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Full Length Research Paper

Groundwater Analysis in Micro watershed (Kachwani singaram) Influenced by Wastewater Irrigation, Peri-urban Hyderabad, India

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Abstract
Today, there are a wide range of groundwater problems in India. Firstly, overall quantity of groundwater decreases yearly because of overexploitation and secondly, there is degradation in water quality. Urban/Peri-urban Agriculture is certainly a new concept at least in India. Due to large difference in the infrastructure and the land cost, people migrate from rural to urban areas and carry out jobs other than agriculture and they form the peri-urban area.This dissertation is based on a study carried out in Hyderabad where in wastewater is important for the livelihood of various social groups using wastewater in the urban, peri-urban and rural area as a source of irrigation along the Musi River. The objective of this work is to assess the impact of peri-urban agriculture including irrigation practices with wastewater on the groundwater system in groundwater quality and elaborate recommandations for farming practices based on the scientific findings. The river is highly contaminated by waste water discharge into Musi River, there is no doubt there are high risks to health associated with use of wastewater. Nevertheless, farmers in the study region were not too much concerned about the quality of wastewater. Because of the fact that wastewater irrigation benefits the community dependant on wastewater for their livelihoods, through employment generation, increased farming income, savings in fertilizer costs, increased reliability of irrigation and access to water, and the proximity to urban markets. Moreover, it was available free of cost. So, banning use of this resource cannot be the solution as wastewater is the only reliable source of irrigation for farmers in this region.

Keywords: *Musi River, Ground Water, Peri-urban, Sodium, Chloride, Potassium and Sulphate.*

Introduction

There are several states in India where more than 90% population is dependent on groundwater for drinking and other purpose. Ground water is also frequently using as the alternative source for agricultural and industrial sector. There are various ways as ground water is contaminated such as use of fertilizer in farming, seepage from effluent bearing water body. Most of the industries discharge their effluent without proper treatment into nearby open pits or pass them through unlined channels, resulting in the contamination of ground water (Jinwal et al, 2008). The incidence of ground water pollution is highest in urban areas where large volumes of waste are concentrated and discharge into relatively small areas*)*. The hydro-geochemical conditions are also responsible for causing significant variations in ground water quality (Rizwan Reza et al, 2009). The amount of water that enters the soil and eventually recharges the groundwater varies seasonally and with location. Most recharge occurs during wet years or wet seasons, when water tables rise and shallow or perched water tables may develop. During dry seasons, particularly with active plant growth or where water is pumped for irrigation, water tables may decline.

When groundwater is pumped and used for irrigation, evapotranspiration/evaporation process and percolation plays a crucial role. Thus the contaminated water flows back to the groundwater reservoir and polluting the source. A contamination might also come from pesticides and fertilizers when farmers spread these through their fields during growing periods. Water quality in the area has deteriorated due to increased human population, rapid urbanisation and unscientific disposal of waste and improper water management. Anthropogenic activities like poultry farms, various industries including chemical and pharmaceuticals, sewage release of reactive pollutants by chemical industries are the main cause for the degradation of water and soil quality in the watershed.

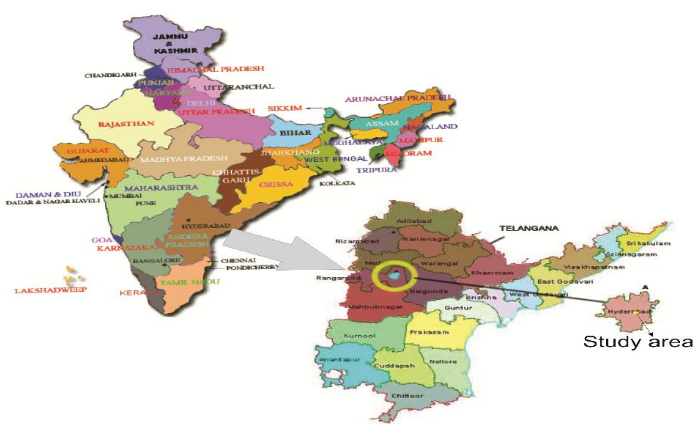
Urban/Peri-urban Agriculture is certainly a new concept at least in India. Due to large difference in the infrastructure and the land cost, people migrate from rural to urban areas and carry out jobs other than agriculture and they form the peri-urban areas. Among Water Resources, groundwater has its unique importance in such areas as hydrology and hydrogeology both become quite different in urban/peri-urban areas as the natural conditions hardly exist. Moreover, particularly in the Peri-urban areas the irrigated agriculture purely depends on the polluted water draining out from the houses. The urban poor, who are often migrants from rural areas, seek out an existence, engaging in many types of livelihood practices, and agriculture is one of them, especially when perennial wastewater/water supplies are available freely Hence, irrigation using alternate source of water e.g., groundwater could be a possibility for safe irrigation. But farmers use also surface water like river, lake, canal... to irrigate their fields. In this case, what is the impact of this type of irrigation on groundwater quality. In this framework, to conduct a study on a representative watershed (Kachwani singaram) along the Musi River downstream of Hyderabad the crops grown can vary from cereal to horticultural crops, depending on the availability and accessibility of land. In peri-urban Hyderabad, a variety of crops, namely rice, fodder and vegetables are grown primarily with wastewater.

