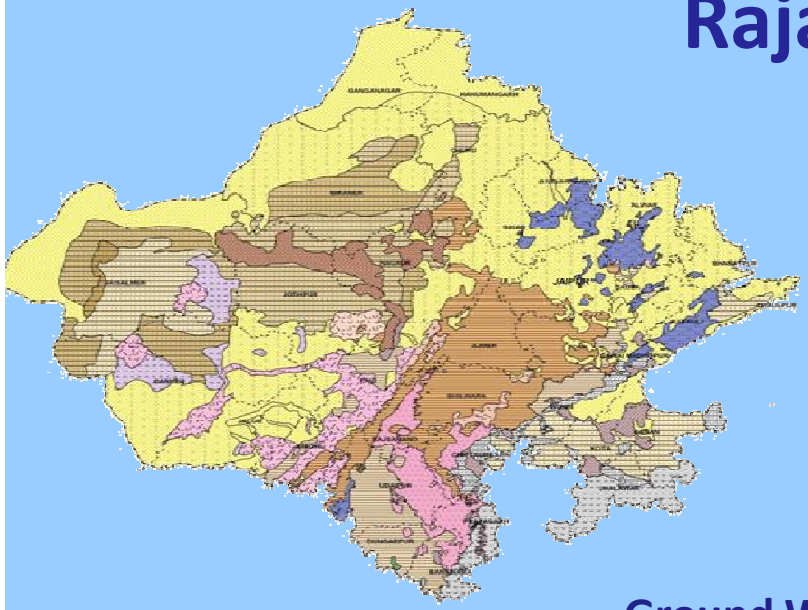
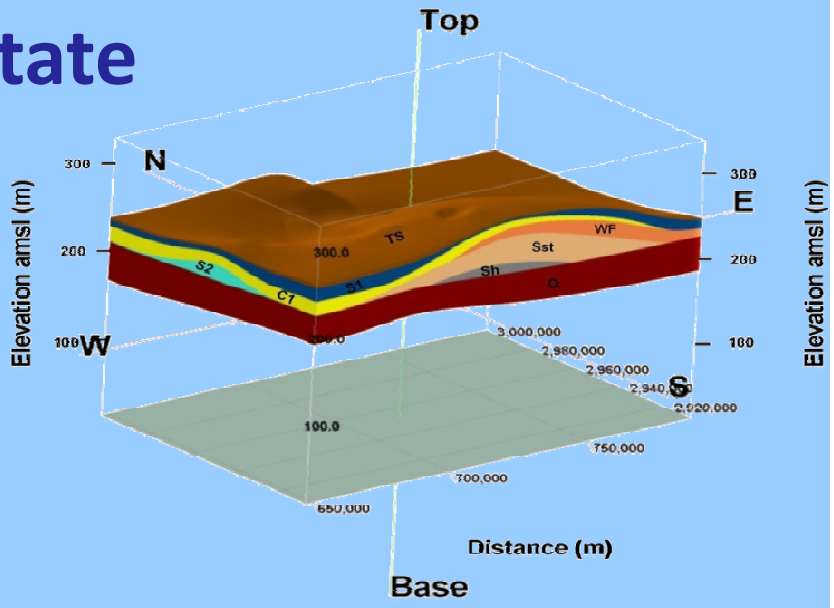
Ground Water Department, Rajasthan

European Union
State Partnership Programme

Aquifer Mapping and Village Level Ground Water Resource Information System for Rajasthan State





M Mehta

Ground Water Management Expert

EU SPP TA Team

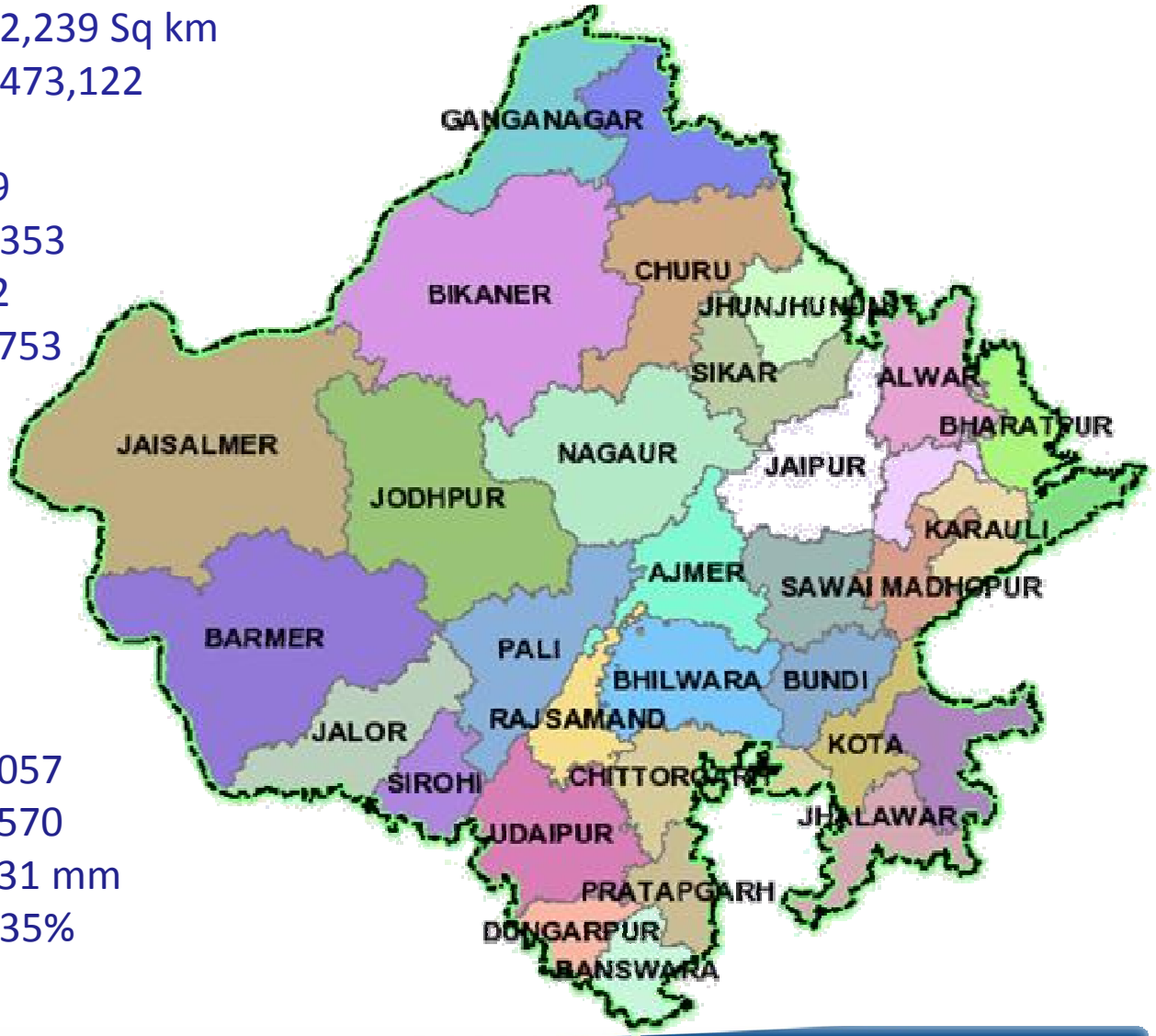
Former Commissioner (GW)

Ministry of Water Resources, GoI

ROLTA
Rolta India Limited

Introduction

Geographical Area : 3,42,239 Sq km
Population : 56,473,122
No. of Districts : 33
No. of Blocks : 249
No. of Villages : 41,353
No. of Towns : 222
No. of Inhabited Villages: 39,753



No. of GMS(GWD) : 8057
No. of GMS(CGWB) : 1570
Average Annual Rainfall : 531 mm
Stage of GW Development: 135%

Rajasthan in the Context of India

Rajasthan is the largest state in India with over 10% of its area but only 1.4% of its water resources

	Rajasthan	India	Rajasthan as % of India
Area (Mha)	34.0	328.0	10.40%
Population (2001) (Million)	56.5	1,050.0	5.40%
Rainfall (mm)	531.0	1,125.0	47.20%
Utilizable water resources (BCM)	32.9	2,300.0	1.40%
a. Surface water (BCM)	21.7	1,870.0	1.16%
b. Ground water (BCM)	11.2	431.0	2.50%
Cultivable area (Mha)	25.7	184.4	13.94%
Irrigated area (Mha)	7.7	105.0	7.30%
Food production (Million tonne)	13.8	211.0	6.60%

Vulnerability of Water Resources in Rajasthan

Source	Availability	Utilisation
Surface water		
Internal	16.05	11.55
Inter-State	17.89	12.66
Total	33.94	23.95 (71%)
Ground water	11.15	15.39 (138%)
Grand Total	44.09	35.78 (86%)

Note: (i) as of year 2008
(ii) units in billion cubic meters unless mentioned otherwise
(iii) Evapo-transpiration: 1500 -2500 mm p.a

Water levels falling at alarming rate in most of the state
Water quality problems due to geological reasons, municipal and industrial pollution

EU SPP Rajasthan- An Overview

Objectives

- State wide water sector reforms leading to sustainable and integrated water resources management
- Support PRIs in 11 districts for:
  - Equitable access to safe, adequate, affordable, sustainable drinking water
  - Conservation and replenishment of surface and ground water

Sector budget support of €80 mn from EU

- € 73.5 mn for the government of Rajasthan implementation from 2007 till December 2013
- Remaining € 6.5 mn – Technical Assistance, Monitoring/Evaluation, Audits (EU contracted)

Time period 2007 - 2013

Sector Budget Support - Components

- **Support to State-wide water sector reforms**
  - Strengthen State Water Resources & Planning Department (SWRPD)
  - Sustainable Water Campaign and
  - Institutional Development of Public Health Engineering, Ground Water, Drinking and Panchayati Raj & Rural Development departments.

- **Support to PRIs/user groups in 11 selected districts and blocks**
  - Institutional Development of PRIs/user groups - particularly women and poor
  - Capacity Development of PRIs/user groups
  - Investment component of PRIs/user groups.

