Mapping groundwater resources in India – a pilot project covering six areas and more than 3000 km^2 of land

CSIR-NGRI, Aarhus University, CGWB

Parties

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Aarhus University, Denmark

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GEUS, Denmark

- Giulio Vignoli

SkyTEM Surveys, Denmark

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HydroGeophysics Group
AARHUS UNIVERSITY

CGWB

Vision for Aquifer Management – AQUIM

- **Identify and map aquifers on the micro level: 100 .. 1000 km^2**
- **Identify groundwater resources**
- **Propose management plans appropriate to the scale of demand**

Establishing a Methodology

- **Pilot study of 6 areas in different hydrogeological terrains**

- **Integration of multiple disciplines and scientific approaches**
  - Hydrogeology
  - Geophysics
  - Hydrochemistry
  - Drilling
  - Groundwater modeling
  - Management approaches

- **Pave the way for the National Aquifer Mapping program NAQUIM**

Formal Organization of AQUIM

World Bank

Ministry of Water Resources, Central Groundwater Board

- Overall project management
- Hydrological modeling and collection of hydrological data
- Drilling of boreholes

National Geophysical Research Institute (NGRI)

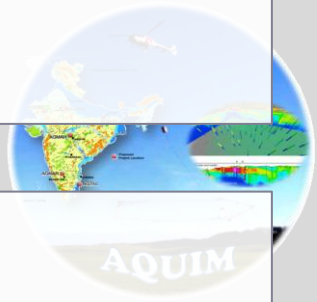
- Planning of all airborne and groundbased surveys
- Data processing, interpretation and reporting

Aarhus University – collaboration agreement with NGRI

- Capacity building in airborne and groundbased geophysics
- Airborne geophysics

SkyTEM Surveys – subcontractor for Aarhus University

- Logistics and airborne geophysics using SkyTEM technology



Presentation Layout

- **The water problem in a nut shell**
- **Airborne electromagnetic data**
- **Status**
- **Conclusion**

Groundwater Crisis - Aquifer Management

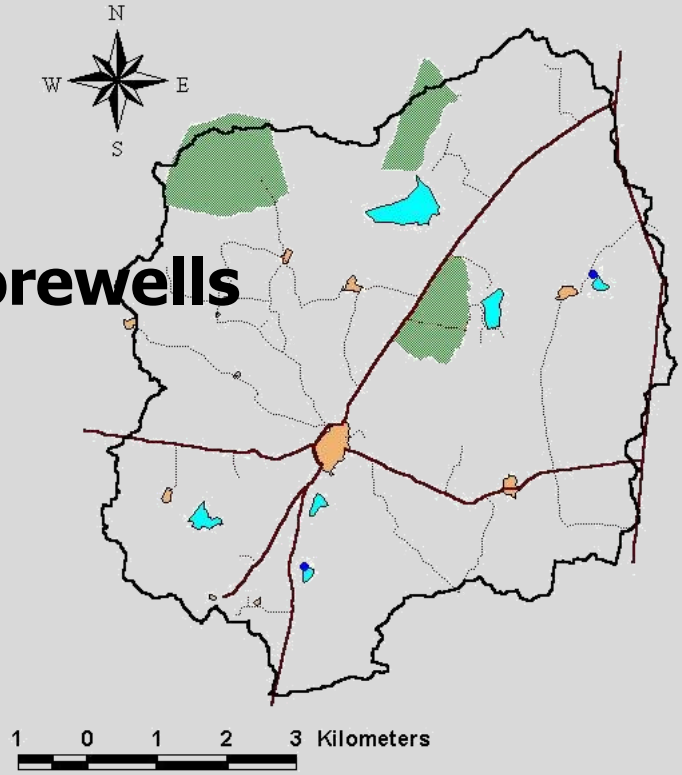
- **Major groundwater crisis in India**

- **The problem is a non-optimal management of the groundwater resources**
  - Over exploitation – in e.g. Dausa the recharge is 100 mm/year but the usage is 170 mm/year
  - Water quality problem – agriculture, industry and natural sources

