

Vol 4 Issue 3 Sept 2014

ISSN No :2231-5063

International Multidisciplinary Research Journal

Golden Research Thoughts

Chief Editor
Dr.Tukaram Narayan Shinde

Publisher
Mrs.Laxmi Ashok Yakkaldevi

Associate Editor
Dr.Rajani Dalvi

Honorary
Mr.Ashok Yakkaldevi

Welcome to GRT

RNI MAHMUL/2011/38595

ISSN No.2231-5063

Golden Research Thoughts Journal is a multidisciplinary research journal, published monthly in English, Hindi & Marathi Language. All research papers submitted to the journal will be double - blind peer reviewed referred by members of the editorial board. Readers will include investigator in universities, research institutes government and industry with research interest in the general subjects.

International Advisory Board

Flávio de São Pedro Filho Federal University of Rondonia, Brazil	Mohammad Hailat Dept. of Mathematical Sciences, University of South Carolina Aiken	Hasan Baktir English Language and Literature Department, Kayseri
Kamani Perera Regional Center For Strategic Studies, Sri Lanka	Abdullah Sabbagh Engineering Studies, Sydney	Ghayoor Abbas Chotana Dept of Chemistry, Lahore University of Management Sciences[PK]
Janaki Sinnasamy Librarian, University of Malaya	Ecaterina Patrascu Spiru Haret University, Bucharest	Anna Maria Constantinovici AL. I. Cuza University, Romania
Romona Mihaila Spiru Haret University, Romania	Loredana Bosca Spiru Haret University, Romania	Ilie Pintea, Spiru Haret University, Romania
Delia Serbescu Spiru Haret University, Bucharest, Romania	Fabricio Moraes de Almeida Federal University of Rondonia, Brazil	Xiaohua Yang PhD, USA
Anurag Misra DBS College, Kanpur	George - Calin SERITAN Faculty of Philosophy and Socio-Political Sciences AL. I. Cuza University, IasiMore
Titus PopPhD, Partium Christian University, Oradea,Romania		

Editorial Board

Pratap Vyamktrao Naikwade ASP College Devrukh,Ratnagiri,MS India	Iresh Swami Ex - VC. Solapur University, Solapur	Rajendra Shendge Director, B.C.U.D. Solapur University, Solapur
R. R. Patil Head Geology Department Solapur University,Solapur	N.S. Dhaygude Ex. Prin. Dayanand College, Solapur	R. R. Yaliker Director Management Institute, Solapur
Rama Bhosale Prin. and Jt. Director Higher Education, Panvel	Narendra Kadu Jt. Director Higher Education, Pune	Umesh Rajderkar Head Humanities & Social Science YCMOU,Nashik
Salve R. N. Department of Sociology, Shivaji University,Kolhapur	K. M. Bhandarkar Praful Patel College of Education, Gondia	S. R. Pandya Head Education Dept. Mumbai University, Mumbai
Govind P. Shinde Bharati Vidyapeeth School of Distance Education Center, Navi Mumbai	Sonal Singh Vikram University, Ujjain	Alka Darshan Shrivastava Shaskiya Snatkottar Mahavidyalaya, Dhar
Chakane Sanjay Dnyaneshwar Arts, Science & Commerce College, Indapur, Pune	G. P. Patankar S. D. M. Degree College, Honavar, Karnataka	Rahul Shriram Sudke Devi Ahilya Vishwavidyalaya, Indore
Awadhesh Kumar Shirotriya Secretary,Play India Play,Meerut(U.P.)	Maj. S. Bakhtiar Choudhary Director,Hyderabad AP India.	S.KANNAN Annamalai University,TN
	S.Parvathi Devi Ph.D.-University of Allahabad	Satish Kumar Kalhotra Maulana Azad National Urdu University
	Sonal Singh, Vikram University, Ujjain	

Address:-Ashok Yakkaldevi 258/34, Raviwar Peth, Solapur - 413 005 Maharashtra, India
Cell : 9595 359 435, Ph No: 02172372010 Email: ayisrj@yahoo.in Website: www.aygrt.isrj.net



STUDY OF THE PHYSICAL PARAMETERS OF SELECTED SPRING WATER OF EAST DISTRICT, SIKKIM

Sudip Kumar Das¹ and Rakibul Islam²

¹M. Sc , Department of Physic , Sikkim University, Gangtok .

