

GEOPHYSICAL MAPPING OF AQUIFER SYSTEM FOR GROUNDWATER RECHARGE AND BASE FLOW ENHANCEMENT



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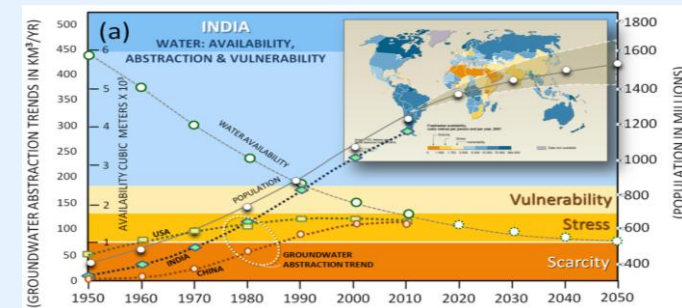
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Major Concern

How watershed development interventions in the catchment and drainage area can improve:

- infiltration, groundwater recharge,
- soil moisture, base flow and
- ultimately the duration and quantity of flow in identified rivers/streams.



Chandra et al., 2016, The Leading Edge

Rejuvenation of Rivers/Streams through Watershed Development Approach

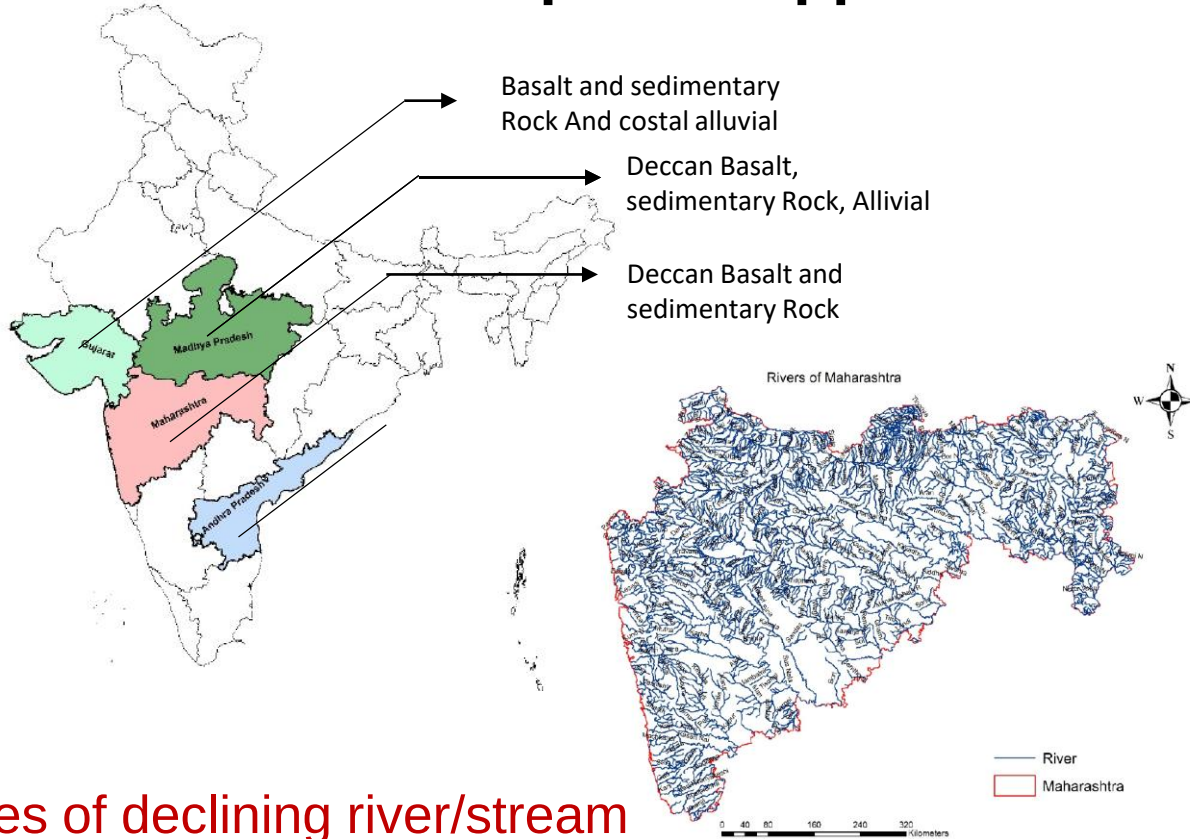


Figure 4: River network of Maharashtra

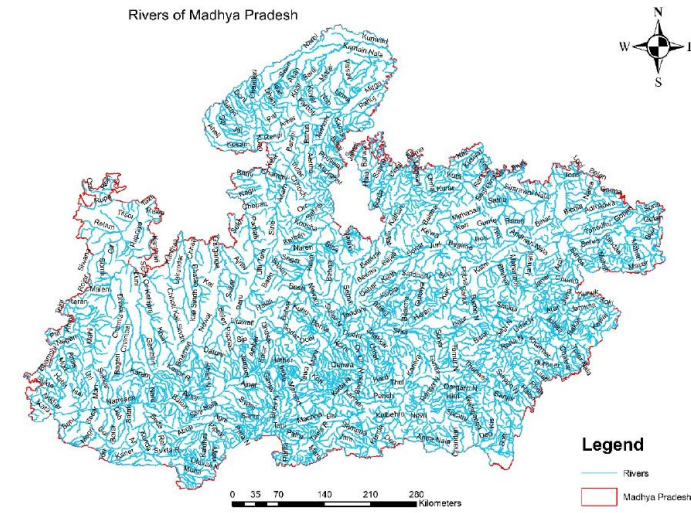
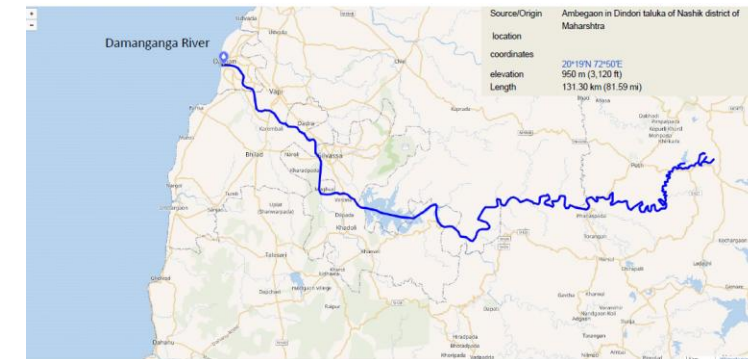


Figure 6: River Network of Madhya Pradesh



Main Objective

Address the root causes of declining river/stream flows by treating the catchment through watershed interventions.

Approach to be followed:

Geophysical Site Characterization followed by site specific MAR structure → lead to an effective recharge enhancing the baseflow

MAJOR GROUNDWATER MANAGEMENT PROGRAMS

Community-Led and Participatory Management

- Jal Shakti Abhiyan: Catch the Rain (JSA: CTR),
 - rainwater harvesting,
 - roof-water collection, and
 - the revival of local traditional water bodies
- Jal Sanchay Jan Bhagidari (JSJB),
 - people's participation to construct low-cost, local artificial recharge structures and borewell recharge shafts
- Atal Bhujal Yojana (Atal Jal), and Mission Amrit Sarovar
- Mission Amrit Sarovar- rejuvenate at least **75 water bodies (ponds)** in every district
- Master Plan for Artificial Recharge to Groundwater
 - MAR structure, check dams, and percolation tanks, linked with MGNREGS
- Pradhan Mantri Krishi Sinchayee Yojana (PMKSY - Per Drop More Crop):

