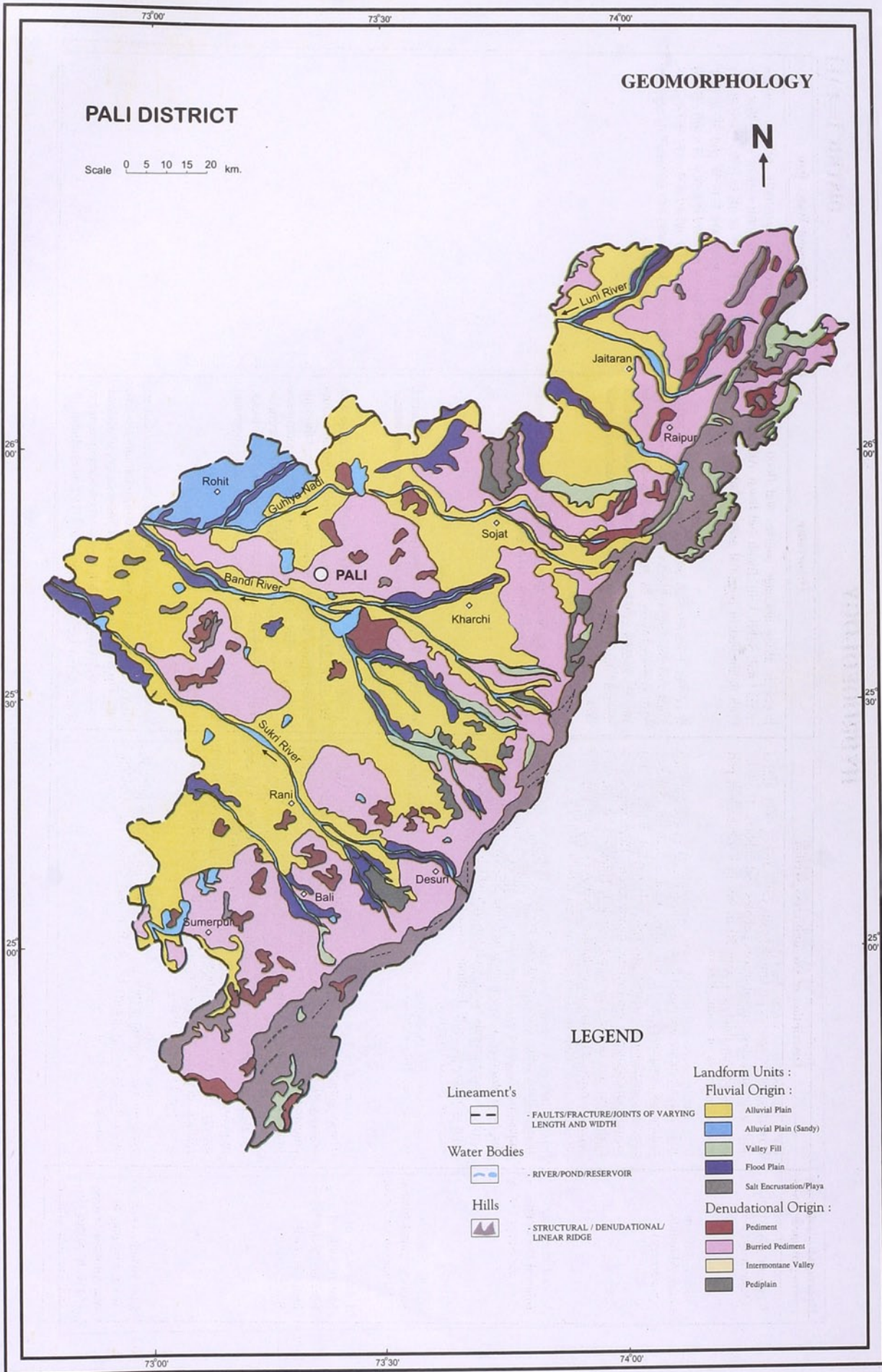


GEOMORPHOLOGY

DISTRICT—PALI

Landform Units	Symbol	Lithology / Material / Description	Occurrence in district	Land use/Land cover
Fluvial Origin Alluvial Plain	AP	Mainly undulating landscape formed due to fluvial activity, comprising of gravels, sand, silt and clay. Terrain mainly undulating, produced by extensive deposition of alluvium.	Mainly concentrated in central, western, northern, in between river courses.	Double crop, single crop (Rabi / Kharif), fallow.
Alluvial Plain (Sandy)	AP (S)	Flat to gentle undulating plain formed due to fluvial activity, mainly consists of gravels, sand, silt and clay with unconsolidated material of varying lithology, predominantly sand along rivers all over the district.	Along northern west margin of the district.	Marginal double crop, single crop (Kharif), open scrub, 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.	Marginal in between hill in east of the district.	Marginal double crop, single crop (Rabi).
Salt Encrustation/ Playa	SE/PL	Topographical depressions comprising of silt, clay & soluble salts, usually undrained and devoid of vegetation.	Negligible in western part.	Salt waste.
Flood Plain	FP	The surface or strip of relatively smooth land adjacent to a river channel formed by river and covered with water when river over flows its bank. Normally subject to periodic flooding.	Mainly along all major tributaries of river Luni.	Double crop, single crop (Rabi / Kharif).
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 around foot hills.	Single crop (Kharif), fallow, open scrub.
Buried Pediment	BP	Pediment covered essentially with relatively thicker alluvial, colluvial or weathered materials.	Scattered in entire district, mainly on western margin of hills.	Marginal double crop, single crop (Kharif), fallow, open scrub.
Intermontane Valley	IV	Depression between mountains, generally broad & linear, filled with colluvial deposit.	Negligible in between hills.	Marginal double crop, single crop (Kharif), fallow, open scrub.
Pediplain	PP	Pediplain essentially covered with soil cover.	In western part of the district.	Single crop, marginal (Rabi / Kharif), open scrub.
Hills Denudational Hill	DH	Steep sided, relict hills undergone denudation, comprising of varying lithology with joints, fractures and lineaments.	Marginal in north.	Land with or without scrub.
Structural Hill	SH	Linear to arcuate hills showing definite trend-lines with varying lithology associated with folding, faulting etc.	On eastern margin.	Forest, mining, open scrub.
Linear Ridge	LR	Long narrow low-lying ridge usually barren, having high run-off may form over varying lithology with controlled strike.	Marginal in north east.	Barren.

