Groundwater Resource, Aquifer Mapping and Management Programme in India

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Ministry of Water Resources, River Development and Ganga Rejuvenation

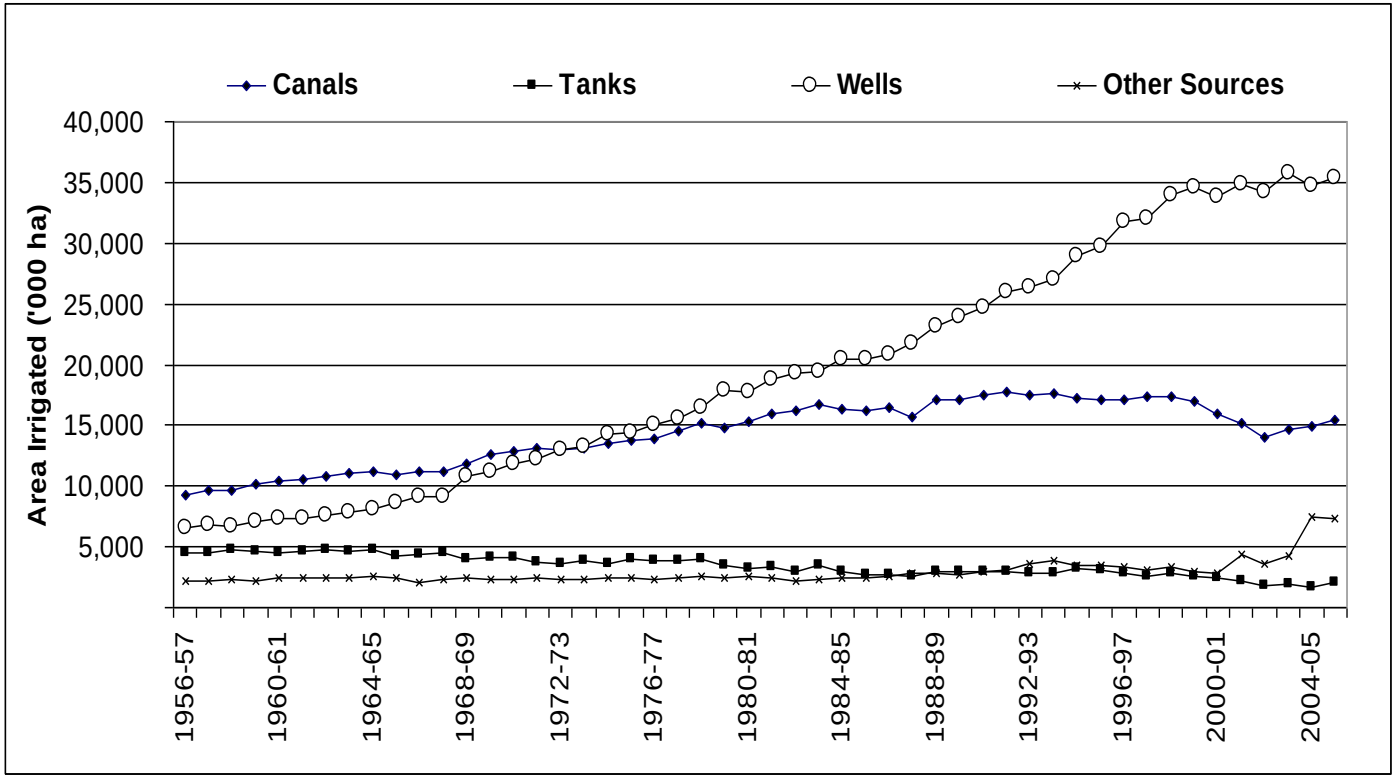
Govt of India

Groundwater an extremely important natural resource in India…

More than 85 % of rural domestic water, about 50% of urban and industrial water and >60% of irrigation water requirements are catered by aquifers.

A rapid increase in ground water extraction in the last 3 decades
Major demand is from Irrigation sector

Area Irrigated by Various Sources in India (1955-06)



Major Ground Water Issues

- Over-exploitation of Ground Water
- Under-utilization of Resources in Eastern States
- Limited availability and Sustainability in hard rock areas
- Water logging and salinity problems in canal command areas
- Contamination, both geogenic and anthropogenic
- Intense use in urban areas
- Climate change and its impact on aquifers, the adverse effects and opportunities

Water Availability

(In Billion cubic meters)

Total Precipitation	:	4000
Total Water Availability	:	1869
Total Utilizable Water	:	1122

