

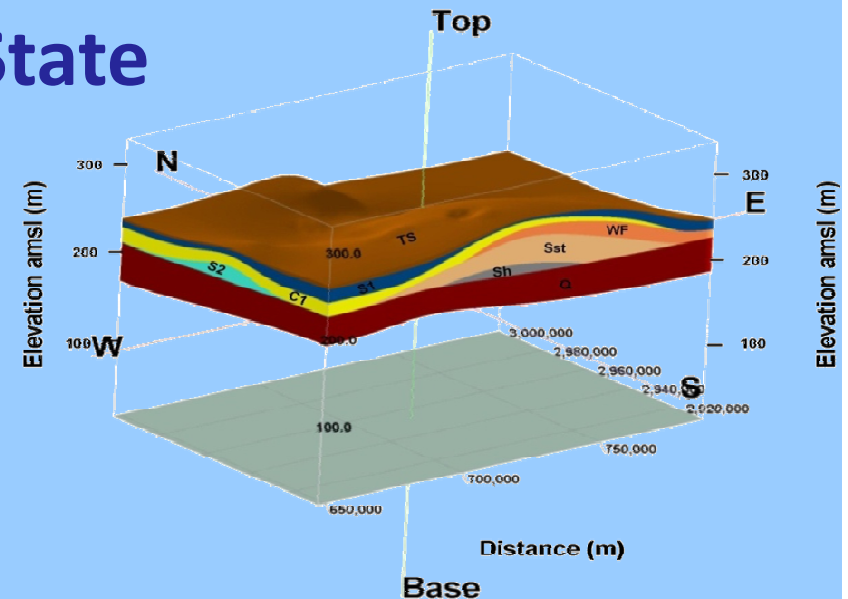
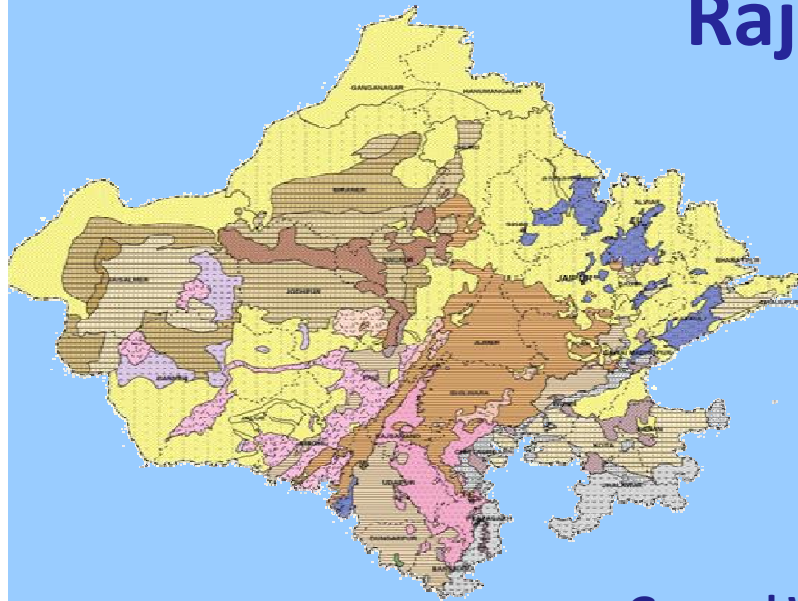


Ground Water Department,  
Rajasthan



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

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## 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

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- **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

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- 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

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- 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

**KEY WELL DATA ENTRY**

**General Information**

District:  Block:  Village:  Well No:  RID:

Well No:

Owner:  Well Type:

**Location**

Latitude:  (12 25 36) Longitude:  (12 25 36)

RL (M.P.):  mamsl RL (G.L.):  mamsl

Location:

Formation:

Potential Zone:  Canal Command Area:  Dia Of Well:  Unit:

Measuring Point:  Unit:  Ground Water Withdrawal:  Unit:

Total Depth:  Unit:  Purpose:

Remarks:

**Entry Form**

District:  Village:  Block:

VES No.:   Assigned No:

VES No.:  Section:  Org.:

Location:

Latitude:  Longitude:  Bearing:

Water Level (m):  Rock Encoun. at (m):  Qlty. of Water:

Proposed Struc.:  Pro. Depth (m):  Exp. Discharge:

Hydro Form.:  Year:  Date:

Report:

Recommendation:

Result:

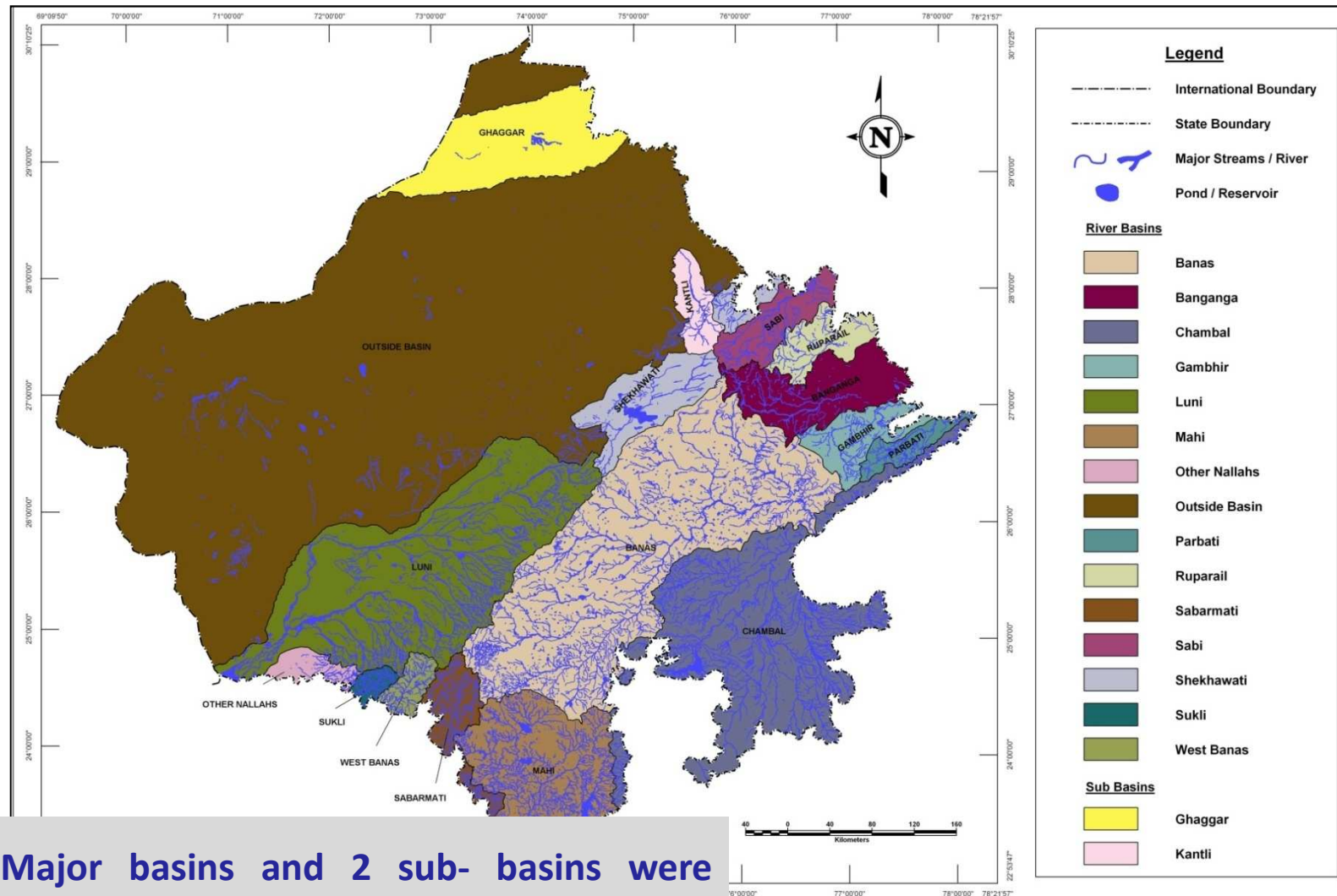
Remarks:

