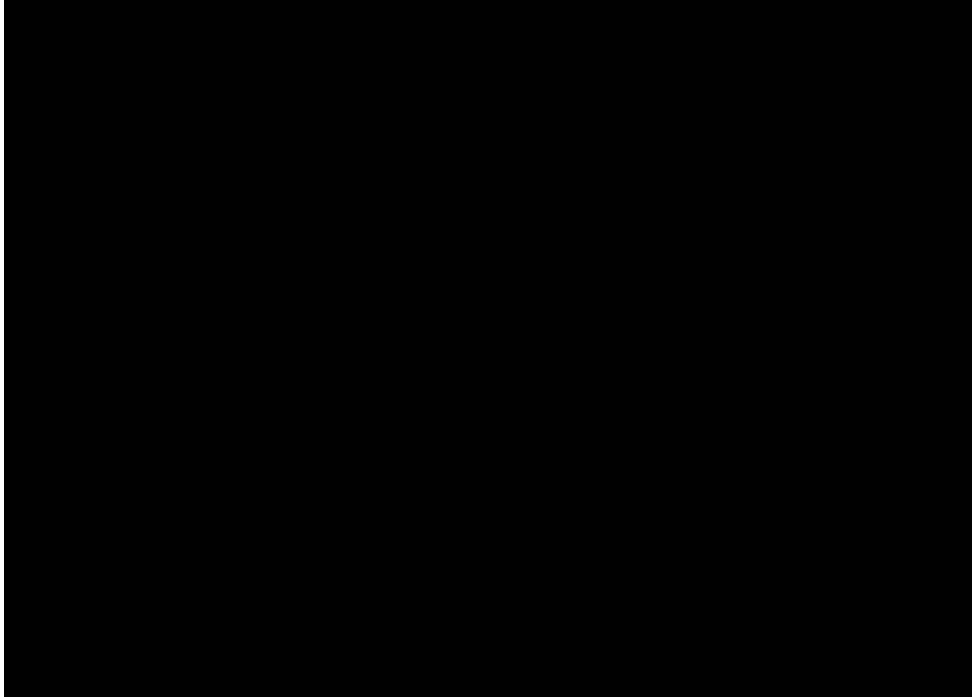
- **Slow Occurring Disasters** – sluggish type over a period of several months and years – e.g. Soil Erosion, Drought…

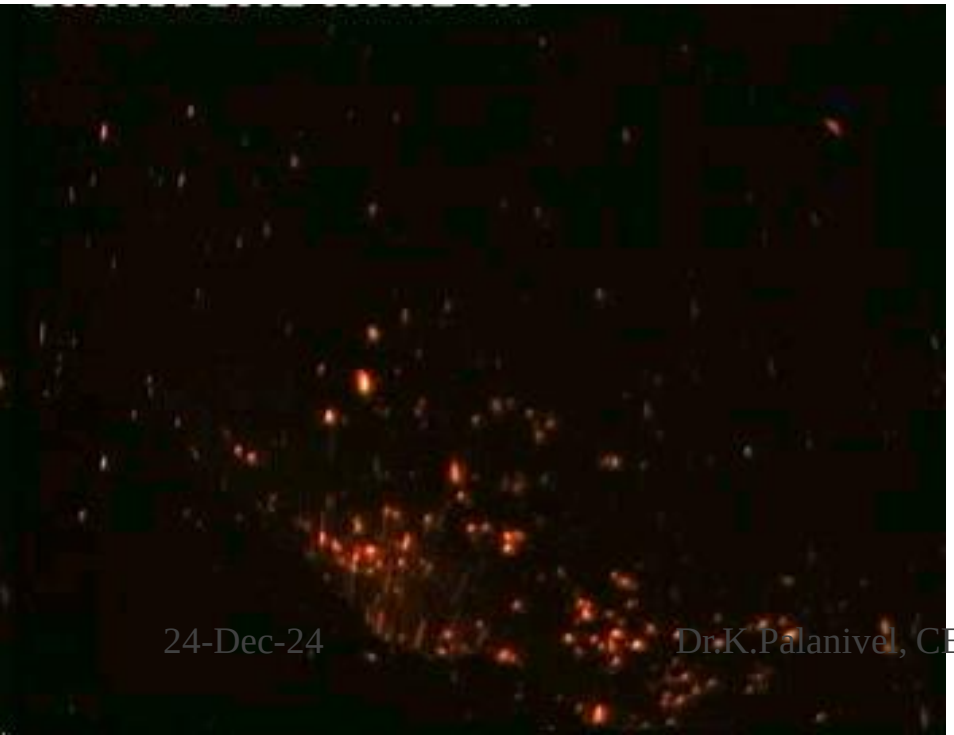
NATURAL DISASTERS

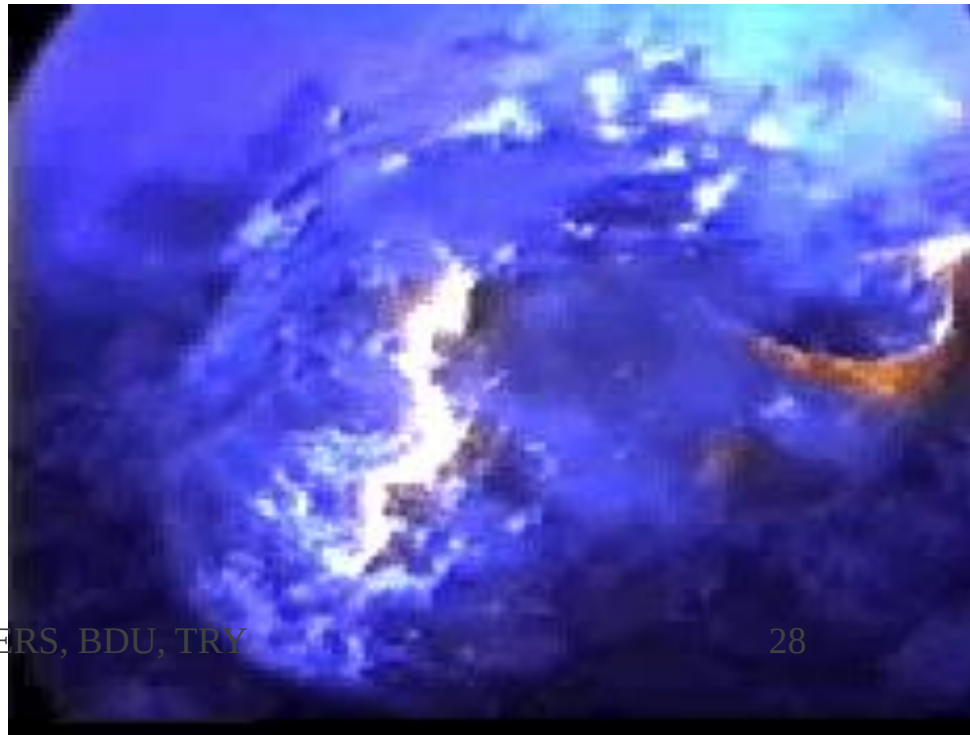
– CAN ALSO BE CLASSIFIED INTO 3 TYPES BASED ON

