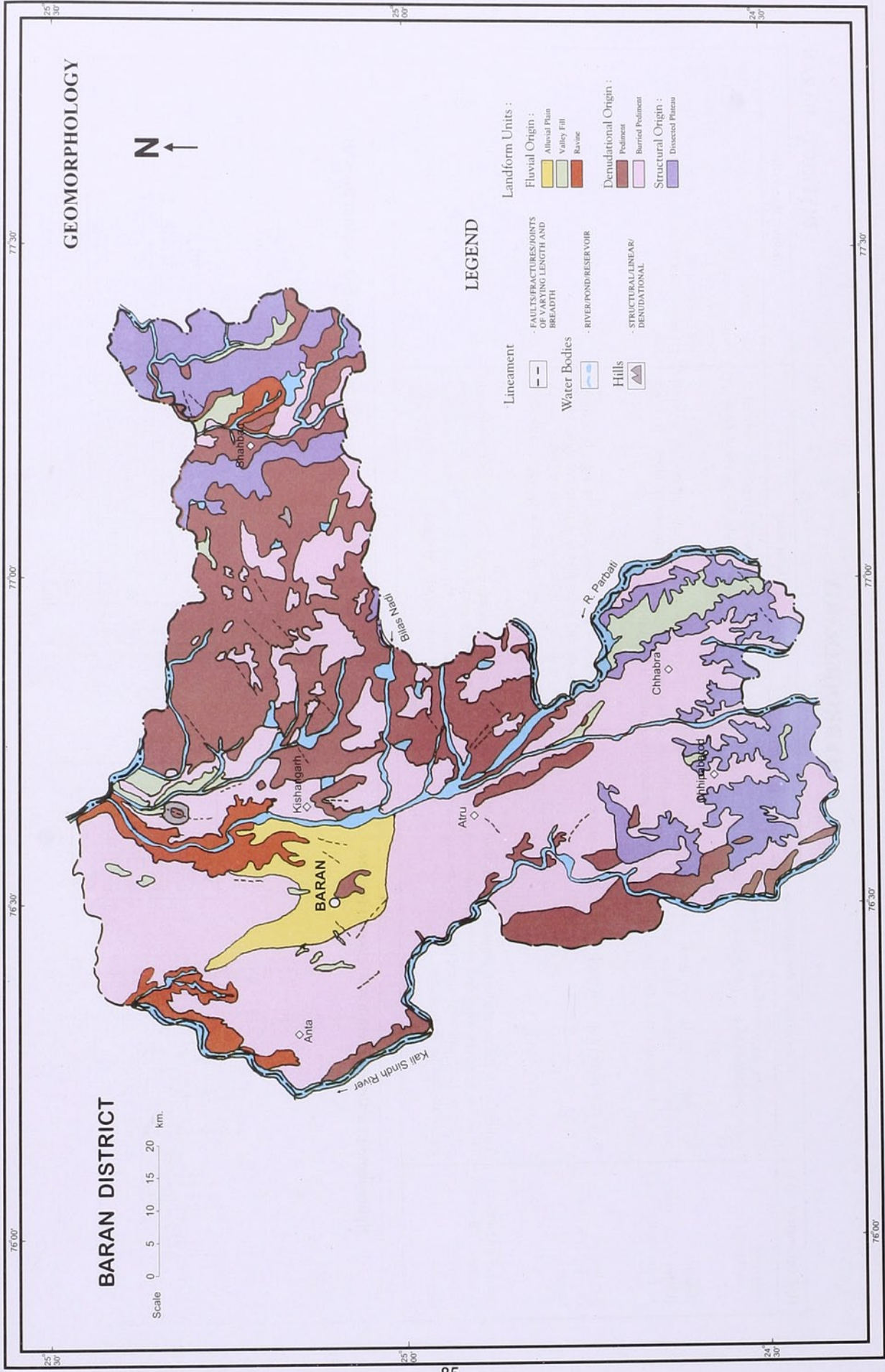


GEOMORPHOLOGY

DISTRICT—BARAN

Landform Units	Symbol	Lithology / Material / Description	Occurrence in district	Land use/Land cover
Fluvial Origin Alluvial Plain	AP	Mainly undulating land scape formed due to fluvial activity, consisting of gravel, sand, silt and clay. Terrain mainly undulating, produced by extensive deposition of alluvium by river system.	Around Baran town.	Double crop, single crop (Rabi), fallow.
Valley Fill	VF	Formed by fluvial activity, usually at lower topographic locations, comprising of boulders, cobbles, pebbles gravels, sand, silt and clay. The unit has consolidated sediment deposits.	In south east and north east part.	Single crop (Rabi), open scrub.
Ravine	RV	Small, narrow, deep, depression, smaller than gorges, larger than gulley, usually carved by running water.	Along Parwati, Kalisindh and Kaku rivers.	Single crop (Kharif), open scrub.
Denudational Origin Pediment	P	Broad gently sloping rock flooring, erosional surface of low relief between hill and plain, comprised of varied lithology, criss crossed by fractures & faults.	Scattered in entire district. Main concentration in north east and south west.	Marginal double crop, single crop (Kharif), open scrub, fallow land.
Buried Pediment	BP	Pediment covered essentially with relatively thicker alluvial, colluvial or weathered materials.	Scattered in entire district, main concentration in north west, central and south.	Marginal double crop, single crop (Rabi / Kharif) fallow, open scrub.
Structural Origin Dissected Plateau	DP	Plateau, criss-crossed by fractures forming deep valleys.	South, south east and north east.	Land with or without scrub.
Hills Structural Hill	SH	Linear to arcuate hills showing definite trend-lines with varying lithology associated with folding, faulting etc.	Near Ramgarh village.	Forest, open scrub.



