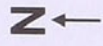


GEOMORPHOLOGY

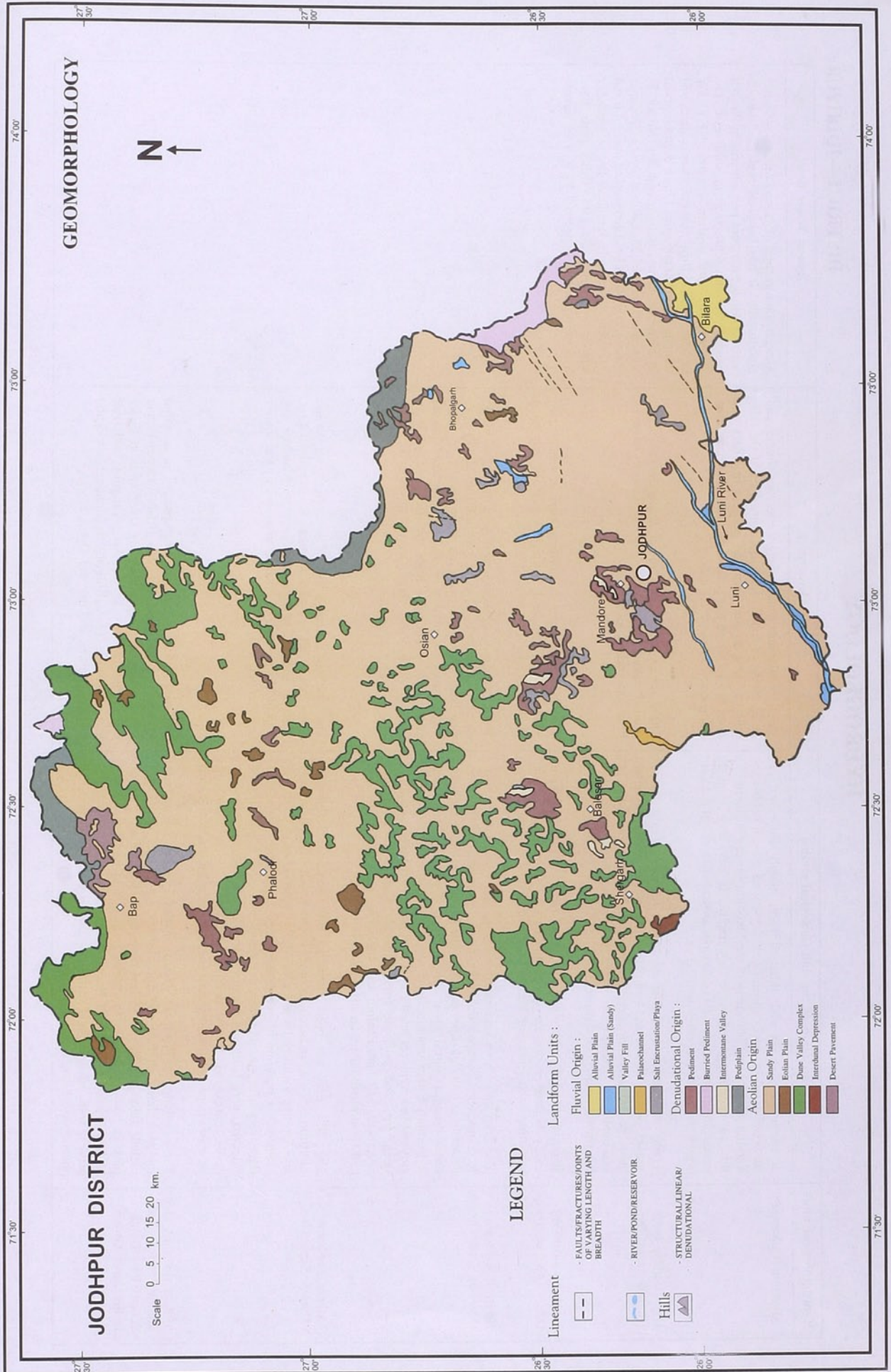
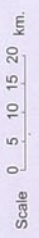
DISTRICT—JODHPUR