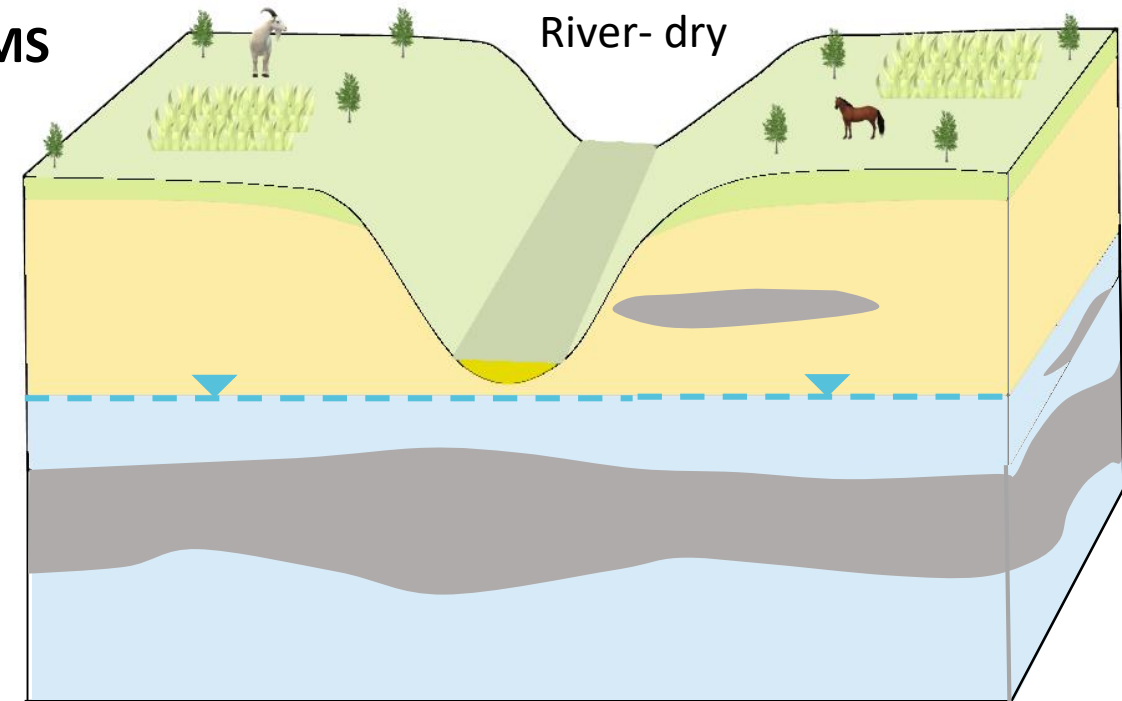
1. Irrespective of major programs on groundwater management, groundwater levels continue to fall

2. Groundwater Recharge is the only solution

3. Groundwater management implementation

➤ Number-based

➤ Often without adequate understanding of subsurface characteristics

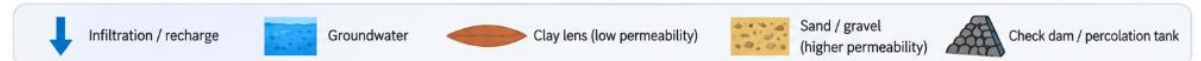
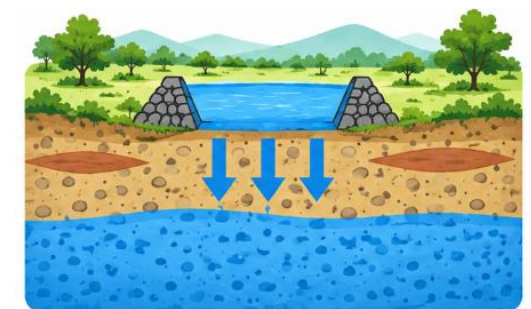


Over-exploited condition

Favourable site? –by Geophysical characterization

Higher No. of the recharge structure $\neq$ Higher the amount of recharge

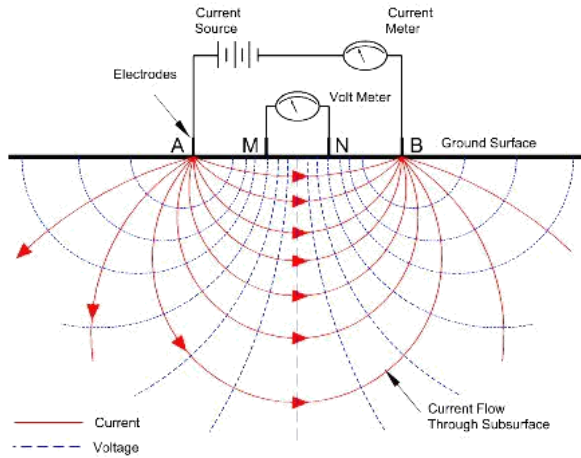
Recharge structure at favourable site leads to effective recharge



EVOLUTION OF GEOPHYSICAL METHODOLOGIES

Output: Resistivity with depth

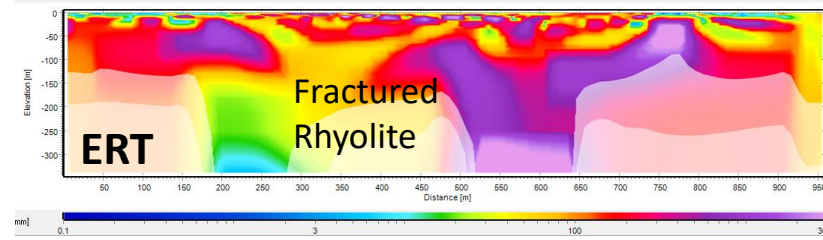
Limitation: lateral heterogeneity



Vertical Electrical Sounding (VES), Profiling

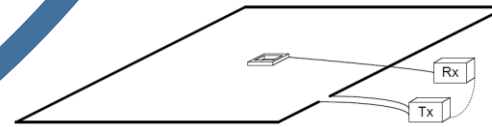
- Electrical Resistivity Tomography (ERT),
- AEM-Frequency Domain
- VES