- **Aquifer mapping is the key for an effective management plan**

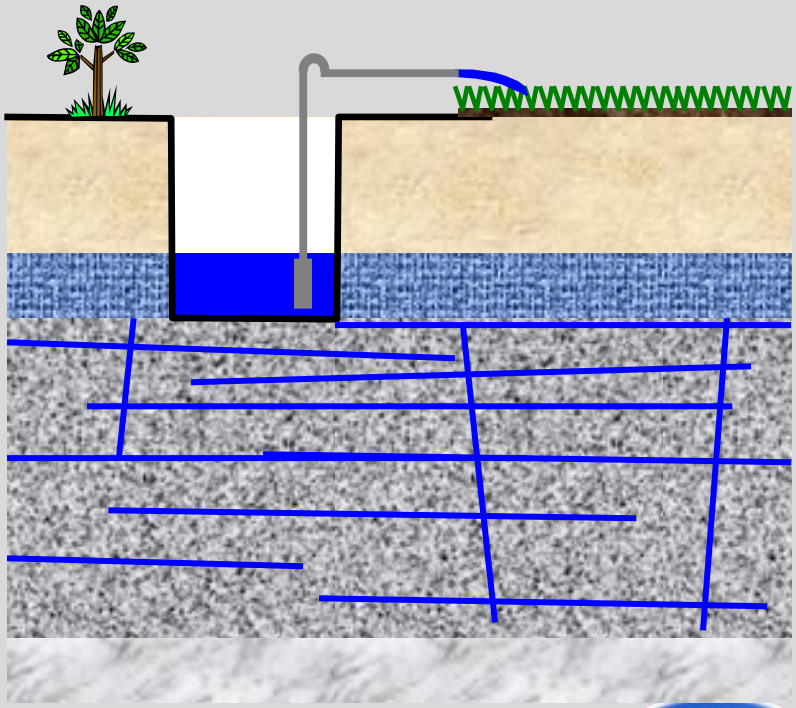
Groundwater Depletion Trend – 1980's

Boreholes



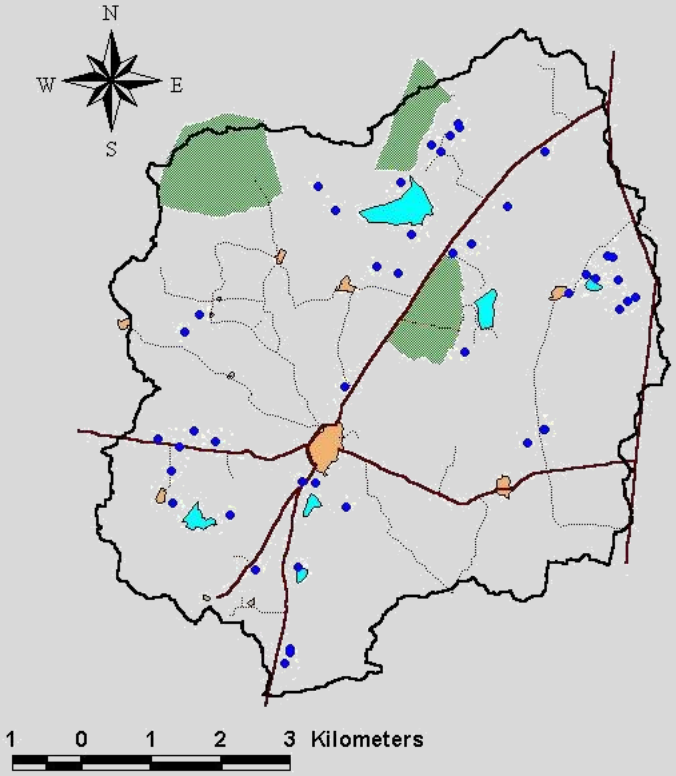
2 borewells

Groundwater level