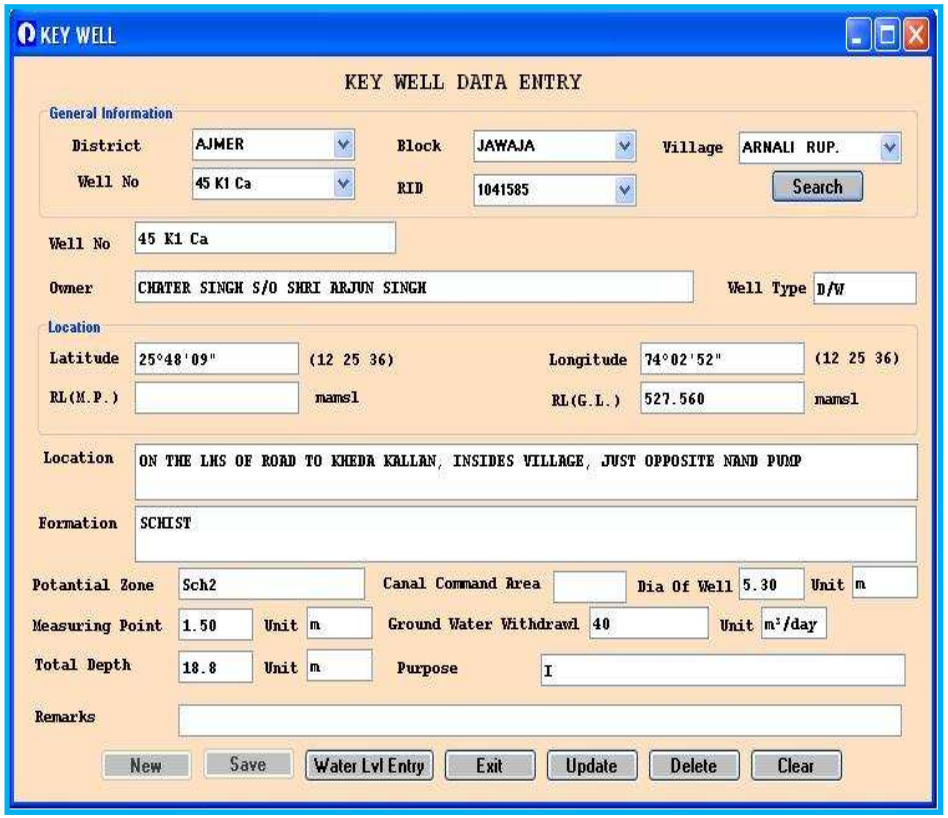
Aquifer Mapping Project Objectives

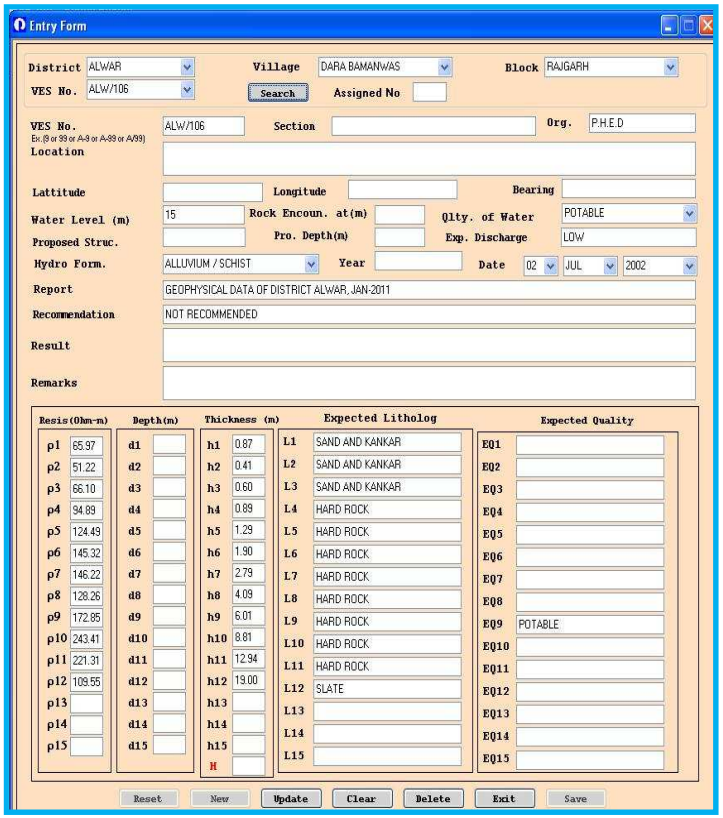
- Computerization of historic ground water data,
- Interpretation of data and demarcation of the aquifer system in three dimensions
- Estimation of the aquifer wise groundwater resources and apportion to the level of village,
- Benchmarking of GW Monitoring network and recommendations for its optimization,
- DGPS Survey of monitoring wells for accurate position and RL establishment,
- Development of Web enabled GIS Application for the assessment and management of Ground water,
- Empowering the community to asses periodical ground water availability
- To equip ground water users / stakeholders with the necessary data, skills and knowledge to manage groundwater resources available in a sustainable manner.

Inputs Used

- Geographical locations of all existing ground water monitoring Wells with their RL values,
- Time series Water Level and Water Quality (1984 – 2011) Data of both GWD and CGWB,
- Exploratory well lithologs of both GWD and CGWB,
- Geophysical Survey Data – Electrical Resistivity data, Interpreted Lithologs, Geophysical well logging data,
- Metrological Data (Rainfall only),
- Aquifer Parameters of both GWD and CGWB,
- Updated Administrative Boundary (state, district, block and village) and Demographic data as per Census of India and State,
- District wise Geological, Geomorphology and Groundwater Potential Zone Maps etc.,
- Guidelines of GEC and Published Annual Assessment Reports of the State Groundwater Department.

Data Entry, Validation & Evaluation

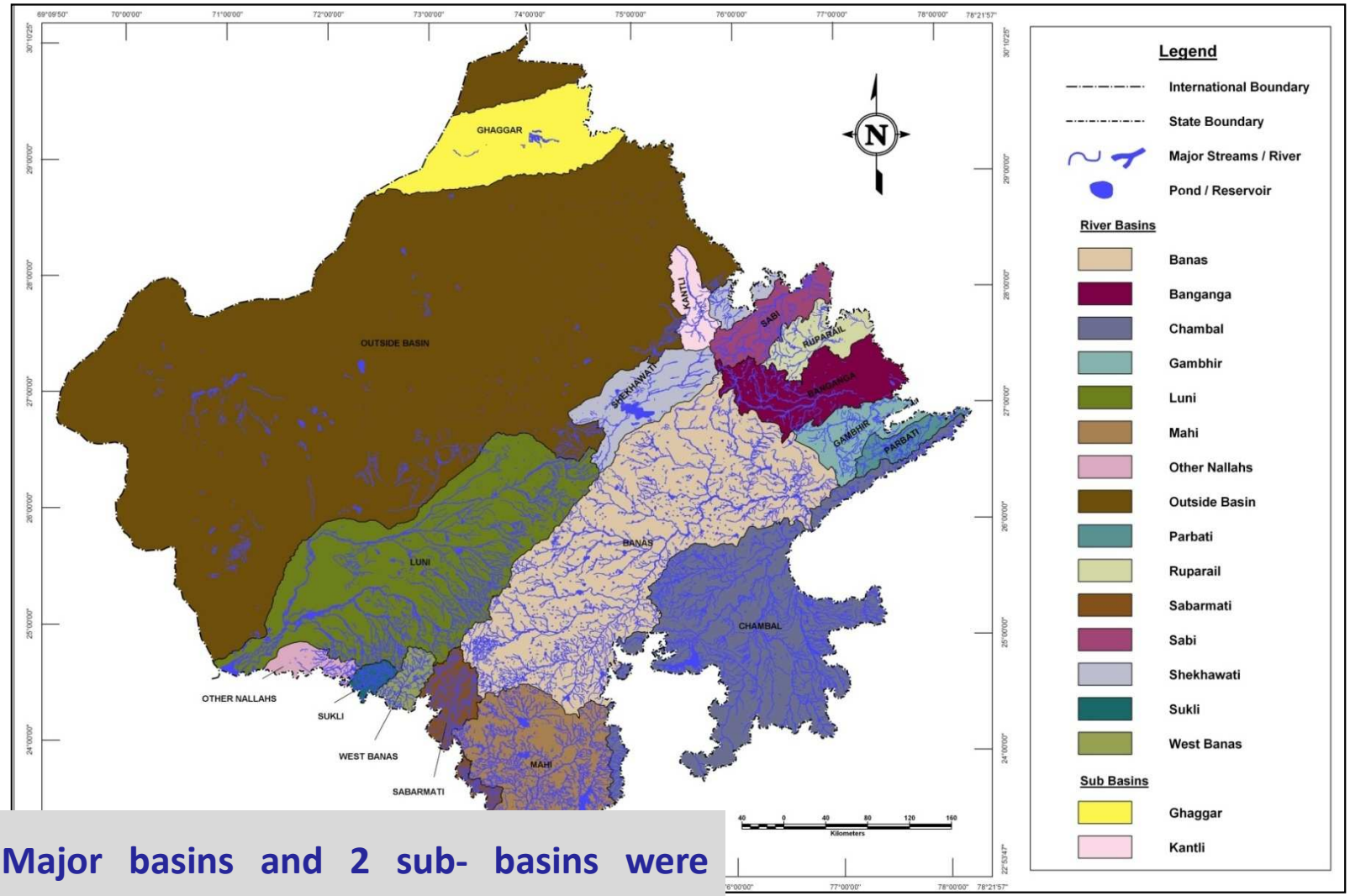




A Snap shot of Key well (WL) / Geophysical Data Entry Form

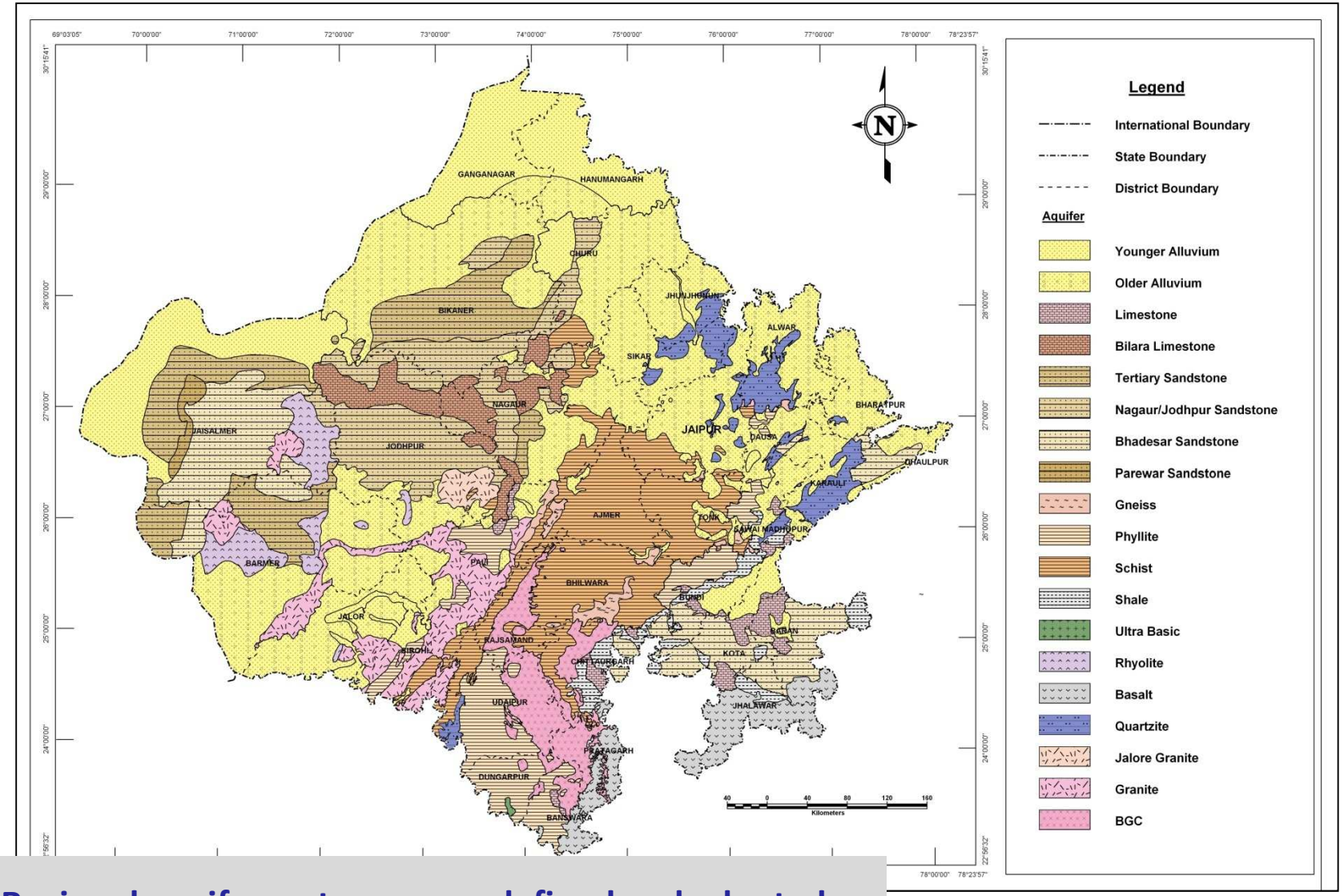
- **For each type of input data, specific forms and formats were designed,**
- **Quality checks were adopted to ensure error free data entry into database**

