International Association of Scientific Innovation and Research (IASIR)
(An Association Unifying the Sciences, Engineering, and Applied Research)

ISSN (Print): 2279-0047
ISSN (Online): 2279-0055

International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS)

www.iasir.net

Study of Urbanization and its effect on Water resources in Yale Mallappa Shetty Kere watershed, Bangalore North taluk using Remote Sensing and GIS

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Abstract: *The study area comprises of Hebbal and Rachenahalli valley. The present condition of storm water drains, surface water bodies and the quality of the ground water has been studied in Yale mallappa Shetty Kere (YMSK) watershed. 1st order streams are encroached in developing of layouts and surface water bodies vanished due to urbanization. The study of toposheets (1:50,000) reveals YMSK consists of 86 Water bodies (WB) in 286 km2. The study of toposheets in 1:25,000 and Remote Sensing data reveals that YMSK consists of 195 WB (including tiny water bodies). The urbanized area covers the town places like satellite town Yalahanka in the North; Hebbal in the south-east and Krishna Rajapuram in the west. The effect of urbanization has created the havoc in managing and maintaining the storm water drains, surface water and quality of ground water. RS & GIS has effectively used in findings for streams encroachment & LU-LC process.*

Keywords: *Morphometry; DEM; Groundwater chemistry; Landuse-Landcover; Remote Sensing; Urbanization.*

I. Introduction

Yale Mallappa Shetty Kere watershed is spread over in an area of 287 km2 in the North taluk of Bangalore and lies between the Latitude13°0', 13°15' & Longitude 77°30', 77°45'(Figure 1). It is a part of Bangalore North taluk and comprises of Hebbal and Rachenahalli valley. The urbanized area covers the town places like satellite town Yalahanka in the North; Hebbal in the south-east and Krishna Rajapuram in the west within the BBMP (Bhruhat Bengaluru Mahanagara Palike) boundary. The altitude varies from 860-954m in the study area covering in topographical map of 57 G/12 NE-NW & SE-SW of 1:25000 scale. The outlet of YMSK joins river Pinakini and reaches finally river Cauvery.

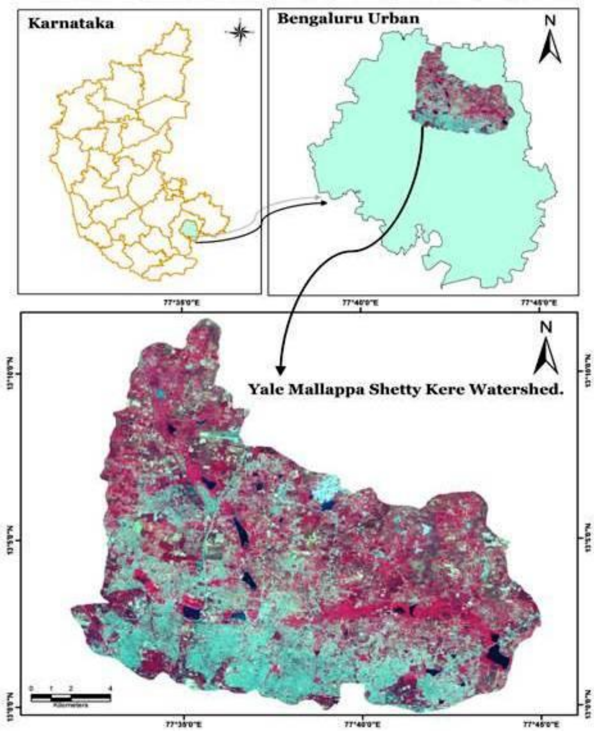

Figure 1: Location Map of YMSK watershed

II. Materials & Methodology

Collection of Secondary data by KSRSAC, MGD & Irrigation dept. Primary data had been collected by Ground check. Application of GIS Software like MapINFO, ARCGIS has extensively used. Satellite Imageries like LISS-III & Google are used. The demand and supply of water to Bangalore city is not matching. Several reasons are there like shortening of streams, vanishing of surface water bodies and etc. An attempt has been made to know the status of ground reality by studying the drainage net work, water bodies and groundwater in northern part Bangalore which encompasses major portion of Yale Mallappa Shetty Kere watershed. All stream orders basin have been delineated. A Digital Elevation Model (DEM) has been generated. The additional quantity of water by managing surface water bodies in the Yale Mallappa Shetty Kere catchment at suitable locations has studied using Remote Sensing and GIS techniques.