Groundwater is affected by many factors such as physicochemical characteristics of soil, rainfall, soil erosion, weathering of rocks, chemical reactions sub-surface, role of microorganism, human and agricultural wastes and industrial effluents. Soil serve as a medium through which groundwater is recharged and any constituent added to soil may adversely affect the quality of groundwater. Anthropocentric inputs due to industrial activities are a major source of metal pollution of soils. Regardless of the source, most of the metallic wastes eventually end up in surface and subsurface waters. The movement of contaminated groundwater is controlled by physical and geochemical properties of (i) the contaminant (ii) the groundwater and (iii) the geological system through which the contaminated groundwater is flowing. Presence of some substances beyond certain limits may make it unsuitable for irrigation, domestic or industrial uses. Corrosion or incrustation of tube well screens is another hazard related to quality of groundwater. It also forms bases for groundwater treatment plan, if required.

Materials and Methods

Study Area

The study is located to the east of Hyderabad (AP), about 20 Km, close to the Musi River which is a tributary of the Krishna River and flows through Hyderabad. The selected watershed (Kachwami Singaram) constitutes a tributary of the Musi River located on the northern side (left bank) of the river. The surface watershed area covers about 2.74 km^2. (Fig 1*:* Location of the Study site within the Musi river catchment)



Sampling and Chemical Analysis

In order to study the major ion geochemistry of groundwater and to assess its quality, groundwater samples were collected from Residential, Agricultural and Industrial of the study area and analyzed for various parameters. A random sampling was used to select sampling points. In all, 25 samples collected and analysis was carried out for pH, electrical conductivity (Ec), Total dissolved solids (TDS), Total hardness (TH), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^+), Potassium (K^+), Carbonate (CO_3^-), Bicarbonate (HCO3-),Chloride (Cl^-), Sulphate (SO_4^{2+}) and Nitrate (NO_3^-) ions. These parameters pH, electrical conductivity were measured by means of pH and Conductivity meters, Total dissolved solids were computed from Ec multiplied by 0.64 (Brown and others 1970). Cations and Anions were determined using (METROHM 882 & 883 Compact IC PLUS) Ion chromatography.

Analysis of cations and anions

In order to study the major ion geochemistry of groundwater and to assess its quality, groundwater samples were collected from the study area and analyzed for various parameters. A random sampling was used to select sampling points In all, 9 samples collected during post-monsoon seasons of 2011. Analysis was carried out for calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), carbonate (CO_3^-), bicarbonate (HCO_3^-), chloride (Cl^-), sulphate (SO_4^{2+}) and nitrate (NO_3^-) ions.

Results and Discussion

Wells	pH	EC (milli Siemens)	TDS (ppt)	Temp ^{0}C	EH (milli volts)
Mu01	7.64	1510	1168.28	29.3	144
Mu02	7.43	970	668.81	29.8	159
Mu04	7.18	1350	930.82	29.8	126
F1	7.21	1500	1055.85	29.8	134
Borewel2	7.44	1700	1315.29	29.8	129
DW1	7.63	1340	923.93	29.3	123
DW2	7.66	1240	854.98	29	146
DW4	7.12	1630	1261.13	29.8	132
DW5	7.64	1330	917.03	29.8	158
P1	7.4	1390	958.4	29	130
5BW1	7.32	1760	1361.71	29	140
HP1	7.27	630	434.38	29.8	130
6BW2	7.18	1530	1183.76	28.3	171
IW1	7.14	1530	1183.76	29	167
IW2	7.8	1620	1253.39	27.3	137
IW3	7.02	1050	723.97	28.2	172
IW5	7.14	1520	1176.02	28.8	165
Borewel 3R	7.46	1370	944.61	28.3	178
Borewel 4R	7.14	900	620.55	28	164
IWP	7.25	2130	1647.98	28.3	162
SCH1	7.46	2210	1709.87	29	162
IR1	7.25	2080	1609.29	28	162
GRANITES	7.05	1510	1168.28	29	168
TABLETS	7.31	1350	930.82	28.3	160

