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Characterization of Sustainable Water Source System Suranga and Surrounding Groundwater Resources at Padre Village Kasargod

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A B S T R A C T

In this paper, water quality parameters of traditional horizontal tunnel Suranga and open well water of Padre micro watershed, border of Dakshina Kannada district and Kasargod district were studied and compared with Indian standard limits to know the suitability of water for domestic purposes and irrigation purposes. Farmers mainly depend on suranga water which will be stored in Madoka or ponds and some are dependent on open wells. Agriculture water samples were collected from open wells and Surangas of the selected study area Padre Village and analysed for water quality parameters like pH, EC, alkalinity, acidity, calcium, magnesium, fluoride, total dissolved solids, Chemical oxygen demand, and nitrate. All physicochemical parameters were within the Indian standard limit. When compared with each other Suranga and open well Turbidity, EC and TDS were more in the open well than in the Surangas water sample. Nitrate and Chemical oxygen demand was nil in Suranga and traces were present in the open well which may be due to seepage of fertilizer used in agriculture into the open wells. Suranga water was safe from the seepage of chemicals into it. Calcium Magnesium and Fluoride were higher when compared to open well but within Indian standard limits (BIS) in Suranga water mainly because of the hardcore laterite soil property. Chances of contamination of Surangas water are less compared to open well. Surangas are an old traditional sustainable method of sourcing water that gives good quality water and has to be protected and maintained.

***Key words*:** Suranga, Horizontal tunnel, Foot hills, Laterite terrain, Water quality parameters

A narrow horizontal tunnel called Suranga is, barely two-and-a-half feet wide and just over five-and-a-half feet high, dug into laterite hills until a water spring is found. The horizontal tunnel Suranga can run from anywhere between 30 meters to 300 meters into a hill. As rain water percolates through laterite and flows into the tunnel, it is carefully channelized in a narrow stream to a small mud reservoir called Madaka, or a pond built near the tunnel. Once water starts flowing from a spring, there is a steady supply of fresh water for years, without having to use pumps and electric motors. Suranga should be understood as a water drainage system. It was identified, relative to other traditional water-harvesting systems in mountains, as a gallery filtration tunnel system that is exclusively constructed in laterite substrate. These laterites have a sound internal structure that does not require support structures [1]. The flow of water is systematically channelized through a tunnel and the water will be collected and used as source of water for domestic purposes and irrigation purposes [2]. This traditional system of water resources can be found in some places especially at border of Dakshina kannada and Kasargod. Farmers in places like Swarga, Panaje, Perla, Vaninagara, Padre depend mainly on this Suranga as source of water. Suranga is best suited for the laterite soil because this type of soil does not collapse while digging. This should not be practiced in other types of soils for the same reason.

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MATERIALS AND METHODS

The GPS coordinates of the locations were recorded by GPS (Montana GPS receiver). Water samples were collected for physico-chemical analysis from 30 sampling sites (Suranga and open Well) from Padre Village. Water was collected in bottles of 2 L size, and these are analyzed using standard methods for physico-chemical properties. Total 30 locations were selected of which 14 open wells, 13 suranga water and 3 combined surangas and open well. The (Fig 1) shows the flow chart of methodology of water sampling and quality analysis. Water sampling was carried out during pre-monsoon and post-monsoon seasons from 2017 to 2019. Water samples were collected from located Suranga sources and some open wells

were collected in 2 ltr polyethylene cans and the basic tests like temperatures pH were conducted in field in both pre monsoon and post monsoon seasons. Physico-chemical parameters were studied in laboratory by Indian standards methods as suggested by the American Public Health Association [3]. Physical tests like temperature, Color, odour, turbidity, Total dissolved solids and Chemical tests like pH, Electrical conductivity, Acidity, Alkalinity, Hardness, Calcium, Magnesium, Chloride, Fluoride, Nitrate, Sulphate, Phosphate, Ammonia were conducted. The results were compared between open well and suranga water and also compared with Indian standards BIS 2012.