GEOMORPHOLOGY

BARAN DISTRICT

Scale 0 5 10 15 20 km.



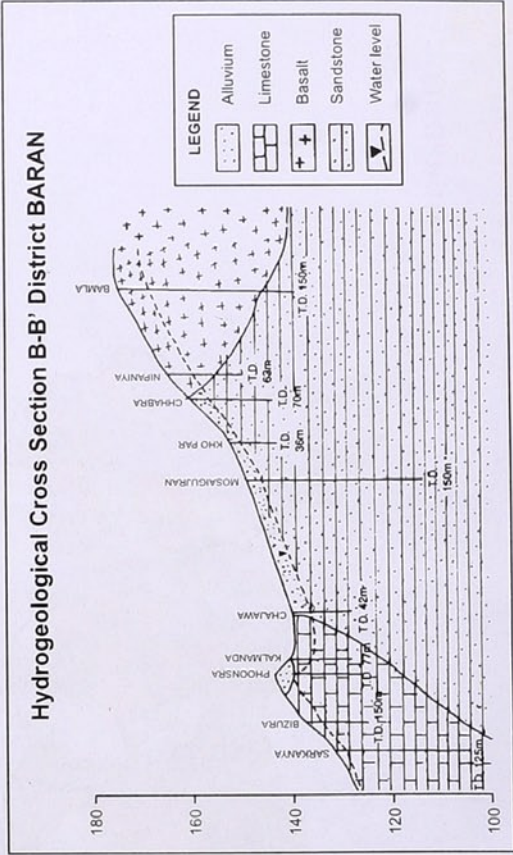
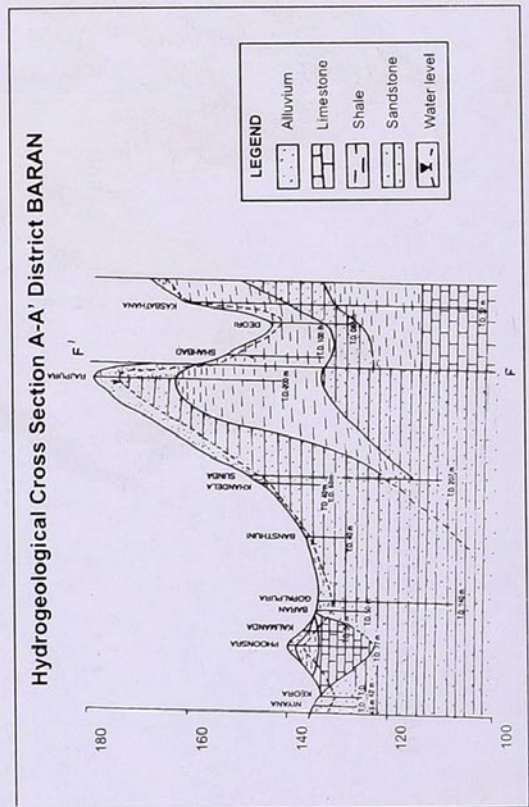
LEGEND

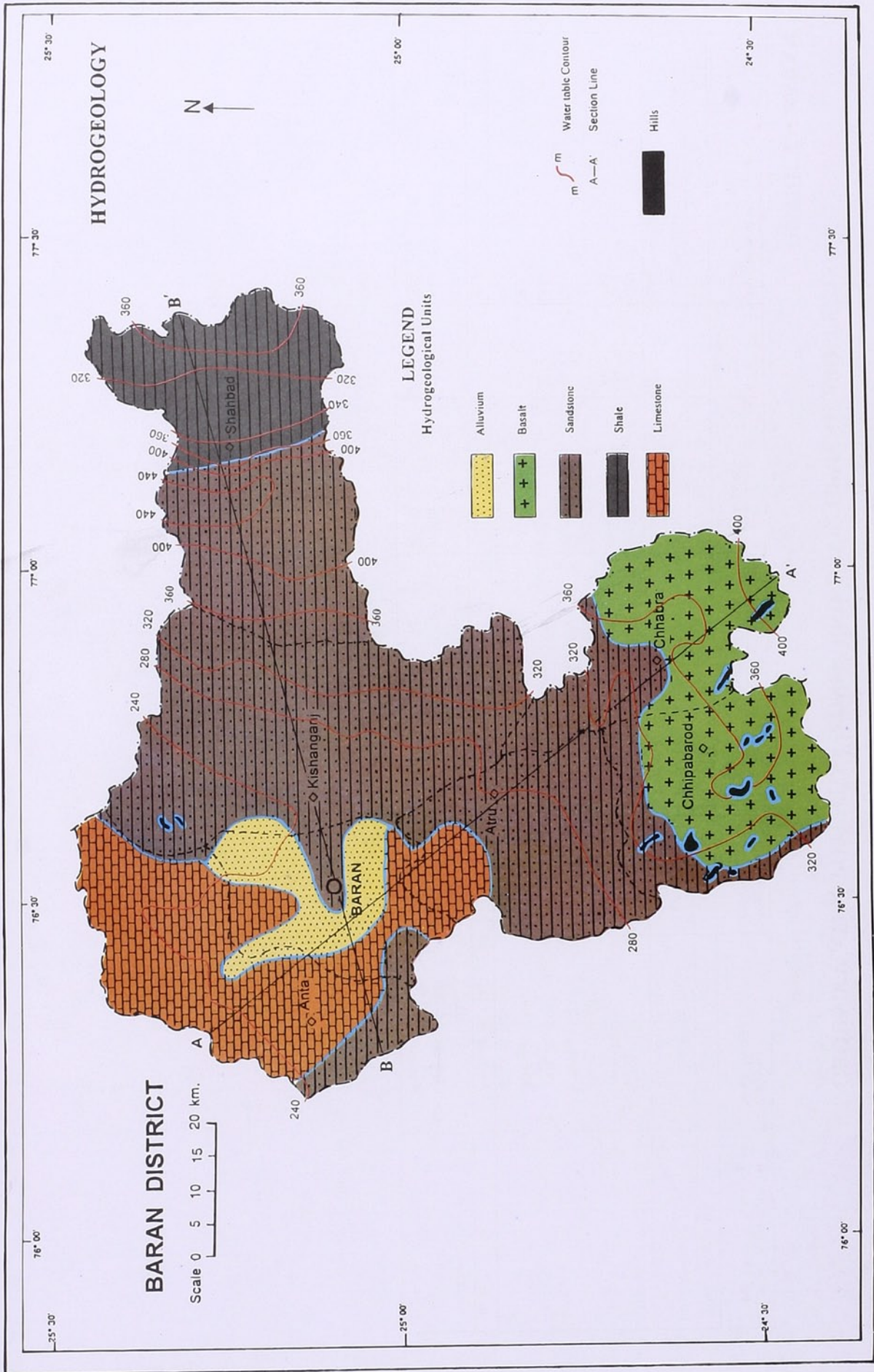
- Lineament: FAULTS/FRACTURES/JOINTS OF VARYING LENGTH AND BREADTH
- Water Bodies: RIVER/POND/RESERVOIR
- Hills: HILLS
- Landform Units:
 - Fluvial Origin:
 - Alluvial Plain
 - Valley Fill
 - Ravine
 - Denudational Origin:
 - Pediment
 - Barried Pediment
 - Structural Origin:
 - Dissected Plateau
- STRUCTURAL/LINEAR/DENUDATIONAL

