IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 9, Issue 3 Ver. I (Mar. 2015), PP 66-71
www.iosrjournals.org

Electrical Conductivity of Lake Water as Environmental Monitoring – A Case Study of Rudrasagar Lake

Mihir Pal[1], Nihar R. Samal[2], Pankaj Kumar Roy[3], & Malabika. B. Roy [4]
[1]*Department, of physics, Ramthakur College, Agartala-799003, INDIA*
[2] *Institute for Sustainable cities, City University of New York, 695 Park Ave, New York, NY 10065, USA*
[3]*School of Water Resource Engineering, Jadavpur University, Kolkata-700032, India*
[4]*Gandhi Centenary B.T.College, Habra, North 24th Paraganas, West Bengal, INDIA*

Abstract : *The development in water quality monitoring has improved considerably during the last few years ,partly because of engineers and scientists using new and sophisticated instruments .The spatial and temporal structure of lake hydrodynamic processes can able to control the lake water quality monitoring very much. One of the most important thermo physical properties of lake water is its electrical conductivity (EC) and this maintains almost a linear relationship with total Dissolved solids (TDS) in case of Rudrasagar, a natural lake in western Tripura. Recent studies on Rudrasagar lake suggest that there exists a good correlation between these two parameters and also both of these increase with depth. The objective of this study is to investigate the temporal and spatial variation of EC which may be a good indicator of water quality monitoring and also of environmental monitoring of the lake surrounding. Seasonal variation of these two parameters EC and TDS has also been analyzed here for following the seasonal trend of water quality. Time- relevant information about water quality monitoring and its availability to residents of lake area is very much significant in this regard.*
Keywords: *Electrical conductivity (EC), Rudrasagar Lake, Total Dissolved Solid (TDS),*

I. Introduction

The changes to the aquatic environment can be easily detected through the lake water quality monitoring and so monitoring on different aspects of water quality over time allows a complete pictures of the status of water resource. All the physical, chemical and biological parameters are to be measured to investigate the degree of stress of the aquatic ecosystem. Water quality monitoring as well as time relevant data for EC and TDS are very useful for implementation of pollution prevention strategies. Electrical conductivity (EC) is the ability of current conduction and in case of water it is also an estimator of the amount of total dissolved salts or ions in water. EC has well established dependency on temperature and so the collected data are to be standardized to 25^0c.With in the temperature range of environmental monitoring (0-30^0c), temperature dependency of EC may be represented by $EC_t = EC_{25} [1 + a(t-25)]$, where EC_t & EC_{25} represent the electrical conductivity at temperature t^0C and 25^0C respectively, a is the temperature compensation factor (Sorensen & Glass,1987).

Again the lake water conductivity may be controlled by various factors like watershed geology, the watershed's size in relation to lake size, wastewater from point sources, runoff from non point sources, atmospheric inputs, evaporation rates, some types of bacterial metabolism etc. Micro siemens per centimeter is the standard and commonly used unit for EC freshwater measurements. Water can picks up variety of dissolved and suspended substances while it runs across the rocks and watershed and thereby moving down the stream channel. The amount of dissolved or soluble materials in water is termed as total dissolved solid (TDS) and is generally measured in (mg/L).Different ions like sodium, potassium, chloride, carbonate, sulfate, calcium, magnesium etc. contribute to the TDS of water. **S**urvival, growth or reproduction of any aquatic organisms is very much controlled by the dissolved ions concentration in lake water. Water will be of freshwater category if its TDS value is less than 1,000mg/L, it will be saline if TDS range lies in between 10,000mg/L and 30,000mg/L and water will be brine for its TDS value above 30,000mg/L (Ela.Wendell P., Introduction to Environmental Engineering and Science, Prentice Hall,3rd ed,2007).TDS is often supervised in order to create a water quality environment favorable for organism productivity.