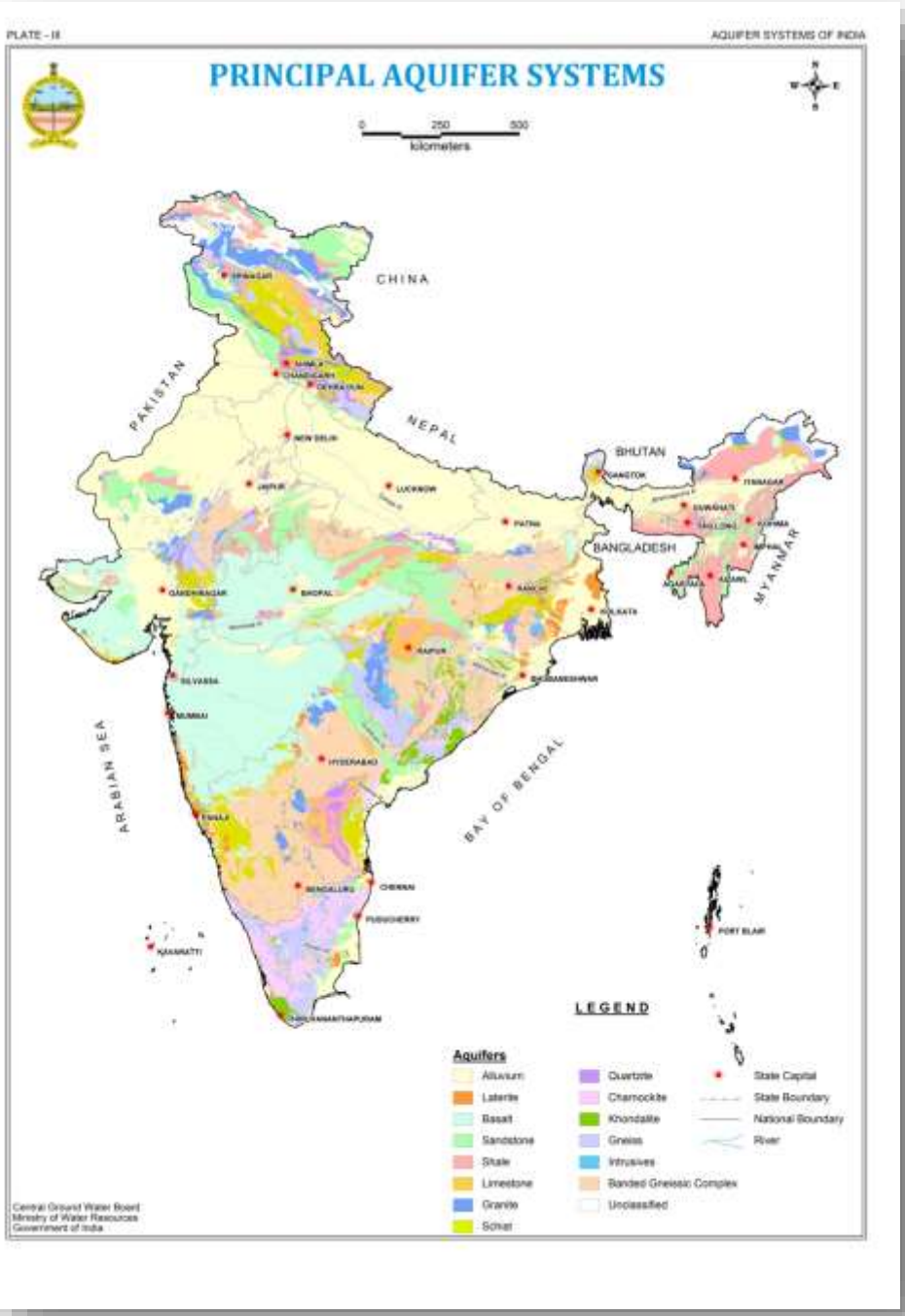
Surface Water - 690

Ground Water - 432/433

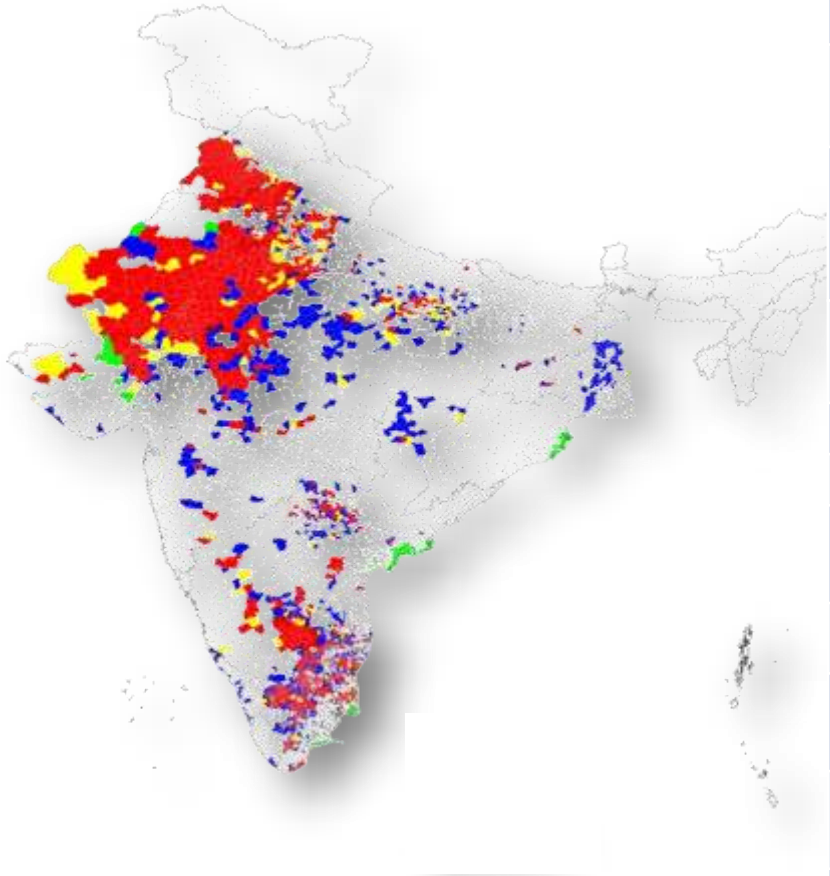
AQUIFER SYSTEMS OF INDIA

All the aquifer systems have been grouped into **14 Principal Aquifer Systems**

1. Alluvium
2. Laterite
3. Basalt
4. Sandstone
5. Shale
6. Limestone
7. Granite
8. Schist
9. Quartzite
10. Charnockite
11. Khondalite
12. Banded Gneissic Complex
13. Gneiss
14. Instrusives



Replenishable Ground water Resource Availability



Sl. No.	Item	2009	2011
1.	Annual Replenishable Resources	431 bcm	433 bcm
2.	Net Annual Ground Water Availability	396 bcm	398 bcm
3.	Annual Ground Water Draft for Irrigation, Domestic & Industrial uses	243 bcm	245 bcm
4.	Stage of Ground Water Development	61%	62%
5.	Categorization		
	Total Assessment Units	5842	6607
	Safe	73%	68%
	Semi-Critical	9%	11%
	Critical	3%	3%
	Over-Exploited	14%	16%
	Saline	1%	1%

Aquifer Mapping & Management Programme

Paradigm shift from groundwater extraction to sustainable management of the resource

- Requires aquifer geometry, potential & quality variation
- Necessitated groundwater management at the local level

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Four major components

- **Mapping of aquifers, resource, quality, recharge potential**
- **Ground Water Modeling and Management Plan**
- **Dissemination of Data/information / plan**
- **Participatory management of the resource**

The issues being addressed

- Identify and delineate the different aquifers, nature of the aquifers
- Yield potential of different aquifers and their vertical interconnectivity
- Spatial behavior of water level in different seasons and understand the long-term water level trend
- Annual replenishable resource, availability in the deeper aquifers.
- Recharge mechanism and potential of different aquifers
- Identifying areas suitable for rain water harvesting and artificial recharge

The issues being addressed (contd….)

- Ground water extraction by different sectors, future water demand.
- Chemical quality of ground water, contamination if any.
- Vulnerability of aquifers to pollution and resource depletion
- Plan for sustainable use of the resource.
- Management information system at place

To initiate the Aquifer Mapping Programme Pilot Projects were taken

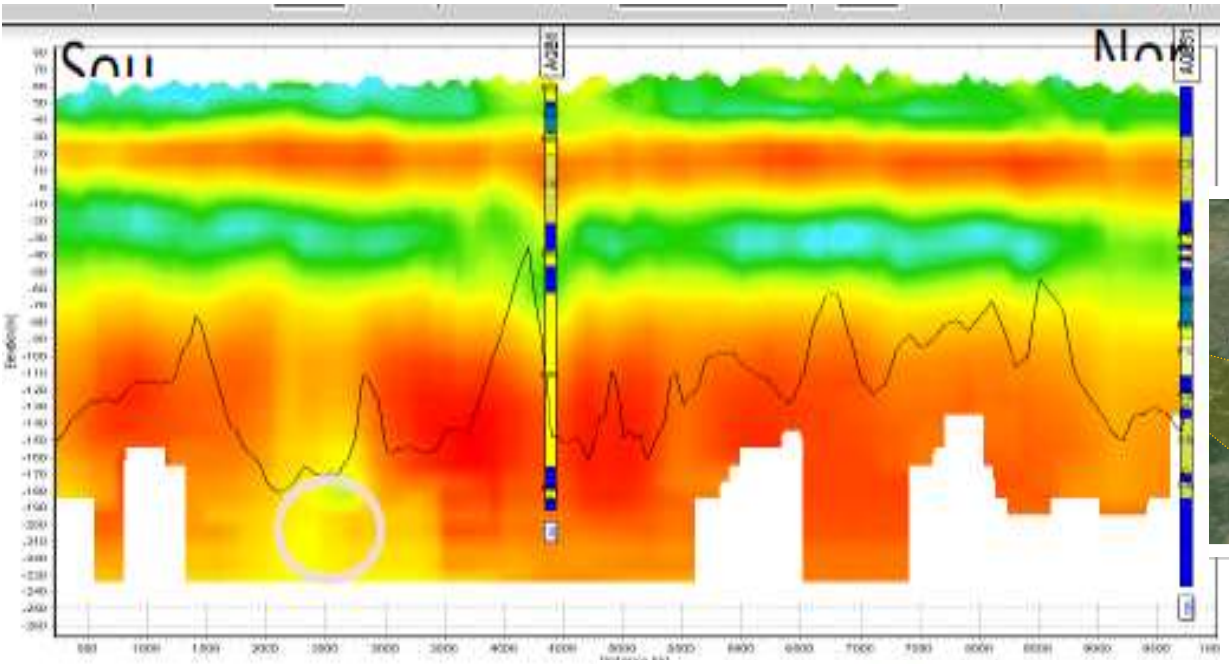
- Completed at 6 different hydrogeological terrains in Bihar, Rajasthan, Maharashtra, Karnataka and Tamil Nadu states
  - All advance Hydrogeological, geochemical, isotopic and geophysical techniques have been applied.