Resis (Ohm-m)	Depth (m)	Thickness (m)	Expected Litholog	Expected Quality
p1 65.97	d1	h1 0.87	L1 SAND AND KANKAR	E01
p2 51.22	d2	h2 0.41	L2 SAND AND KANKAR	E02
p3 66.10	d3	h3 0.60	L3 SAND AND KANKAR	E03
p4 94.89	d4	h4 0.89	L4 HARD ROCK	E04
p5 124.49	d5	h5 1.29	L5 HARD ROCK	E05
p6 145.32	d6	h6 1.90	L6 HARD ROCK	E06
p7 146.22	d7	h7 2.79	L7 HARD ROCK	E07
p8 128.26	d8	h8 4.09	L8 HARD ROCK	E08
p9 172.85	d9	h9 6.01	L9 HARD ROCK	E09 POTABLE
p10 243.41	d10	h10 8.81	L10 HARD ROCK	E010
p11 221.31	d11	h11 12.94	L11 HARD ROCK	E011
p12 109.95	d12	h12 19.00	L12 SLATE	E012
p13	d13	h13	L13	E013
p14	d14	h14	L14	E014
p15	d15	h15	L15	E015

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

**19 Regional aquifer systems were defined and adopted**

# Basin Wise Thematic Maps

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- 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



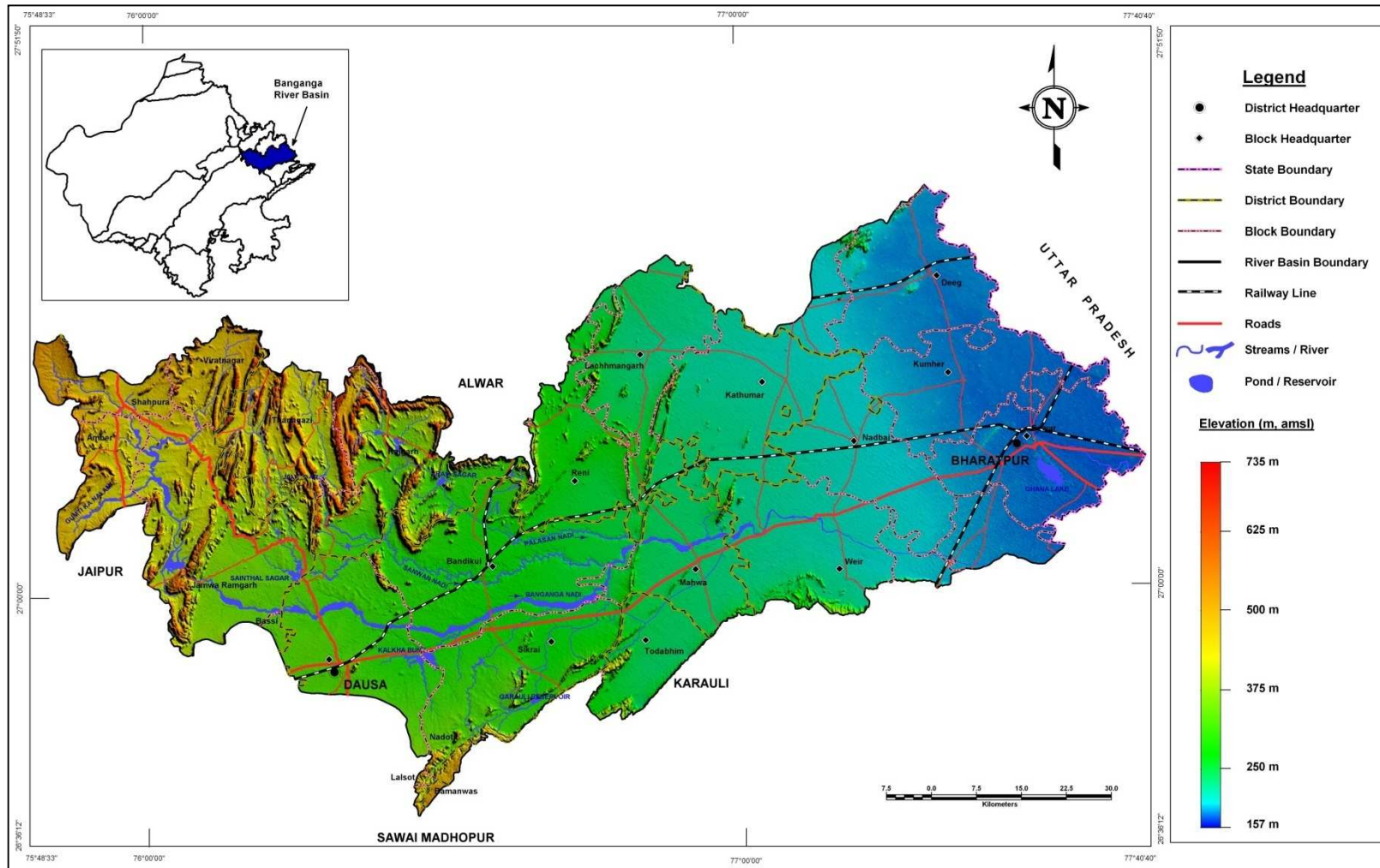
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# **A sample basin walk through – Banganga basin**