Aquifer characteristics. EC: Electrical Conductivity, pH, Temperature, TDS, Reduction potential

- **pH** is one of the important factor of ground water. In the study area pH varies from 7.0 to 7.8 samples were within the permissible limit prescribed by Indian standards. The pH of water is this study area is slightly alkaline in nature. It is observed that 32% of samples come under fresh water and 68% of the samples come under brackish water (TDS >1000 mg/l).

- **Electrical Conductivity (EC):** Conductivity is the measure of capacity of a substance to conduct the electric current. Most of the salts in water are present in their ionic forms and capable of conducting current and conductivity is a good indicator to assess groundwater quality. Electrical conductivity is an indication of the concentration of total dissolved solids and major ions in a given water body. The EC values in majority of samples are higher than permissible limit. High conductance (>1500 µs/cm) was observed for 52% as per WHO (2006) and BIS (ISO 10500:1991) of the groundwater samples and this may be attributed to high salinity in groundwater of the study area. Excess salinity reduces the osmotic activity of plants and thus interferes with the absorption of water and nutrients from the soil.

- **Total dissolved solids (TDS):** The total dissolved solids (TDS) are the concentrations of all dissolved minerals in water indicate the general nature of salinity of water. The total dissolved solids in all the study area varies from 600 to 2300 mg/l. The higher value of total dissolved solids is attributed to application of agricultural fertilizer contributing the higher concentration of ions in to the groundwater. Nearly, 16% Total hardness of groundwater of the study area exceeded the desirable limits (>500mg/l) according to WHO (2006) and BIS (ISO 10500:1991), this hardness of water is due to the presence of alkaline earths such as calcium and magnesium.
- High concentrations in chloride, sodium, potassium and sulphate confirm the significant contamination of Musi river water.

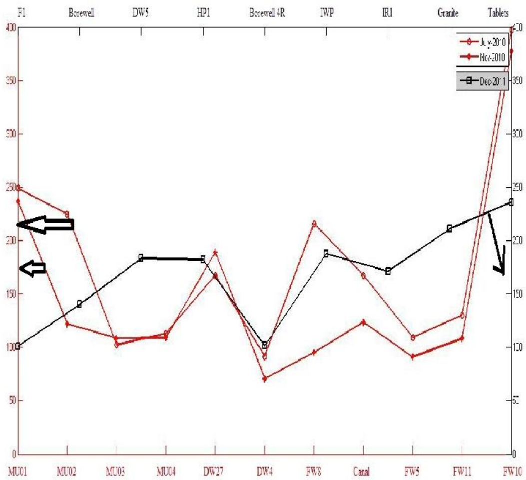


Fig 2: Observed data of **Sodium** concentration from different wells

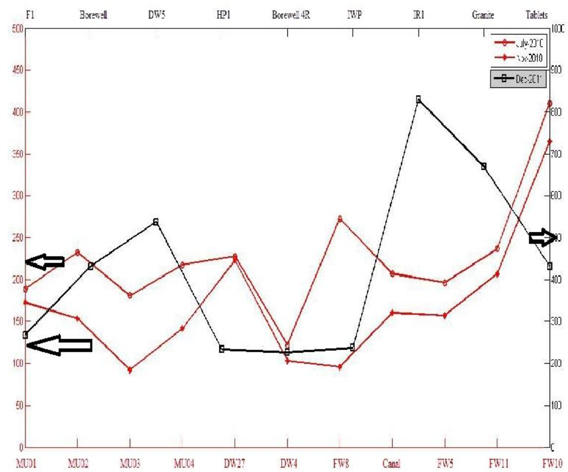


Fig: 3 Observed data of **Chloride** concentration from different wells

Figure 2 depicts some of the sodium samples which are exceeding the permissible limit as shown in graph. In continuation to the above investigation the analysis done for the same wells in the month of November 2010, it was analyzed that the concentration of sodium increased in comparison to July as depicted by the above Figure. This indicates the pollution level of the ground water is increased due to urbanization and industrialization. Further the analysis conducted in December 2011, about 96% of sodium samples from the study area exceeded the desirable limit (600mg/l) as per BIS (ISO 10500:1991) for agricultural purposes. On comparing these results with BIS standards it can be depicted that the increasing trend has been observed in sodium concentration from July'2010 to December'2011.