- **NATURAL PROCESSES INDUCED** – Eg. Earthquake and Volcanoes by Plate tectonism.
- **HUMAN ACTIVITES INDUCED** – Eg. Reservoir induced earthquake @Maharashtra state, Koyna dam .
- **INDUCED BY THE INTERVENTION OF BOTH HUMAN ACTIVITIES AND NATURAL PROCESSES** – Eg. Landslides of Thirumala hills.
- WHAT CAN BE DONE?
  - Remote sensing / Geotechnology based vulnerable area identification
  - Damage assessment after the event
  - Forecasting for evacuation & preparedness
  - Inducing parameters identification
  - Suggestion of remedial measures, mitigation and management plans.









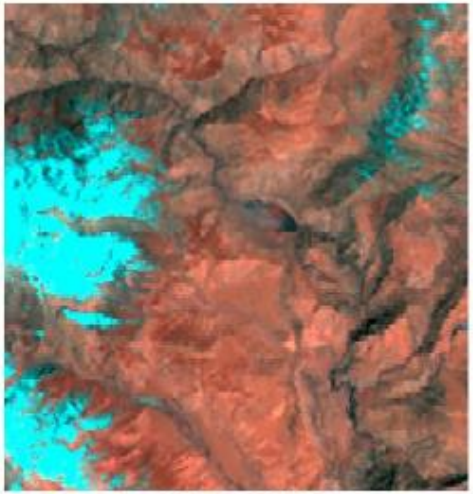
The Hindu, June 6 2008:

China QUAKE LAKE nears bursting point

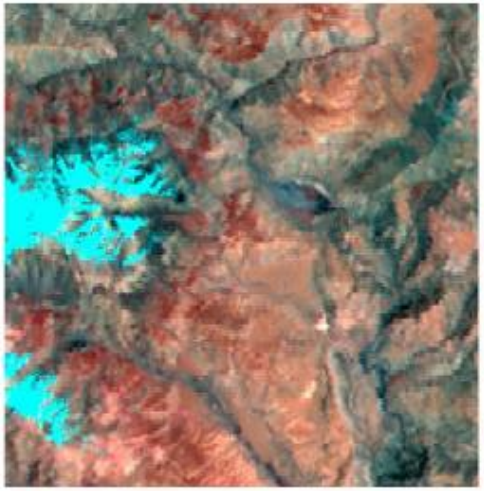
- Earthquake (May 12) induced landslides have blocked the Tangjiashan river formed a very big Quake Lake.
- Water level raised to 738.71m
- More than 2,50,000 have to be relocated
- More than 600 armed police and soldiers
- dug a 475m-channel to divert the water
- More than 30 such unstable lakes formed

Disaster Chains

Disasters are induced one by one as Chains



April 16, 2004



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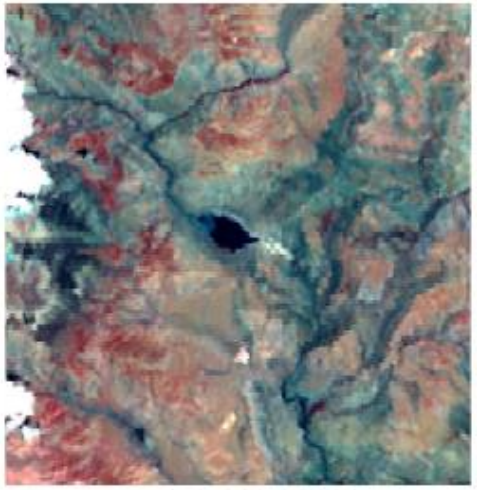

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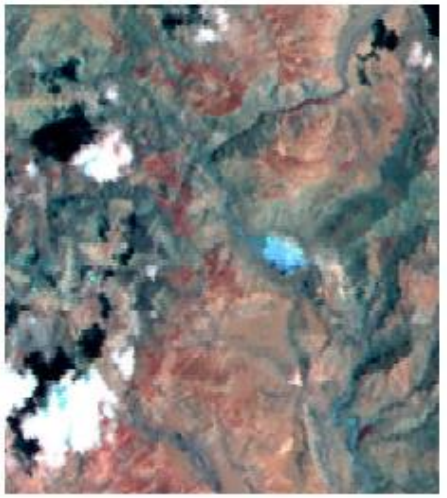

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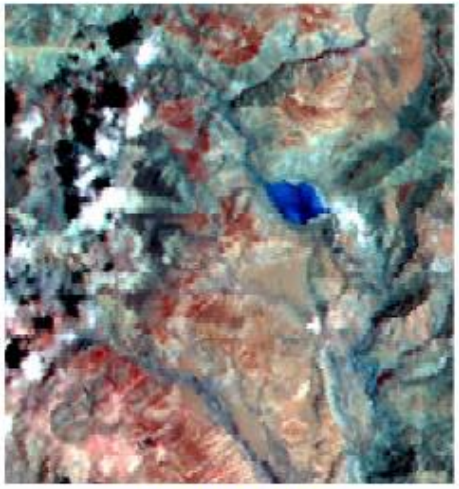

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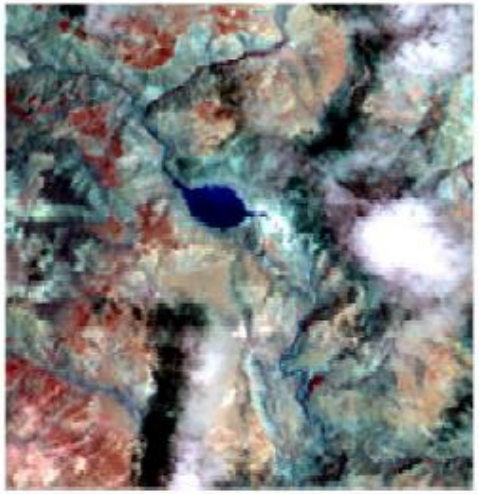