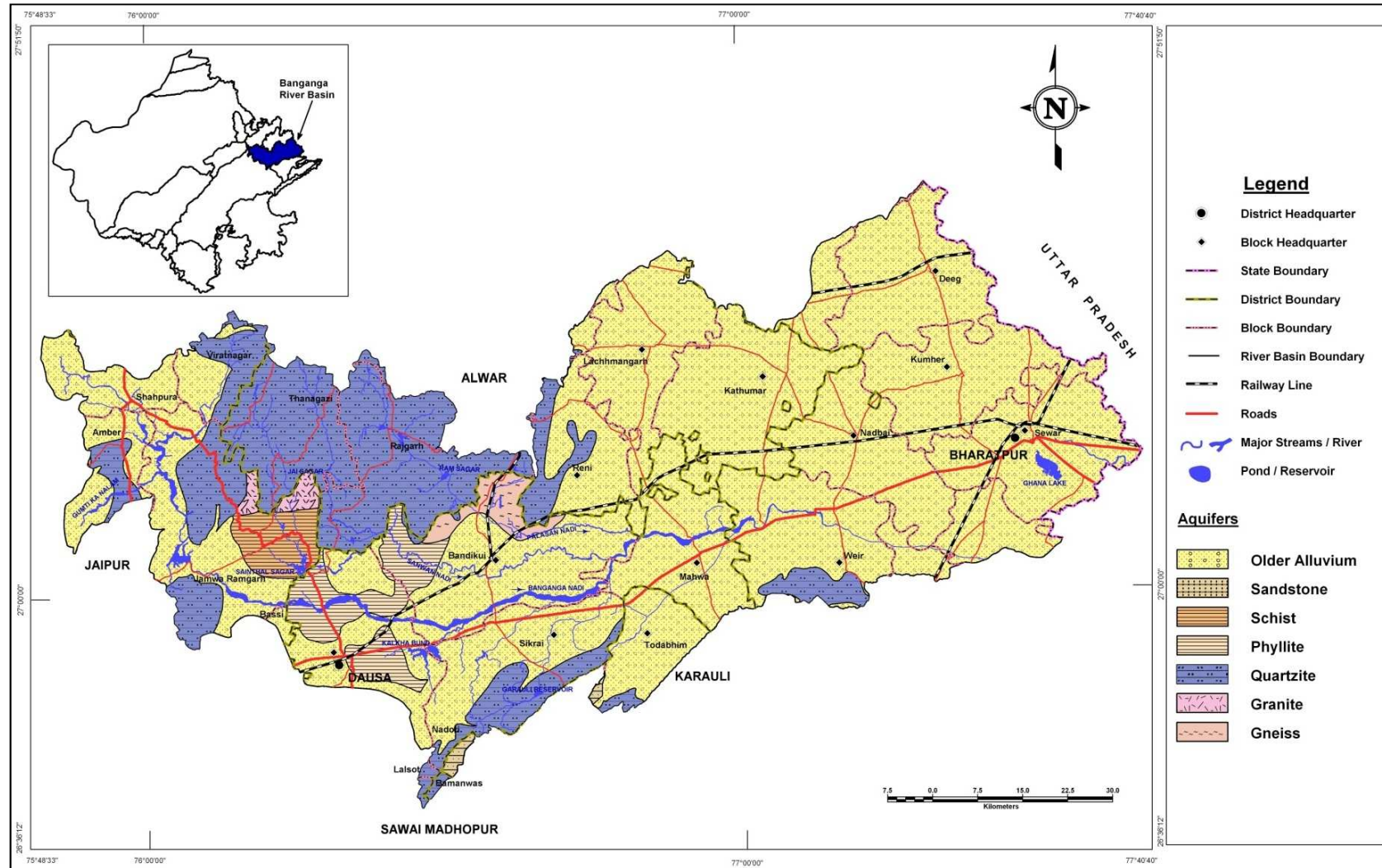




# Banganga River Basin- Topography

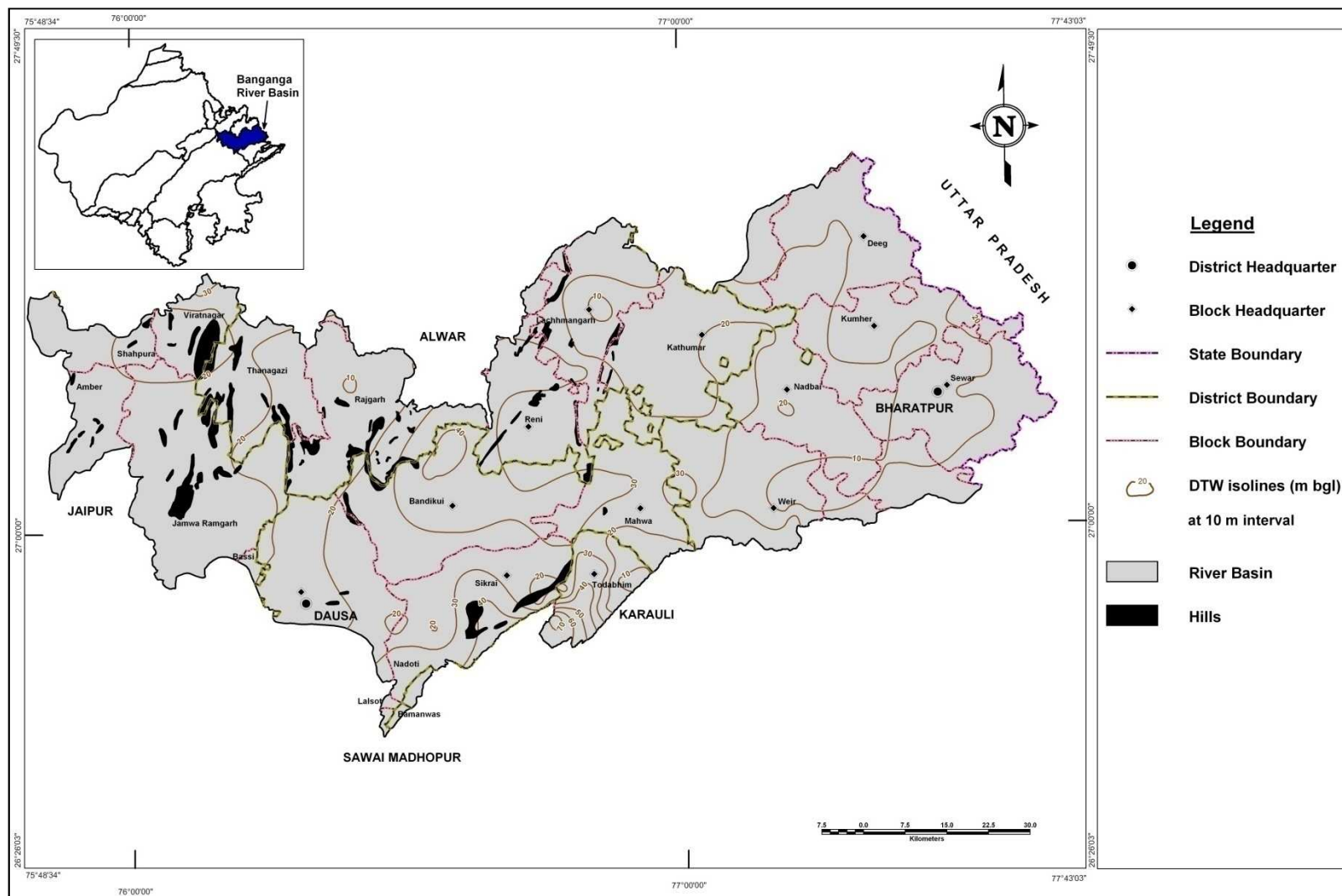


# BANGANGA RIVER BASIN - Aquifer Distribution



# BANGANGA RIVER BASIN –

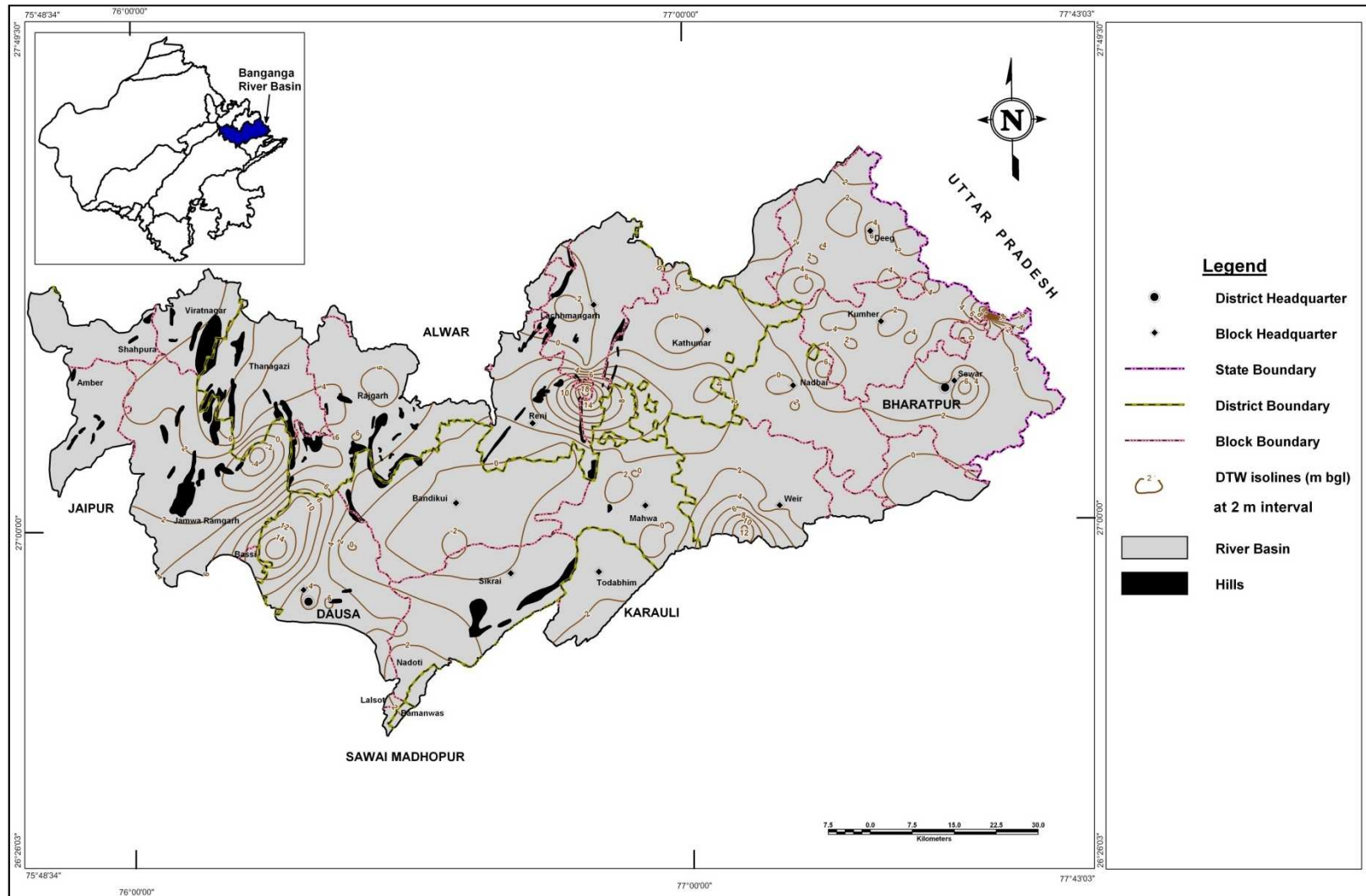
## Pre-Monsoon Depth to Water level (2000-09)





