BANGALORE (R) DISTRICT

1. Location

Bangalore (Rural) district is located in the southeastern portion of Karnataka State with geographical area of 5,815 sq. km. It is bounded by Tumkur district on western portion, Mandya district on southwestern portion, Chamarajanagara district on southern portion, Kolar district on northeastern portion and southeastern portion of the district is bounded by Tamil Nadu State. It lies between 12° 14' to 13° 29' N Latitude and 77° 05' to 77° 58' E Longitude.

2. Demography

As per the 1991 census, Bangalore (Rural) district has a population 1,673,194. The total number of villages / habitations in the district are 3,394. Bangalore (Rural) district has 8 taluks viz., Channapatna, Devanahalli, Dodballapura, Hoskote, Kanakapura, Magadi, Nelamangala and Ramanagaram.

3. Climate, Drainage and Soil

The climate of the district is salubrious and very agreeable. It is free from extremes. The main features of the climate of the district are the agreeable range of temperatures and the two rainy seasons. Two other important features are the predominant low clouding and the more or less steady temperatures during the entire year. The climate of Bangalore (Rural) District is classified as the seasonally dry tropical savanna climate with temperature varying between 16° C to 35° C. The district receives an average of annual rainfall of 793.6 mm. The district is drained by Dakshina Pinakini, Arkavathi, Vrushabhavati, Cauvery, Kumudavati, Shimsha and Kanva rivers. Major portion of the district is covered by red sandy soil.

4. Geology and Groundwater occurrence

Bangalore district consists of Peninsular Gneisses covering almost 80 % of the aerial extent with remaining 20 % consisting of Closepet granites. From the groundwater point of view the rocks are classified as crystalline formations. The fracture / fissure system developed along with joints and faults traversing the rocks facilitate groundwater circulation and hold moderate quantity of water. The quality of groundwater is governed by the mineralogical composition of the rocks. Groundwater occurs in the water table conditions in the weathered and decomposed mantle and also under semi-confined conditions in the deeper fractures.

5. Groundwater quality characterization

To understand and gather information on groundwater quality, 9,528 groundwater samples collected from 2,866 villages / habitations in Bangalore (Rural) district have been analysed by RDED.

The water samples have been analysed for only 14 parameters such as Turbidity, Colour, Conductivity, Hydrogen ion concentration (pH), Total Dissolved Salts (TDS), Total Hardness (TH), Calcium Hardness (CalH), Chloride (Cl), Sulphate (SO_4), Fluoride (F), Nitrate (NO_3), Alkalinity (Alk), Iron (Fe) and Bacteria. The data is presented in the Table.

5.1 Physical characters

Turbidity

In all, 561 samples collected from 311 villages / habitations have higher turbidity. Higher turbidity in the range of 10.1 to 536 JTU is reported from Channapatna (147 out of 1200 samples), Devanahalli (28 out of 593 samples), Dodballapura (72 out of 1145 samples), Hoskote (1 out of 660 samples), Kanakapura (48 out of 2086 samples), Nelamangala (39 out of 966 samples) and Ramanagaram (257 out of 984 samples) taluks.

Colour

None of the sample analysed in the entire district have shown higher colour intensity.

Electrical Conductivity (EC)

The EC values in the different taluks of Bangalore (rural) district are Channapatna 290-15000 m mhos/cm, Devanahalli 130-7600 m mhos/cm, Dodballapura 60-5430 m mhos/cm, Hoskote 87-6200 m mhos/cm, Kanakapura 40-3300 m mhos/cm, Magadi 6-2892 m mhos/cm, Nelamangala 40-8740 m mhos/cm and Ramanagaram 100-4500 m mhos/cm.

Hydrogen Ion Concentration (pH)

About 283 samples (nearly 5 %) covering 287 villages, have recorded the variation in pH value from acidic to basic in the range of 1.2 - 9.85. The range of pH value recorded in the other taluks are: Channapatna 8.6-9.85 (29 samples), Devanahalli 6.2-6.4 (23 samples), Dodballapura 6.1-6.4 (14 samples), Hoskote 6.1-8.6 (32 samples), Kanakapura 1.2-9.2 (22 samples), Magadi 5.1-9.2 (3 samples), Nelamangala 6.02-6.49 (51 samples) and Ramanagaram 8.55-9.35 (109 samples).