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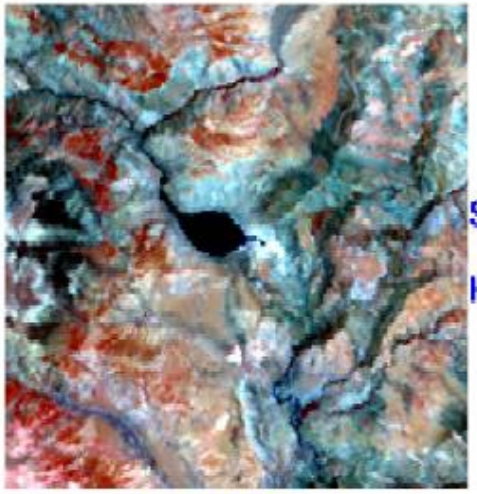


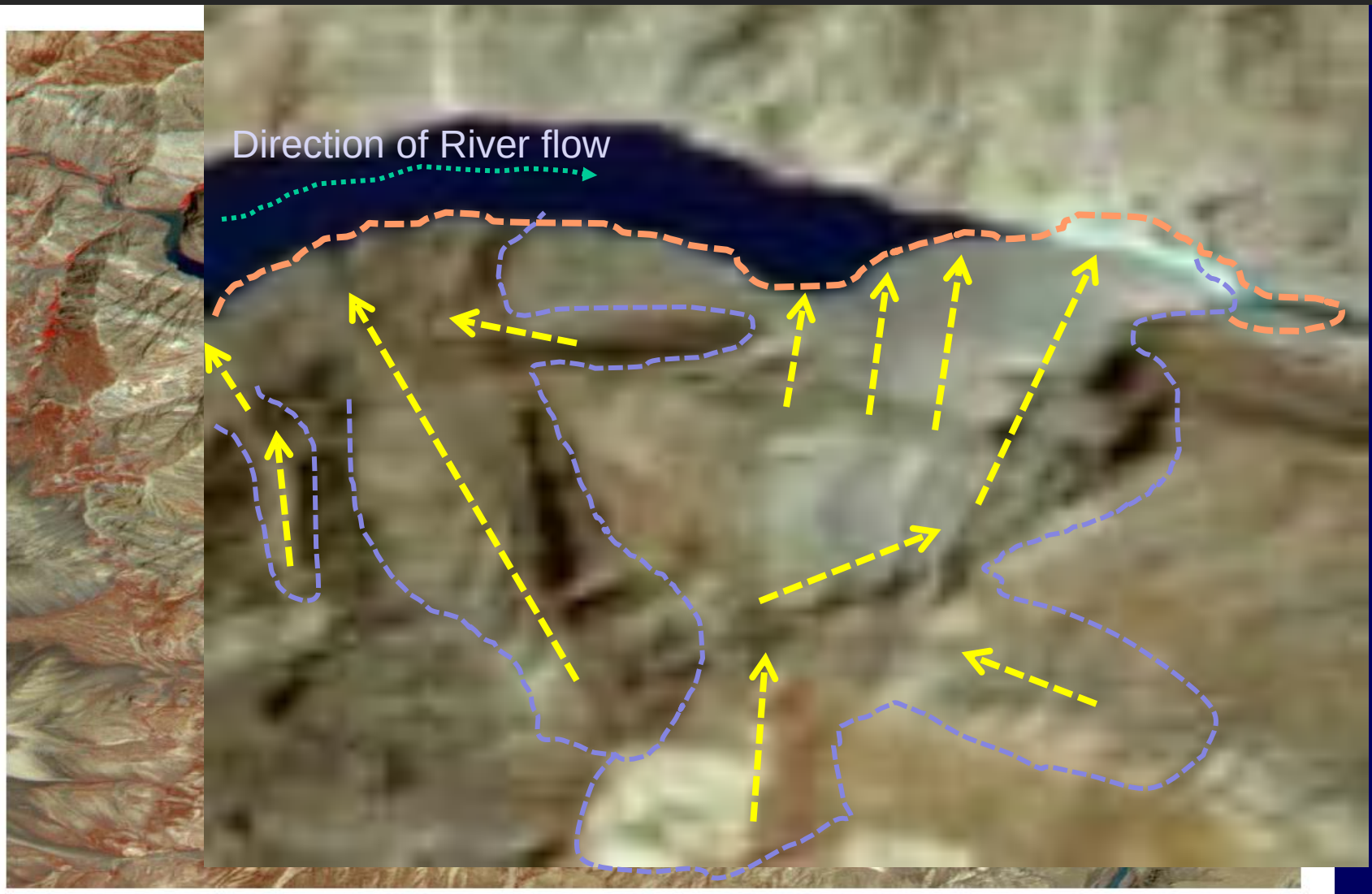
July 26, 2004

Prepared By

Space Applications Centre (ISI
&
Himachal Pradesh Remote Ser

Temporal Variations of the Lake extent using AWiFS

Earthquake → triggered **Landslides**, →Natural **Dam** (submerges large forest area -habitat for animals and birds) → **Breech** → **Flood** → **Lahar** (speedy downward movement of thick & massive slurry – i.e. watery clay, and total live burial of villages on its way to downstream)