HYDROGEOLOGY

DISTRICT—BARAN

Hydrogeological units	Description of the unit/Geological section	Occurrence	Ground Water flow
Alluvium (Quaternary)	It comprises unconsolidated to semi-consolidated, sand, silt and clays. Thickness of alluvium varies from few metres to about 40 m.	The litho unit occurs in a localised pocket confined to Baran block. It occupies nearly 4% potential area.	The general direction of ground water flow varies. Around Shahbad ground water mound has been located. In other parts flow direction has been inferred SE to NW or E to W. Hydraulic gradient around Baran-Anta-Atru is comparatively low.
Basalt (Upper cretaceous to Palaeocene)	It is dark green to steel grey, fine to medium grained and porphyritic at places. Basalt varies from hard, massive to amygdaloidal and vesicular type. Intertrappeans are practically absent.	The litho unit encompasses southern part of the area and confined to Chhabra and Chhipabarod blocks. It covers nearly 14% potential area.	
Sandstone (Vindhyan Super Group)	It is buff to red coloured hard, compact and quartzitic.	The litho unit covers most extensive area. It occupies Kishanganj and major part of Atru and Shahbad blocks and spreads in peripheral part of the adjoining blocks. Sandstone, shale and sandstone occupy nearly 56% potential area.	
Shale, Limestone (Vindhyan Super Group)	Limestone is fine to medium grained, grey, yellow, buff, red and chocolate coloured. Grey and yellowish limestones, at places are siliceous, hard and less susceptible to weathering. Limestone is often interbedded with shales.	Shale occupies eastern part of Shahbad block. Limestone spreads in major part of Anta block with some peripheral area of adjoining Atru and Baran blocks. Shale and limestone cover nearly 9% and 17% potential area respectively.	



