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Assessment of Groundwater Quality Using GIS Techniques: A Case Study of Mysore City

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Abstract: ***The study has been conducted to prepare a map of groundwater quality zones in Mysore city during pre- and post-monsoon seasons. The study uses secondary data, collected from different and relevant sources. Inverse distance weighted method of the Geographical Information Systems is used to prepare the distribution map of physio-chemical parameters of groundwater while overlay method is used to assess temporal changes and prepare groundwater quality zones of Mysore city. The results of study show that the quality of groundwater varies both spatially and temporally in Mysore city. The results also show that the area extent of good and moderate groundwater zones decreases after monsoon while poor and very poor zone areas increase.***

Key Words: **Physio-chemical parameters, GIS, Inverse distance weighted method, Overlay analysis**

I. INTRODUCTION

Water is the basic requirement for all life on Earth. The origin of life has been attributed principally to water, along with other basic elements. Any natural or man-made activity on the surface of the earth will impact most on the quality and quantity of water. This is taken into the biospheric systems and ultimately leads to hydrological extremes.

Groundwater is one of earth's most vital renewable and widely distributed resources as well as an important source of water supply throughout the world. The quality of water is a vital concern for mankind since it is directly linked with human welfare. Groundwater is water that exists in the pore spaces and fractures of rocks and sediments beneath the Earth's surface. It originates as rainfall or snow, and then moves through the soil into the groundwater system, from where it eventually makes its way back to surface streams, lakes, or oceans. It is naturally replenished from above, as surface water from precipitation, streams, and rivers infiltrates into the ground (Lara Fabrizi).

II. STUDY AREA

Mysore is the second largest city in the state of Karnataka (Map: 1). It is the headquarters of Mysore district and the Mysore division and is 146 km (91 mi) southwest of Bangalore, the capital of the state. It is located between 12°18'N and12°30'N latitudes and 76°39'E and 76°42'E longitudes and has an average altitude of 770 meters (2,526 ft.). Mysore has a warm and cool climate throughout the year. It is salubrious, too. The climate of Mysore is moderate. The weather in winter is cool and summers are bearable. The minimum temperature in winter is around 15^{o} Celsius and in summer the maximum temperature is around 35^{o} Celsius. Mysore gets most of its rains during the monsoon between June and September. The annual average rainfall of Mysore is around 860 mm. The summer season is from March to June, followed by the monsoon season from July to November and the winter season is from December to February. Mysore lies however in the tropics, with summer temperatures ranging from 21^{o} to 35^{o} Celsius, while winter sees the temperatures dropping down from 30^{o} to 12^{o} C.

III. METHODOLOGY

The study is based on secondary data, which have been collected from different sources, such as the hydro-geological maps of Mysore City which have been collected from the MUDA (Mysore Urban Development Authority), the Groundwater Quality for Pre- and Post-Monsoon seasons, and the geographical location of the sample points have been collected from the Mines and Geology Department, Mysore. Based on available six physio-chemical parameters (Chlorine, Iron, Fluoride, Nitrates, Total Hardness and Per Hydrogen Ions) for the year 2011, three kinds of analysis were carried out, that is:

a) Analyzing the spatial distribution of each parameter in pre- and post-monsoon;

b) Temporal changes between pre- and post-monsoon; and

c) Preparation of zonation maps of the groundwater quality during pre- and post-monsoons using Geographical Information Systems (GIS) techniques.

ArcGIS 9.2 has been used for geo-referencing, vector layer and inverse distance weighted (IDW) analysis. The IDW generated mapping for each parameter which have then used to do overlay analysis, to create the groundwater zonation. The Indian Standard Specification for Drinking Water is IS: 10500 adopted to classify the water quality data. MS Excel has been used to encode, analyze and create graphical representations of the numerical data.

IV. RESULTS AND DISCUSSION

The value of each physio-chemical parameter during pre- and post-monsoon seasons has been mapped using IDW techniques, and its spatial distribution in Mysore city has been found (fig: 1). The results of each parameter have been classified into three categories: Desirable (which is highly suitable for drinking purposes), Portable (which is not good but can be used for drinking purposes) and Non-Portable

