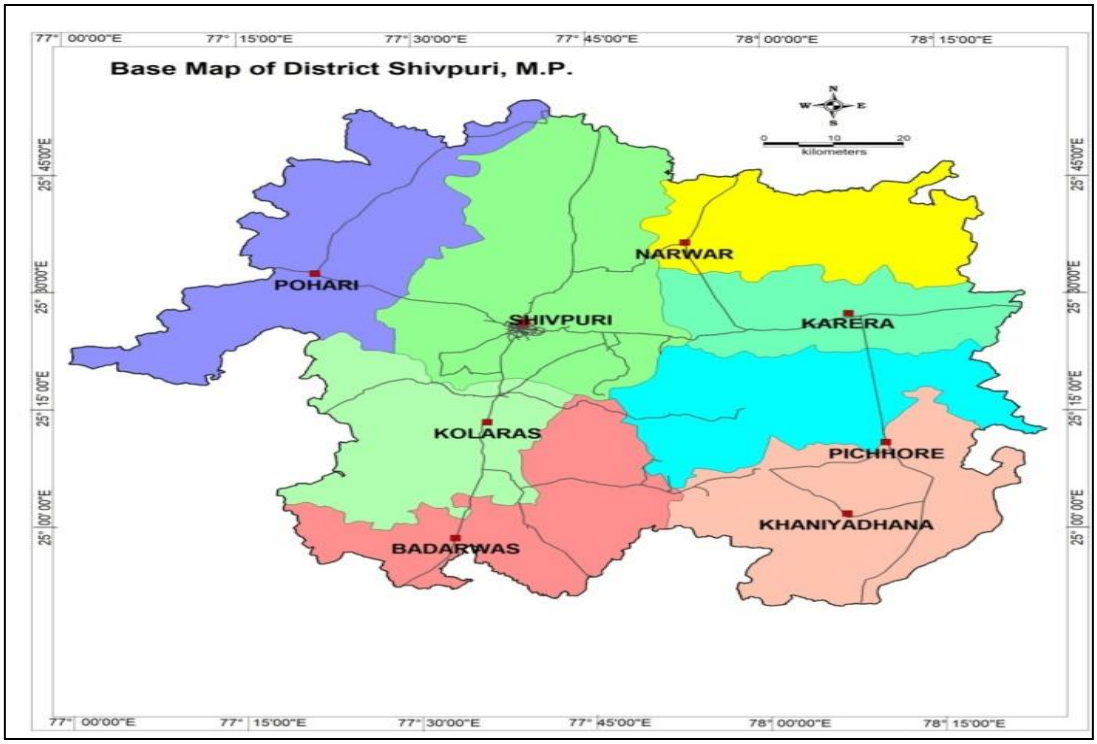
केन्द्रीय भूमि जल बोर्ड
जल संसाधन, नदी विकास और गंगा संरक्षण
विभाग, जल शक्ति मंत्रालय
भारत सरकार
Central Ground Water Board
Department of Water Resources, River
Development and Ganga Rejuvenation,
Ministry of Jal Shakti
Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

SHIVPURI DISTRICT
MADHYA PRADESH

उत्तर मध्य क्षेत्र, भोपाल
North Central Region, Bhopal

AQUIFER MAPPING AND GROUND WATER MANAGEMENT PLAN OF SHIVPURI DISTRICT, MADHYA PRADESH



By

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(AAP: 2020-21)

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North Central Region

Bhopal

PREFACE

Aquifer mapping is as a multi-disciplinary scientific process, wherein combinations of geological, geophysical, hydrological and geochemical studies are applied to characterize the quantity, quality and sustainability of ground water resources. Systematic aquifer mapping is a procedure to improve our understanding of the hydrogeological framework of aquifer system.

Under the project on National Aquifer Mapping (NAQUIM) in XII & XIII Plan to formulate sustainable aquifer management plan, Central Ground Water Board (CGWB), North Central Region, Bhopal has taken up Shivpuri district to prepare the Aquifer Maps for the Shivpuri district and formulate Block-wise Aquifer Management Plan.

Shivpuri district occupies an area of 10066 sq km out of which 3122 sq. km. is covered with forest area. The major rivers flowing through the area includes the river Parwati, Kuno, Betwa and Mahur falling in Sind sub basin of Yamuna basin. The major part of the district is covered by the Vindhayan sandstones and Shales while the eastern part of the district is covered by Granite and Gneiss. Deccan trap lava flows and patches of recent alluvium exposed in southern part of the district and a small area in northern part respectively. On the basis of the 31 exploratory bore wells drilled by CGWB, NCR under its GW Exploratory program, it has been observed that the yield varies from meagre to 28.4 lps. As per the Dynamic Ground Water Resource Assessment Report (2020), the net ground water availability in the district is 747.29 MCM and ground water extraction for all uses is 524.88 MCM, resulting the stage of ground water extraction to be **70.24%** as a whole for the district.

The Shivpuri district falls under semi_critical category. After the implemented of post interventions in the report, the stage of GW extraction is expected to improve from **70.24%** to **58.64%** for the Shivpuri district and additional area for the irrigation will be 66759 ha. Shivpuri district comprises of eight blocks, namely, Shivpuri, Kolaras, Badarwas, Karera, Narwar, Pichor, Khanniyadhana and Pohari.

As per the Management plan prepared under NAQUIM of all the Block of Shivpuri District, a total number of 676 Percolation Tanks, 1449 Nala Bunds, 1136 Check Dams and1634 farm ponds have been proposed in Shivpuri District for sustainable development and management of ground water resources.

Results of these comprehensive studies will contribute significantly to sustainable development and management of ground water resources. It will not only enhance the long-term aquifer monitoring networks but also help in building the conceptual and quantitative regional ground water flow models for planners, policy makers and other stakeholders.

I would like to place on record my appreciation of the untiring efforts of **Sh. S. K. Shrivastava, Scientist-'D'** for preparing the Aquifer maps and Management plan and compiling this informative report. I fondly hope that this report will serve as a valuable guide for sustainable development of Ground Water in the Shivpuri district, Madhya Pradesh.

Rana Chatterjee
Regional Director

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CHAPTER-1

INTRODUCTION

Aquifer mapping can be defined as a scientific process, wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. Systematic aquifer mapping can improve our understanding of the geologic framework of aquifers, their hydrologic characteristics, water levels in the aquifers and how they change over time, and the occurrence of natural and anthropogenic contaminants that affect the portability of ground water. Results of these studies will contribute significantly to resource management tools such as long-term aquifer monitoring networks and conceptual and quantitative regional ground-water-flow models used by planners, policy makers and other stake holders. Aquifer mapping at the appropriate scale can help to prepare, implement and monitor the efficacy of various management interventions aimed for long-term sustainability of our precious ground water resources, which in turn, will help to achieve drinking water security, improved irrigation facilities and sustainability in water resources development in the country as a whole. Various on-going activities of Central Ground Water Board, such as ground water monitoring, ground water resource assessment, artificial recharge and ground water exploration in drought, water scarcity and vulnerable areas can also be integrated in the aquifer mapping project.

1.1. Objectives:

Aquifer Mapping is an attempt to combine a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. The major objectives of aquifer mapping are

- Delineation of lateral and vertical disposition of aquifers and their characterization on 1: 50,000
- Quantification of ground water availability and assessment of its quality to formulate aquifer
- Management plans to facilitate sustainable management of ground water resources at appropriate scales through participatory management approach with active involvement of stakeholders.

1.2. Scope of the Study:

The Social Outputs and benefits are less tangible but their significance in the contest of sustainable management of ground water resources cannot be underestimated.

- Involvement of community and stakeholders would enable the State Governments to manage their resources in an efficient and equitable manner, thereby contributing to improve overall development.
- Demystification of science will result in better understanding of aquifers at community level. The amalgamation of scientific inputs and traditional wisdom would ensure sustainable ground water resource management.
- Community participation and management would ensure sustainable cropping pattern, thereby contributing towards food security.

1.3 Approach and Methodology:

National Aquifer Mapping Programme basically aims at characterizing the geometry, parameters, behaviour of ground water levels and status of ground water development in various aquifer systems to facilitate Major Aquifers planning of their sustainable management. The major activities involved in this process include compilation of existing data, identification of data gaps and generation of data for filling data gaps and preparation of aquifer maps. The overall methodology of aquifer mapping is presented once the maps are prepared, plans for sustainable management of ground water resources in the aquifers mapped shall be formulated and implemented through participatory approach involving all stakeholders. Methodology flow chart is given in fig.1.

1.4 Study Area:

Shivpuri district is located in the northern part of the state of Madhya Pradesh and occupies as area of 10066 sq. km. and recharge worthy area is 9770.49 sq. km with a population of 1726050 according to census 2011. The district extends between the North latitudes 25^{o} 10´ and 25^{o} 32´ and East longitude 77^{o} 11´ and 78^{o} 1´ . It is bounded in the North by district Gwalior, in the south by the district Guna, in the east by the district Datia and in the west by the Rajasthan state (Fig. 2 & 3). The district is well connected by road and railway network. It is falling in Survey of India toposheets nos. 54H, K& L. Details of blocks in the study area are given in Table 1.

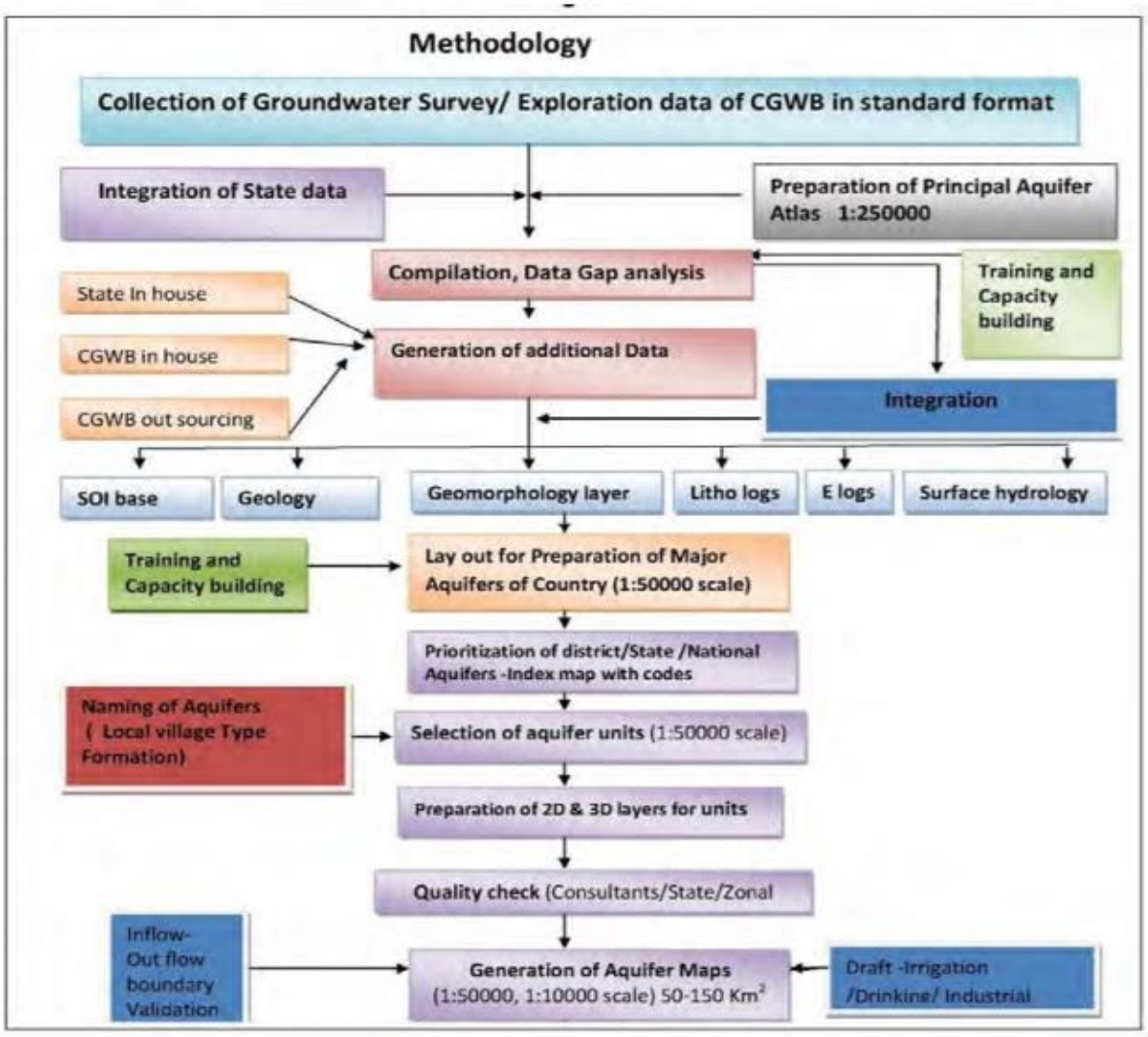

Fig.1:Methodology

Table 1: Block wise number of villages

S. No	Block	No of villages
1.	Shivpuri	181
2.	Kolaras	191
3.	Badarwas	140
4.	Karera	100
5.	Narwar	145
6.	Pichor	128
7.	Khanniyadhana	182
8.	Pohari	238
Total		**1305**