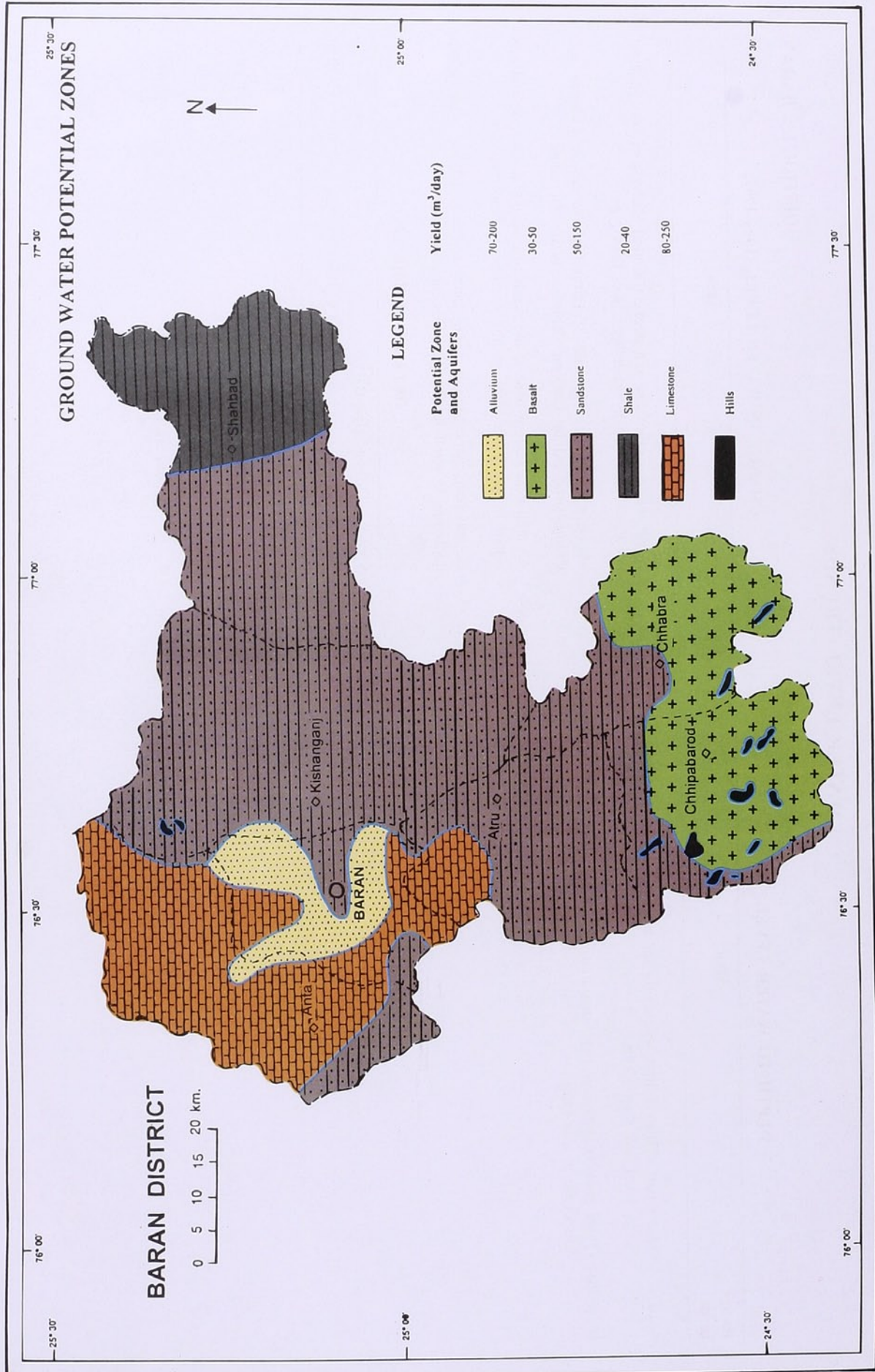


GROUND WATER POTENTIAL ZONES AND DEVELOPMENT PROSPECTS

DISTRICT - BARAN

Aquifer in the Potential Zone (Area in Km ²)	Occurrence * Block (Area in Km ²)	Water Level (1997) in m.	Type	Well Parameters		E.C. X10 ⁻⁶ stem/cm	Development Prospects	
				Proposed depth in m	Discharge in m ³ /day			
Alluvium (274.74)	* Baran (274.74)	<25	TW/DW	80-100/30-50	70-200	<2	Safe	
Basalt (966.80)	* Chhabra (498.40)	<10	TW/DW	80-100/20-30	40-60	<2	Semi Critical	
	* Chhipabarod (468.40)	<15	TW/DW	80-100/25-30	40-60	<2	Semi Critical	
Sandstone (3830.52)	* Anta (123.22)	<15	TW/DW	80-100/25-30	50-150	<2	Safe	
	* Atru (706.54)	<15	TW/DW	80-100/25-30	50-150	<2	Safe	
	* Baran (134.17)	<15	TW/DW	80-100/25-30	50-150	<2	Safe	
	* Chhabra (274.97)	<10	TW/DW	80-100/20-30	50-150	<2	Safe	
	* Chhipabarod (336.10)	<15	TW/DW	80-100/25-30	50-150	<2	Safe	
	* Kishanganj (1429.72)	<20	TW/DW	80-100/30-50	50-150	<2	Safe	
	* Shahbad (825.80)	<20	TW/DW	80-100/30-50	50-150	<2	Safe	
	* Shahbad (637.14)	<15	DW	20-25	25-35	<2	Safe	
	Limestone (1183.01)	* Anta (825.78)	<10	TW/DW	80-100/20-40	85-270	<2	Safe
		* Atru (139.93)	<20	TW/DW	80-100/30-50	85-270	<2	Safe
* Baran (217.30)		<25	TW/DW	80-100/30-50	85-270	<2	Semi Critical	

TW - Tube wells DW - Dug wells Safe - <65% stage of development Semi Critical - 65-85% development Critical - 85-100% development Over exploited - >100% development