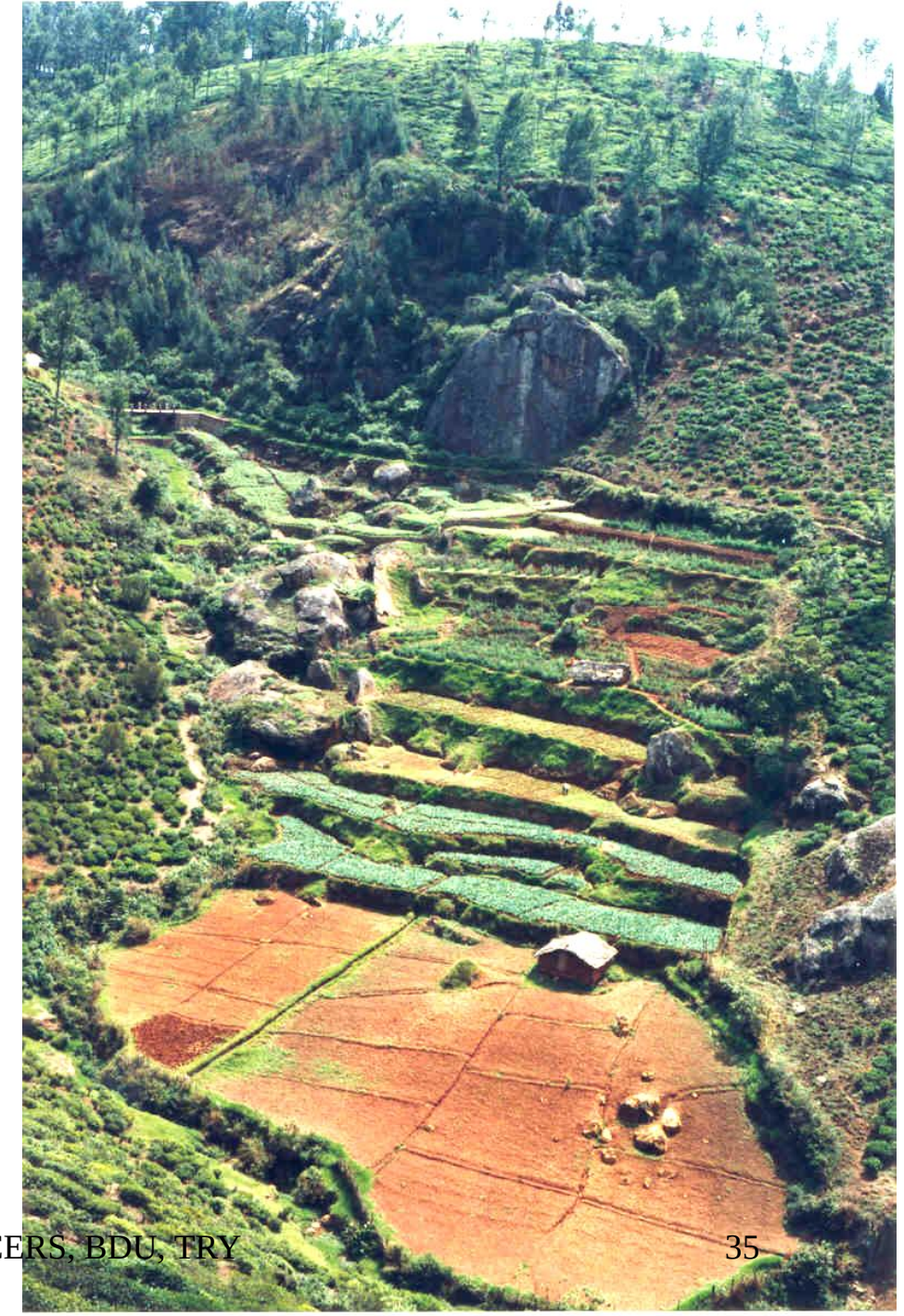


LANDSLIDES

ROCKFALL

ROCKSLUMP

ROCKSLIDE



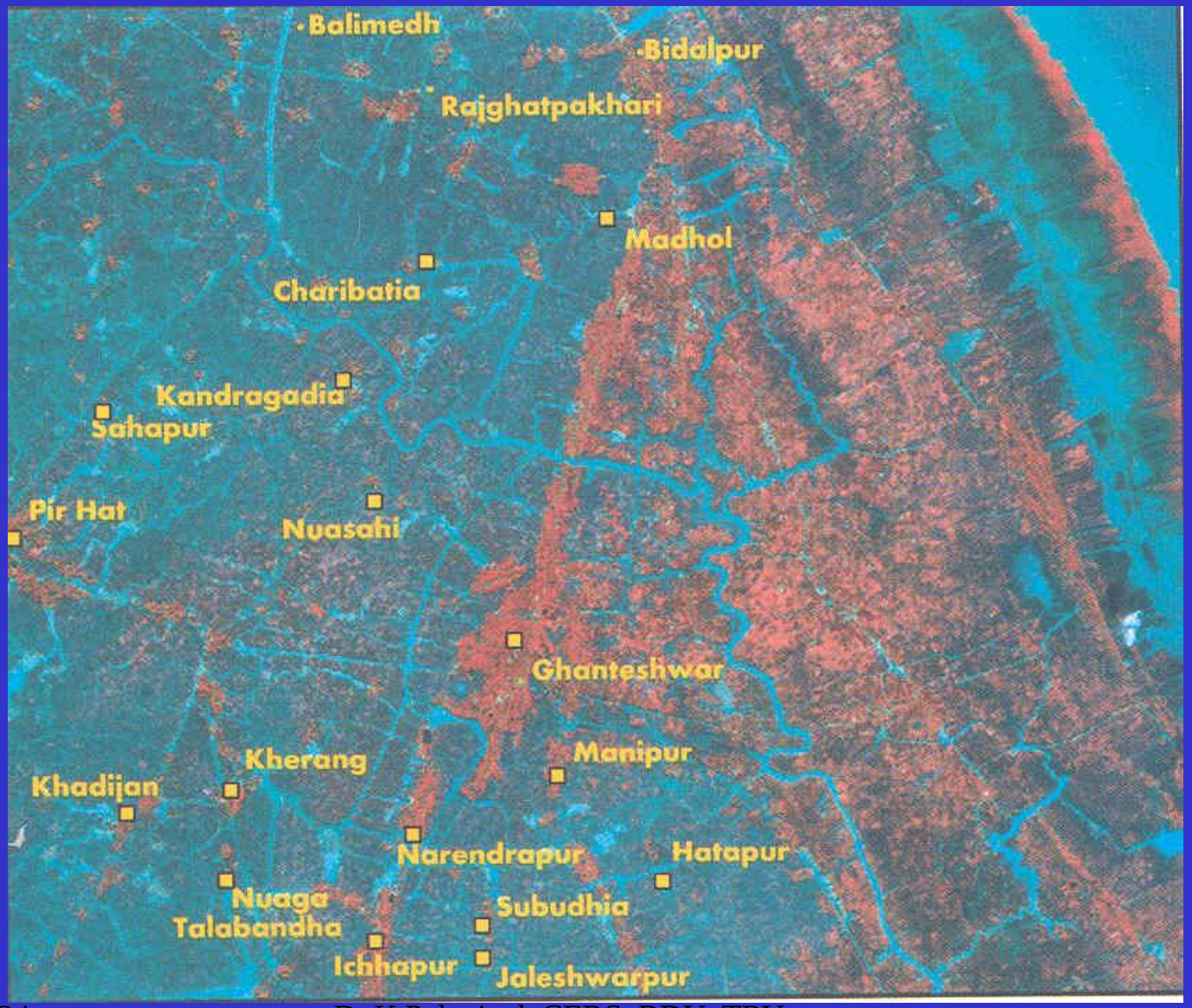
LANDSLIP

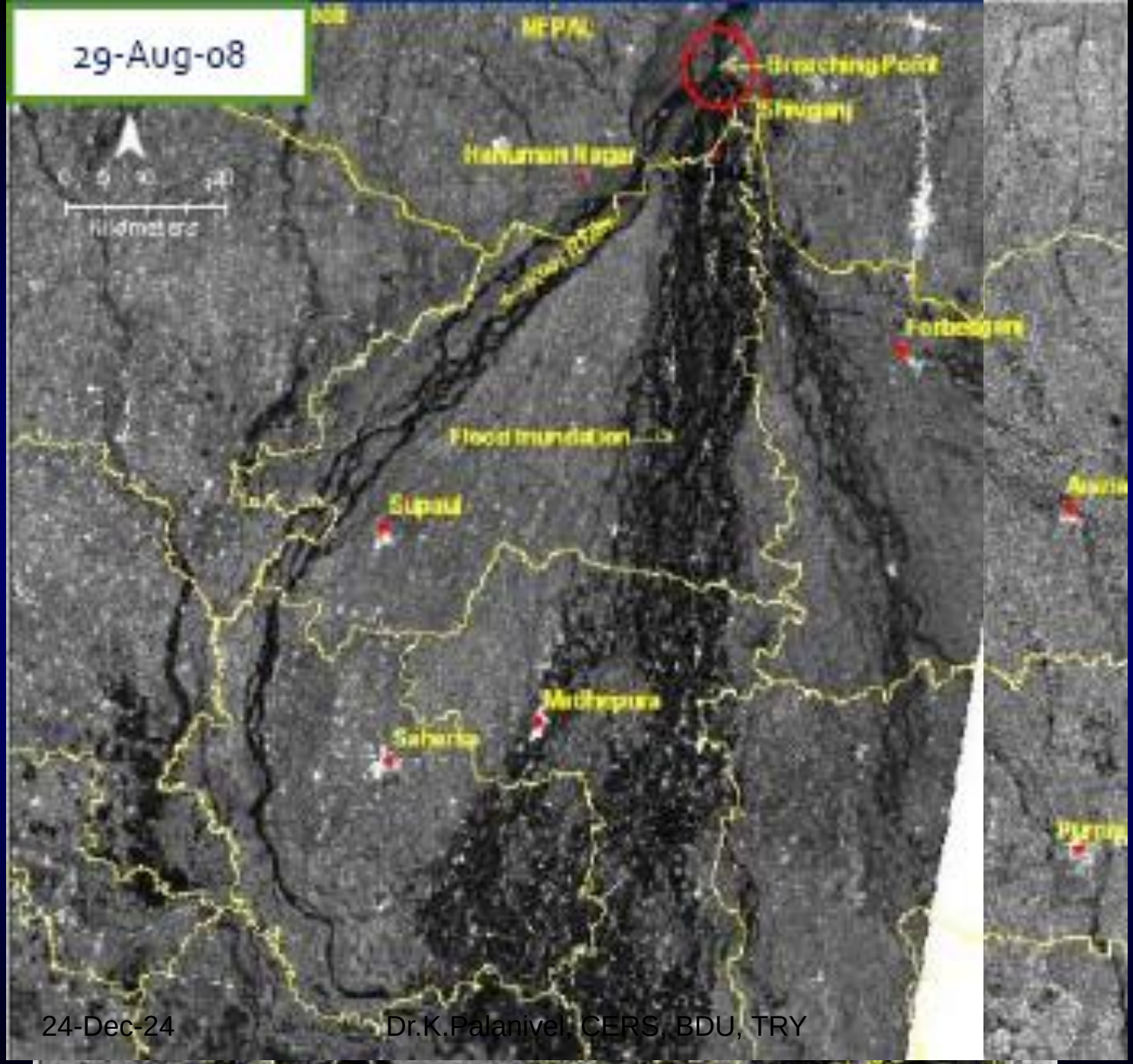
TRANSLATIONAL SLIP

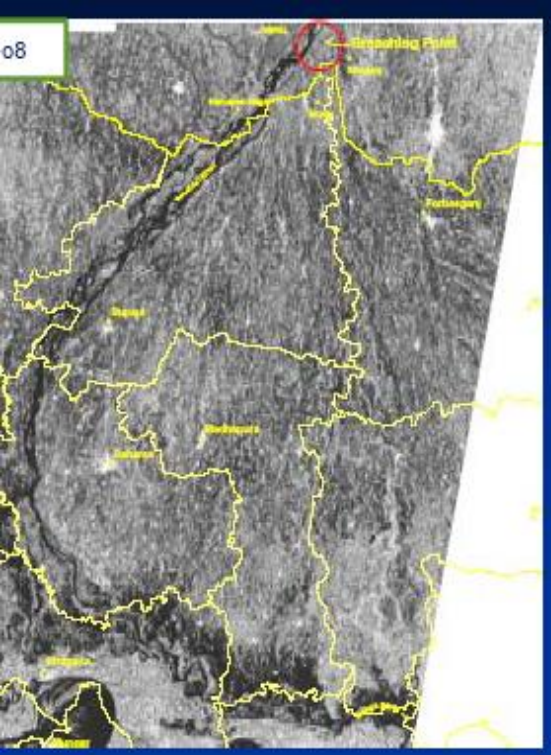
IRS – WIFS – ORISSA-BEFORE CYCLONE