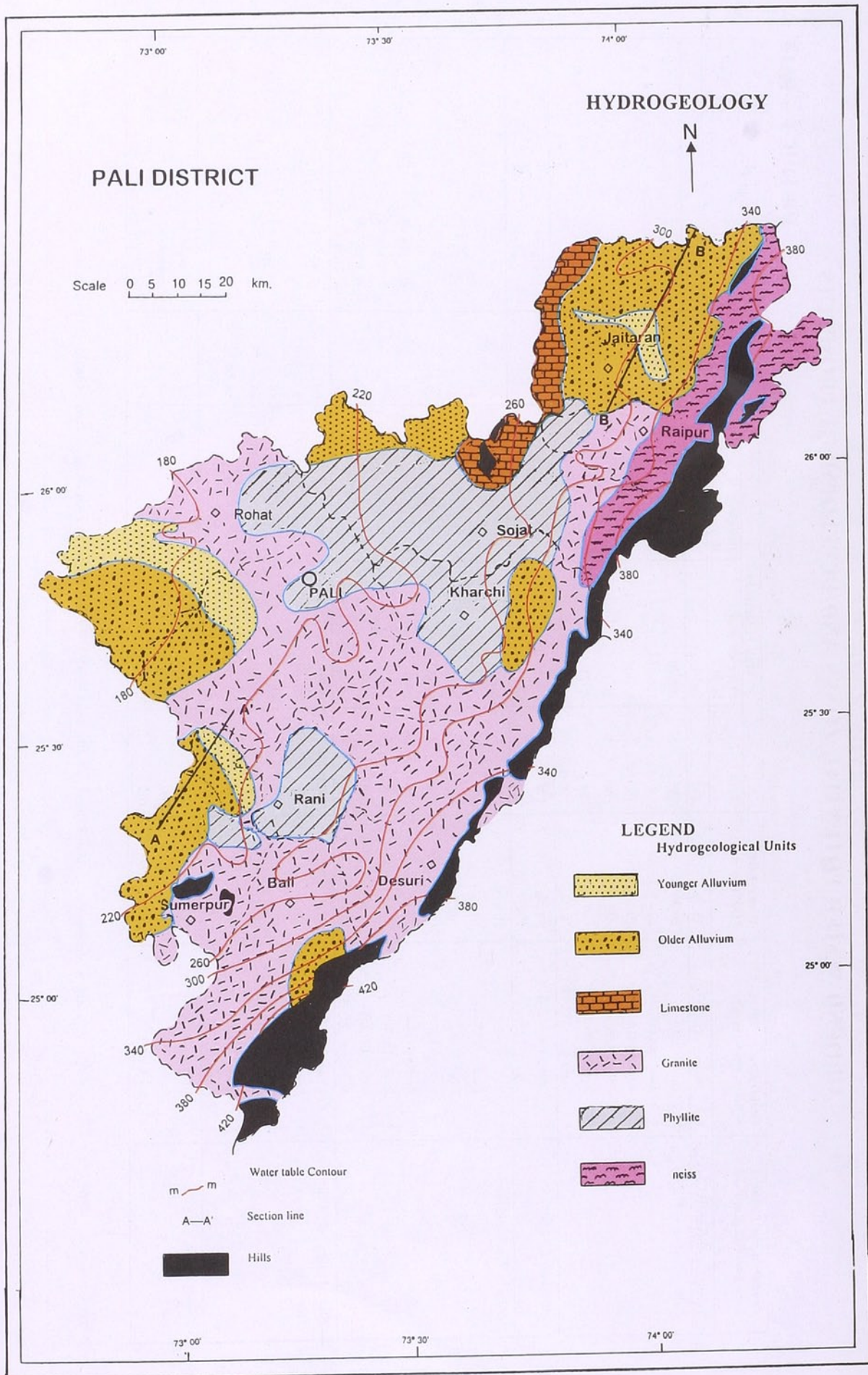


HYDROGEOLOGY

DISTRICT—PALI

Hydrogeological units	Description of the unit/cross section	Occurrence	Ground Water flow
Younger Alluvium (Quaternary)	It mainly comprises stream laid deposits consisted of sand, gravel with some silt, clays and at places pebbles and cobbles. The litho unit normally has thickness upto 50 m but in north eastern part attains thickness of about 100 m.	It occurs along drainage courses and flood plains of rivers Luni, Sukri, Lirri, Bandi and Jawai. Alluvium has been delineated in potential area in Jaitaran block.	Ground water flow generally follows surface drainage pattern. In north eastern area, flow has been inferred E to W or SE to NW. Western and south western area have E to W and SE to NW flow. Hydraulic gradient is gentle in north eastern and central area (1.3 m/km) and more steep in the southern part. It indicates low permeability aquifers in the southern area.
Older Alluvium (Quaternary)	It is heterogeneous mixture of semi consolidated to consolidated sediments comprising sand, silt, clay, kankar and silt. Sand is generally medium to coarse grained, subrounded, while gravel include subangular to sub-rounded quartz grains. Rock fragments in the litho unit are angular to subrounded. Thickness of alluvium varies considerably due to undulating bed rock topography and observed maximum in north eastern area (about 100 m).	It covers Jaitaran, Pali and Rohat blocks and part of Sojat and Sumerpur blocks. Alluvium occupies nearly 22% potential area. In Jaitaran and Sumerpur blocks alluvial aquifer cover extensive area. In other parts, a limited alluvial thickness have been recorded in potential area.	
Bilara Limestone (Marwar Super Group)	It is of dark grey colour, hard and compact dolomitic and cherty limestone. At some localities cavities and collapse structures have also been observed. Cross section trending NE-SW in north eastern peripheral area reveals block fault through which central block has been up thrown and Jodhpur sandstone. Juxta-position with younger Bilara limestone.	It encompasses Sojat and Jaitaran blocks, where covers nearly 2% area in potential zone.	
Jodhpur Sandstone (Marwar Super Group)	It comprises gritty sandstone and siltstone intercalated with shales.	It encloses small area on the northern peripheral part in Jaitaran block. The litho unit has not been demarcated in potential area.	
Malani suite of Igneous rocks (Post Delhi & Delhi Super group)	These comprises Erinpura, Jalor, Siwana granites and Malani rhyolite of Post Delhi group. Erinpura granite is essentially grey coloured biotite hornblende granite and varies from medium grained, equigranular to porphyritic and gneissic types. Granite is massive and sparsely jointed, but exfoliation and spheroidal weathering is common. Jalor and Siwana granite are pink and grey in colour. Pink variety is more soft than grey. Malani rhyolite is mostly brick red to dark brown and black and associated with felsites, devitrified lava with acid tufts. Rhyolite varies in texture from porphyritic to glassy.	Granites cover major part of the district. Central and Western and some pockets in north eastern and south-western parts are only exception where other litho unit occupy the area. Erinpura/Jalor granite encompasses nearly 42% potential area. Malani rhyolite occurs in north western and western part of Pali and Rohat blocks. This litho unit has not been demarcated as potential area.	
Calc schist, Gneiss, Slate, Phyllite, Schist and Granite Gneiss (Aravalli Super Group and Pre-Aravallies)	Aravalli Super Group comprises dark brown, grey and purple slates with thin bands of quartzite, phyllite and schist. Pre Aravallies include gneisses and schists.	Aravalli super group cover extensive area in central part and occupies small area in northern and south western parts. Pre Aravalli gneisses and schists occupy small area along the Aravalli foot hill zone on the eastern periphery. Gneiss and schist occupy nearly 31% potential area.	

