

Possibility on Contamination of Upper MUSI Ground Water for Flow Water at River End



Mohammed Zakir Hussain, PVS Vara Prasad, Yamini S Verma

Abstract: The musli river historically provided farmers downstream of hyderabad with irrigation water for the cultivation of paddy for the duration of and after the monsoon rains. Through the construction of weirs, river water is retained in large and small reservoirs on the river from wherein it is diverted thru irrigation canals to village tanks and agricultural fields. This paper focuses on the sample description and corrective requirements after the survey samples at unique black points alongside musli. The presence heavy metals and microbiological pollutants have made the groundwater dangerous for consuming at diverse places in hyderabad. It has also proved that there is large issue of city groundwater recharge in this region. The internet urban recharge factor of groundwater in this region changed into anticipated to be about 567. 51 mm/a and natural recharge element turned into observed to be 52. 78 mm/a. The combination of tools carried out, the outcomes received and the recommendations provided in this have a look at will be helpful for neighborhood planners and selection makers to shield and restore the water assets on this location. The existing work also makes a speciality of the scope of infection by float water immersion at 2d part of musli river in ground as nicely agriculture. The consequences taken into consideration from 2017 june to may additionally 2019 for the actual identifications, the parameters are y18 and y19 for graphical enter.

Key words: Musli, water quality assessment, ground water

I. INTRODUCTION

On a first visit to the musli river inside the heart of the city one might without difficulty finish that the boom of the metropolis and the consequent big-scale disposal of wastewater into the river has been an ecological catastrophe. Yet the river had lengthily been dry, and one ought to argue that huge scale wastewater disposal has given the river a brand new life. The origins of the wastewater are in large part home and do concentrations improved hastily after 17 km. A benthic survey alongside the river determined that habitat situations for macro-invertebrates improved unexpectedly, and consequently greater taxa richness turned into determined with increasing distance from the metropolis. In a few elements of the city, it is dynamically more active and, in different components, it suggests much less development or expansion sports (deng and huang, 2004).

Revised Manuscript Received on November 30, 2019.

* Correspondence Author

Mohammed Zakir Hussain*, Research Scholar, Shri JTT University, Jhunjunu, Rajasthan. zakirafroz@gmail.com

Dr. PVS Vara Prasad, Principal, GIET ENG CLG, RAJAMANDRI.

Dr. Yamini S Verma, Assistant Professor, Shri JTT University, Jhunjunu, Rajasthan

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license [http://creativecommons.org/licenses/by-nc-nd/4.0/](https://creativecommons.org/licenses/by-nc-nd/4.0/)

In lots of megacities in india, it has been noticed that in city increase of cities, the encircling place of city built up which had herbal flora cowl or agriculture or water bodies, and so forth. Becomes the victim of urban encroachment. Spatial growth of cities results in to exchange in previous land use kind. Such phenomenon of city sprawl is characterized by using haphazard patchwork of improvement, which results in an unsuitable development in towns. To save you this form of sprawl inside the destiny, it is important to monitor the increase of the city (vinoth kumar et al., 2007). Mapping and monitoring the city sprawl, due to city decay inside the centres of cities, at normal durations may be very vital for city planners to understand the trend of improvement on the city outer edge and eventually to regulate it (Lv et al., 2012). However, the impact of UV light at the first six sample points has probably been minimal, as a consequence of the high turbidity which prevents effective penetration of UV light into the water column (Otaki et al. 2003). Recontamination of Musi-water with E. coli downstream of irrigation weirs should be considered, and would suggest and even higher treatment performance as currently But, the impact of uv mild at the first six sample factors has probably been minimum, on account of the excessive turbidity which prevents effective penetration of uv light into the water column (otaki et al. 2003). Recontamination of musli-water with e. Coli downstream of irrigation weirs should be taken into consideration, and could advise and even higher treatment overall performance as presently reported, as the river is frequently utilized by water buffaloes for bathing and drinking. The growth in salinity from 2. Zero ds m⁻¹ to 2. 3 ds m⁻¹ can not be explained by way of evaporation by myself and the most likely clarification is the inflow of saline drainage water from irrigated fields. Soil irrigated with wastewater turned into determined to more or less gather 34 kg/ha/yr(mccartney et al. 2008).

II. PROBLEM DEFINITION

The adjustments in land use and human manipulation of environment have severely affected the water resources of this place. But, targeted studies about its urban growth trend the usage of remote sensing and gis techniques in addition to evaluation of effect of urbanization on water resources are scarce and now not to be had in an included setup for hyderabad. The evaluation of groundwater in hyderabad is essential with a purpose to examine the interaction between urban land use and groundwater within the subsequent step. Finally, the relation and interplay among urban increase and the groundwater assets could be examined within an effect evaluation. The final results of this study can be an efficient tool for water assets management in addition to to support making plans tactics and formulate regulations to manual or redirect spatial increase in incipient mega city- hyderabad.

III. OBJECTIVE

- Determination of the impact of urban land use on the groundwater table and the scenario of groundwater contamination near MUSI.
- Identification of the probable sources and the characteristics of contaminant loading in the study area,
- Estimation of the natural and urban components of groundwater recharge and approximation of all the inflow as well as outflow components of urban water balance for Hyderabad city.

IV. STUDY AREA AND MAPPING

The present study occupying the area of MUSI first half session metro city Hyderabad urban and sub-urban areas for primary conceptual frame work, the below map shows the urban addition of contaminants to river basin.

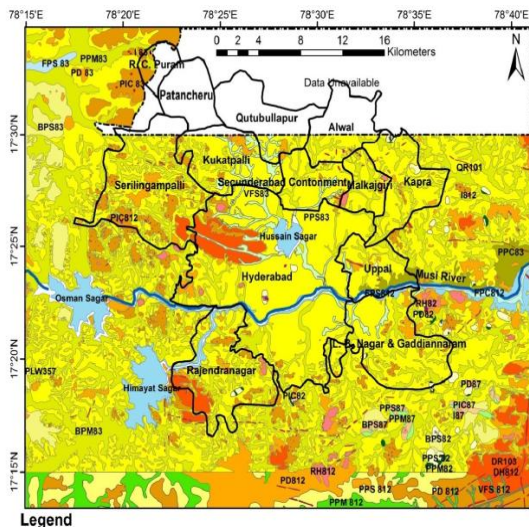


Figure: 1.1 Monitoring points with reference code, lat, log and Altitude.