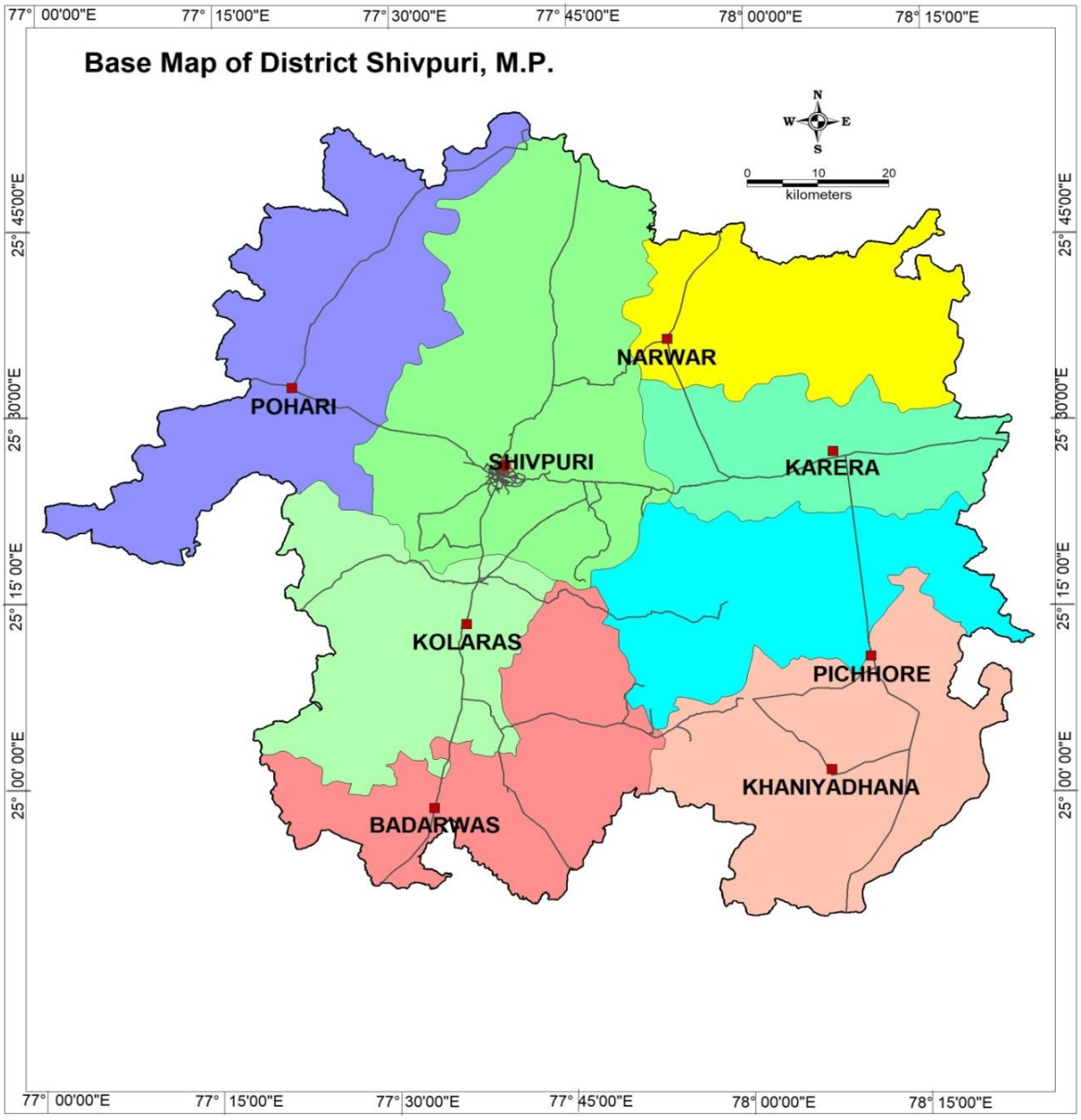

Fig.2: Base Map of Shivpuri District

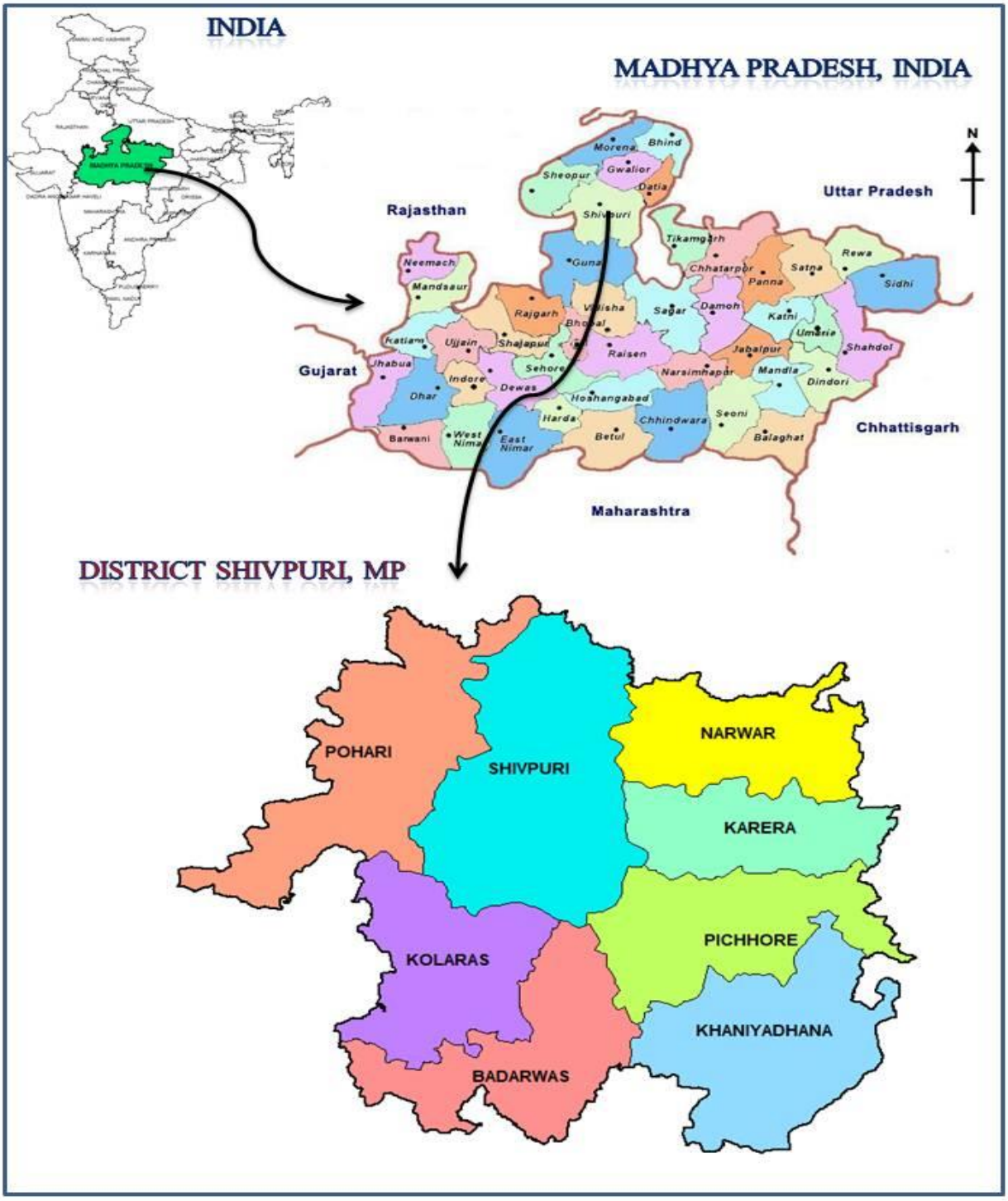

Fig.3: Location Map of Shivpuri District

1.5 Rainfall and Climate:

The climate of the Shivpuri district can be classified mainly into three seasons. Winter season starts from middle of October to end of February. March to May constitute summer season and the monsoon season starts from second week of June to end of September.

The normal annual rainfall of Shivpuri district is 816.3 mm. The district receives maximum rainfall during southwest monsoon period i.e. June to November. About 92% of annual rainfall is received during monsoon season. Average annual rainfall of the district is given in table 2.

During winter season the January is the coldest month with the temperature falling as low as 6^0 C and max up to 11^0 C. During the month of May, temperature goes up to 43^0 C (max.) and 30^0 C as minimum.

Table 2: Average annual Rainfall of Shivpuri District (June to May)

S.No.	Block	2012&13 Rainfall (mm)	2013&14 Rainfall (mm)	2014&15 Rainfall (mm)	2015&16 Rainfall (mm)
1	Shivpuri	937.8	982	553	604
2	Kolaras	1213	1345	644	850
3	Badarwas	847	1426	730	435
4	Karera	786	1156	643	693
5	Narwar	812	1686	940	754
6	Pichor	1195	1773	700	694
7	Khanniyadhana	1215	1158	734	899
8	Pohari	819	926	661	971

1.6 Physiography:

In Shivpuri district, landforms are mainly Denudation hills of Vindhyan sediments and pediments of granites are predominant. Apart from these geomorphic units feature like alluvial plain. Valley fills, intermundane valley and Deccan trap plateau are also seen. The maximum elevation is 506 m above MSL and minimum elevation is 191.5 m above MSL (Fig.4 & 5).

Rivers of Sind Sub-basin drain the entire Shivpuri district. All the rivers are almost northerly flowing. Shivpuridistrict is an upland region over the Bundelkhand plains, with escarp in the east, characterized by rugged up landing topography with north south trending parallel ridges and

intervening valleys. The eastern part is a pediplain over the granite. The Sind Rivers flowing northerly forms the major drainage in the eastern and central parts and river Kuno is another major river in the western parts. The district falls in the Yamuna basin. The district can be divided into four subbasins.

The district is generally covered with sandy clay soil derived from the weathering of Bundelkhand Granites and the Vindhyan formations. The southern part of the district is covered by the black cotton soils derived by the weathering of the Deccan trap formation. Depth of the soil varies from paper-thin to 15m. The colour of the sandy soil is light yellow to yellowish brown. The central and southern part of the district is covered by lateritic soil of dark brown to yellowish brown in colour. Alluvium is found all along the major and minor rivers, it consists of gravel, silt, sand and pebbles.

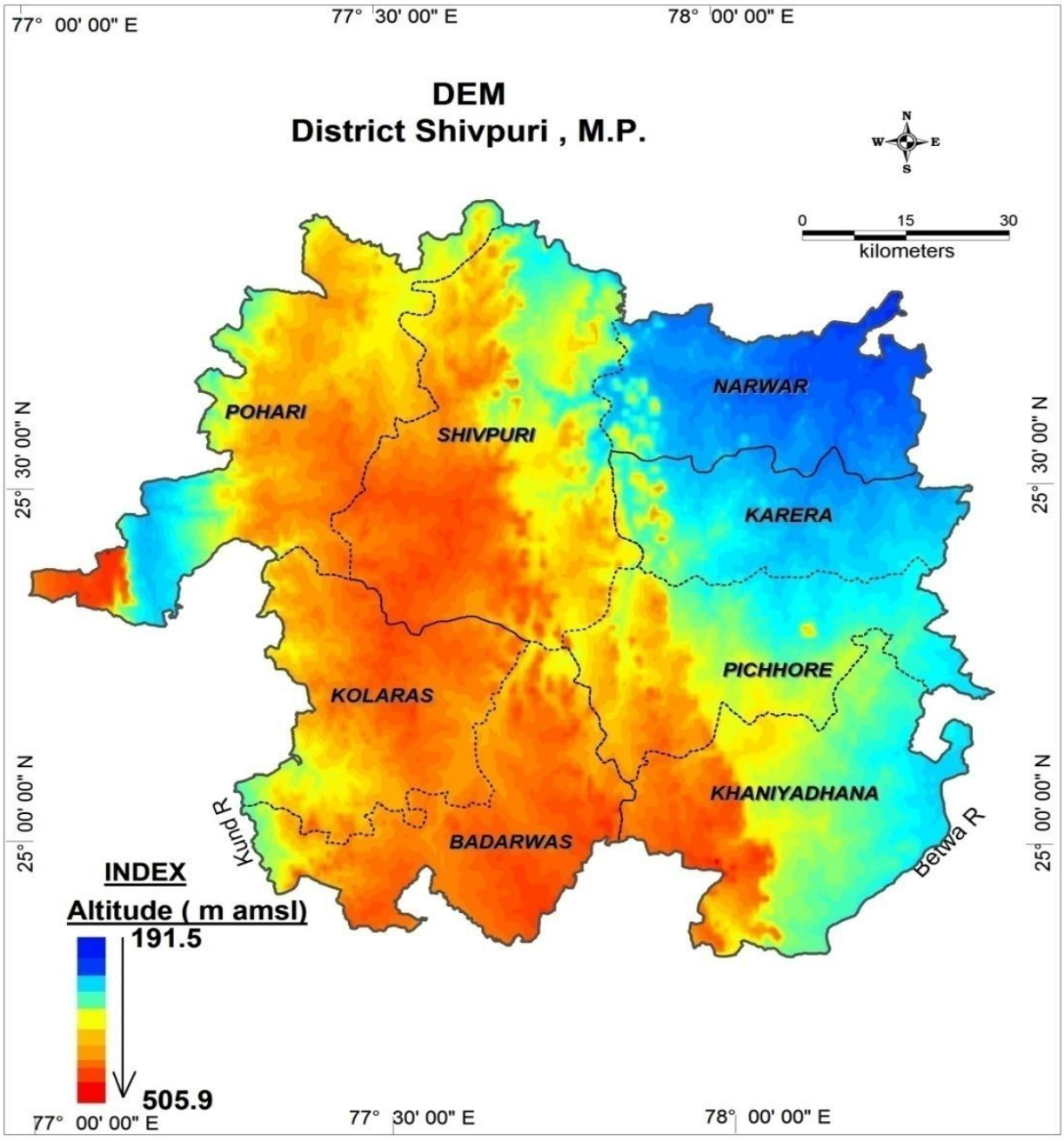

Fig.4: Digital Elevation Model of Shivpuri District

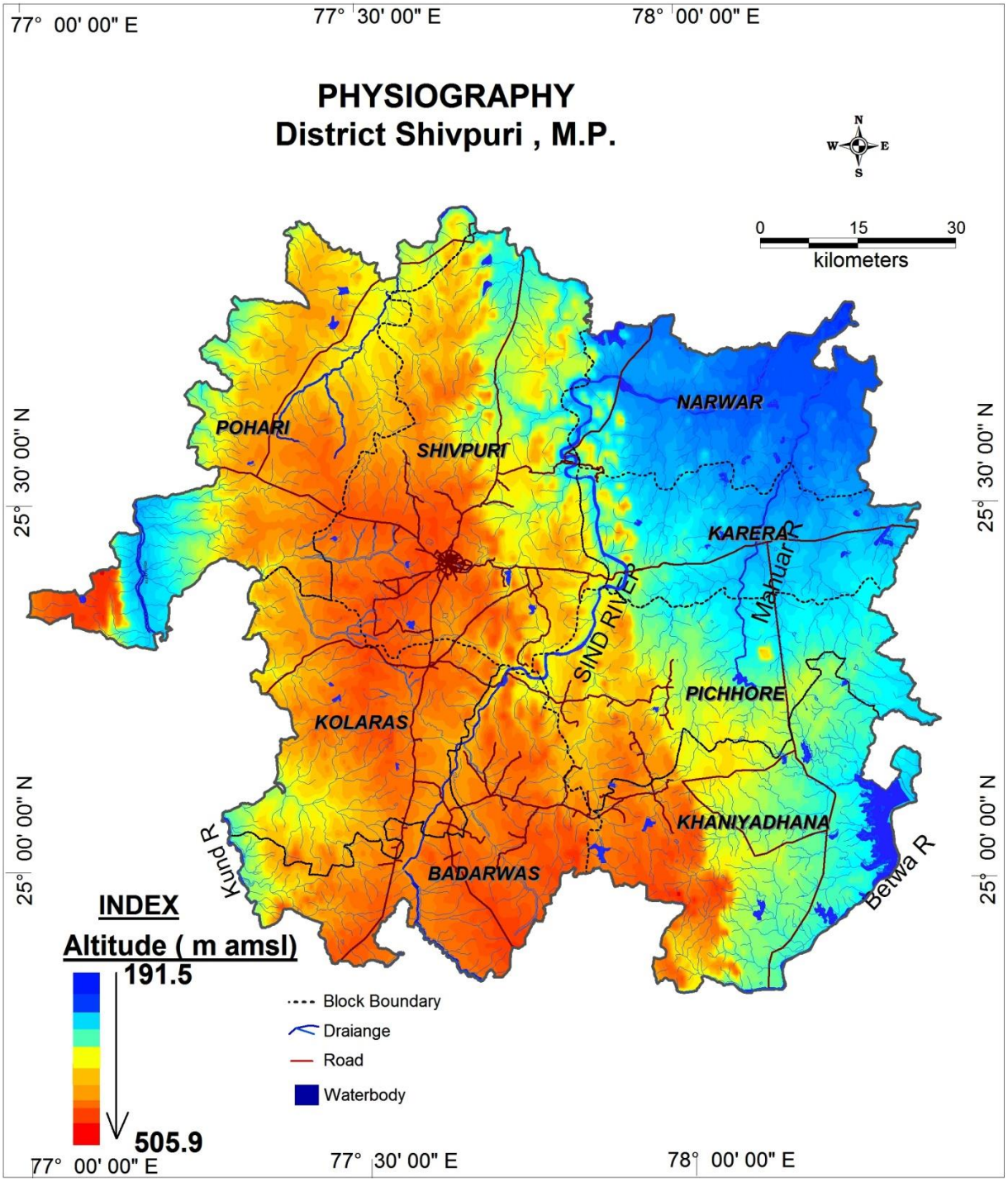

Fig.5: Physiographical Map of Shivpuri District

1.7 Geomorphology:

Physiographically, the district is an upland region over the Bundelkhand plains, with escarp in the east, characterized by rugged up landing topography with north south trending parallel ridges and intervening valleys. The eastern part is a pediplain over the granite. The maximum elevation is 522 m above MSL and minimum elevation is 266 m above MSL. In Shivpuri district, landforms are mainly Denudation hills of Vindhyan sediments and pediments of granites are predominant. Apart from these geomorphic units features like alluvial plain. Valley fills, intermundane valley and Deccan trap plateau arte also seen.