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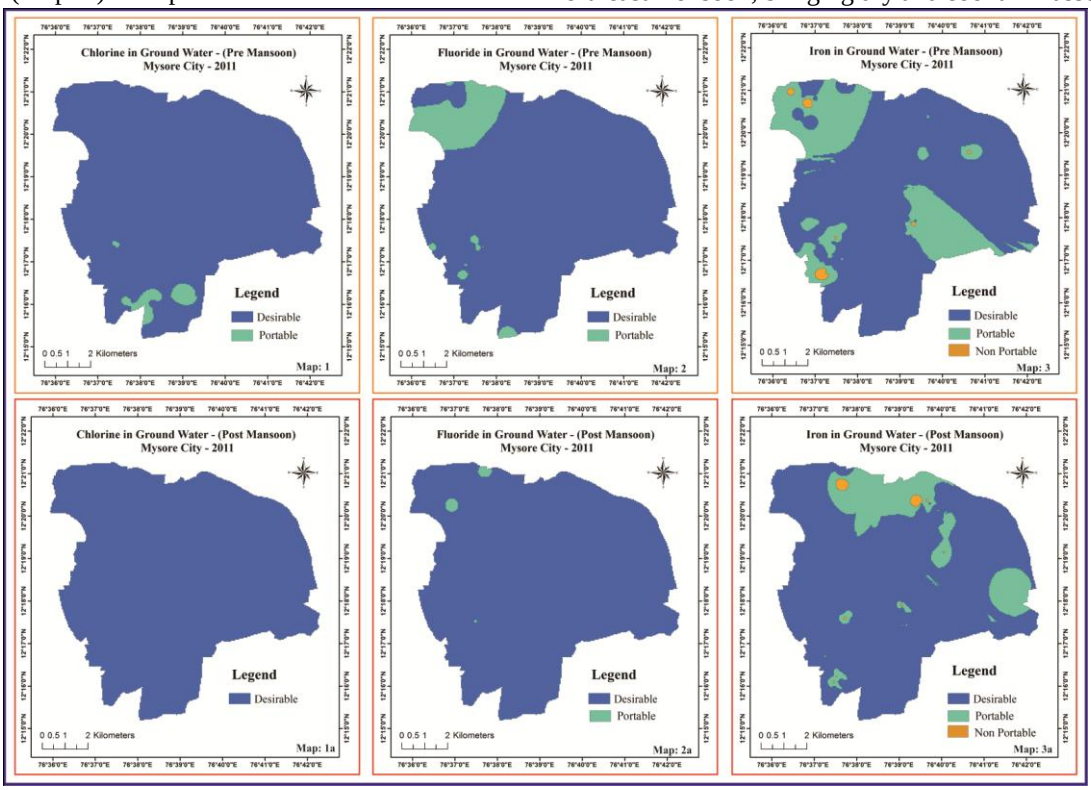
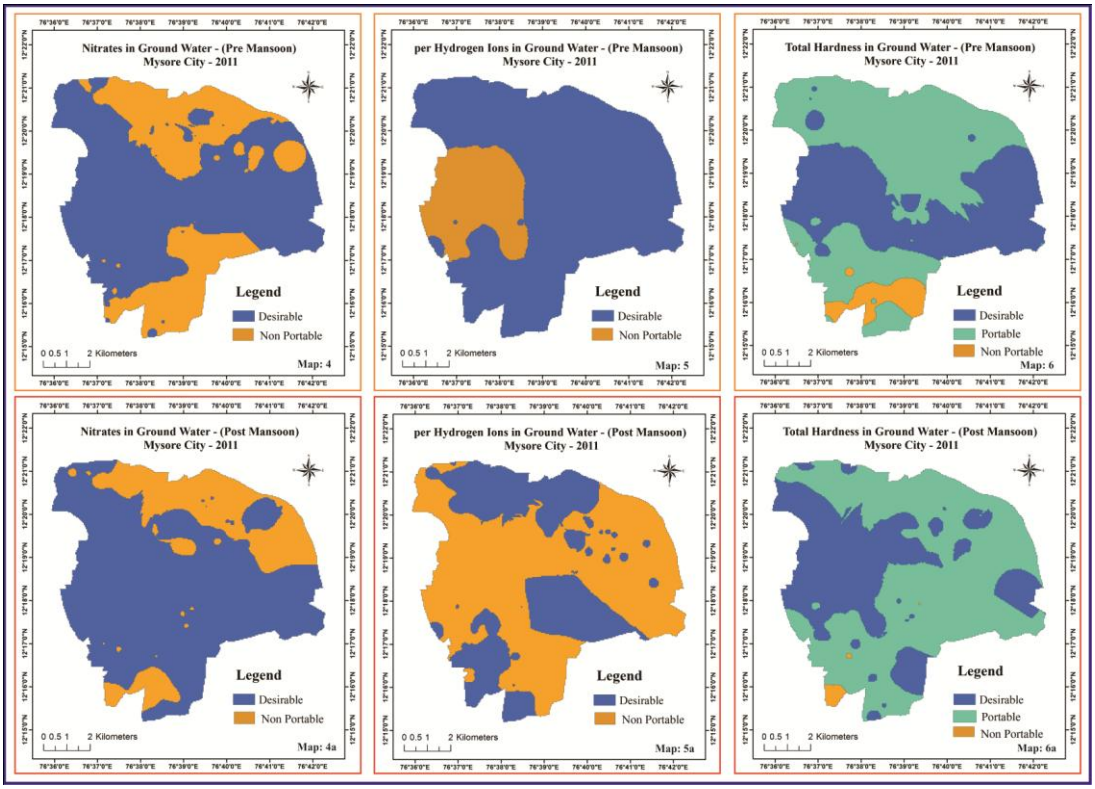
(which is not suitable for drinking purposes), as per the Indian Standard Specifications for drinking water.