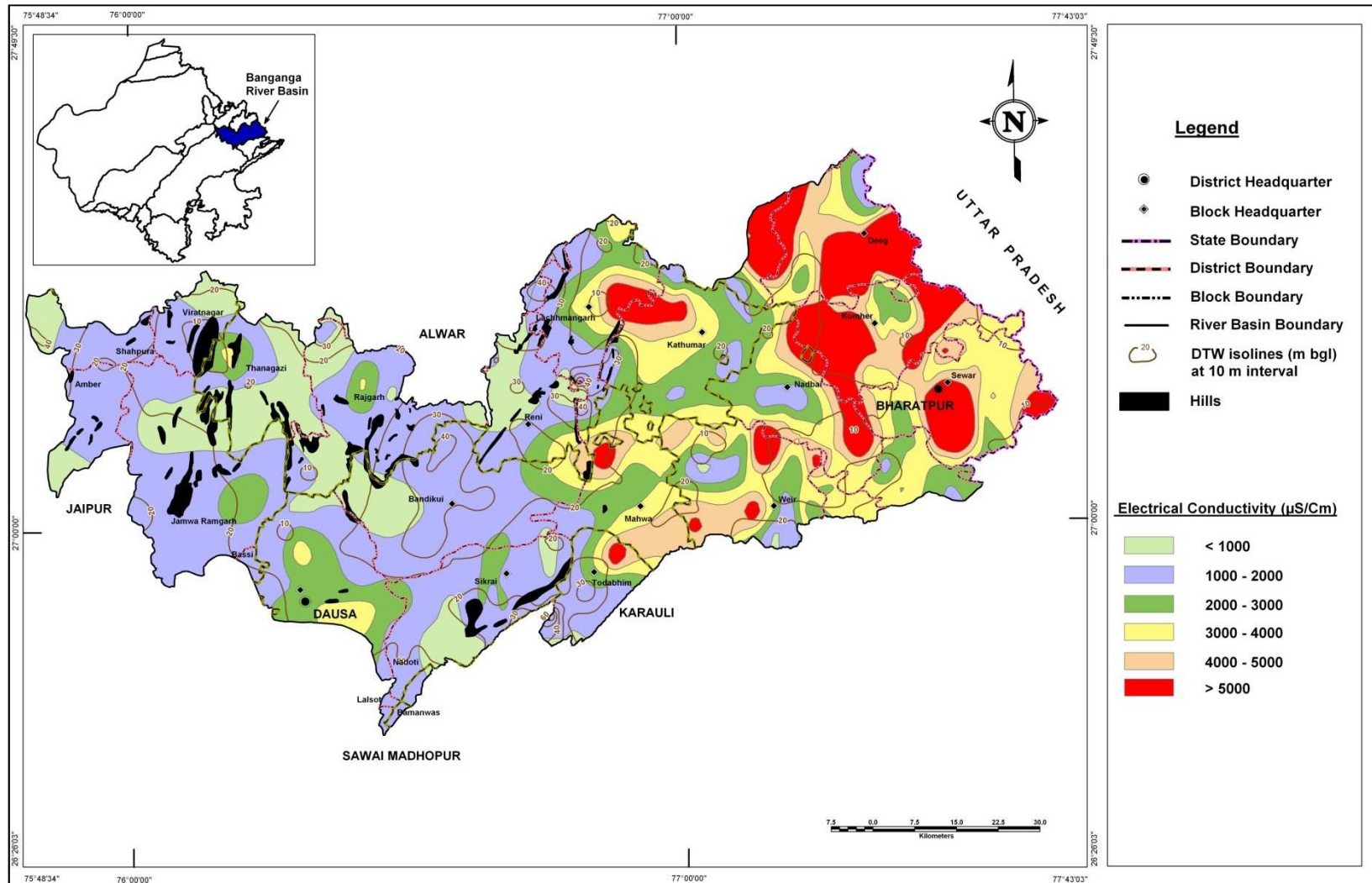
# BANGANGA RIVER BASIN –

## Water level fluctuation (Pre-Post Monsoon, 2010)



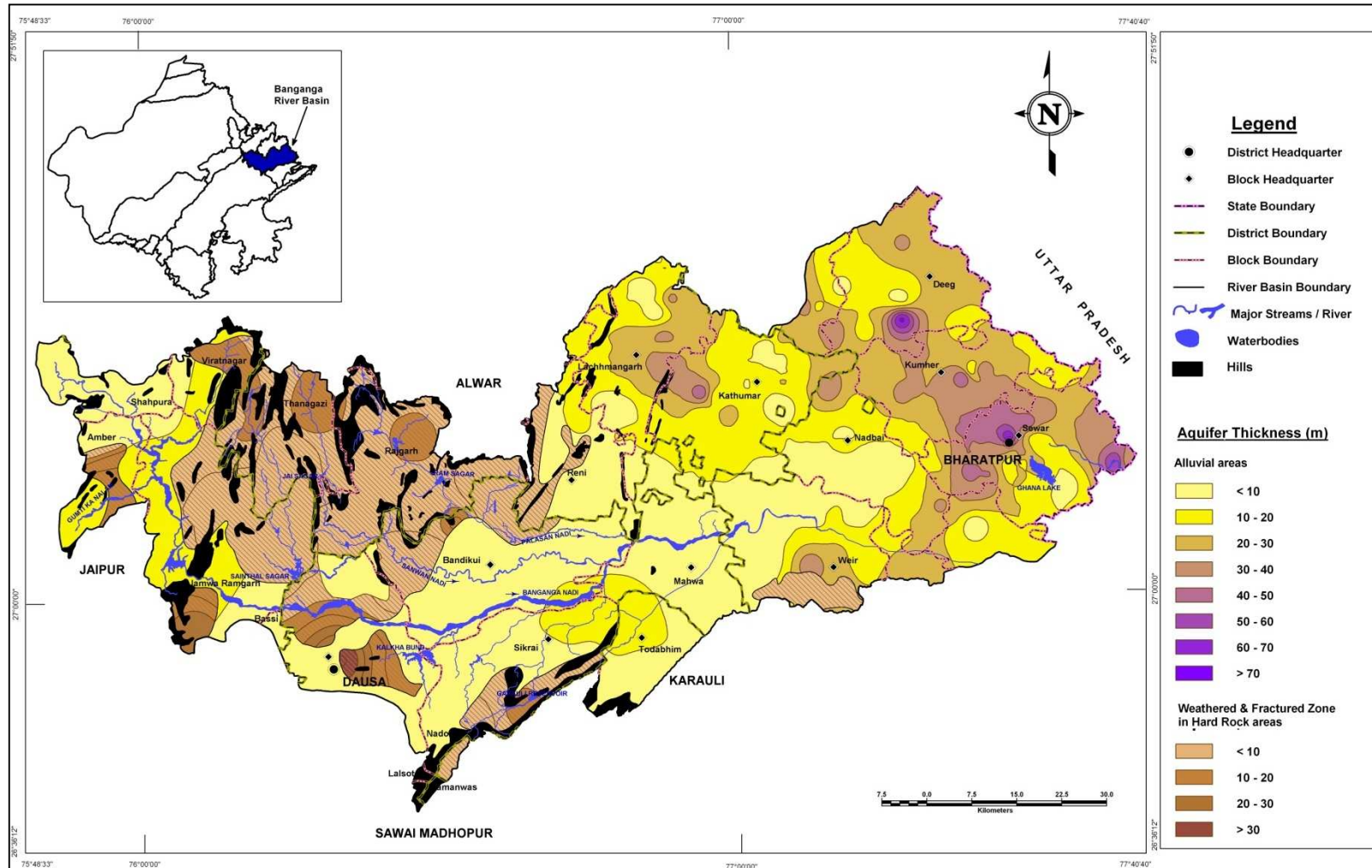
# BANGANGA RIVER BASIN –

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