²Research Scholar , Department of Geography, Sikkim University, Gangtok .

Abstract:-Water samples from springs were collected from 5 completely different location across the Duga space of the East geographical region, to know the final distribution of components like Na, potassium, calcium, magnesium, sulphate, nitrate, Electrical physical phenomenon, Total Dissolved Solids and pH scale, and its variation with temperature, and verification the equation of Electrical physical phenomenon and temperature. conjointly perceive the influence of ions concentration on Electrical physical phenomenon (EC). Total Dissolved Solids and Electrical physical phenomenon normally increase with decrease in altitude. Gypsum, Brine kind rocks were found to be the most issue dominant the chemistry of the spring waters.

Chemical compositions of all the spring waters ar within the potable vary

Keywords:Spring water quality, altitudes, electric conductivity, temperature and linearity.

INTRODUCTION

Water is an important natural resource of the mother earth. Out of total area of the earth surface about 75% area cover by water, out of which near about 97% water is sea water and remaining 3% is fresh water (Stanley 2010). Within this major portion of fresh water is found in the form of glacier. Very little amount of liquid form of fresh water is available in River, streams, springs, atmospheric moisture, soil water and aquifer and natural springs. All of these are considered as the main source of fresh water. The ground water flowing to the surface as the spring throughout the year serves as the main source of water for drinking. About 80 % Sikkim's rural household are depends on spring water for supply of drinking water (Roy 2009). But the rising population and related activities such as agriculture and industry not only raises the demand of available fresh water but also pollutes the available fresh water on the earth surface. It also has impact on, spring ecosystem, aquatic flora and fauna, and also to the human health.

The Electrical Conductivity (EC) and Total Dissolved Solid (TDS) are influences by the chemical composition. Major chemicals properties of water that determined by the presence of amount of dissolved magnesium, calcium, sodium, sulphate, nitrates, chloride and they are influence by electrical conductivity.

Electrical conductivity (EC) is the reciprocal relation \bar{Y} (sigma). In ionic liquids, electrons or holes but conduction occurs by ions, which with the concentration of ions. salt water is has high electrical conductivity.

Electrical Conductivity of water refers to its ability to conduct electrical current. In water, Electrical Conductivity depends on the dissolved ions concentrations which are capable of charge carriers. The mobility of ions and electrical conductivity of water also depends on temperature. An increase in water temperature will leads to decrease in its viscosity and increase in the mobility of the ions in water and increase in the number of ions in water due to dissociation of molecules (Barron et al 2007).The mobility of a charged ion depends on its ionic size and charge. The EC of a fluid are depend on chemical species which are present in it and not just their concentration and mobility. The Electrical Conductivity is an indicator of Total Dissolve Solid (TDS) because ionic concentration of water is related to TDS (Masakihayashi 2004). EC of water sample is commonly used to examine the freshness of

water and also estimate the physical properties (such as TDS, concentration of ions) in spring hydrograph. The major positively charged ions of spring water in Sikkim Himalaya are sodium, calcium, potassium and magnesium and the major negatively charged ions are chloride, sulphate, carbonate, and bi-carbonate. Nitrates and phosphates are minor conductor, but biologically they are very important because determining quality of water.

This study attempts to understand the water quality of selected springs of East Sikkim and also try to verify linear relationship among the temperature, altitudes, TDS and EC of the spring water of sample site.