WATER LEVEL TRENDS

DISTRICT : BARAN

DEPTH TO WATER LEVEL

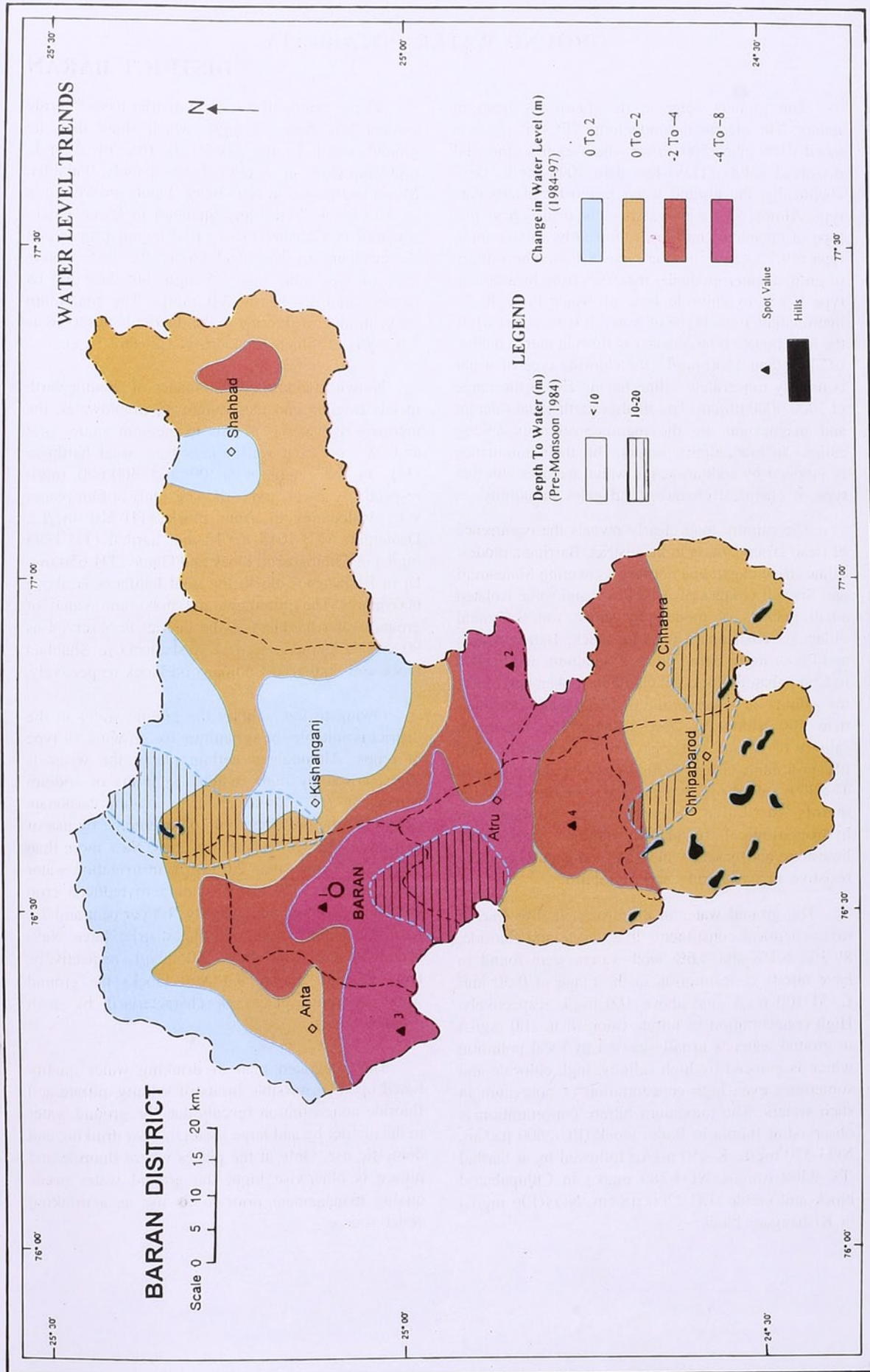
Range in m	Area
< 10	Major part of the district, excluding three small pockets, has depth to water level less than 10 m.
10 to 20	Three pockets located in parts of Baran, Atru, Chhipabarod and Chhabra blocks lie in this range.

CHANGE IN WATER LEVEL (1984-1997)

Range in m	Area
0 to 2	North western periphery and pockets around Kishanganj and Shahbad show marginal rise in water level, less than 2 m.
0 to -2	Major part of the area east of Baran and spread in Chhabra and Chhipabarod exhibit marginal depletion within the range.
-2 to -4	A patch near eastern border, and north of Chhabra & Chhipabarod and a part of Baran and Anta exhibit depletion within this range.
-4 to -8	Central part encompassing Anta, Baran and Atru blocks exhibit steep depletion in water level within this range.

DETAILS OF THE SPOT

Spot code	Village (Block)	Change in water level in m (1984-97)
1.	Andan (Atru)	(-) 7.61
2.	Vadipura (Kishanganj)	(-) 17.90
3.	Sorsan (Anta)	(-) 7.20
4.	Vadipura (Kishanganj)	(-) 10.64



GROUND WATER POTABILITY

DISTRICT BARAN

The ground water in the district is fresh in nature. The electrical conductivity (EC) of water is usually less than 1500 $\mu\text{S}/\text{cm}$ which signifies the total dissolved solids (TDS) less than 1000 mg/L. Geochemically, the ground water is mostly bicarbonate type. Almost 72% well waters in the district have this type of chemical character followed by mixed anion type (19.7%) and chloride type (8.1%). The salinity of ground water gradually increases from bicarbonate type water to chloride type of water through the intermediate mixed type of water. It is seen that while the bicarbonate type of water is fresh in nature having EC less than 1500 mg/L, the chloride type of water is usually moderately saline having EC in the range of 2000-4000 $\mu\text{S}/\text{cm}$. The alkaline earth metal calcium and magnesium are the main constituents among cations in low salinity waters. But their dominance is subdued by sodium as the water acquires chloride type of chemical character and gains in salinity.

The salinity map clearly reveals the occurrence of fresh ground water in the district. Barring a modest saline stripe in extreme northwest covering Malbamori and Siswali villages of Anta block and some isolated small pockets of moderately saline waters around villages - Kishanpura in Anta block; Bamla, Baran and Phoonsre in Baran block; Daulatpura and Sarthal in Chhipabarod block and Garde in Kishanganj block, the salinity of water in the district ranges from less than 500 $\mu\text{S}/\text{cm}$ to 2000 $\mu\text{S}/\text{cm}$. The maximum salinity of ground water has been observed as 3300 $\mu\text{S}/\text{cm}$ around village Sarthal in Chhipabarod block. The low salinity of ground water in the district is mainly attributed to sub-humid climate and hydrogeological formations (shales, sandstone, limestone and basalt) which are comparatively more resistive to weathering and dissolution.