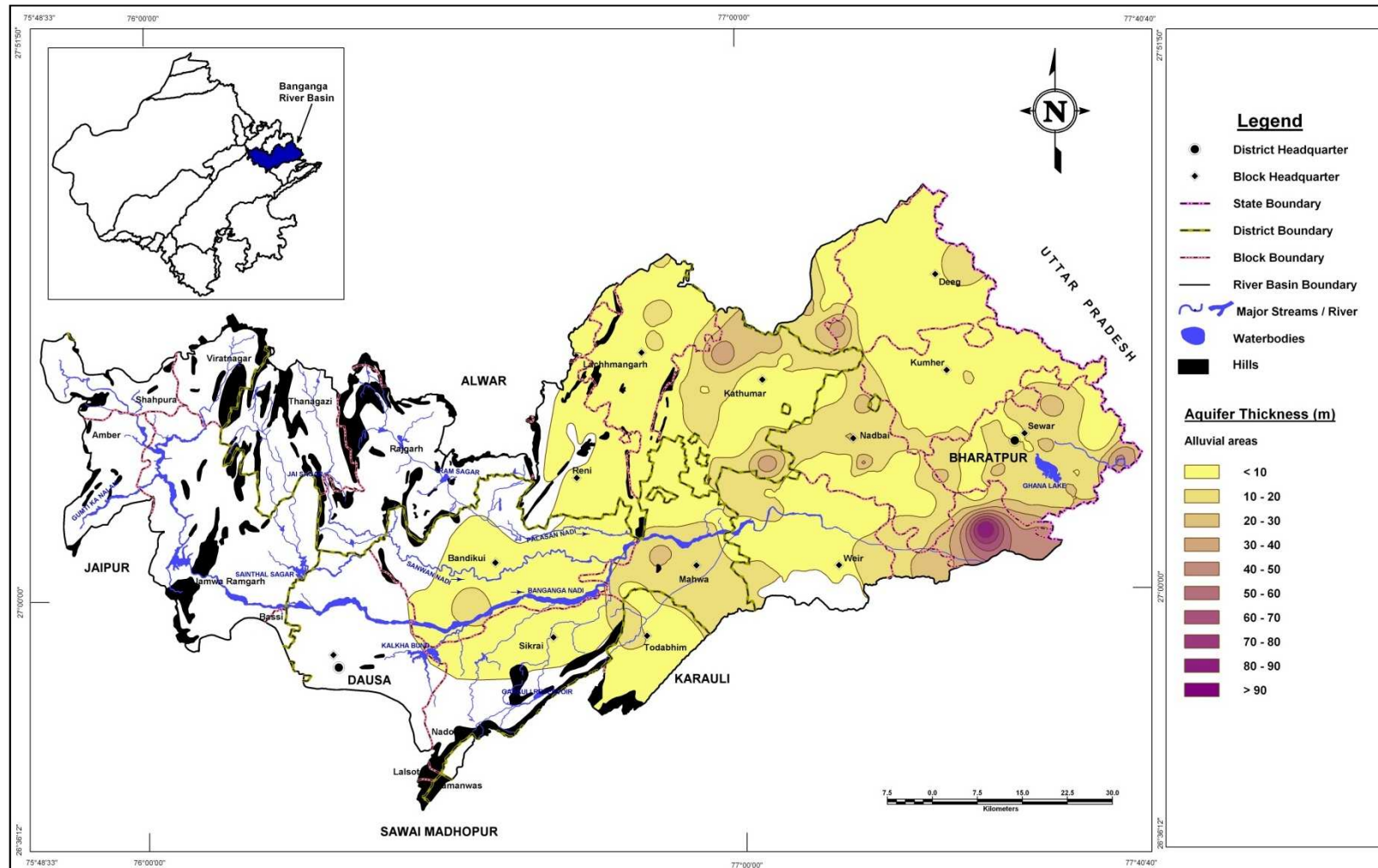
# BANGANGA RIVER BASIN –

## Thickness of Unconfined Aquifer





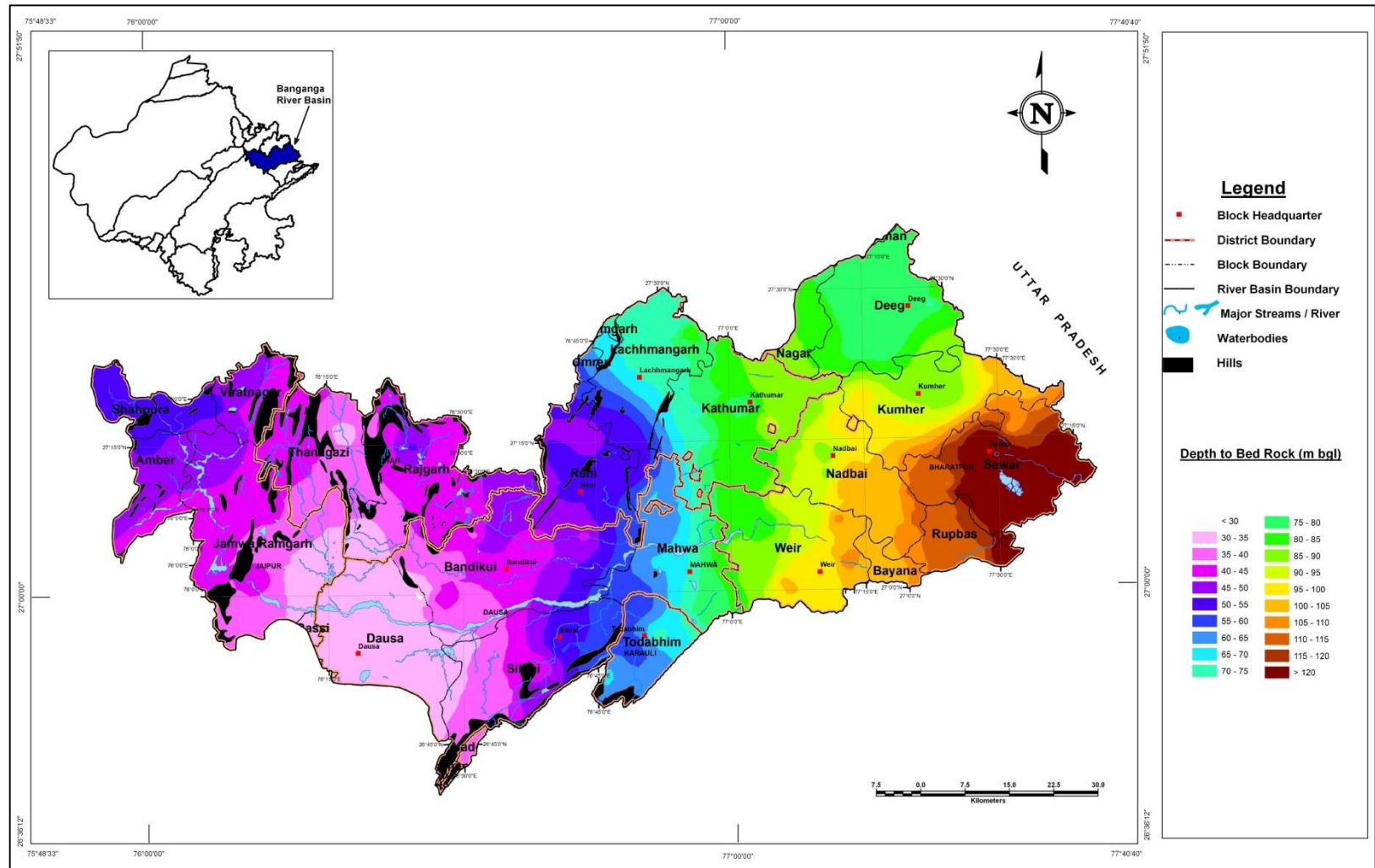
# BANGANGA RIVER BASIN – Thickness of First Confined Aquifer