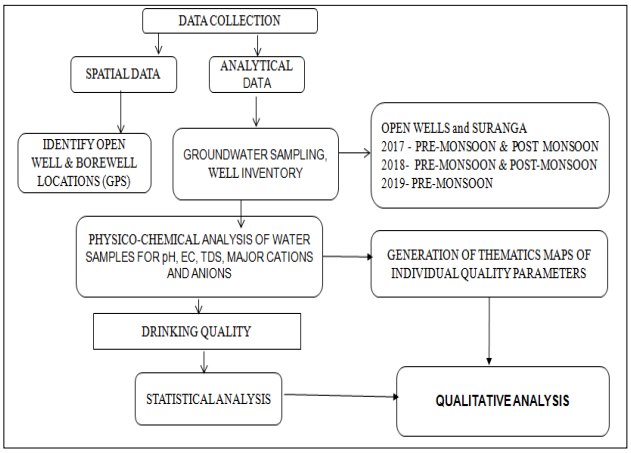

Fig 1 Flow chart showing the methodology of water sampling

RESULTS AND DISCUSSION

Surangas are the very old traditional sustainable water resource system of southern part of India especially suitable for self-retaining laterite hill soil profile. Rain water gets in filtered through layers of laterite soil with the help of roots of trees and will be extracted through horizontal tunnels which will have very less exposure into the pollution. Padre micro watershed mainly depends on the surangas dug into one main Puthrakala hill. According to local people the taste of surangas water is similar to mineral water and even this water is good for skin and hair. Water quality of surangas and openwell during pre-monsoon and post-monsoon were analyzed. The water quality parameters like pH, EC, TDS, turbidity, Iron, Fluoride and Nitrate were analyzed and Isovariation map of the parameters prepared using ARCGIS [4-6].

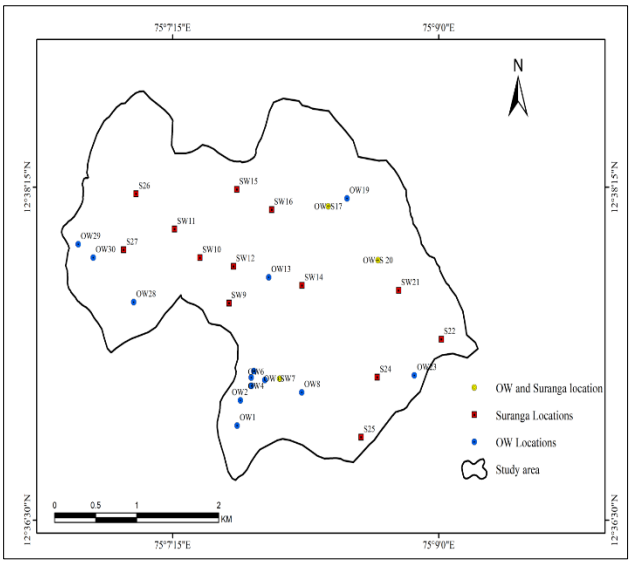

Fig 2 Water sample locations (SW Suranga and OW Open well)