The more chemical ions or dissolved salts a body of water contains, the higher the conductivity will be. Consequently, conductivity may be correlated to total dissolved solids and chloride ions. The correlation factor varies between 0.55 and 0.8(E.A. Atekwana et al.2004).Significant change in conductivity may be due to either natural flooding, evaporation or man-made pollution and can be very detrimental to water quality. So sudden increase or decrease in conductivity in a body of water may indicate pollution .Agricultural runoff or a sewage leak may be the primary cause of rise in conductivity due to the additional chloride, phosphate and nitrate ions.

In case of estuaries it is noticed that conductivity and salinity fluctuates due to change of water level also. During rise and fall of tides saltwater is pushed into estuary from ocean and pulled out from estuary respectively, which causes rising and lowering of both the water quality parameters respectively. An oil spill or addition of other organic compounds might decrease conductivity as these elements do not break down into ions. So in both cases, the additional dissolved solids will show a negative impact on water quality.

II. Methodology

Study Area: Geographically the Rudrasagar Lake ($23^{\circ}29^{'}$ N and $90^{\circ}01^{'}$ E), a floodplain wetland of Gumti river is located in the Melaghar Block under Sonamura Sub-Division and is about 50 km from the state capital of Tripura. Hydro morphologically, Rudrasagar lake is a natural sedimentation water reservoir, that has three evergreen types of influx namely, Noacherra, Durlavnaraya cherra and Kemtali cherra.The actual sediment particles transferred along with the flow and takes up residence within the tank in the occasion as well as the apparent clear water discharges into the river Gomati through a connective route that is Kachigang just as one outflow. Consequently no rock enhancement can be found having 50m is actually silt (Clay loam) and also down below enhancement is actually sandy. Encompassing hillocks are generally involving delicate sedimentary enhancement. Average water basin area of the lake has been identified 1. 95 sq kilometer throughout the entire observation periods.