Code	Sampling Points	Latitude N	Longitude -E	Alt. M
L01	River Musi at Osmansagar lake	17°22' 51"	78°18' 59"	595
L02	River Esi at Himayatsagar Lake	17°19' 55"	78°21' 49"	569
R01	River Musi at Moosarambagh bridge	17°22' 46"	78°31' 00"	581
R02	River Musi at Nagole bridge	17°22' 58"	78°33' 29"	510
R03	River Musi at Culvert, Pratapasingaram	17°22' 49"	78°40' 03"	442
R04	River Musi at Culvert, Pillaipalli	17°23' 07"	78°44' 14"	434
R05	River Musi at Weir, Narayanarao Katwa, Peerjadiguda	17°23' 18"	78°35' 52"	465
R06	River Musi reservoir at	17°22' 46"	78°31' 00"	405

	asaniguda, Suryapet			
R07	River Krishna at Vadapalle after River Musi confluence	17°25' 59"	79°40' 53"	371

V. RESULTS AND DISCUSSIONS

Table 2: Limit as per BIS/ IS:11624 (1986), IS 10500:1991, IS 10500:2018

S. No.	Parameter (expressed as mg/L except pH)	Acceptable Limit	Permissible Limit in absence of alternate source	Observed values
1	pH	6.5 – 8.5	6.5 - 8.5	6.9-9.0
2	TDS	500	2000	595-1420
3	Calcium as Ca)	75	200	20-345
4	Chloride as Cl	250	1000	135-260
5	Magnesium as Mg	30	100	68-299 mg/L
6	Sulphate as SO ₄	200	400	67-101
7	Total Alkalinity (TA as CaCO ₃)	200	600	132-304
8	Total Hardness (TH as CaCO ₃)	200	600	140-414

This study is on two lakes, six River Musi points in downstream, one River Krishna downstream point after confluence with River Musi from more than 270 samples.

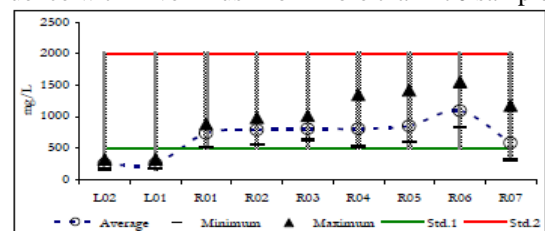


Figure 5.1 Trends of TDS in the year 2018-2019

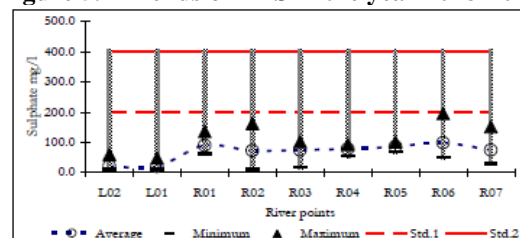


Figure 5.2 Trends of sulphate in the year 2018-2019

The rough and wild terrain of river course on downstream sequence points supports self purification at R03, R04, R06 and R07 as shown in a gradual increase in DO with decrease in COD.

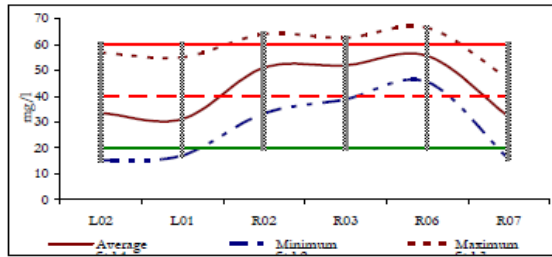


Figure 5.3 Trends of Percent Sodium in the year 2018-2019

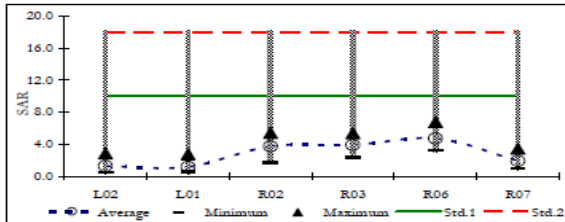
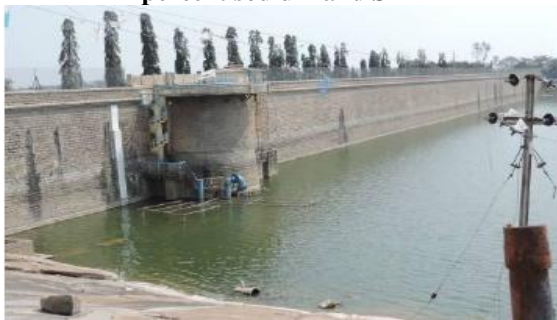
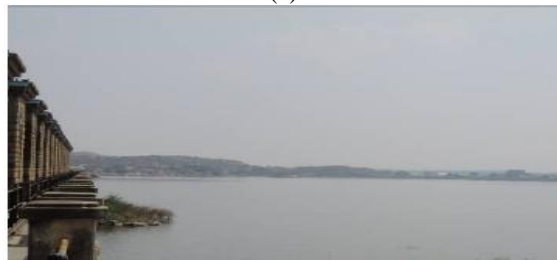


Figure 5.4 Show increase order towards downstream in percent sodium and SAR

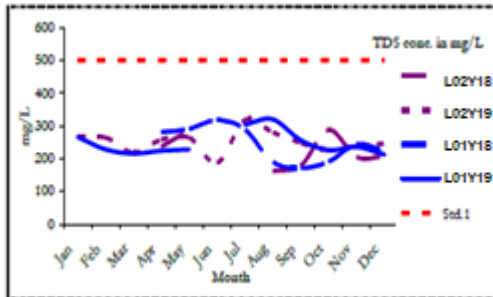


(a)

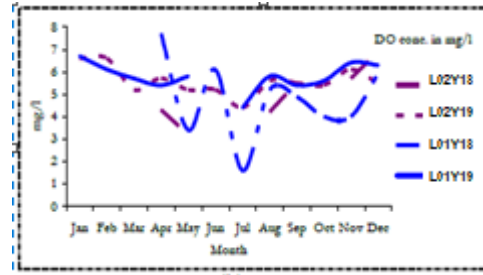


(b)

Fig. 5.5: photographic view of (a) L01 and (b) L02 Lakes
The L01 u/s of Musi at Gandipet and L02 u/s of Esi a tributary of River Musi are almost equal trends of all the parameters as their catchments are part of river bed, overlapped and adjacent.



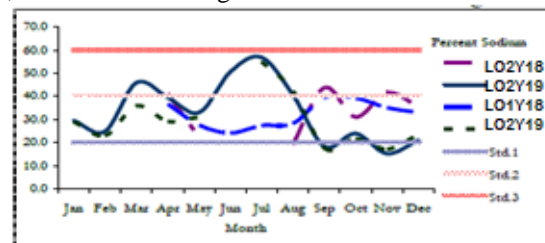
(a)



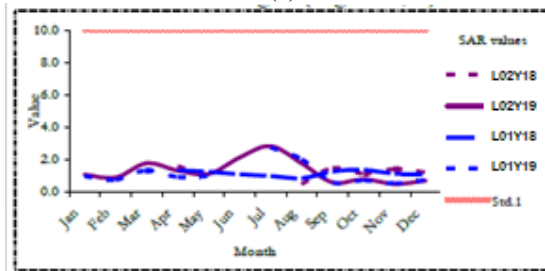
(b)

Fig.5.6: (a) Trends of TDS and (b) DO of L01 and L02 during 2018 – 2019

Trends for L01 and L02 during 2018-2019 shown at Figures are similar trends for all parameters. Trends of TDS are with in acceptable limit, little fluctuations and few pollution sources in the catchment. The TDS of these lakes ranges 160–320 mg/L. Averages of TDS, TSS Chloride, Sulphate, DO and COD are far below the standards, and of 245, 11, 33, 19, 5.1 and 24, respectively, ranging 162-320, 4-47, 19-65, 9-59, 1.6-77 and 8-78 mg/L.