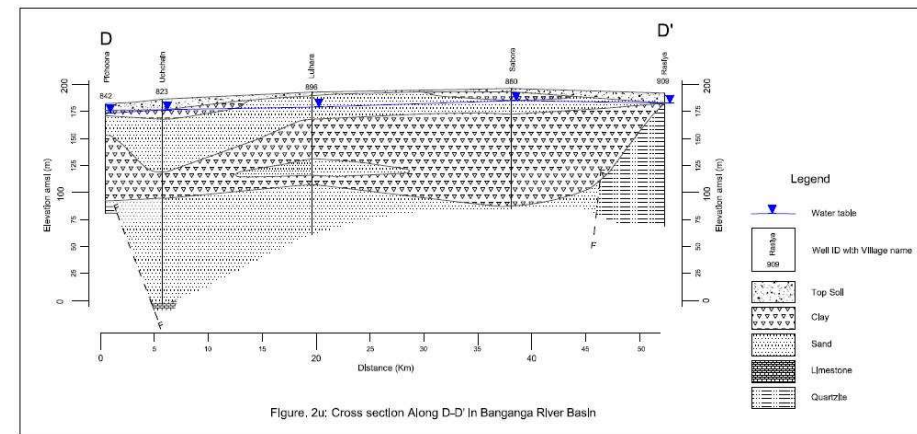
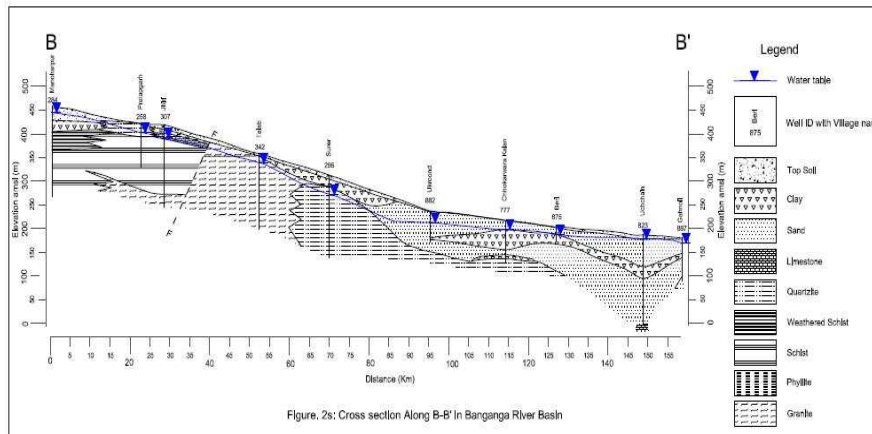
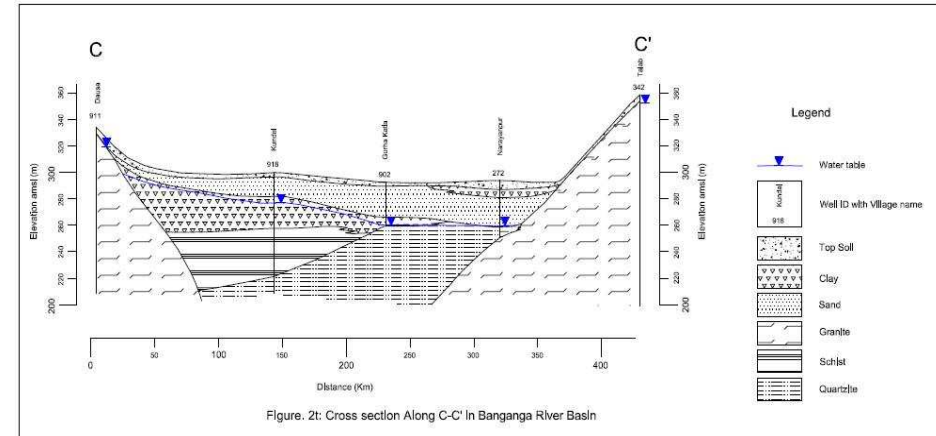
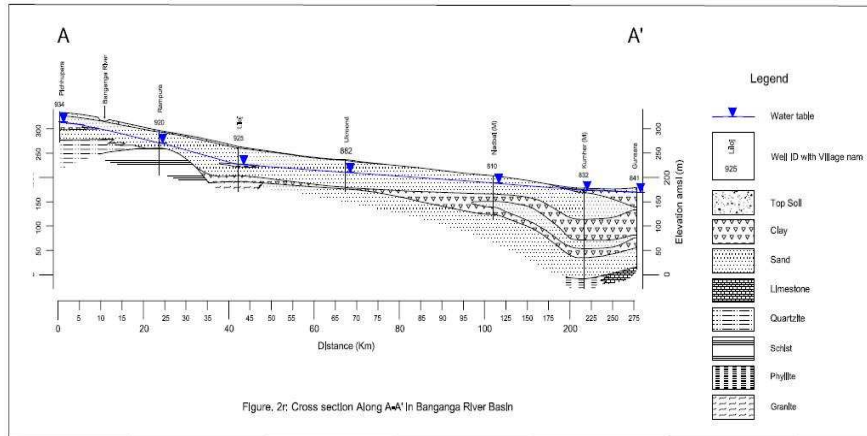
The map displays the Banganga River Basin, which spans across several districts in Rajasthan: Jaipur, Alwar, Dausa, Karauli, and Bharatpur. The basin's boundary is outlined in black. Major streams and rivers are shown in blue, including the Banganga Nadi, Kalas Nadi, and others. Topographic features like hills are marked with black symbols. The map also shows administrative boundaries for districts and blocks, as well as the state boundary with Uttar Pradesh to the east. An inset map in the top left corner shows the location of the Banganga River Basin within the state of Rajasthan. A legend on the right side explains the symbols used for district headquarter, block headquarter, state boundary, district boundary, block boundary, river basin boundary, major streams/river, waterbodies, and hills. Below the legend, a section titled 'Aquifer Thickness (m)' provides a color-coded scale for alluvial areas, ranging from less than 10 meters (yellow) to more than 40 meters (dark purple). A scale bar at the bottom right indicates distances in kilometers (0 to 30 km). A north arrow is located in the top right corner. The map is framed by coordinates: 75°48'33" to 77°40'40" longitude and 26°38'12" to 27°15'30" latitude.