IRS – WIFS – ORISSA AFTER CYCLONE

RADARSAT – ORISSA – POST – CYCLONE




29-Aug-08
NEPAL
Breaching Point
Shivganj
Hanuman Nagar
Kilometers
Forbesganj
Flood inundation
Supaul
Madhepura
Saharsa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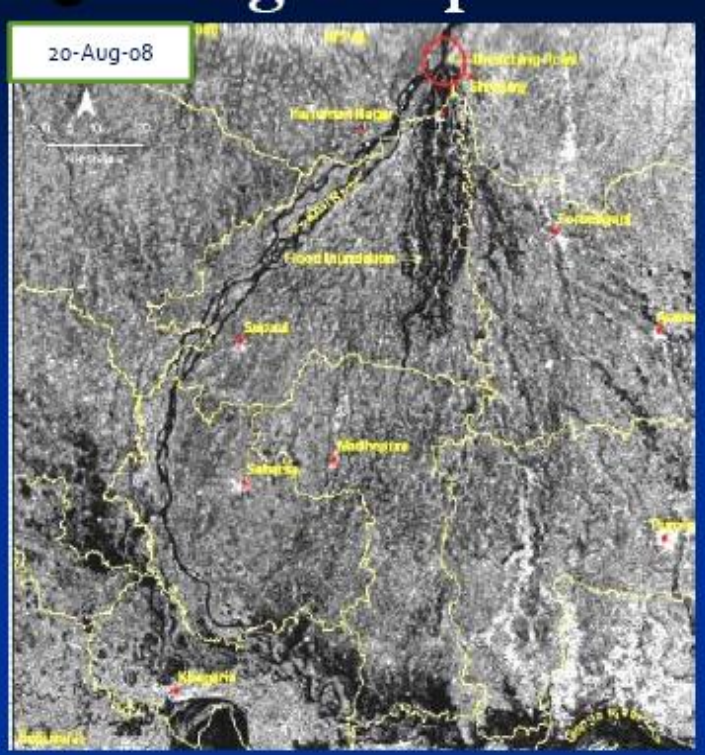