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, consists of gravels, sand, silt and clay. Terrain mainly undulating, produced by extensive deposition of alluvium by river system.	Near Bilara, Pichiyak.	Marginal double crop, single crop (Kharif), open scrub, fallow land.
Alluvial Plain (Sandy)	AP (S)	Flat to gentle undulating plain formed due to fluvial activity, mainly comprises of gravels, sand, silt and clay with unconsolidated material of varying lithology, predominantly sand along river.	Near Luni town Salawas, Jhalamand, Dudiya, Birai (Buna & matah).	Marginal double crop, Marginal Kharif crop, open scrub.
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.	Kaylana hills, Dajjar, Keru (Near Jodhpur town).	Double crop.
Palaeochannel	PC	Mainly buried on abandoned stream/river courses, comprising of coarse textured material of variable sizes.	In between Agolai to Bambar.	Double crop, open scrub.
Salt Encrustation/ Playa	PL/SE	Topographical depressions comprising of clay, silt, sand and soluble salts, usually undrained and devoid of vegetation.	Along western & northern part of the district mainly near Bap, Dediya, Kaparda, Banar etc.	Salt quarries and salt waste.
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.	Near Jodhpur, Osian, Bhopalgarh, Ransigaon, Balesar, Phalodi.	Marginal double crop, marginal Kharif crop, open scrub, fallow.
Buried Pediment	BP	Pediment covered essentially with relatively thicker alluvial, colluvial or weathered materials.	Negligible on northern and along eastern margin.	Marginal Kharif crop, open scrub, fallow.
Intermontane Valley	IV	Depression between mountain/pediment zone, generally broad & linear filled with colluvial deposit.	In between hills, south eastern of district.	Marginal double crop, single crop (Rabi / Kharif) fallow.
Pediplain	PP	Pediplain essentially covered with soil cover in western part.	On northern side of the district.	Open scrub, marginal Kharif crop.
Aeolian Origin Sandy Plain	SP	Formed by aeolian activity, wind blown sand with gentle sloping to undulating plain, comprising of coarse sand, fine sand, silt & clay.	Distributed uniformly along every part of district, vast patch along eastern part of district.	Marginal Kharif crop, land with or without scrubs.
Eolian Plain	EP	Formed by aeolian activity, with sand dunes of varying heights, size, slope. Long stretches of sand sheet. Gentle sloping flat to undulating plain, comprised of fine to medium grained sand and silt. Also scattered xerophatic vegetation.	Scattered in entire district. South of Punasar village on northern eastern margin.	Marginal Kharif crop, open scrub.
Dune Valley Complex	DVC	Clusters of dunes and interdunal spaces with undulating topography formed due to wind blown activity comprising of unconsolidated sand and silt.	Scattered almost in entire district but increases towards western, north western & northern part of the district.	Land with or without scrubs.
Interdunal Depression	ID	Slightly depressed area in between the dunal complex showing moisture and fine sediments.	Negligible in south west.	Marginal Kharif crop, open scrub.
Desert Pavement	DEP	Desert plain having coarse angular.	Along northern part of Bap village.	Open scrub, negligible Kharif.
Hill Denudational Hill	DH	Steep sided, relict hills undergone denudation, comprising of varying lithology with joints, fractures and lineaments.	Jodhpur (in between Indroka & Malanga), Osian, Hardhani, Melana, Bhopalgarh.	Forest, Mining, open scrub.

GEOMORPHOLOGY



JODHPUR DISTRICT



LEGEND

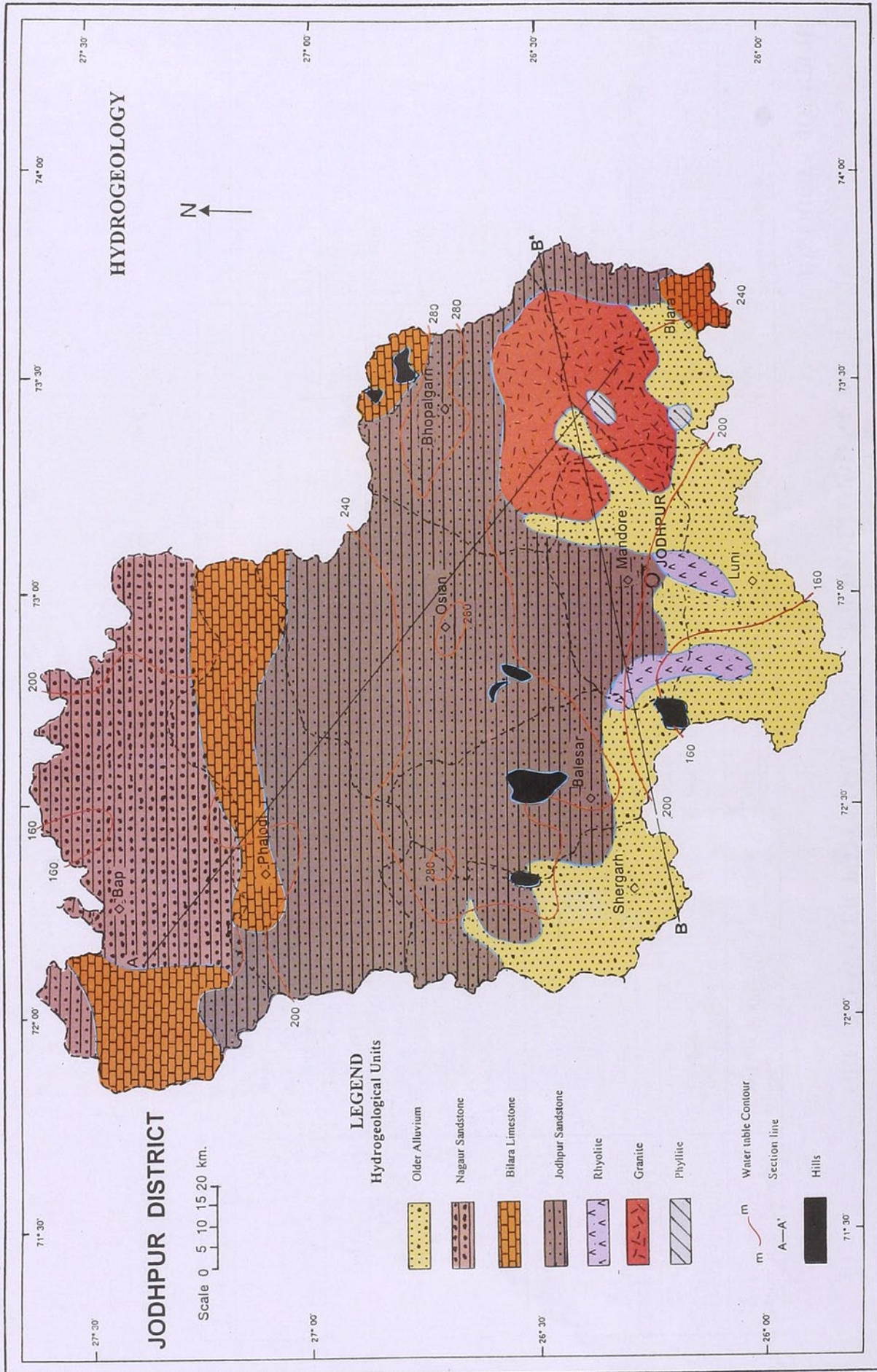
- Lineament**
- - - FAULTS/FRACTURES/JOINTS OF VARYING LENGTH AND BREADTH
 - RIVER/POND/RESERVOIR
 - Hills
 - STRUCTURAL/LINEAR/DENUDATIONAL
- Landform Units :**
- Fluvial Origin :**
- Alluvial Plain
 - Alluvial Plain (Sandy)
 - Valley Fill
 - Paleochannel
 - Salt Encrustation Playa
- Denudational Origin :**
- Pediment
 - Buried Pediment
 - Inermontane Valley
 - Pediplain
- Aeolian Origin**
- Sandy Plain
 - Eolian Plain
 - Dune Valley Complex
 - Interdunal Depression
 - Desert Pavement