1.8 Soil cover :

The district is generally covered with sandy clay soil derived from the weathering of Bundelkhand granites and the Vindhyan formations. The southern part of the district is covered by the black cotton soils derived by the weathering of the Deccan trap formation. Depth of the soil varies from paper-thin to 15m. The colour of the sandy soil is light yellow to yellowish brown. The central and southern part of the district is covered by lateritic soil of dark brown to yellowish brown in colour. Alluvium is found all along the major and minor rivers, it consists of gravel, silt, sand and pebbles.

1.9 Hydrology and Drainage:

Sind– Parwati Sub basin

The Sind – Parwati sub basin of the Chambal River is in Yamuna basin. River Parwati flows west to east and forms the northern boundary of the district. This sub basin attains maximum height of 499.2 m above MSL at village Piparsuma and minimum 415.38 m above MSL. The general topography is hilly and sloping toward North & West.

Sind – Kuno Sub Basin

The River Kuno flows from south to north forms western boundary of the district. The general slope is south – east to north – west i.e. towards Sind River. Sub basin attains maximum height of 575 m above MSL at village Bhaopur and minimum of 342 m above MSL at the confluence of river Kuno and Sind.

Sind – Betwa Sub Basin

River Betwa flows from SW to NE and forms eastern boundary of the district. The general slope is towards NE. The maximum height in the sub basin is 417 m above MSL in Loharchha reserve forest

and minimum is 313 m above MSL near village Bharot.

Sind – Mahur Sub Basin

The RiverMahur crosses the hilly area at an elevation of 296.91 m above MSL after flowing from south to north in Pichor block enters into Karera block at village Bardi. The general slope of the sub basin is towards North.

Drainage map is shown in fig.6.

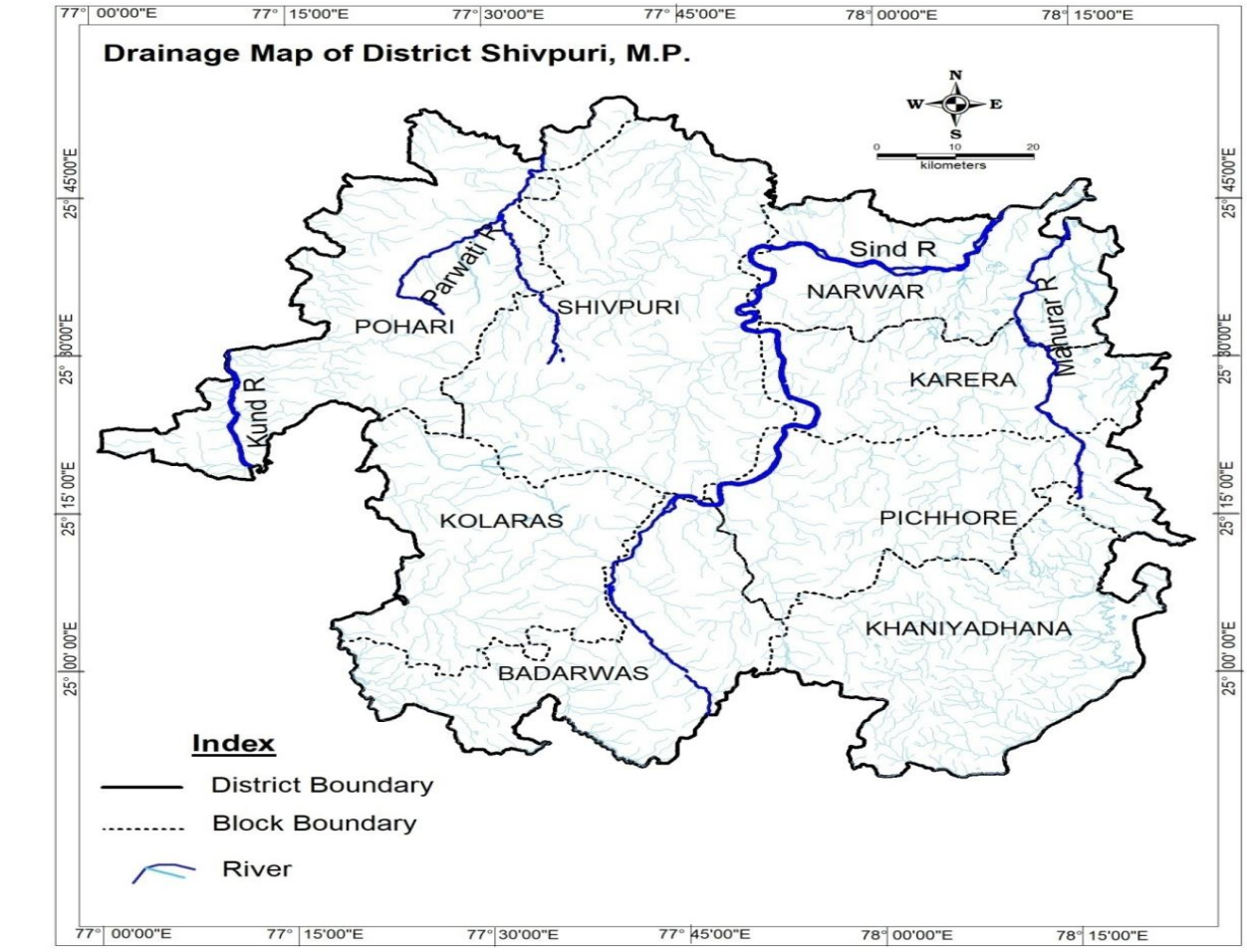

Fig.6: Drainage Map of Shivpuri District

1.10 Land Use, Irrigation, and Cropping Pattern:

As per the district statistical handbook 2015, the total area of Shivpuri district is 10066 sq km. out of which forest area is 3122, cultivable land is 6653.38 sq.kms; and net shown area is 4466.45. Rivers of

Sind Sub-basin drain the entire Shivpuri district. Betwa & Sind Rivers flowing northerly forms the major drainage in the eastern and central parts and river Kuno is another major river in the western parts. The district falls in the Yamuna basin. The area irrigated by tube wells is 778.36 sq km, by open-wells 983.96 sq.kms, by canals 733.58 sq.kms and by ponds 89.16 sq.kms. The total area under irrigation from various sources was only 60 % of the net sown area.

The principal crops grown are Wheat, Rice, Maize, Jowar and others. It is sown in an area of 237929 ha. The other major Rabi crop is gram under which an area of 81145 ha is sown. Urad is sown in an area of 25199 ha. The total area under Cereal crops is 120905 ha and under Oilseeds it is 326775 ha. (2014-15).

However the major part of the area fall in the Ganga basin. The drainage of the district is towards north and north east. The five rivers, from west to east are the Bina, the Dhasan, the Bewas, the Sonar and the Bamner. The Bina takes its course upto several Kilometer to the south of the district and enters it near village Mahura. After flowing through Rahatgarh, the river takes a north easterly course and at places forms the boundary with Vidisha district. Land use/land cover map of the district is represented by fig. 7.

Table 3: Irrigation Details (2015-16)

Block	Tube Well Irrigated Area (Ha)	Dug Well Irrigated Area (Ha)	Ground Water Irrigated Area (Ha)	Canal Irrigated Area (Ha)	Pond Irrigated Area (Ha)	Other Water Irrigated Area (Ha)
Shivpuri	12056	2876	14932	811	805	756
Kolaras	23793	1474	25267	NA	NA	257
Badarwas	28431	14840	43271	3413	412	5018
Karera	NA	16416	16416	6493	800	1168
Narwar	756	7796	8552	40151	393	2631
Pichor	194	31147	31341	1820	2198	NA
Khanniyadhana	527	17558	18085	20612	4168	1413
Pohari	7807	4392	12199	58	140	1373
Total	**73564**	**96499**	**170063**	**73358**	**8916**	**12616**

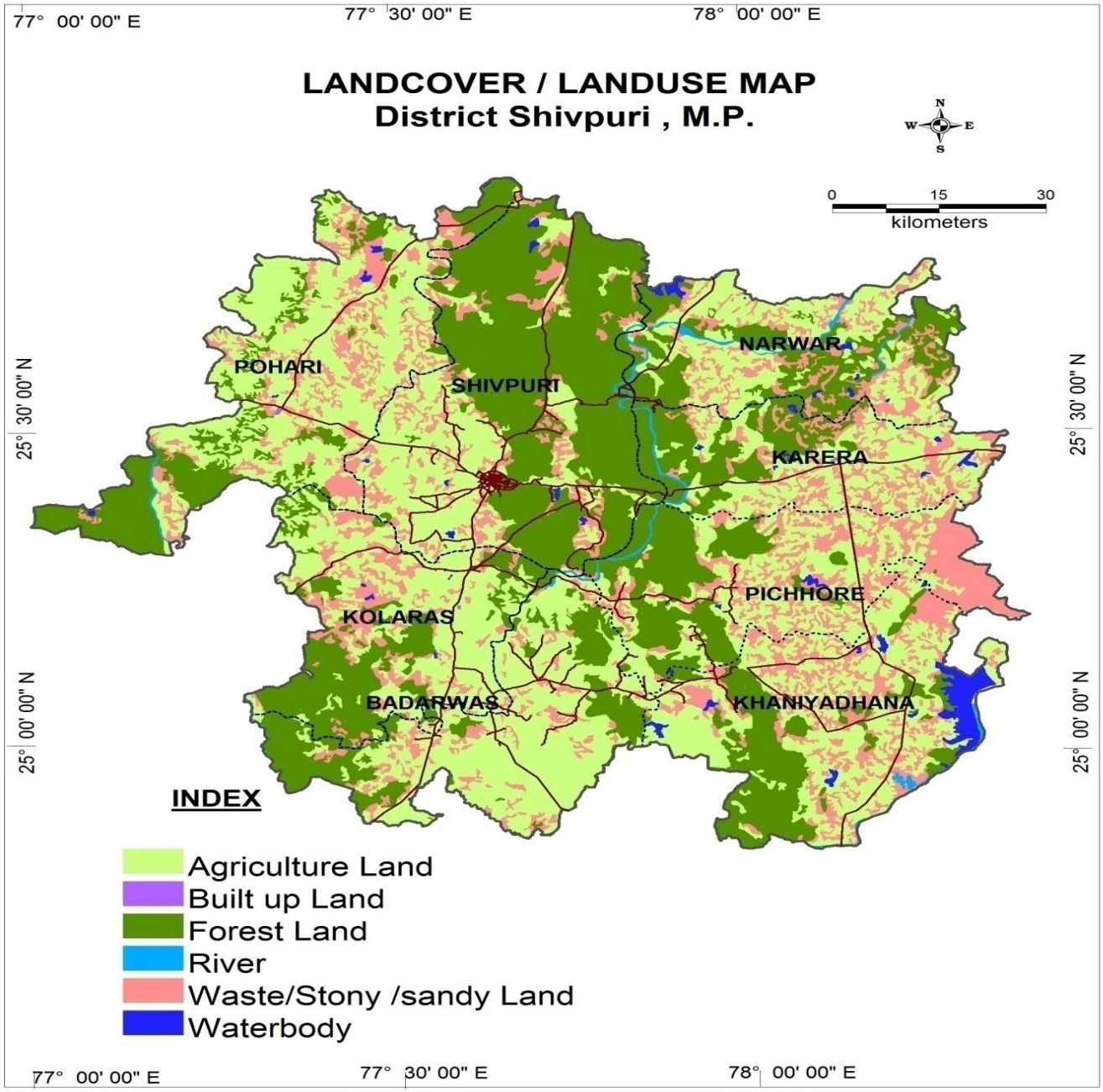

Fig.7: Land use Map of Shivpuri District

CHAPTER-2
DATA COLLECTION AND GENERATION

2.1 Hydrogeology:

The general geological successions in the district are given in table 4.

Table 4: General geological successions of Shivpuri district

Age	Stratigraphic Unit	Lithology
Quaternary to Recent		Alluvium and Laterite
……Unconformity……		
Upper Cretaceous to Lower Eocene		Deccan Trap Basalt
Upper Proterozoic Vindhyan Super Group (Bhander Group) Archeans		Sandstone and shale Granite & Gneiss

The District is characterized by variety of geological formations representing vast period of geological time (Fig.8).

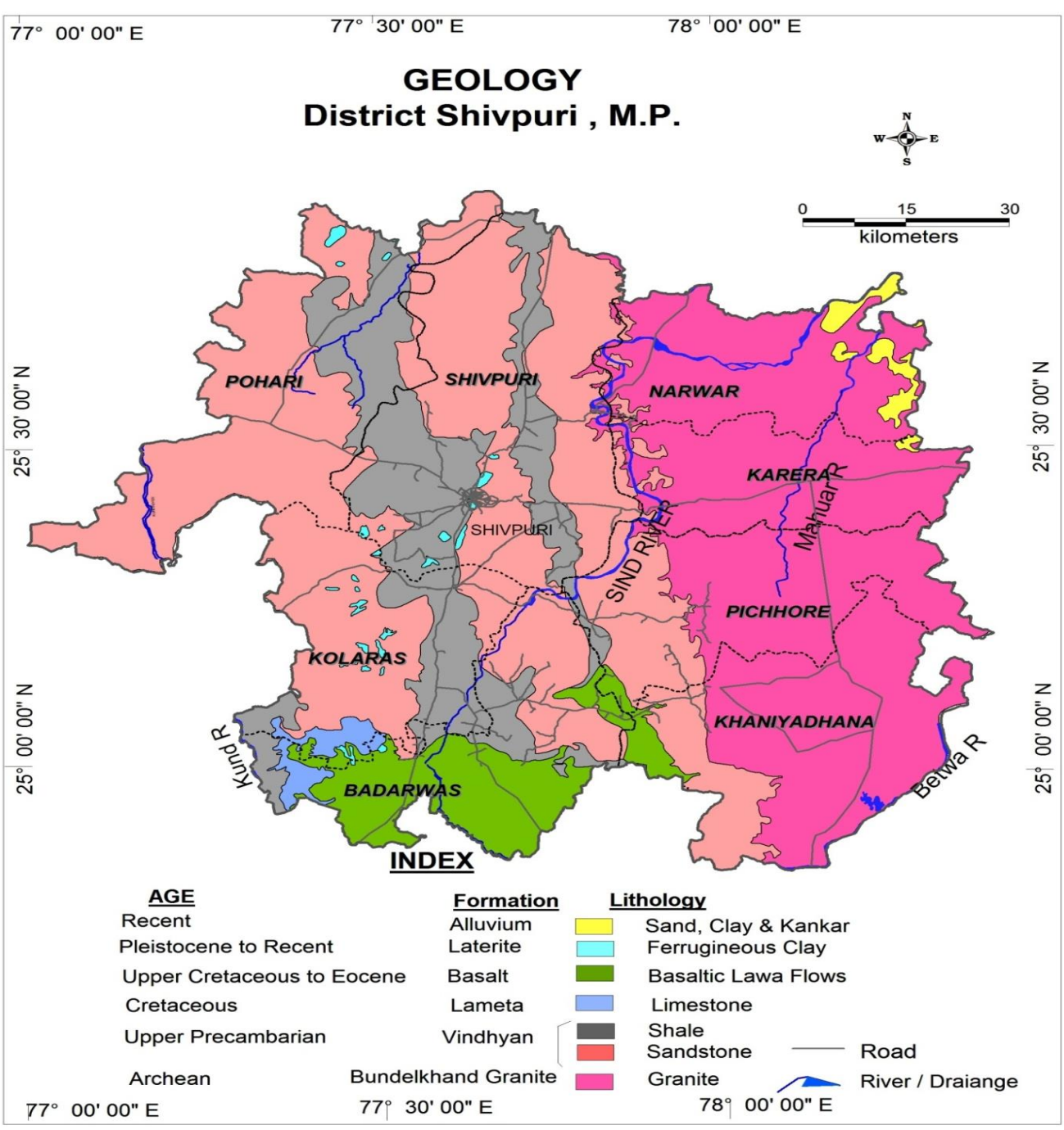

Fig.8: Geological Map of Shivpuri District

- **Alluvium**

Ground water occurs in the granular zones of sands and gravels. The extent and thickness of this formation is limited. The maximum thickness of the alluvium is 15m therefore large diameter dug wells can be constructed. Yield of this formation ranges from 5 to 10 lps and ground water occurs under water tablecondition.