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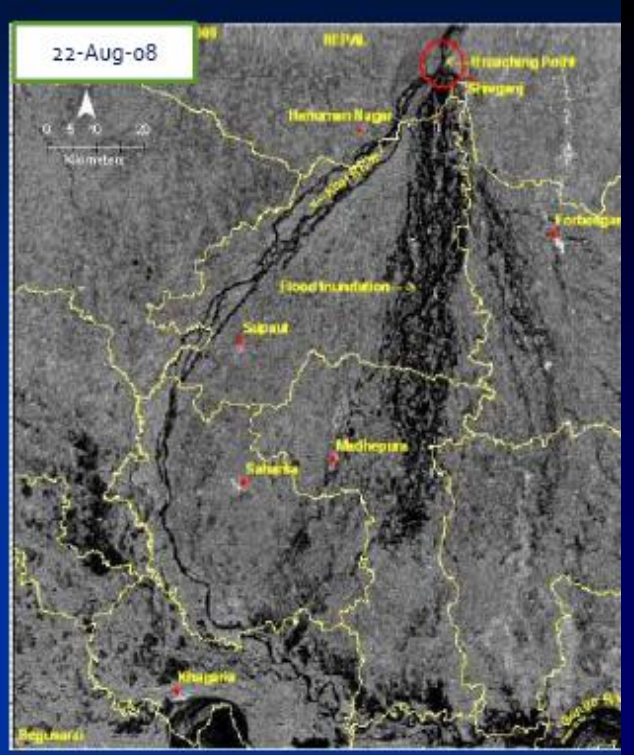
NEPAL
Breaching Point
Hanuman Nagar
Flood Inundation
Supaul
Madhepura
Saharsa
Khagaria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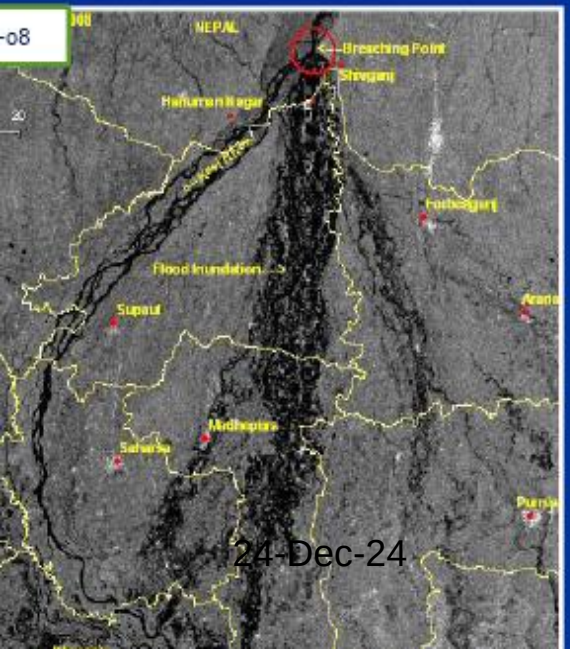