River Basins



15 Major basins and 2 sub- basins were adopted and refined using SRTM DEM

Aquifer Distribution Map



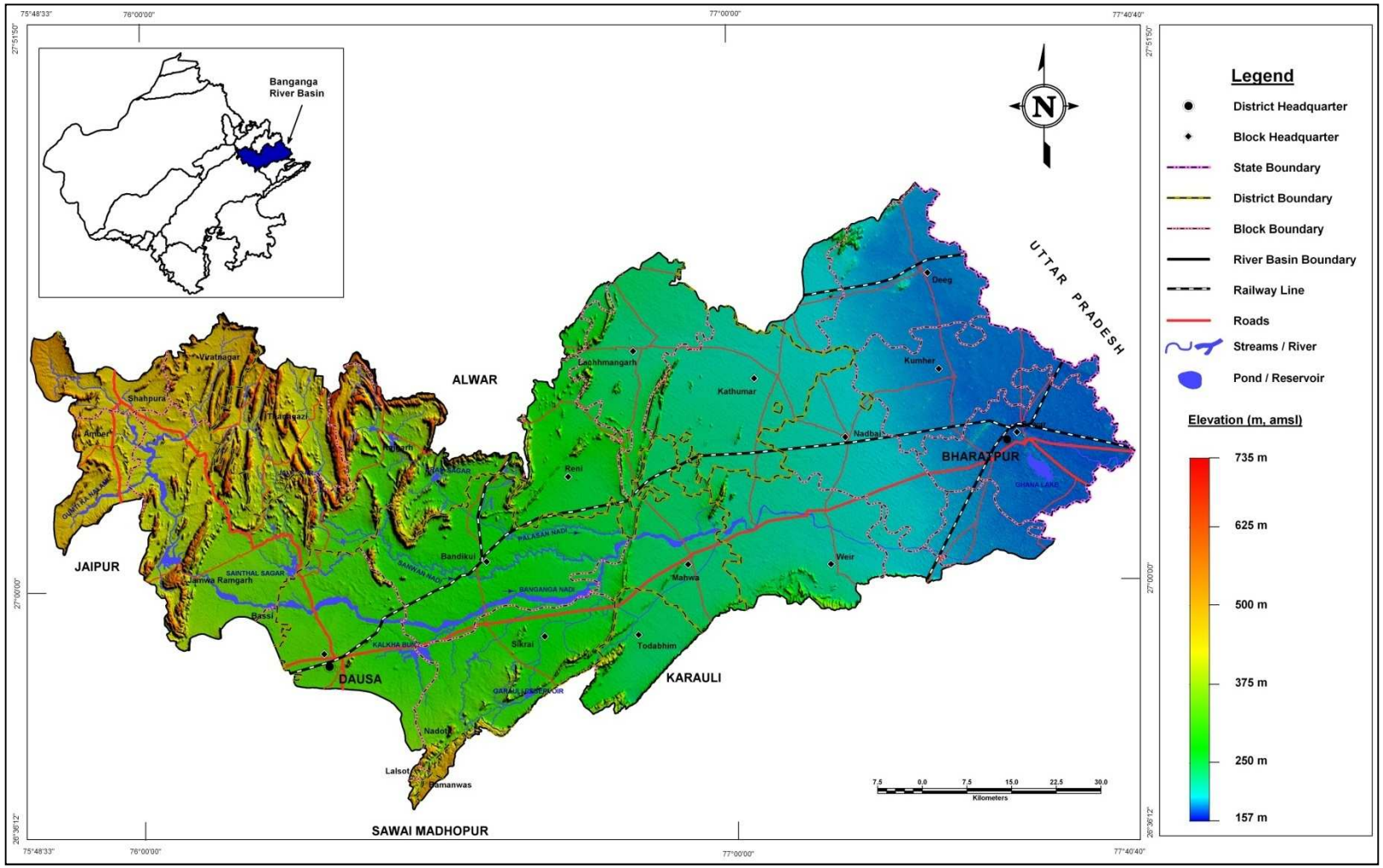
19 Regional aquifer systems were defined and adopted

Basin Wise Thematic Maps

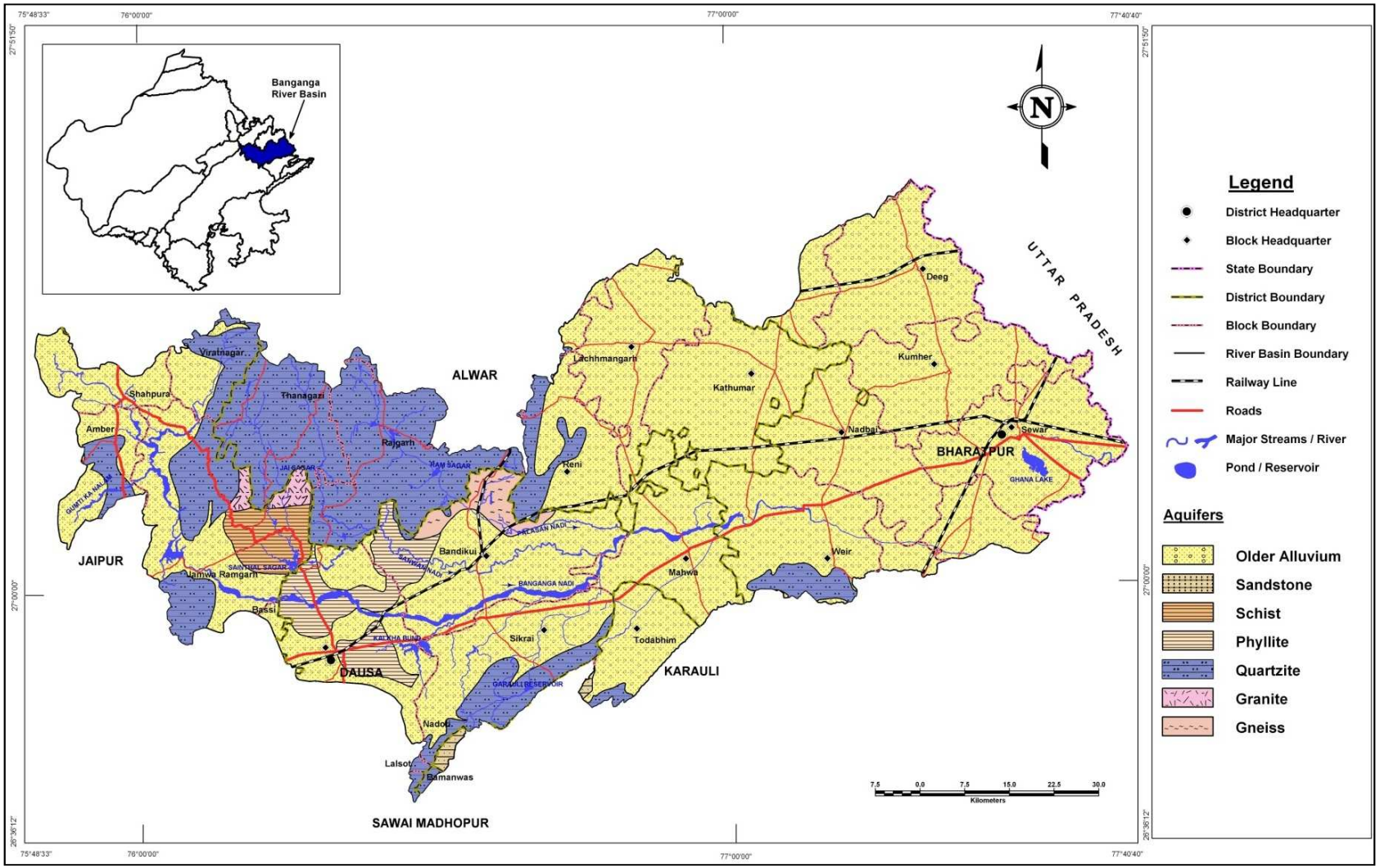
- Digital maps on following themes were prepared for systematic assessment of aquifers in a basin:
  - Geological , geomorphological, groundwater potential maps,
  - Well (GMS and Exploratory) location maps,
  - Depth to water level, Water table elevation and fluctuation maps
  - Water quality maps (EC, Chloride, Fluoride, Nitrate) distribution maps
  - Depth to bedrock maps
  - Isopach maps for Unconfined and Confined aquifers (if present)
  - Multiple Vertical cross sections across the basin
  - 3D maps for panel diagram