Figure 3 depicts the chloride concentration of the ground water samples analyzed in July 2010, November 2010 and December 2011The first sample analysis was done in July 2010.It was observed that the chloride concentration was within the permissible limits as per BIS 1991(250 mg/l) in the study area. The second sampling analysis was done in the month of November 2010; it was observed that the concentration of the chloride is decreasing when compared to the first sample analysis as shown in the above graph. The present analysis was conducted in December 2011 in the same aquifer and it was analyzed that chloride of 36% samples from the study area exceed the desirable limit (250 mg/l) as per BIS (ISO 10500:1991) for agricultural purposes. On comparing these results with BIS standards it can be depicted that the increasing trend has been observed in calcium concentration from July'2010 to December'2011.

Fig 4: Observed data of potassium Concentration from different wells

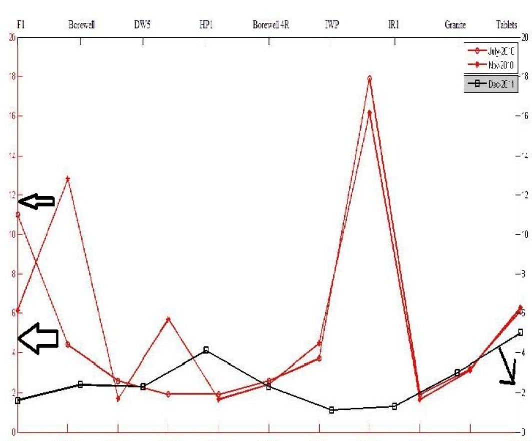


Fig 5: Observed data of Sulphate concentration of different wells

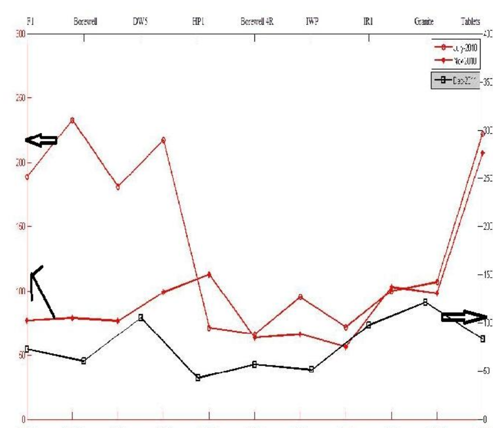


Figure 4, depicts the potassium concentration of the ground water samples analyzed in July 2010, November 2010 and December 2011. As per our readings Taken from the study area (Kachwani singaram) in July 2010 of above mentioned wells, some of the sodium samples which are exceeding the permissible limit as shown in graph. In continuation to the above investigation was the analysis done for the same wells in the month of November 2010, comparing to the July month readings the concentration of the potassium is increased which is shown in graph. This indicates the pollution level of the ground water is increased due to urbanization and industrialization. Further the Analysis conducted in December 2011 and for Potassium nearly 12% of the samples exceed the desirable limit (10 mg/l) as per BIS (ISO 10500:1991) for agricultural purposes. On comparing these results with BIS standards (permissible Calcium limit 200 mg/L), it can be depicted that the increasing trend has been observed in calcium concentration from July'2010 to December'2011.

Figure 5 depicts the sulphate concentration of the ground water samples analyzed in July 2010, November 2010 and December 2011. As per our readings Taken from the study area (Kachwani singaram) in July 2010 of above mentioned wells, some of the sodium samples which are exceeding the permissible limit as shown in graph. In continuation to the above investigation was the analysis done for the same wells in the month of November 2010, it was analyzed that the concentration of Calcium decreased in comparison to July as depicted by the above Figure.Further the analysis conducted in December 2011. All sulphate samples are within the desirable limit of (200 mg/l) as per BIS (ISO 10500:1991) for agricultural purposes

Conclusion

The Study area in south-eastern part of the Ranga Reddy district is a hard-rock terrain consisting of granites and forms a part of the Peninsular Shield of India. Groundwater samples collected from Residential and Agricultural of this region have been analyzed for various ionic and non ionic parameters to assess its quality for irrigational purposes. From the study it can be concluded that the ground water quality has been degraded over the years due to the extensive use of wastewater for irrigation in agricultural fields. While in some region of the study area, ground water samples showed variation in EC and TDS even though the canal water is not used for irrigation. This reports contamination is due to return flow from canal water.