HYDROGEOLOGY

DISTRICT—JODHPUR

Hydrogeological units	Description of the unit/Geological section	Occurrence	Ground Water flow
Alluvium (Quaternary)	It comprises younger and older alluvium mainly composed of unconsolidated to semi consolidated clays, sand gravel, pebble in varying proportions. Thickness of the litho unit varies considerably due to undulating bed rock topography. It has been tapped maximum in area south west of Jodhpur around villages Pal & Doli where thickness recorded upto 60 m.	Younger alluvium occurs along the stream courses and flood plains of Luni, Mithri and Jojri. Part of the litho unit in Shergarh and localised pockets in Bilara and Luni blocks which has potable ground water have been categorised as potential area.	The general direction of ground water flow varies significantly. It has been inferred southeast to northwest in the northern part whereas in Phalodi block it become south west to north east. The southern and north western area have NE to SW or NNE to SSW flow. Ground water mounds and troughs having small spread have been observed in Mandore, Osian, Balesar and Bap blocks. In area south west of Phalodi and west of Jodhpur hydraulic gradient has been worked out as 4.0 and 5.0 m/km respectively. It indicate low permeability aquifer underlying the area. Other parts have hydraulic gradient between 1.14 to 1.81 m/km.
Bap Boulder Beds (Permo-carboniferous)	These are composed of rounded to sub-rounded poorly sorted gravel, pebble, cobble and boulders of limestone, granite, rhyolite, quartzite and slaty formation. The litho unit has poor specific yield and quality of ground water is saline; so it has not been included in ground water potential area.	These cover small area around Bap. Due to saline ground water and poor yield, Bap boulder beds have not been categorised as aquifer.	
Nagaur sandstone (Marwar Super Group)	It comprises red, buff, pink, medium to coarse grained, massive thinly bedded sandstone with intercalations of clay and shale horizons with lenticular bodies of anhydrite and gypsum.	The litho unit occurs in northern part of the district, where cover Bap and peripheral part of adjoining Phalodi block.	
Bilara limestone (Marwar Super Group)	The litho unit shows considerable lateral and vertical variations. It comprises Dhanapsa dolomite, Gotan limestone and Pundloo dolomite in order of super position. The Dhanpa dolomite includes cherty dolomite and silicious dolomitic limestone with cherty beds. In Borunda-Bilara area limestone are mostly dolomitic, grey or dark grey to black at places interbedded with thin cherty layers and show steep dips and pitching folds and are highly crumpled and cavernous. In Chadi-Phalodi area limestone is cherty or siliceous and do not exhibit much disturbances.	The litho unit occupies extensive area in Phalodi block. Part of Bhopalgarh, Bilara, Osian and Bap blocks have also been demarcated with limestone aquifer. In south eastern area comprising Bilara and Bhopalgarh block, aquifer has abnormally high specific yield while in Phalodi block, it has comparatively low specific yield.	
Jodhpur sandstone (Marwar Super Group)	The litho unit has been classified into Sonia and Girbakar sandstone. Sonia sandstone includes boulder beds in the basal part and overlies weathered surface of Malani igneous suite. Girbakar sandstone is made up of yellow and purple sandstone interbedded shale, clay siltstone and flute casts. Sandstone is red to pink or buff coloured, very hard and compact at places micaceous, showing ripple marks and current bedding. Thickness of the litho unit increases north west ward where has been tapped more than 300m.	The litho unit is main source of water in the region and cover nearly 61% potential area. It occupies Osian, Phalodi, Balesar, Bhopalgarh, Shergarh, Mandore and Bap blocks in order of area encompassed by the aquifer in potential area.	
Malani rhyolite Jalor granite Phyllite and Schist (Post Delhi, Delhi Super Group)	These belong to Punagarh group of Delhi Super Group and includes slates, phyllite and mica schists. Post Delhi formations include Jalor granite and Malani rhyolite. Jalor granite is grey or pink in colour, medium to coarse grained, and non porphyritic. Malani rhyolite is buff dark brown pink and grey in colour interbedded with ash beds and tuffs. Rhyolite is porphyritic and has phenocryst of quartz and feldspar.	The oldest rocks occur as isolated patches in alluvium in south eastern part between Bilara-Jodhpur-Peepar section, west of Peepar and near Dangiawas in Bilara block. Post Delhi rocks, i.e., Malani rhyolite and Jalor granite, occupy Bilara, Bhopalgarh, Mandore blocks and localised places in Luni and Osian blocks.	