5.2 Chemical Characters

Total Dissolved Salts (TDS)

Only 42 samples covering 29 villages/habitations have higher TDS content in the range of 2010-5220 ppm. The ranges of abnormal TDS content in different taluks are: Channapatna 2300-2600 ppm (3 samples) Dodballapura 2010-3250 ppm (5 samples), Hoskote 2020-4130 ppm (17 samples), Kanakapura 2060 ppm (the lone sample), Nelamangala 2040-5220 ppm (14 samples) and Ramanagaram

2491-2530 ppm (2 samples). The highest value of 5220 ppm is reported from Hotlappanapalya village in Nelamangala taluk. The samples from Magadi and Devanahalli taluks have not reported abnormal concentration of TDS.

Total Hardness (TH)

About 434 samples covering 276 villages/habitations have higher TH content in the range of 601-2920 ppm. The ranges of abnormal TH content in different taluks are - Channapatna 620-900 ppm (74 samples), Devanahalli 607-1179.12 ppm (19 samples), Dodballapura 601-2920 ppm (97 samples), Hoskote 608-2550 ppm (132 samples), Kanakapura 630-960 ppm (9 sample), Magadi 615-900 (16 samples), Nelamangala 604-2256 ppm (82 samples) and Ramanagaram 620-1160 ppm (5 samples). The highest value of 2920 ppm is reported from M.N. Halli village in Dodballapura taluk.

Calcium Hardness (CaIH)

As many as 2,206 samples spread across 1,016 villages have analysed higher CaIH content in the range of 201-1652 ppm. The range recorded in different taluks are: Channapatna 210-940 ppm (668 samples), Devanahalli 201-481.2 ppm (47 samples), Dodballapura 201-1205 ppm (166 samples), Hoskote 204-1308 ppm (334 samples), Kanakapura 210-960 ppm (429 samples), Magadi 246-941 (12 samples), Nelamangala 204-1652 ppm (287 samples) and Ramanagaram 220-780 ppm (263 samples). The maximum content of 1652 ppm is reported from Kalalghatta village in Nelamangala taluk.

Chloride (Cl)

Only 15 samples covering 15 villages/habitations have higher Cl content in the range of 1008-2220 ppm. The ranges of abnormal Cl content recorded in different taluks are; Channapatna 1106-2127 ppm (5 samples), Hoskote 1023-1634 ppm (4 samples), Kanakapura 1700 ppm (the lone sample), Nelamangala 1008-2220 ppm (4 samples) and Ramanagaram 1134 ppm (the lone sample). The highest value of 2220 ppm is reported from Kuluvanahalli village of Nelamangala taluk. The samples analysed from Devanahalli, Dodballapura and Magadi taluks have not reported abnormal Chloride content.

Sulphate (SO_4)

Just 15 samples covering 13 villages/habitations have higher SO_4 content in the range of 402-710 ppm. The ranges of abnormal SO_4 content in different taluks are; Hoskote 710 ppm (the lone sample) and Ramanagaram 402-560 ppm (14 samples). The highest value of 710 ppm is reported from Thalapanahalli village in Hoskote taluk. The samples from Channapatna, Devanahalli, Dodballapura, Kanakapura, Magadi and Nelamangala taluks have no excess SO_4 content.

Fluoride (F)

In total, 660 samples spread across 401 villages have analysed Fluoride content ranging from 1.51-10.05 ppm and the records in different taluks are: - Channapatna 1.53-3.12 ppm (57 samples), Dodballapura 1.54-10.05 ppm (28 samples), Hoskote 1.55-3.6 ppm (12 samples), Kanakapura 1.51-2.5 ppm (136 samples), Magadi 1.6-4.5 ppm (260 samples), Nelamangala 1.6-4.8 ppm (39 samples) and Ramanagaram 1.51-2.3 ppm (128 samples). The maximum Fluoride content of 10.05 ppm is reported from Kantanakunta village in Dodballapura taluk. Samples from Devanahalli taluk have not reported abnormality in Fluoride content.