Geophysical techniques like, TEM, ERT, GRP, Heli-based Electromagnatic survey

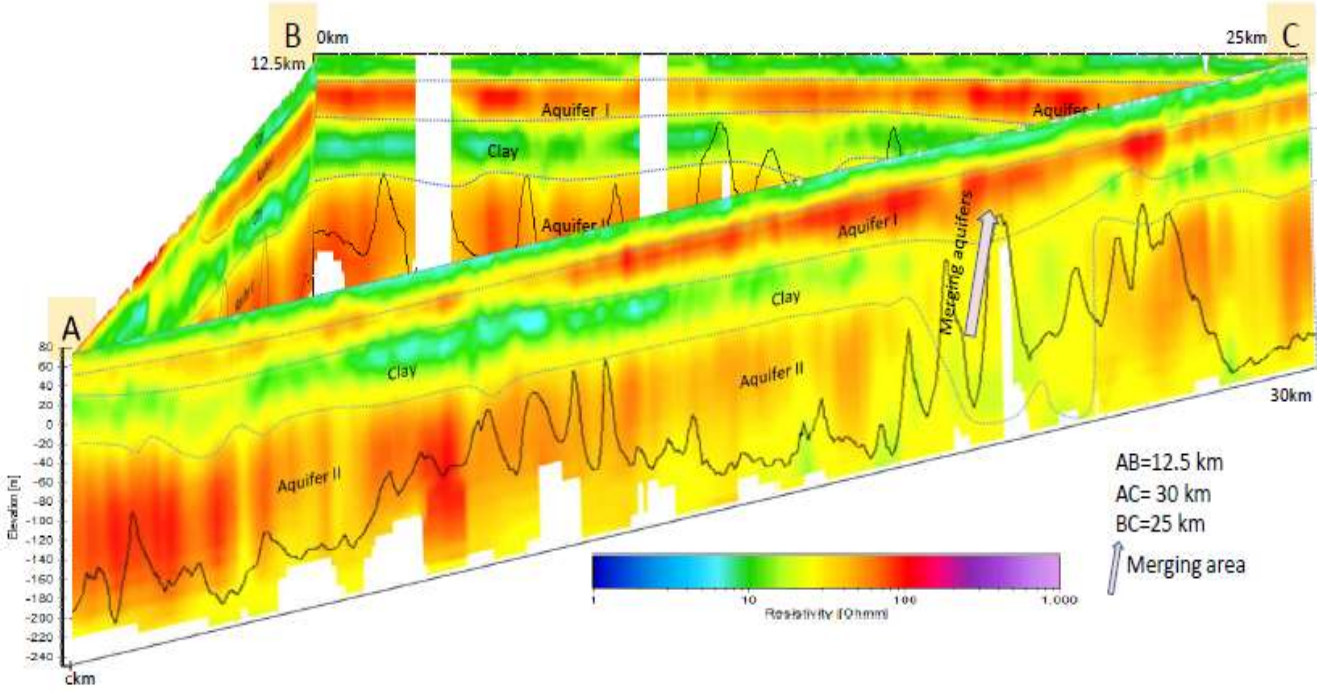
Isotope application like, Stable oxygen and hydrogen, Tritium, C-14

PILOT PROJECT AREAS

Pilot Project Areas	Km^2
Baswa-Bandikui Watershed, Dausa District, Rajasthan - I – AQRAJ	598
Maner-Khagaul Area, Patna Dist, Bihar (Watershed GNDK013)- II – AQBHR	521
Watershed WGKKC-2, Nagpur district, Maharashtra - III – AQMAH	360
Parts of Tumkur District, Karnataka - IV – AQKAR	376
Lower Vellar, Cuddalore district, Tamil Nadu - V – AQTND	344
Part of Thar Desert, Jaisalmer District, Rajasthan. - VI – AQDRT	675

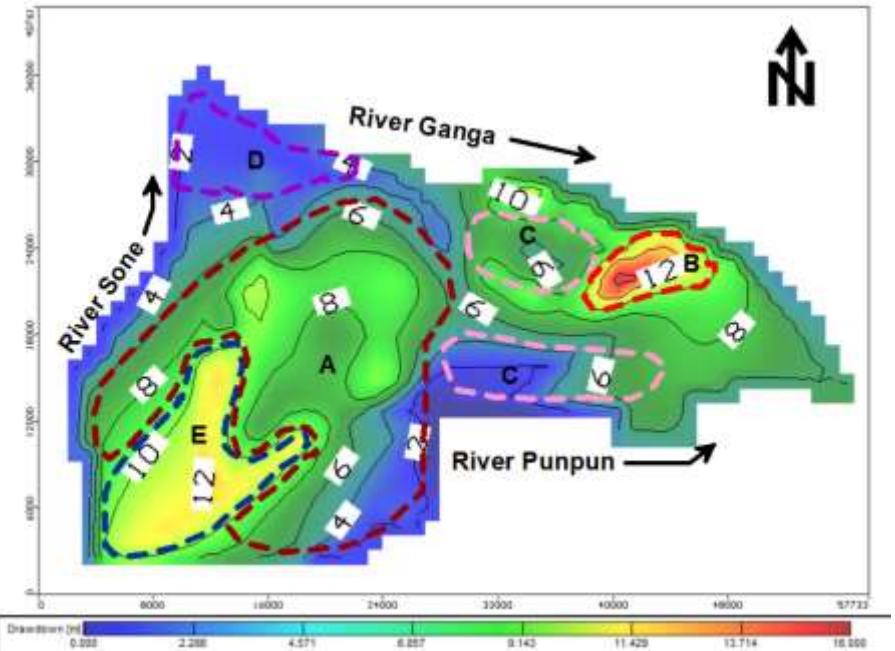


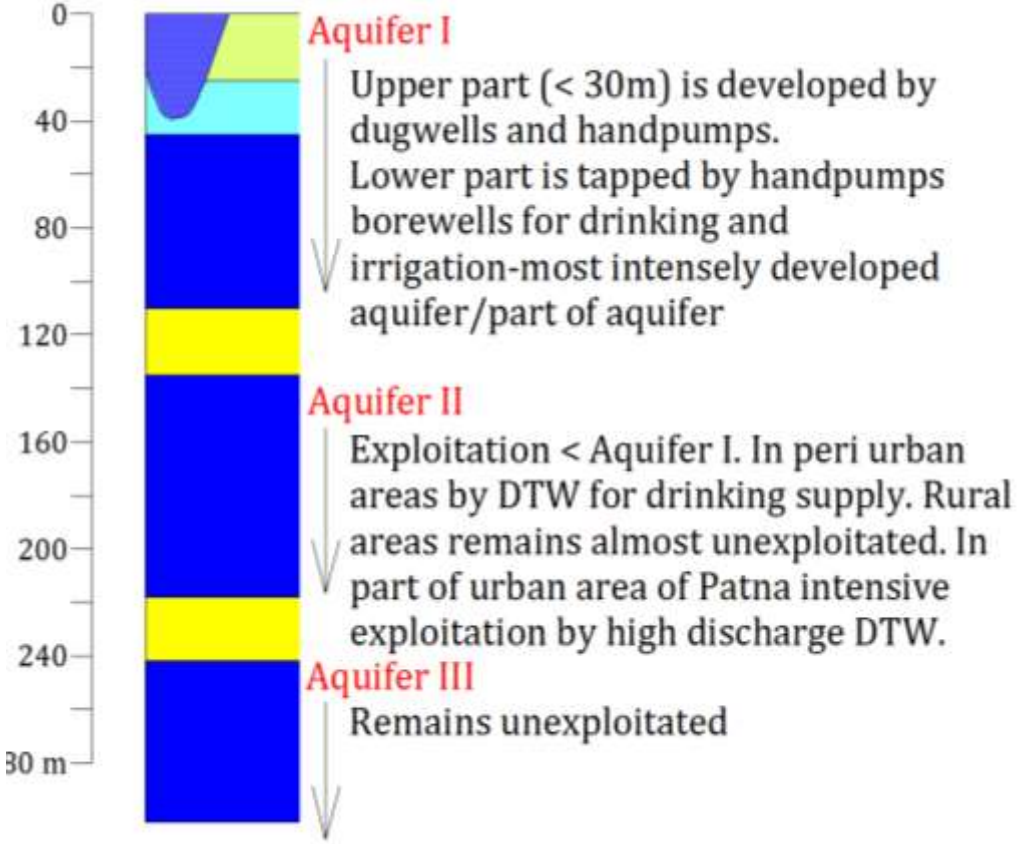
Highly potential aquifers in the Gangetic Plains delineated through Heliborne EM survey