1990's-2000's



- Multi-channel ERT
- Ground TEM
- AEM-FD

2000's-2010's

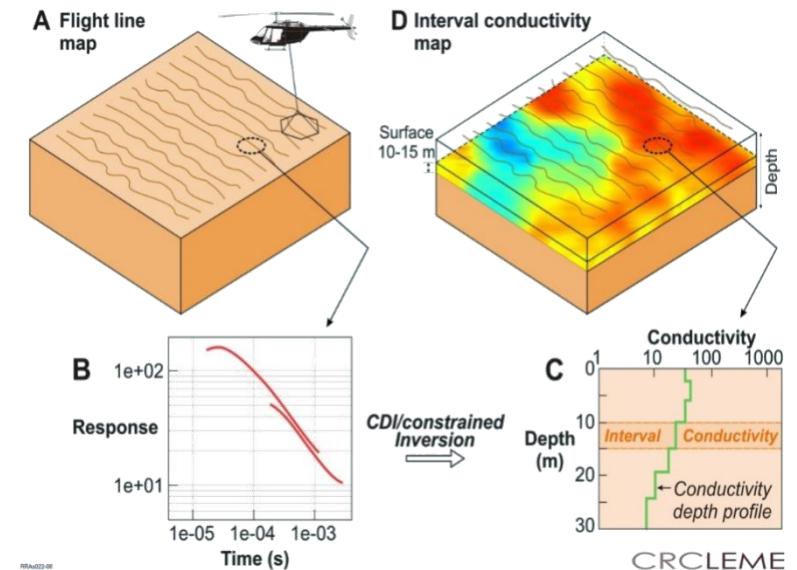


2010's-2020's

- Heliborne TEM
- Ground TEM
- Multi-channel ERT

2020's- --

- Heliborne/Drone TEM
- Towed TEM
- EVRI / ERT
- Ground TEM



1960-1990

Present State-of-the-Art Technologies

Heliborne TEM



Ground based towed TEM (tTEM) system

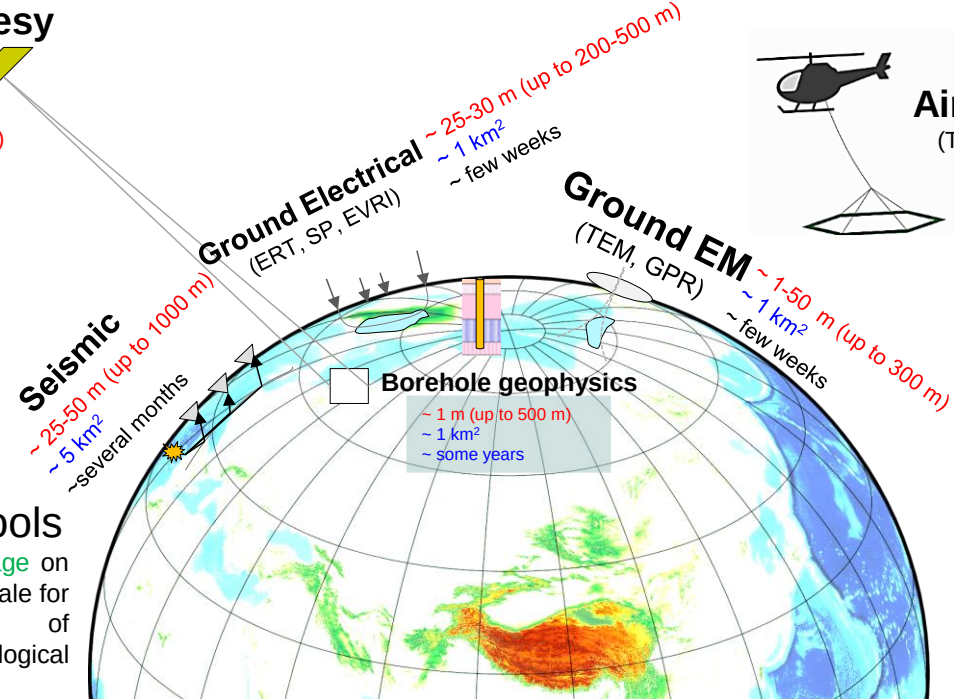


Satellite geodesy (GRACE)

~ 1 km or more (surface)
> 10⁵ km² or more
~ few weeks

Geophysical Tools

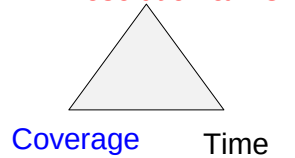
gives the subsurface image on a regional and, or local scale for exploratory purposes of aquifers in different geological set-ups



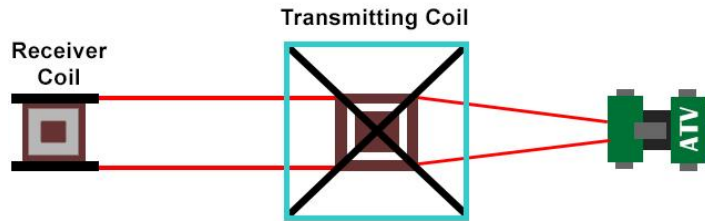
Airborne surveys (TEM, FDEM, Magnetics)

~ 30-50 m (up to 500 m)
> 10⁴ km² or more
~ few months

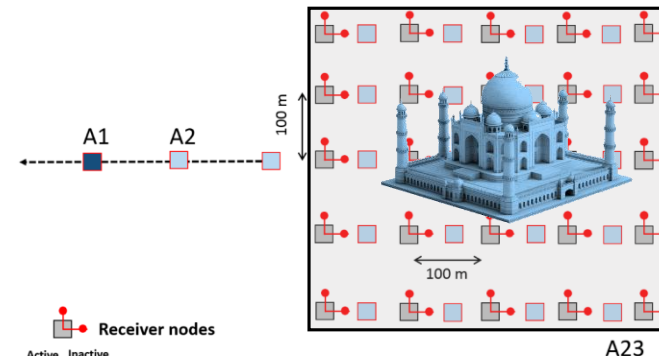
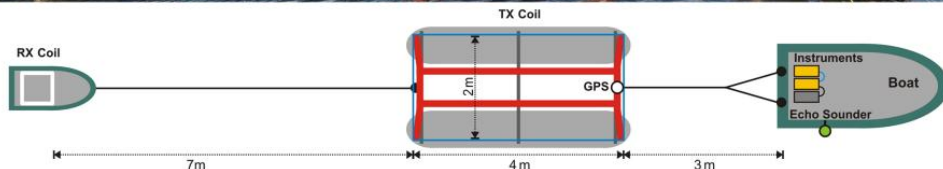
Resolution & DOI



Ground based towed TEM (tTEM) system



Waterborne Flow TEM (fTEM)