Nitrate (NO_3)

Totally 144 samples covering 82 villages/habitations have higher NO_3 content in the range of 103-222 ppm. The ranges of abnormal NO_3 content in different taluks are - Dodballapura 176 ppm (the lone sample) and Magadi 103-222 ppm (143 samples). The highest value of 222 ppm is reported from Bylakere village in Magadi taluk. The samples collected from Channapatna, Devanahalli, Kanakapura, Hoskote, Nelamangala and Ramanagaram taluks have not reported abnormal NO_3 content.

Alkalinity (Alk)

Only 151 samples covering 107 villages have reported abnormal Alkalinity value ranging from 607 to 2622 ppm. The range of Alkalinity values recorded in different taluks are - Channapatna 620-1300 ppm (70 samples), Dodballapura 607-836 ppm (3 samples), Hoskote 608-770 ppm (4 samples), Kanakapura 660-830 ppm (4 samples), Magadi 610-990 ppm (23 samples), Nelamangala 612-2622 ppm (16 samples) and Ramanagaram 620-900 ppm (31 samples). The maximum Alkalinity of 2622 ppm is reported from Thyamgondlu village in Nelamamgala taluk. Samples analysed in Devanahalli taluk have not reported abnormal Alkalinity.

Iron (Fe)

About 464 samples analysed from 267 villages / habitations have analysed excess iron in the range of 1.01-32 ppm. The higher iron content in different taluks are: Channapatna 1.01-5.1 ppm (169 samples), Devanahalli 1.26-3.3 ppm (6 samples), Dodballapura 1.04-3.02 ppm (4 samples), Hoskote 1.2-32 ppm (43 samples), Kanakapura 1.02-2.2 ppm (22 samples), Magadi 1.2-2 (6 samples), Nelamangala 1.03-10.2 ppm (31 samples) and Ramanagaram 1.01-3.3 ppm (183 samples). The highest Fe content of 32 ppm is recorded from B.Agrahara village from Hoskote taluk.

Bacteria *(E.coli)*

Nearly 25 % of analysed samples (2357) from 1140 villages have shown the presence of Bacteria in water. The bacterial count varies between 1 and 10444 No.s / 100 ml of water. The bacterial counts reported in different taluks are -

Channapatna 1-86 (754 samples), Devanahalli 1-150 (130 samples), Dodballapura 2-35 (153 samples), Hoskote 1-10444 (35 samples), Kanakapura 1-25 (779 samples), Nelamangala 10-2400 (39 samples) and Ramanagaram 1-25 (467 samples). The samples analysed in Magadi taluk have not reported bacterial incidence in the drinking water samples. The highest count of 10444 is reported from Allappanahalli village in Hoskote taluk.

5.3 Spatial Variation

Bacteria (E.Coli)

The map depicting bacterial incidence indicates that, bacteria are more commonly seen in the entire district spread randomly. Bacterial contamination is point specific and varies considerably.

Fluoride (F)

The isoconcentration map of Fluoride (Fig.2A) indicates that, higher Fluoride concentration is confined only to isolated patches in the western and southern parts covering Magadi, Ramanagaram and Kanakapura taluks.

Total Dissolved Salts (TDS)

The spatial variation map (Fig.2B) depicts that; patches of higher average TDS concentrations are seen in Hoskote, Ramanagaram and Nelamangala taluks only.

Total Hardness (TH)

The map showing TH variation (Fig.2C) reveals that, higher average concentration is seen in the northern and southern parts covering Hoskote, Nelamangala, Dodballapura and Kanakapura taluks.

Iron (Fe)

Isoconcentration map generated for Iron (Fig.2D) reveals patches of higher average concentrations of iron are confined to the southern portion of the district covering Channapatna, Ramanagaram and Kanakapura taluks, Hoskote taluk in the eastern portion and Nelamangala taluk in the northwestern portion of the district.