(a)



(b)

Figure 5.7 Percent Sodium of L01 and L02, (b) SAR of L01 and L02

Range and averages of ph, percent sodium and sar are 6. 9-8. 7, 8; 15-57, 33; and zero. 5-2. Eight, 1. 1 respectively. Those lakes show tds round 242 mg/l representing splendid consuming nice water requires with the aid of traditional filtration for thirteen–47 mg/l suspended solids (tss) removal. This high-quality is attained through protection of lakes catchment. The do in no way decreases 1. 6, and on average 5. Three mg/l is top notch for aquatic lifestyles. The cod is round 25 mg/l. Percentage sodium show medium danger class is void because of low tds, constitute low risk elegance and sar values are 1. 1 constitute an extremely good water class underneath ir. Hwqr. The 8+zero. 7 ph represents slight primary and occasional deviations suggest these lakes are covered. The mpn counts general and fe, cal coli-form (~50, ~3) support fe, cal infection. The domestic sewage becoming a member of from catchment calls for disinfection for domestic use.

Possibility on Contamination of Upper MUSI Ground Water for Flow Water at River End



Fig 5.8 A view of (a) River Musi at R01, (b) R02

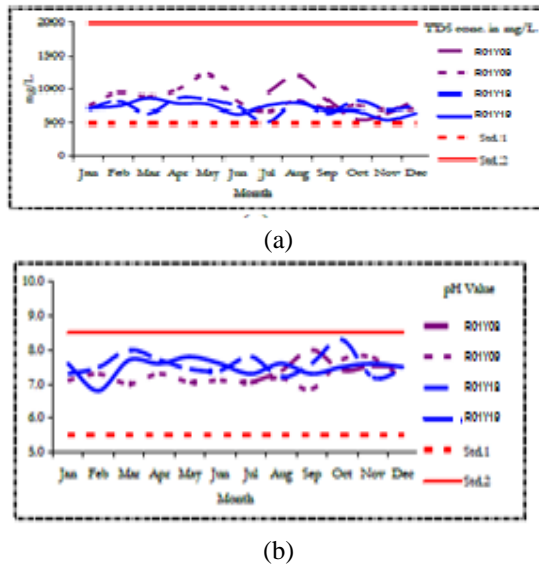


Fig 5.9 (a) TDS and (b) pH of R01 during 2008 – 2009 and 2018 – 2019

The averages of TDS, TSS, Chloride, Sulphate, DO and COD are 733, 140, 163, 89, 0 and 316, respectively, ranging 510-877, 20-345, 132-204, 61-136, 0 and 51-677 mg/L. The range and average of pH is 6.8-8.3 and 7.5 respectively, shown at Figures 5.1, 5.2, 5.3.-5.9,5.10)

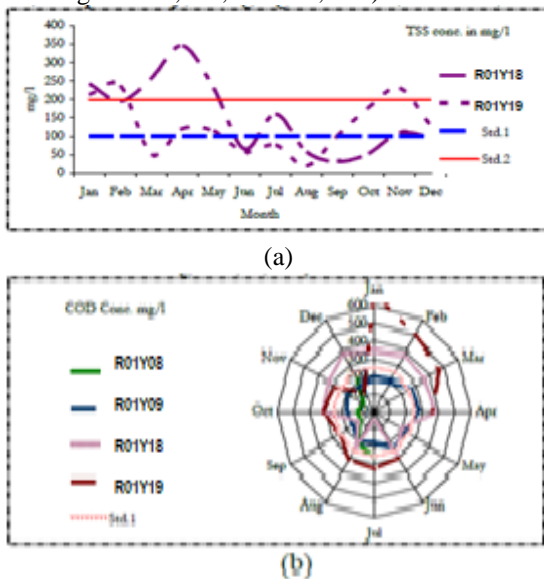


Fig.5.10: (a) TSS and (b) COD of R01 during 2008 – 2009 and 2018 – 2019.

The TSS exceeds inland surface water standards (100 mg/L) except June, August and September 2018-2019, exceeded on land irrigation standards (200 mg/L) on March, April and November 2019 (Fig.5.10a). High COD found in 2019 followed 2018, in January - April (Fig.10b).

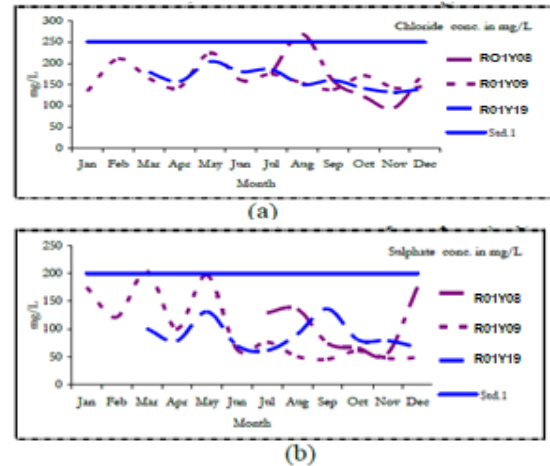


Fig.5.11: (a) Chloride and (b) Sulphate of R01 during 2008 – 2009 and 2018 – 2019

The Chloride is crossing desirable limit on August 2009 and Sulphate is in limit (Fig.5.11). R01 shows heavy organic pollution and needs diversion of drains through Amberpet STP. Percent sodium is medium and high hazard class and SAR is low hazard class of Ir. HWQR as shown at Fig.5.12.

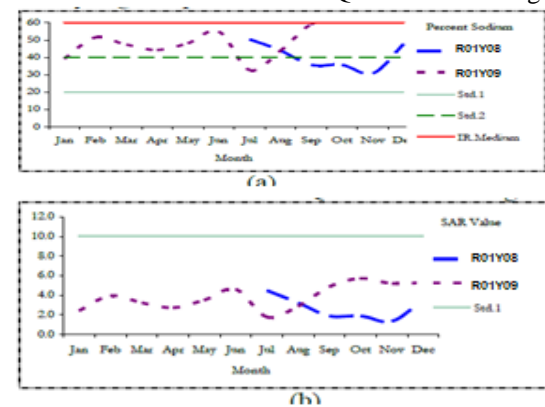
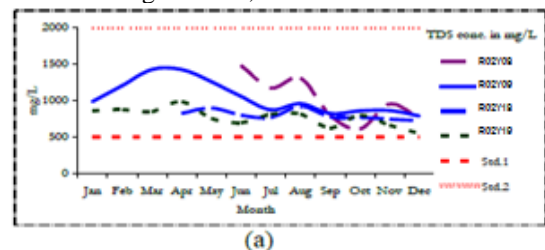


Fig.5.12: (a) Percent Sodium and (b) SAR of R01 during 2008 – 2009 and 2018 – 2019.