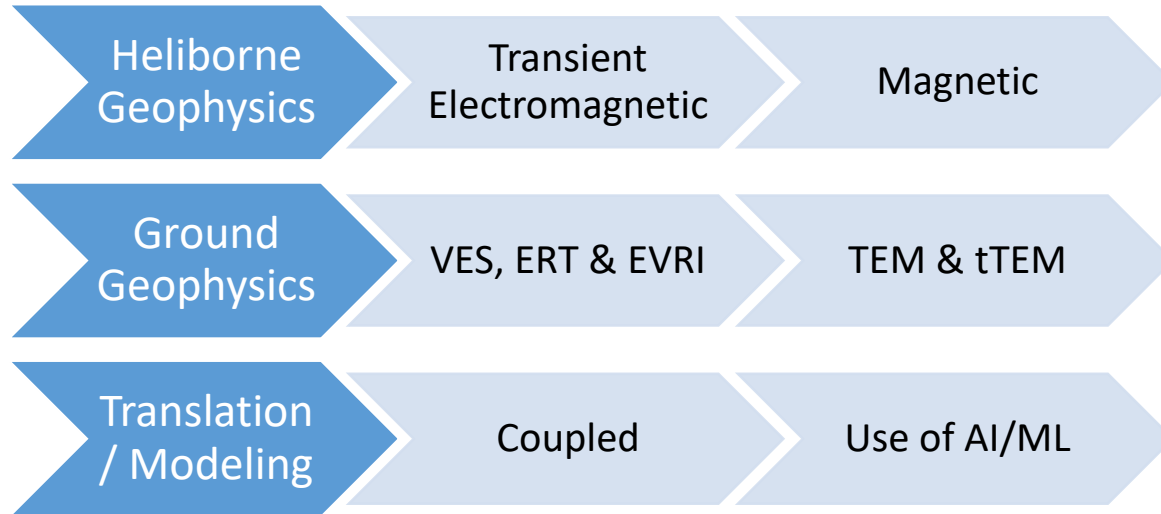
Proposed Layout

B2 B1

EVRI- 3D Resistivity

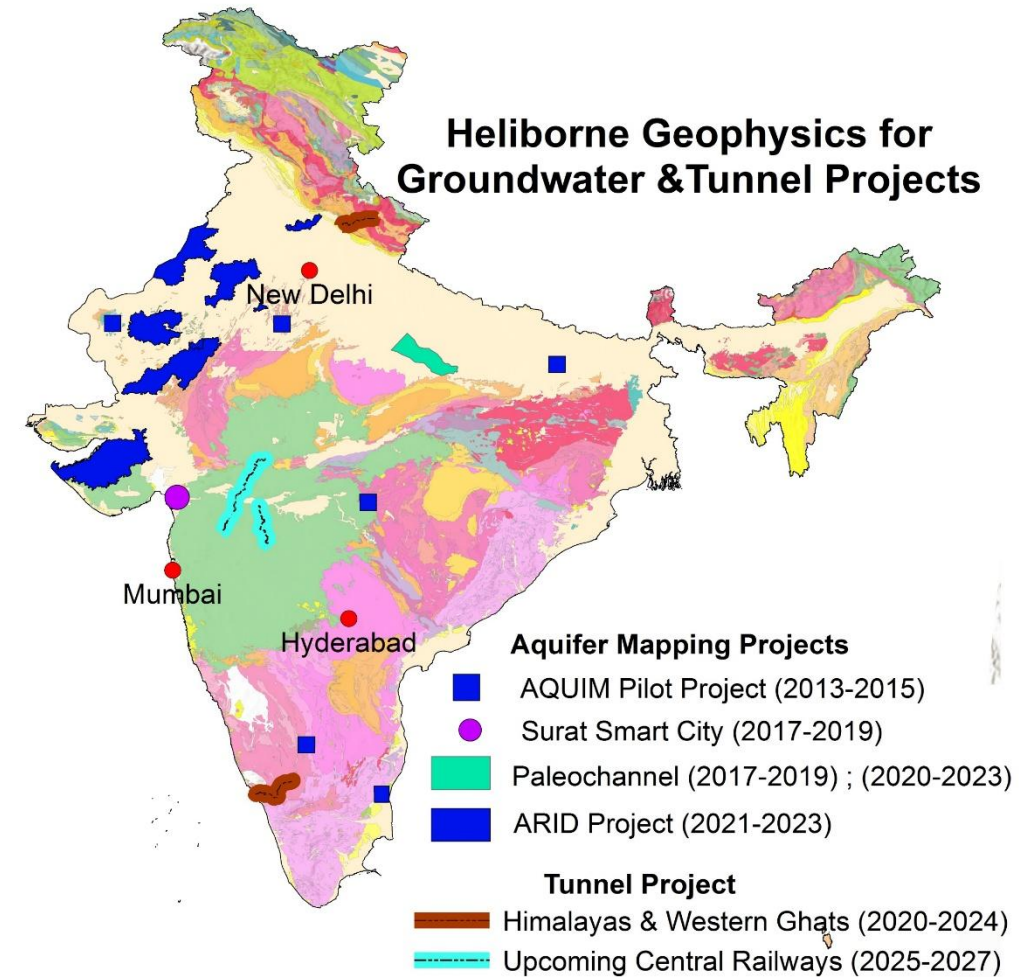
INTEGRATED GEOSCIENTIFIC SOLUTIONS

Integrated hydrogeophysical, hydrogeological, and hydrochemical studies.



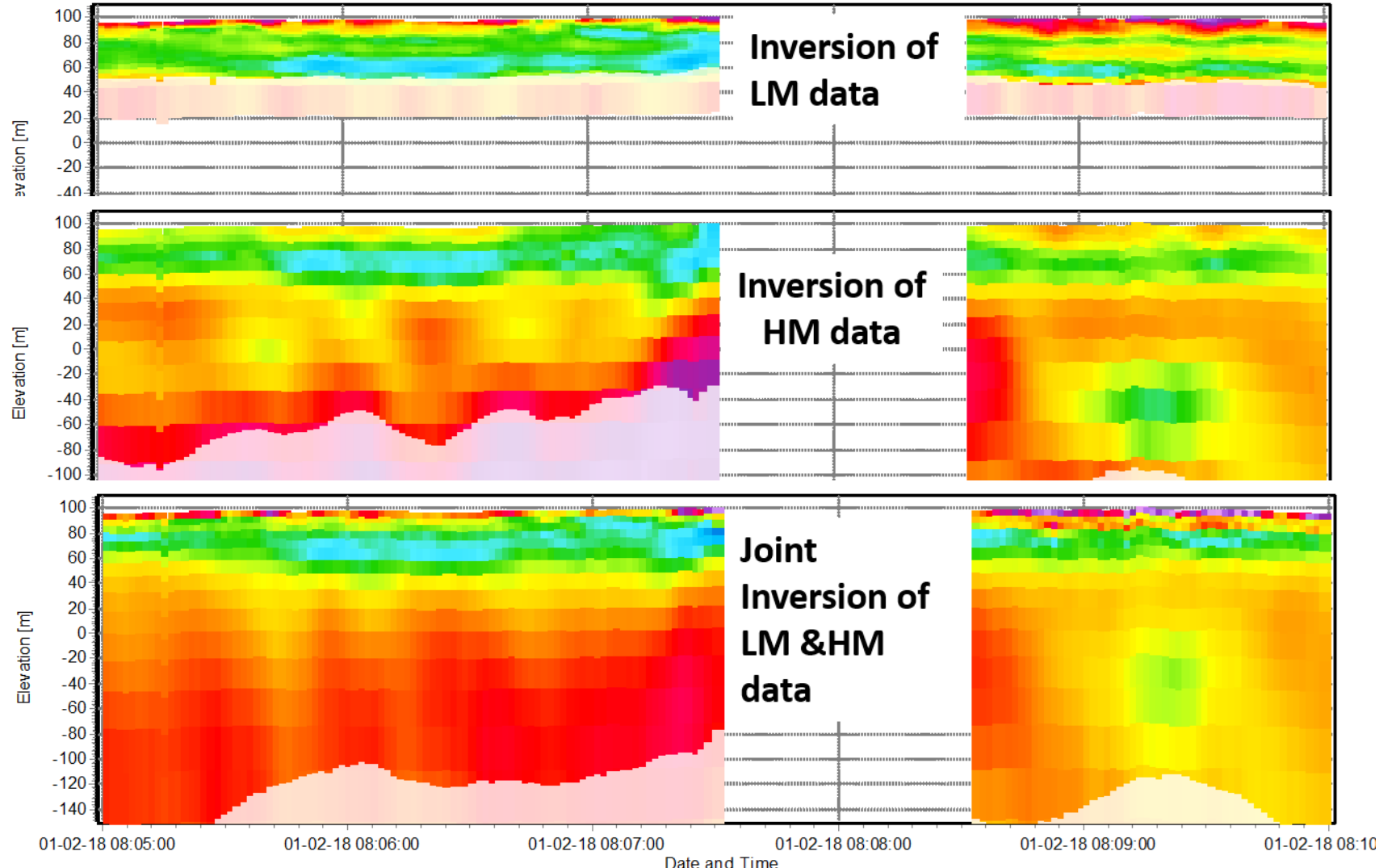
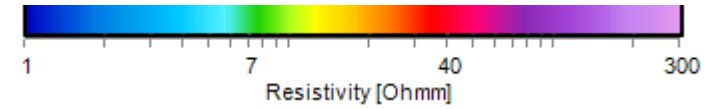
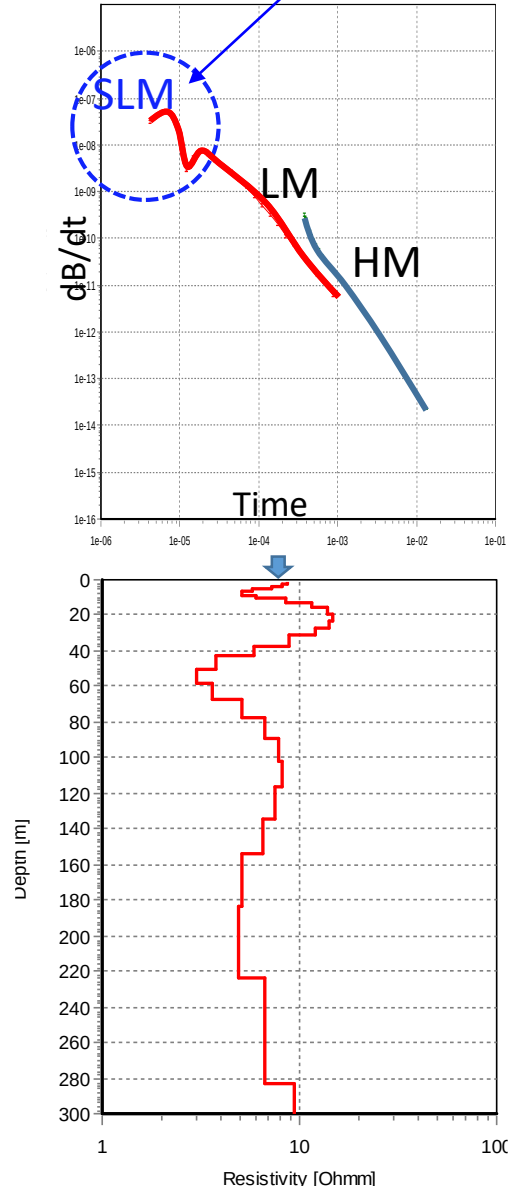
Aquifer mapping- exceptional results