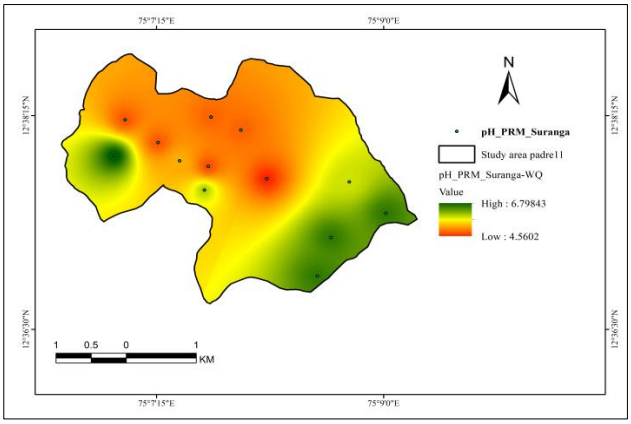

Fig 2a pH pre-monsoon season Suranga

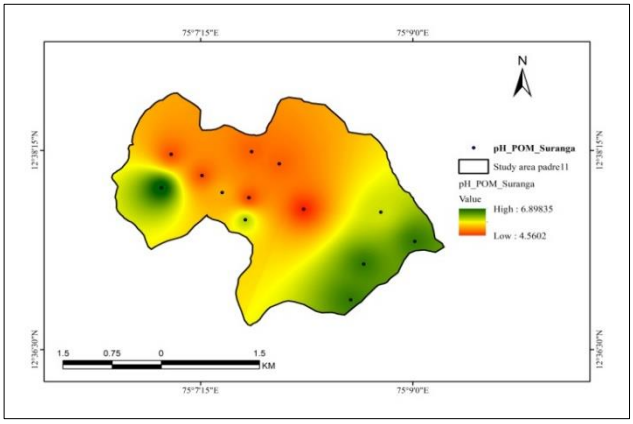

Fig 2b pH post-monsoon season Suranga

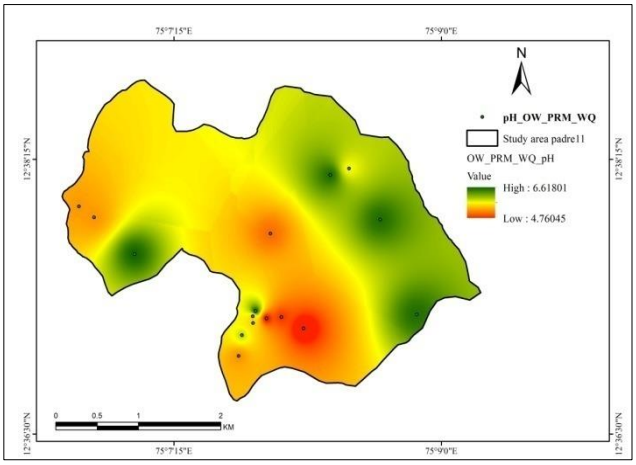

Fig 2c pH pre-monsoon season Open well

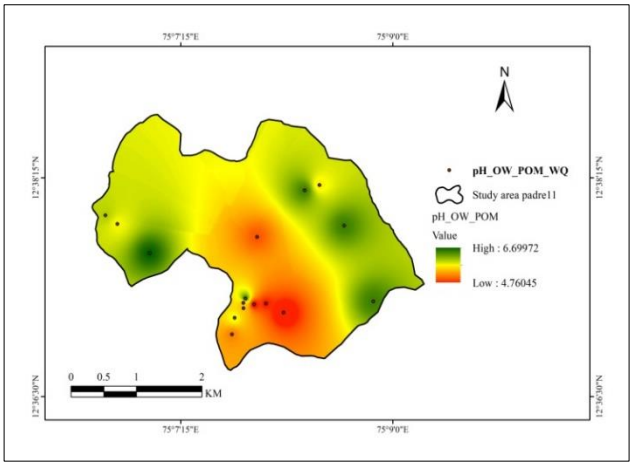

Fig 2d pH post-monsoon season open well

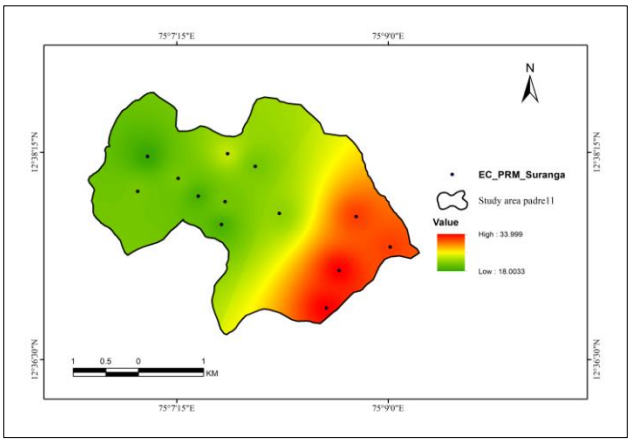

Fig 3a EC pre-monsoon season Suranga

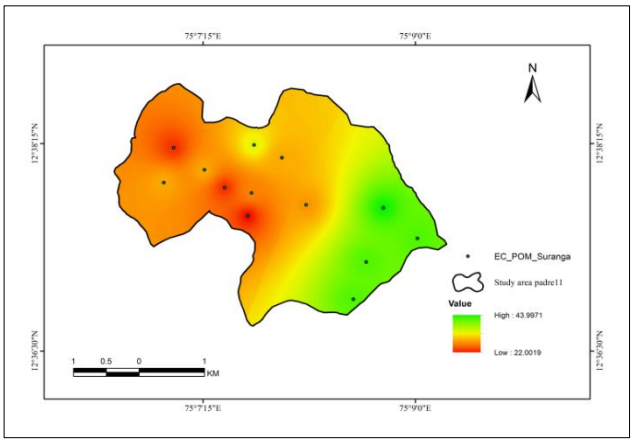

Fig 3b EC post-monsoon season Suranga

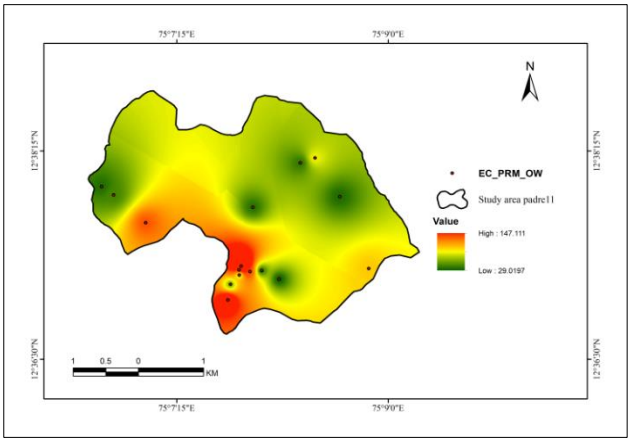

Fig 3c EC pre-monsoon season Open Well

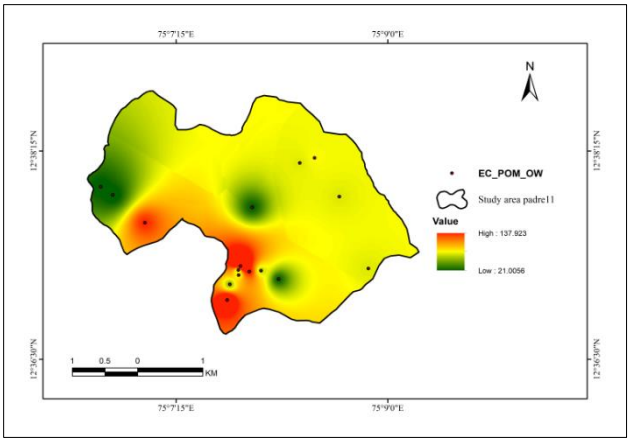

Fig 3d EC post-monsoon season open well

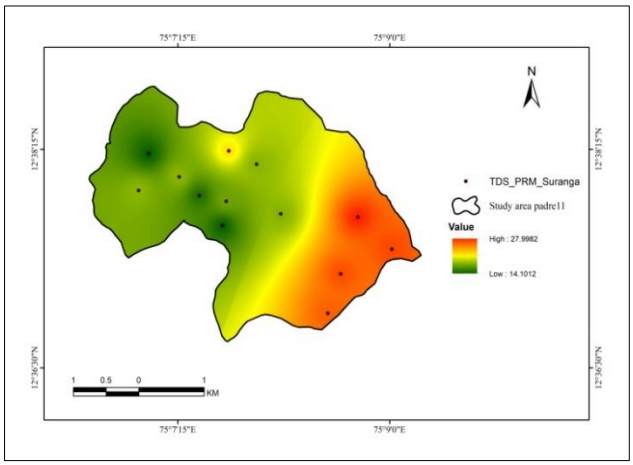

Fig 4a TDS Pre-monsoon season Suranga

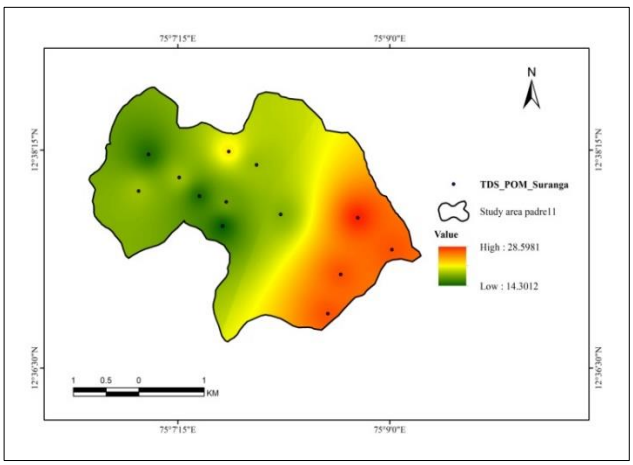

Fig 4b TDS post-monsoon season Suranga

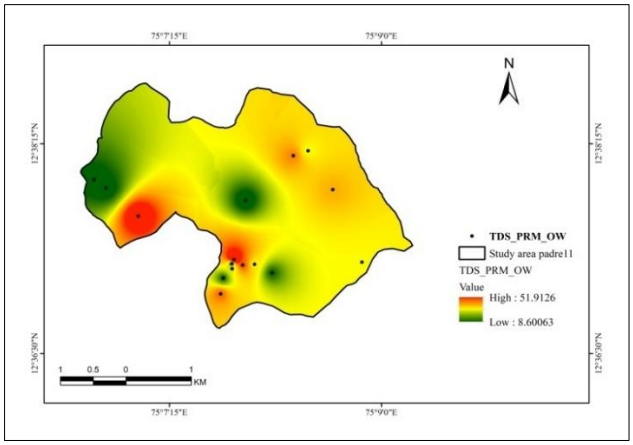

Fig 4c TDS Pre-monsoon season open well

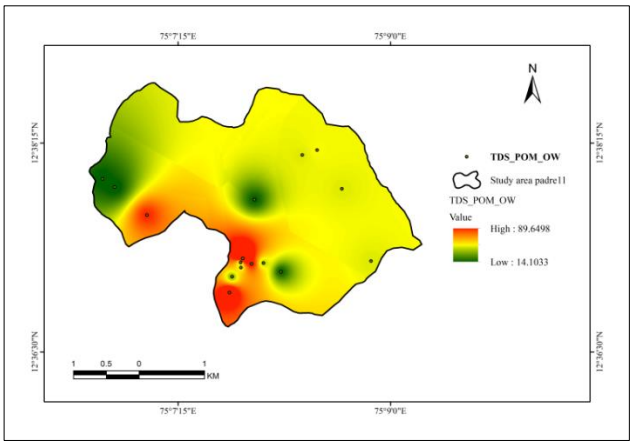

Fig 4d TDS post-monsoon season open well

pH of water sample from surangas were slightly acidic in the range of 4.5 to 6.7 when compared to open wells in the range of 4.7 to 7. The open wells located near the hill side south direction of study area was more acidic compare to north side of study area. pH of open well was less acidic during post-monsoon compare to pre-monsoon and not much variation observed in surangas. Electric conductivity observed in open wells in range of 29 to 147µS/cm during pre-monsoon and in range of 21 to 137µS/cm during post-monsoon. EC of suranga observed 18 to 34µS/cm during pre-monsoon season and it has been observed in the range of 22 to 44 µS/cm during post-monsoon season. Electrical conductivity was more in open well both pre-monsoon and post-monsoon seasons compared to suranga [7]. pH of suranga and open well during pre-monsoon and post-monsoon is shown in (Fig 2a-d). EC of suranga and open well during pre-monsoon and post-monsoon is shown in (Fig 3a-d).