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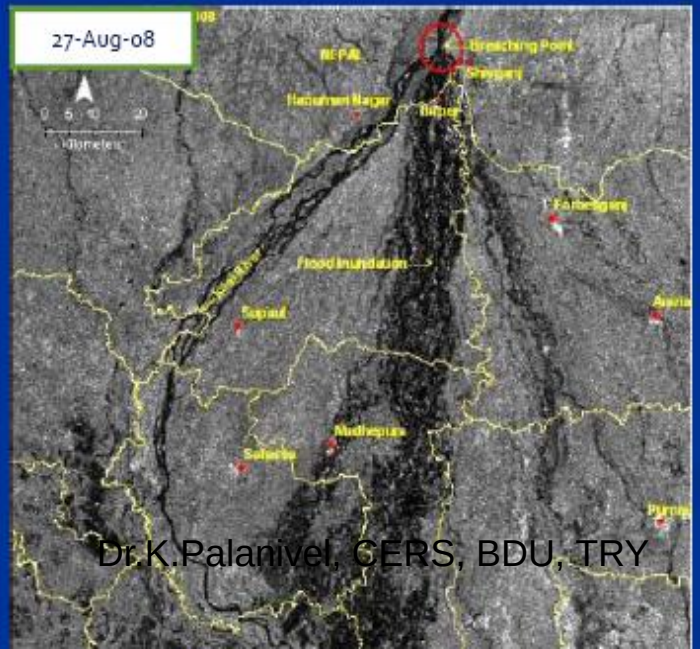
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Supaul
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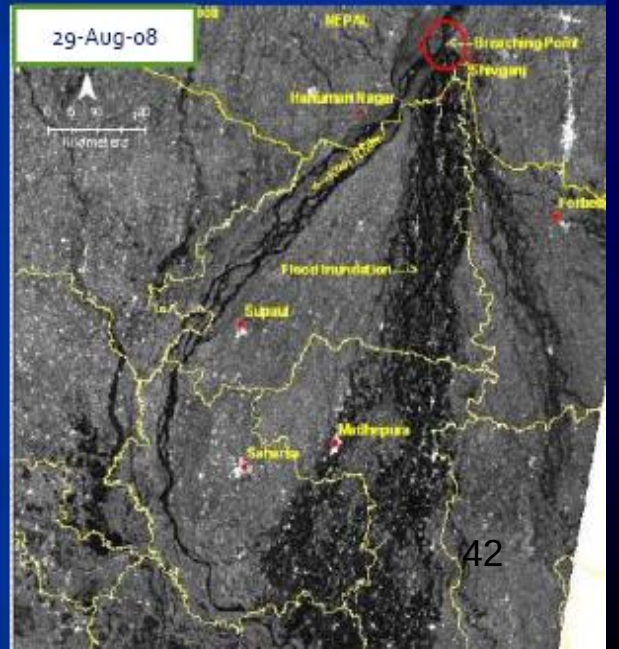
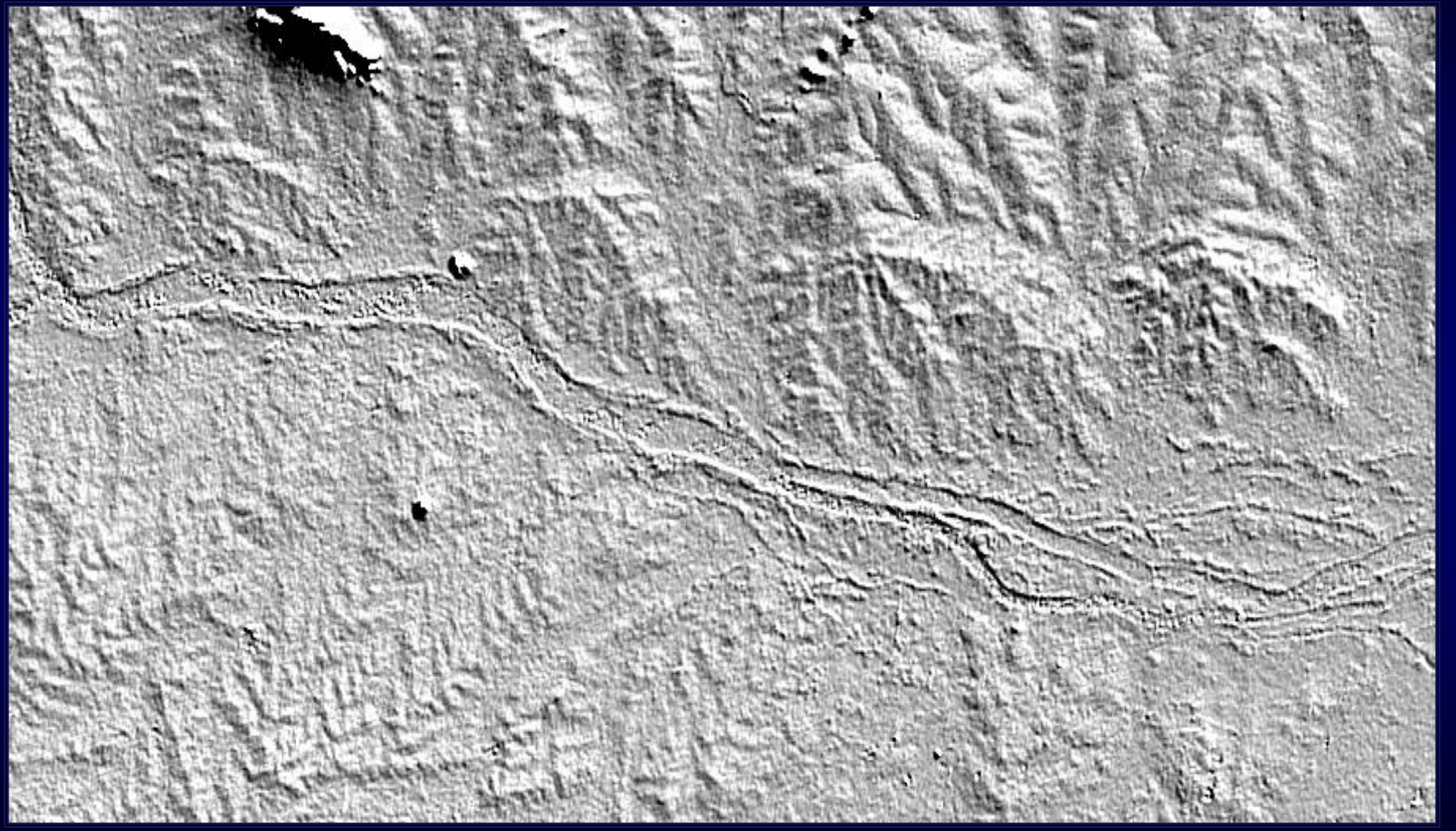
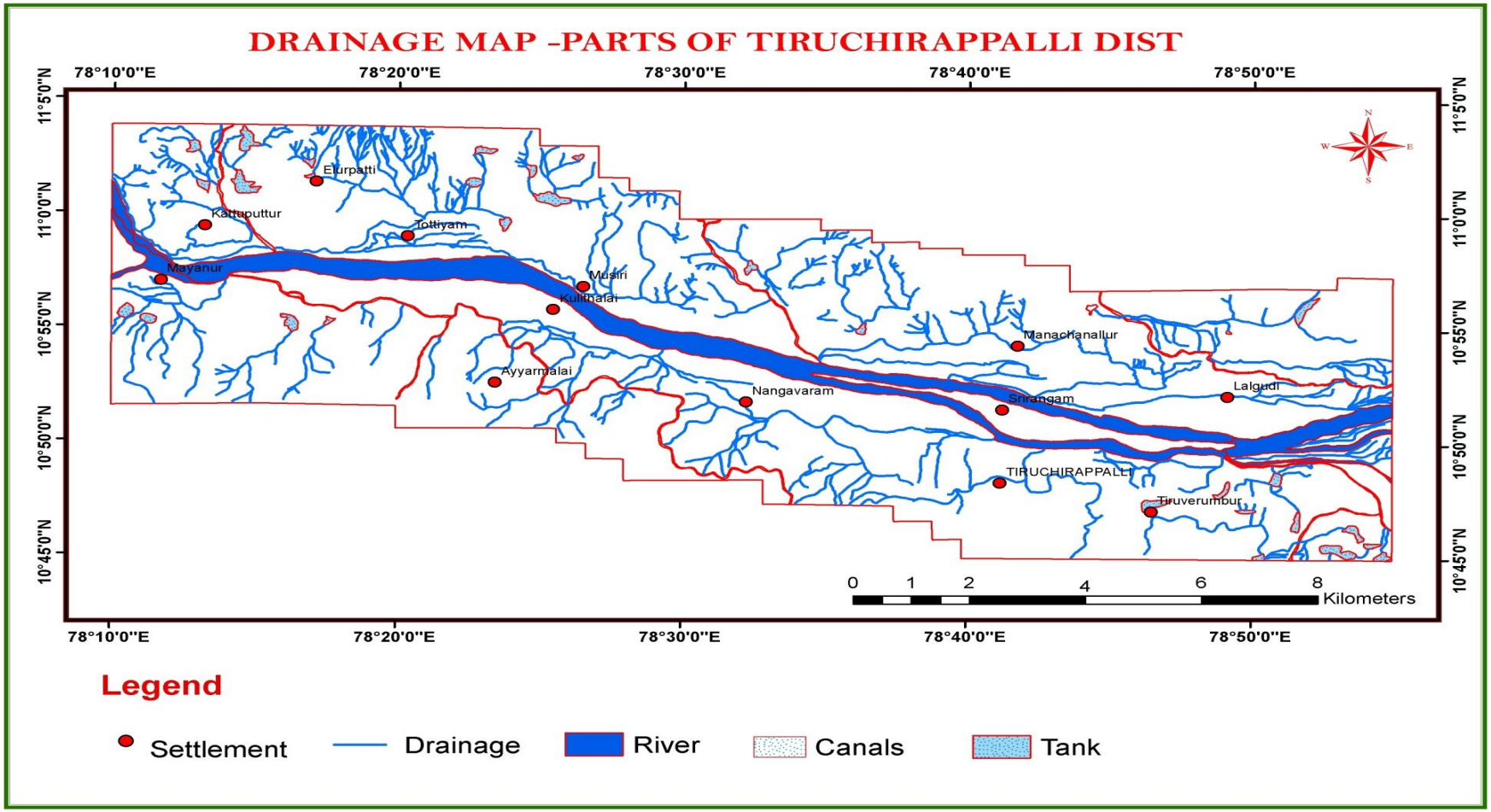