III. Results and Discussion

Drainage and water bodies: The study indicates a series of 192 tanks and tiny-water bodies are interconnected with a well developed drainage network (Figure 2). The terrain analysis has been attempted to get a feel of linear aspects, areal aspects and relief aspects. It is a fifth order stream and consists of 132 first order streams; seventy four II-order streams; twenty one III-order streams; three IV-order streams (Figure3). The morphometric details like Streams number, Bifurcation ratio, Cumulative length, Mean area are tabulated (Table 1). The bifurcation ratio of I to V order streams is 4.25. The mean stream length of I to V order streams is 0.52, 1.27, 2.57, 6.35 and 11.90 respectively. The mean areas of the streams are 0.38, 2.04, 9.02, 47.14 and 287.23 km^2 for I to V order streams respectively.

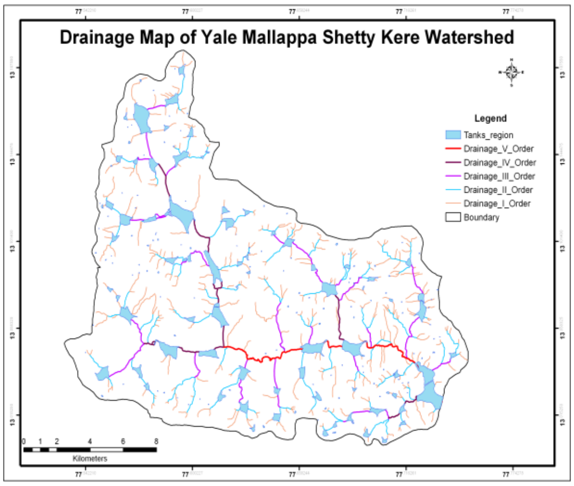

Figure 2: Drainage and water bodies

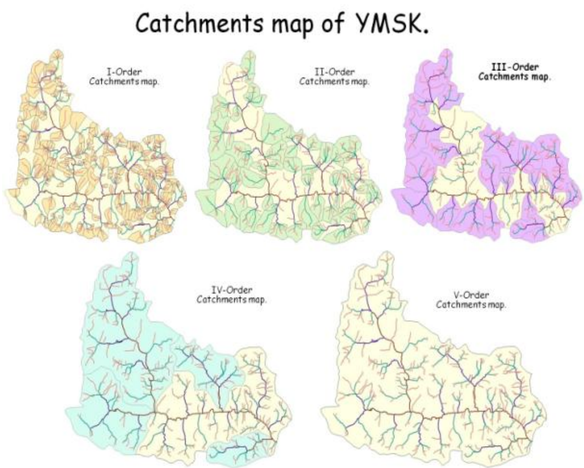

Figure 3: Catchment map

Order	No. of Streams	Bifurcation Ratio	Cumulative Length (km)	Mean Length (km)	Mean Area (km^2)
1	318	3.97	165.8	0.52	0.38
2	80	3.8	101.9	1.27	2.04
3	21	5.25	54	2.57	9.02
4	4		25.4	6.35	47.14
		4			
5	1		11.9	11.90	287.23

Table 1: Morphometric details

Contour Map:

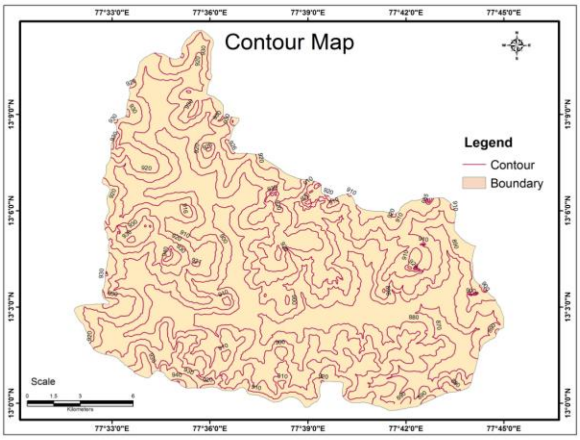

Figure 4: Contour Map

The contour elevation varies from 870m to 953m with in the study area (Figure 4). Using this contour data and ArcGIS software, DEM has been generated to know the relief aspects & slope gradation. The Water bodies and drainage lines are draped. This depicts the exact location of the Water bodies and drainage lines w.r.t the elevation within the study area.