# BANGANGA RIVER BASIN –

## Depth to Bedrock



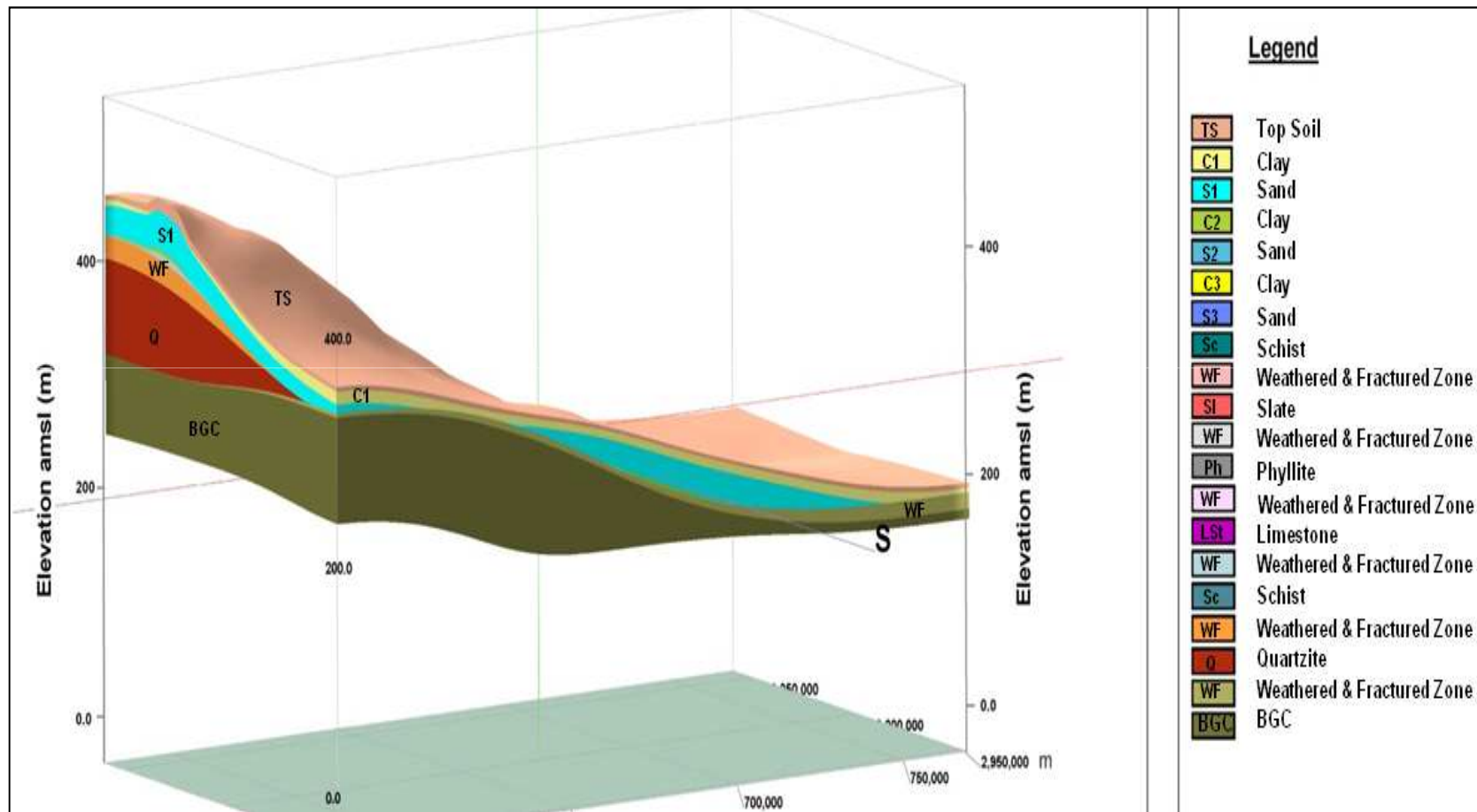
# BANGANGA RIVER BASIN – Hydrogeological Cross-sections





# BANGANGA RIVER BASIN –

## 3D Aquifer Model





# Static and Dynamic GW Resource Assessment

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- 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)

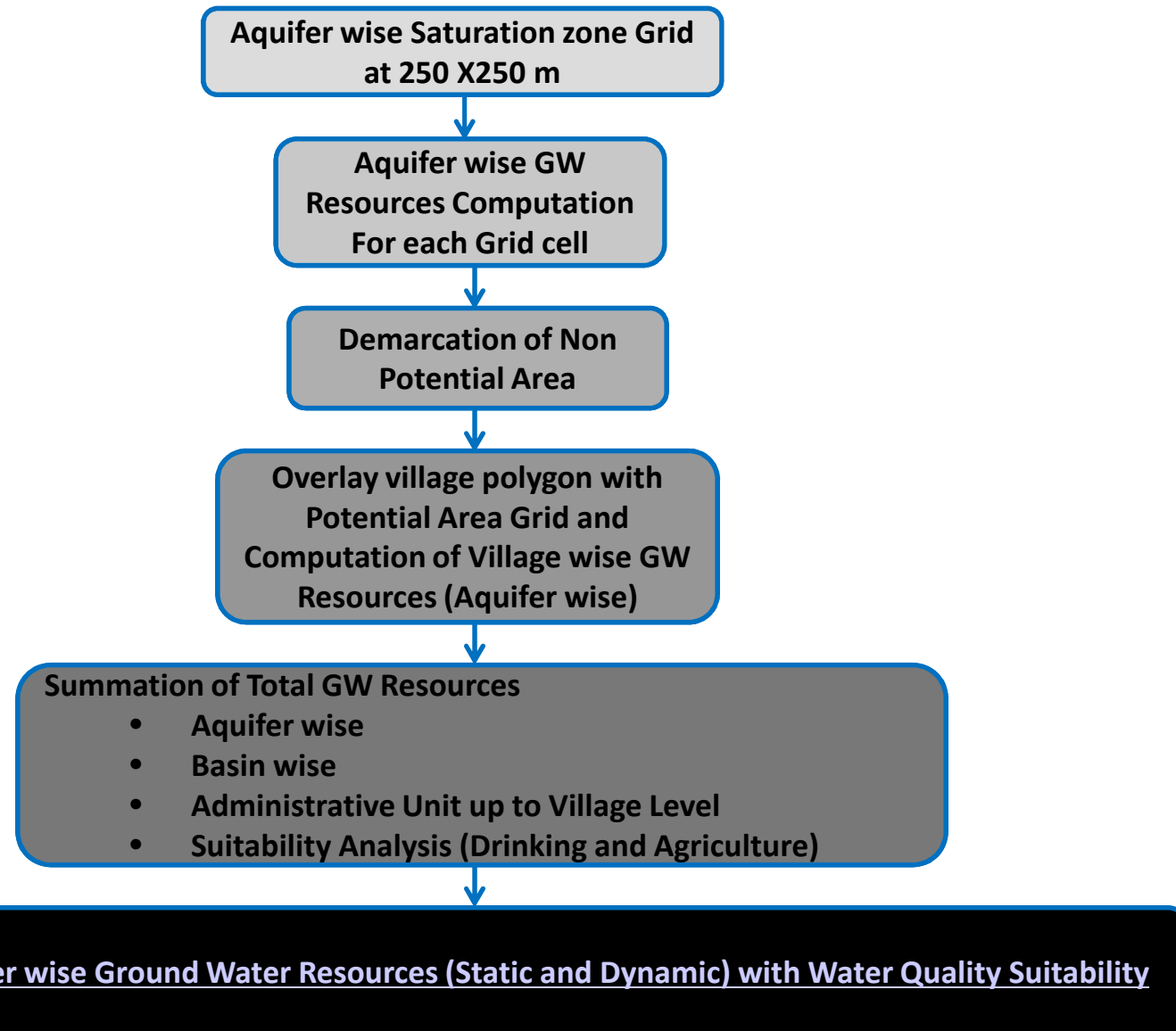
Basin Name	Dynamic Resources *	Static Resources *
	(mcm)	(mcm)
Banas	2,305.06	12,175.11
Banganga	710.66	10,139.45
Chambal	1,557.04	5,170.23
Gambhir	475.57	5,281.91
Ghaggar	246.72	44,829.12
Kantli	140.77	3,124.82
Luni	2,068.62	58,084.68
Mahi	383.01	2,896.80
Other Nallahs	17.83	6,138.36
Outside Basin	4,745.37	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
<b>Total</b>	<b>14,025.82</b>	<b>411,094.93</b>

# Static and Dynamic GW Resources- Rajasthan

(Aquifer wise)

Aquifer Name	Dynamic Resources *	Static Resources *
	(mcm)	(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
<b>Total</b>	<b>14,025.82</b>	<b>411,094.93</b>

# 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




**Ground Water Information System**  
Developed by Ground Water Department, Jodhpur, Rajasthan

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### Rajasthan Ground Water Information System




▼ Know RGWD

▼ Publications/Reports

▼ Notices

▼ MIS Reports

Welcome to Rajasthan Ground Water Information System



I'm Ground Water Department, introducing myself. I believe that you would be interested to know the mystery of my name as you would be eager to know the mystery of water concealed below the earth.