A sample basin walk through – Banganga basin

Banganga River Basin- Topography

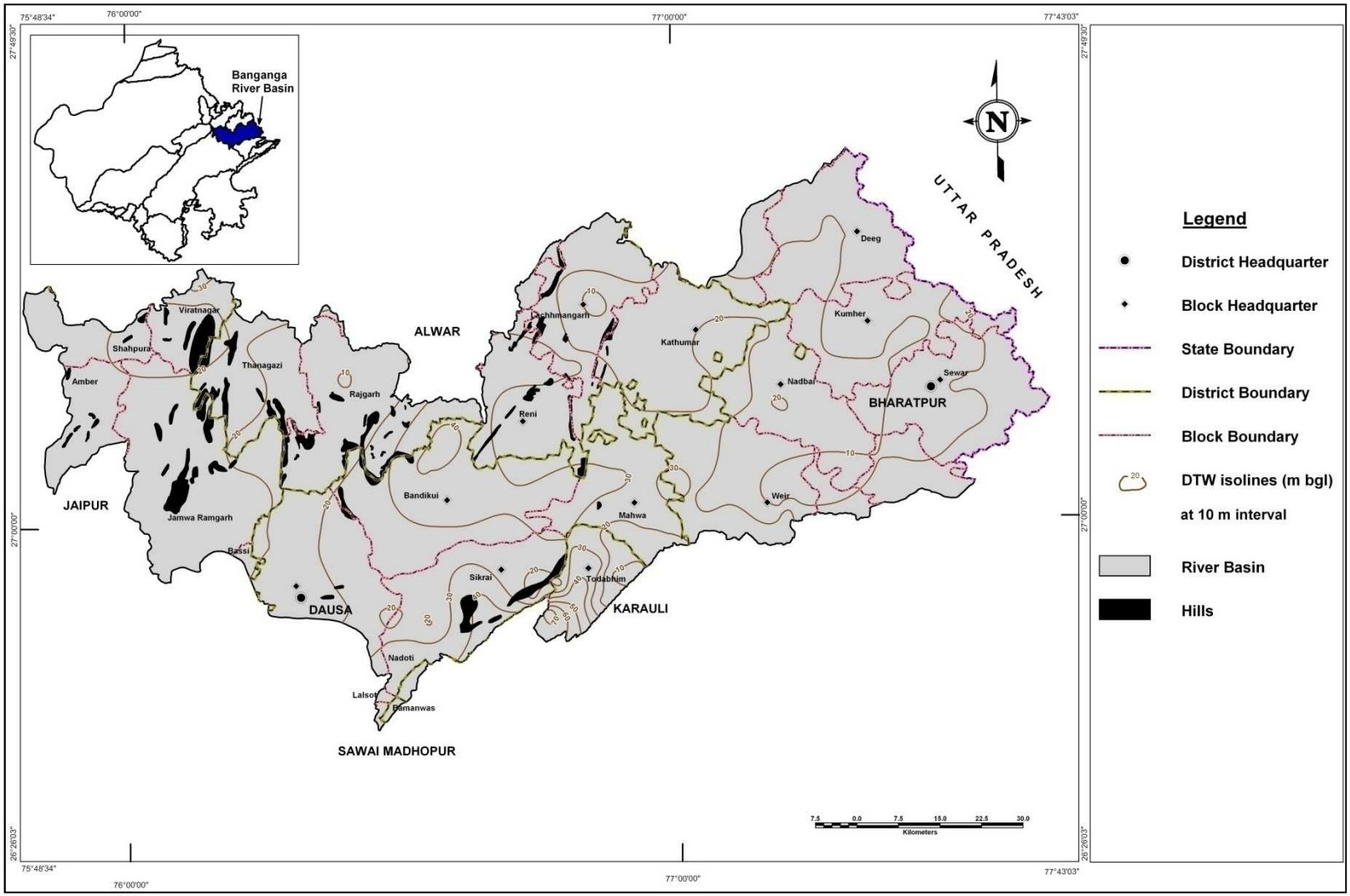


BANGANGA RIVER BASIN - Aquifer Distribution



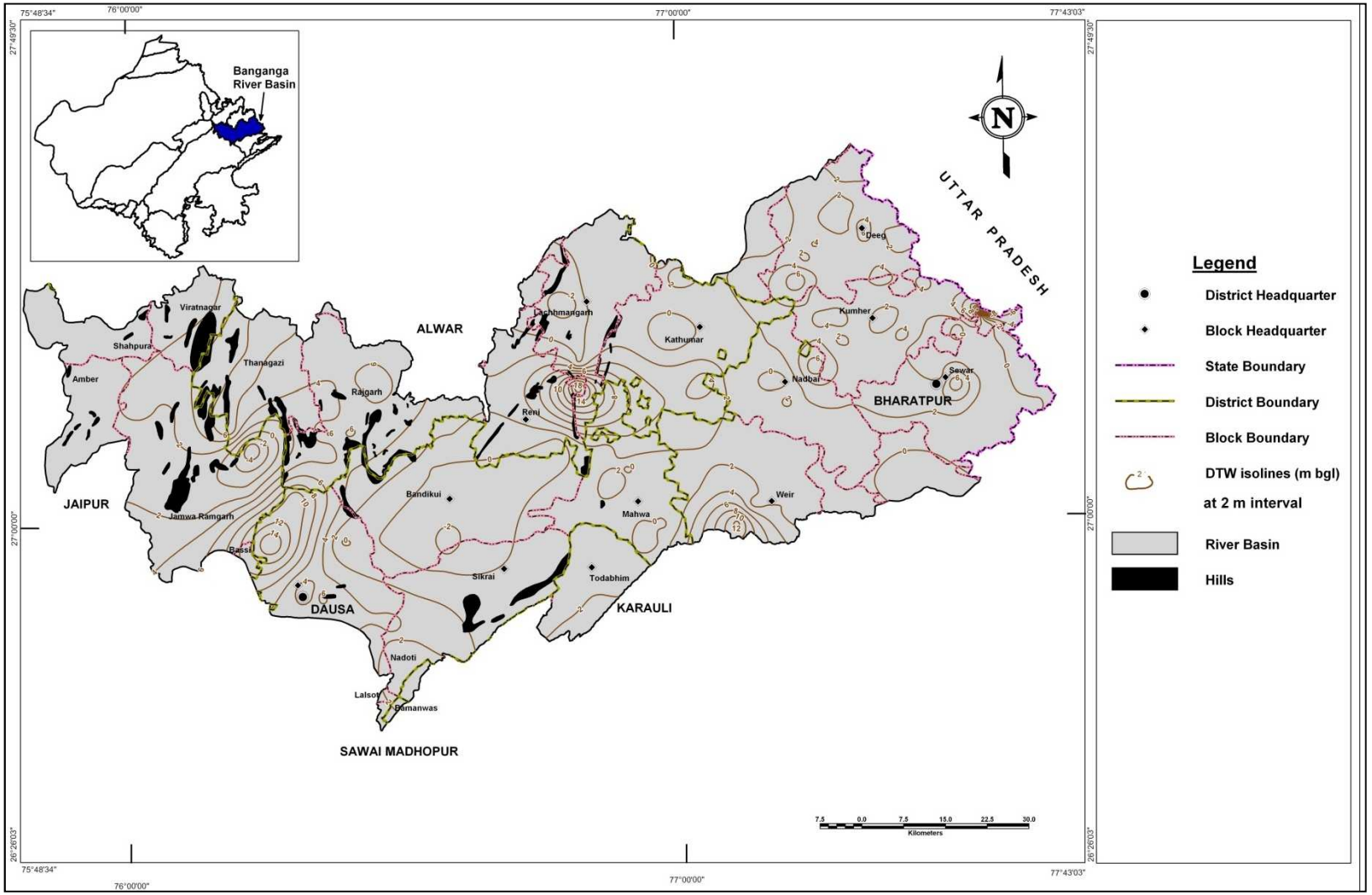
BANGANGA RIVER BASIN –

Pre-Monsoon Depth to Water level (2000-09)



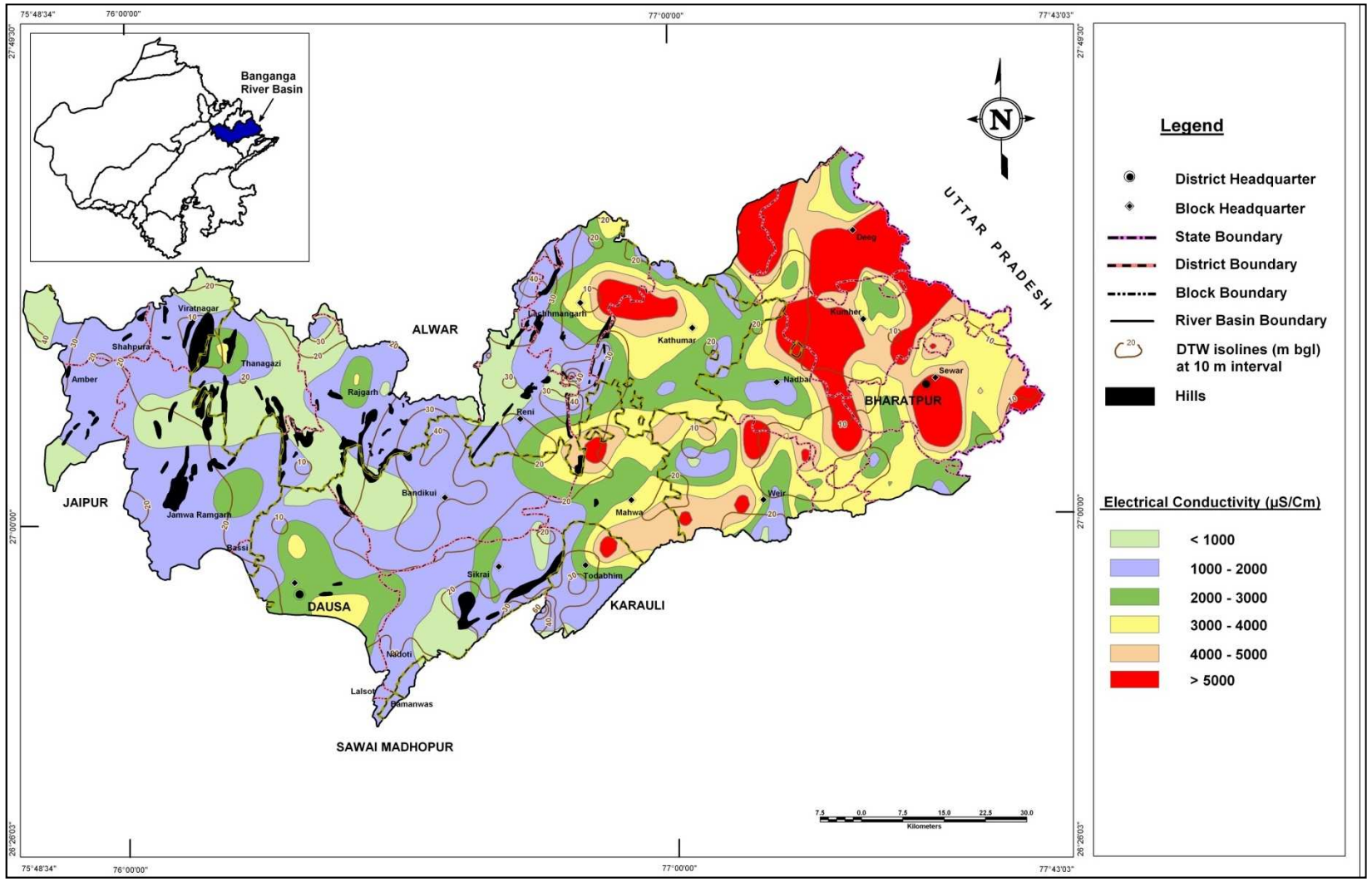
BANGANGA RIVER BASIN –

Water level fluctuation (Pre-Post Monsoon, 2010)