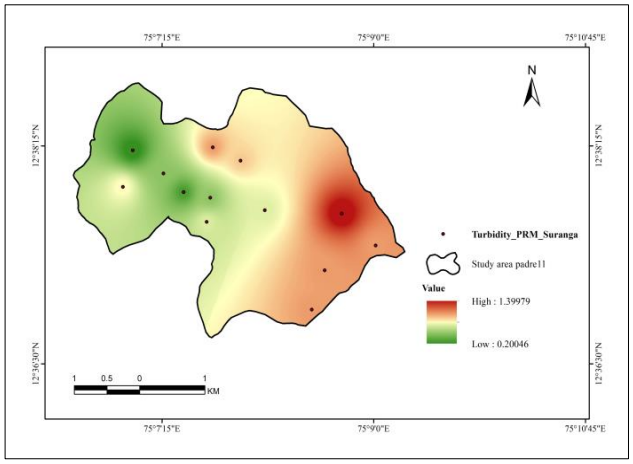

Fig 5a Turbidity pre-monsoon season Suranga

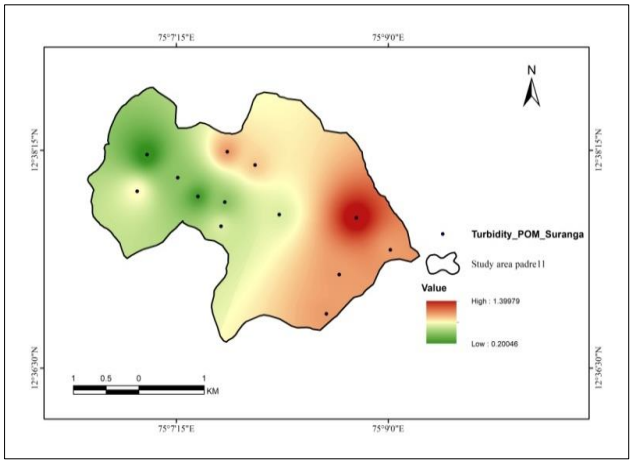

Fig 5a Turbidity post-monsoon season Suranga

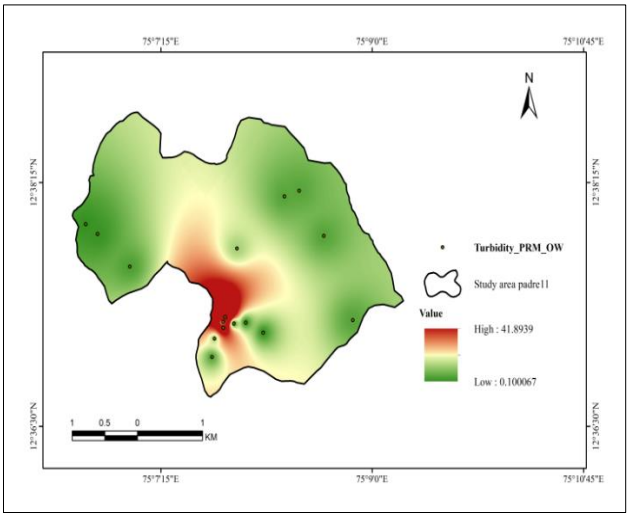

Fig 5a Turbidity pre-monsoon season open well

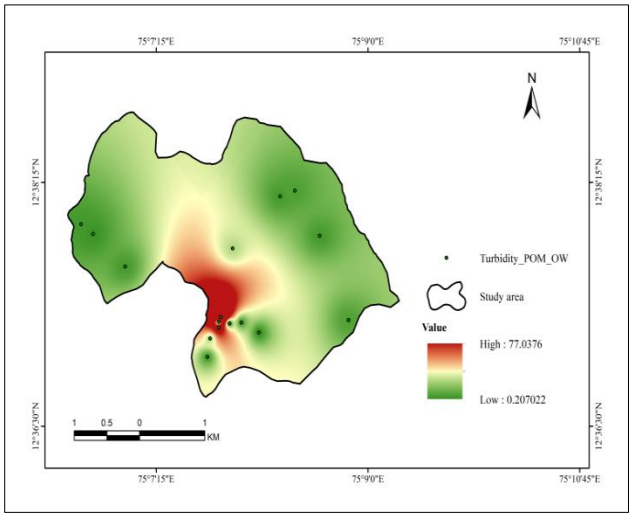

Fig 5a Fluoride post-monsoon season open well

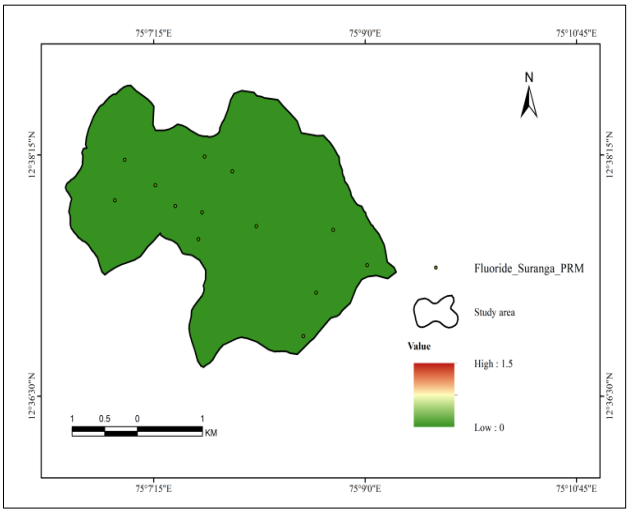

Fig 6a Fluoride pre-monsoon season Suranga

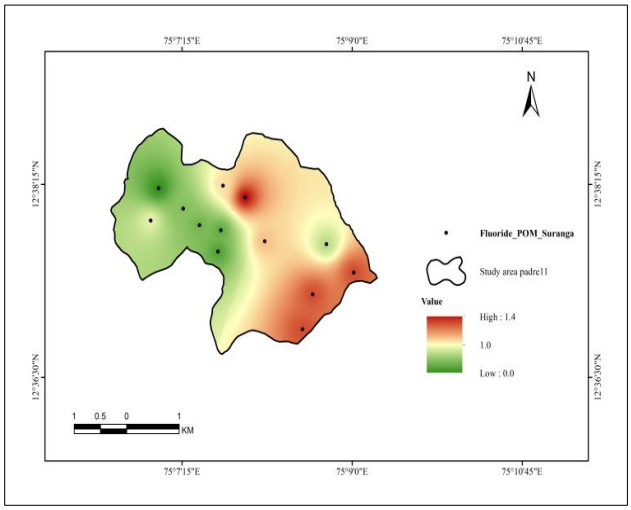

Fig 6b Fluoride post-monsoon season Suranga

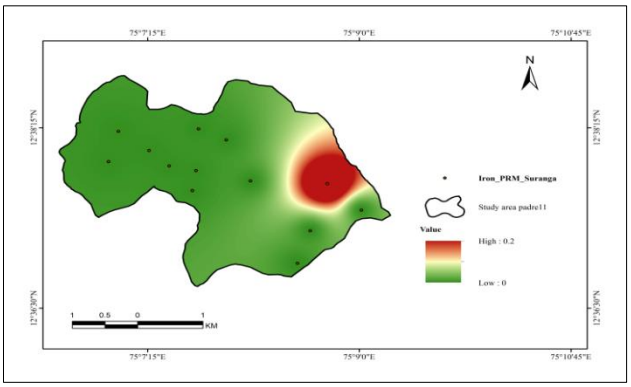

Fig 7a Iron pre-monsoon season Suranga

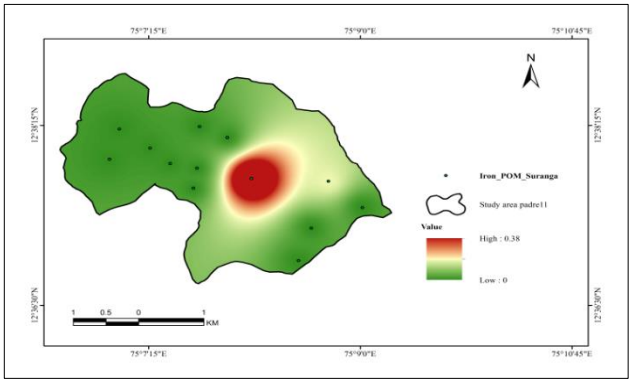

Fig 7a Iron post-monsoon season Suranga

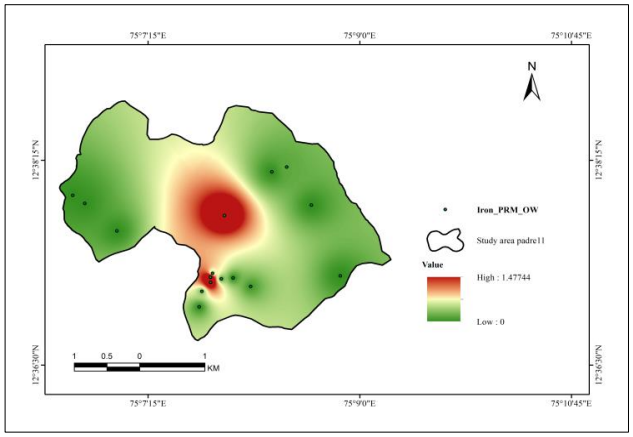

Fig 7a Iron pre-monsoon season open well

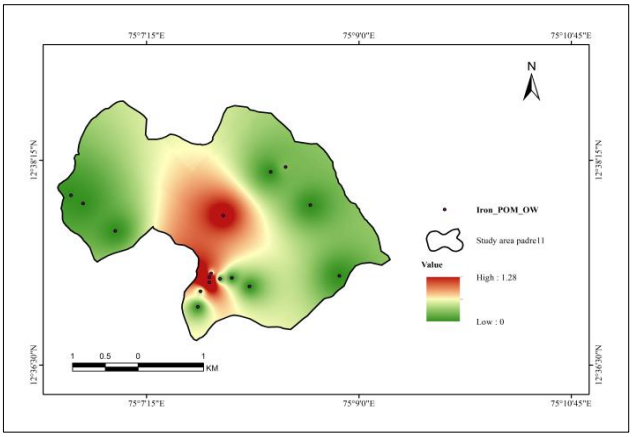

Fig 7b Iron post-monsoon season open well

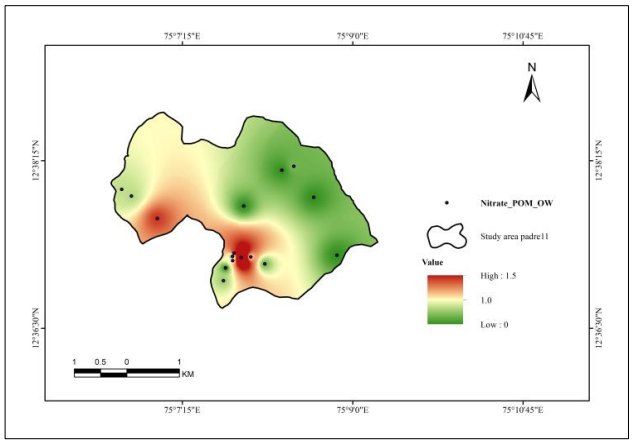

Fig 7c Nitrate post-monsoon season open well

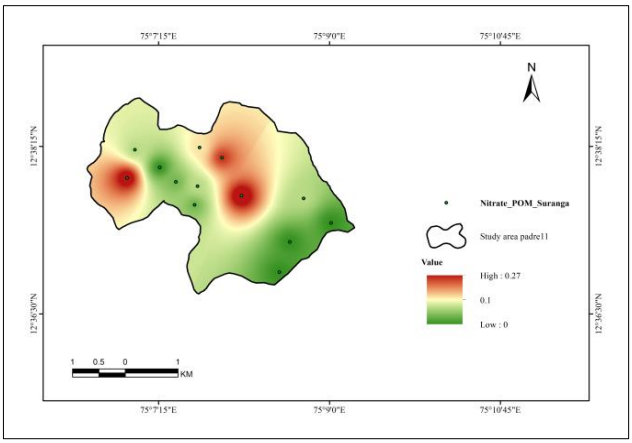

Fig 7d Nitrate post-monsoon season surangas

The TDS of surangas in pre-monsoon and post-monsoon season has been observed in the range of 14 to 28mg/l and 14 to 28.5mg/l. No seasonal variation in TDS observed in surangas water. TDS of open well water in pre-monsoon and post-monsoon season has been observed in range of 8 to 51.91mg/l and 14 to 