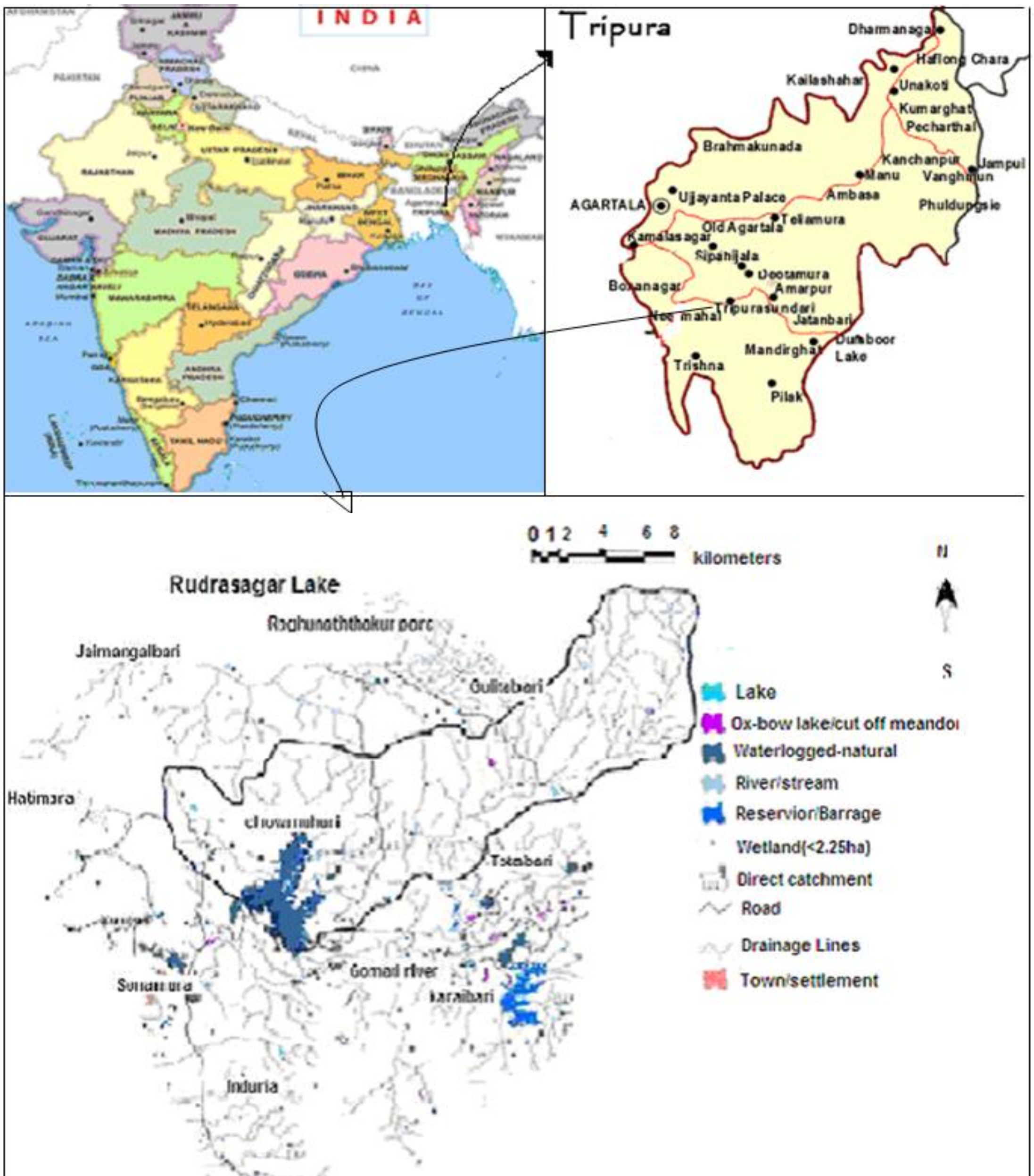

Figure 1.Map for Study Site of Rudrasagar lake based on Resourcesat-1 LISS-III(courtesy ISRO)

Sampling details: The observation stations are selected considering the maximum water depth along the mid reach and considering the less human intervention of water of the lake. The TDS and EC at the two observation stations S1 & S2 are recorded at different depths simultaneously by two multipurpose water quality analyzer devices at a time. Data are stored in memory cells of the devices which are then transferred to the database of the computer. The water quality analyzer devices are usually calibrated before the field work in every sampling day following the laboratory methods (APHA, 1989). The resolutions of EC and TDS measurements are 0.001ms/cm and 0.001g/L respectively.

III. Results And Discussion

For following the variation of EC and TDS with depth, collected data during the 2nd week of March 2014 i.e during summer season at the time of sampling 14:10 hours has been used. Figures 2 and 3 show the variation of EC and TDS with depth in sampling site S1 of Rudrasagar lake whereas figure 4 and 5 show the variation of the two quantities with depth in sampling site S2.

Figures 2 to 5 reveals that both EC and TDS increase with depth in both the selected sites s1 and s2 of the lake Rudrasagar. All the EC values collected were standardized to 25^0c and thereby nullifying its dependency on temperature .Figure 6 represents the graph and equation showing relationship between EC and TDS for the lake Rudrasagar. The regression model developed from EC and TDS profiles for this lake shows a strong relationship between these two specific parameters. The correlation ratio between them is found to be 0.64 for this lake. Increase of this ratio may be an indicator of pollution of lake water.(Mitra et.al ,2005)