For cross section(s) please see page no. 548

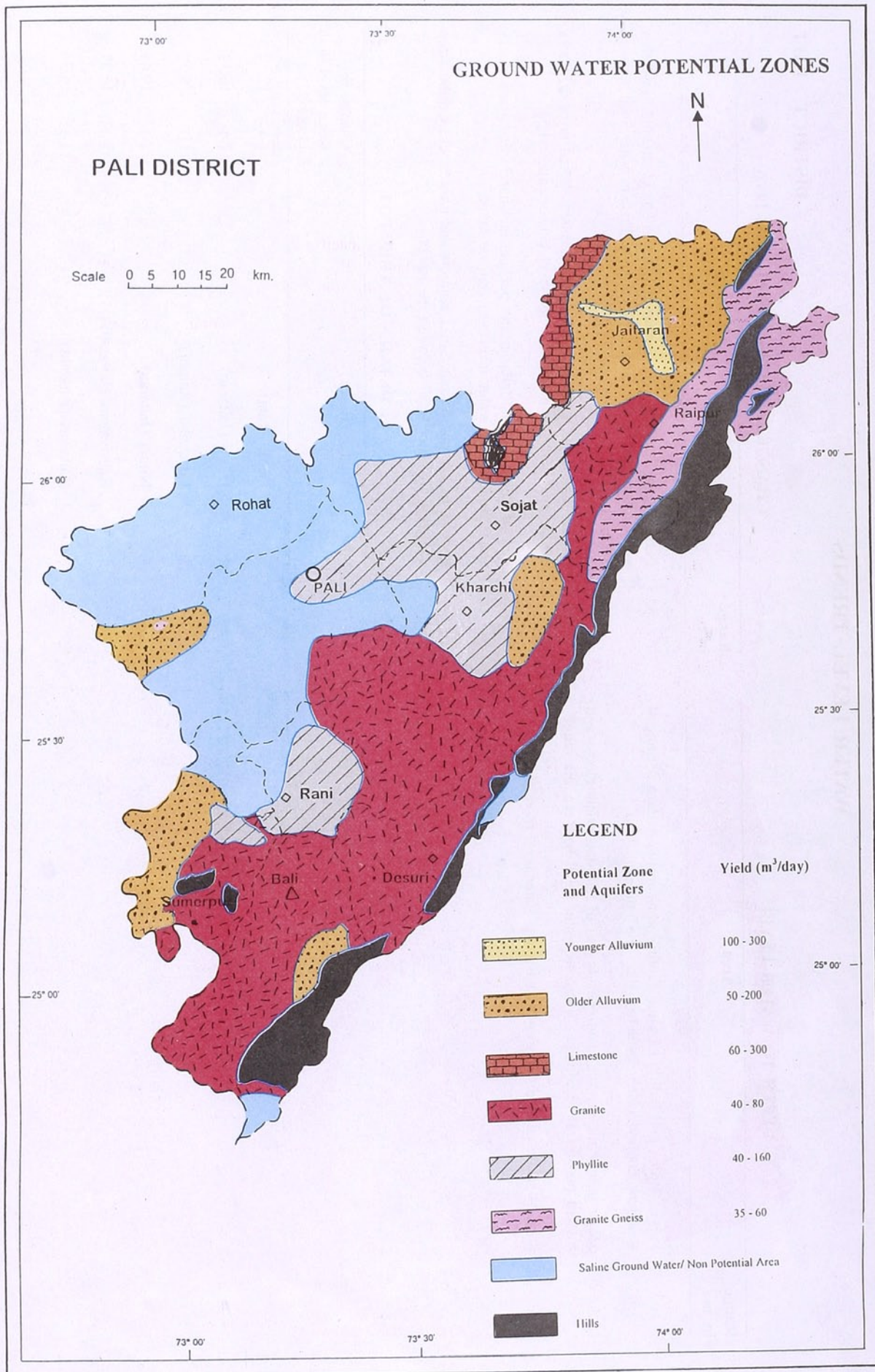


GROUND WATER POTENTIAL ZONES AND DEVELOPMENT PROSPECTS

DISTRICT - PALI

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 ⁻⁶ siem/cm	Development Prospects	
			Type	Proposed depth in m	Discharge in m ³ /day			
Younger Alluvium (81.24)	* Jaitaran (81.24)	15-40	TW	100-130	40-450	<4	Critical	
Older Alluvium (1573.93)	* Bali (87.50)	20-30	TW	80-100	35-150	<4	Safe	
	* Jaitaran (793.74)	20-45	TW	100-130	35-400	<4	Over exploited	
	* Kharechi (145.50)	10-30	TW	80-100	35-150	<4	Semi Critical	
	* Pali (75.00)	<20	DW	25-35	35-120	4-6	Safe	
	* Rohat (106.25)	<10	DW	25-35	35-120	4-6	Safe	
	* Sumerpur (365.94)	10-20	TW/DW	80-100/25-35	80-100	<4,4-6	Safe	
	* Jaitaran (137.50)	30-50	TW	100-130	50-450	<4	Over drafted	
	* Sojat (98.56)	10-50	TW/DW	100-110/25-35	50-350	4-6	Over drafted	
Ertapura Granite (3140.61)	* Bali (856.25)	10-25	DW	25-35	30-60	<4	Safe	
	* Desuri (565.31)	10-25	DW	25-35	30-60	<4	Critical	
	* Kharechi (673.25)	10-25	DW	25-35	30-60	<4	Critical	
	* Pali (178.18)	10-20	DW	25-35	30-60	<4,4-6	Safe	
	* Raipur (156.25)	20-35	DW	25-45	30-60	<4	Over exploited	
	* Rani (360.90)	15-25	DW	25-45	30-60	<4	Over exploited	
	* Sojat (139.15)	15-25	DW	25-40	30-60	<4	Over exploited	
	* Sumerpur (211.32)	<20	DW	30-45	45-95	<4	Safe	
	Slate, Phyllites & Schist (1623.44)	* Kharechi (331.25)	10-15	TW/DW	80-100/25-35	40-200	<4	Over drafted
		* Pali (56.25)	<20	TW/DW	80-100/25-35	40-180	4-6	Safe
* Raipur (100.00)		<15	TW/DW	80-100/25-35	40-200	<4	Over exploited	
* Rani (264.27)		15-35	TW/DW	80-100/25-35	40-150	<4	Safe	
* Sojat (788.53)		10-35	TW/DW	80-100/25-45	40-180	<4,4-6	Safe	
* Sumerpur (83.14)		<30	TW/DW	80-100/25-35	50-140	<4	Safe	
Granite Gneiss (707.26)	* Jaitaran (200.00)	<10	DW	20-35	20-60	<4	Over exploited	
	* Raipur (400.00)	<15	DW	20-35	20-60	<4	Over exploited	
	* Sojat (107.26)	10-20	DW	25-35	20-60	<4	Over exploited	