The ground water in the district is also free of toxic chemical constituents like nitrate and fluoride. 89.3%, 6.1% and 4.6% well waters were found to have nitrate concentration in the range of 0-50 mg/L, 51-100 mg/L and above 100 mg/L respectively. High concentration of nitrate (more than 100 mg/L) in ground water is usually caused by local pollution which is evinced by high salinity, high chloride and sometimes even high concentration of potassium in such waters. The maximum nitrate concentration is observed at Bamla in Baran block (EC-2600 $\mu\text{S}/\text{cm}$, NO_3 -370 mg/L, K-450 mg/L) followed by at Sarthal (EC-3300 $\mu\text{S}/\text{cm}$, NO_3 -280 mg/L) in Chhipabarod block and Garde (EC-2200 $\mu\text{S}/\text{cm}$, NO_3 -196 mg/L) in Kishanganj block.

95 per cent well waters in district have fluoride content less than 1.5 mg/L which show that the ground water in the district is free of fluoride problem. Only at a few places namely, Palaitha, Miana and Dugari in Anta block; Dhota and Motipura in Atru block; Maira and Shaigarh in Baran block; Bhaonra in Chhabra block; Kishanganj proper and Bodhanohera in Shahabad block, the well waters have fluoride more than 1.5 mg/L but there too its concentration is below 3.0 mg/L. The maximum concentration of fluoride in the district is observed as 2.6 mg/L at village Bhaonra in Chhabra block.

Notwithstanding the dominance of alkaline earth metals calcium and magnesium in groundwater, the hardness of water is of low to medium value. 74.2 and 23.7 per cent well waters have total hardness (TH) in the range of 0-300 and 300-600 mg/L respectively as calcium carbonate. Only at four places viz., Malbamori in Anta block (TH-710 mg/L); Daulatpura (TH-1015 mg/L) and Sarthal (TH-1295 mg/L) in Chhipabarod block and Garde (TH-650 mg/L) in Kishanganj block, the total hardness is above 600 mg/L. The minimum and maximum value of ground water hardness in the district is observed as 90 and 1295 mg/L seen at Kasbathana in Shahbad block and Sarthal in Chhipabarod block respectively.

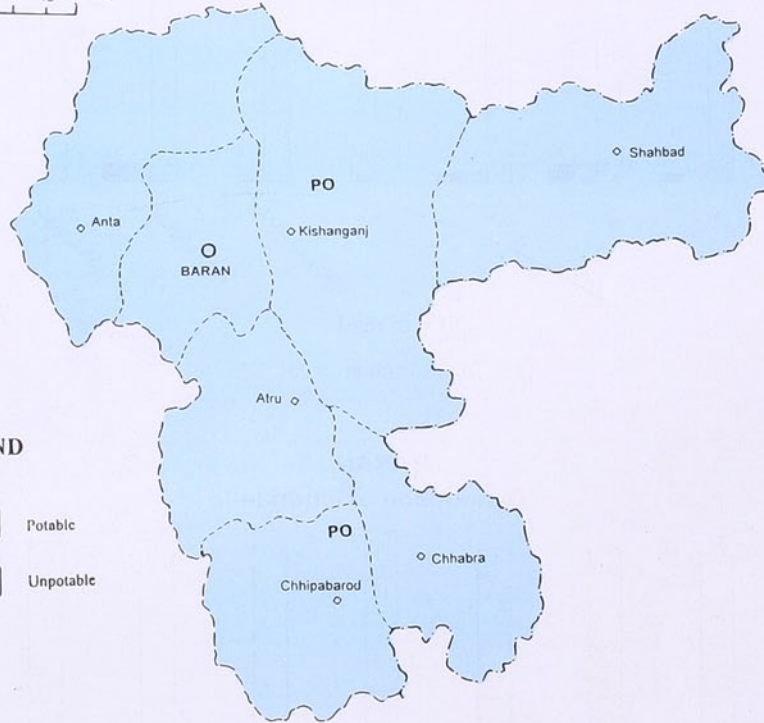
Owing to low salinity the ground water in the district is suitable for agriculture for growing all type of crops. Although at certain places the water is characterised by high sodicity in terms of sodium percentage (Na%) and residual sodium carbonate (RSC) but the problem could be overcome by use of gypsum along with irrigation waters. Na% more than 70 and RSC more than 2.0 meq/L in irrigation water may cause such problems leading to reduced crop yield and poor soil permeability. 4.5 per cent and 7.1 per cent ground waters in the district have Na% above 70 and RSC above 2.0 meq/L respectively. Only in Anta, Baran and Atru blocks the ground water at some places is characterised by such problem.

The integrated map of drinking water quality based upon permissible limits of salinity, nitrate and fluoride concentration reveals that the ground water in the district by and large is suitable for drinking and domestic use. Only at the places where fluoride and nitrate is otherwise high, the ground water needs quality management prior to its use as a drinking water source.