Aquifer Management Plan

Both spatially and vertically





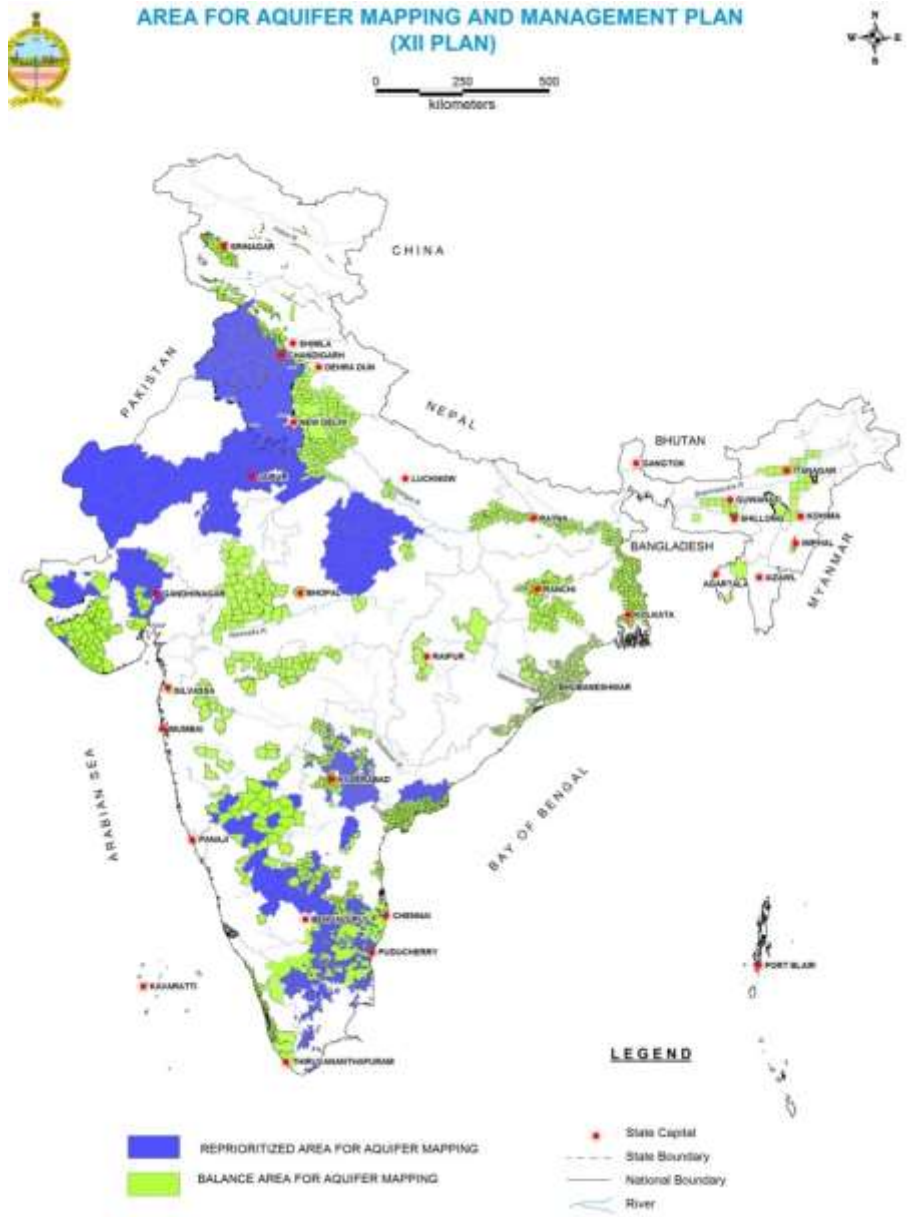
Plan of National Aquifer Mapping
(M km2)

Area identified for aquifer mapping	**- 2.325**
Targeted area during XII Five Year Plan	**- 0.889**
Targeted area to be covered in next five year	**- 1.436**

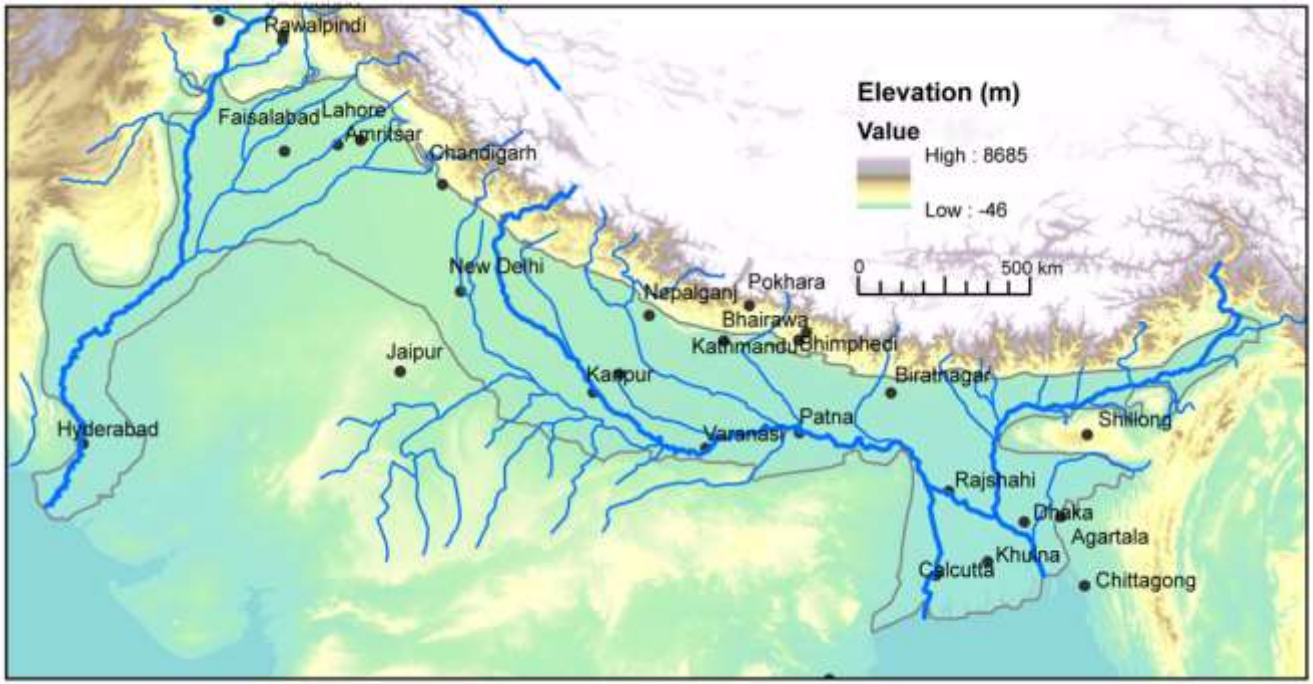
Priority- 0.525 million km2 from the 8 states (Punjab, Haryana, Rajasthan, Gujarat, Tamilnadu, Karnataka, Telengana, Andhra Pradesh and *Bundelkhand area* in UP and MP