River Musi at Nagole bridge (R02)

Fig.5.8(b) shows River Musi at R02. It is after confluence Amberpet STP outlet and some drains in south central parts of the city. The DO levels of River Musi at R02 are zero. Trends of R02 during 2008 – 2009 and 2018 – 2019 for TDS, pH, TSS, COD, Chloride, Sulphate, Percent Sodium and SAR are represented in Figs.5.1-5.4, 5.13–5.16.



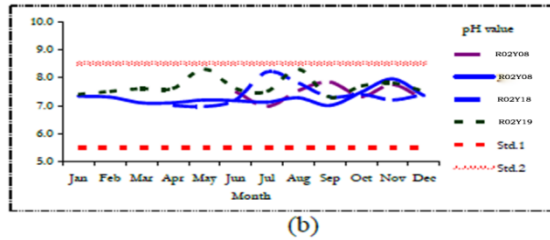
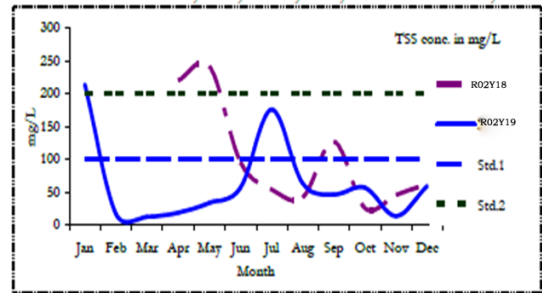
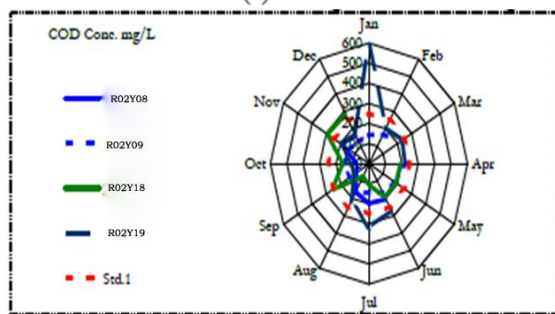


Fig.5.13: (a) TDS, (b) pH of R02 during 2008 – 2009 and 2018 – 2019

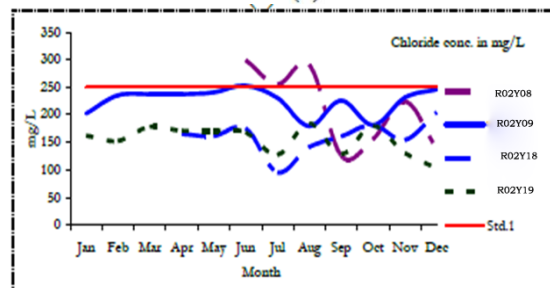
Averages of TDS, TSS, Chloride, Sulphate, DO and COD are 783, 80, 156, 72, 0.1 and 220, respectively, ranging 548-979, 12-242, 95-204, 11- 162, 0-2.2 and 75-596 mg/L shown at Figs.5.13-5.15



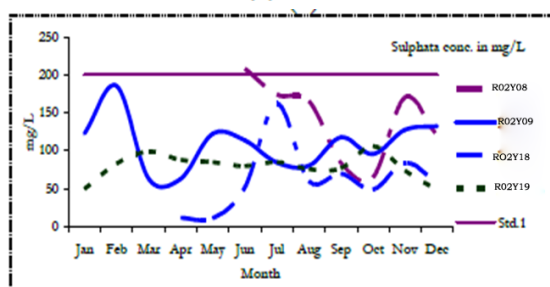
(a)



(b)



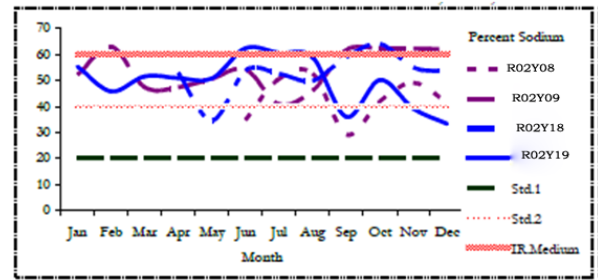
(c)



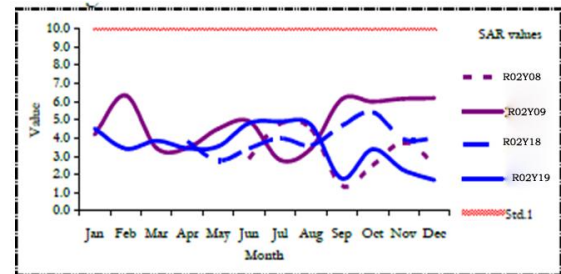
(d)

Fig.5.14: (a) TSS, (b) COD (c) Chloride, (d) Sulphate of R02 during 2008 – 2009 and 2018 – 2019

TSS exceeded the desirable limit in May 2018. The Chloride and Sulphate crossed desirable limit in June 2008 (Fig 5.14). Range and averages of pH, Percent Sodium and SAR at R02 and high hazard class and SAR is low hazard class of Ir. HWQR as shown at Fig.5.15.



(a)



(b)

Fig.5.15: (a) Percent Sodium, (b) SAR of R02 during 2008 – 2009 and 2018 – 2019

River Musi at Weir, Narayanarao Katwa (R05)

Photographic views of River Musi at R05 shown at Fig 5.16(a) the silt with water hyacinth, (b) encroachment with municipal dump and construction activities



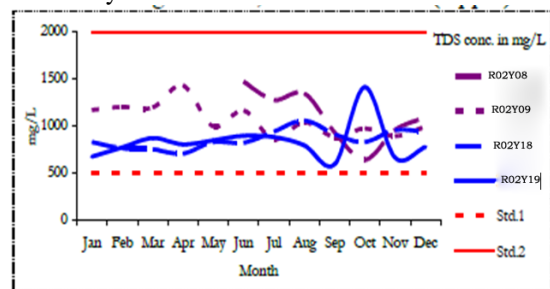
(a)



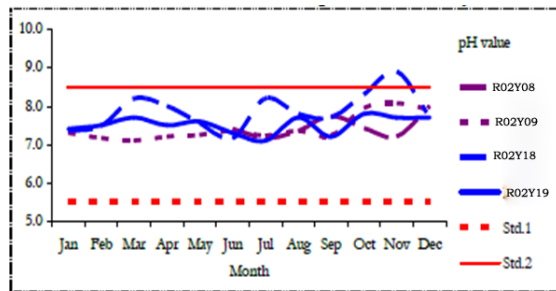
(b)

Fig.5.16: View of River Musi at R05 (a) the silt with water hyacinth, (b) encroachments.