6. Conclusion

The water quality data of Bangalore (Rural) district has reflected the presence of excess Hardness, Fluoride, Iron and Bacteria. Water hardness can be reduced by some conventional methods. In case of Fluoride, utmost care is essential since many samples have analyzed excess Fluoride. Though a little amount of Fluoride is essential for bone development in the infants, excess consumption of Fluoride will induce physical disabilities and Dental Fluorosis. Therefore, it is very essential to treat the water to the desirable standard before it is supplied for the drinking

purpose. To overcome the problem related to the excess Iron content, an attention is required during the source development such as use of galvanized iron / PVC pipes and proper casing. The most important and harmful component is the presence of Bacteria viz. *E. coli* in the drinking water. The consumption of such water may cause the diseases such as Malaria, Diarrhea etc. Probably, these organisms might have been introduced into the groundwater regime by anthropogenic activities. This clearly indicates non-hygienic / poor sanitation condition prevailing at village levels. To overcome this both the user and the administrator must be trained properly and awareness has to be created regarding hygienic aspects.

Table: Comprehensive analysis of water quality data of Bangalore (Rural) District

SL.NO.	Name of the taluks	Number of villages/ habitations	Number of sampled villages	Number of samples analysed	Water quality scenario	Bact (c/100 ml)-0	Tur (10) JTU	Color (25) HU	Cond - mmhos /cm	pH (6.5-8.5)	TDS (2000) ppm	TH (600) ppm	CalH (200) ppm	Cl (1000) ppm	SO_4 (400) ppm	F (1.5) ppm	NO_3 (100) ppm	Alk (600) ppm	Fe (1) ppm
1	Channapatna	263	223	1200	No. of samples beyond permissible limit	754	147	-	-	29	3	74	668	5	-	57	-	70	169
					No. of villages affected	202	65	-	-	108	3	52	176	5	-	23	-	46	62
					Range	1-86	11-536	-	290-15000	8.6-9.85	2300-2600	620-900	210-940	1106-2127	-	1.53-3.12	-	620-1300	1.01-5.1
2	Devanahalli	260	194	593	No. of samples beyond permissible limit	130	28	-	-	23	-	19	47	-	-	-	-	-	6
					No. of villages affected	96	21	-	-	18	-	14	29	-	-	-	-	-	6
					Range	1-150	11-89.1	-	130-7600	6.2-6.4	-	607-1179.12	201-461.2	-	-	-	-	-	1.26-3.3
3	Dodballapur	403	343	1145	No. of samples beyond permissible limit	153	72	-	-	14	5	97	166	-	-	28	1	3	4
					No. of villages affected	128	59	-	-	11	5	63	105	-	-	23	1	3	4
					Range	2-35	10.1-24.2	-	60-5430	6.1-6.4	2010-3250	601-2920	201-1205	-	-	1.54-10.05	176.08	607-836	1.04-3.02
4	Hosakote	337	242	660	No. of samples beyond permissible limit	35	1	-	-	32	17	132	334	4	1	12	-	4	43
					No. of villages affected	30	1	-	-	24	14	84	160	4	1	12	-	4	31
					Range	1-10444	50	-	87-6200	6.1-8.6	2020-4130	608-2550	204-1308	1023-1634	710	1.55-3.6	-	608-770	1.2-32
5	Kanakapura	612	641	2086	No. of samples beyond permissible limit	779	48	-	-	22	1	9	429	1	-	136	-	4	22
					No. of villages affected	451	39	-	-	17	1	6	258	1	-	99	-	4	18
					Range	1-25	11-45	-	40-3300	1.2-9.2	2060	630-960	210-960	1700	-	1.51-2.5	-	660-830	1.02-2.2
6	Magadi	521	610	1894	No. of samples beyond permissible limit	-	8	-	-	3	-	16	12	-	-	260	143	23	6
					No. of villages affected	-	5	-	-	3	-	9	11	-	-	141	81	15	5
					Range	-	12-30	-	6-2892	5.1-9.2	-	615-900	246-941	-	-	1.6-4.5	103-222	610-990	1.2-2
7	Nelamangala	346	340	966	No. of samples beyond permissible limit	39	39	-	-	51	14	82	287	4	-	39	-	16	31
					No. of villages affected	37	39	-	-	41	4	43	152	4	-	33	-	7	24
					Range	10-2400	12-45	-	40-8740	6.02-6.49	2040-5220	604-2256	204-1652	1008-2220	-	1.6-4.8	-	612-2622	1.03-10.2
8	Ramanagaram	325	273	984	No. of samples beyond permissible limit	467	257	-	-	109	2	5	263	1	14	128	-	31	183
					No. of villages affected	196	121	-	-	65	2	5	125	1	12	70	-	28	117
					Range	1-25	11-330	-	100-4500	8.55-9.35	2491-2530	620-1160	220-780	1134	402-560	1.51-2.3	-	620-900	1.01-3.3
	Total	3067	2866	9528	No. of samples beyond permissible limit	2357	561	-	-	283	42	434	2206	15	15	660	144	151	464
					No. of villages affected	1140	311	-	-	287	29	276	1016	15	13	401	82	107	267
					Range	1-10444	10.1-536	-	6-15000	1.2-9.85	2010-5220	601-2920	201-1652	1008-2220	402-710	1.51-10.05	103-222	607-2622	1.01-32