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 : PALI

DEPTH TO WATER LEVEL

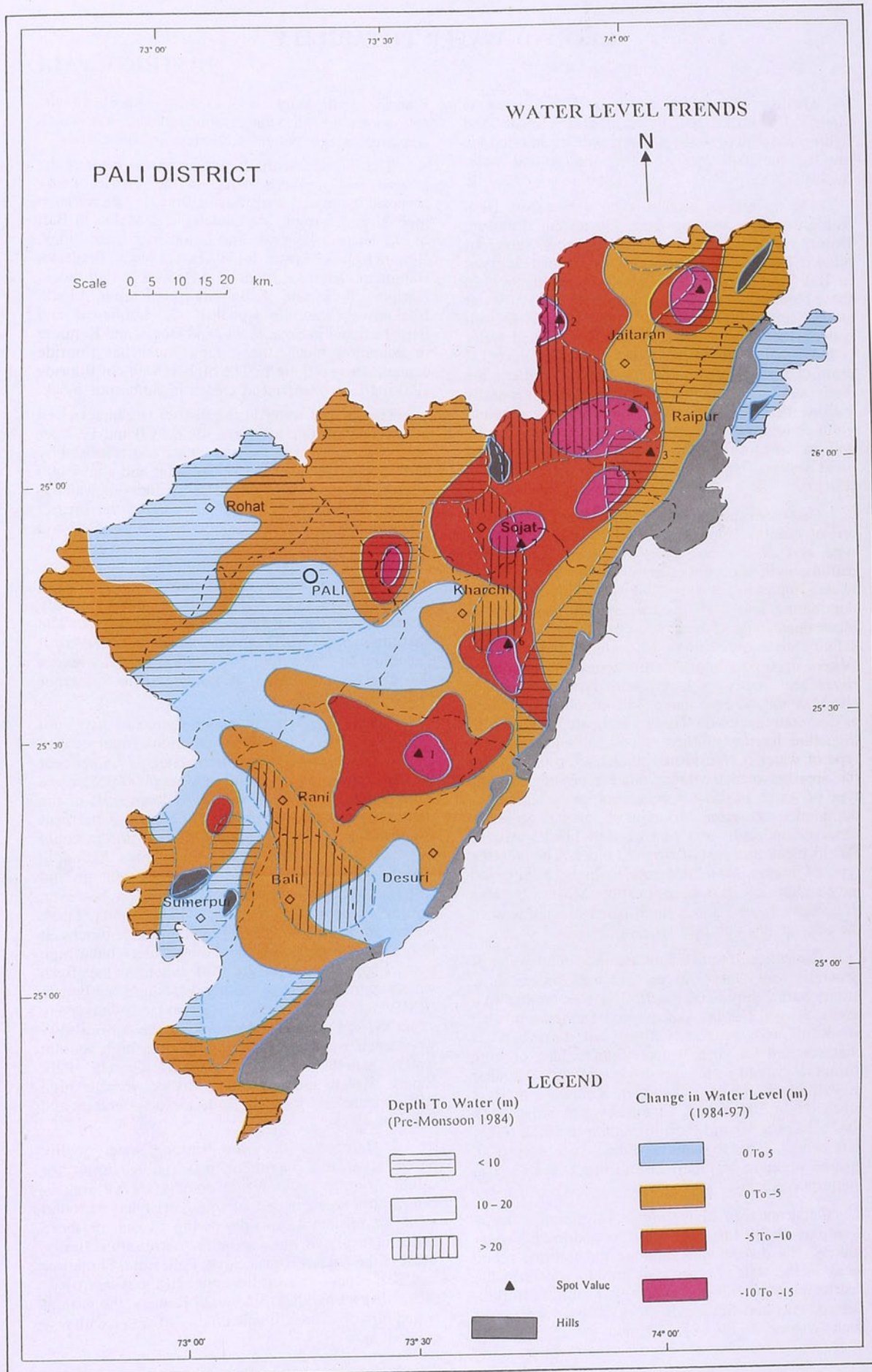
Range in m	Area
< 10	Part of Rohat and Pali blocks and foothill zone in the eastern peripheral area has shallow water level less than the range.
10 to 20	Major part of the district, leaving aside part of Pali and Rohat blocks and eastern peripheral region, has depth to water level between the range.
> 20	Pockets scattered in different parts has deep water level more than 20 m.

CHANGE IN WATER LEVEL (1984-1997)

Range in m	Area
0 to 5	Part of Rohat, Pali, Bali, Sumerpur and Desuri blocks situated in western and southern part of the district show marginal rise in water level between the range.
0 to -5	Part of Pali, Sojat, Jaitaran blocks and pockets scattered in other blocks exhibit marginal depletion in water level between the range.
-5 to -10	Part of Sojat, Raipur, Jaitaran and pockets in Kharchi and Rani blocks show depletion in water level between the range.
-10 to -15	Pockets in Jaitaran, Raipur, Sojat, Kharchi and Rani blocks exhibit 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.	Deoli (Rani)	(-) 12.10
2.	Latoti (Jaitaran)	(-) 16.39
3.	Leelamba (Raipur)	(-) 18.30
4.	Nimaj (Jaitaran)	(-) 19.44
5.	Rabriyawas (Jaitaran)	(-) 15.37
6.	Ranawas (Kharchi)	(-) 14.34



GROUND WATER POTABILITY

DISTRICT PALI

Quality of ground water in Pali district is significantly influenced by semi-arid climate and hydrogeological diversity-salinity, sodicity and fluoride are the major factors affecting the ground water quality.

The salinity of ground water varies from fresh to highly saline ranging from 330 $\mu\text{S}/\text{cm}$ (Ranalan; Desuri block) to 36000 $\mu\text{S}/\text{cm}$ (Chanod; Sumerpur block). The fresh water pockets are mainly occupied in Bali, Desuri and Rani blocks of the district. In these blocks the electrical conductivity (EC) of water is less than 2000 $\mu\text{S}/\text{cm}$ in more than 70% well waters. In Pali and Rohat blocks, the ground water is more saline. 40% and 65% well waters have EC more than 8000 $\mu\text{S}/\text{cm}$. Among various aquifers, the wells sunk in calcschist and calc-gneiss generally yield water of low salinity whereas those in alluvium yield ground water mostly of saline character. Granite and gneisses form potential aquifers in the district and yield water of moderate quality (Average EC-3577 $\mu\text{S}/\text{cm}$).

Geo-chemically, 40.2% ground water in the district are of chloride type followed by 33% bicarbonate type and 26.3% mix type of water. Among the cations, sodium occurs as the major species in 75.4% water samples followed by 22% as calcium-magnesium dominating and 2.5% as calcium dominating. The bicarbonate type of waters are characterised by low salinity and low content of sodium and chloride. Waters occurring near foothill zones and along the rivers are mostly of bicarbonate type in chemical character and have calcium or calcium plus magnesium as dominating cations. These waters are usually fresh in nature having salinity below 1500 $\mu\text{S}/\text{cm}$. Mix type of water is transitional in character and occupy the area between the bicarbonate type and chloride type of water. In these waters, none of the anion has dominating character. Mix type of water is generally observed in south and east of Bali block, west of Desuri block and east of Kharchi block. The chloride type of waters have moderate to high salinity and have sodium as the dominant cation. Most of the area in northwest, west and a small patch in southwest of the district has chloride type of water.