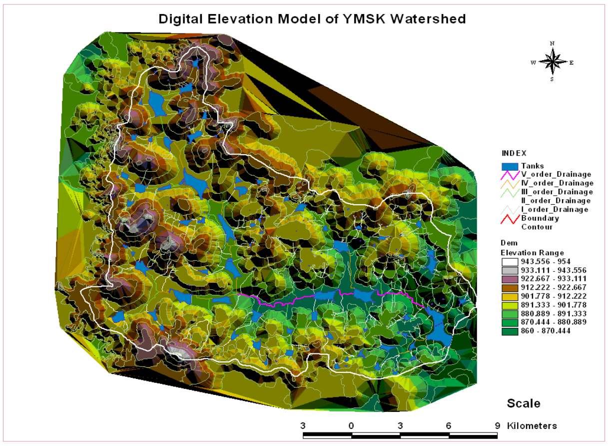

Figure 5: Digital Elevation Model (DEM) of Yale Mallappa Shetty Kere

Contour values have been digitized allowing them to be manipulated into versatile displays of topographic data as Digital Elevation Models or DEMs (Figure 5). The most common digital data of the shape of the earth's surface is cell-based Digital Elevation Models (DEMs). This data is used as input to quantify the characteristics of the land surface.

A DEM is the 3D view raster representation of a continuous surface, usually referencing the surface of the earth as in the real world. The accuracy of this data is determined primarily by the resolution (the distance between sample points). Other factors affecting accuracy are data type and the actual sampling of the surface when creating the original DEM [8]. Recent studies have demonstrated that the accuracy of parameters extracted from DEMs is comparable to those obtained by manual methods while the processing time is much less [9] [11]. The DEM for the study area has been generated using contours of 10m in ArcGIS 3D-analyst tool.

Surface water study:

A detailed study of hydrogeological setup has been carried out on a series of three tanks namely:

1. Doddabommasandra tank
2. Narasipura tank
3. Tindlu tank

A comparison of present and earlier status of storm water drainage has been attempted in the present study (Figure 6). The quantitative morphometric analysis of drainage system is an important aspect of characterization of watersheds [10].

Change detection study also has been carried out. Status of water spread area has also been studied for the following water bodies (Table 2). Any catchment area undergoing urbanization thus experiences the aforementioned and the resultant effect is an increase in runoff discharge and sediment generation. [2][5][6][7]

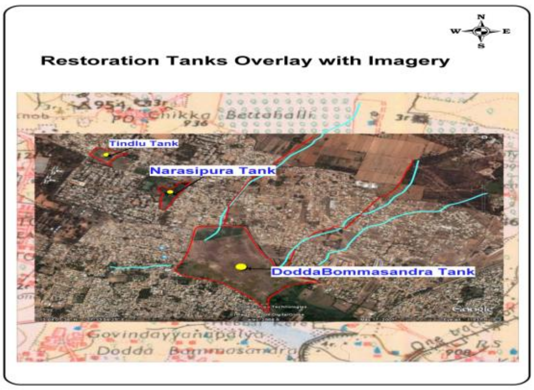

Figure 6: Comparison map

Tank name	Water Spread Area (ha)		
	Present	Old	Difference
Dodda Bommasandra	46.41	38.86	7.55
Thindlu	3.897	2.577	1.32
Narsipura	4.268	3.281	0.99

Table 2: Water spread details

Topographic map has been used for the earlier status and satellite data has been used for the present status. Google earth imagery has been considered for this purpose. The resolution is not enough to bring out some more important details and the same may be taken up using quick bird data in the next stage. The drainage detail of each watershed has been studied and tabulated (Table 3). The table shows the 1storder streams lengths as in toposheets; as seen in satellite imagery and also difference between them.