R05 is the River Musi point after confluence of outlets from Nogole STP, Nallacheruvu (Uppal) STP, major drains connected through Nallacheruvu outlet from the northeast part of the city



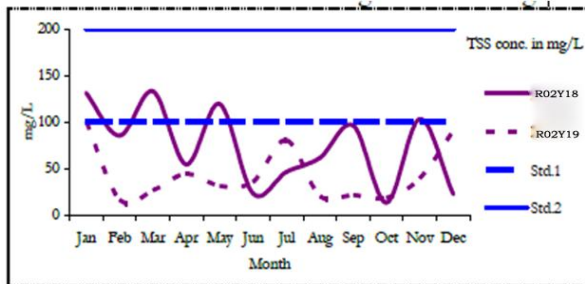
(a)



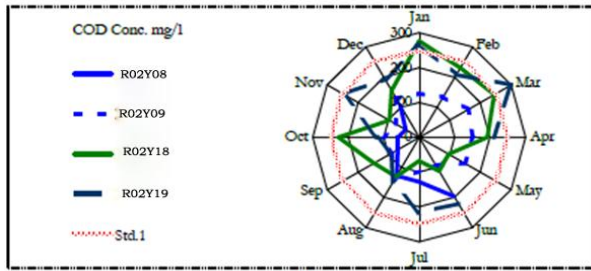
(b)

Fig.5.17: (a) TDS, (b) pH of R05 during 2008–2009 and 2018–2019.

Trends of R05 during 2008 – 2009 and 2018 – 2019 for TDS, pH, TSS, Chloride, Sulphate, COD, percent sodium and SAR are at Figs.5.17–5.19. Range and averages of pH shown at Fig.17(b).

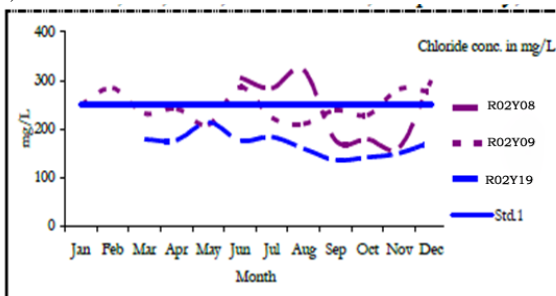


(a)

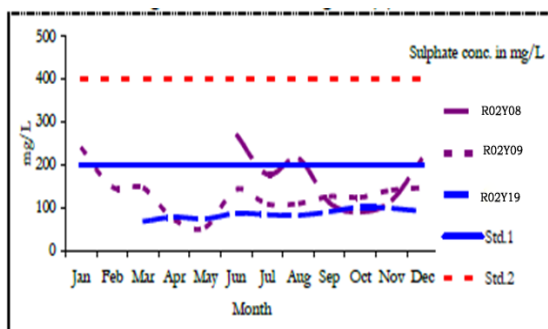


(b)

Averages of TDS, TSS, Chloride, Sulphate and COD are 847, 59, 168, 85 and 182, respectively, ranging 595-1414, 13-133, 135-213, 67-101 and 68-299 mg/L, shown at Fig.5.17(a), 5.18, 5.19.



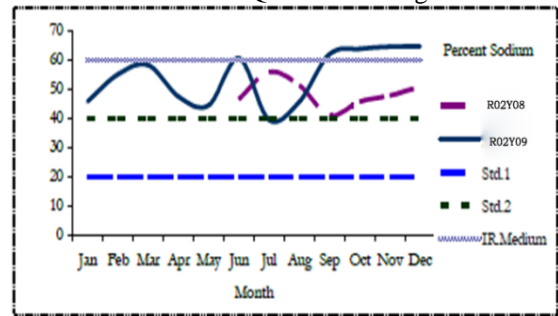
(a)



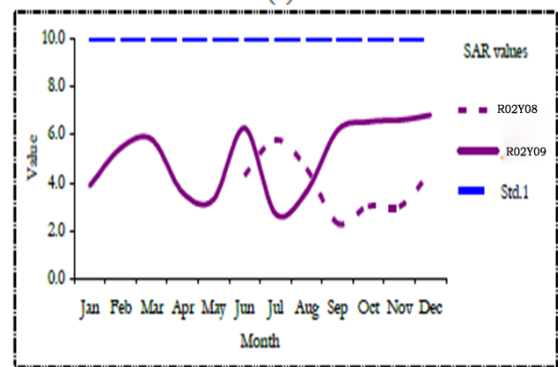
(b)

Fig.19: (a) Chloride, (b) Sulphate of R05 during 2008–2009 and 2018–2019.

The Chloride and Sulphate fluctuating and exceed the desirable limit frequently in 2008 (Fig.5.19). Up to this point there is no scope for aquatic life as the DO is negligible. Percent sodium is medium and high hazard class and SAR is low hazard class of Ir. HWQR shown at Fig.20.



(a)

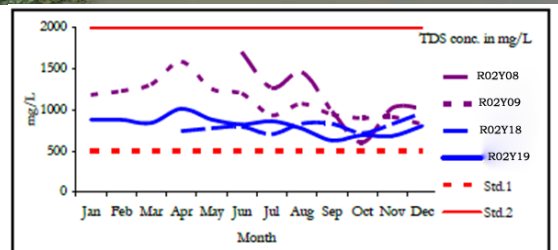


(b)

Fig.20: (a) Percent Sodium, (b) SAR of R05 during 2008 – 2009 and 2018 – 2019

River Musi at Pratapasingaram (R03)

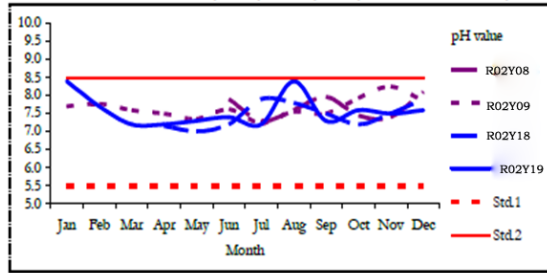
Fig.5.21 is a photographic view of River Musi at R03 at immediate downstream of the R05. Trends for R03 for parameters during 2008 – 2009 and 2018 – 2019 are at Figs.5.21b, 5.22–25.