Other areas- 0.364 million km2

0.132 million km2 area aquifer maps prepared

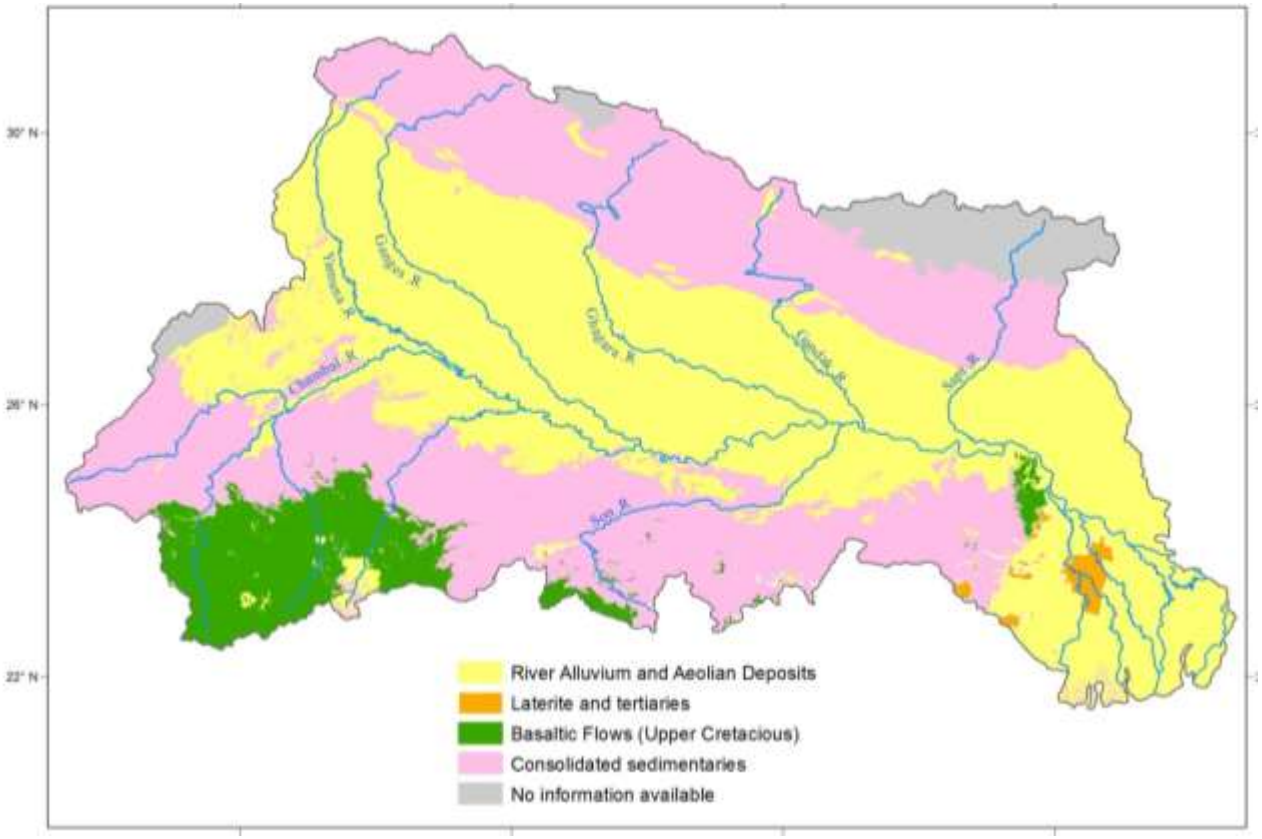


- The Ganges River Basin is of staggering scale, one of the largest in the world (~ 1.2 million km^2).
- Mainly in India (85%), remaining in Nepal (12%) and downstream Bangladesh (3%).
- World's most populous river basin, home to more than 655 million people. Population density is 550 people per km^2 (more than 10 times the global average) and as many as 1285 people per km^2 in Bangladesh



The Gangetic Plains, underlain by alluvial and aeolian deposits at the central part of the basin and the deltaic part form one of the most potential aquifer systems in the world.

More than 1/3 of dynamic resource and >90% of static resource is confined in the Plains

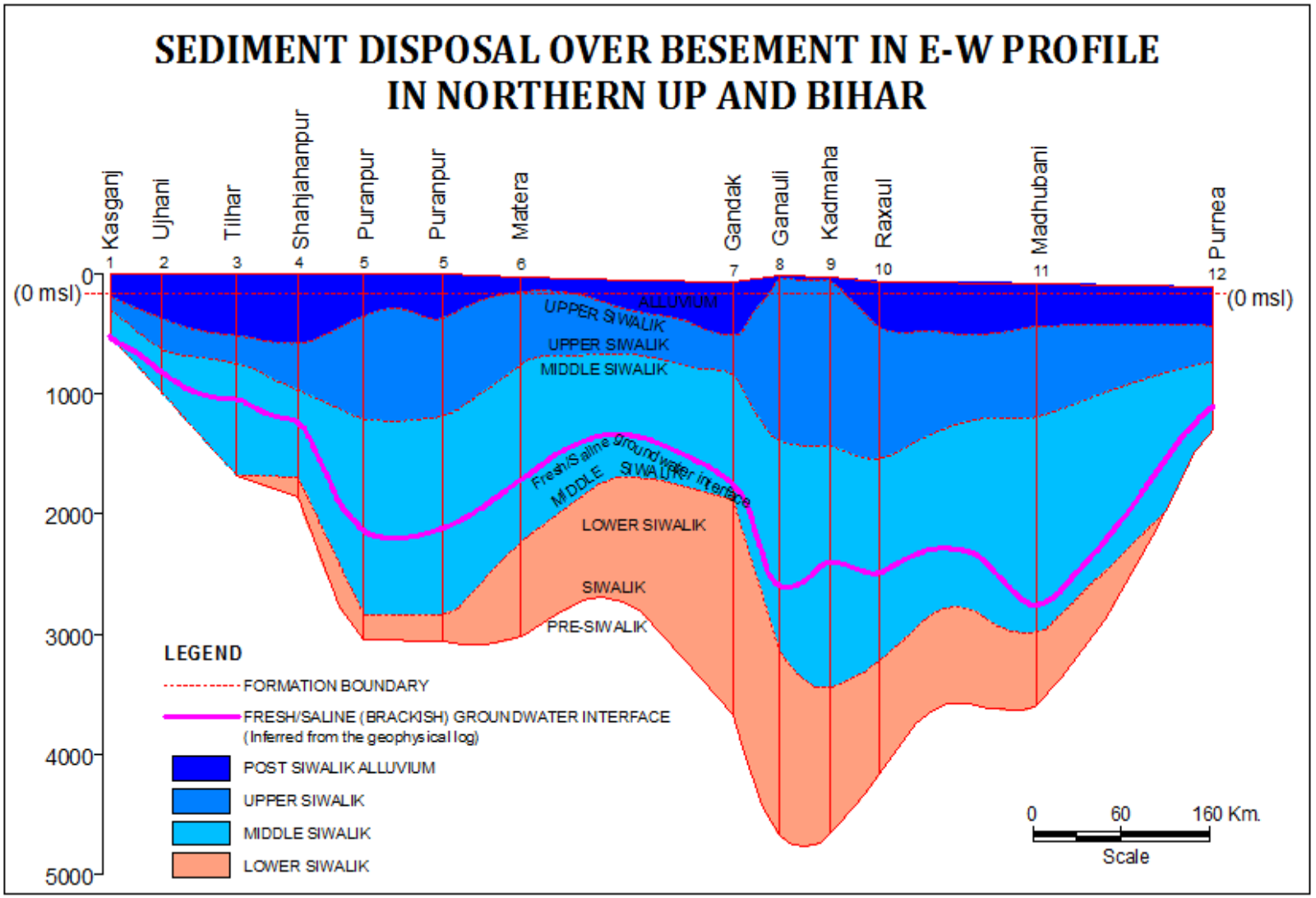


The aquifers can be classified based on the geology, characteristic and yield potential of the aquifers