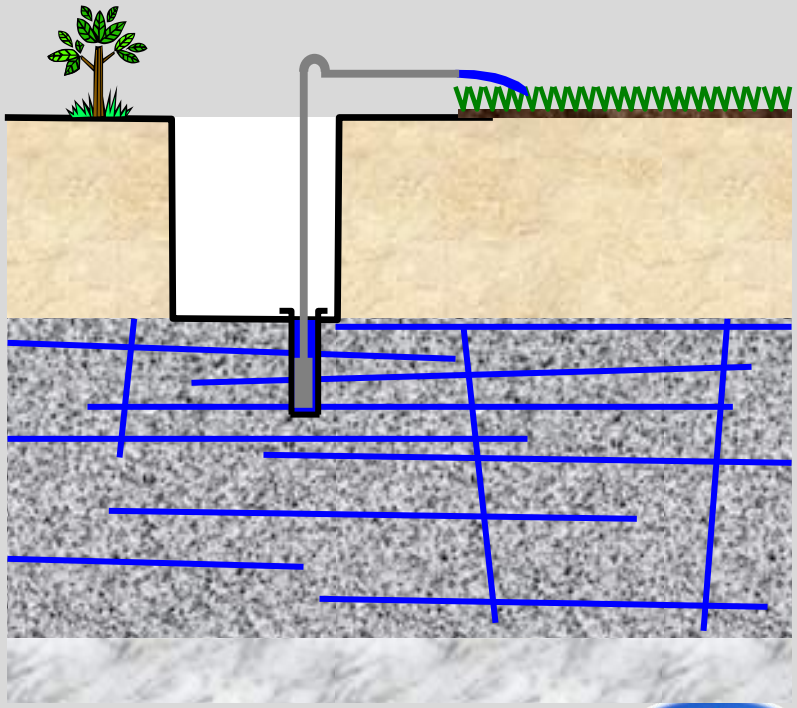


Groundwater Depletion Trend – 1990's

Boreholes

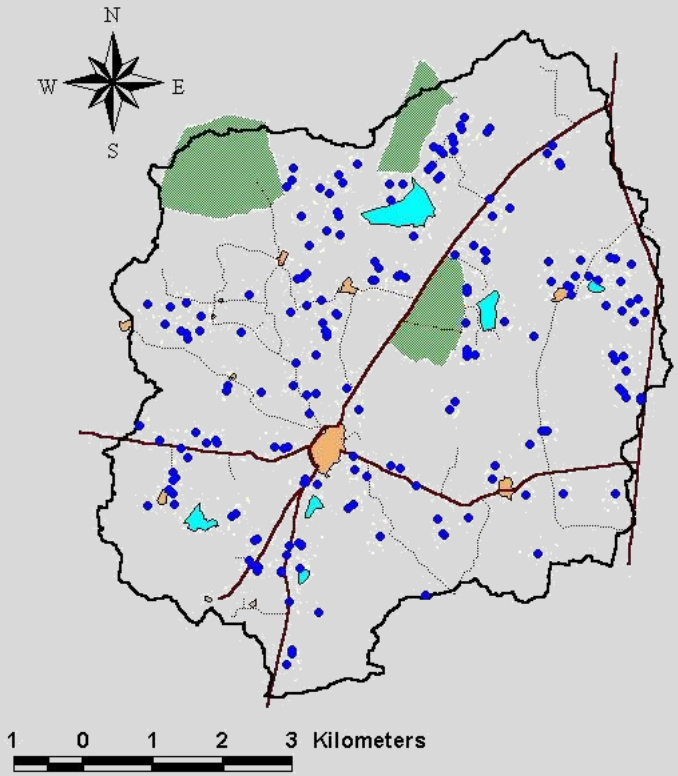


Groundwater level

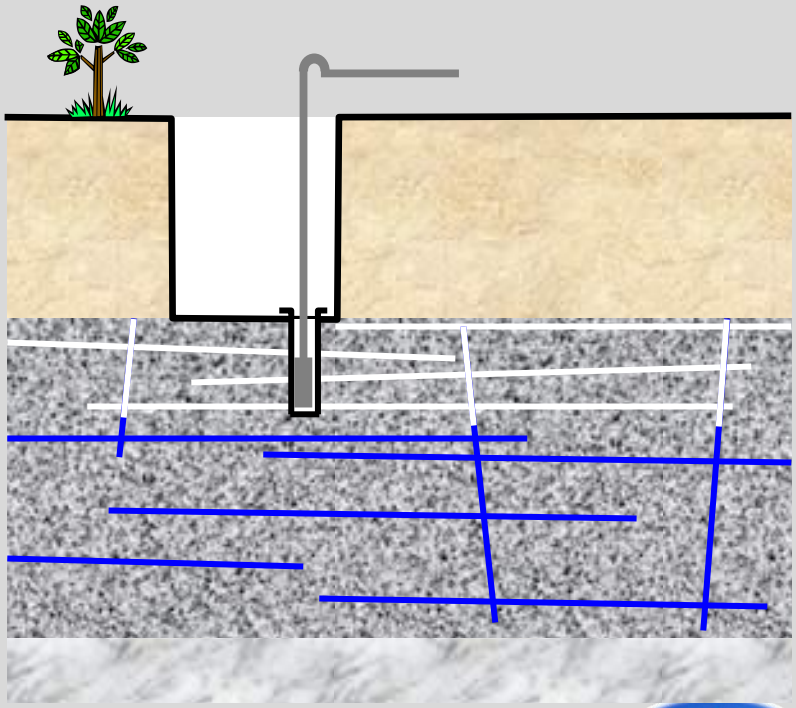


Groundwater Depletion Trend – 1995