For cross section(s) please see page no. 547

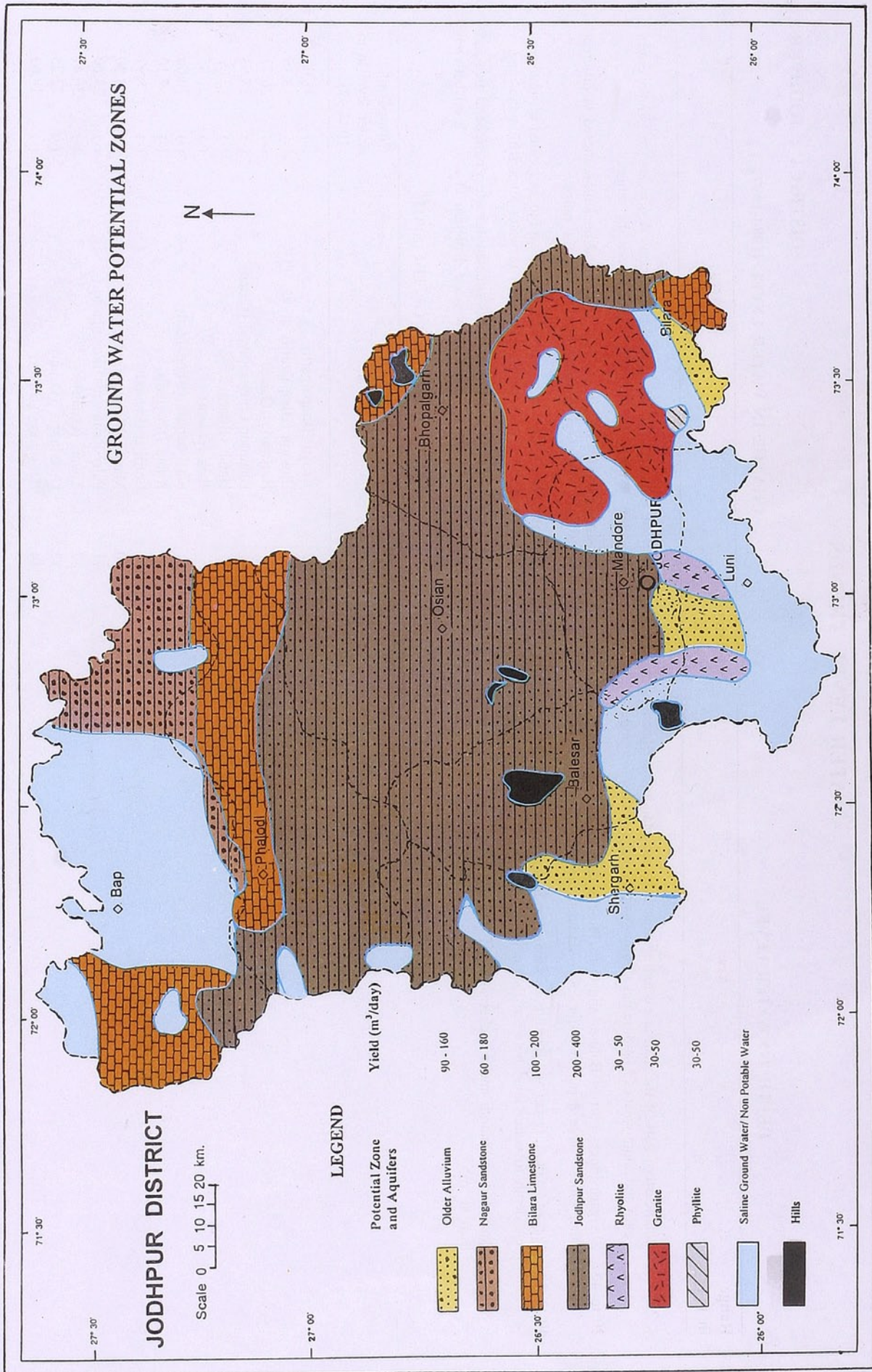


GROUND WATER POTENTIAL ZONES AND DEVELOPMENT PROSPECTS

DISTRICT - JODHPUR

Aquifer in the Potential Zone (Area in Km ²)	Occurrence * Block (Area in Km ²)	Water Level (1997) in m.	Well Parameters		E.C. X10 ³ μ siem/cm	Development Prospects
			Type	Proposed depth in m		
Older Alluvium (826.75)	* Bilara (120.38)	<15	DW	20-25	4-8	Semi Critical
	* Luni (290.74)	35-70	TW/DW	80-100/25-40	4-8	Critical
	* Shergarh (415.63)	20-50	TW/DW	120-140/35-50	4-8	Safe
Nagaur Sandstone (790.41)	* Bap (790.41)	25-70	TW	150-200	4-8	Safe
	* Bap (843.69)	30-75	TW	150-200	4-8	Safe
Bilara Limestone (2821.44)	* Bhopalgarh (217.50)	50-55	TW	100-150	<4	Over exploited
	* Bilara (467.00)	20-60	TW/DW	100-125/25-45	<4	Over exploited
	* Osian (100.00)	70-75	TW	120-160	<4	Safe
	* Phalodi (1193.25)	35-100	TW	150-200	<4	Safe
	* Balesar (1475.00)	15-50	DW/TW	35-50/120-140	<4	Safe
	* Bap (456.13)	60-80	TW	150-200	<4	Tekra zone-Over exploited, Bungri zone - safe
Jodhpur Sandstone (10106.84)	* Bhopalgarh (994.38)	15-45	TW/DCB	150-175/50-60	<4	Over exploited
	* Mandore (603.12)	15-30	TW/DW	100-150/30-40	<4	Safe
	* Osian (3928.08)	20-100	TW/DW	100-175/25-30	<4	Western part safe, other part Over exploited
	* Phalodi (1794.00)	30-100	TW	150-200	<4	Two localised area Over exploited
	* Shergarh (856.13)	20-50	TW/DW	100-140/20-40	<4,4-8	Over exploited
	* Luni (276.85)	10-30	DW	25-40	4-8	Safe
Rholite (383.10)	* Mandore (106.25)	10-43	DW	25-50	4-6	Safe
	* Bhopalgarh (468.75)	15-50	DW	30-55	<4	Safe
Granite (1596.75)	* Bilara (653.00)	10-30	DW	20-40	<4	Safe
	* Mandore (362.50)	10-20	DW	30-40	4-8	Safe
Phyllite and Schist (81.25)	* Osian (112.50)	<20	DW	25-30	<4	Over exploited
	* Bilara (81.25)	10-25	DW	30-40	4-8	Safe