The concentration of nitrate in ground water is generally low. Only 7.2 per cent well waters show nitrate value above 100 mg/L. The area around Juni Endla, Kirwa, Dhola, Akadara and Sanderao in west of Rani and around Chhang in northeast is characterised by such waters. Spot values of high nitrate in ground water are also observed at Manihar in Pali block (NO_3^- ; 350 mg/L), Khinwara in Rani block (NO_3^- ; 203 mg/L), Chandanwal in Sojat block (NO_3^- ; 123 mg/L) and Palri in Sumerpur block (NO_3^- ; 310 mg/L). The maximum nitrate is observed in ground water at Manihari in Pali block and Palri in Sumerpur block.

Occurrence of high fluoride in ground water is a serious health hazard if used as a drinking water source. The district ranks among the fluoride prone areas in the state. 71 per cent ground waters in the district have fluoride content above 1.5 mg/L. In Bali, Desuri, Pali and Sumerpur blocks the percentage of such waters is 86, 75, 83 and 78 respectively.

Fluoride rich waters are seen in almost all the formations viz., alluvium, granite, gneisses etc. which constitute major potential aquifers in the district.

The fluoride distribution map shows most of the eastern and northern parts of the district being occupied by ground water having fluoride concentration more than 1.5 mg/L. At Gudalas and Malnu in Bali block, Jetaran, Jajanwas and Latoti in Jetaran block, Bithura Khurd, Marwar Jn. in Kharchi block, Bhalelao, Bhumdara, Khorwa, Madri and Ramsia in Pali block, Haripur, Nok and Sabalpura in Raipur block, Bhakariwala gaon in Rohat block. Lundawas and Sardarsamand in Sojat block, and Gogra and Kenpura in Sumerpur block, the ground water has fluoride content above 5.0 mg/L. The highest value of fluoride 12.0 mg/L is observed at Gogra in Sumerpur block.

The ground water in the district is characterised by low to moderate hardness. 49.2, 31.0 and 19.7 per cent water samples of the district are characterised by hardness in the range 0-300, 300-600 and above 600 mg/L as calcium carbonate. The hardness of water is comparatively more in northern part of the district covering Rohat, Pali and Sojat blocks. 45%, 46% and 30% ground waters in these blocks have hardness above 600 mg/L respectively. Rani block in south, on the other hand, has modest values for hardness in ground water, 83% well waters in the block are characterised by hardness below 300 mg/L. The maximum hardness in ground water is observed at Kharchigaon in Kharchi block (2350 mg/L) whereas the lowest value is seen at Takhatgarh in Sumerpur block (85 mg/L).

Ground water is the major source of irrigation in the district. As per the Anonymous water quality criterion for rating the irrigation waters, 77.3 per cent ground waters having salinity below 6000 $\mu\text{S}/\text{cm}$ are suitable for irrigation on the sandy loam soils of the district for all type of crops. The next 5.7 per cent waters of the salinity range 6000-8000 $\mu\text{S}/\text{cm}$ could be used for irrigating salt-tolerant crops including wheat and mustard. The rest 17.1 per cent ground waters having salinity above 8000 $\mu\text{S}/\text{cm}$, however, unsuitable for irrigation owing to high salinity. These waters are mostly found in Rohat and Pali blocks. It is further observed that the saline waters have high percentage of sodium (>70%) whereas the fresh waters generally have residual sodium carbonate (RSC) more than 2.0 meq/L. The two factors adversely effect the soil properties by reducing the permeability when such water is used for irrigation, high sodium waters generally occur in Jetaran, Kharchi, Pali, Raipur, Rohat and Sumerpur blocks whereas high RSC waters are seen in Bali, Desuri, Jetaran and Kharchi blocks.

An integrated map for drinking water quality based upon the maximum permissible limits for salinity, nitrate and fluoride content shows area in central and western part of the district have ground water of unsuitable quality owing to one or more constituent above the maximum permissible limits. Most of the area of Rohat, Sojat, Pali, Rani, Sumerpur and Bali blocks fall in this zone. In the eastern part of the district parallel to Aravalli Ranges, the ground water, however, has suitable quality of water with few exceptions.