High concentrations in chloride, sodium, potassium and sulphate confirm the significant contamination of Musi river water. On comparing these ionic results with the BIS (1991) permissible limits for agricultural purposes it has been concluded that the increasing trend has been observed in all ion concentration from July 2010 to December 2011.

Excess of Na and Cl^- concentrations deteriorates the soil quality and damage sensitive crops. Hence these soils require gypsum treatment to improve permeability of soils and yields of the crops. It is also recommended to have a periodical monitoring of the environment in this area and mitigate measures be implemented to avoid further deterioration of the Environment for Sustainable Development.

High conductance (>1500 µs/cm) was observed as per BIS (ISO 10500:1991) of the groundwater samples and this may be attributed to high salinity in groundwater of the study area. Excess salinity reduces the osmotic activity of plants and thus interferes with the absorption of water and nutrients from the soil.

References

Anon (2012) Agriculture use in Parts of Vaijapur, District Aurangabad, MS, India. *Research Journal of Chemical Sciences* Vol. 2(1), 25-31, Jan. (2012)

Biggs T.W and Jiang B.2009. Soil Salinity and Exchangeable Cations in a Wastewater Irrigated Area, India. *Journal of Environmental Quality* Vol 38: 887-896.

Buechler S. and Mekala D.G.2005. Local Responses to Water Resource Degradation in India: Groundwater Farmer Innovations and the Reversal of Knowledge Flows. *Journal of Environment and Development* **14** (4): 410-438.

Celio M., Scott C. And Giordano M.2009. Urban–agricultural water appropriation: the Hyderabad, India case. *The Geographical Journal,* Vol. **175**, No. 3

Deshpande S.M. and Aher K.R.2011 Evaluation of Groundwater Quality and its Suitability for Drinking and Agriculture use in Parts of Vaijapur, District Aurangabad, MS, India. *Research Journal of Chemical Sciences,* Vol. **2(1),** 25-31, Jan. **(2012)**

Dewandel B., Gandolfi J.M., Zaidi F.K., Ahmed S. and Subrahmanyam K. 2007.A Decision support tool with variable agro climatic scenarios for sustainable groundwater management in semi-arid hard-rock areas. *Current Science*, vol. **92**, no. 8

Dewandel, B., Gandolfi, JM., de Condappa, D., Ahmed, S. 2008. An efficient methodology for estimating irrigation return flow coefficients of irrigated crops at watershed and seasonal scales, *Hydrological Processes* 22: 1700–1712

F. Brissaud. Groundwater recharge with recycled municipal wastewater: criteria for health related guidelines. *Hydrosciences, MSE, Univ. Montpellier II, 34095 Montpellier Cedex 05, France.*

Jeena .T. sreenivasan and v.ratna reddy waste water irrigation in India. PAPER FOR PRESENTATION IN THE INSEE CONFERENCE 2009

Karanth, K.R.1987.Groundwater Assessment, Development and Management, Tata McGraw Hills Publication Company Limited. New Delhi.

Manoj Kumar Meena, Subroto Dutta*andRashmi Pradhan. Environmental impacts of wastewater irrigation on groundwater quality a case study of ajmer city, rajasthan (india). *Electronic journal of Environment,Agriculture and Food chemistry.*

McCartney M., Scott C., Ensink J., Jiang B. and Biggs T. W.,2008.Salinity implications of wastewater irrigation in the Musi River catchment in India. *Cey. J. Sci. (Bio. Sci.)* **37** (1): 49-59.

Michaela FRIEDLOVÁ 2010 .The Influence of Heavy Metals on Soil Biological and Chemical Properties

Pay Drechsel, Christopher A. Scott, Liqa Raschid-Sally, Mark Redwood and Akiça Bahri. Wastewater Irrigation and Health. *IWMI, International Development Research Institute.*

Rana, L Dhankhar, R and Chhikara.S. 2010. Soil Characteristics Affected by long term Application of Sewage Wastewater. *Int. J. Environ. Res., 4(3):513-518, Summer 2010*

Status of Ground water quality in india part – ii. groundwater quality series:gwqs/ 10/2007-2008. central pollution control board.

U.K. shukla 2010. Hydrochemistry for the assessment of ground water quality in Varanasi a fast urbanizing center in uttar Pradesh, India.*Environ monit asses (2011) 173:279-300*

Urban wastewater use for irrigation: A case study of farmers along Musi River in Hyderabad. *Karnataka J. Agric. Sci., 22(1): (235-237) 2009*