1. Alluvial - multi-layered settings
2. Coastal alluvial / Basalt- saline and fresh zone
3. Deccan Basalt- Nagpur, MP
4. Granitic Hard Rock- Karnataka

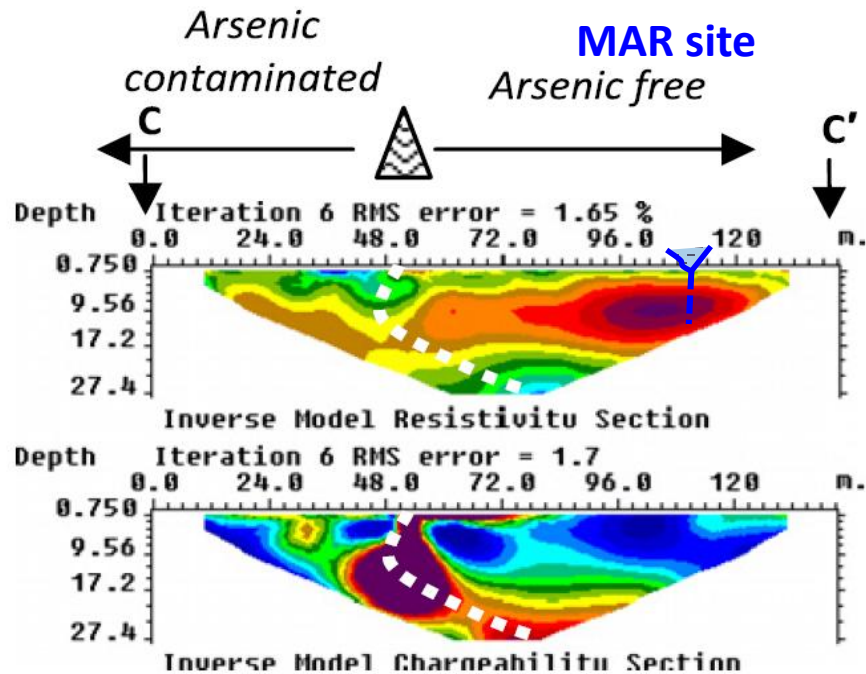
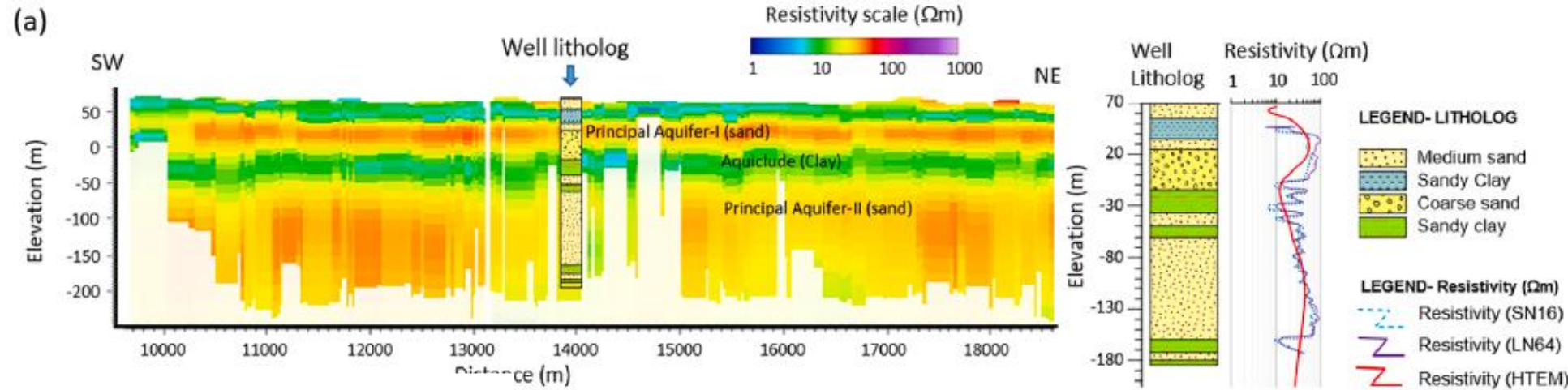
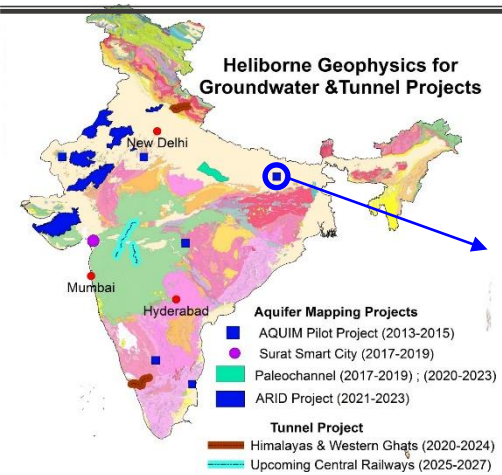