PALI DISTRICT

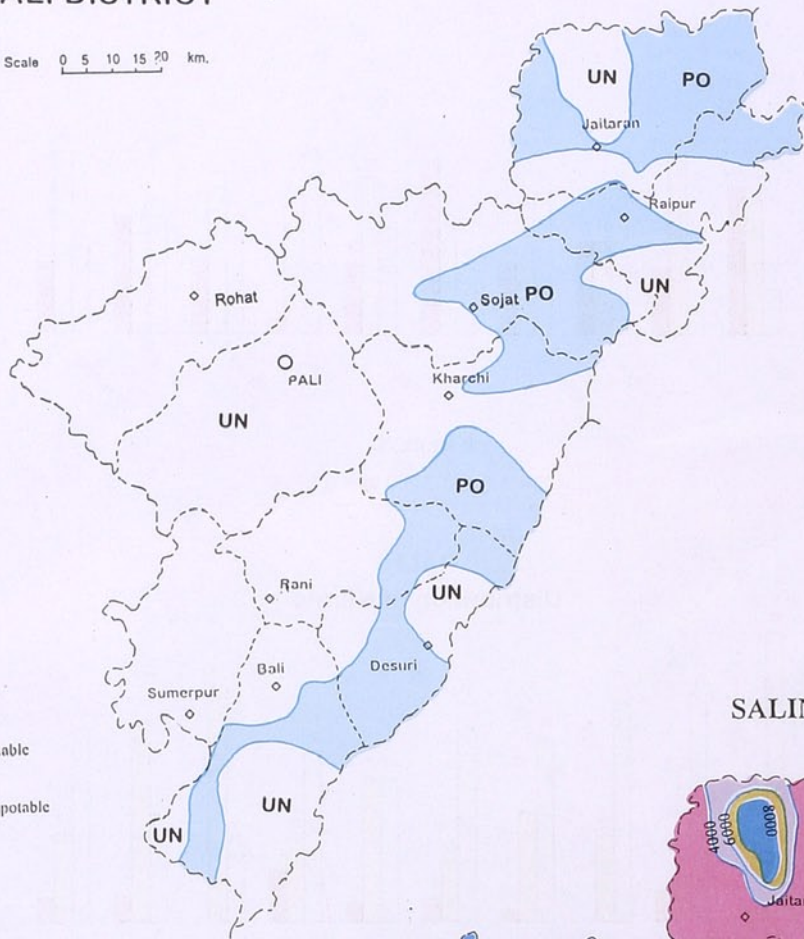
GROUND WATER POTABILITY

Scale 0 5 10 15 20 km.