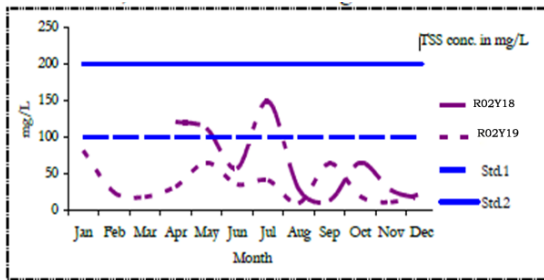
(b)

Fig.5.21: (a) A view of River Musi at R03, (b) TDS of R03 during 2008 – 2009 and 2018 – 2019

Averages of TDS, TSS, Chloride, Sulphate, DO and COD are 804, 48, 174, 73, 0.4 and 124, respectively, ranging 626-1010, 9-149, 134-246, 17-102, 0-3.4 and 49-199 mg/L.



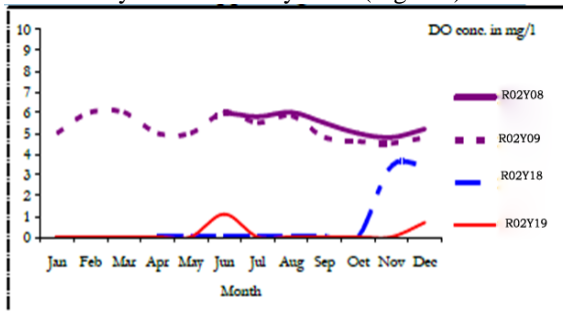
(a)



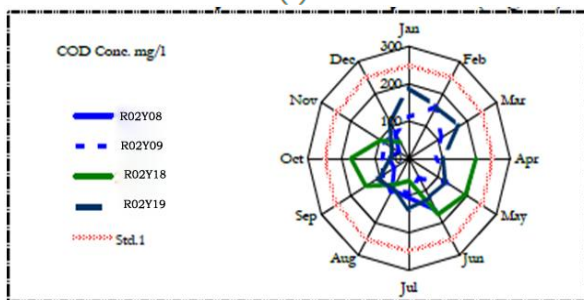
(b)

Fig.22: (a) pH (b) TSS of R03 during 2008 – 2009 and 2018 – 2019

DO during 1998-1999 is ranging 4-6 and during 2018-2019 is near “0” indicate deterioration of River and not supporting fresh water fish. Chloride fluctuates and exceeds the desirable limit frequently and high in 2008 – 2009 and 2018 – 2019 show efficiency of treatment systems (Fig5.24).



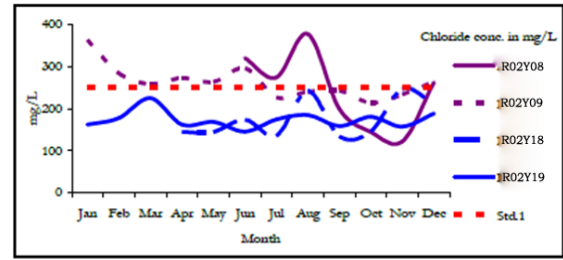
(a)



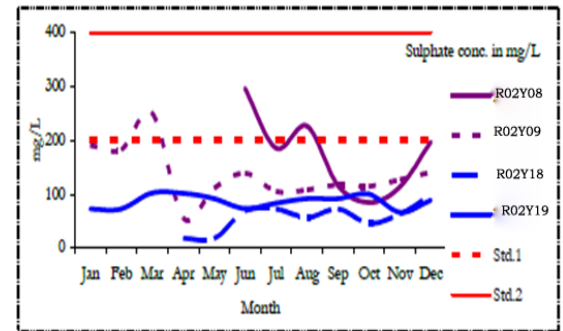
(b)

Fig.23: (a) DO (b) COD of R03 during 2008 – 2009 and 2018 – 2019

The Sulphate exceeds the desirable limit in June and August 2008 and show higher concentrations during 2008 – 2009 and 2018 – 2019 and would be the result of CETP/STP facilities.



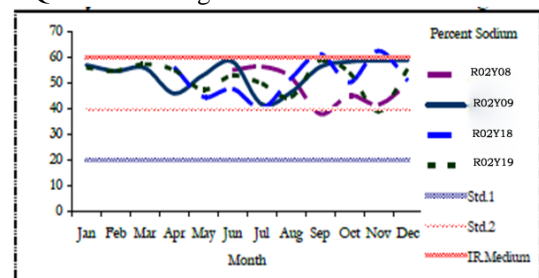
(a)



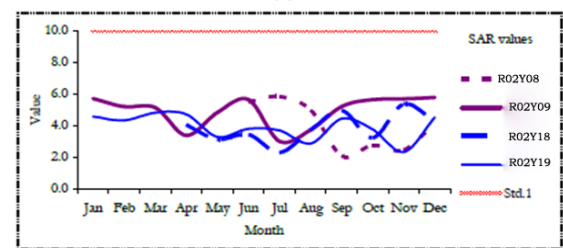
(b)

Fig.24: (a) Chloride (b) Sulphate of R03 during 2008 – 2009 and 2018 – 2019

Range and averages of pH, Percent Sodium and SAR are 7-8.4, 7.5; 39-62, 52 respectively. Percent sodium is in medium and high hazard class and SAR is low hazard class of Ir. HWQR shown at Fig 5.25



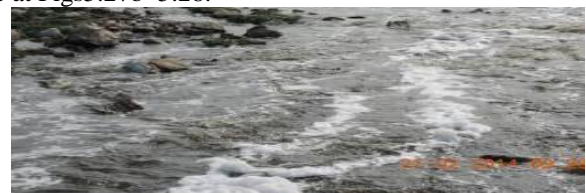
(a)



(b)

Fig.25: (a) Percent Sodium (b) SAR of R03 during 2008 – 2009 and 2018 – 2019

River Musi at Pillaipalli (R04) Fig5.26 is a photographic view of River Musi at R04 immediate downstream of R03. Trends for R04 during 2008 – 2009 and 2018 – 2019 for parameters are at Figs5.27b–5.28.



(a)

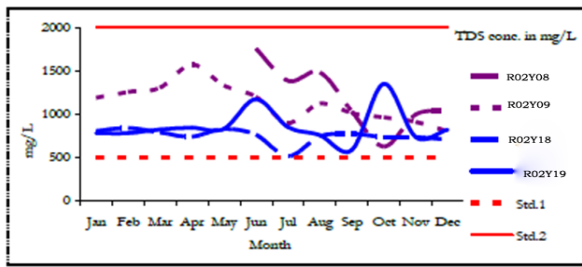
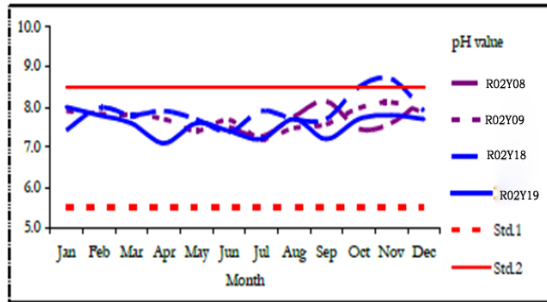
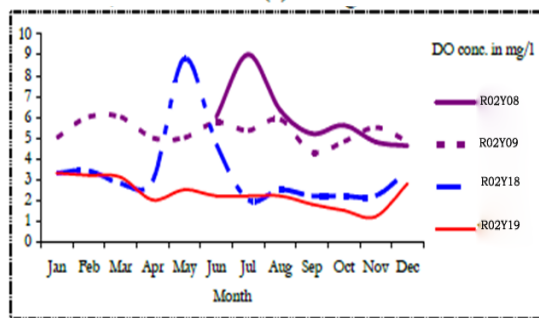


Fig.26: A photographic view of River Musi at R04 (b) TDS during 2008 – 2009 and 2018 – 2019

Averages of TDS, TSS, Chloride, Sulphate, DO and COD are 804, 25, 200, 77, 2.9 and 110, respectively, ranging 514-1346, 4-146, 138-480, 55-92, 1.2-8.8 and 36-288 mg/L.