V. SPATIAL DISTRIBUTION

The spatial distribution of pre- and post- monsoon groundwater quality has been analyzed, resulting in the maps shown below (Map: 2). The pre-monsoon is hot season from April to June; it is the traditional period when the winter pattern of pressure and winds get disturbed prior to the establishment of the summer monsoon, is often referred to as 'pre-monsoon' season, and the months from October to December come under the post-Monsoon season. During these months, there is a different monsoon cycle called the northeast monsoon, bringing dry and cool air masses to India.





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Spatial distribution of Chlorine during Pre-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	82.41	98
2	Portable	1.93	2
3	Non-Portable	0	0

Spatial distribution of Chlorine during Post-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	84.34	100
2	Portable	0	0
3	Non-Portable	0	0

Spatial distribution of Iron during Pre-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	64.19	76
2	Portable	19.66	23
3	Non Portable	0.49	1

Spatial distribution of Iron during Post-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	70.90	84
2	Portable	12.97	15
3	Non Portable	0.47	1

Spatial distribution of Fluoride during Pre-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	76.52	91
2	Portable	7.83	9
3	Non Portable	0.00	0

Spatial distribution of Fluoride during Post-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	83.85	99
2	Portable	0.49	1
3	Non Portable	0.00	0

Spatial distribution of Nitrates during Pre-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	55.03	65
2	Portable	0.00	0
3	Non Portable	29.31	35

Spatial distribution of Nitrates during Post-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	63.41	75
2	Portable	0.00	0
3	Non Portable	20.93	25

Spatial distribution of Total Hardness during Pre-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	33.42	40
2	Portable	46.56	55
3	Non Portable	4.36	5

Spatial distribution of Total Hardness during Post-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	30.21	36
2	Portable	53.19	63
3	Non Portable	0.69	1

Spatial distribution of Per Hydrogen Ions during Pre-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	68.29	81
2	Portable	0.00	0
3	Non Portable	16.06	19

Spatial distribution of Per Hydrogen Ions during Post-monsoon 2011

S. No	Class	Area in km^2	Percent
1	Desirable	30.21	36
2	Portable	0.00	0
3	Non Portable	54.13	64

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Chlorine: During the pre – monsoon season, the results of chlorine show that 82.40 km^2 (98 per cent) is covered by desirable water quality, and 1.93 km^2 area (2 per cent) is covered by portable water quality while no area is covered by non-portable water quality during the pre-monsoon season. In the post-monsoon season, the results of chlorine analysis show 84.34 km^2 (100 per cent) of area with desirable water quality while no area has portable and non-portable water quality during the post- monsoon season. Therefore, it clearly shows that portable water quality areas have been converted into desirable value after monsoon.

Iron: The spatial distribution of Iron shows that 64.18 km^2 (76 per cent) of the area is covered by desirable water quality, and 19.66 km^2 (23 per cent) area is covered by portable water quality, while 0.49 km^2 (1 per cent) of the area is covered by non-portable water quality. The result of the post-monsoon Iron distribution shows that 70.90 km^2 (84 per cent) of area comes under desirable water quality, and 12.97 km^2 (15 per cent) of the area has portable water quality, while 0.47 km^2 (1 per cent) of the area has non-portable water quality. The result also shows that there are not much changes in non-portable water quality and its spatial distribution, while 7 per cent of the portable water quality has been converted into desirable quality in the post-monsoon.