BANGALORE RURAL DISTRICT

FIG.2A : FLUORIDE VARIATION

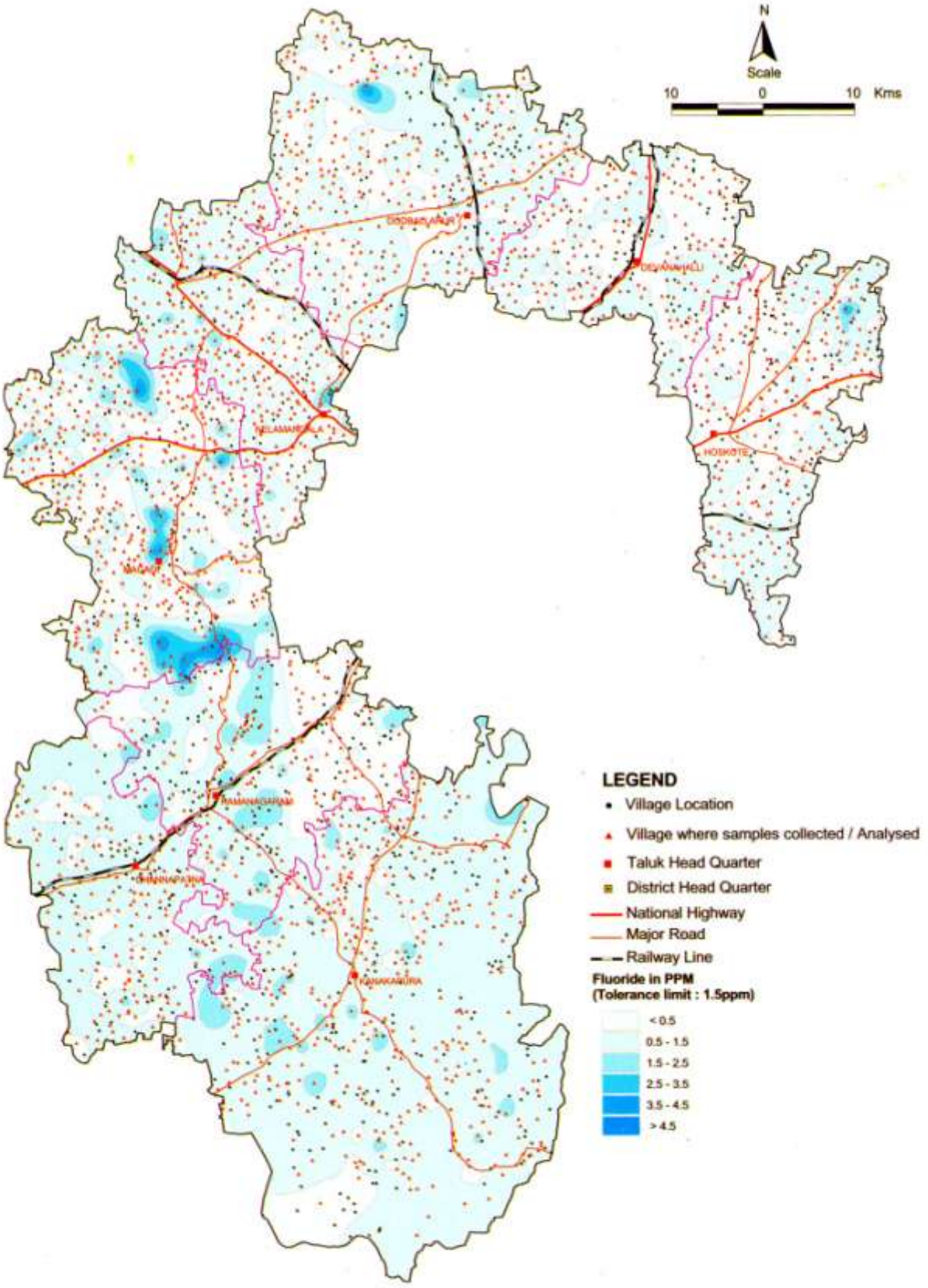

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FIG.2B : VARIATION OF TOTAL DISSOLVED SALTS (TDS)