LEGEND

- PO Potable
- UN Unpotable

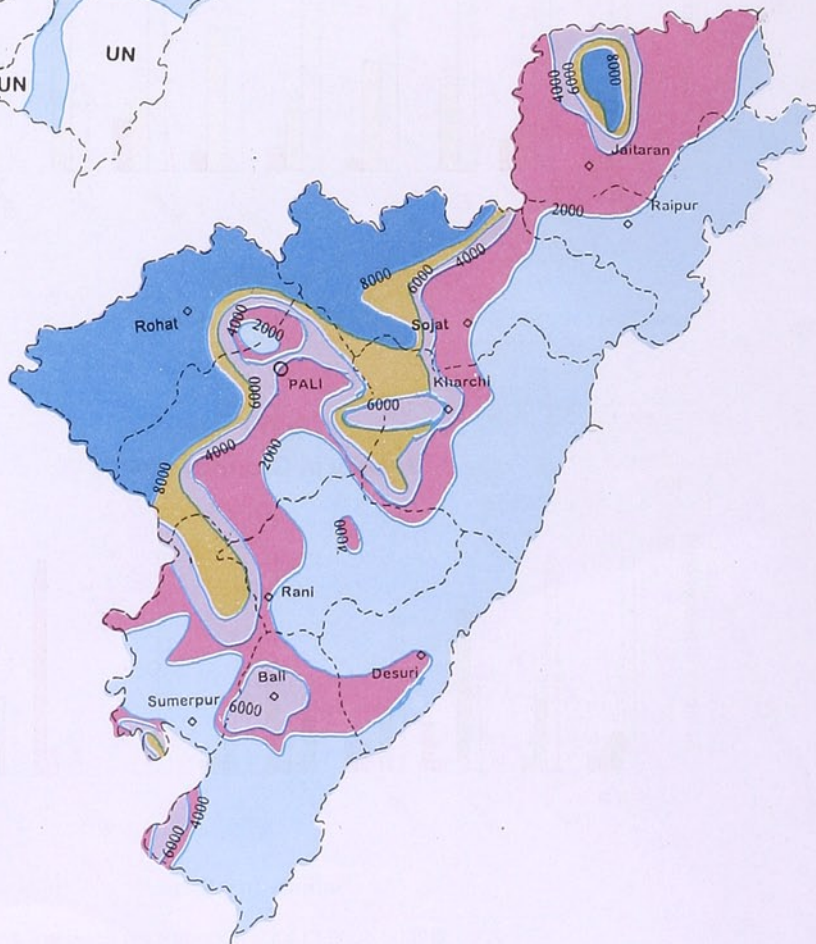


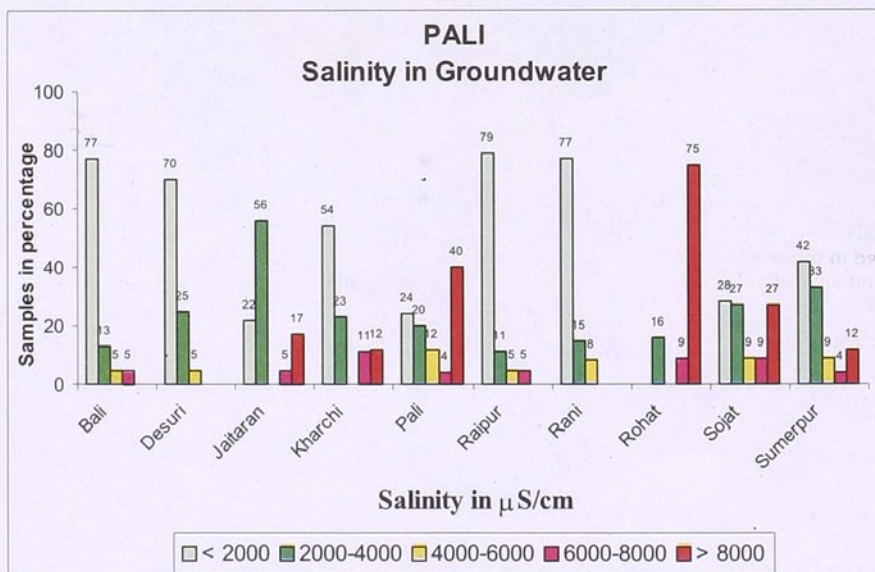
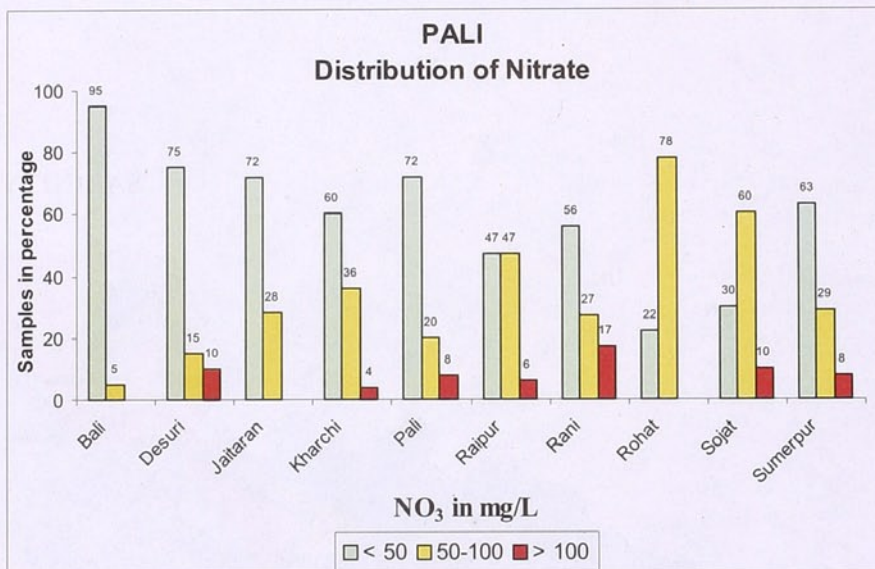
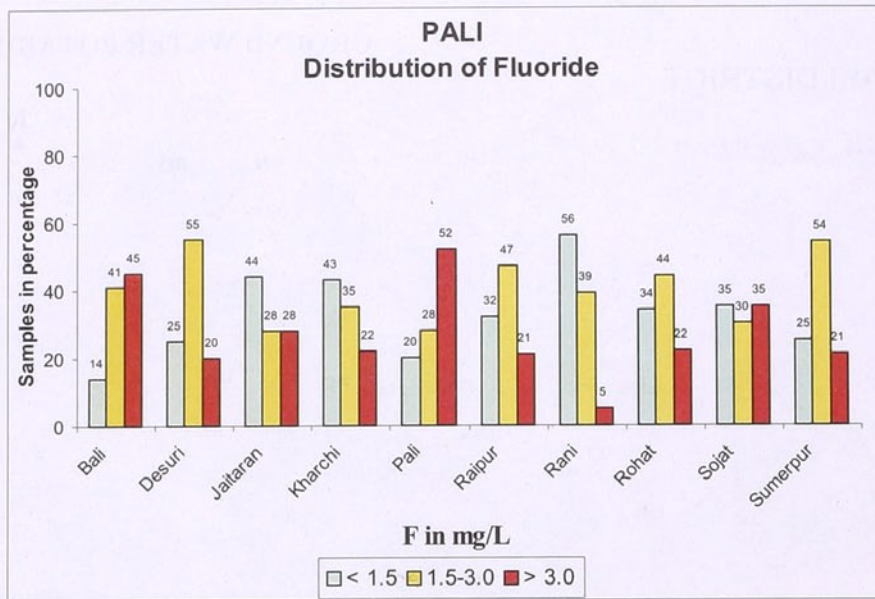
SALINITY