The signal - SkyTEM

SLM provides very shallow subsurface info starting from 1-2 m downward

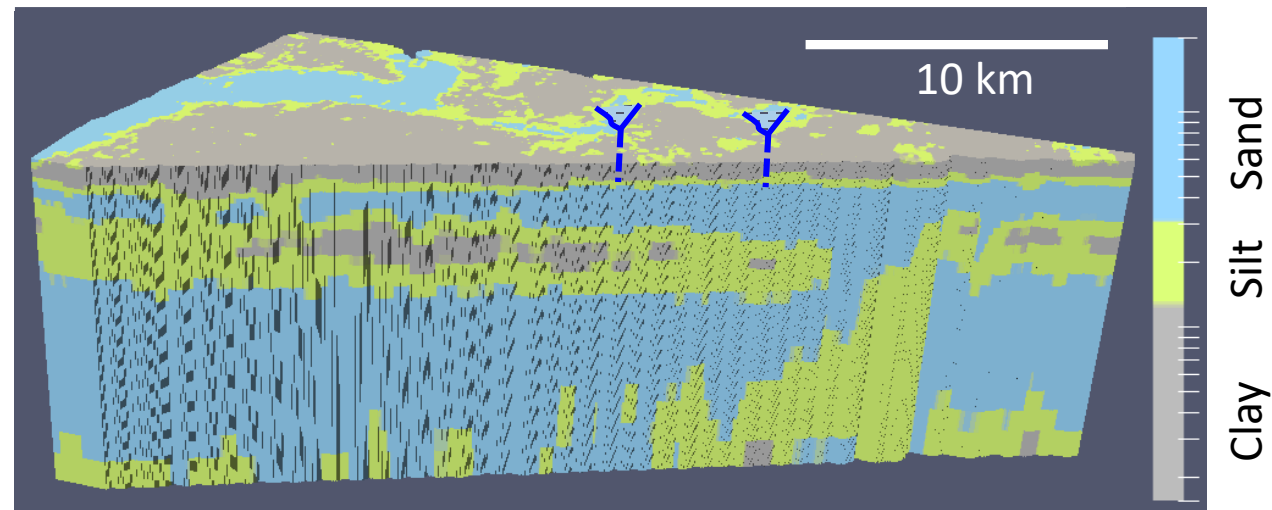


Multichannel aquifer, Arsenic affected



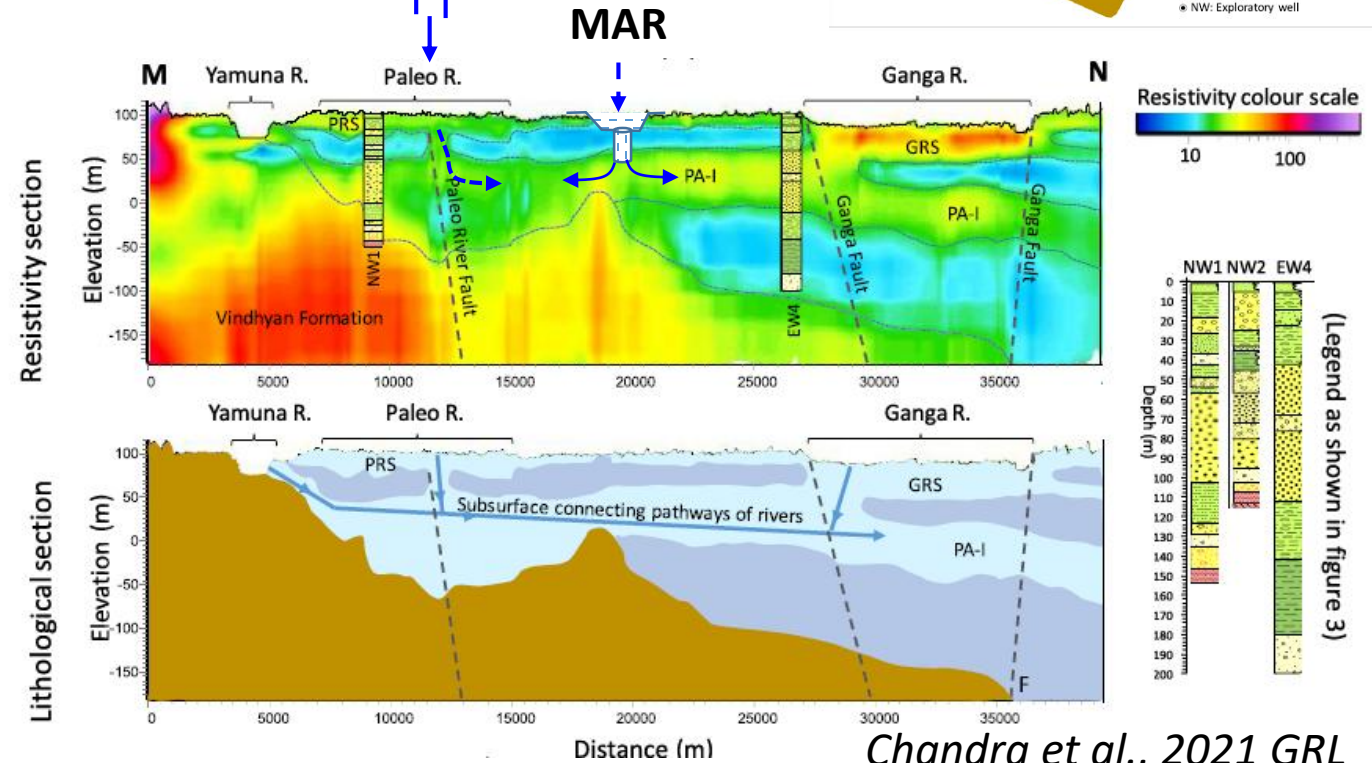
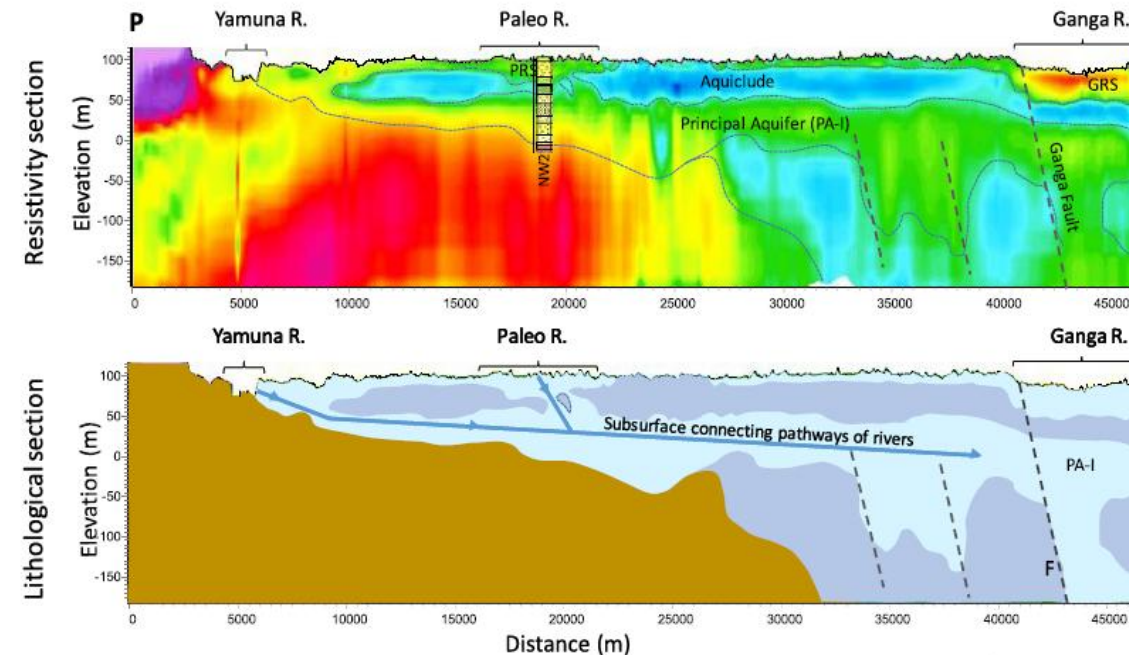
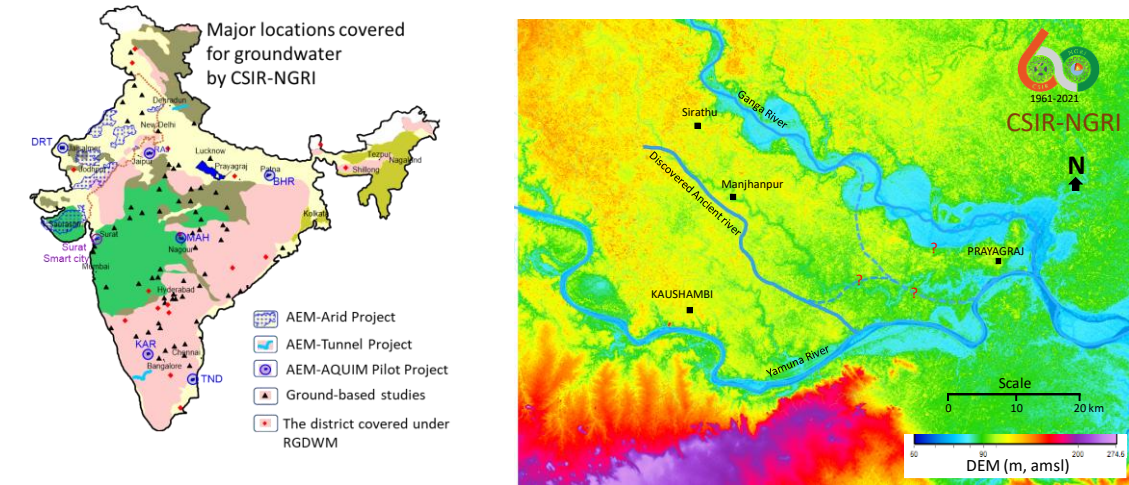
Ganga Alluvium, Bihar