GROUND WATER POTABILITY

BARAN DISTRICT

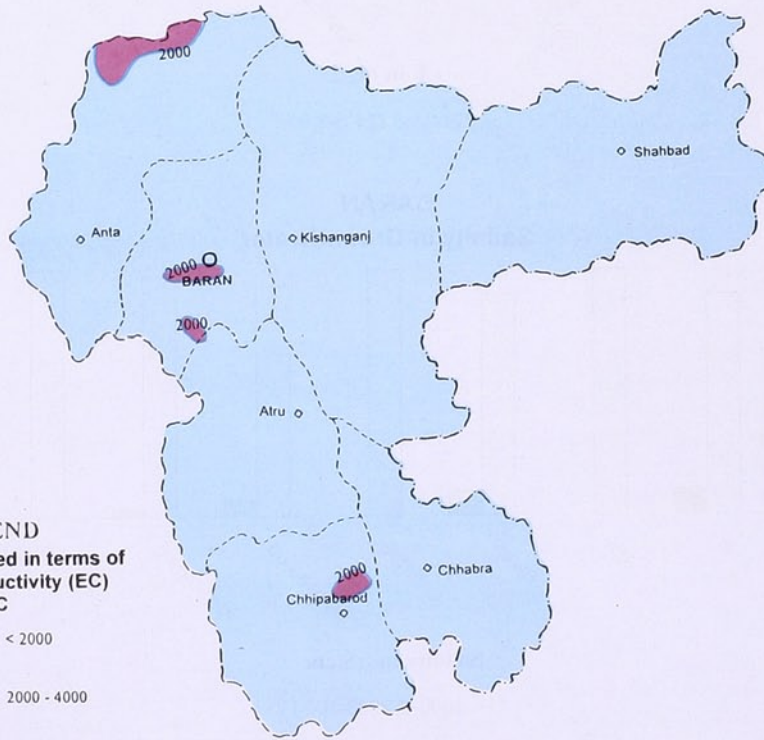
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LEGEND

- PO Potable
- UN Unpotable

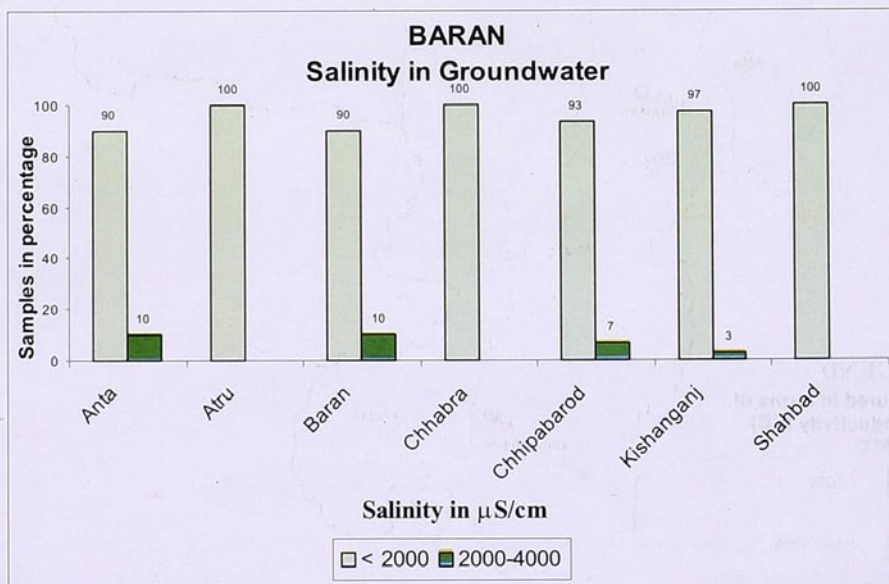
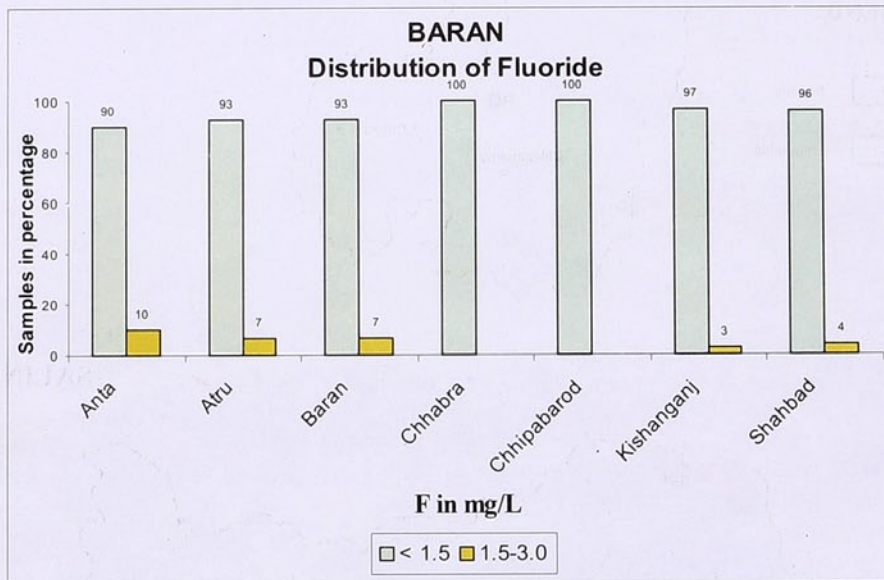
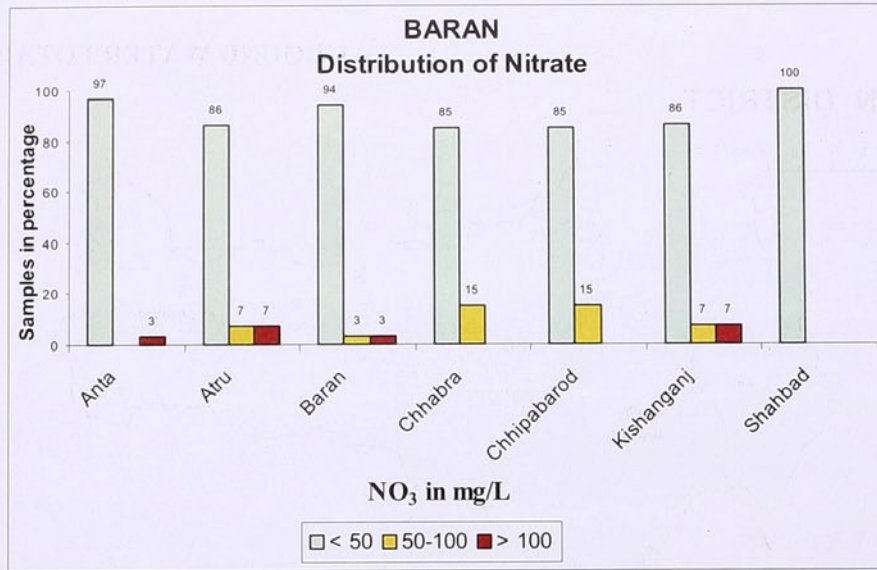
SALINITY