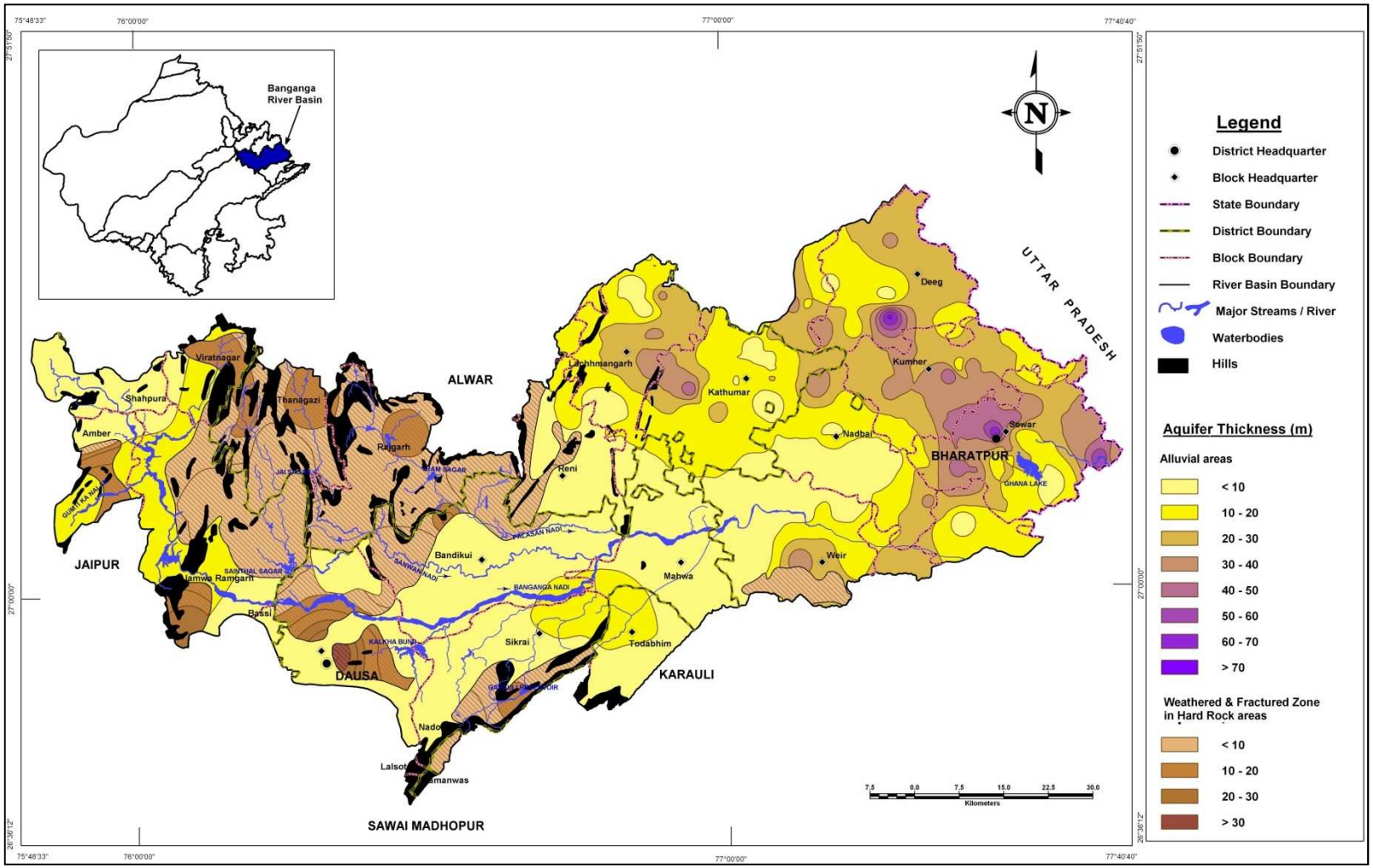
BANGANGA RIVER BASIN –

Average Ground Water EC (Pre-Monsoon 2005-09)