- **Laterite**

Laterites are iron rich semi-consolidated formation consist of cavities. Thickness of this formation ranges from 3 to 75 m. The porosity and permeability are sufficient to act as good aquifer when it is occurring in low-lying areas. The yield of the dug wells constructed in this formation ranges from 2 to 4lps.

- **Deccan Trap**

Water bearing capacities in Deccan trap formation differ from flow to flow. Phreatic aquifer occurs in weathered, jointed and fractured basalts. In the areas where weathered basaltic layer is extensive, a continues aquifer can be traced to some distance, however due to low permeability of the weathered basalt the aquifer sustain limited ground water withdrawal. The groundwater at deeper levels occurs under semi confined to confined conditions in vesicular, jointed & fractured basalts. Yield of the wells in this formation varies from 1 to 5 lps. Unit draft of the wells varies from 0.0027 to 0.036mcm/year**.**

Under the Ground water Exploration Programme CGWB has constructed the exploratory wells & observation wells of 25.50 to 148.60 m deep. The depth to water levels in these wells varies from 6.00 to 29.60 m bgl and discharge of the wells ranges from negligible to 1.8 lps with a draw down maximum up to 48.00m.

- **Vindhyan Sandstone and Shale**

Sandstone of the Vindhyan formation is compact and having poor permeability, Joints and fractures in the sand stone controls the occurrence and movement of the ground water. Soil and weathered mantle developed in the Vindhyan formation is generally thin and as result ground water occurs at shallow depth under unconfined condition in jointed, fractured & weathered rocks. Yield of the wells ranges from 1 to 2 lps. Unit draft of the wells ranges from 0.001 to 0.026 mcm/year.

Under the Ground water Exploration Programme CGWB has constructed the exploratory wells

&observation wells of 50.35 to 203.4 m deep. The depth to water levels in these wells varies from 4.38 to 29.60 m bgl and discharge of the wells ranges from 0.18 to 14.50 lps with a draw down ranges from 14.00 to 60.00 m.

- **Archeans**

The Granites are most extensive rock formation in the Karera and Narwar blocks. Ground Water occurs in the weathered part and vertical and horizontal joints. The yield of the wells is restricted to the weathered mantle and ranges from less than one to 3 lps. Unit extraction of the wells in the formation varies from 0.00075 to 0.0051 mcm/year.

Fig. 9 shows the hydrogeology of the district.

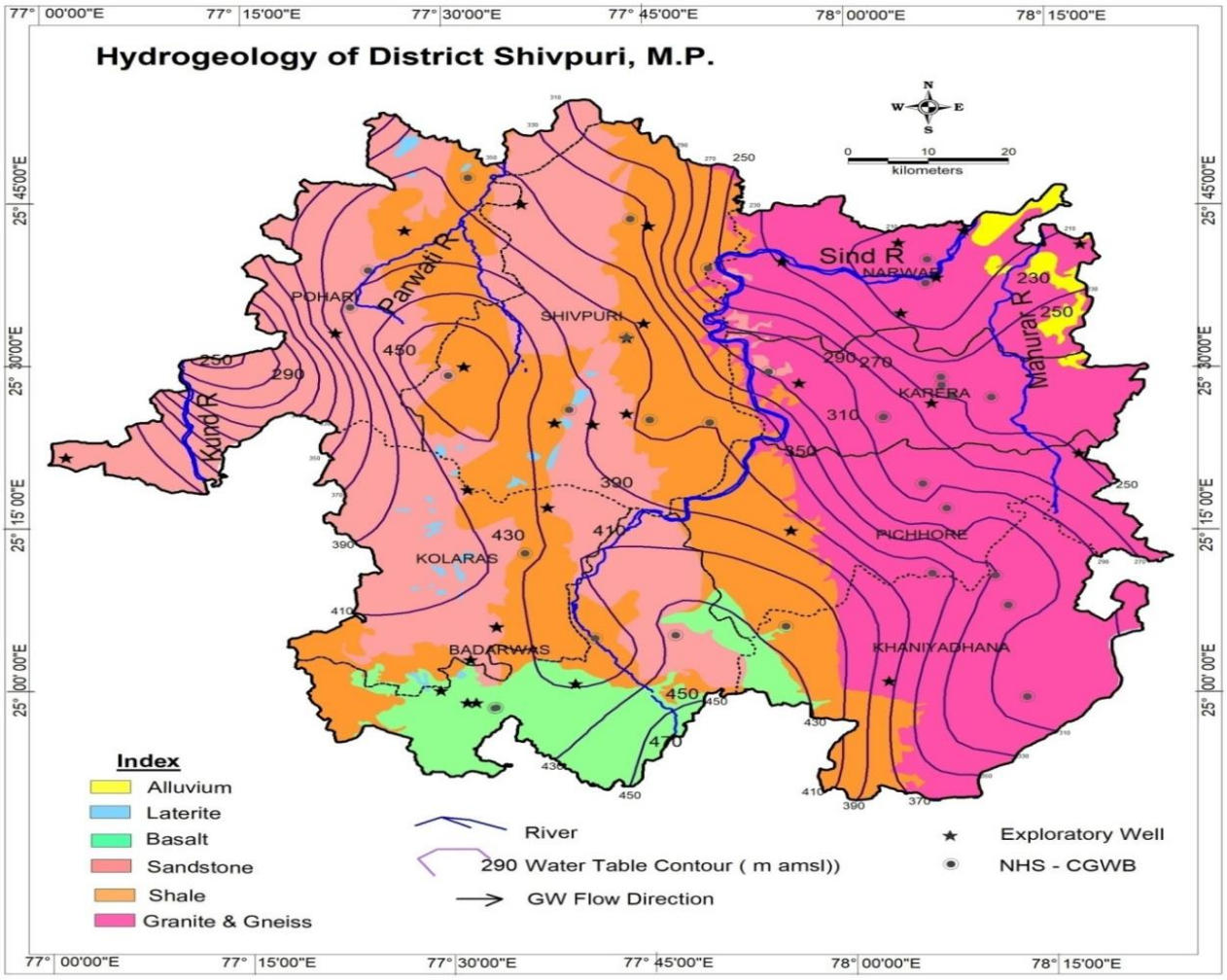

Fig.9: Hydrogeological Map of Shivpuri District

2.2. Ground water scenario:

The monitoring of ground water levels of the area gives a picture of the behavior of ground water regime over space and time. It is a very important parameter that is used in assessing the ground water resources and clearing area for future development. In Shivpuri district, CGWB is monitoring ground water levels four times a year. There are 30 national hydrograph stations (NHS) and 6 piezometers. The behavior of ground water regime for the pre-monsoon and post-monsoon period of 2019 is discussed herewith.

- **Pre-monsoon (May 2019)**

The Pre-monsoon depth to water level (DTWL) (fig.9) ranged between 3.82 to 17.47 m.bgl. In major part of the area, water level is in the ranges from 6 to 12 m.bgl.

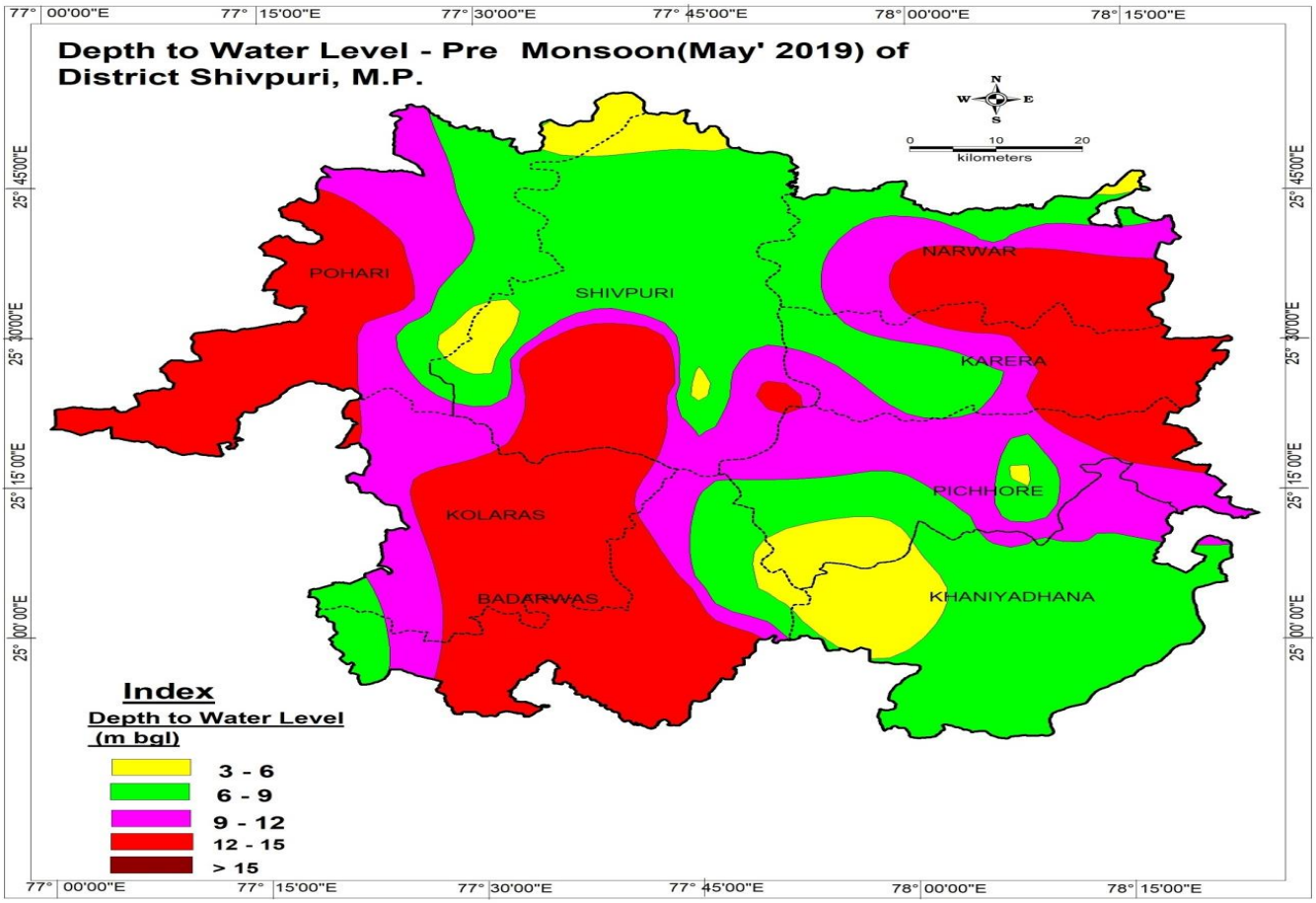

Fig.10: Pre-monsoon (May 2019) DTWL Map of Shivpuri district

- **Post-Monsoon (Nov 2019)**

The depth to water levels during the post monsoon period varies from 1.00 to 9.05 m.bgl. In major part of the district, water level ranges from 3 to 9 m.bgl.