Fluoride: The result of fluoride analysis shows that 76.51 km^2 (91 per cent) of the area is covered by desirable water quality and 7.82 km^2 (9 per cent) of the area comes under portable water quality while no area comes under non-portable quality during the pre-monsoon season. In post-monsoon season 83.85 km^2 of (99 per cent) the area has desirable quality, and 0.49 km^2 (1 per cent) of the area is under portable quality, while no area comes under non-portable quality of groundwater. It clearly shows that no area is covered by non-portable quality during pre- and post-monsoon seasons. In the pre-monsoon season, 9 per cent of the portable water quality area has decreased to 1 per cent during the post-monsoon, decreased 8 per cent of the area is converted to desirable water quality during the post monsoon.

Nitrates: The result of nitrates spatial distribution during pre-monsoon shows that 55.03 km^2 (65 per cent) of the area comes under desirable quality, and no area comes under portable quality, while 29.30 km^2 (35 per cent) of the area have covered by non-portable quality. In post monsoon season 63.41 km^2 (75 per cent) area is having desirable quality, and no area is having portable quality, while 20.92 km^2 (25 per cent) of the area is having non-portable water quality. It transpires that portable quality of nitrates is zero during pre- and post-monsoon season. In post-monsoon season 10 per cent of non-portable quality space has been converted into the desirable quality, which indicates the non-portable value has decreased during post-monsoon season.

Total Hardness: The result of total hardness shows that, during pre-monsoon season 33.42 km^2 (40 per cent) of the area have been covered by desirable quality, and 46.55 km^2 (55 per cent) area comes under portable quality, while 4.35 km^2 (5 per cent) of the area have been covered by non-portable quality. In post monsoon season 30.21 km^2 (36 per cent) area have desirable quality, and 53.18 km^2 (63 per cent) of the area is having portable quality, while 0.69 km^2 (1 per cent) area is having non-portable quality, so it is clearly visible that 4 percentage of desirable quality area and 4 percentage of non-portable quality area have decreased, the decreased area have been converted into portable quality.

Per Hydrogen Ions: The result shows that, during the pre-monsoon season 68.28 km^2 (81 per cent) of the area have desirable quality, but no area has portable quality, while 16.05 km^2 (19 per cent) of the area comes under non-portable quality. During the post monsoon season 30.21 km^2 (36 per cent) area have desirable quality, and no area has portable quality, while 54.12 km^2 (64 per cent) area has non-portable quality. It clearly shows that, no area is comes under portable quality during the pre- and post-monsoon season. In post-monsoon season 45 per cent of desirable quality area has been decreased, and 45 percentage of the non-portable quality area have been increased.

VI. TEMPORAL CHANGES OF PHYSIO-CHEMICAL PARAMETERS

The temporal changes of each parameter of groundwater between pre- and post-monsoon have been analyzed for the nature and extent of spatial distribution result.

Chlorine: The portable area has increased 2 per cent (1.93 km^2) during the post monsoon season. Ninety-eight per cent of the area is unchanged, which means 98 per cent (82.40 km^2) of the area has same water quality during pre- and post-monsoon seasons. The results also suggest that after monsoon chlorine water quality is desirable for the entire Mysore city.

Iron: The desirable area has increased by 21 percent after monsoon (70.90 km^2) the portable area has decreased after monsoon (12.97 km^2), and non-portable area also decreased (0.46 km^2). Sixty-six per cent of the area unchanged and this means that 66 per cent (56.10 km^2) area is having same Fe value in pre- and post-monsoon season.

Fluoride: The changes in Fluoride show that 9 percent (7.33 km^2) of the portable area has decreased in the post-monsoon season, and 91 per cent (76.51 km^2) of the desirable area has increased in the post-monsoon season. And 0.49 km^2 of the area is unchanged.

Nitrate: In the post-monsoon season, the desirable value has increased by 10 per cent (63.41 km^2) and non-portable value has decreased by 10 per cent (20.92 km^2). About 79 per cent of the area is unchanged (66.50 km^2) and has the same NO_3 value in pre- and post-monsoon seasons.

Total Hardness: In the post-monsoon season, the desirable value has decreased by 4 per cent while portable value has increased by 8 per cent and non-portable area also decreased by 4 per cent. The unchanged area is 61 per cent

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(51.92 km^2) which means that it has the same TH value during the pre- and post- monsoon.