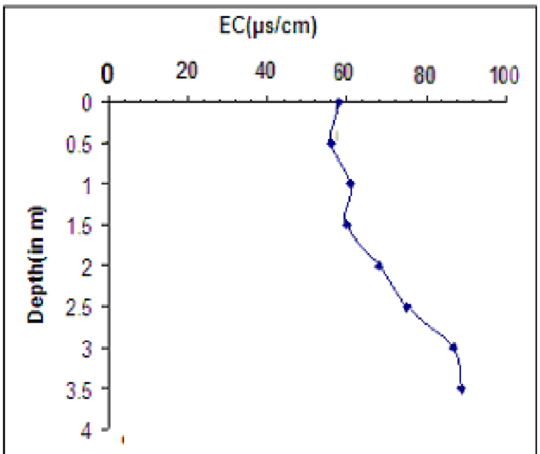

Figure 2 : Variation of EC with Depth in site 1

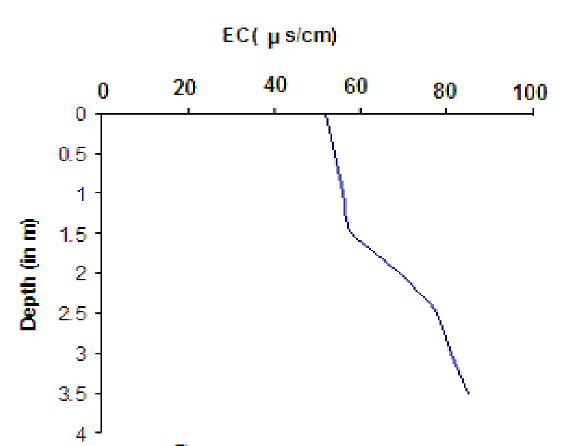

Figure 3 :Variation of EC with Depth in Site2

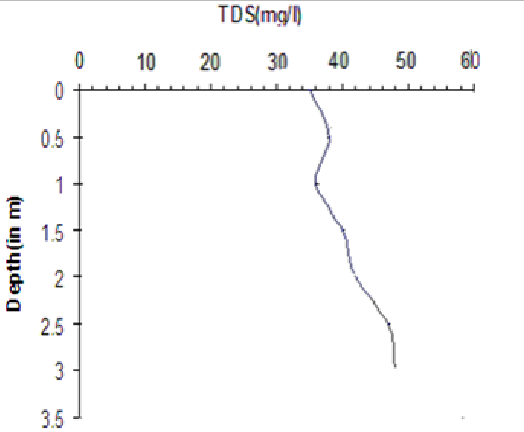

Figure 4 :Variation of TDS with Depth in site1

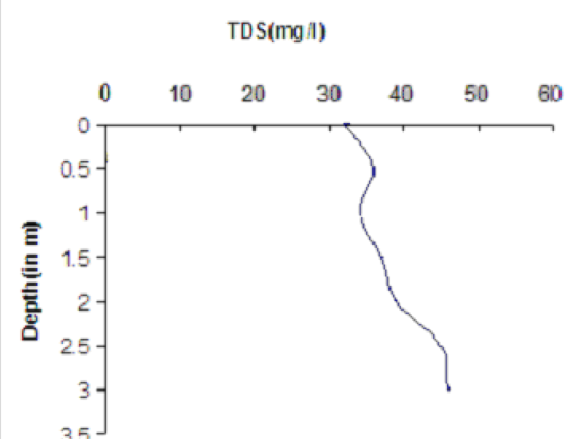

Figure 5 :Variation of TDS with depth in site 2

The regression model developed between the two parameters DO and TDS suggests that there exist a good correlation between them. The regression equation between them has been displayed in fig6.The correlation ratio between them is found as 0.6327 and the R^2 value as 0.9963

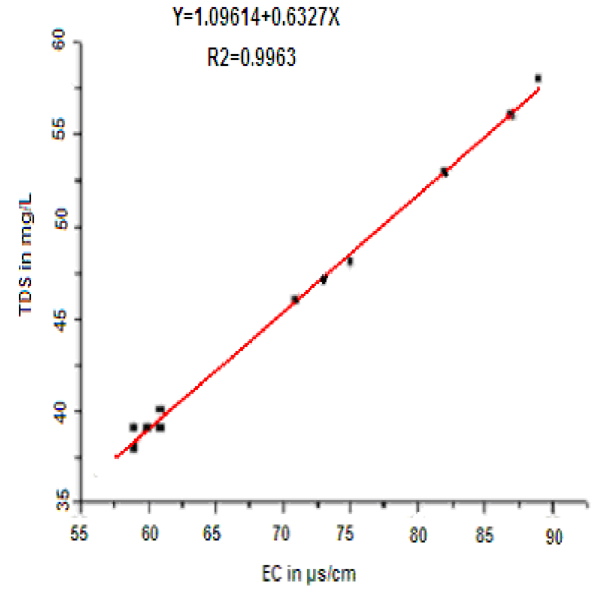

Figure 6: TDS-EC relation for Rudrasagar Lake

Figure**7** explores the seasonal variation of conductivity in both the stations s1 and s2 chosen. If an increasing trend is noted over a period of years then conductivity is a good indicator of potential watershed or lake