The study reveals that the entire streams order have been shortened in length. Majority of 1st order streams are shortened and many drainages are vanished due to development activities like layout formation and construction on the drainage lines. The water spread area also reduced in majority of the cases. As a consequence of shortening of the streams, the rate of infiltration has been drastically decreased and resulted in depletion of ground water level. The water spread area also increased at some places indicating blockage of drains causing spread over of water in the nearby vicinity. The shortening of the stream length varies from 12% to 100%. This indicates development of new layouts and slums on the drainage lines. Encroachment of "RajaKaluve" has become the order of the day. Both surface water and groundwater problems increased enormously. Surface water during rainy season gave rise to flash floods. Ground water level touched nearly thousand feet below the surface creation of artificial recharge sites in these watersheds is possible against good storage of surface water. Maintenance of these tanks (desilting etc.) and drainage lines are very essential as this is the "Life Lines"[8].

Tank name	Toposheet	Satellite Imagery	Shortening of Stream (m)	% of Shortening
Dodda Bommasabndra	414	0	414	100
	2163	1346	817	37.77
	1833	1597	236	12.88
	1892	260.1	1631.9	86.25
	6302	3203.1	3098.9	49.17
Thindlu	---	---	---	---
Narshipura	---	---	---	---

Table 3: I-Order stream details:

Ground water chemistry:

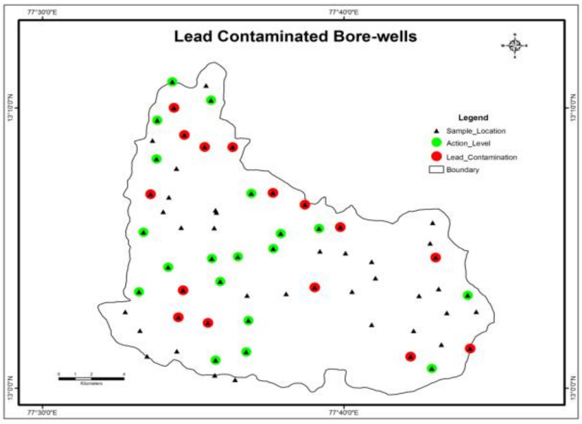

Figure 7: Borewell water sample locations map

	Cluster-1				Cluster-2			Cluster-3			Cluster-4		
Sl. No	5	7	8	9	21	22	23	30	63	66	33	44	49
Ec	561	394	130	714	693	612	518	372	1369	1307	924	1513	515
TDS	397	285	93	494	483	436	366	262	914	960	653	1066	367
PH	7.1	7.1	6.5	6.3	7	6.4	6.9	6.2	8.4	7.3	6.9	7	7.1
Temp	28	27	29	28	29	29	29	28	27	27	28	28	28
TH	90	200	90	320	280	210	190	120	420	540	420	750	240
ca	60	120	80	210	190	140	140	70	300	380	270	490	160
Mg	30	80	10	110	90	70	50	50	120	160	150	260	80
Na	8.8	19.6	12.4	20	28	25.7	25.1	18.7	57.8	32.6	26.6	14.7	9.3
K	12.7	2.6	4.3	2.5	3	2.6	3.8	2.3	5	5.2	3.3	12.5	1.6
Cl mg/lit	99.83	63.53	45.38	136.13	179.94	163.35	99.83	90.75	349.89	399.88	219.93	435.61	81.68
Hco3 Mg/lit	180	220	70	210	200	110	50	80	210	160	270	260	140
NITRATE	10.65	0.26	0.99	15.43	5.05	15.09	4.44	10.70	5.15	15.71	11.80	10.31	13.99
N-NO3	42.57	0.94	2.86	61.47	19.98	60.06	17.63	42.76	20.43	62.39	47.16	41.00	55.81
SO4	0.115	0.073	0.109	0.189	0.187	0.121	0.23	0.051	0.598	0.426	0.296	0.696	0.249
F	0.08	0.2	0.1	0.2	0.05	0.4	1	0.05	0.2	0.2	0.1	0.1	0.2
Cu mg/L	0.0089	0.0035	0.0106	0.0035	0.0089	0.0115	0.0071	0.0053	0.0133	0.0177	0.0062	0.0062	0.0035
Fe mg/lt	0.3750	0.1500	0.4375	0.2000	0.1750	0.1750	0.1500	0.1500	0.1750	0.3900	0.1500	0.1750	0.2000
Zn mg/lt	0.4153	0.1864	0.0932	0.0763	0.1186	0.0424	0.3898	0.0424	0.0847	0.0339	0.8305	-0.0169	0.0000
Cd mg/lt	0.0050	0.0000	0.0050	0.0000	0.0075	0.0025	0.0000	0.0000	0.0025	0.0000	0.0000	0.0025	0.0025
Pb Conc mg/l	0.0842	0.1053	0.2105	0.3368	0.3158	0.3158	0.1053	0.0842	0.0632	0.0632	0.0842	0.0632	0.1474