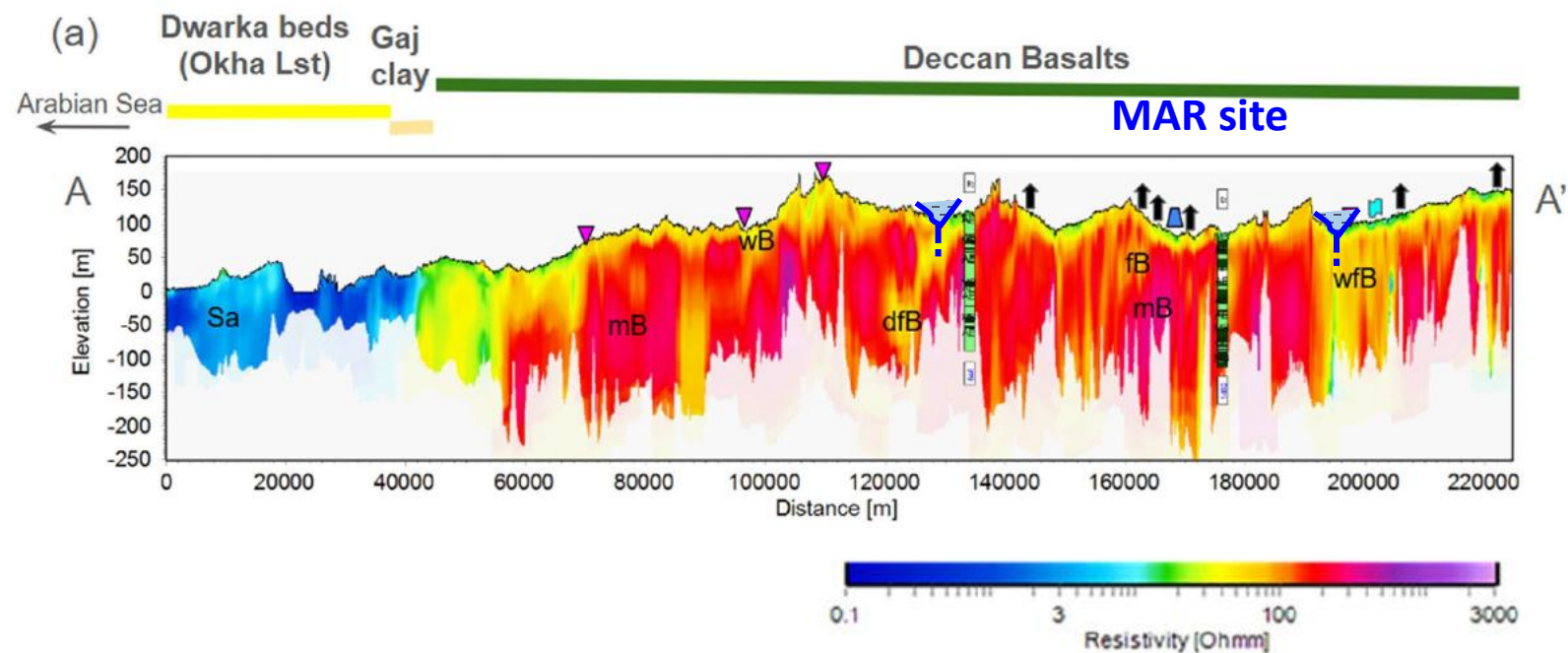
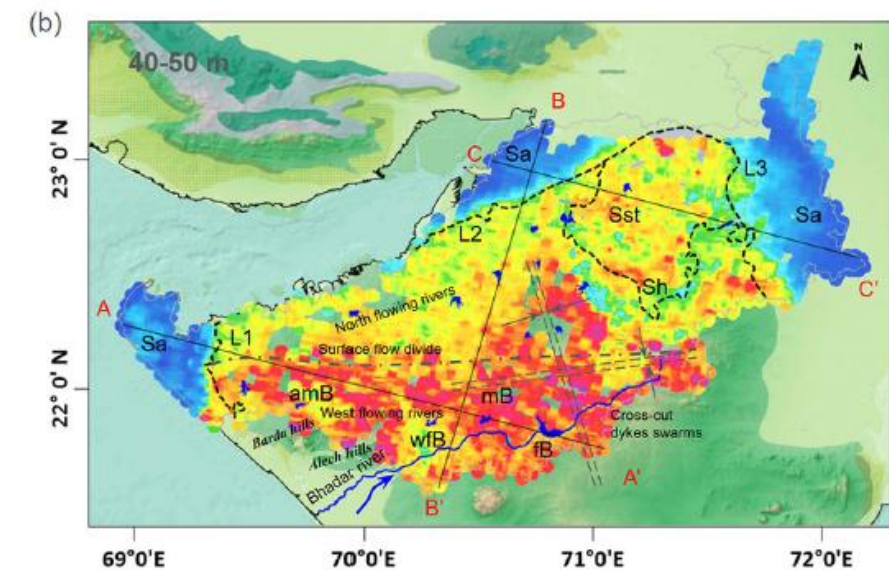
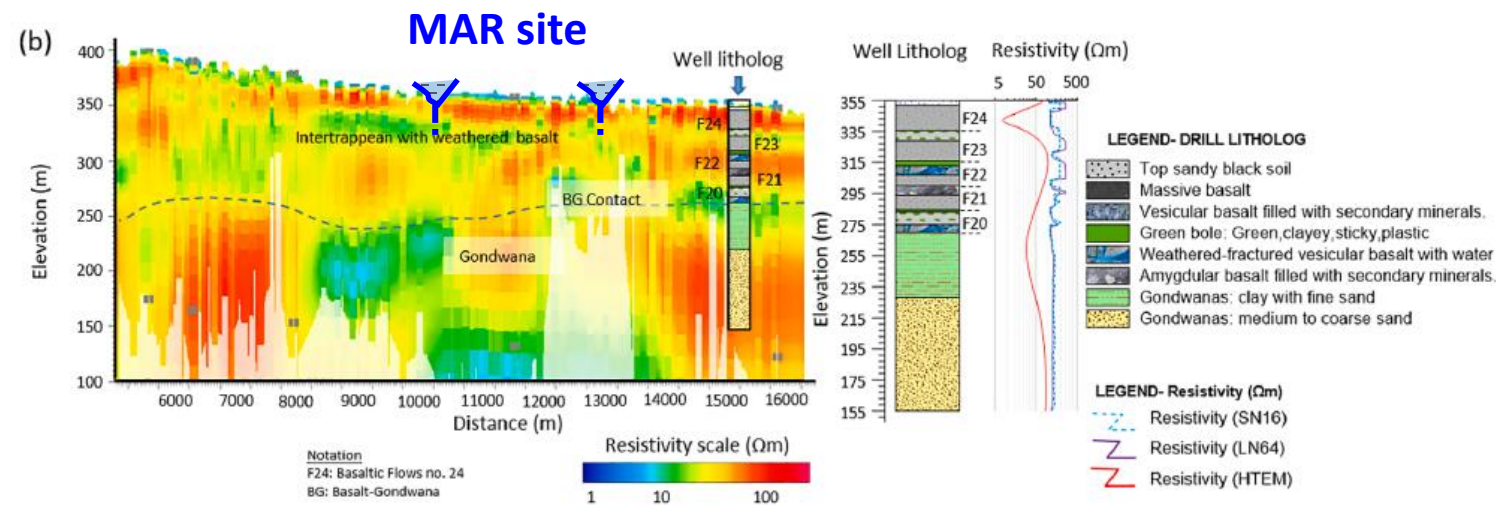
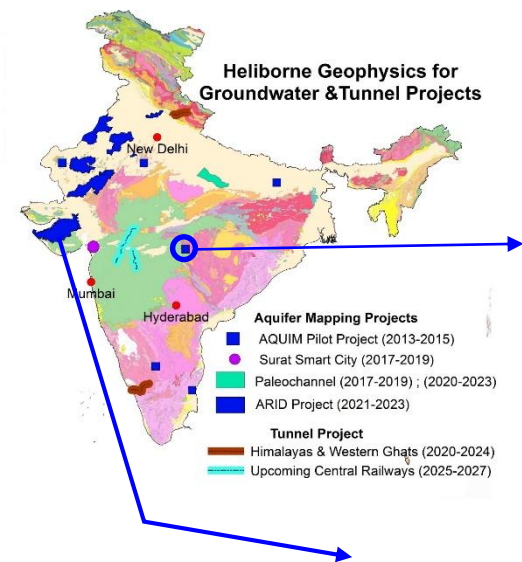
MAR site