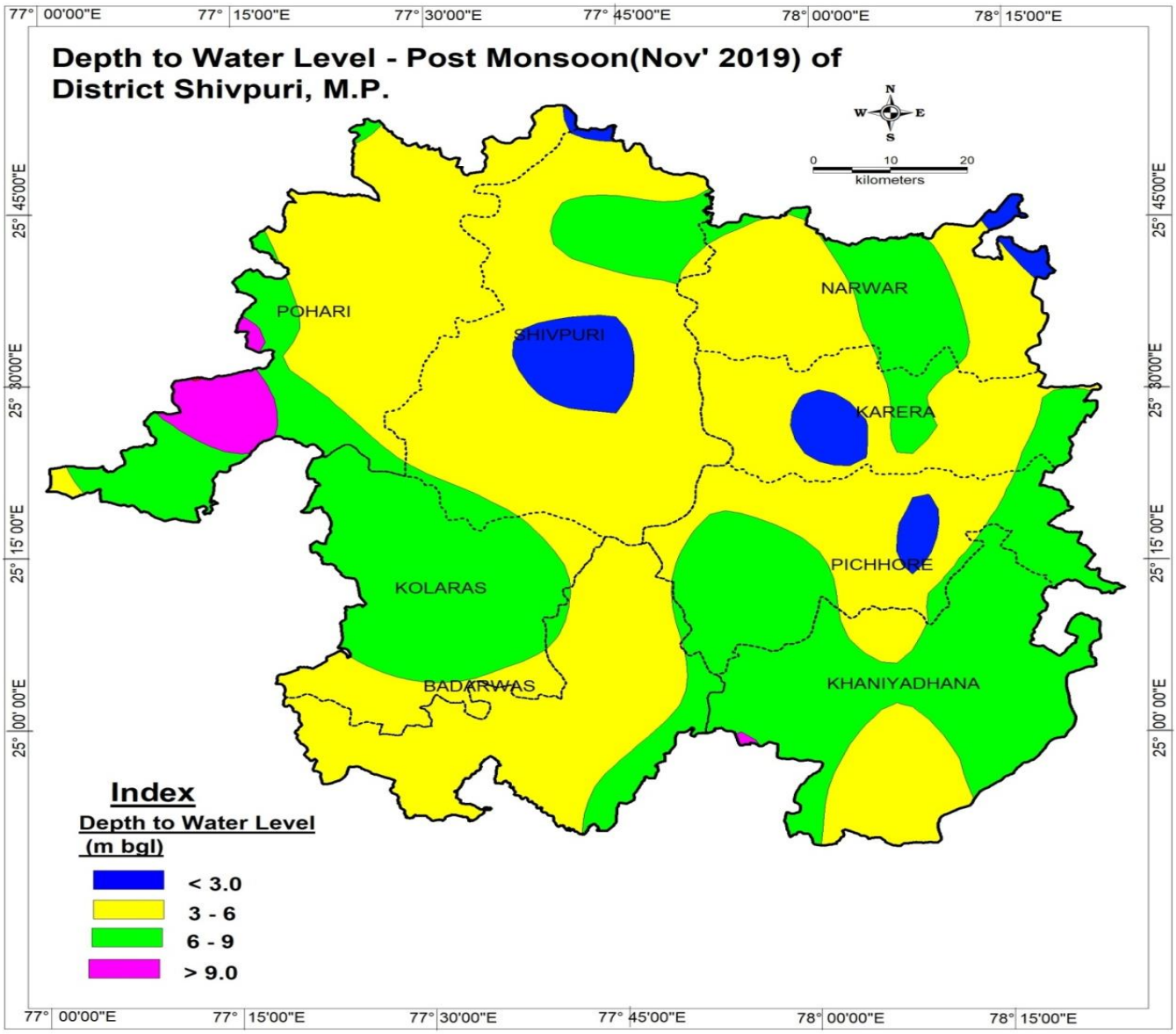

Fig.11: Post-Monsoon (Nov 2019) DTWL Map of Shivpuri district

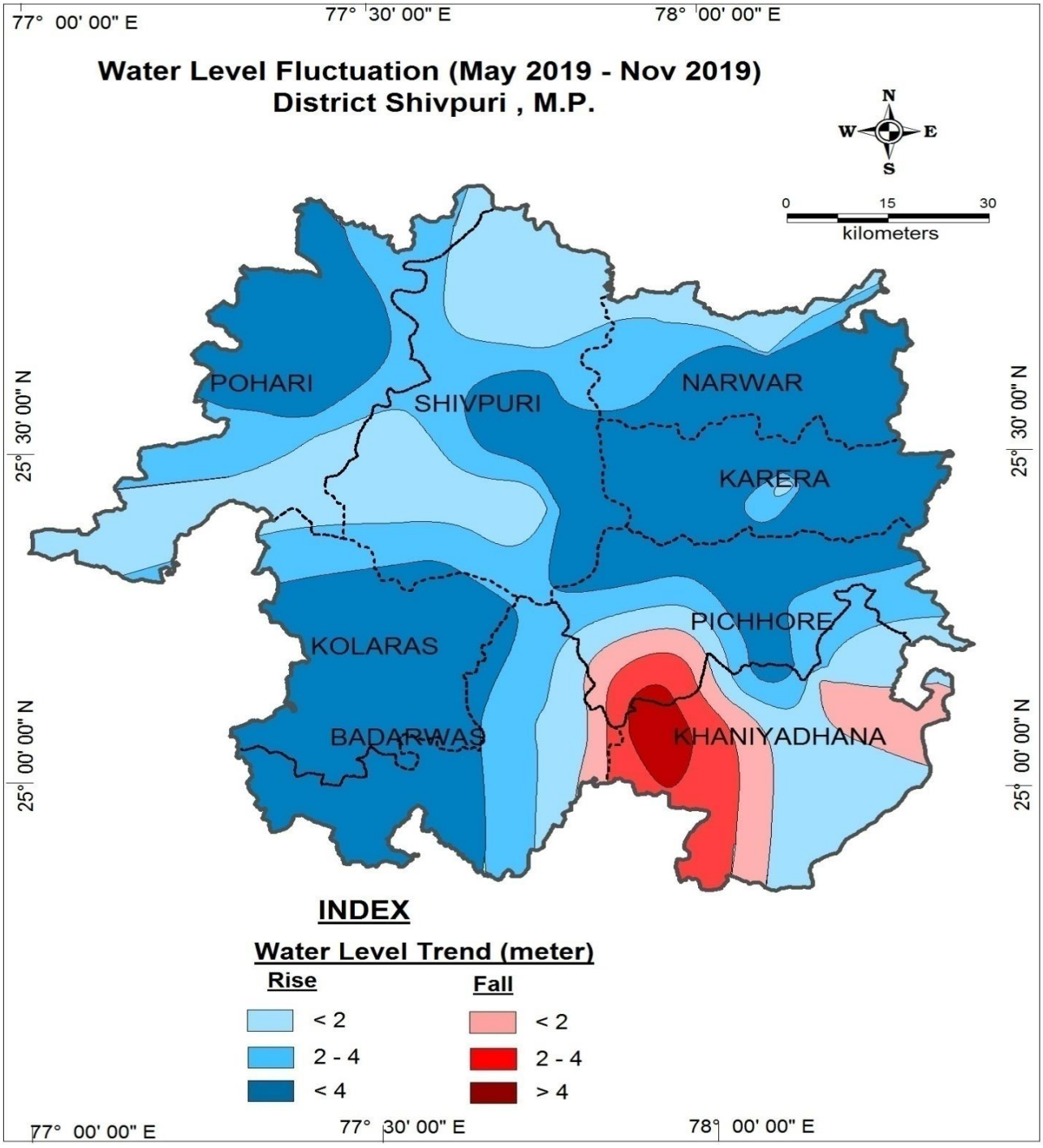

Fig.12: Water Level Fluctuation (May 2019-Nov 2019) Map of Shivpuri district

- **Groundwater to level trend 2009 to 2018:**

Analyses of Groundwater level data of pre-monsoon period indicate that there is rising trend in the range of 2.41 to 47.51 cm/yr and declining trend in the range of 1.74 to 28.94 cm/yr. While the post-monsoon period indicate that there is rising trend in the range of 1.02 to 39.94 cm/yr and declining trend in the range of 27.01 to 43.88 cm/yr.

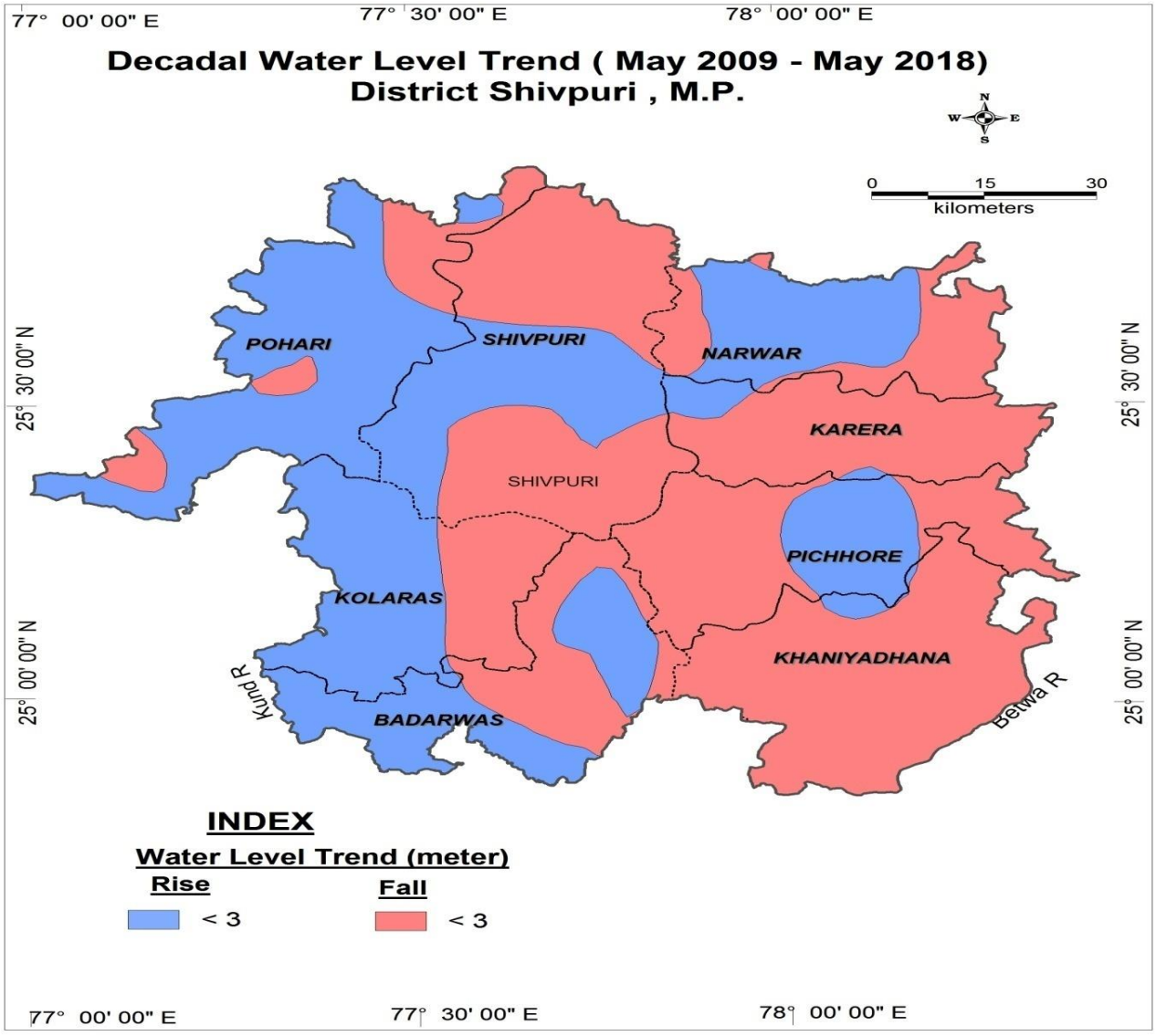

Fig.13: Decadal Water Level trend (Pre-monsoon) Map of Shivpuri District

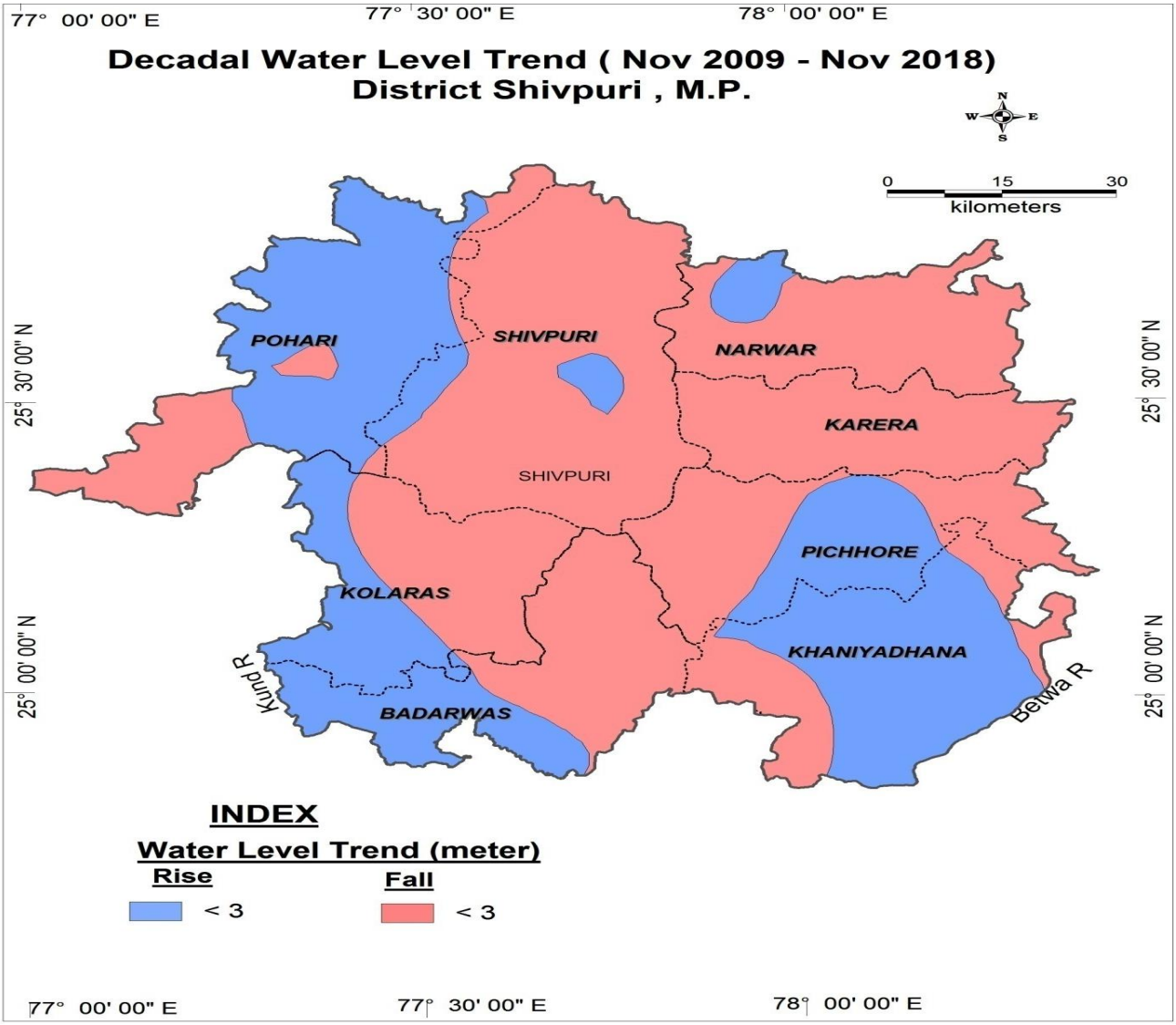

Fig.14: Decadal Water Level trend (Post-monsoon) Map of Shivpuri District

2.3 Ground Water Exploration:

CGWB has drilled 30 exploratory wells and 6 Piezometers in Shivpuri district. On the basis of samples collected during drilling, lithologs have been prepared. The aquifer parameters are calculated on the basis of pumping tests. The salient details of these bore wells are given in Table 5.