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Salinity measured in terms of Electrical Conductivity (EC) in $\mu\text{S/cm}$ at 25°C

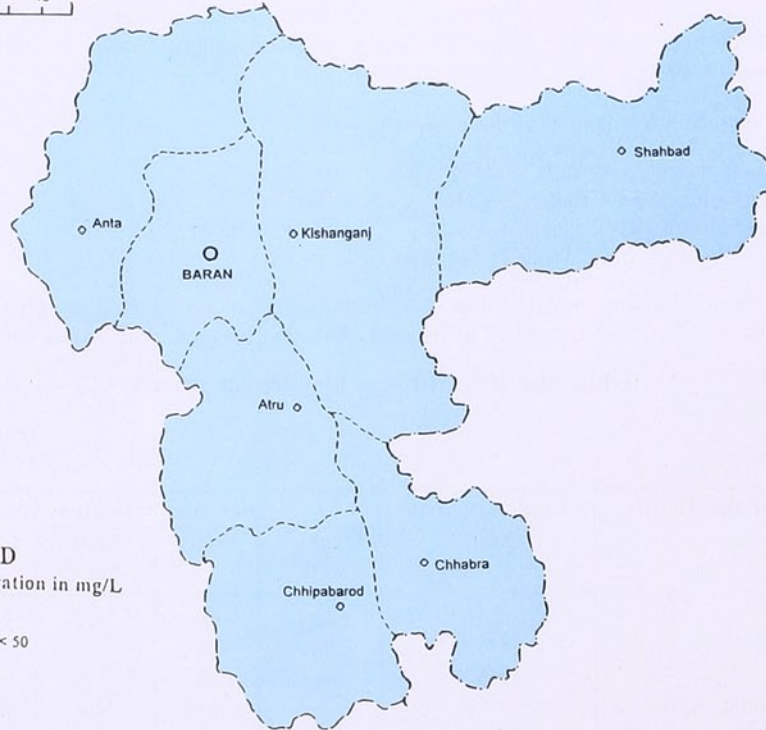
- < 2000
- 2000 - 4000




NITRATE DISTRIBUTION

BARAN DISTRICT

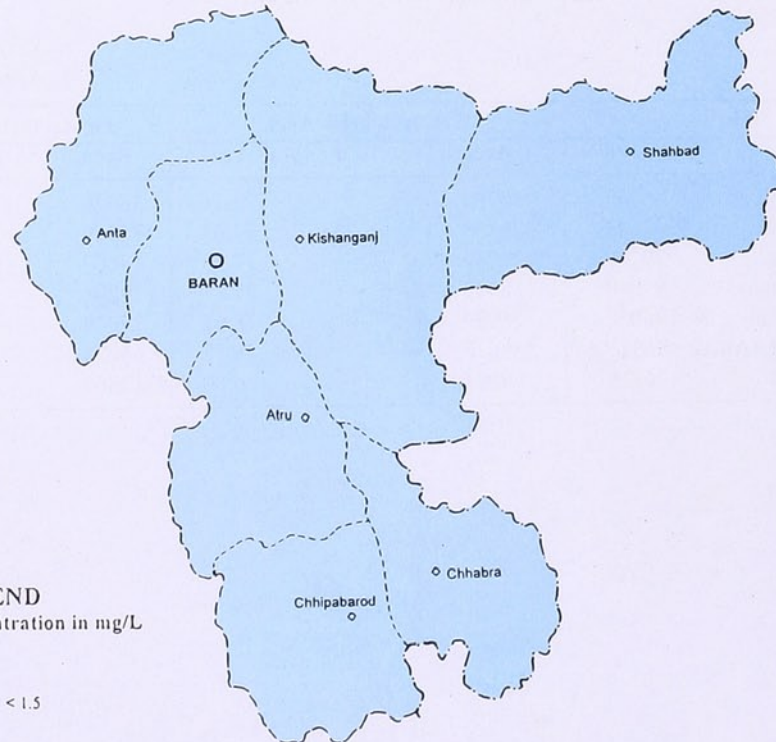
Scale 0 5 10 15 20 km.




LEGEND
Nitrate Concentration in mg/L

 < 50

FLUORIDE DISTRIBUTION



LEGEND
Fluoride Concentration in mg/L

 < 1.5