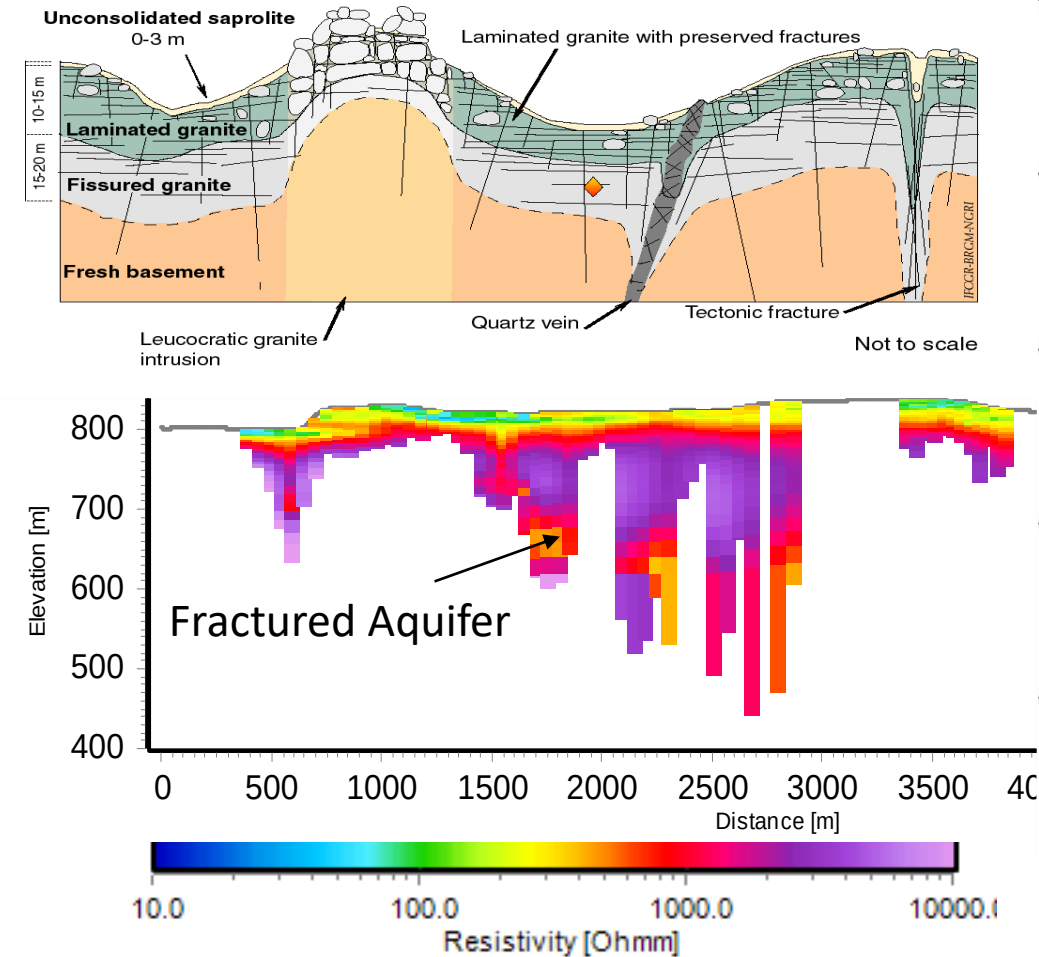
Multichannel aquifer, Paleochannel and MAR sites

Rejuvenation through Managed aquifer recharge (MAR)

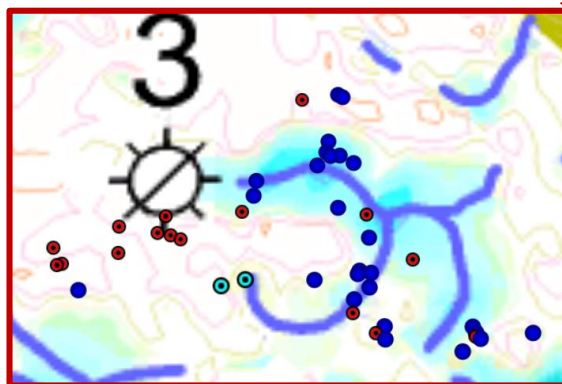
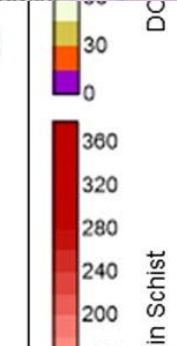
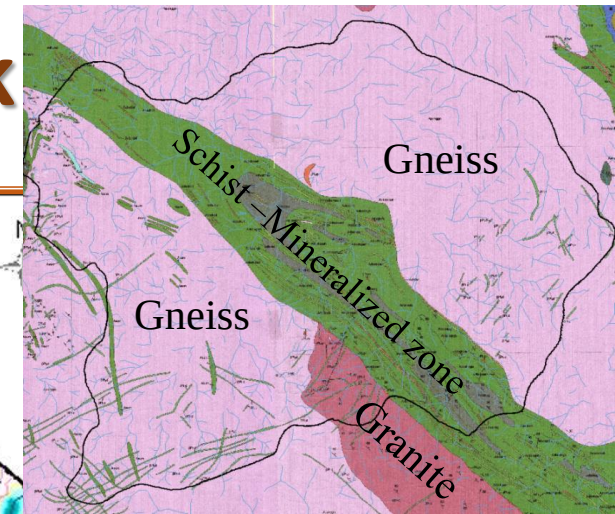
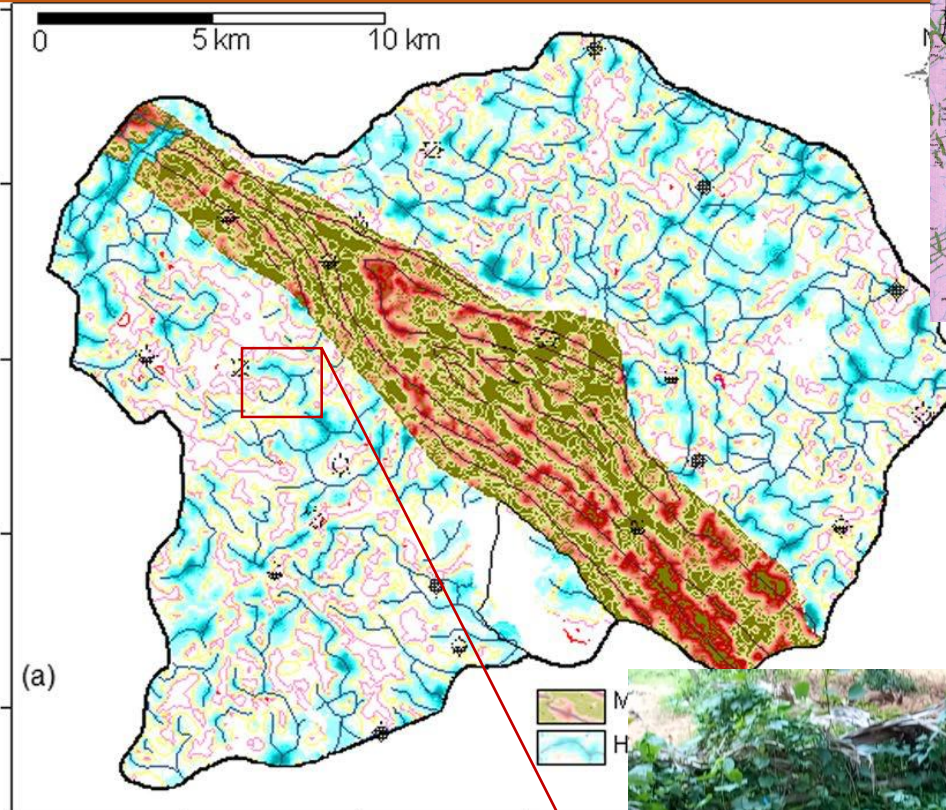




Crystalline Rock- Bedrock Fracture Network



Deep weathered-fractured zone become conductive target for EM measurement and hence sporadically distributed fractures become good target



Summary

Non-invasive geophysics offers variety of tools for subsurface characterization at varying scales and speed.

Integrated AEM survey Established that surface (rivers and paleochannel) and subsurface (aquifer system and buried paleochannel) are hydrogeologically connected at places making them an unified system

Address the root causes of declining river/stream flows requires geophysical intervention to Rejuvenation of Rivers / Streams by Watershed Development Approach (RRWDA) i.e. Geophysical Site Characterization followed by site specific MAR structure → lead to an effective recharge enhancing the baseflow

Thank
You