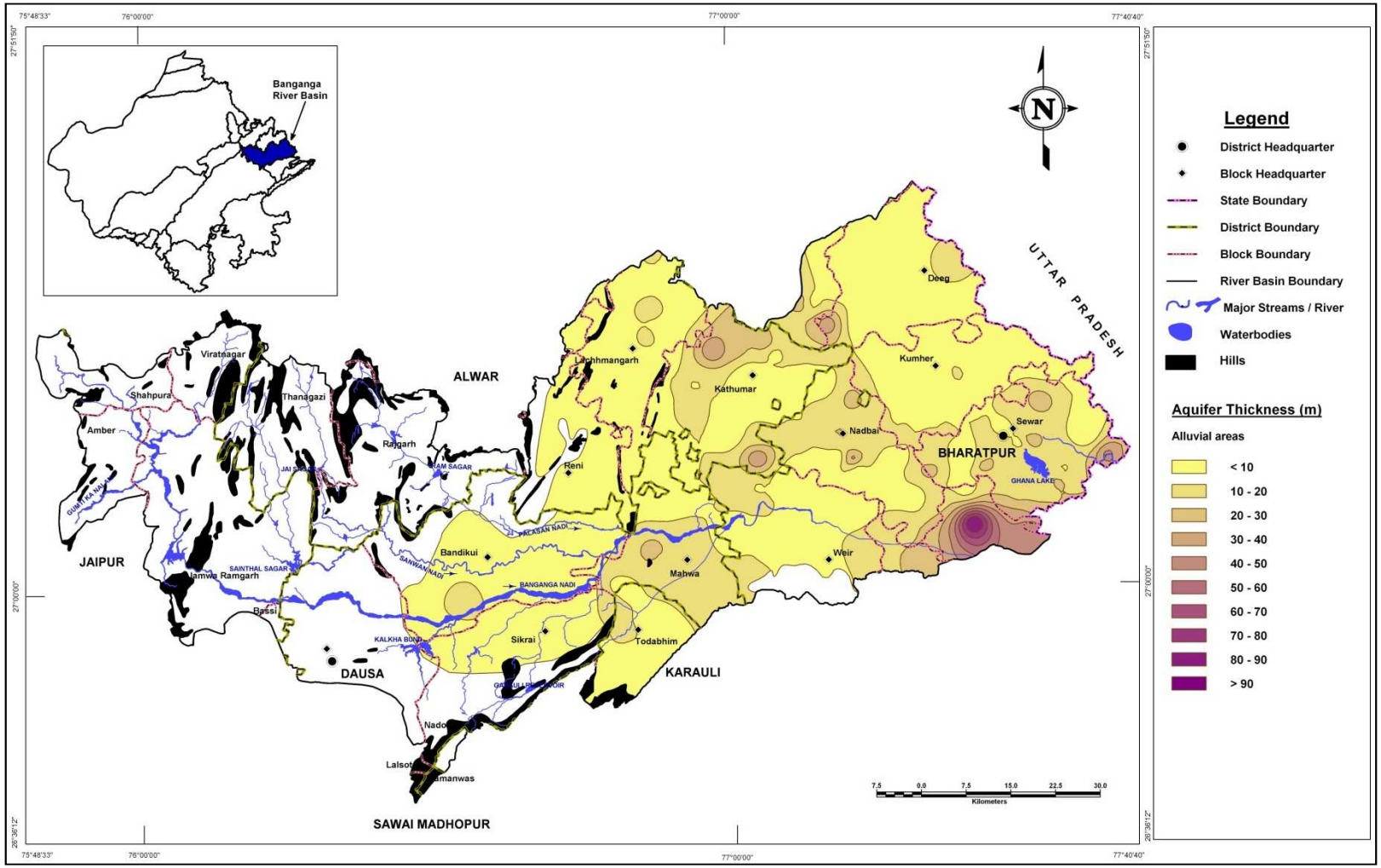
BANGANGA RIVER BASIN –

Thickness of Unconfined Aquifer



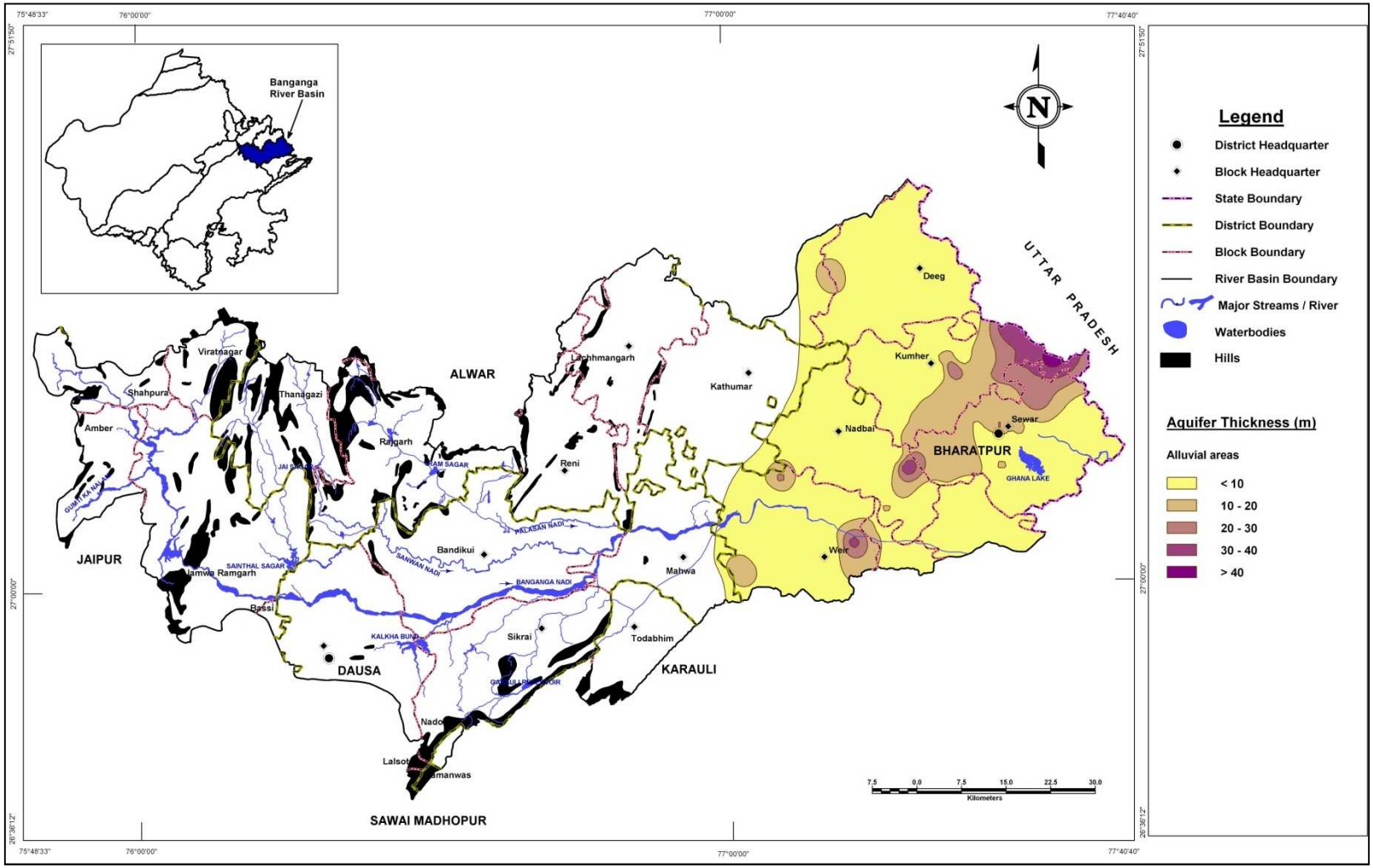
BANGANGA RIVER BASIN –

Thickness of First Confined Aquifer



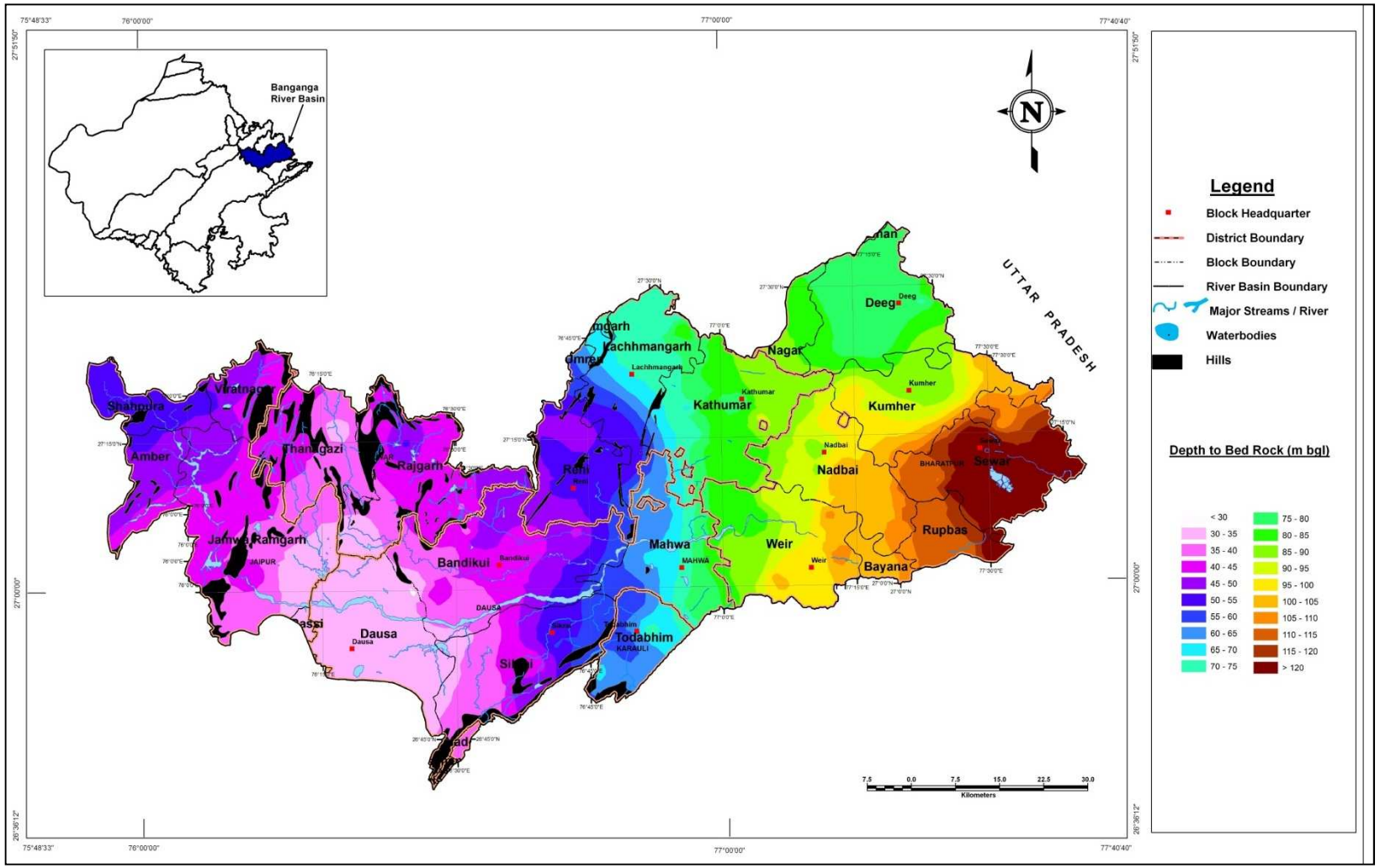
BANGANGA RIVER BASIN –

Thickness of Second Confined Aquifer



BANGANGA RIVER BASIN –

Depth to Bedrock



BANGANGA RIVER BASIN –

Hydrogeological Cross-sections

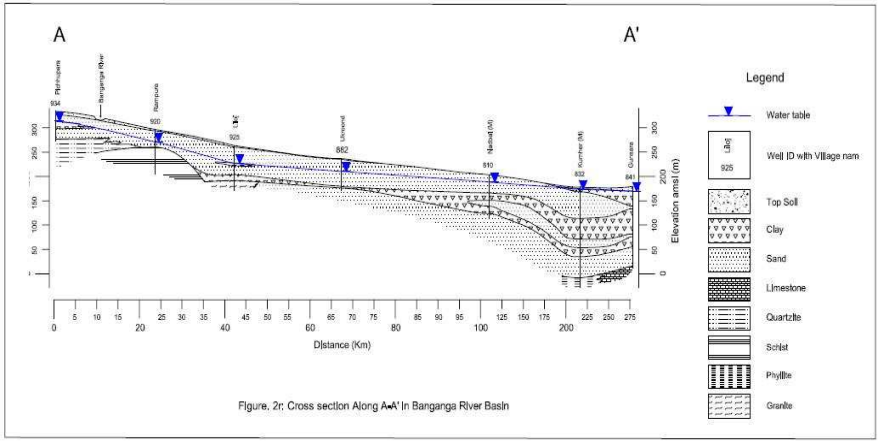


Figure. 2r: Cross section Along A-A' In Banganga River Basin

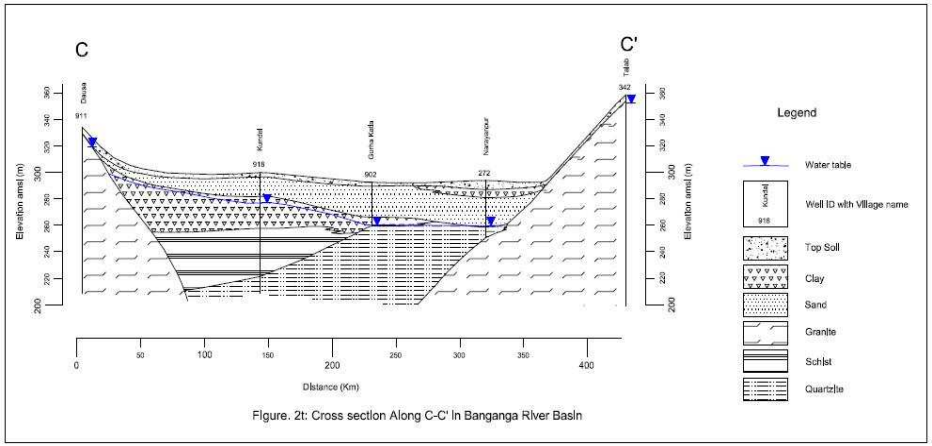


Figure. 2t: Cross section Along C-C' In Banganga River Basin

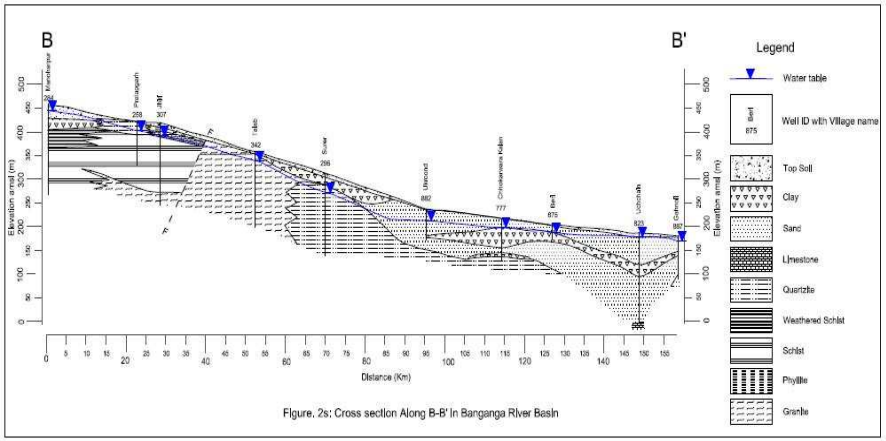


Figure. 2s: Cross section Along B-B' In Banganga River Basin

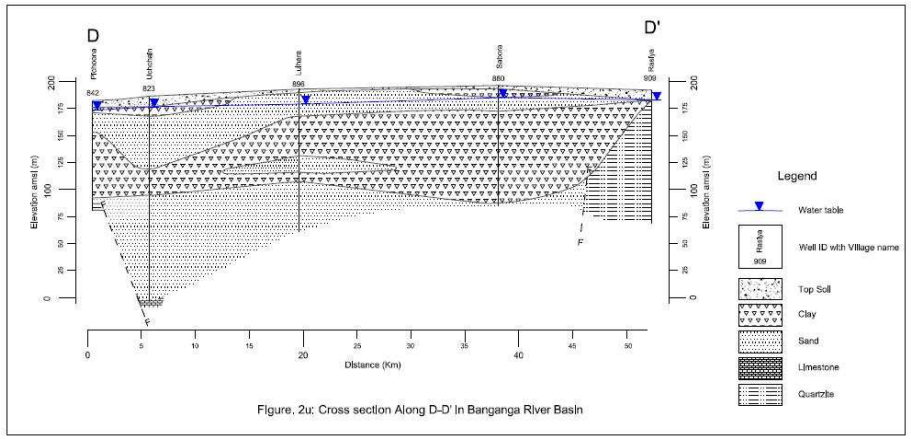
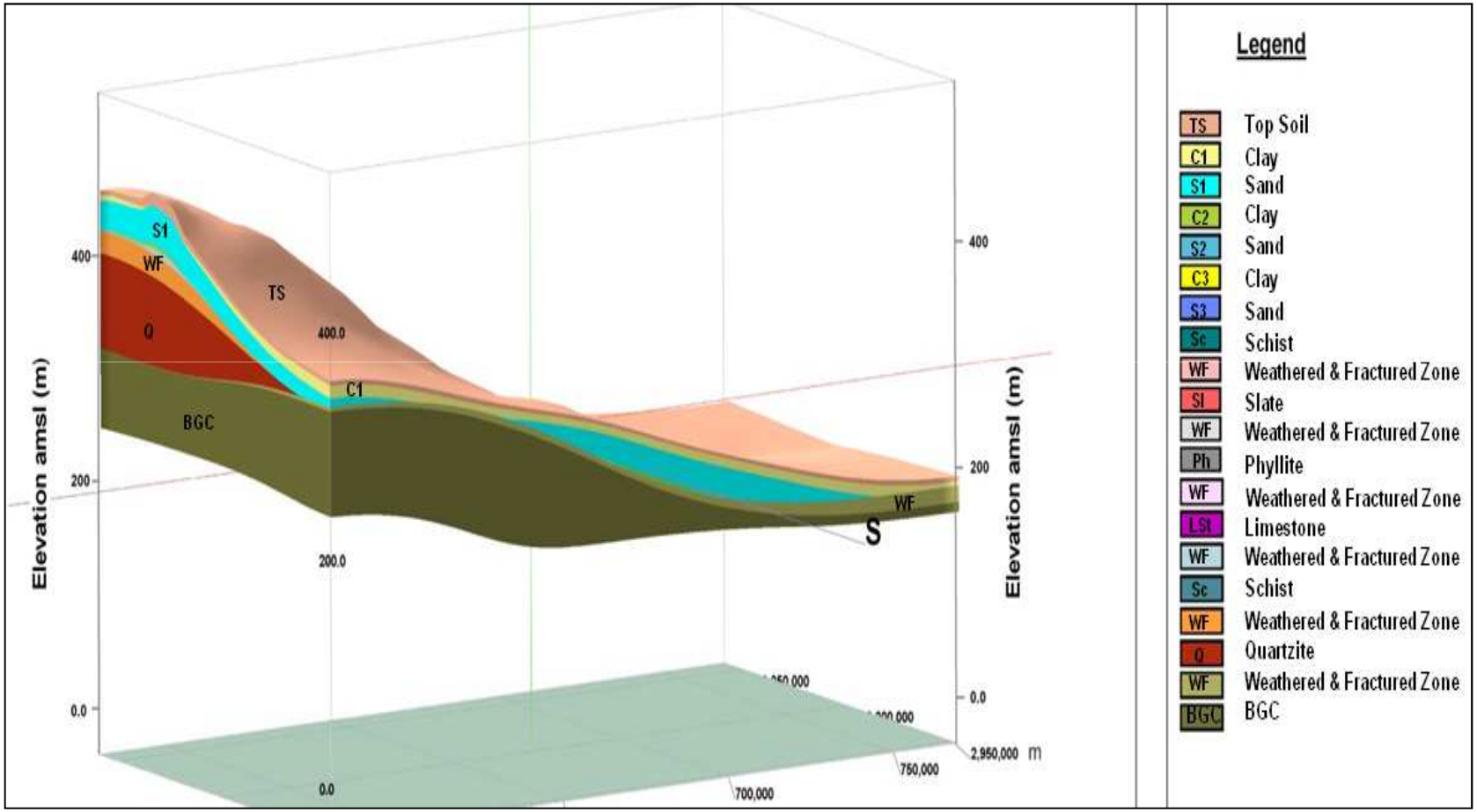