29-Aug-08
NEPAL
Breaching Point
Hanuman Nagar
Flood Inundation
Supaul
Madhepura
Saharsa

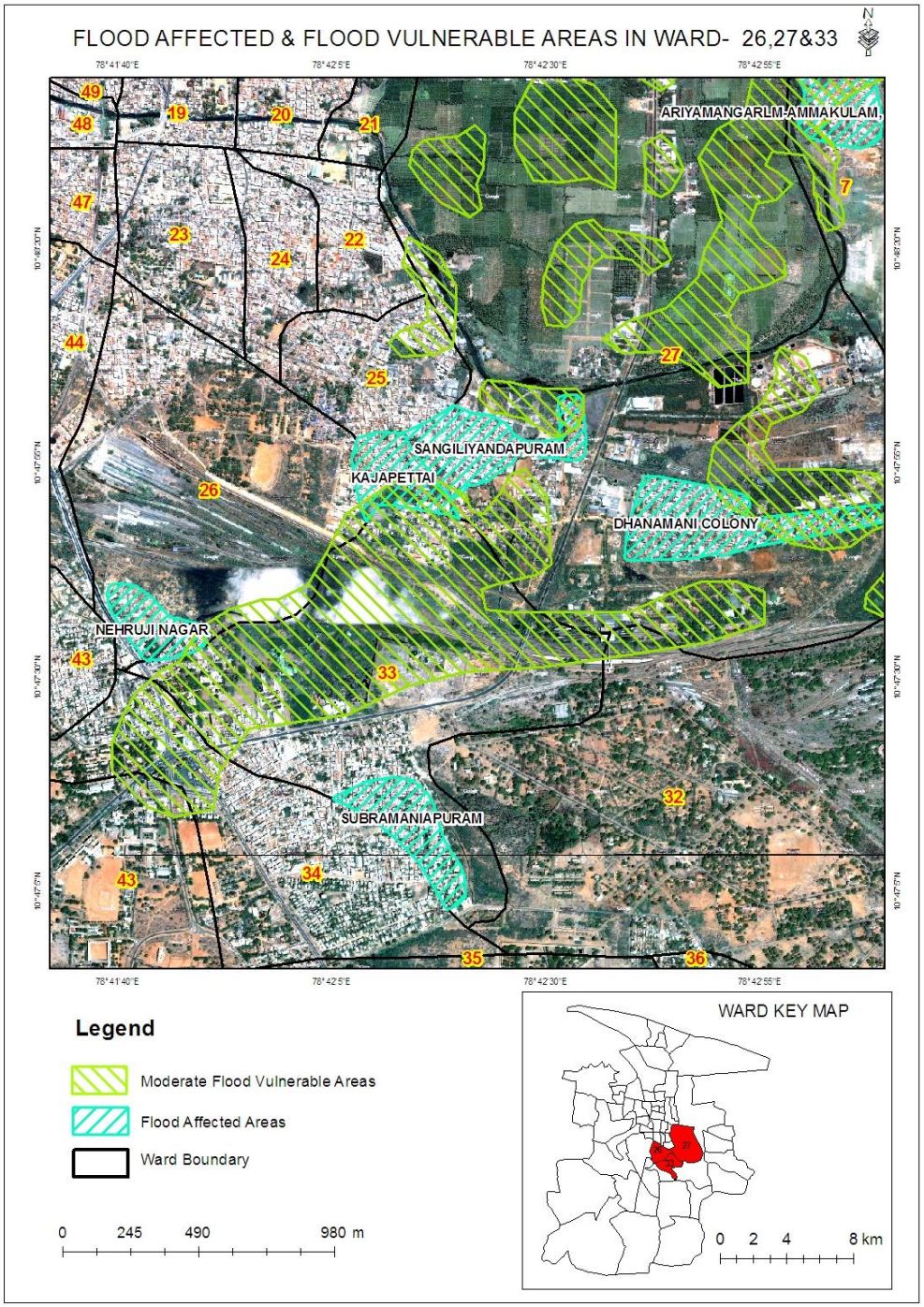
MAPPING OF FLOOD VULNERABLE AREAS (E.g. Tiruchirappalli area) using SHADED RELIEF MAP



Using - SRM (flat and low lying areas), - Quantum of water flow, - Soil properties, soil conditions (Dry-Damp-Wet)



- Drainage map was prepared from the SOI Toposheets (58J/1, 5, 9, 13, 58I/4, 5).
- Here all the possible rivers, streams and tanks prone for flooding were identified.
- Cauvery and Kolidam Rivers and the canals that are prone for flooding are shown.
- Suggested for resurrection (desiltation) of silt choaked supply canals, drainages and tanks.
- Further, to harvest the flood water through palaeochannels to the water starving/deficit areas.



Flood vulnerable areas and affected areas in Wards 26, 27&33, Tiruchirappalli Corporation

TSUNAMI

- Reasons for Tsunami
  - Submarine Earthquake based plate disposition
  - Landslides and massive rockfalls along rocky seacliffs
  - Massive snow avalanches along sea sides
  - Submarine volcanic explosion, etc.
- On time prediction – will help us to forewarn the people along sea shore as the waves take time to reach the shore.
- Natural Geomorphic landforms developed along the coast need to be protected and maintained as such – to minimise the destruction due to tsunami.
- Promoting Mangrove plantation – will mitigate tsunami