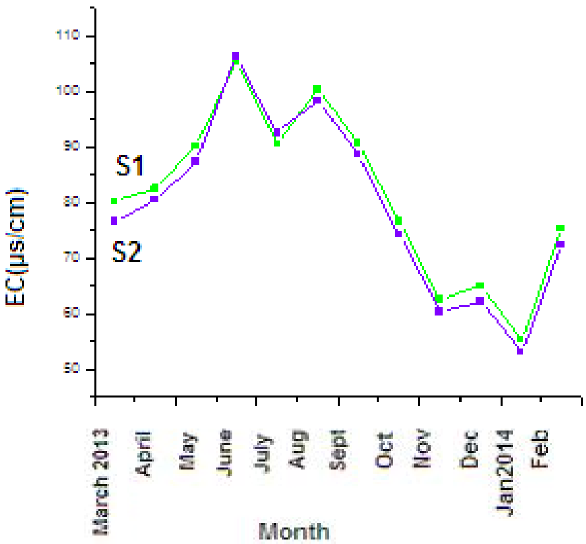

Fig 7 : Seasonal variation of EC of th water of Rudrasagar lake problems over the long term .Seasonal variations in conductivity are not only affected by average temperature but also by water flow. In case of lakes where inflow is marginal seasonal averages may depends mainly on temperature and evaporation. If flooding occurs due to heavy rain fall, the conductivity mainly depends on water body and surrounding soil. There are several spikes in the seasonal variation pattern of EC. Dilution of the water source occurs in wet season due to rainfall and thereby decreasing the conductivity level. On the other hand if floodplain contains nutrient-rich soil, previously dry salt ions can enter solution as it is flooded, thereby raising the conductivity level. For such lowering or rising of conductivity level in the seasonal pattern, spikes occur. In case of Rudrasagar lake the maximum conductivity was recorded during the summer season while minimum during winter season. In site S2 maximum and minimum value of EC has been identified as 104.35 µs/cm and 53.76 µs/cm respectively whereas its average value was found as 81.18 ± 3.52 µs/cm throughout the entire season of study.

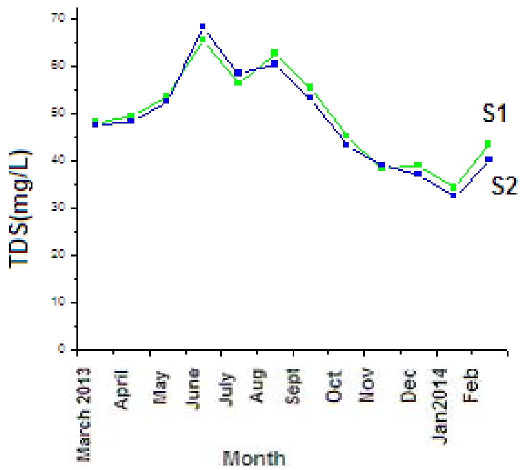

Fig 8 : Seasonal variation of TDS of the water of Rudrasagar lake

Figure 8 explores the seasonal variation of TDS in both the stations s1 and s2.There is several spikes in the seasonal variation pattern of TDS also. The maximum values of TDS occurred during summer and monsoon month whereas the minimum value occurred during winter season. The maximum and minimum value of TDS is 68.75mg/L and 35.23mg/L and has been identified in summer and winter season respectively. Average value of TDS has been estimated as 49.242±9.77 mg/L throughout the entire seasonal cycle studied.