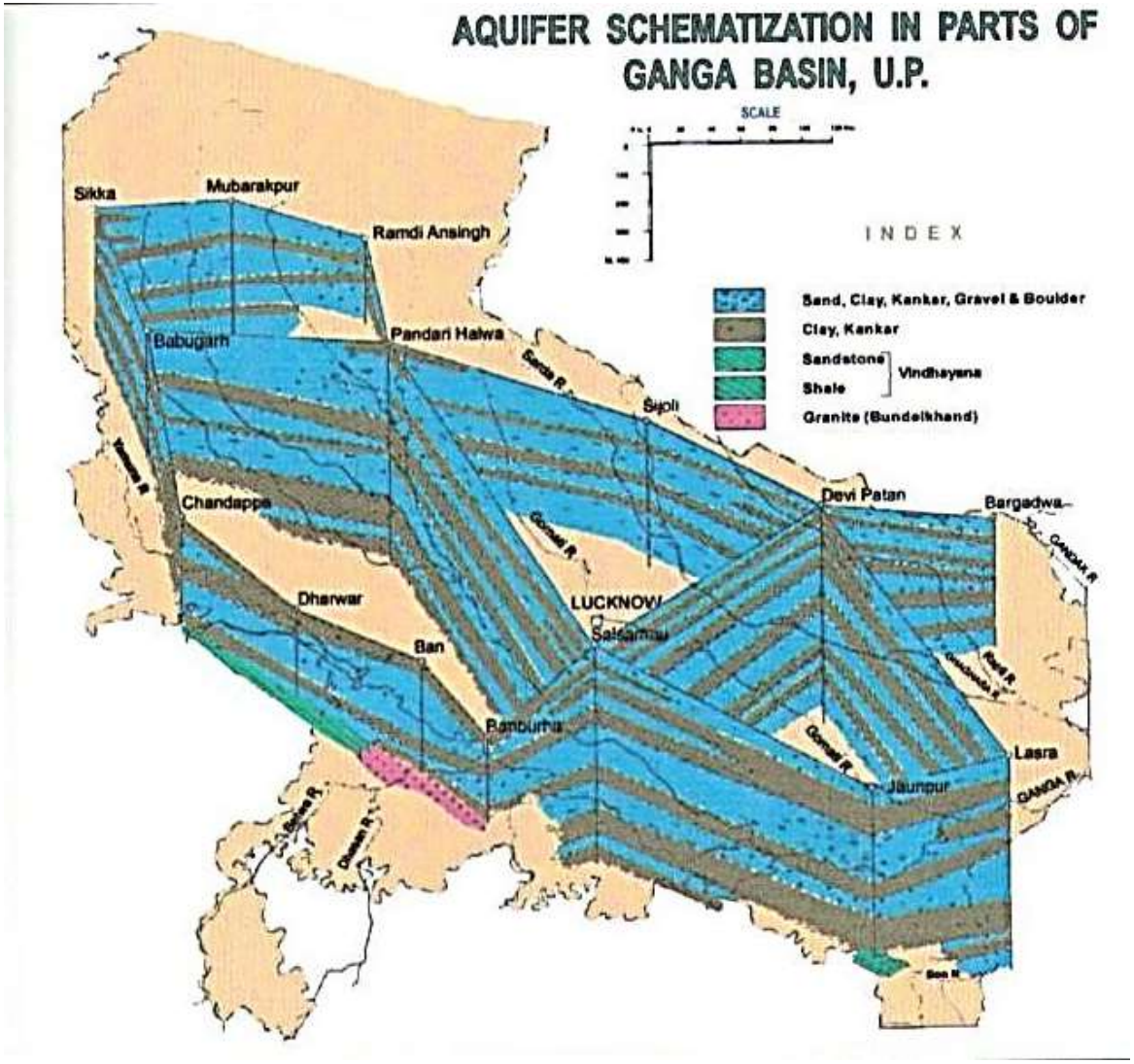
- **Bhabar and Terai belt aquifers**
- **Large Alluvial Fan aquifers**
- **Flood Plain aquifers**
- **Marginal Alluvial Plain aquifers**
- **Deltaic aquifers**

All the units are rich in ground water resources. Except the marginal alluvial plain areas.
The large alluvial fans are the most potential part of the plains, discharge even >350 m3/hr with <6-8 m drawdown.

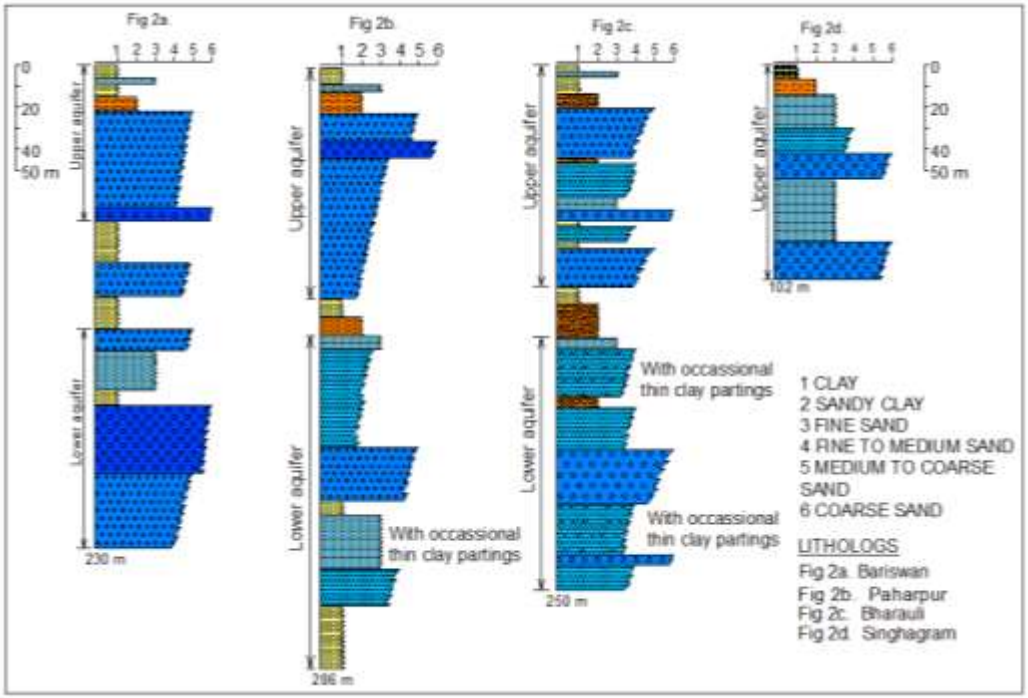
Hugely thick unconsolidated & highly potential aquifers