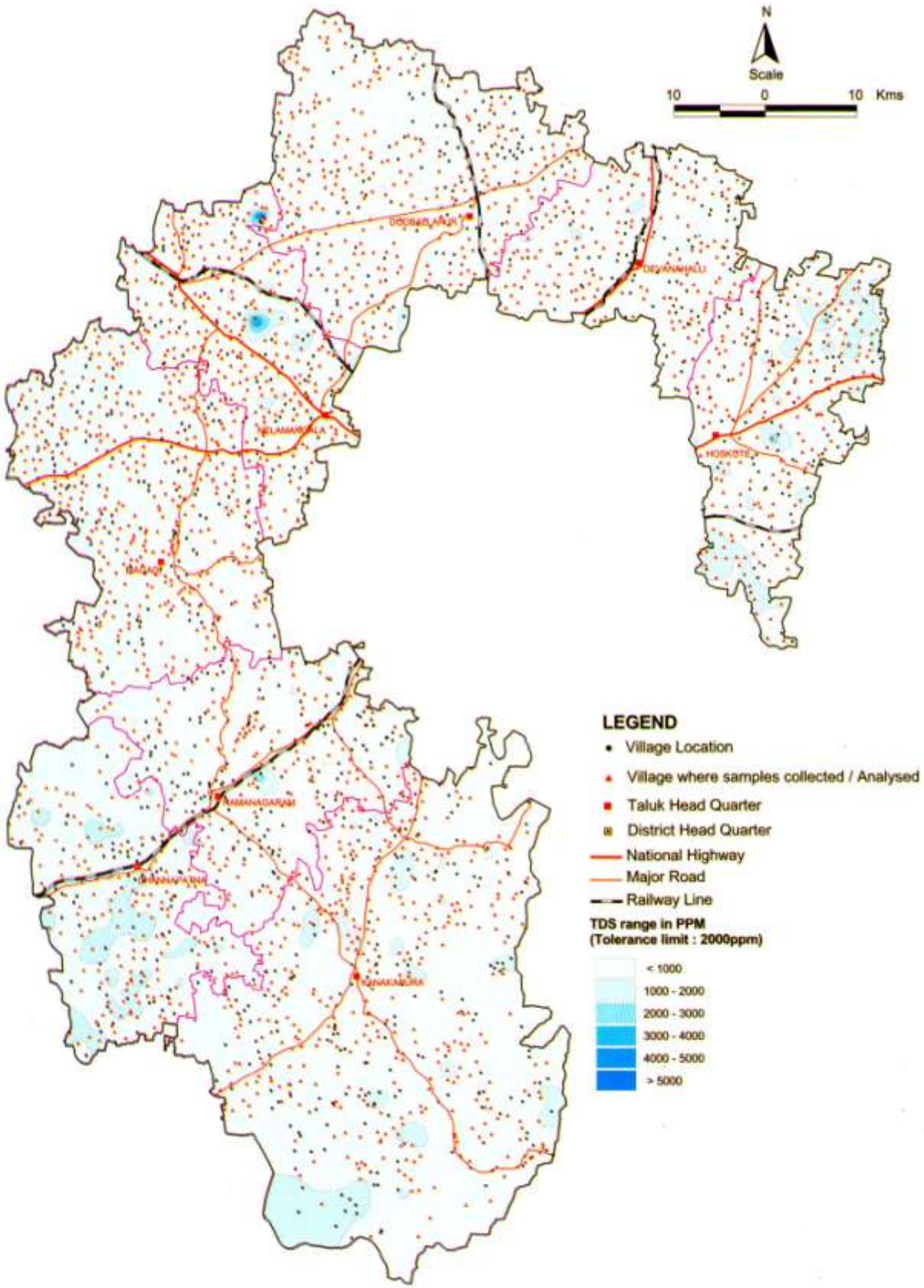

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FIG.2C : VARIATION OF TOTAL HARDNESS (TH)