After the independence, I was established to combat the problem of water for irrigation and drinking. Thus, the Government of India, in 1949, under the ministry of Food and Irrigation established "Rajasthan-Bhu-Garbh- Mandal" for exploration and exploitation of ground water for the purposes of drinking and irrigation. In the beginning, the head quarter of the Mandal was at Jaipur, which later was shifted to Jodhpur in 1951. The Mandal started functioning under one Administrative officer with only one Rotary drilling rig and one percussion rig. Like Mandal, the Agriculture Department of Government of Rajasthan also purchased a few machineries for drilling and deepening of wells. Thus, The Mandal and the Agriculture Departments both started similar works for different agencies. [More info](#)

[Return to Map](#)

#### News

**Two die in helicopter crane crash**  
Two people are killed when a helicopter crashes into a crane at the top of a building in Vauxhall in central London, police confirm.  
**Source(1):** BBC Wednesday, January 16, 2013 3:11:13 PM


**Inquiry into horsemeat in burgers**  
Investigations are under way to try to discover how horsemeat got into some beefburgers on sale in UK and Irish supermarkets, including Tesco.  
**Source(2):** BBC Wednesday, January 16, 2013 10:29:59 AM

Central Ground Water Board Rajasthan Water Resources Water Resource Information System

# WEB GIS APPLICATION -




## *Village Level Ground Water Summary*

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

**Ground Water Information System**  
Developed by Ground Water Department, Jodhpur, Rajasthan

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Select your village to see the Village Report:

District  Block  Gram Panchayat (Optional)  Village **Village Details:**

Population : 1376

Area (Sq.km.) : 7.42

Aquifer : Phyllite

	Electrical Conductivity (EC)	Chloride (Cl)	Fluoride (F)
Human	Suitable	Suitable	Unsuitable
Cattle	Suitable	Suitable	Suitable

Suitable For Agriculture : Suitable

Static Resources (MCM) : 3.3425

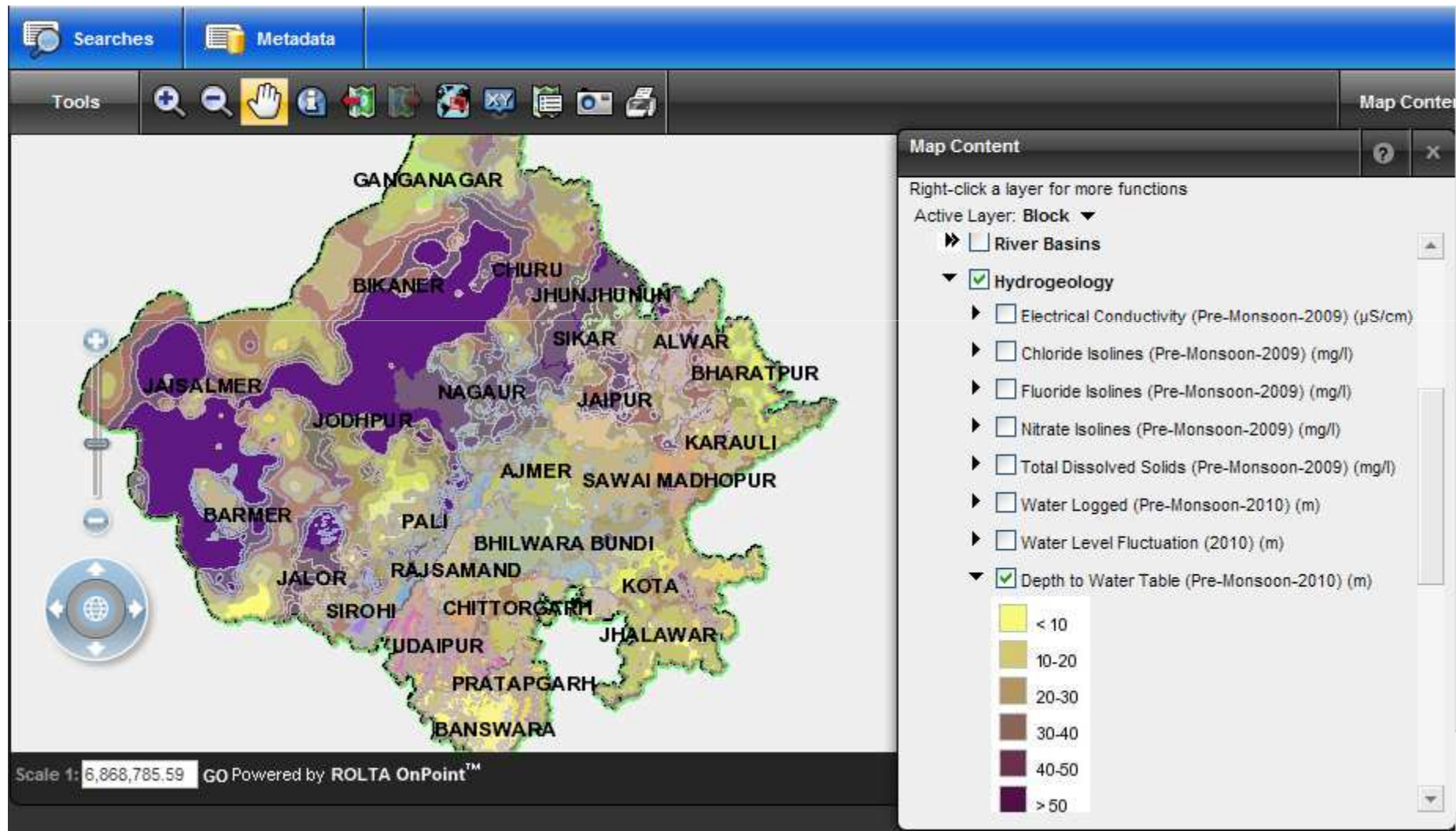
Dynamic Resources (2010) (MCM) : 0.2623



# 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

District:	<input type="text" value="GANGANAGAR"/>	Block:	<input type="text" value="SURATGARH"/>	Gram Panchayat:(Optional)	<input type="text" value="BIRMANA"/>	Village:	<input type="text" value="HARISINGHPURA"/>
-----------	---	--------	--	---------------------------	--------------------------------------	----------	--

Pre-Monsoon Depth to water level (mbgl) :	<input type="text" value="13.5"/>	(Please enter the depth to water level as on 15th June)
Post-Monsoon Depth to water level (mbgl) :	<input type="text" value="11.23"/>	Date: <input type="text" value="06/19/2012"/> 

**Water Quality :** Ground water quality is **Unsuitable** for drinking purpose.  
(drinking water quality standards adopted from Bureau of Indian Standards 1991, later amended till 2008, for dissolved Solids, chloride and Fluoride concentration)

**Water Resources:** The ground water resources being computed here based on difference in water table depth from pre-monsoon levels to the current date of measurement. On this basis, the change in storage reflects available 'dynamic groundwater resource' only.

Assuming 40 liters per day per person of domestic requirement. The available dynamic ground water resource will meet the domestic water requirements for next **40 days**, provided the same is not utilised for any other purpose till the next.

Caution: Till the next monsoon, ground water extraction should be limited for drinking water only; any extraction for other purpose will enhance the drinking water crises in the village.

**Groundwater recharge / enrichment Tips:**  
To ensure availability of drinking water in the village, it is recommended that groundwater recharge should be done through construction of various structures at village level for available surplus rainwater.  
For effective and better results, the local Ground Water Office must be consultant for information regarding site specific suitable groundwater recharge structures.  
For agriculture and other water needs surface water harvesting must adopted.

# Achievements

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- 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 computed 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

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- 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***

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