Boreholes

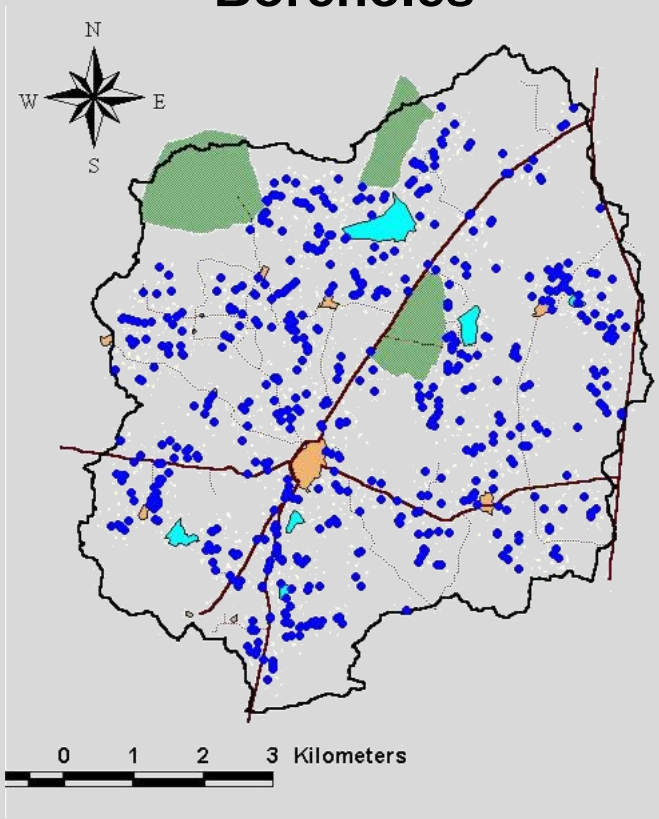


Groundwater level

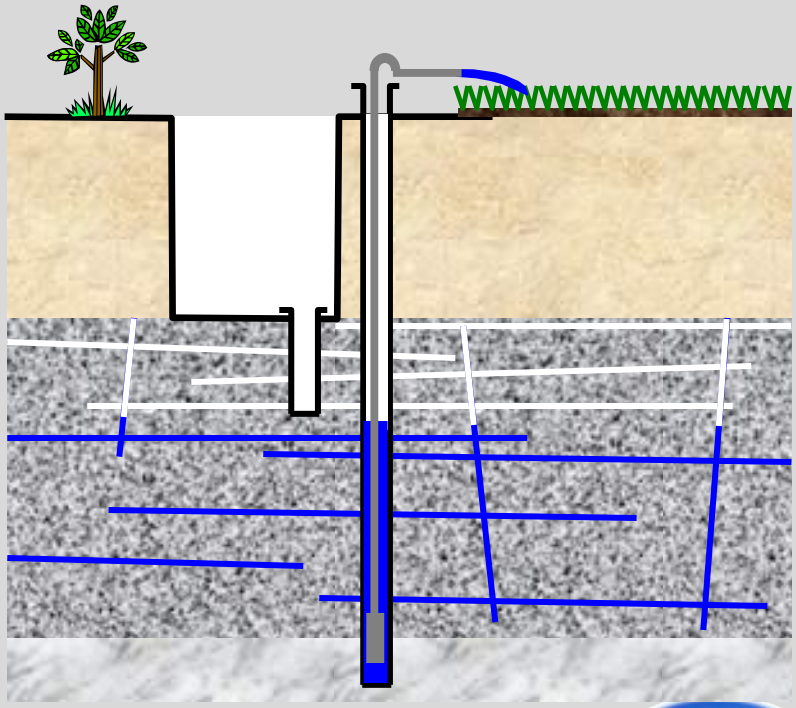


Groundwater Depletion Trend – 2000

Boreholes

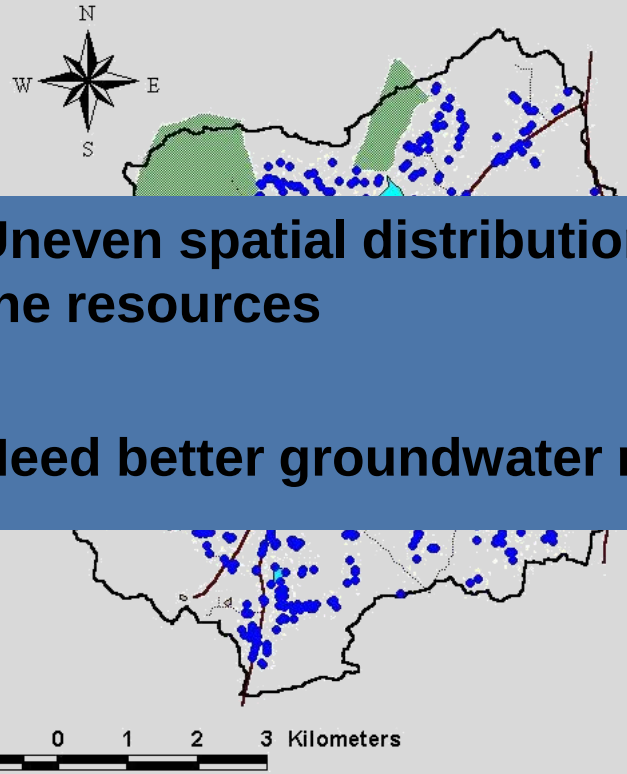


Groundwater level