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





PALI DISTRICT

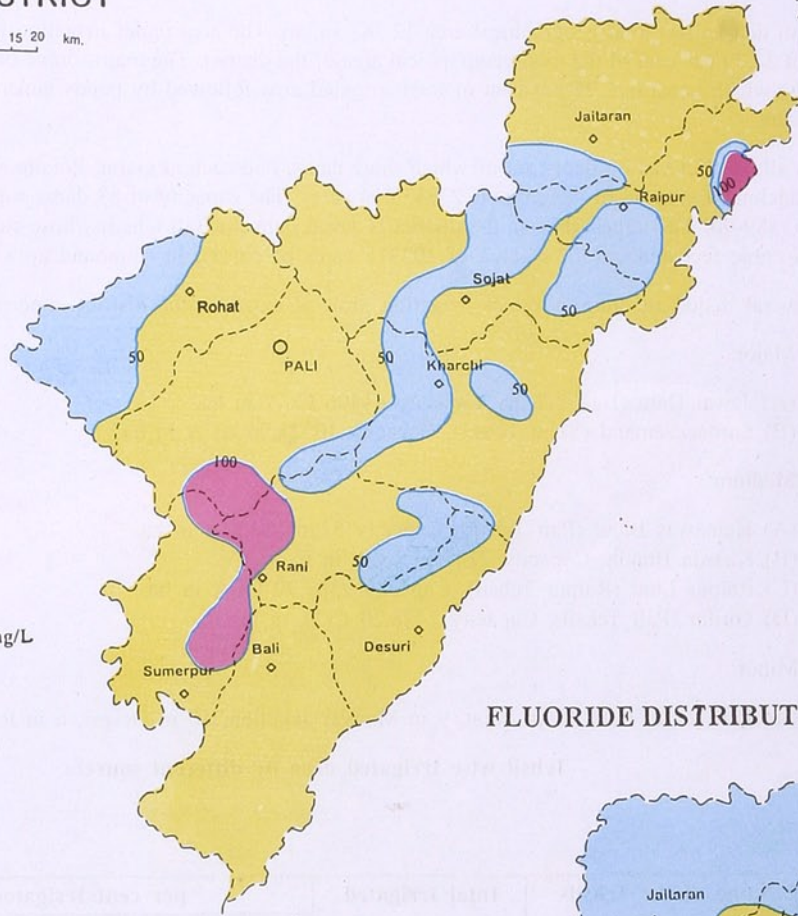
Scale 0 5 10 15 20 km.

NITRATE DISTRIBUTION



LEGEND

Nitrate Concentration in mg/L



FLUORIDE DISTRIBUTION

LEGEND

Fluoride Concentration in mg/L