89.64mg/l. TDS of open well located near to hill area south side of the study area was more compare to other locations [8]. TDS was more during post-monsoon season compare to pre-monsoon. Rainfall is the main source of water for opens well. Some of solids in soil dissolved in rainwater and percolated to open well. Isovariation of TDS of surangas, open well during pre-monsoon and post-monsoon season is shown in (Fig 4a-d).

Turbidity of surangas water sample observed 0.2 to 1.4NTU during both pre-monsoon and post-monsoon seasons. It has been observed that no seasonal variation of turbidity in surangas water. In open well turbidity in pre-monsoon and post-monsoon was between 0.1 to 41.81 and 0.2 to 77.03NTU. There is a seasonal variation in open well. The open wells which are located near to South direction foot of Puthrakala Hill of study area were more turbid. Isovariation maps of turbidity in both surangas and open wells during seasons shown in (Fig 5a-d).

The fluoride content of surangas during pre-monsoon season was nil and during post-monsoon season 0 to 1.4mg/l. NE and SE side of study area fluoride content was present in both surangas and open well during post-monsoon season but within BIS standard limit. Fluoride content of open wells during pre-monsoon and post-monsoon seasons was in range of 0 to 1.4mg/l and 0 to 1.2mg/l. The source of fluoride in water is mainly due to the laterite soil profile. (Fig 6a-d) shows the Isovariation map of fluoride of surangas and open well in both the seasons [9-10].

The nitrate content was not observed in both surangas and open wells during pre-monsoon and traces of 0.1 to 0.27mg/l were found in surangas located in north and west side near to agricultural plots of study area. Nitrate content was

observed in range of 0 to 1.5mg/l during post-monsoon season in open wells located on south side of study area foot of Puthrakala hill. The fertilizers used for agricultural purpose will seep along with runoff will be the source of nitrate content in open well during post-monsoon season. Alkalinity, acidity and hardness were within BIS limit both in surangas and open well both seasons. Calcium, magnesium and chloride content of water samples from surangas and open wells are also within limit and magnesium and chloride contents are slightly higher in surangas compare to open well. Traces of chemical oxygen demand in range of 12 to 24mg/l were found in 3 open wells located near Puthrakala hill in south side of the study area during both pre-monsoon and post-monsoon seasons. Chemical fertilizers utilized for agriculture will be source of COD in open wells but are within BIS limit [11].