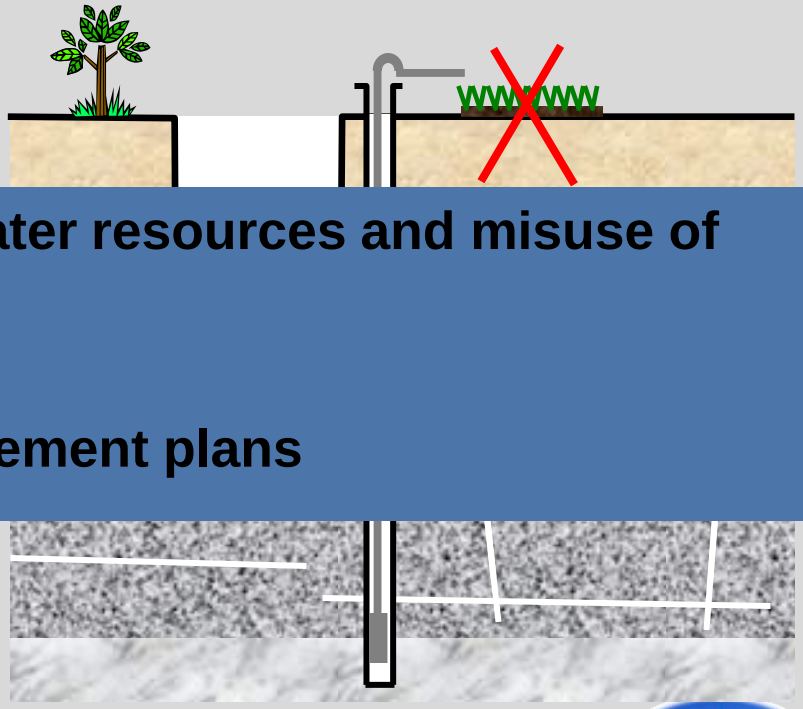


Groundwater Depletion Trend – 2010

Boreholes



Groundwater level



- **Uneven spatial distribution of water resources and misuse of the resources**
- **Need better groundwater management plans**