Table 4: Physico-chemical parameters

The collection of borewell water sample locations are shown (Figure 7). Analysis of Ground water in the study area depicts the contamination level in bore well samples in Four cluster as tabulated (Table 4). APHA method has been diploid for ground water samples [8]. Bore well locations such as No.5, 7, 8, 9, 22, 23, 30, 63,66,33,44 and49 has been grouped. The physico-chemical parameters like EC, TDS, Na, Cl, NO3, F and Fe are above action level and parameters like TH, Ca, Mg and Pb are above permissible limits (Table 4). Cluster-1 has studied in detail in which parameters like Ca, Mg, Na, NO_3 and Fe are above action level and Pb is above permissible level. The detailed Landuse –Landcover is carried out to know the sources for contamination in the study area.

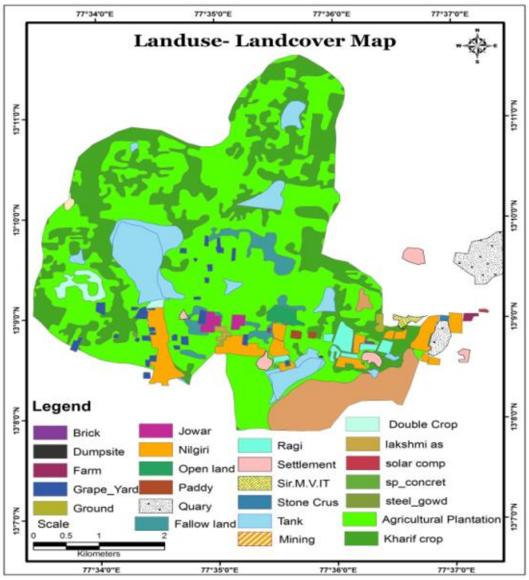

Figure 8: Landuse-Landcover map

Landuse-Landcover: The landuse/ landcover map is done in detail (Figure 8). The main features observed in the study area is the Brick manufacturing units, Dumpsite, Fodder industry, Garages, Poultry, Quarry, Stone crushers, Chewing-gum factory, Asphalt units, Solar cell factory, Steel-ware house and agricultural lands. There are Settlements, Educational centers & open lands also. Actions of man such as agricultural activities, civil construction works, deforestation process, bush burning, overgrazing drainage blockage, poor waste management; all resulting from increased population pressure do most of the time manifest inform of soil erosion, flood, drought and desertification[1]. Hollis identified five ways in which urbanization; resulting in the imposition of impermeable surface and their related activities within a drainage basin affect the natural functioning of hydrological cycle[4].

Water Bodies	No. of Tanks	Volume (ML)
Major Tanks	51	24010.200
Medium Tanks	28	1367.556
Existing Kalyani/Katte	44	287.400
Vanished Major Tank	1	285.730
Vanished Minor Tank	5	86.984
Vanished ponds	35	120.373
Total	195	
Total existing	**154**	**25665.156**
70 % of available water		**17965.609**
Per capita requirement of water	150 liters/day	
Annual per capita requirement per person (ltr)/yr	54750.00	
Annual per capita requirement per person (Mltr)/yr	0.05	
Available water per year (for No.of persons)	**328139**	