TW - Tube wells DCB - Dug cum borewells 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 : JODHPUR

DEPTH TO WATER LEVEL

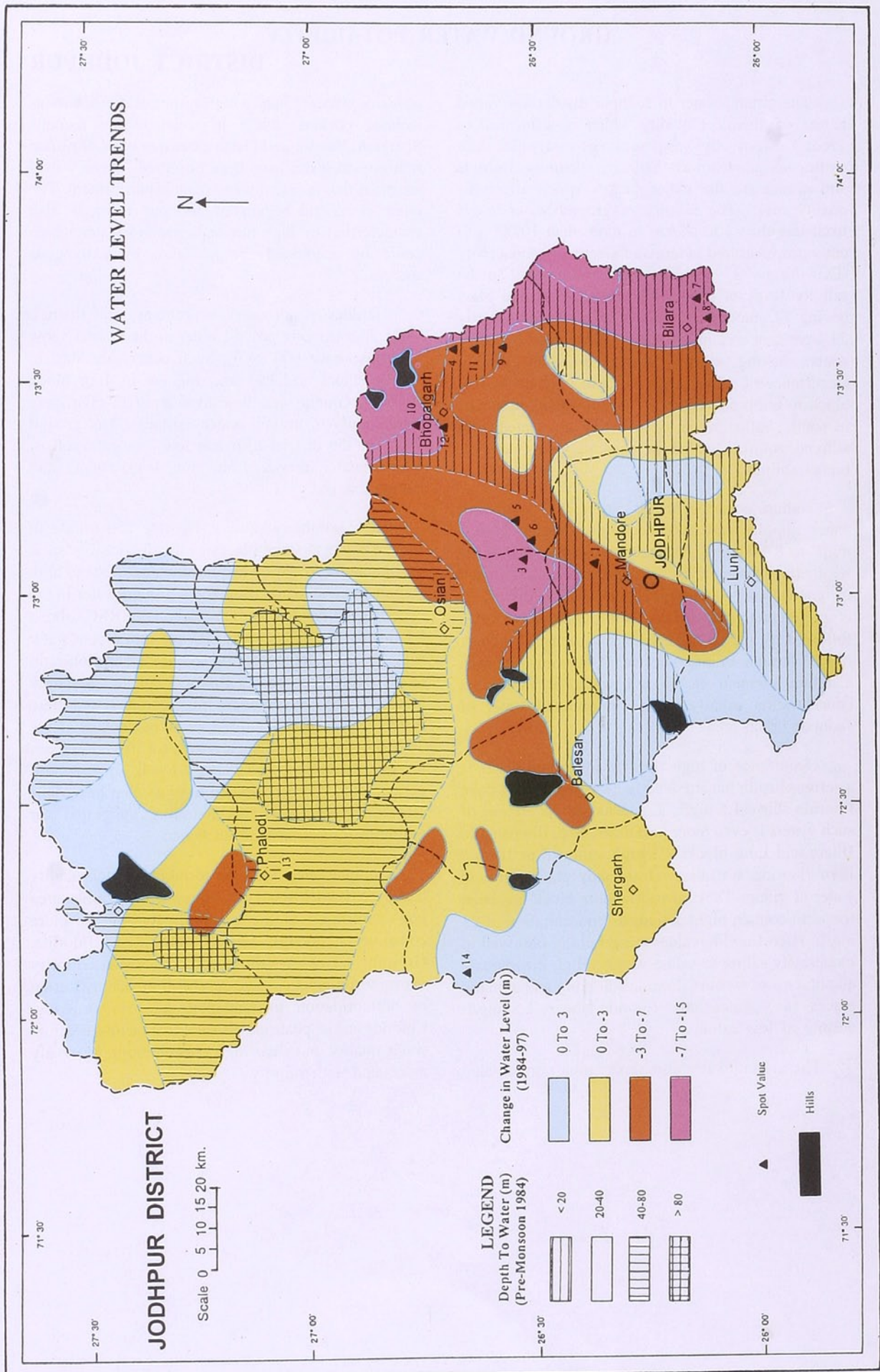
Range in m	Area
< 20	Southeastern part of the district excluding area between Mandore - Bhopal - garh and south west of Mandore has shallow water level less than the range.
20 to 40	Shergarh block, part of Balesar and Osian blocks and pockets scattered in other blocks have depth to water level between the range.
40 to 80	Part of Phalodi, Osian and Bap blocks situated in northern part of the district has depth to water level between the range.
> 80	Area east of Phalodi and a pocket south of Bap has deep water level more than 80 m.

CHANGE IN WATER LEVEL (1984-1997)

Range in m	Area
0 to 3	Part of Bap and Phalodi blocks and pockets demarcated in southwestern boundary exhibit rise in water level between the range.
0 to -3	Western part of Phalodi and Bap blocks and pockets scattered in different parts show depletion in water level within the range.
-3 to -7	Part of Osian, Bhopalgarh, Mandore and Bilara blocks located in southeastern part of the district exhibit depletion in water level within the range.
-7 to -15	Part of Bilara and Bhopalgarh blocks situated in eastern peripheral area and a pocket south-east of Osian show steep depletion in water level between the range.