935 bore wells:
-707 in use
-228 not used

Survey Areas

Desert underlined by Limestone at Jaisalmer, Rajasthan

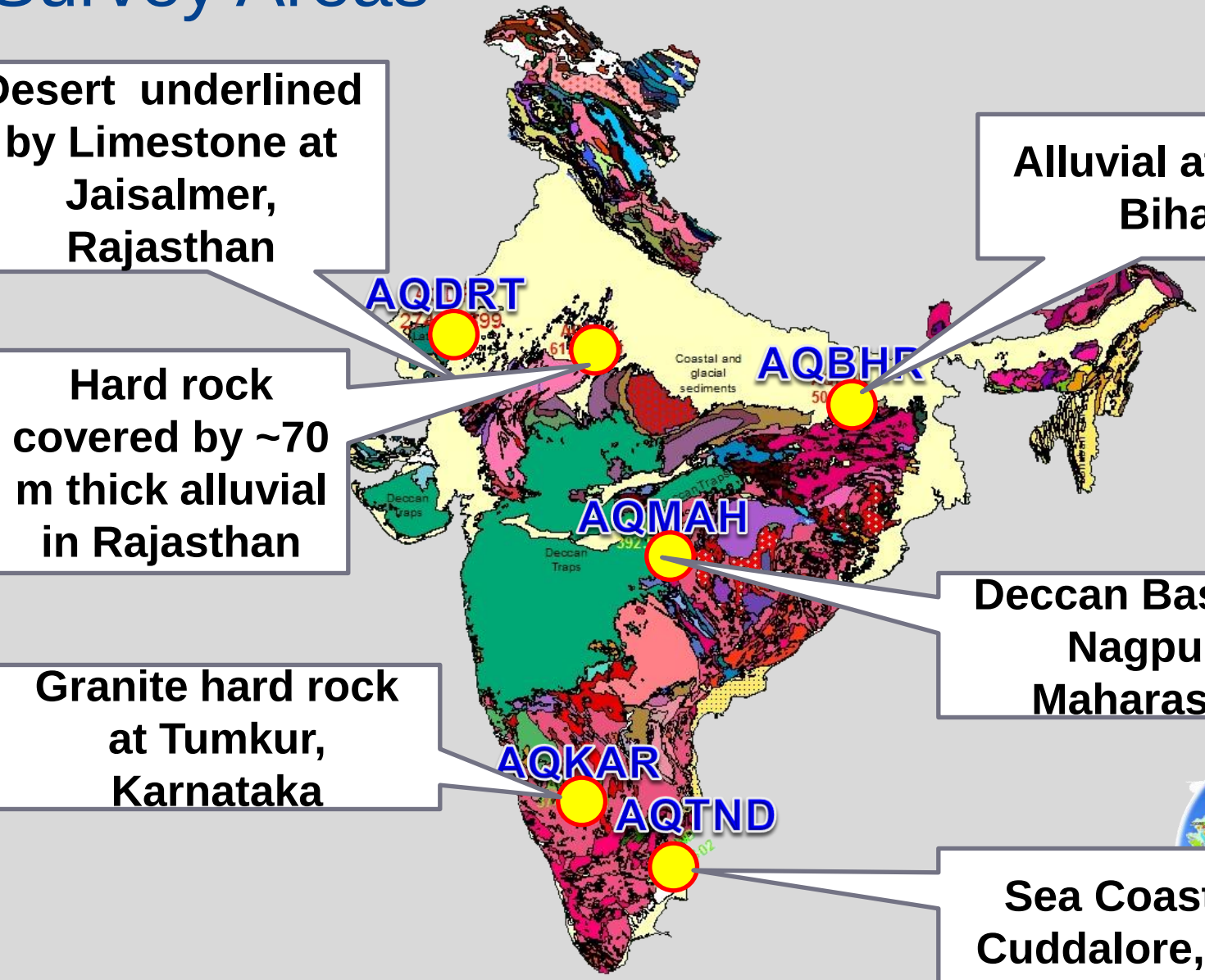
Alluvial at MGP, Bihar

Hard rock covered by ~70 m thick alluvial in Rajasthan

Deccan Basalt at Nagpur, Maharastra

Granite hard rock at Tumkur, Karnataka

Sea Coast at Cuddalore, T.N.



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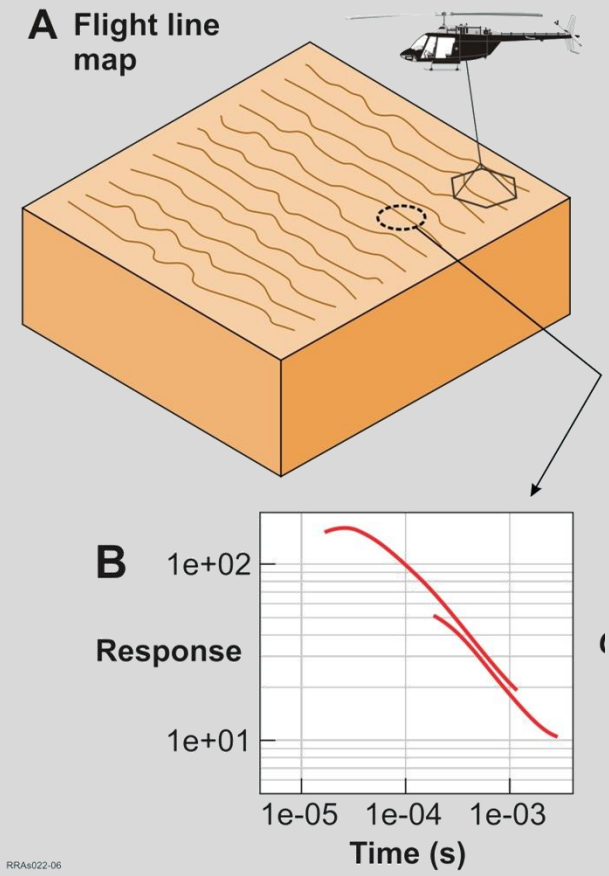
A Geophysical Paradigm Shift in India