Figure. 2u: Cross section Along D-D' In Banganga River Basin

BANGANGA RIVER BASIN –

3D Aquifer Model



Static and Dynamic GW Resource Assessment

- Appraisal of current methodology of RGWD carried out and suitable refinements suggested,
- All the ground water recharge and discharge data linked to corresponding spatial features,
- Overlay analyses carried for isopach, GWP and other thematic maps for computation of basin wise, aquifer wise and village wise ground water resources,
- Both static and dynamic ground water resources were computed at 250m grid cells that can be summarized to any boundary,
- Quickly replicable and standardized methodology finalized for computation of resources annually.

Static and Dynamic GW Resources- Rajasthan

(Basin Wise)

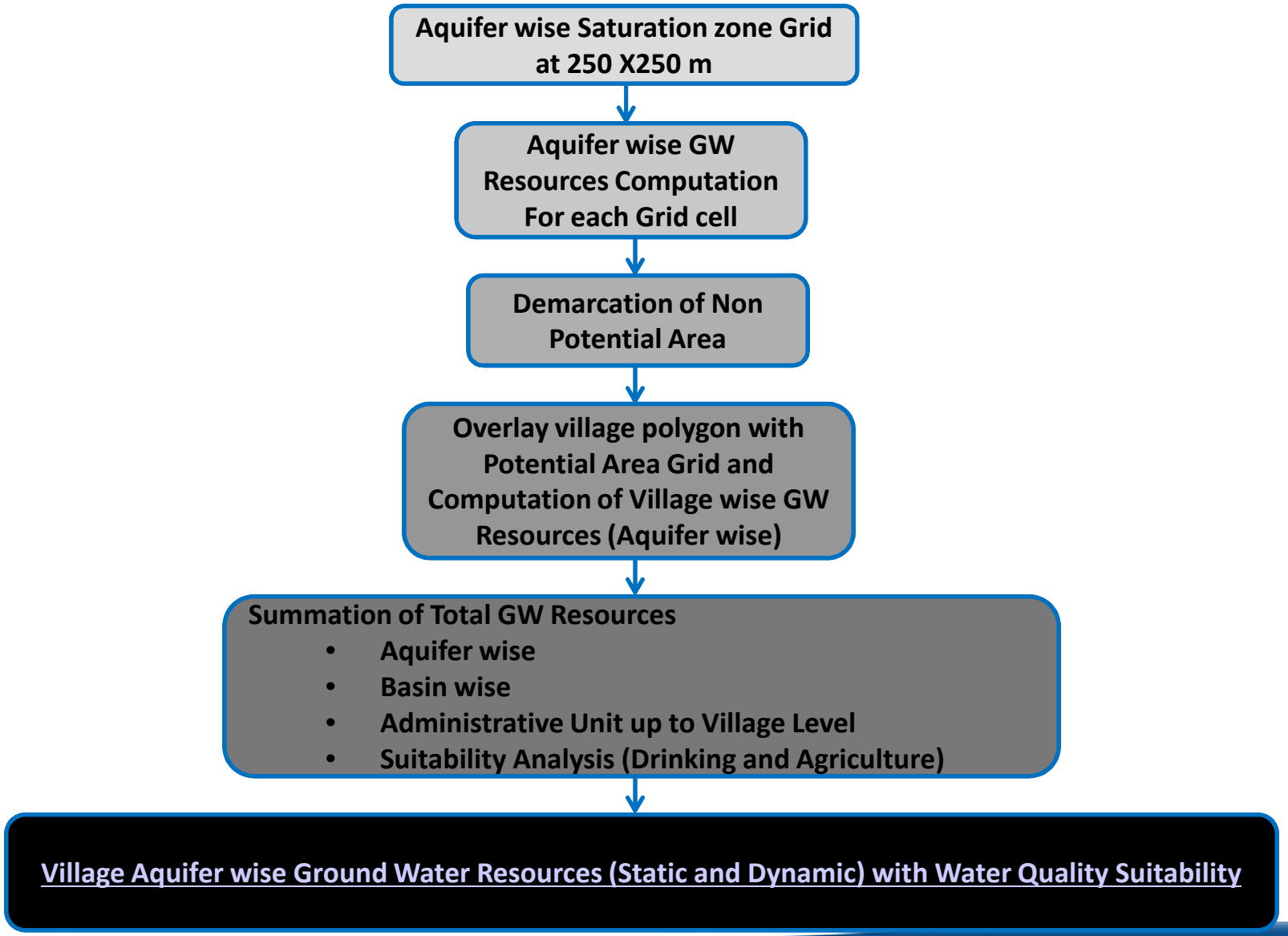
Basin Name	Dynamic Resources * (mcm)	Static Resources * (mcm)
Banas	2,305.06	12,175.11
Banganga	710.66	10,139.45
Chambal	1,557.04	5,170.23
Gambhir	475.57	5,281.91
Ghaggar	246.72	44,829.12
Kantli	140.77	3,124.82
Luni	2,068.62	58,084.68
Mahi	383.01	2,896.80
Other Nallahs	17.83	6,138.36
Outside Basin	4,745.37	241,635.66
Parbati	140.78	2,664.52
Ruparail	386.95	5,313.16
Sabarmati	79.25	637.27
Sabi	234.32	5,725.46
Shekhawati	443.29	6,648.27
Sukli	26.58	245
West Banas	64.01	385.11
Total	**14,025.82**	**411,094.93**

Static and Dynamic GW Resources- Rajasthan

(Aquifer wise)

Aquifer Name	Dynamic Resources * (mcm)	Static Resources * (mcm)
Basalt	207.21	629.95
BGC	270.01	2,226.93
Bilara Limestone	279.87	3,361.23
Gneiss	469.08	2,353.74
Granite	218.2	2,165.74
Granite Jalore	53.05	512.09
Limestone	246.39	1,064.26
Nagaur & Jodhpur Sandstone	291.48	4,453.79
Older Alluvium	5,712.20	199,826.99
Parewar Sandstone	47.71	1,150.22
Phyllite	461.29	3,231.78
Quartzite	170.14	999.36
Rhyolite	117.05	950.22
Sandstone	873.9	11,423.80
Schist	641.7	4,506.50
Shale	120.74	224.07
Tertiary Sandstone	534.61	17,965.53
Ultra Basic	2.06	18.96
Younger Alluvium	3,309.13	154,029.76
Total	**14,025.82**	**411,094.93**

Apportion of Ground Water Resources to Villages



Monitoring Network Strengthening

- DGPS survey for establishment of sub-meter accurate X, Y and Z of more than 8000 wells,
- Geostatistical techniques in GIS were used for carrying out benchmarking and optimization of monitoring network,
- Separate analysis for water quality and water level have been carried out at sub-aquifer level,
- Recommendations for both reduction network of wells in areas where possible and strengthening in other areas made. Use of AWLR/DWLRs also made,