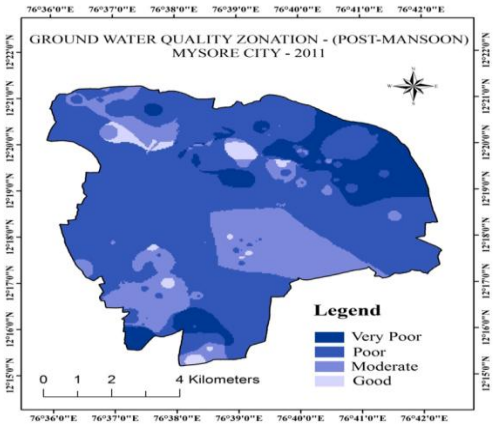
Per Hydrogen Ions: In the post-monsoon season, the desirable value has decreased by 45 per cent and 55 per cent of the area is unchanged (46.26 km^2), which means that this area has the same pH value during pre and post monsoon.

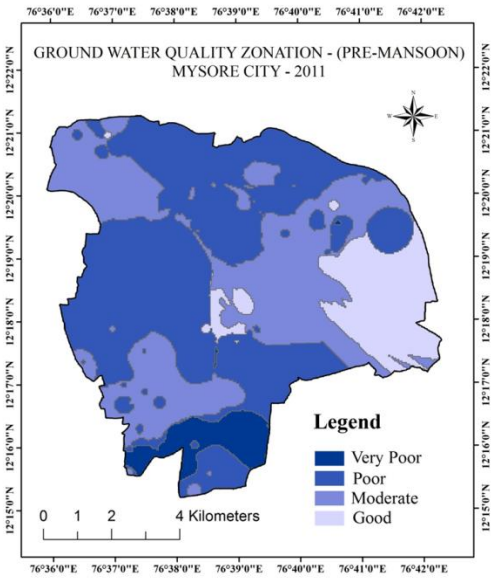
Groundwater Quality Zone 2011						
S.No.	Class	Pre-Monsoon		Post-Monsoon		Change in Area km^2
		Area in km^2	%	Area in km^2	Percent	
1	Good	10.68	13	1.75	2	-8.93
2	Moderate	27.70	33	17.20	20	-10.49
3	Poor	41.72	49	54.55	65	12.83
4	Very Poor	4.25	5	10.83	13	6.59

VII. GROUNDWATER QUALITY ZONE

The groundwater zonation map has been prepared using the overlay analysis of the GIS, and the value of each parameter during the pre- and post-monsoon seasons is used as input to prepare the groundwater quality zones. The results of overlay analysis are divided into four categories such as 'Good, Moderate, Poor and Very Poor' (Map: 3). The results also indicate that the quality of water zones entirely differs from pre- monsoon to post-monsoon. During the pre-monsoon season, 13 per cent of the area (10.67 km^2) has good water quality, 33 per cent of the area (27.69 km^2) has moderate groundwater quality, 49 per cent of the area (41.717 km^2) has poor groundwater quality and 5 per cent of the area (4.24 km^2) has very poor groundwater quality. In the post-monsoon season 2 per cent of the area (1.75 km^2) has good groundwater quality, 20 per cent of the area (17.20 km^2) has moderate groundwater quality, 65 per cent of the area (54.54 km^2) has poor groundwater quality and 13 per cent of the area (10.83 km^2) has very poor ground water quality.

A comparison of pre-monsoon zonal result with post-monsoon result shows that 8.93 km^2 of good and 10.49 km^2 of moderate groundwater quality zones have shown decrease, while 12.83 km^2 of poor and 6.59 km^2 of very poor zones have increased.





VIII. CONCLUSION

The study of groundwater quality during pre- and post-monsoon seasons in Mysore city has been usefully made. The changes in water quality parameters between the pre- and post-monsoons show natural and human impacts on groundwater quality. The comparison of pre- and post-monsoon groundwater quality shows that good and moderate zone areas decreased and the poor and very poor areas increased. This is due to rainwaters which are recharged to the ground during the monsoons react with the minerals present in the soils, weather, rock and the solution activities during the post-monsoon season as compared to the pre-monsoon, due to which the post-monsoon groundwater quality changes have happened. The study suggests that GIS is one of the best techniques to analyze groundwater quality and the tools that are used in this study can be adopted for any other place to study groundwater quality.

REFERENCES

[1] A K Gorai and Subhash Kumar (2013): Spatial Distribution Analysis of Groundwater Quality Index Using GIS: A Case Study of Ranchi Municipal Corporation (RMC) Area.