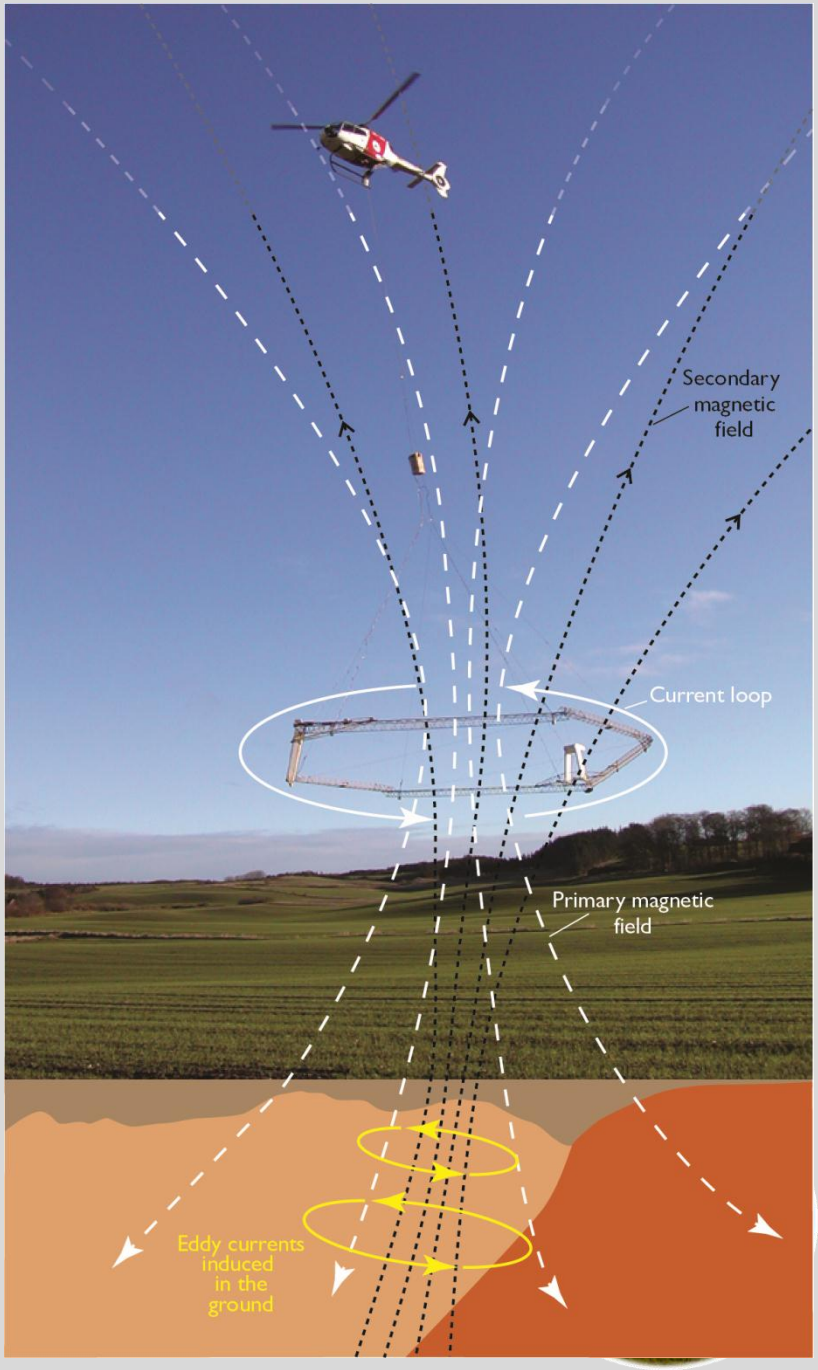
- **The best and most reliable method for aquifer mapping was Schlumberger soundings (VES) – the method of the 1970's!**

- **Long discussions with CGWB on replacing VES with**
  - **Electrical Resistivity Imaging – 2D profiles**
  - **Transient electromagnetic soundings**