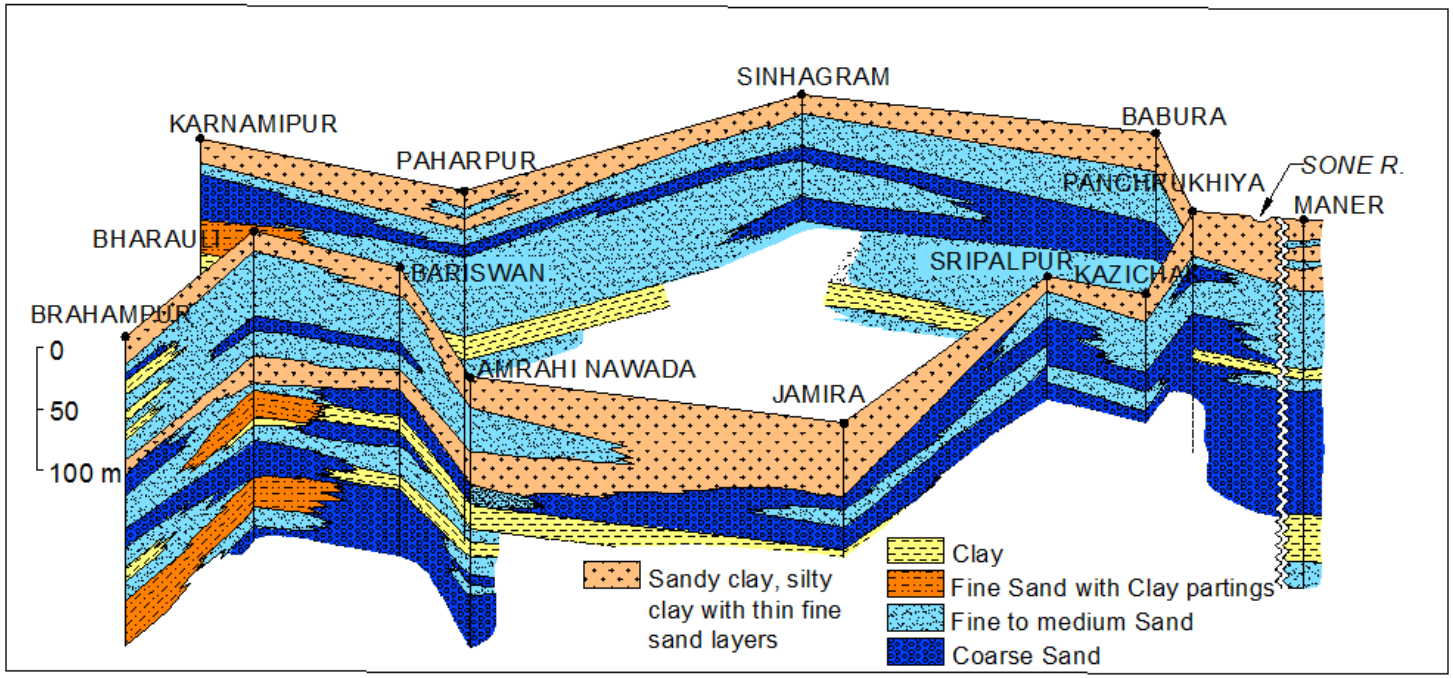


Upper Ganga Plain- Uttar Pradesh State

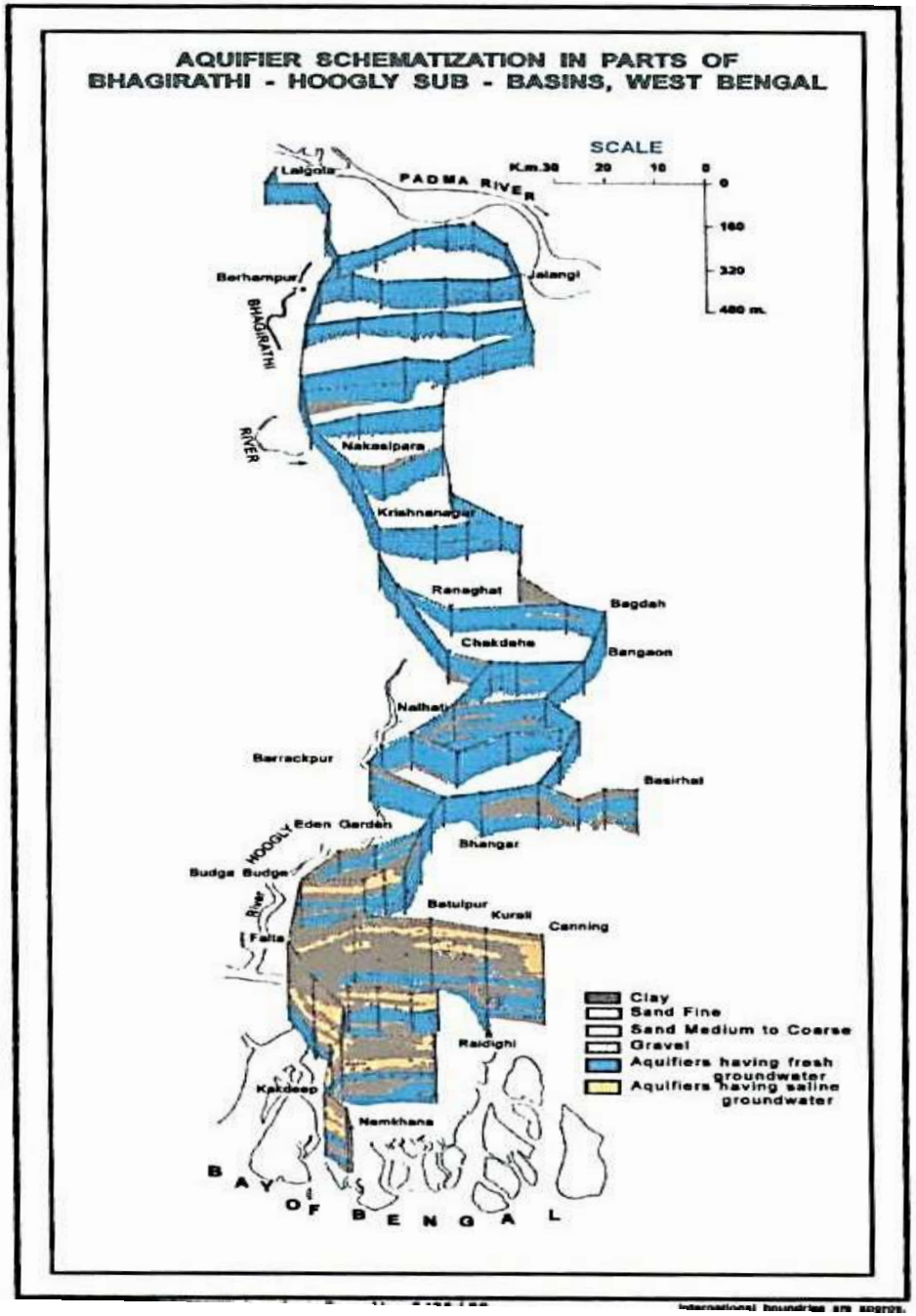


Middle Ganga Plain- Bihar State

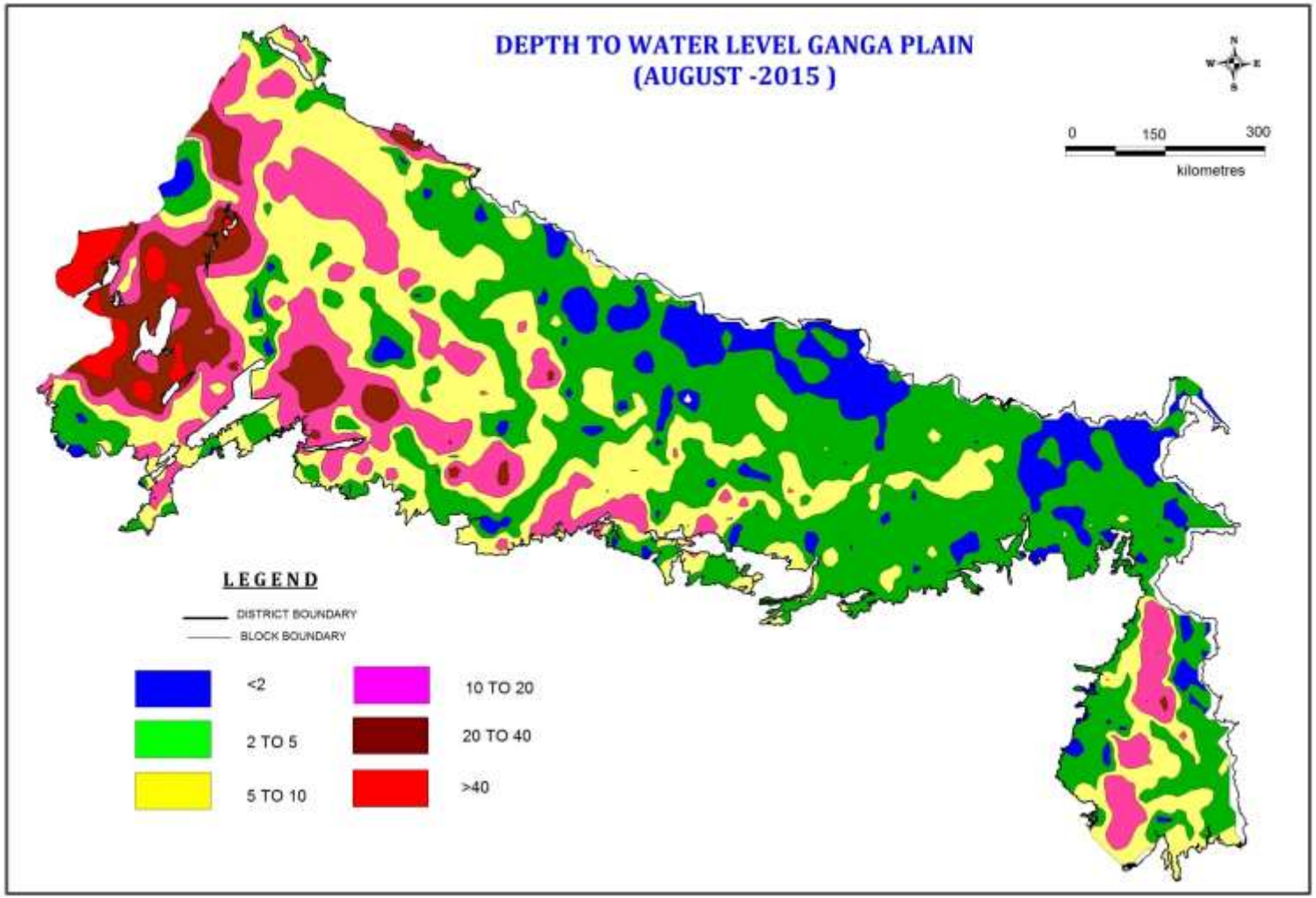




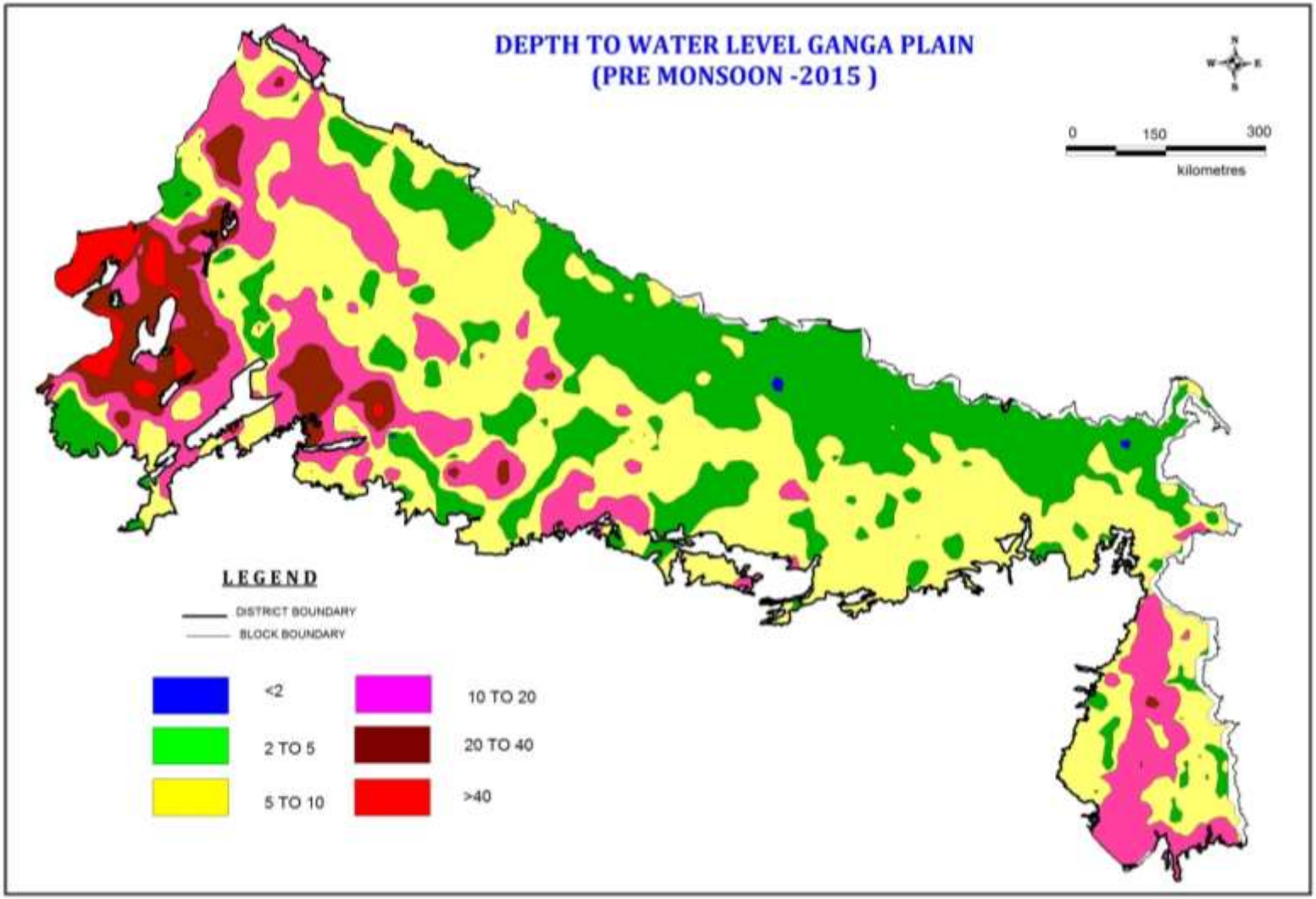
Lower Ganga Plain and the Deltaic Region- West Bengal state



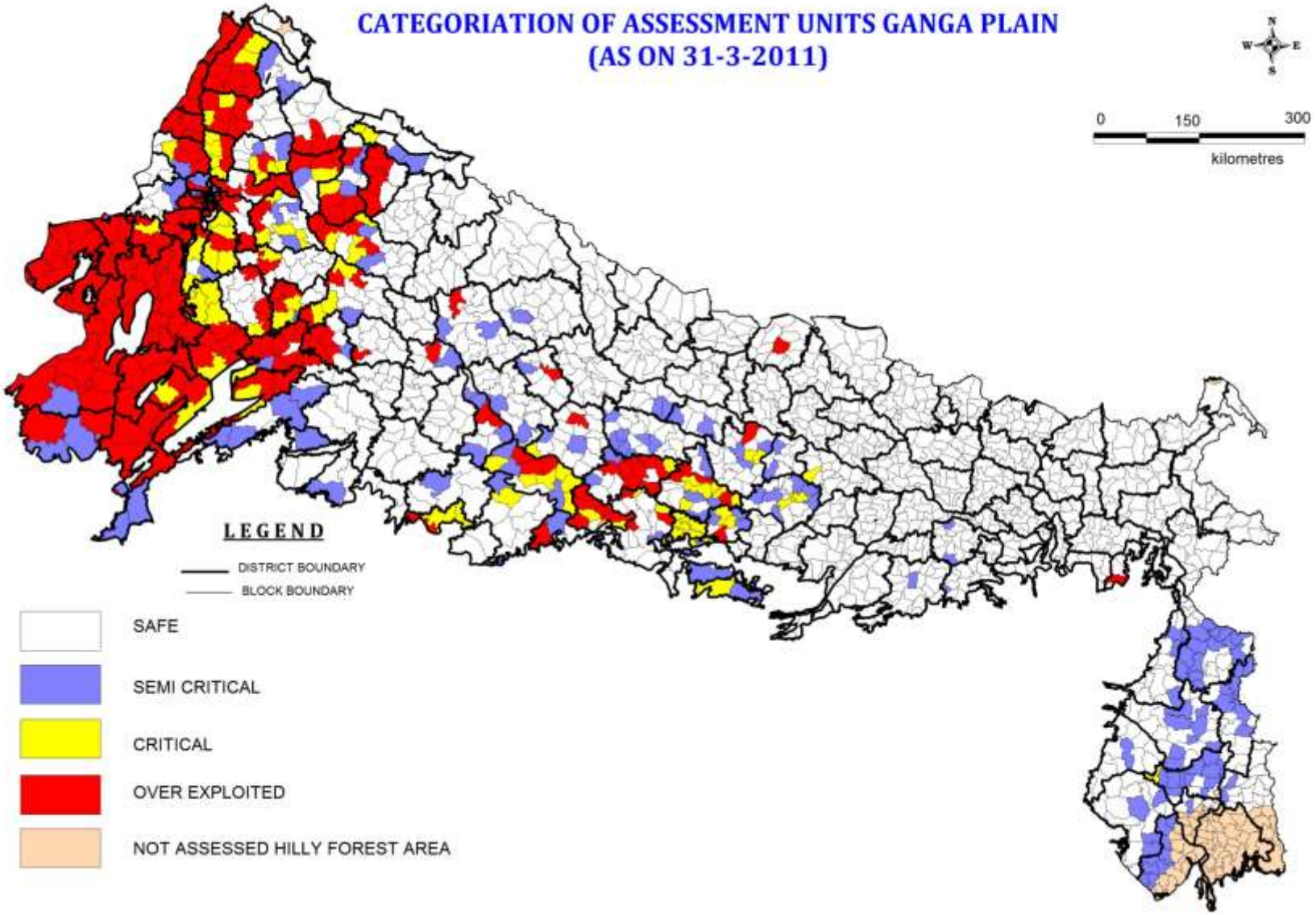
Behavior of water levels in the Gangetic Plains (Mid monsoon 2014)



Behavior of water levels in the Gangetic Plains (Pre monsoon 2015)



CATEGORIATION OF ASSESSMENT UNITS GANGA PLAIN
(AS ON 31-3-2011)



Ground water is by and large potable and fit for irrigation use.

At places, reported contamination are; Fluoride, nitrate, pesticides, iron, salinity, local-scale heavy metals etc.

Arsenic contamination is reported in shallow aquifers (<120 m below ground) at places

Thanks