The statistical analysis of the surangas and open well in both seasons is given in (Table 1-2). Total 16 parameters were considered during pre-monsoon and post-monsoon seasonal variations. Average mean of minimum and maximum values are calculated. Standard deviation of all 16 parameters was calculated.

Table 1 The statistical analysis of water quality for Suranga water sample

Suranga	BIS (2012)	Pre-monsoon				Post-monsoon			
Parameters		Min.	Max.	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.
Temp°C		27.90	33.30	28.38	1.30	27.20	28.50	27.54	0.32
pH	6.5-8.5	4.56	6.80	5.59	0.85	4.56	6.90	5.62	0.85
Turbidity	10	0.10	3.00	0.88	0.66	0.20	1.40	0.81	0.31
EC µs/cm	1500	18	34	26.24	6.26	22.00	44.00	33.56	8.12
TDS (mg/l)	500-2000	8.60	28.00	20.27	5.75	14.30	28.60	21.82	5.28
Ca^{++} (mg/l)	200	0.43	3.85	1.87	1.23	0.80	4.01	2.11	1.17
Mg^{++} (mg/l)	100	0.20	22.50	2.41	5.27	0.49	26.47	2.90	6.39
Na^{+} (mg/l)	200	5.40	8.48	6.90	0.77	11.00	17.86	14.22	1.91
K^{+} (mg/l)	12	0.36	0.89	0.62	0.14	0.99	3.10	1.97	0.51
Fe (mg/l)		0.00	1.40	0.09	0.34	0.00	0.38	0.03	0.10
HCO_3 (mg/l)	400	7.40	13.40	9.28	1.39	7.00	13.00	8.94	1.40
Cl (mg/l)	1000	8.10	22.10	15.45	4.32	6.00	18.00	13.25	3.92
NO_3 (mg/l)	45	0.00	0.00	0.00	0.00	0.00	0.27	0.09	0.10
SO_4 (mg/l)	400	0.00	1.80	0.11	0.44	0.00	2.90	0.18	0.73
F (mg/l)	1.5	0.00	0.50	0.03	0.12	0.02	1.41	0.72	0.48
TH (mg/l)	200-600	0.80	23.60	4.27	5.38	1.29	28.07	5.00	6.49

Table 2 The statistical analysis of water quality for open well water sample

OW	BIS (2012)	Pre-monsoon				Post-monsoon			
Parameters		Min.	Max.	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.
Temp°C		28.00	33.40	30.48	1.87	28.00	29.30	28.51	10.04
pH	6.5-8.5	4.76	6.63	5.71	0.62	4.76	6.70	5.78	1.65
Turbidity	10	0.10	42.30	5.41	12.14	0.20	77.80	9.22	20.05
EC µs/cm	1500	29	148	61.83	33.01	21.00	139.00	48.54	35.23
TDS (mg/l)	500-2000	8.90	52.30	21.70	13.11	14.10	90.35	31.58	22.87
Ca^{++} (mg/l)	200	1.10	16.20	4.33	4.01	0.80	15.23	3.76	3.69
Mg^{++} (mg/l)	100	0.51	6.10	1.58	1.56	0.40	5.83	1.38	1.46
Na^{+} (mg/l)	200	9.14	12.10	10.54	0.82	2.16	4.60	3.02	1.20
K^{+}(mg/l)	12	0.87	1.52	1.07	0.21	0.99	3.10	1.97	0.51
Fe (mg/l)		0.00	1.30	0.25	0.45	0.00	4.90	0.52	1.26
HCO_3 (mg/l)	400	8.40	28.00	17.09	5.47	9.00	16.00	12.22	4.64
Cl (mg/l)	1000	10.10	18.20	14.82	3.23	8.00	18.00	13.08	5.64
NO_3 (mg/l)	45	0.00	0.00	0.00	0.00	0.00	1.50	0.25	0.39
SO_4 (mg/l)	400	0.00	21.00	2.97	6.41	0.00	26.70	3.48	7.29
F (mg/l)	1.5	0.00	1.40	0.42	0.40	0.00	1.22	0.34	0.34
TH (mg/l)	200-600	1.75	22.30	5.92	5.51	1.29	21.06	5.13	5.10

CONCLUSION

The quality of water depends on the source of water and also depends on the location of source of water. Chances of contamination are less in surangas water compare to open well. Open well water will be more turbid compare to surangas and during post-monsoon seasons open well water has to be treated to remove the turbidity before drinking purpose. Old traditional sustainable method of source of water surangas are best practice for both drinking and irrigation purpose and can be utilized without treatment. Suranga water is clean and clear for usage compare to open well in laterite terrain.

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