Table 5: Per-capita Availability of water

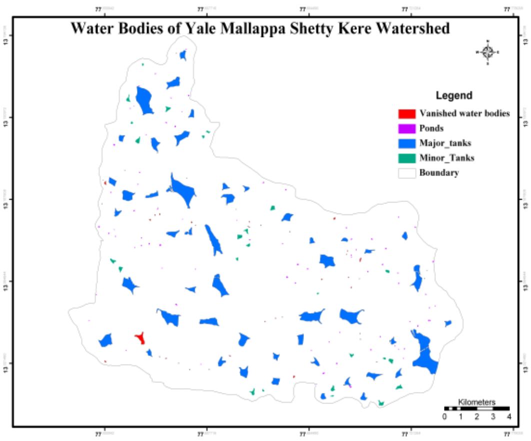

Figure 9: Existing and Vanished tanks map

It is necessary to maintain the drainage network & water bodies without polluting. Importance may be given for both drinking purpose and artificial recharge. Already one minor tank and 35 tiny water bodies vanished due to urbanization (Figure 9). It is astonish to note 44 tiny water bodies are still exist in the valley yielding approximately 287 MLtrs along with 24010 MLtrs from Major and 1368 MLtrs from Minor Tanks. Assuming 150ltr/day per capita, taking into account 70% of water from Major & Minor water bodies, it is possible to cater water for 328139 persons (Table 5). The tiny water bodies may be maintained from the point of recharging the ground water[8].

IV: Discussion & Conclusions

The shortening of the stream length varies from 12% to 100%. This indicates development of new layouts and slums on the drainage lines. Encroachment of "RajaKaluve" (Feeder channel) has become the order of the day. Both surface water and groundwater problems increased enormously. Surface water during rainy season gave rise to flash floods. Ground water level touched nearly thousand feet below the surface and water contamination is increasing. Creation of artificial recharge sites in these watersheds is possible against good storage of surface water. Maintenance of these tanks (desilting etc..) and taking care of drainage lines along with developmental activities is very essential as this is going to be the "Life Lines" of society.

References

[1] Ajewole Davies Ojo, (2010), Spatial dimension of drainage channel responses to urbanization in a tropical city, 51st Annual Conference of the Association of Nigerian Geographers (ANG) held at Kogi State University, Anyigba.

[2] Anderson, H.W. (1957) Relating sediment yield to watershed variables. Trans. Amer. Geophys. Union, 38, 921-4

[3] APHA (1995): Standard Methods (18 Ed.) for the examination of water and waste water, APHA, AWWA, WPCE, Washington DC.

[4] Hollis, G.E. (1988), "Rain, roads, roofs and runoff Hydrology in cities" Journal of the Geographical Association, Vol. 73, part I, No.38.

[5] Jeje, K and Agu, A.N. (1 990) Runoff from bonded plots in Alakowe in Southwestern Nigeria. Applied Geography, Vol. 10.

[6] Jeje, L.K. and Nabegu, A. (1982) Sediment yield in response to rainstorms and landuse in small drainage basins in Ife area of Southwestern Nigeria, Niger ian Geographical Journal, 25

[7] Nabegu, A.B. (2005) Determinant of sediment yield in river basins: implications for reservoir management. International Journal of Environmental Issues Vol. 3.

[8] Renuka Prasad. T.J, (2011). Study of Drainages, Water bodies and Groundwater around Bangalore along with water auditing and budgeting using Remote sensing and GIS, Geological Society of India, Memoir 79, pp. 190-214.

[9] Saraf, A.K, and Choudhury, P.R. (1998). Integrated remote sensing and GIS for groundwater exploration and identification of artificial recharge sites, International Journal of Remote Sensing, Vol. 19, pp. 1825-1841.

[10] Strahler, A.N. (1964), "Quantitative geomorphology of drainage basins and channel networks", Handbook of Applied Hydrology, (New York, Mc.Graw Hill Book Company, 1964), pp 411.

[11] Wang, X., and Yin, Z. Y. (1998). A comparison of drainage networks derived from digital elevation models at two scales, Journal of Hydrology, Vol. 210, pp. 221-241.

V: Acknowledgments

Authors are thankful to Dr.A.N.Yellappa Reddy for valuable suggestions apart from encouragement to take up research which leads to sustainable development and Dr. Rudresh Kumar. K.J for all the help provided to carry out chemical analysis with valuable suggestions. Also thankful to Dr. Raja Mohan, Director, ICMR, Dr. Ravi Babu, Scientist, ICMR for providing laboratory facility to analyse heavy metals; Mr. Shivalinga Murthy, Director, Dept of Mines and Geology and Mrs. Shashirekha, Chief Chemist, Department of Mines and Geology, Govt. of Karnataka, Mr. Jagadeesha M. Kattimani for the valuable assistance in the field work and GIS work and indeed thankful to UGC for financial assistance under Research Fellowship in science for Meritorious Students (RFSMS), New Delhi.