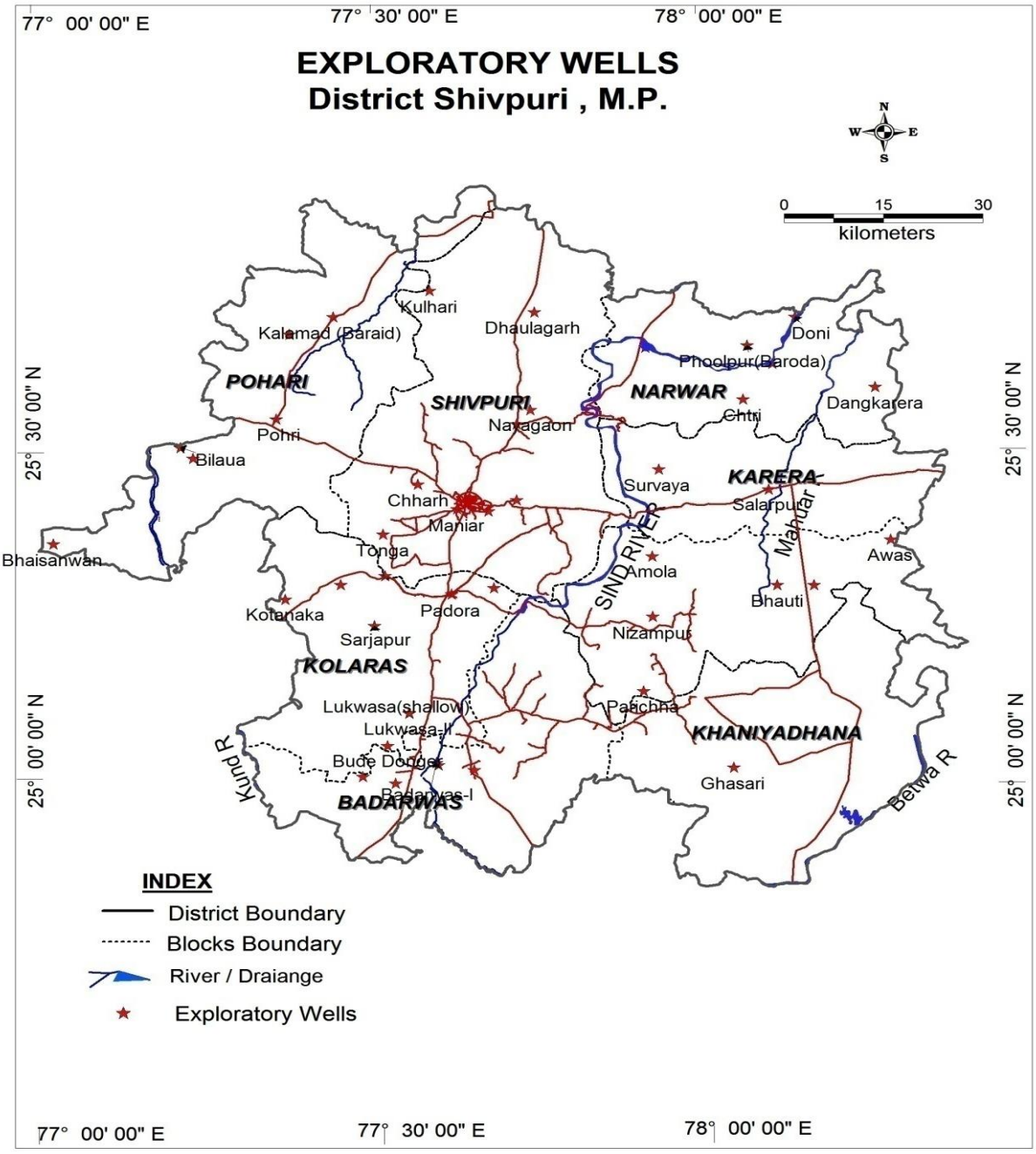

Fig.15:Ground Water Exploration Map of Shivpuri District

Table 5: Salient features of borewells in the district

S. No	Location	Latitude	Longitude	Year of Drilling	Depth drilled (mbgl)	Depth constructed (mbgl)	Lithology	Aquifer zones tapped (mbgl)	SWL (mbgl)	Discharge (lps)	Drawdown (m)	Trasmissivity (m^2 / day)
1	Badarwas-I	24.983333	72.544444	2000-01	31		Sandstone					
2	Badarwas-II	24.983333	72.544444	2000-01	121	121	Sandstone	16-21, 29-32	12.75	1	34	0.54
3	Bhaisanwan	25.359722	77.034167	2000-01	202.4	202.4	Sandstone	10-12, 71-81	53	2.2	17	5.89
4	BudeDonger	25.05	77.5375	2000-01	202.4	202.4	Sandstone Shale			0.23	--	
5	Chtri	25.583333	78.072222	99-2000	203.5	203.5	Granite Gneiss	4.0-7.0	6.7	0	13.8	
6	Dangkarera	25.193333	78.613333	99-2000	148.5	148.5	Granite Gneiss	14-18 144-146	12.98	3.4	26.72	
7	Dhaulagarh	25.716667	77.758333	2000-01	115.4	115.4	Sandstone Shale	20-28,68-82 108-116	10.86	16	40.6	119
8	Doni	25.71	78.150833	99-2000	203	203	Granite gneiss	22-26	6	0.3		2
9	Ghasari	25.016667	78.058333	99-2000	201	201	Granite gneiss	14-16	9	0.2		
10	Kalamad (Baraid)	25.709444	77.455	2000-01	179.1		Sandstone shale	140-144	14.56	0.25		
11	Kulhari	25.75	77.6	2000-01	202.2	202.2	Shale and sandstone	77-80	19.26	2	39	30
12	Ludhawali	25.012778	77.667778	2000-01	156.2	156.2	Sandstone and shale	26-33 37-48 66-67	11.44	18.08	5.76	395
13	Lukwasa (shallow)	25.1	77.569444	2000-01	28	25	Alluvium basalt	24-25 18-24	7.5	0.03	120	30
14	Lukwasa-II	25.100556	77.57	2001-02	148.6	148.6	Basalt sandstone	12-200	5.4	0.1		
15	Maniar	25.413889	77.641667	2000-01	141.9	141.9	Sandstone shale	17-29,55-61 67-75,90-100	28.4	14	5.82	
16	Narwar	25.6625	77.925	2000-01	200.1	200.1	Granite gneiss	18-21	5.72	1.5	53	1.19

S. No	Location	Latitude	Longitude	Year of Drilling	Depth drilled (mbgl)	Depth constructed (mbgl)	Lithology	Aquifer zones tapped (mbgl)	SWL (mbgl)	Discharge (lps)	Drawdown (m)	Trasmissivity (m^2 / day)
17	Nayagaon	25.566667	77.752222	2000-01	203	203	Sandstone shale granite gneiss	32-38	16	0.8	38.07	0.34
18	Nizampur	25.248611	77.936111	99-2000	202.5	202.5	granite gneiss	28.50-31.0		1.5	47.65	0.94
19	Phoolpur (Baroda)	25.820833	78.091667	99-2000	124.4	124.4	granite gneiss	121-123	4.02	0.05	171	5.7
20	Pohri	25.552222	77.369444	2000-01	203.4	203.4	shale & sandstone	40-65,76-83	50	2.8	60.7	
21	Salarpur	25.444444	78.110833	99-2000	203.5	203.5	granite gneiss	11-14, 118-123	11	0.4	37.5	0.29
22	Sehora	25.637778	78.116667	99-2000	195.5	195.5	granite gneiss	51-53	7.32	0.3		
23	Singhan	25.002222	77.500278	2001-02	142.4		Sandstone shale	25-35	Artesian	0.5	48	
24	Sirsod	25.5	70.528889	99-2000	201.4		granite gneiss	3.50-7.0 96-99 107-109 128-126	3.1	1.8	51	51
25	Survaya	25.475	77.945833	2000-01	203	203	Sandstone /shale /granite gneiss	93-99	2.7	0.5	46	
26	Padora	25.283333	77.633333	2001-02	101	101	Sandstone/ shale	38-41	16.8	3	2.2	
27	Dehrawara	25.311111	77.533333	2001-02	203	203	Shale	175-180	11.3	0		
28	Barodi	25.411111	77.688889	2001-02	203	203	Sandstone /shale	40-45	14.5	2		

S. No	Location	Latitude	Longitude	Year of Drilling	Depth drilled (mbgl)	Depth constructed (mbgl)	Lithology	Aquifer zones tapped (mbgl)	SWL (mbgl)	Discharge (lps)	Drawdown (m)	Trasmissivity (m^2 / day)
29	Barai	25.983333	77.533333	2001-02	50.5	50.5	Shale	40-42	5.65	1		
30	Shivpuri	25.427778	77.731111	2001-02	202	202	Sandstone /shale	68-70,91-95	18	1.5		
31	Satanwara	25.544444	77.731111	2001-02	166.25	166.25	Shale	16.85-19.00 50-54	16.85	0.5		

2.4 Hydro chemical scenario:

- **Ground Water Quality of Shivpuri District**

The chemical analysis of 32 numbers of ground water samples collected in the pre-monsoon 2019 from different blocks Badarwas (3 nos.), Karera (7 nos.), Khaniyadhana (5 nos.), Kolaras (1 no.), Narwar (4 nos.), Pichhore (3 nos.), Pohari (3 nos.), Shivpuri (6 nos.) of Shivpuri district.

In the district pH of ground water is neutral to slightly alkaline in nature and the ranged in between 7.12 to 8.08; the highest value of pH (8.08) has been observed in Gobardhan dug well. The pH values of different blocks of Shivpuri district are as: Badarwas (7.33 to 7.74); Karera (7.36 to 7.83); Khaniyadhana (7.12 to 7.71); Kolaras (7.51); Narwar (7.21 to 7.82); Pichhore (7.40 to 7.97); Pohari (7.33 to 8.08); Shivpuri (7.35 to 7.74). The electrical conductivity of ground water in Shivpuri district ranges between 315 to 2891 µS/cm at 25°C and the maximum EC value at Ainpura (2891 µS/cm at 25°C). The electrical conductivity shows that the ground water is good to moderately saline in nature. At some locations electrical conductivity shows moderately saline in nature i.e.Satanwara (1535) of Shivpuri block; SirsodChouraha (1772) of Karera block; Badarwas (1959) of Badarwas block; Pichhore (1978) of Khaniyadhana block; Sehore (2390) of Narwar block; Ainpura (2891) of Pohari block. The electrical conductivity of ground water in different blocks have been observed of Shivpuri district are as Badarwas (580 to 1959); Karera (626 to 1772); Khaniyadhana (717 to 1978); Kolaras (650 to 650); Narwar (504 to 2390); Pichhore (665 to 1228); Pohari (833 to 2891) and Shivpuri (319 to 1535).

The fluoride concentration was ranged in between 0.12 to 1.14 mg/l. In the district, fluoride concentration has not been observed more than BIS recommendation of fluoride concentration in drinking water i.e. 1.5 mg/l. The maximum concentration of fluoride has been recorded in the dug well of Karerai.e. 1.14 mg/l. The fluoride concentration in different blocks of Shivpuri district are as Badarwas (0.22 to 0.33), Karera (0.48 to 1.14), Khaniyadhana (0.12 to 0.65), Kolaras (0.24 to 0.24), Narwar (0.49 to 1.04), Pichhore (0.5 to 1.09), Pohari (0.53 to 0.77) And Shivpuri (0.36 to 1.07). In the district, nitrate concentration in ground water ranged in between 8 to 263 mg/l. About 37.5% ground water samples recorded nitrate concentration within the acceptable limit of 45 mg/l and 62.5% water samples recorded more than 45 mg/l as per BIS recommendation. The high nitrate concentration has been recorded in ground water of Toda Karea (48 mg/l), Awas (49 mg/l), Satanwara (49 mg/l),

Karera(51 mg/l), Masoori (56 mg/l), Sikandara (57 mg/l), Mangroni (58 mg/l), Sarsod (67 mg/l), Languri (69 mg/l), Sitapur (73 mg/l), Pohari (79 mg/l), Semri (88 mg/l), Narwar (89 mg/l), Sehore (99 mg/l), Ganeshkhera (102 mg/l), Badarwas (104 mg/l), Achhroni New (116 mg/l), SirsodChouraha (117 mg/l), Pichhore (194 mg/l) and Ainpura (263 mg/l). The nitrate concentration in different blocks of Shivpuri district are as Badarwas (21 to 104); Karera (48 to 117); Khaniyadhana (20 to 194); Kolaras (30 to 30); Narwar (14 to 99); Pichhore (11 to 88); Pohari (16 to 263); Shivpuri (8 to 49). The Total hardness have been in ground water of different blocks of Shivpuri district are as Badarwas (180 to 565); Karera (215 to 525); Khaniyadhana (215 to 535); Kolaras (178 to 178); Narwar (160 to 574); Pichhore (245 to 315); Pohari (235 to 960) and Shivpuri (64 to 470).

As per the piper diagram (fig.16), water samples are Calcium Bi-carbonate (Ca-HCO_3) (temporary hardness), Sodium Chloride (Saline) and Mixed Types of water. The blocks of Shivpuri districts shows types of water are as follows: Badarwas (Ca-HCO_3), Karera (Ca-HCO_3 and Mixed,), Khaniyadhana (Ca-HCO_3 and Mixed), Kolaras (Ca-HCO_3), Narwar (Ca-HCO_3, Mixed and NaCl), Pichhore (Ca-HCO_3), Pohari (Ca-HCO_3, Mixed and NaCl), Shivpuri (Ca-HCO_3, Mixed and NaCl).

The US Salinity Diagram (fig.17) shows the ground water is medium to high salinity classes i.e. C_2S_1, C_3S_1 and C_4S_1. The C_3S_2 and C_4S_2 classes of water may be used for irrigation purpose with proper soil management. The blocks of Shivpuri districts shows types of water for irrigation purposes are as follows: Badarwas (C_2S_1, C3S1), Karera (C_2S_1, C3S1,), Khaniyadhana (C_2S_1, C3S1,), Kolaras (C_2S_1), Narwar (C_2S_1, C3S1, C_4S_1), Pichhore (C_2S_1, C3S1,), Pohari (C_3S_1, C4S1) and Shivpuri (C_2S_1, C3S1,).

Ground water quality of district is presented in table 6.