DETAILS OF THE SPOT

Spot code	Village (Block)	Change in water level in m (1984-97)
1.	Artiya (Bhopalgarh)	(-) 18.63
2.	Bagoria (Bhopalgarh)	(-) 18.35
3.	Binjwaria (Osian)	(-) 26.77
4.	Bhainsar Chawandiyali (Osian)	(-) 23.63
5.	Harsh (Bilara)	(-) 22.09
6.	Jhak (Bilara)	(-) 21.85
7.	Khawaspura (Bhopalgarh)	(-) 20.00
8.	Kalau (Shergarh)	(-) 7.10
9.	Lordiya (Phalodi)	(-) 8.97
10.	Manai (Mandore)	(-) 43.30
11.	Patri Ranawat (Bhopalgarh)	(-) 24.60
12.	Tiwari (Osian)	(-) 36.41
13.	Umednagar (Osian)	(-) 22.25
14.	Ransigaon (Bilara)	(-) 18.63



GROUND WATER POTABILITY

DISTRICT JODHPUR

The ground water in Jodhpur district has varied nature of chemical quality which is influenced to great extent by regional geomorphic and hydrogeologic features. Salinity, alkalinity, fluoride and nitrate are the major factors which affect the quality most. The salinity of ground water varies from less than 500 $\mu\text{S}/\text{cm}$ to more than 10,000 $\mu\text{S}/\text{cm}$ when measured in terms of electrical conductivity (EC). Nearly 37 per cent water sources fall in the salinity level of moderately saline to saline class having EC more than 4000 $\mu\text{S}/\text{cm}$. Further, nearly 23.4 per cent area in the district is occupied by saline waters having salinity more than 8000 $\mu\text{S}/\text{cm}$. Occurrence of saline water is more frequent in Bap block in north and Bilara, Luni and Mandore blocks in south. Saline water is generally associated with alluvial aquifers which in general, yield water of higher salinity.

Sodium occurs as major cation in 73.9 per cent water samples and its concentration varies from 5 mg/L to 8700 mg/L. The major source of sodium is weathering of plagioclase feldspars which are abundant in igneous and metamorphic rocks of the district. It is preferentially associated with chloride (63.3%) followed by mixed anions (27.5%) and bicarbonate (9.1%) among anionic species. Potassium is though a minor element in ground water, its abnormal concentration usually occurs in polluted water of Jodhpur urban area.

Occurrence of high fluoride in ground water is a serious health hazard. Nearly 48% well waters have fluoride above 1.5 mg/L. Frequency of occurrence of such waters is even more in Balesar, Bap, Bhopalgarh, Bilara and Luni blocks. Though values 5 to 10 mg/L of fluoride are observed at many places, ground water at village Daikara in Mandore block has been found to contain highest fluoride concentration of 22 mg/L. High fluoride values are generally observed in moderately saline to saline waters. High bicarbonate alkalinity also favours fluoride solubility and at many places such water have fluoride above 1.5 mg/L despite of low salinity.

The ground water also shows high nitrate value

at many places. Usually high nitrate water occurs as isolated pockets, while in some blocks namely, Shergarh, Balesar and Osian extensive belts of nitrate rich ground water have been observed. These waters are often rich in calcium and magnesium content. The inner peripheral region of Jodhpur town is also characterised by high nitrate in ground water which could be accounted for pollution by extraneous sources.

Hardness is not a serious problem in the district. Only, 32.9 per cent ground water in the district show hardness above 600 mg/L. Such waters are least in Balesar block (12.3%) and highest in Bap block (53.5%). Granite and limestone aquifers contribute significantly to ground water hardness. The ground water in the district also has low concentration of other metal ions viz., iron, zinc, lead, copper and manganese etc.

High salinity, alkalinity, fluoride and nitrate in ground water at some places in the district renders it unsuitable for irrigation and drinking use. Due to high sodium content nearly 25 percent ground water in the district have residual sodium carbonate (RSC) above 2.0 meq/L. Similarly, nearly 20.4 per cent groundwater samples are characterised by sodium adsorption ratio (SAR) more than 18. In Bilara, Luni and Mandore blocks, high SAR values are more common and these waters usually have soluble sodium percentage above 70. Continuous use of such waters for irrigation leads to soil alkalinity which may result in low soil permeability. Use of gypsum to overcome hazardous effect of sodic water is therefore suggested for optimum utilisation of such water.

An integrated map for drinking water quality based on ICMR standards shows considerable area non-conforming to the standards for one or more constituents amongst salinity, nitrate and fluoride. Ground water at these places needs quality management practices like desalination, denitrification or defluoridation to render it safe for drinking. Chloride and sulphate are also additive factors affecting water quality, but their high concentration is mostly associated with salinity.