IV Conclusion

This paper explores that there exists a linear relationship between TDS and EC for the lake water Rudrasagar, which is located in the upper catchment area of the river Gumti. The correlation ratio is found as 0.6327 which is almost equal to the freshwater ratio of insignificant pollution. However this ratio may be affected by any change in meteorological and morphological condition. The seasonal variation of EC and TDS of this lake shows several spikes in their profile. The temporal and spatial variation of EC studied here, may be taken as a good indicator of water quality monitoring as well as environmental monitoring of this lake.

Acknowledgement

The authors are grateful in the real sense of the term to the authorities of Rudrasagar Lake for permitting and providing necessary facilities during fieldwork. Authors also gratefully acknowledge the Civil Engineering Dept .NIT, Agartala who have helped by supplying necessary instrument for field measurement. Also the authors gratefully acknowledge the School of water Resource Engineering, Jadavpur University, Kolkata and its Director for their inspiration and constant encouragement. . Financial support due to release of grant-in-aid having grant no F.5-67/2013-14(MRP/NERO) from UGC (N.E.R.O), Govt. of India, Guwahati is sincerely acknowledged.

References

[1]. Beauchamp, R.S.A. (1956). The electrical conductivity of the headwaters of the White Nile. Nature, London 178, 616-619
[2]. Clesceri, L.S., Greenberg, A.E., Trussell, R.R., 1989. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington, DC

[3]. DeZuane, John (1997). Handbook of Drinking Water Quality (2nd ed.). John Wiley and Sons.
[4]. Edmondson, W.T. (1956). Measurement of conductivity of lake water in situ. Ecology 37, 201-204.
[5]. Fenn, C.R. 1987. Electrical conductivity. In Glacio-fluvial Sediment Transfer: An Alpine Perspective. A.M. Gurnell and M.J. Clark (editors). John Wiley and Sons, Chichester, U.K., pp. 377–414
[6]. Glenn Carlson,(2005) 'Total Dissolved Solids from Conductivity', Technical note 14,www.In-situ.com.
[7]. Hayashi, M. 2004. Temperature-electrical conductivity relation of water for environmental monitoring and geophysical data inversion. Environmental Monitoring and Assessment 96:119–128.
[8]. Imboden,D. and A. Wuest(1995)Physics and Chemistry of Lakes,Springer,pp.91-93
[9]. Kobayashi, D., Y. Ishii, and Y. Kodama. 1999. Stream temperature, specific conductance and runoff process in mountain watersheds. Hydrological Processes 13(6):865–876.
[10]. Mortimer, C.H. (1941–1942). The exchange of dissolved substances between mud and water in lakes: I and II. Journal of Ecology 29, 280-329. III and IV. Journal of Ecology 30, 147-201.
[11]. Mäntynen , M. 2000. Calculating the temperature coefficient for electric conductivity measurements and some observations of the connection between TDS and electric conductivity, Working Report 2000-16, Posiva Oy .
[12]. Narayanan, P. (2003) Analysis of environmental pollutants: principles and quantitative methods. Taylor & Francis
[13]. N.C. Mondal, V.P. Singh; Journal of Hydrology 405, 235–247, 2011.
[14]. Pal. M, Roy .M.B & Roy. P.K.2015. Seasonal response of water Temperature of Lake Rudrasagar in relation to some Physico-Chemical Characteristics .Energy Research and Environmental Management: An Innovative Approach ,pp 23-27
[15]. Pawlowicz, R. (2008). Calculating the conductivity of natural waters. Limnology and Oceanography: Methods 6, 489-501.
[16]. Pawlowicz, R. (2008). Calculating the conductivity of natural waters. Limnology and Oceanography: Methods 6, 489-501.
[17]. Smith, S.H. (1962). Temperature correction in conductivity measurements. Limnology and Oceanography 7, 330-334.
[18]. Smart, C.C. 1992. Temperature compensation of electrical conductivity in glacial meltwaters. Journal of Glaciology 38(128):9–12.
[19]. Talbot, J.D.R., House, W.A. & Pethybridge, A.D. (1990). Prediction of the temperature dependence of electrical conductance for river waters. Water Research 24, 1295–1304.