WEB GIS APPLICATION -

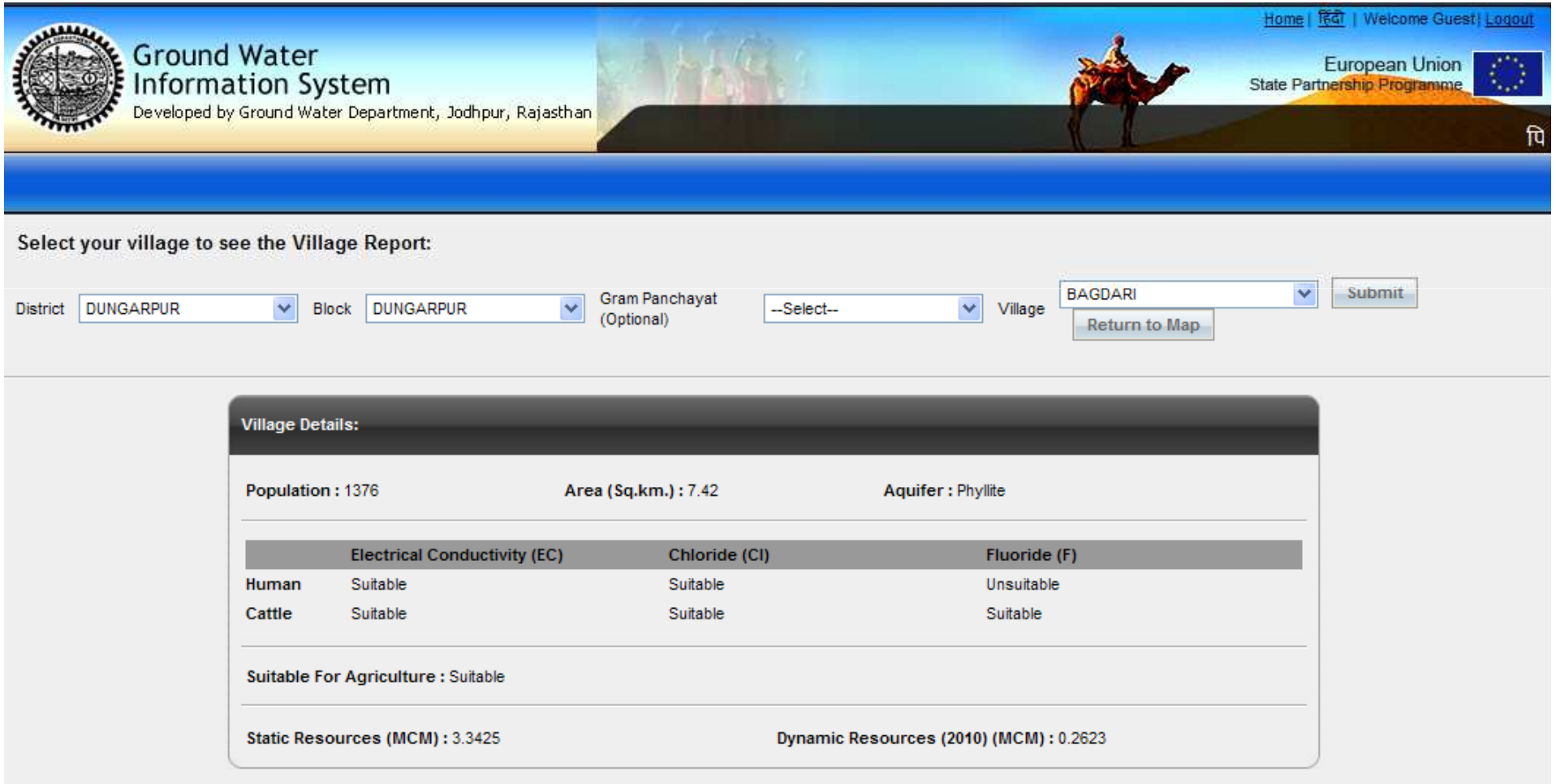
Ground Water Information System

To quickly access GWD Rajasthan's info base in the form of maps and data related to groundwater level and quality of the state

WEB GIS APPLICATION -

Village Level Ground Water Summary

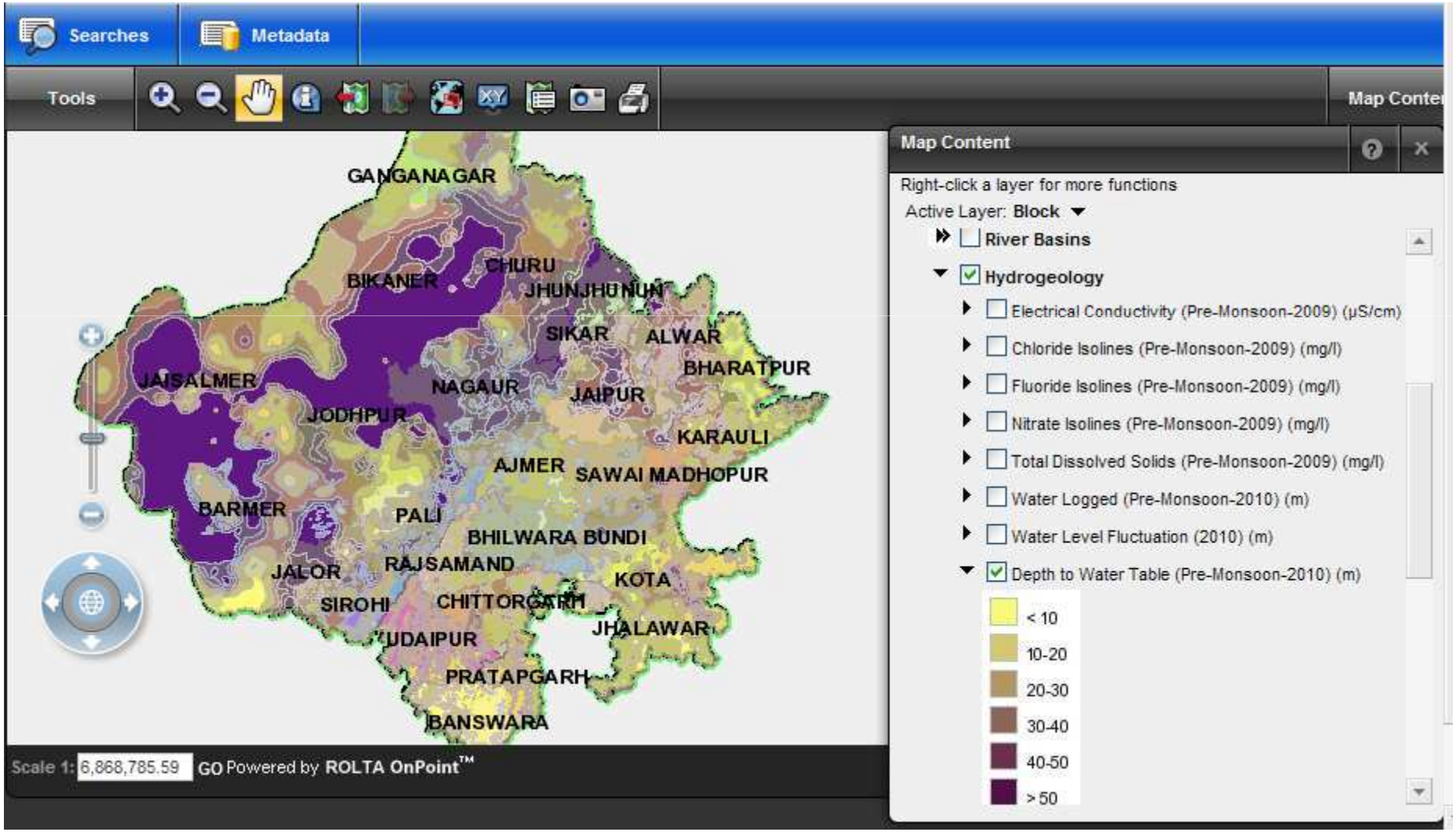
Visualize the data village level data in the form of graphs, analytical charts maps and reports



WEB GIS APPLICATION -

Statewide Thematic Ground Water Maps

A sample map of depth to water table (Pre Monsoon, 2010)



WEB GIS APPLICATION -

Graphical Presentation of Archived Data

Intuitive water level charts for any historic year range

WEB GIS APPLICATION -

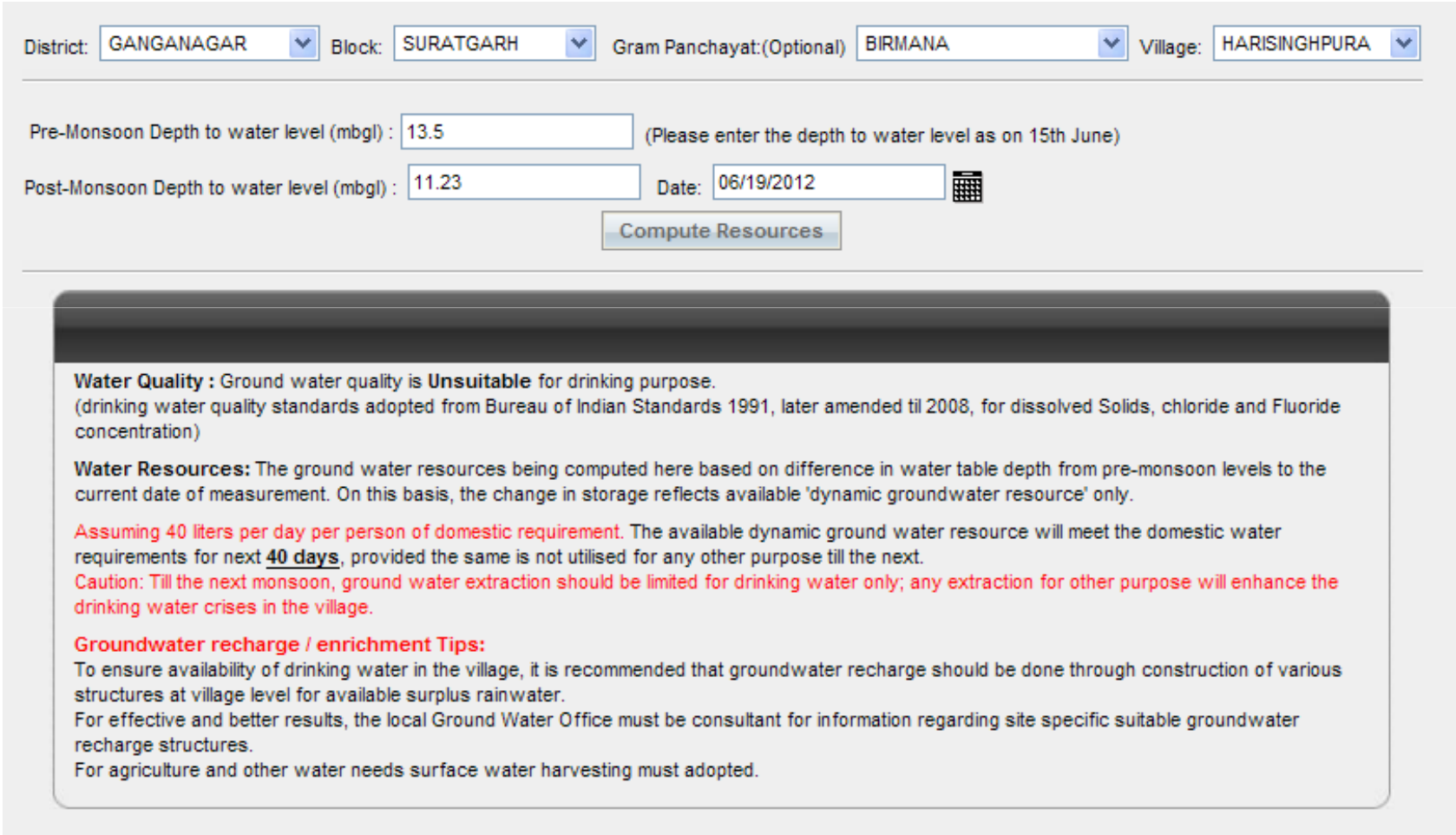
Graphical Presentation of Archived Data

Water quality variation charts to visualize trends

WEB GIS APPLICATION -

for Village Level GW Resources Management

User to input basic WL depth to know the balance GW resources



Achievements

- All the relevant historic ground water related possessed by Department is digitally available for scientists,
- The Department now has large number of GIS software licenses and those for ground water study (like: Surfer, Aquachem, Rockworks, Visual Modflow) for quickly derive analytical results,
- CGWB and GWD data integrated through implementation of GEMS at GWD,
- Training on all the softwares has been imparted to GWD scientists for carrying out GIS based mapping and analysis,
- GW resource can now be conputed very quickly, accurately and annually,
- All the data and maps are in public domain,
- Villagers can access the information interactively and participate in GW management,

Road Ahead

- Computerization of all the district offices,
- Improving the distribution and accuracy of parameters for GW assessment,
- Synergy and interaction with other water related departments within State and Centre
- Continuous learning and enhance of skills
- Involvement of village level stakeholders through awareness raising campaigns

Thank You