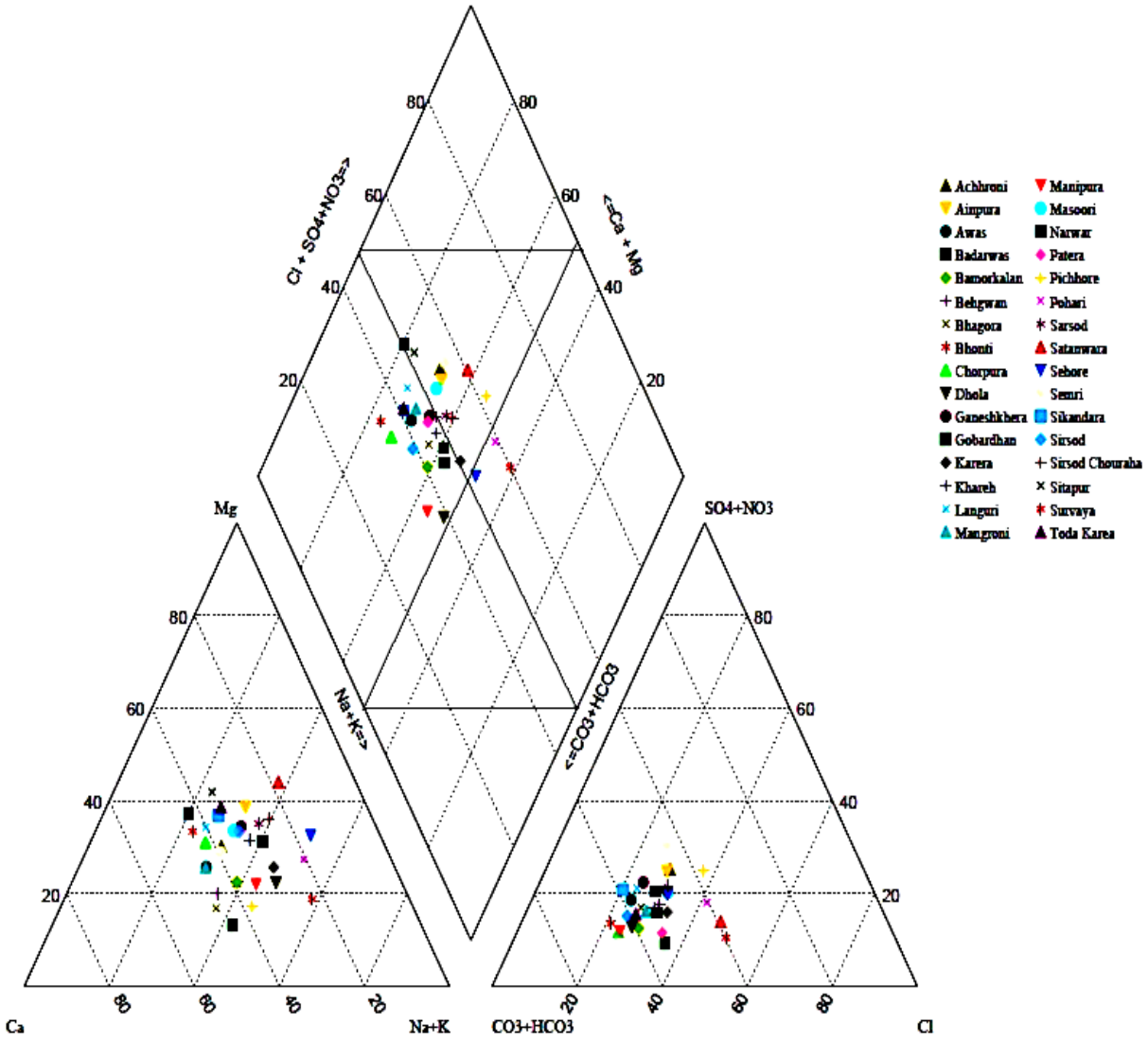

Fig.16: Hill Piper diagram for Shivpuri district

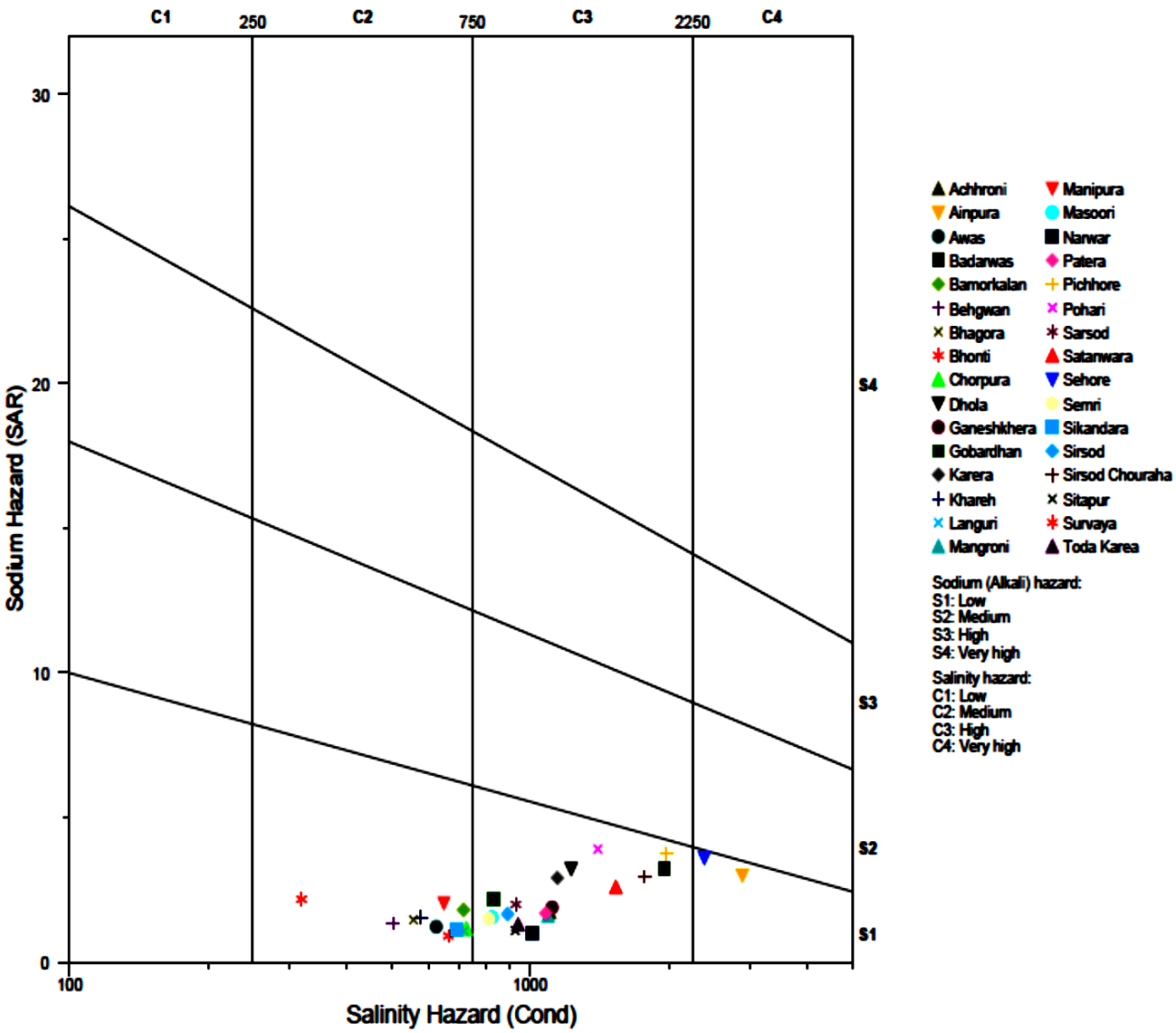

Fig.17: US Salinity diagram for Shivpuri district

Table 6: Ground Water quality of Shivpuri District

S. No.	Block	Location	pH	EC	CO_3	HCO_3	Cl	SO_4	NO_3	F	TH	Ca	Mg	Na	K	PO_4	SiO_2
1	Badarwas	Badarwas	7.33	1959	0	602	203	60	104	0.33	565	108	72	176	2.57	0.1	30
2	Badarwas	Ganeshkhera	7.63	1117	0	353	94	38	102	0.22	365	70	46	83	4.1	BDL	25
3	Badarwas	Khareh	7.74	580	0	183	59	29	21	0.33	180	36	22	48	2.1	BDL	29
4	Karera	Awas	7.41	626	0	213	50	16	49	0.77	215	54	19	41	1.6	BDL	26
5	Karera	Karera	7.61	1146	0	341	129	45	51	1.14	305	64	35	117	1.79	BDL	14
6	Karera	Languri	7.66	718	0	231	57	16	69	0.92	260	56	29	40	1.55	BDL	19
7	Karera	Sarsod	7.47	932	0	267	95	36	67	1.11	282	50	39	78	1.98	BDL	23
8	Karera	Sikandara	7.36	691	0	236	48	22	57	0.59	243	48	30	41	1.25	BDL	33
9	Karera	SirsodChouraha	7.83	1772	0	497	183	86	117	0.56	525	85	76	156	1.45	BDL	33
10	Karera	Toda Karea	7.4	942	0	321	83	30	48	0.48	337	63	43	55	2.48	BDL	33
11	Khaniyadhana	Achhroni New	7.19	1103	0	298	111	40	116	0.39	375	84	40	77	1.82	BDL	36
12	Khaniyadhana	Bamorkalan New	7.44	717	0	249	69	26	20	0.65	215	54	19	61	1.5	BDL	33
13	Khaniyadhana	Masoori	7.42	826	0	236	88	34	56	0.12	272	55	33	59	2.48	BDL	22
14	Khaniyadhana	Pichhore	7.12	1978	0	442	253	80	194	0.41	535	147	41	199	2.47	BDL	18
15	Khaniyadhana	Sitapur	7.71	929	0	273	93	32	73	0.3	347	63	46	47	1.98	BDL	47
16	Kolaras	Manipura New	7.51	650	0	242	53	12	30	0.24	178	44	17	63	1.35	BDL	38
17	Narwar	Behgwan	7.68	504	0	152	52	30	14	0.96	160	44	12	39	1.7	BDL	45
18	Narwar	Mangroni	7.82	1094	0	353	104	36	58	0.49	370	94	33	71	2.12	BDL	42
19	Narwar	Narwar	7.21	1010	0	309	98	28	89	0.71	396	85	45	45	1.32	BDL	10
20	Narwar	Sehore	7.35	2390	0	679	253	141	99	1.04	574	77	93	199	130.4	BDL	22
21	Pichhore	Bhonti	7.97	665	0	249	47	20	27	0.6	245	56	26	33	1.23	0.11	24
22	Pichhore	Dhola	7.96	1228	0	438	111	64	11	1.09	315	72	33	132	3.37	BDL	18
23	Pichhore	Semri	7.4	815	0	212	73	48	88	0.5	272	63	28	57	1.66	0.16	40
24	Pohari	Ainpura	7.33	2891	0	785	282	126	263	0.64	960	164	134	214	1.5	BDL	24
25	Pohari	Gobardhan	8.08	833	0	268	102	24	16	0.77	235	72	13	77	2.87	BDL	18
26	Pohari	Pohari	7.56	1404	0	333	198	56	79	0.53	332	57	46	164	2.55	BDL	36

S. No.	Block	Location	pH	EC	CO_3	HCO_3	Cl	SO_4	NO_3	F	TH	Ca	Mg	Na	K	PO_4	SiO_2
27	Shivpuri	Bhagora	7.51	558	0	183	50	24	25	0.47	170	50	11	44	2.14	BDL	48
28	Shivpuri	Chorpura	7.5	727	0	274	59	27	16	0.36	260	60	27	43	2.7	BDL	37
29	Shivpuri	Patera	7.59	1082	0	273	100	31	19	1.07	277	55	34	65	1.38	0.14	41
30	Shivpuri	Satanwara	7.35	1535	0	358	248	62	49	0.48	470	55	81	129	3.67	BDL	18
31	Shivpuri	Sirsod	7.74	894	0	315	73	48	18	0.45	287	57	35	65	1.99	BDL	38
32	Shivpuri	Survaya	7.62	319	0	73	53	9	8	0.68	64	14	7	40	1.7	BDL	21

CHAPTER-3

DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

The lithological data collected from CGWB Exploratory Bore wells were studied, compiled and integrated as per 2-Dimensional Cross section. From the 2-D Section is presented in the fig &it has been interpreted that the major water bearing zones has been encountered in weathered/fractured basalts, Vindhyans sandstone and Granite formation.

The region is dominantly occupied by sandstone/Shale and Granite. The sub-surface lithology has been broadly classified into Top soil underlain by Weathered Basalt and Sandstone/Shale and Granite/Gneiss.

3.1 2-D Cross Section of Shivpuri District:

2-Dimensional cross-section along the section line Budadongar-LukwasaLadhawali-Maniar-Dholagarh (fig.18) and Sirsod-Chhitri-Sihol (fig.19) respectively covering the wells has been prepared. The cross-section shows that the shallow aquifer is continuing for the whole region and occurs as narrow pinches. The deeper aquifers whereas, occurs not throughout the section line and can be encountered at depth where fractures are present.

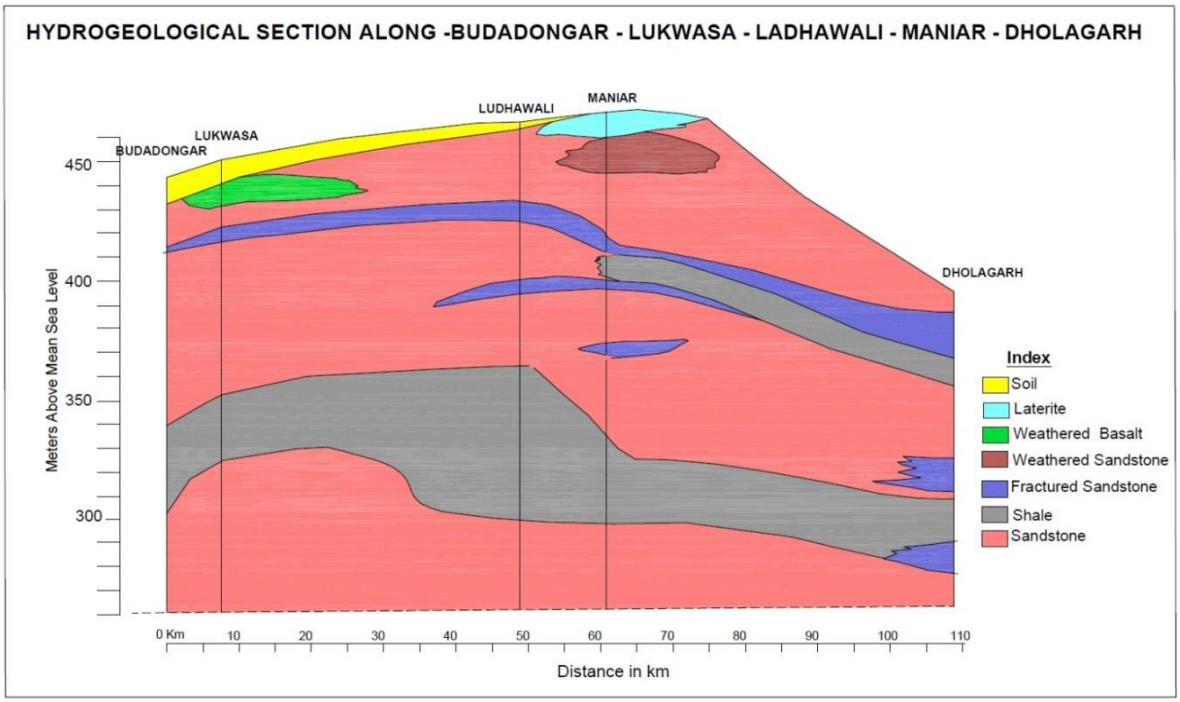

Fig.18: Hydrogeological Cross-Section I

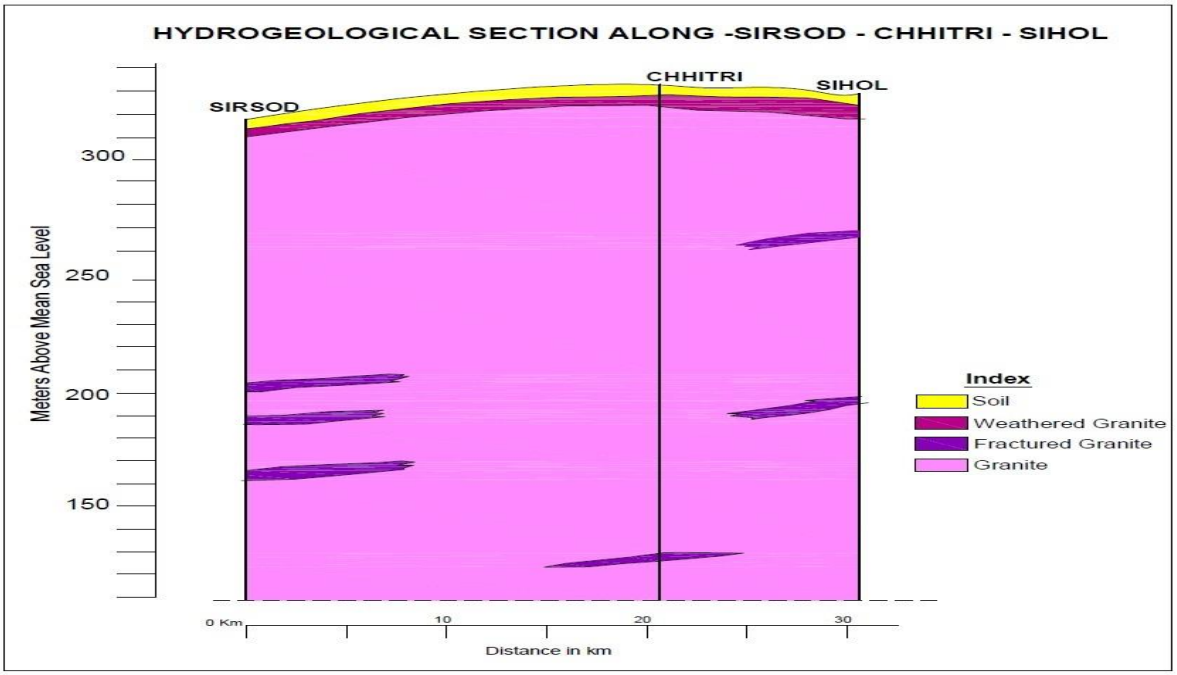

Fig.19: Hydrogeological Cross-Section II

CHAPTER-4

GROUND WATER RESOURCES

4.1 Dynamic Ground Water Resources

Shivpuri district is underlain by Bundelkhand granite; Vindhyan Sandstone, Basaltic lava flows of Deccan trap and Alluvium. Dynamic ground water resources of the district have been estimated for year -2020 on block-wise basis. Out of 1027800ha of geographical area, 977049ha (95 %) is ground water recharge worthy area and 50751 ha (5 %) is hilly area. There are eight number of assessment units (blocks) in the district which fall under non-command (92.89%) and command (7 %) sub units. Badarwas, Khaniyadhana, Narwar ,Pichor and Kolaras blocks of the district are categorized. as semi critical while Pohri, Shivpuri and Karera blocks falls under safe category of Ground water extraction.