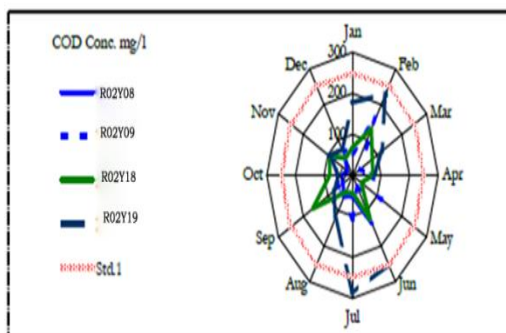
(a)



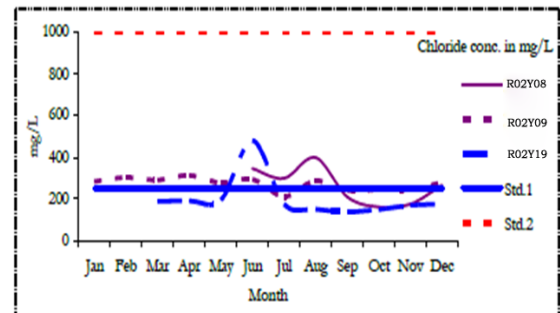
(b)

Fig.27: (a) pH (b) DO of R04 during 2008 – 2009 and 2018 – 2019

The range and average of pH at Fig 5.27 a) DO is 4-7 and 1-3 mg/L during 2008 – 2009 and 2018 – 2019, respectively, as shown at Fig 5.27(b). Chloride exceeds the desirable limit frequently on 2008- 2019, and July 2019 and with-in limit during 2019 except June. The Sulphate exceed in June to August 2008.



(a)



(b)

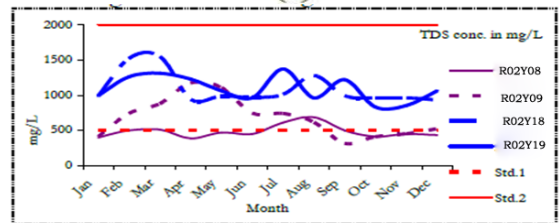
Fig 5.28: (a) COD (b) Chloride of R04 during 2008–2009 and 2018–2019

Musi reservoir (R06) and River Krishna after confluence with River Musi at Vadapalle (R07)

Fig 5.29 is a photographic view of R06 at Kasaniguda, Suryapet, Nalgonda. R06 is the River Musi point representing storage after the confluence of a Tributary Bikkeru. Trends are prepared for R06 and R07 from the monitoring data during 2018–2019 at Figs 5.30–5.32.



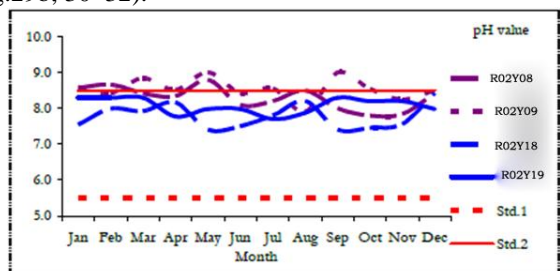
(a)



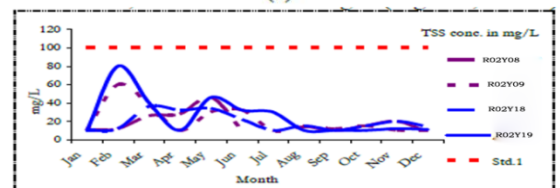
(b)

Fig 5.29: (a) A view of R06 (b) TDS, of R06 and R07 during 2018–2019.

Averages of TDS, TSS, Chloride, Sulphate, DO and COD at R06 are 1090, 22, 243, 97, 4.8 and 23, respectively, ranging 830-1547, 10-80, 84-365, 48-195, 3.1-7.0 and 5-95 mg/L (Fig.29b, 30–32).



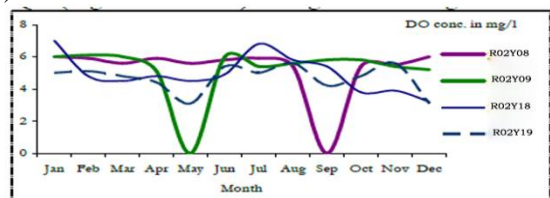
(a)



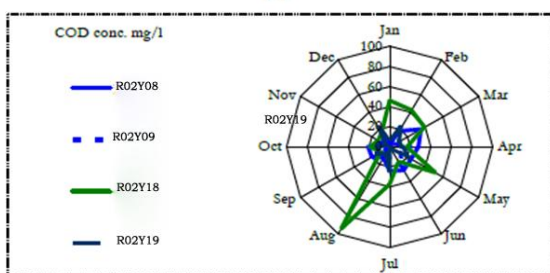
(b)

Fig 5.30: (a) pH (b) TSS of R06 and R07 during 2018–2019.

Chloride exceeds desirable limit very frequently at R06 and Percent Sodium frequently reaches to very high hazard with respect to Ir. HWQR (Fig. 5.33a and 5.34a). Range and averages of pH, Percent Sodium and SAR at R06 are 7.4–8.4, 7.9; 45–66, 56 and 3.2–6.8, 4.7, respectively (Figs 5.30a, 5.33).



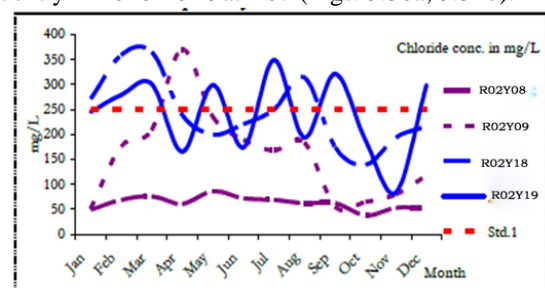
(a)



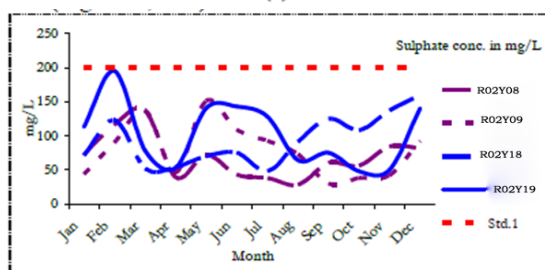
(b)

Fig 5.31: (a) DO (b) COD, of R06 and R07 during 2018–2019.