GROUND WATER POTABILITY

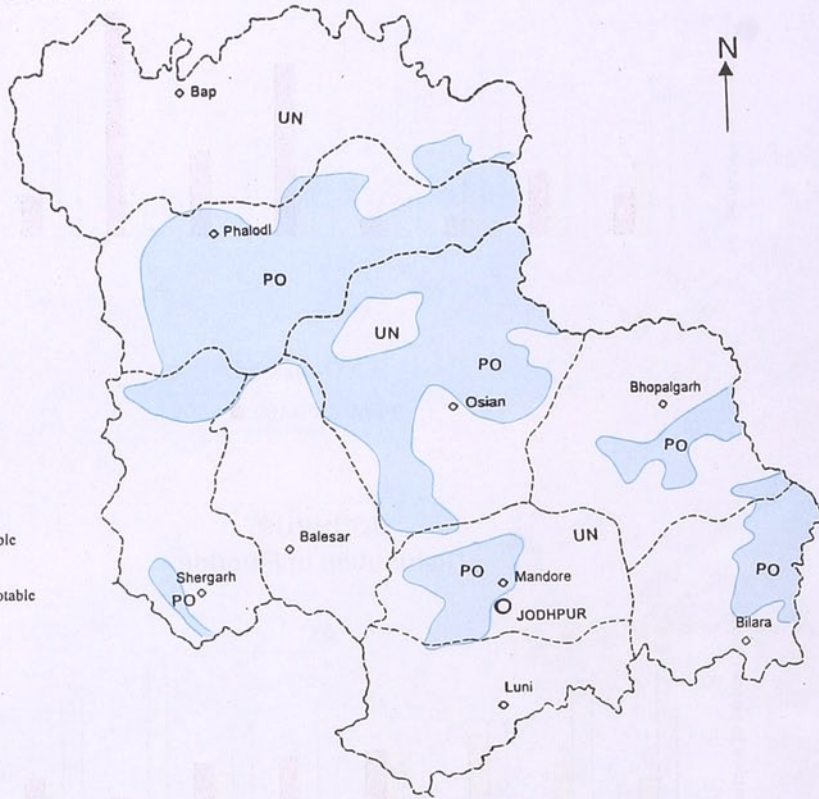
JODHPUR DISTRICT

Scale 0 5 10 15 20 km.