The highest stage of ground water extraction is computed as 83.82 % in Khaniyadhana block. The Annual Extractable Ground Water Recharge in ham is 74729.04and ground water draft for all uses is 52488.42 ham, making stage of ground water extraction 70.24% as a whole for district. After making allocation for future domestic and industrial supply for next 25 years, balance available ground water for future use would be 21613.11 ham.

Table 7: Total area of Shivpuri district

District	Name of Assessment Unit (Block)	Type of rock formation	Recharge worthy area of formation in ha	Area extent (in hectares)						
				Total Geographical Area	Hilly Area	Ground Water Recharge Worthy Area			Shallow Water Table Area	Flood Prone Area
						Command area	Non-command area	Poor ground water quality area		
Shivpuri	**Badarwas**	Vindhyan Sandstone & Shale	115176	121600	6424	3424	111752	0	0	0
Shivpuri	**Karera**	Archaean Granite & Alluvium	99900	101400	1500	13022	86878	0	0	0
Shivpuri	**Khanniyadhana**	Vindhyan Sandstone & Shale	123244	129200	5956	20650	102594	0	0	0
Shivpuri	**Kolaras**	Vindhyan Sandstone & Shale	107491	115200	7709	0	107491	0	0	0
Shivpuri	**Narwar**	Granite & Alluvium	92800	98400	5600	12617	80183	0	0	0
Shivpuri	**Pichor**	Vindhyan Sandstone & Shale	102884	109100	6216	14559	88325	0	0	0
Shivpuri	**Pohri**	Vindhyan Sandstone & Shale	151518	157300	5782	2399	149119	0	0	0
Shivpuri	**Shivpuri**	Vindhyan Sandstone & Shale	184036	195600	11564	2750	181286	0	0	0

Table 8: Dynamic ground water resource estimation of Shivpuri District

(As on March' 2020)

Assessment Unit Name	Recharge from Rainfall-Monsoon Season (Ham)	Recharge from Other Sources-Monsoon Season (Ham)	Recharge from Rainfall-Non Monsoon Season (Ham)	Recharge from Other Sources-Non Monsoon Season (Ham)	Total Annual Ground Water Recharge (Ham)	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)
Pohri	11464.29	391.37	0	1528.85	13384.51	698.19	12686.32
Pichor	4978.17	399.41	0	2022	7399.58	464.4	6935.18
Shivpuri	8909.84	430.22	0	1659	10999.06	575.99	10423.07
Khanniyadhana	7482.45	591.08	0	2062.08	10135.61	1013.57	9122.04
Kolaras	7847.01	354.16	0	1447.45	9648.62	482.43	9166.19
Karera	5330.44	339.12	0	1610.59	7280.15	364.01	6916.14
Badarwas	9565.66	672.95	0	2208.59	12447.2	1199.09	11248.11
Narwar	6511.48	484.08	0	2151.09	9146.65	914.66	8231.99
District total	**62089.34**	**3662.39**	**0**	**14689.65**	**80441.38**	**5712.34**	**74729.04**

Assessment Unit Name	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization
Pohri	5662.39	0	628.2409	6290.63	717.94	6305.99	49.59	safe
Pichor	5029.15	0	542.5747	5571.74	620.04	1285.97	80.34	semi_critical
Shivpuri	5923.01	0	495.8423	6418.85	566.64	3933.42	61.58	safe
Khanniyadhana	6997.23	0	649.1554	7646.37	741.85	1382.98	83.82	semi_critical
Kolaras	6830.25	0	408.2423	7238.49	466.53	1869.41	78.97	semi_critical
Karera	3206.31	0	630.8908	3837.19	720.97	2988.87	55.48	safe
Badarwas	8681.10	0	502.1166	9183.22	573.8	1993.21	81.64	semi_critical
Narwar	5764.04	0	537.899	6301.93	614.7	1853.26	76.55	semi_critical
District total	**48093.48**	**0**	**4394.96**	**52488.42**	**5022.47**	**21613.11**	**70.24**	**semi_critical**

CHAPTER-5

GROUND WATER RELATED ISSUES

5.1 Ground Water Depletion

- There are many parts in the district having water scarcity.

5.2 Ground Water Quality

- The quality of ground water is potable except in some parts where higher concentration of nitrate is reported.
- There is slightly saline water reported in some isolated parts of the district.

5.3 Borehole drilling

- Drilling problems may occur due to collapsible red bole formation.

CHAPTER-6

GROUND MANAGEMENT STRATEGIES

The Ground water extraction is less than 70% in 3 blocks namely Karera, Pohri and Shivpuri. Therefore, the areas falling under these blocks may be taken up for further extraction of the Groundwater. It is also observed that the granular / jointed /fractured zones are encountered within the 50 m. depth. Therefore, construction of shallow depth bore-wells is recommended in the area. The rest of the 5 blocks namely Kolaras, Khanniadhana, Narwar, Badarwas and Pichor falls under semi critical category of Ground water extraction.

6.1. District Ground Water Management Plan

Shivpuri district has been facing problems of ground water exploitation which in turn depleting the ground water resources in the area. This has led to evolve sustainable water conservation and management practices through an integrated approach. The ground water management plan for Shivpuri district has been made keeping in view the area specific details and includes the strategies like enhancing the ground water resources through construction of artificial recharge structures such as percolation tanks, check dams/nala bunds, recharge shafts, etc. and ensuring water use efficiency through maintenance/ renovation of existing water bodies/water conservation structures. Also, adoption of micro-irrigation techniques such as sprinkler irrigation has been proposed, that would not only conserve ground water resources by reducing extraction, but would also increase the net cropping area thereby augmenting the agricultural economy of the district.

6.1.1. Supply Side Management

Artificial recharge to ground water is one of the most efficient, scientifically proven and cost effective technology to mitigate the problems of over exploitation of ground water resources. The artificial recharge technique simultaneously augments the ground water storage, reduces the ground water quality problems and also improves the sustainability of wells in the affected areas.

The supply side management plan for Shivpuri district has been formulated using the basic concepts of hydrogeology. Sub-surface storage is calculated by multiplying the total area with the respective

specific yield (considering the variable lithology) and the unsaturated zone thickness obtained by subtracting 3 mts. from the post-monsoon water level. The volume of ground water recharge generated through pre-existing rain water harvesting/water conservation structures is subtracted from the sub-surface storage to assess the available storage potential. Thus, the surface water requirement to completely saturate the sub-surface storage is obtained by multiplying a factor of 1.33 to available storage potential. A runoff coefficient factor of 0.23 has been considered for Shivpuri district to calculate the total surface water runoff, 30% of which accounts to the non-committed runoff which is available to sustain the proposed artificial recharge structures. Further, the number of structures has been calculated by allotting 35%, 20% and 35% of non-committed runoff to Percolation tanks, Recharge shafts and Nala bunds/Check dams/Cement Plugs respectively. The remaining runoff is considered to restore the pre-existing village tanks, ponds and water conservation structures. A detailed calculation of the proposed artificial recharge structures is presented in the Table 9.

Table 9: Supply side management plan

S. No	District	Assessment Unit Name	Area (Sq. Km)	Normal Annual Rainfall (mm)	Average Post-monsoon Water Level (m bgl)	Suitable Area for AR (sq.km)	no of Existing percolation tanks	no of Existing Check Dams	no of Existing nala bunds/cement plugs	no of Existing village ponds/ Farm Ponds	no of percolation tanks Proposed	no of Check Dams	no of nala bunds/ cement plugs	no of village ponds/ Farm Ponds
1	Shivpuri	Badarwas	1151.76	728	5.79	381	7	805	408	11	113	0	0	333
2	Shivpuri	Karera	999	770	5.65	1089.34	3	921	34	10	98	0	254	278
3	Shivpuri	Khanniyadhana	1232.44	966	5.1	984	5	1309	17	7	67	0	189	199
4	Shivpuri	Kolaras	1074.91	782.3	7.24	1172.88	20	742	80	33	92	221	241	288
5	Shivpuri	Narwar	928	787	4.5	997.82	27	499	39	82	70	0	238	195
6	Shivpuri	Pichor	1028.84	721	6.32	872	4	772	31	338	97	94	258	0
7	Shivpuri	Pohri	1515.18	1162	5.09	966.68	19	536	183	111	139	821	269	341
8	Shivpuri	Shivpuri	1840.36	1044	1.86	1457.36	12	293	36	104	0	0	0	0
	Total		**9770.49**	**6960.3**	**41.55**	**7921.08**	**97**	**5877**	**828**	**696**	**676**	**1136**	**1449**	**1634**

6.1.2. Demand Side Management

Micro irrigation technologies such as drip and sprinkler systems are being increasingly promoted as technological solutions for achieving water conservation. Micro-irrigation comprises two technologies—drip irrigation and sprinkler. Both saves conveyance losses and improve water application efficiency by applying water near the root-zone of the plant. Some benefits of the micro-irrigation have been listed below:

The increase in yield for different crops ranges from 27 per cent to 88 per cent and water saving ranges from 36 per cent to 68 per cent vis-à-vis conventional flow irrigation systems (Phansalker and Verma, 2005).

1. It enables farmers to grow crops which would not be possible under conventional systems since it can irrigate adequately with lower water quantities.
2. It saves costs of hired labour and other inputs like fertilizer.
3. It reduces the energy needs for pumping, thus reducing energy per ha of irrigation because of its reduced water needs. However, overall energy needs of the agriculture sector may not get reduced because most farmers use the increased water efficiency to bring more area under irrigation.

Adoption of Sprinkler irrigation techniques would save 20% of gross ground water draft for irrigation. Also, the 60% of additional recharge created by construction of artificial recharge structures can be utilized to increase the total cropping area, thereby enhancing the productivity and economy of the district.

6.2. Post-Intervention Impact

The expected outcome of the proposed interventions from both supply side and demand side has been described in Table 10. It can be envisaged that the stage of ground water extraction for the Shivpuri district, would reduce to **58.64%** as compared to the present stage of ground water extraction of **70.24** % after implying and successful implementation of proposed interventions.

Table 10: Post-Intervention Impact

Block	Net GW Availability (MCM)	GW extraction for Irrigation (MCM)	GW extractionfor Domestic & Industrial (MCM)	Total GW extraction (MCM)	Stage of GW Extraction %	Saving by Sprinkler in (MCM)	Additional recharge created by AR (MCM)	After intervention of AR Structure Net GW Avl.(MCM)	After intervention of AR Structure &utilisation of 60% of additional GW created. (MCM)	extraction after sprinkler & additional area created for agriculture (MCM)	Stage of Extraction %	Additional area irrigated by GW after intervention (Sq.Km)
Badarwas	112.48	86.81	5.02	91.83	81.64	16.95	68.76	181.24	41.26	116.14	64.08	103
Karera	69.16	32.06	6.3	38.37	55.48	6.7	59.64	128.8	35.78	67.45	52.37	89
Khanniyadhana	91.22	69.97	6.49	76.46	83.82	13.89	53.37	144.59	32.02	94.59	65.42	80
Kolaras	91.66	68.3	4.08	72.38	78.97	12.89	64.17	155.83	38.50	97.99	62.88	96
Narwar	82.32	57.64	5.38	63.02	76.55	11.33	55.4	137.72	33.24	84.93	61.67	83
Pichor	69.35	50.29	5.43	55.72	80.34	9.74	44.64	113.99	26.78	72.76	63.83	67
Pohri	126.86	56.62	6.28	62.91	49.59	11.05	90.46	217.32	54.28	106.14	48.84	136
Shivpuri	104.23	59.23	4.96	64.19	61.58	11.6	109.87	214.1	65.92	118.51	55.35	165
TOTAL	**747.29**	**480.93**	**43.94**	**524.88**	**70.24**	**94.15**	**546.31**	**1293.59**	**327.79**	**758.52**	**58.64**	**819.00**

CHAPTER-7

CONCLUSIONS AND RECOMMENDATIONS

- The construction of Ground water abstraction structures in the blocks of Khanniyadhana, Narwar, Badarwas and Pichor may be regulated as stage of ground water extraction has approaching more than 70%.
- There is need of artificial recharge of Ground water in the suitable areas of the district.
- The nitrate affected areas may be explored to find out alternative source / aquifers of ground water.
- Shivpuri district is located in the northern part of the state of Madhya Pradesh and occupies as area of 10066 sq km. and recharge worthy area is 9770.49 sq km.
- Rivers of Sind Sub-basin drained the entire Shivpuri district. All the rivers are almost northerly flowing. The Sind Rivers flowing northerly forms the major drainage in the eastern and central parts and river Kuno is another major river in the western parts. The district falls in the Yamuna basin.
- The district is generally covered with Bundelkhand granite and Vindhyan system formations. The southern part of the district is covered by Deccan traps.
- Shivpuri district comprises of 8 blocks, namely Shivpuri, Kolaras, Badarwas, Karera, Narwar, Pichor, Khanniyadhana and Pohari.
- The phreatic aquifer is recharged during monsoon which sustains for 3 to 4 months.
- More stress on Groundwater, 64 % area is irrigated by Ground water while 36 % area is irrigated through surface water.
- 60.75 % area is irrigated of net shown area.
- Groundwater to level trend 2009 to 2018 pre-monsoon period indicate that there is rising trend in the range of 2.41 to 47.51 cm/yr and declining trend in the range of 1.74 to 28.94 cm/yr. While the post-monsoon period indicate that there is rising trend in the range of 1.02 to 39.94 cm/yr and declining trend in the range of 27.01 to 43.88 cm/yr.
- The maximum concentration of nitrate has been observed at Semri (46 mg/l), Sikandara (46 mg/l), Masoori (48 mg/l), Bhagora (49 mg/l), Languri (53 mg/l),

Sirsod (53 mg/l), Pohari (58 mg/l), Satanwara (74 mg/l), Sehore (96 mg/l), Achhroni New (104 mg/l), Narwar (119 mg/l), SirsodChouraha (120 mg/l), Pichhore (156 mg/l), Karera (163 mg/l) and Bhonti (177 mg/l). Total hardness of ground water in the study area ranged in between 91 to 768 mg/l. The high concentration has been observed in the village of Bhonti (768 mg/l).

- On the basis of the 31 exploratory wells and 6 Piezometers in Shivpuri district, CGWN/NCR under its exploratory program, it has been observed that the yield varies from meagre to 0.05 lps at Phoolpur to 18.05 lps at Ludhawali.
- As per the Dynamic Ground Water Resource Assessment Report (2020), there are eight assessment units (block) in the district out of which 3 blocks fall under safe category. The net ground water availability in the district is 74729.04 ham and ground water extraction for all uses is 52488.42 ham, making stage of ground water extraction 70.24 % as a whole.
- After the interventions suggested in the report, the stage of extraction is expected to improve from **70.24** % to **58.64** % for the Shivpuri district.
- As per the Management plan prepared under NAQUIM of all the Block of Shivpuri District, a total number of 676 Percolation Tanks, 1449 Nala Bunds, 1136 Check Dams and 1634 farm ponds have been proposed.
- The numbers of artificial recharge structures have been proposed based on the CGWB Master plan 2020. It may be differ from the field condition as well as Changes in dynamic Ground water recourses.
- It is also recommended that implementation intervention would be in three Phases, First Phase should be in those blocks where stage of Ground Water extraction is more than 70 %.
- The second phase would be in those blocks where stage of GW extraction is less than70%.

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