[2] Balakrishnan, P. et al. (2011): Groundwater quality mapping using geographic information system (GIS): A case study of Gulbarga City, Karnataka, India.

[3] Biswas, Arkoprovo et al., (2012): Delineation of Groundwater Potential Zones using Satellite Remote Sensing and Geographic Information System Techniques A Case study from Ganjam district, Orissa, India.

[4] Chandra I. et al. (2011): Assessment of Groundwater Pollution in Parts of Guntur District Using Remote Sensing & GIS.

[5] Chenini, Ismail et al., (2010): Groundwater Recharge Zone Mapping Using GIS-Based Multi-criteria Analysis: A Case Study in Central Tunisia (Maknassy Basin).

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 8, February 2014

[6] Krishnan, S. et al. (2012): Study of Groundwater Quality with GIS Application for Coonoor Taluk in Nilgiri District.

[7] Mahadevaswamy, G. et al., (2011): Groundwater quality studies in Nanjangud Taluk, Mysore District, and Karnataka, India.

[8] Nirmala, B. et al. (2012): Seasonal Variations of Physico-Chemical Characteristics of Groundwater Samples of Mysore City, Karanataka, India.

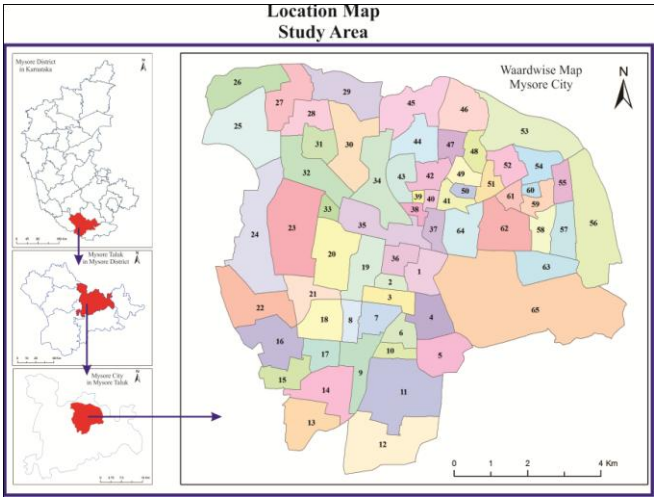
[9] Rahman, A. (2008): A GIS based DRASTIC model for assessing groundwater vulnerability in shallow aquifer in Aligarh, India.

[10] Ravisankar, N. (2004): Study of groundwater quality in tsunami affected areas of Sirkazhi taluk, Nagapattinam district, Tamil Nadu, India, Centre for Water Resources, Anna University, and Chennai.

[11] Salah, Hamad (2009): Geostatistical analysis of groundwater levels in the south Al Jabal Al Akhdar area using GIS.

[12] Tirkey Anamika Shalini (2012): Groundwater Level and Rainfall Variability Trend Analysis using GIS in parts of Jharkhand state (India) for Sustainable Management of Water Resources.

APPENDIX



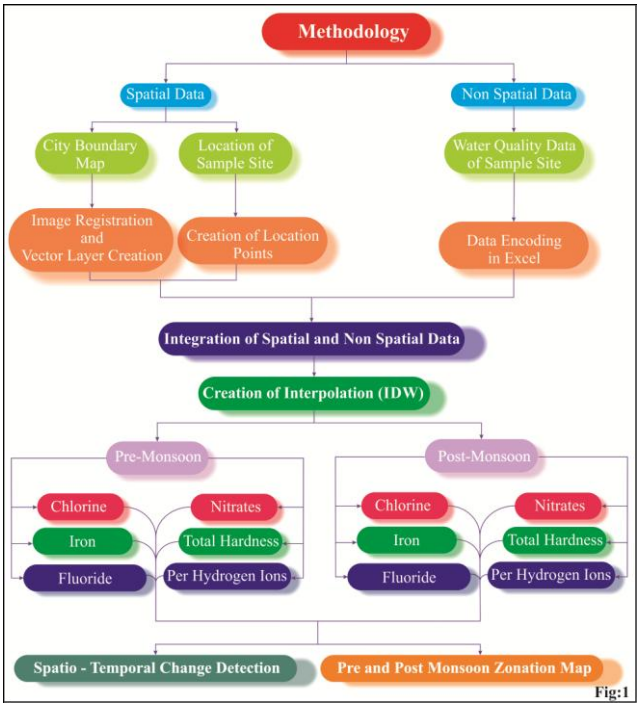


Fig:1