LEGEND

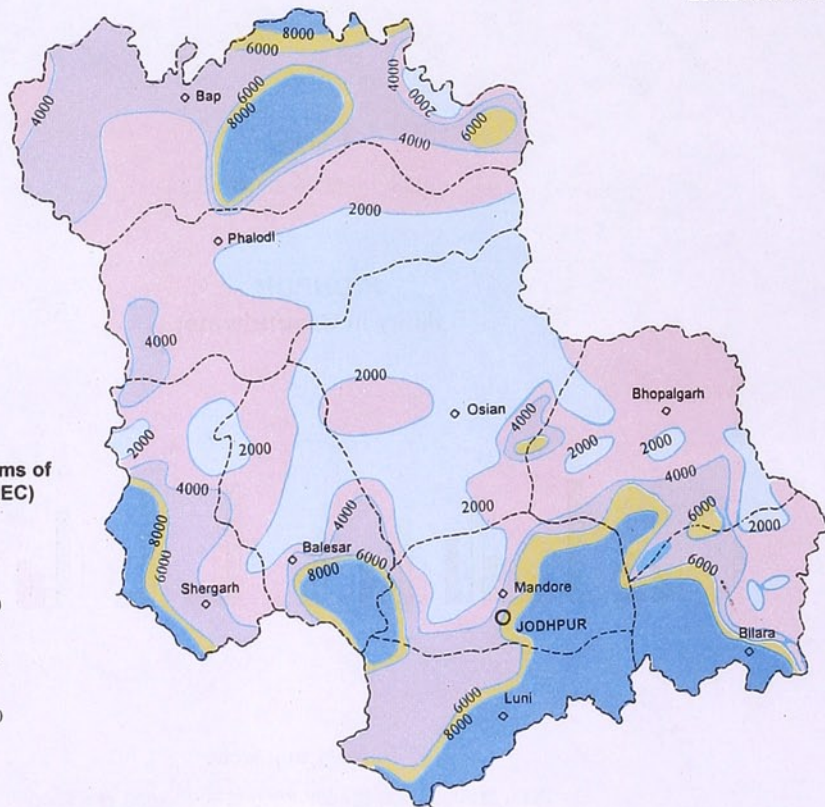
- PO Potable
- UN Unpotable

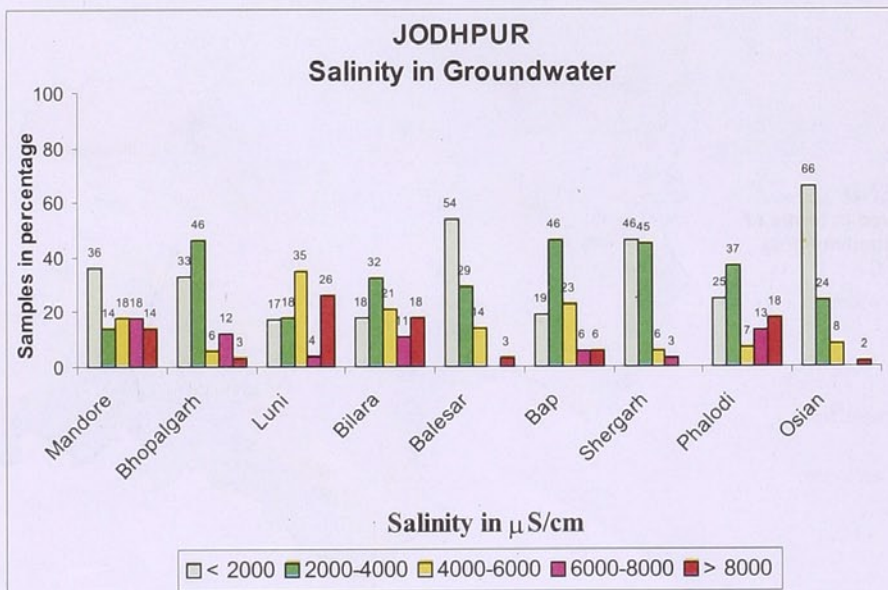
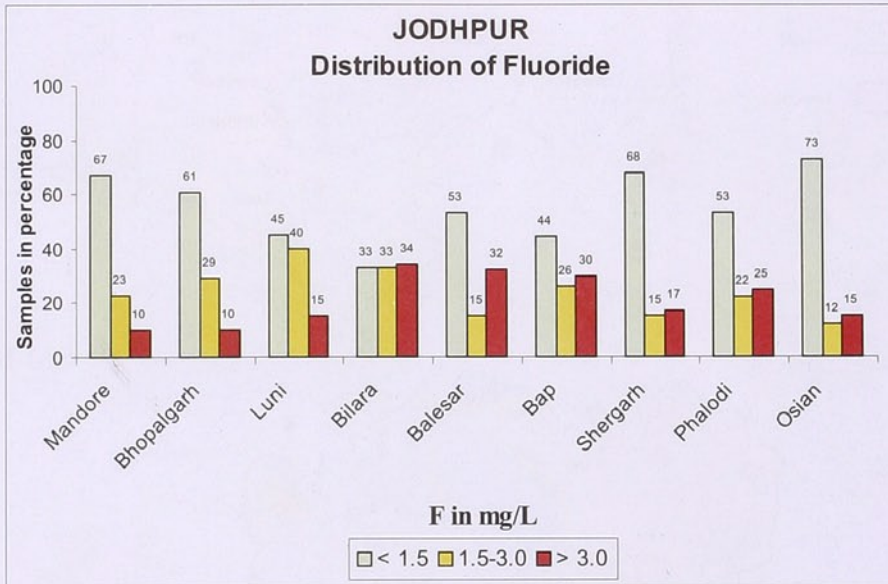
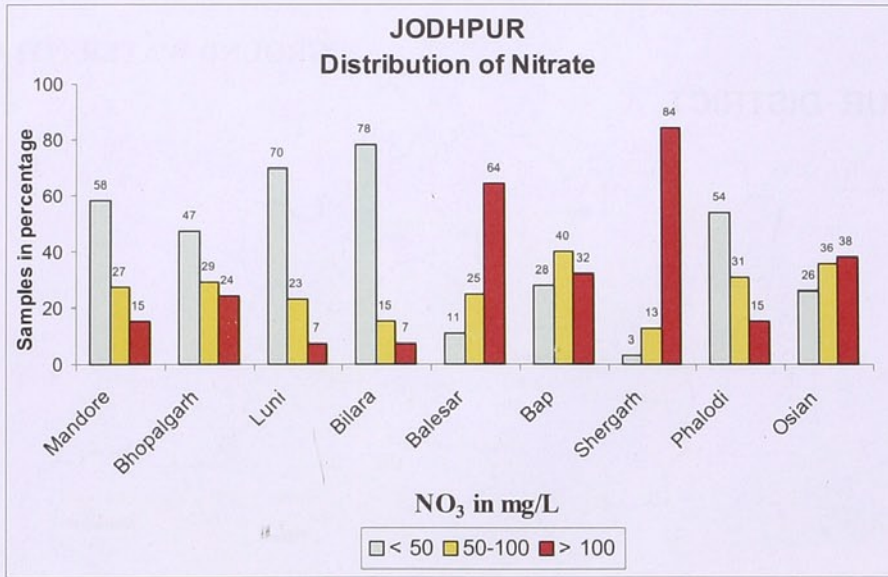


SALINITY

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

- < 2000
- 2000 - 4000
- 4000 - 6000
- 6000 - 8000
- > 8000





NITRATE DISTRIBUTION

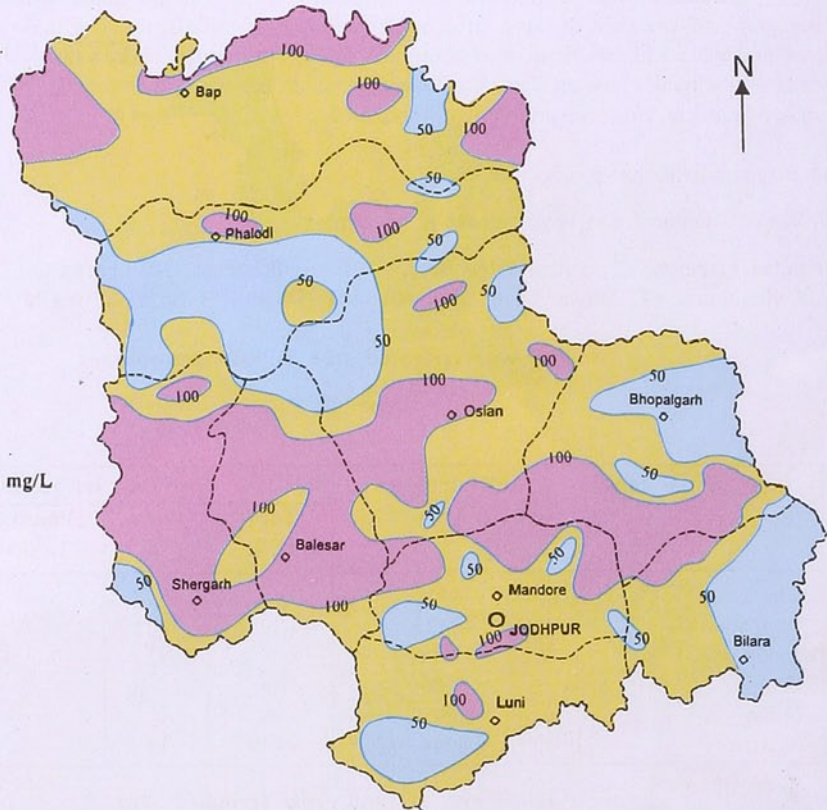
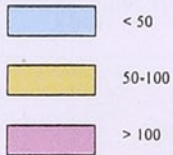
JODHPUR DISTRICT

Scale 0 5 10 15 20 km.



LEGEND

Nitrate Concentration in mg/L



FLUORIDE DISTRIBUTION

LEGEND

Fluoride Concentration in mg/L