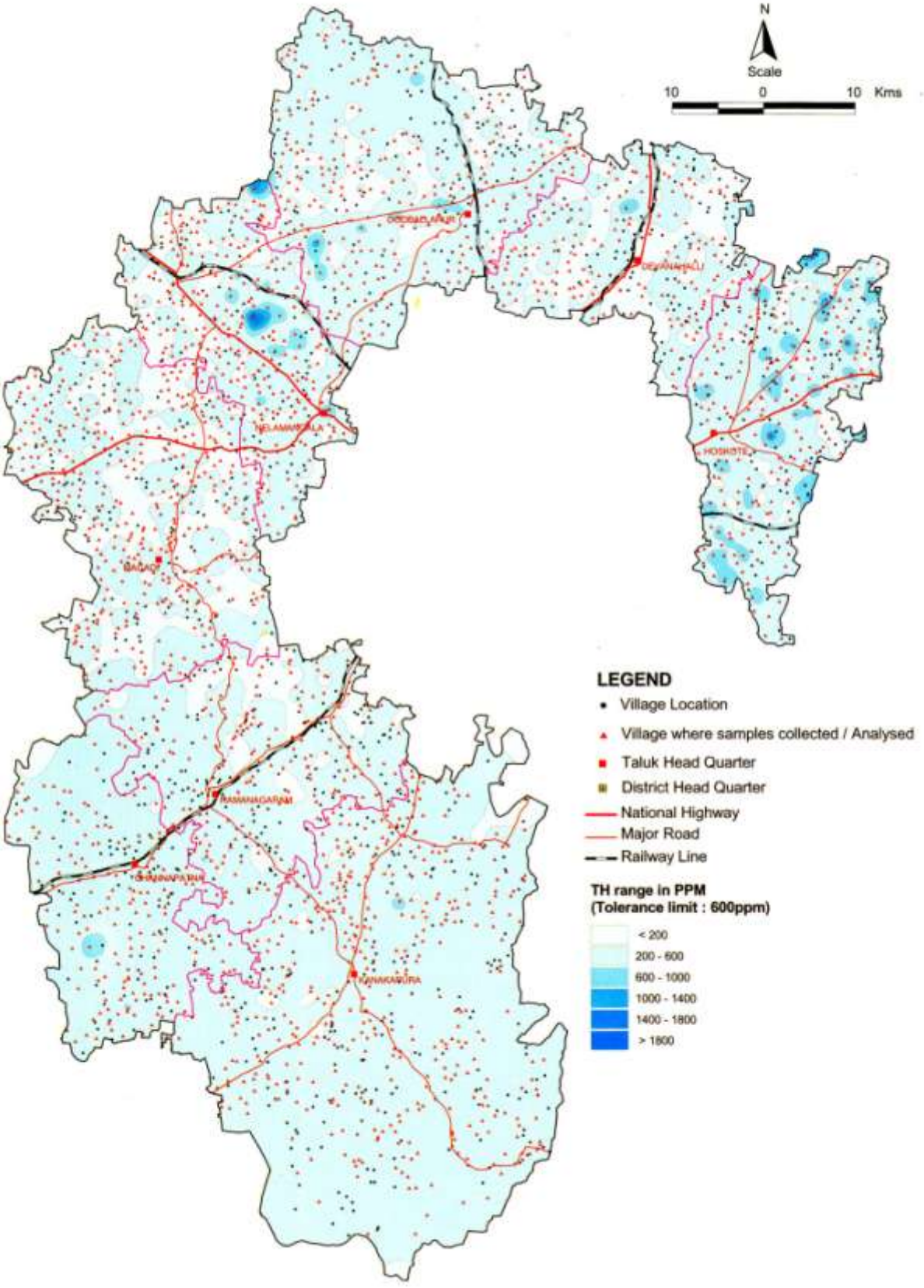

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FIG.2D : IRON VARIATION