R07 is the River Krishna point after the confluence of River Musi. Averages of TDS, TSS, Chloride, Sulphate, DO and COD at R07 are 576, 20, 110, 74, 5.2 and 15, respectively, ranging 310–1173, 8–60, 38–370, 28–151, 0–6.1 and 4–35 mg/L (Figs 5.29b, 5.30–32). COD attained high value in August 2018. The pH and Chloride exceeds desirable limit frequently in 2018–2019 at R07 (Figs. 5.30a, 5.31b).



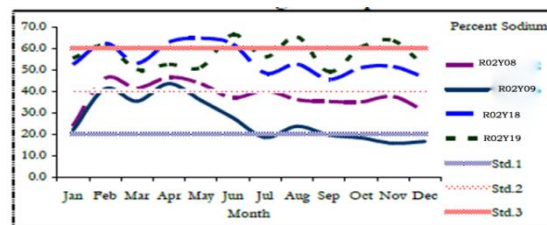
(a)



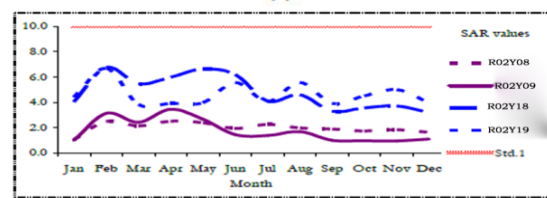
(b)

Fig 5.32: (a) Chloride (b) Sulphate of R06 and R07 during 2018–2019.

Range and averages of pH, Percent Sodium and SAR at R07 are 7.8–9.0, 8.4; 16–47, 32 and 1.0–3.5, 1.9 respectively (Figs. 5.30a, 5.34). The flow of River Krishna at R07 is meager except few months and village drains joined it resulting to low DO, higher values of COD, TSS, TDS, Chloride and Sulphate.



(a)



(b)

Fig 5.33: (a) Percent Sodium (b) SAR of R06 and R07 during 2018–2019.

Health indicator bacteria and nematode species

A look at throughout the direction of the survey (January 2008 – December 2009), 143 (66%) water samples from various points have been observed to be positive for helminthes eggs. Three exceptional helminth species had been detected; hookworm changed into the most not unusual (65%) of all samples, observed via ascaris (forty five%) and trichuris (nine%). Hookworm and ascaris concentrations were located to be similar at the first sample points, whilst trichuris concentrations have been determined to be tons lower. Concentrations of all three helminths decreased swiftly at sampling points after the primary weir (R05) at peerjadiguda and reduced similarly with every additional weir as much as 30 km stretch on down flow of river Musi consisting thirteen weirs finally Musi reservoir. Trichuris eggs were the primary to disappear from river water, followed by means of ascaris, even as hookworm eggs have been the remaining to vanish from the river. The E. coli and F. coli concentrations during 2008–09 and 2018–2019 at the first weirs were high and comparable with those in raw sewage though they decreased rapidly with increasing distance from the city.

VI. CONCLUSIONS

Interpretation of Hydro geochemical data shows that category hard, slightly acidic nature. This reveals that the groundwater samples of study area fall in hard to very hard category, trilinear diagram shows that all of the samples fall in the field of SO₄²⁻, Cl⁻, Mg²⁺ type water. There are many ways to describe the quality of water. Depending on how the water is used and what you are looking for, different parameters are important. Here follows a short description of the parameters used in this work. P^H is an indicator of the acidity or basicity of water. The normal pH range for irrigation water is 6.5 to 8.4. The pH is seldom a problem in itself. The main reason for pH measuring is to detect abnormal water, which may contain toxic ions or cause a nutritional imbalance. The study also reveals the scope of carrying these hard metals to the bottom area of Musi river and its effects in the next study.

REFERENCES

1. Adewuyi, Y.G., (2001). Sonochemistry: Environmental Science and Engineering Applications. Ind. Eng. Chem. Res., 41, 4681.

Possibility on Contamination of Upper MUSI Ground Water for Flow Water at River End

2. Alberttutier., (2010). Soil and Ground Water Remediation Guidelines Alberta Environment. ISBN:978-0-7785-9949-4, <http://environment.gov.ab.ca/info>.
3. Arie.; Grostash.; Elizabeth A, Edwards., (2006). A1, 1, 1-trichloroethane-degrading Anaerobic Mixed Microbial Culture Enhances Bio Transformation of Mixtures of Chlorinated Ethenes & Ethanes. *Applied microbial*. 72(12): 7849-7856.
4. Barth, J. and Hahne, W., (2002). Review article. *Aliment. Pharmacol. Ther.* 16:suppl. 1, pp. 31-33.
5. Butler, R.; Ehrenberg, S.; Godley, A R.; Lake, R., Lytton, L.; Cartmell, E., (2006). Remediation of bromate-contaminated groundwater in an ex situ fixed-film bioreactor. *Science of The Total Environment* Volume: 366, Issue: 1, Pages: 12-20.
6. Hadjer, K., T. Klein., M. Schopp., Water consumption embedded in its social context, north-western Benin. *Physics and Chemistry of the Earth*, 30, 357-64 (2005)
7. Sujatha T., Shatrugna V., Vidyasagar P., Begum N., Padmavathy N.S., Reddy G.C.K. and Rao. G.V.N. Timed activity studies for assessing the energy expenditure of women from an urban slum in South India. In *Food and Nutrition Bulletin* 24(2), 193-99 (2003)
8. Chen, X. and Chen, X. 2003. Sensitivity Analysis and Determination of streambed leakance and Aquifer Hydraulic properties *Journal of Hydrology*, Vol.284, pp.270-284
9. Abdullah and Tamer Al-Assa'd 2006. —Modelling of Groundwater flow for Mujib aquifer in Jordoni, p. 289-297. Brodie, R.S. 1998.
10. Integrating GIS and RDBMS technologies during construction of a regional groundwater model. *Environ Modell Software* 14:119–128.
11. Xu, X., Huang, G.H. and Qu, Z.Y. 2009. Integrating MODFLOW and GIS technologies for assessing impacts of irrigation management and groundwater use in the Hetao Irrigation water flow process. *US Geological Survey OpenFile Report* 00-92.
12. Mahesh kumar 2004. Ground water flow model of north east musi basin, Ranga Reddy district, Andhra Pradesh using finite difference method. M. Tech thesis Submitted to Osmania University, Hyderabad, India.