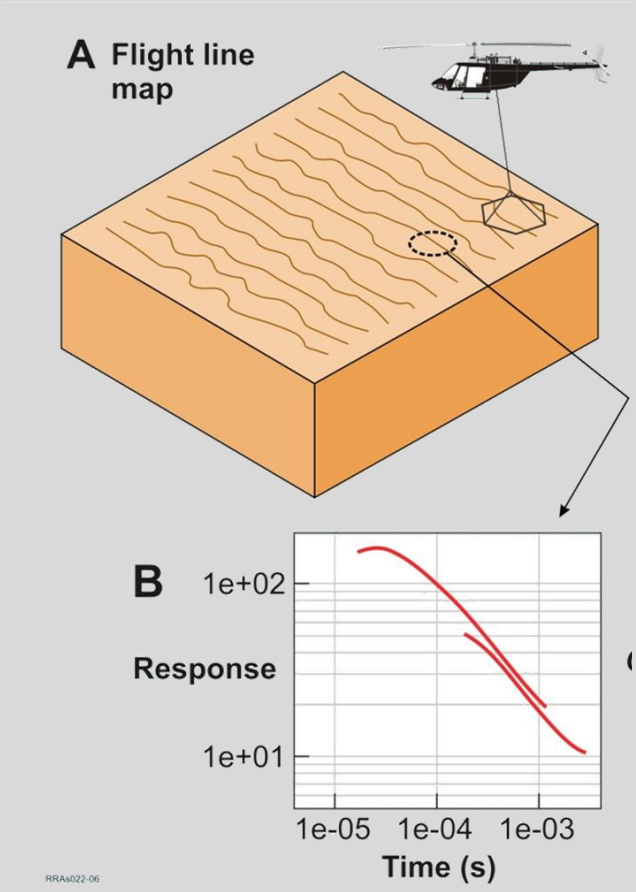
- **SkyTEM for full area coverage**

Heliborne Technology





Heliborne Technology



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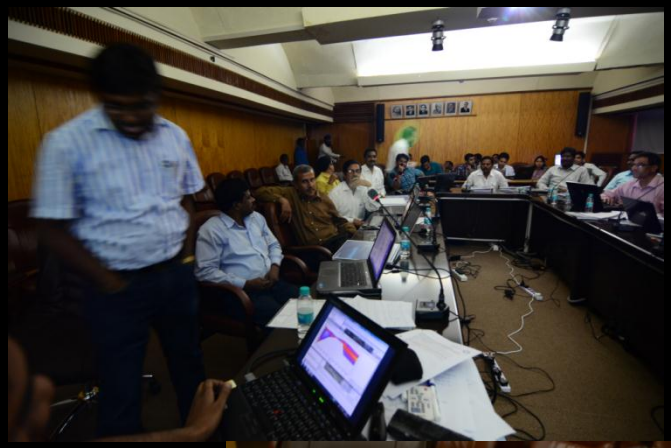
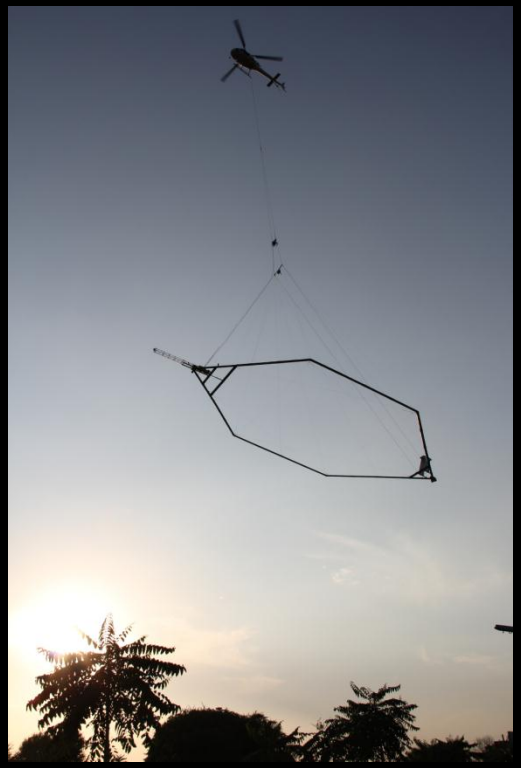
Groundwater Research
Centre Franco-Indien de Recherche sur les Eaux Souterraines





Capacity Building in 2012 - 2013

- **Training courses for ERT, groundbased TEM and SkyTEM**
- **Training courses in data processing and inversion using Aarhus Workbench and ViewTEM (developed in Aarhus)**
- **Training courses in extracting simple hydrogeological surfaces**

- **Processing crew of four at the NRGI campus receiving SkyTEM data twice a week**
- **Interpretation crew of two making the hydrogeological interpretations**

Capacity Building in 2012 - 2013

- **Staff from Aarhus in Hyderabad about every month for a year**
- **Daily contact on email or Skype**
- **Training and instrument calibration in Denmark**
- **Participation in all major meetings in India**

Collected Geophysical Data

- **11000 km of SkyTEM data with the 304 and the 504 system**
  - 4 areas of each 1000 – 3000 km
  - The last 3000 km is being flown as we speak
- **Very bureaucratic system**
  - Every move requires permission and takes a long time
- **Data has not been released by the military**
  - No results yet!
- **No data can leave the field area!**
  - All data quality control and on-site inversion in the field

- **Hundreds of VES soundings, TEM soundings and ERT profiles has been done before the SkyTEM – internal politics**

- **Many new boreholes – another story…..**

Results so far

- **“In the four areas flown results are spectacular” - the World Bank says!**
  - Alluvium mapping
  - Depth to bedrock
  - Scapolite thickness

Results so far

- Fracture zones
- Saltwater intrusion
- **Data collection finished February 15th.**

Will we succeed?

- **Yes, but results will not be taken in detail into the hydrological modeling because of lack of expertise and time ☹**

- **Results will be used to form the NAQUIM project but it is still unclear to which office the authority will be given**

Right now?

- **Finishing work with the data and then reporting**
- **Workshop for GSI and AMD in March**
- **For further strengthen the collaboration we like to have an adjunct professorship for Dr. SK Verma (NGRI) at Aarhus University**
- **Permanent research center with Indian CSIR-NGRI, French BRGM, Danish GEUS and Aarhus University**

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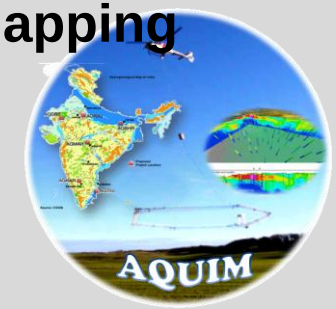
Conclusion

- **Aquifer based groundwater management 😐**
- **Precise aquifer mapping ☺**
- **Establishing geophysical methodology to be up-scaled to entire country ☺**

- **Successful collaboration despite different cultures, bureaucratic system, and technical skills ☺**

- **We need to be there and work with our partners ☺**

- **Huge potential for export of Danish Water Resource Mapping Technology ☺**




Thanks for listening!