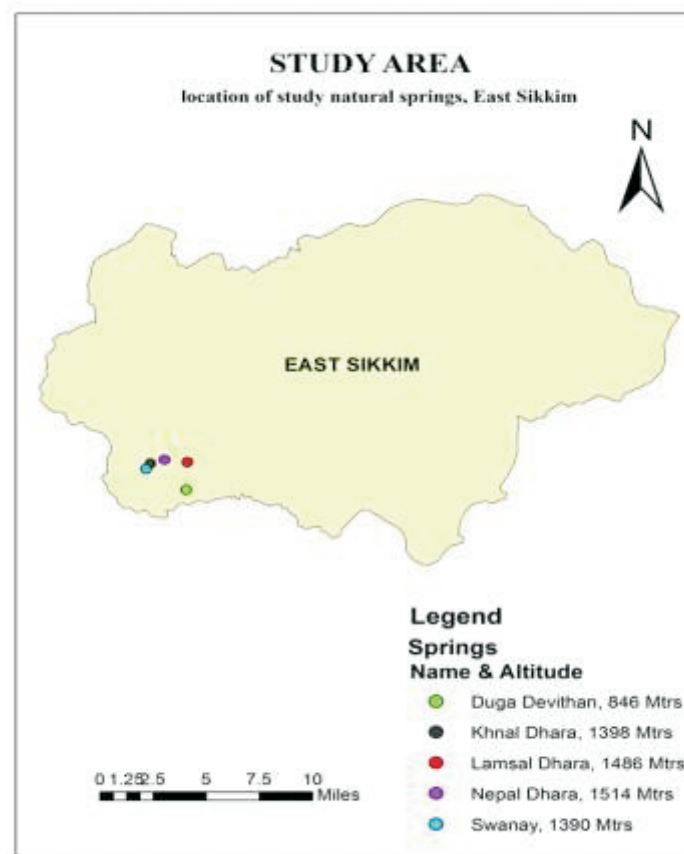
STUDY AREA

Sikkim is the second smallest and least populous state and geographically diverse Himalayan state of India, situated between 27° 00' 46" to 28° 07' 48" N latitude and 88° 00' 58" to 88° 55' 25" E longitude with geographical area of 7,096 sq km. Being a part of Himalayas Mountain the natural elevation of the state are ranges from 300 m to 8598 m (Tambe et. al 2011). The study watershed area fall under east district of Sikkim whose natural elevation lies between from 950m at Duga to 1250m (M.S.L) at Lamsal Dhara. The study watershed region located in rain shadow zone of Sikkim therefore, these regions received relatively less amount of precipitation as compare to other parts of the state.

In terms of geology, Sikkim is best displayed in the form of Teesta gorge flowing in general from north to the south. A sequence of high grade meta-sedimentary rocks ranges from calc-granulites, schist, quartzite and gneisses to migmatites and a numbers of granitic intrusions are exposed in the Axial Zone of North Sikkim. Southern part of teesta basin is characterized by low-grade pelite-psammite assemblage belongs to the Daling formation Darjeeling gneiss and Daling Group and followed by sandstone shale-coal assemblage of Gondwana formation. The Central Crystalline rocks are separated from the gneisses and schist's belonging to Darjeeling gneiss and Daling Group.

Due to fragile nature of its landscape number of small streams, channels and snow fed rivers and natural spring are originated elsewhere in the Sikkim. Generally springs of Sikkim are classified into – hot springs; most of them are found in south, west and north district of Sikkim. The soft water springs are found in east and north Sikkim. Most of them are originates either from depression or fracture zone. From this zone aquifer water come out to the surface due gravitational force and flows out to the surface as spring.

In the Himalayan region springs are the origin of many streams and rivers. Natural springs are very significant to the mountain communities, because it is a prime source of irrigation and fresh drinking water.



OBJECTIVE OF STUDY:

Following are main objectives of study

- 1) natural springs of the study area.
- 2) To understand the interrelation among Altitude, water pH etc.
- 3) To understand the interrelation among water pH, Electrical Conductivity and Total Dissolved Solid with changing temperature.
- 4) To verify the linear equation between Electric Conductivity and Temperature.

METHODOLOGY

For this study natural springs from east Sikkim especially spring which located relatively rain shadow area are selected. The field survey has conducted during winter. The sample spring are randomly selected from the study area. Five natural springs namely; Duga Devithan source, Khanal Dhara, Swanay Dhara, Lamsal Dhara and Nepal Dhara are selected for this study.

GPS tool is used to know the coordinates and measure the elevation of study springs. The Arc GIS tool is used to map the study natural spring. Water samples are collected from field in polythene bottle. To avoid contamination the bottles are pre-washed and dried. After filled with water, the bottles are sealed with air tight cork and immediately brought to the laboratory for analysis.

The pH value of water samples are measured by dipping electrode pH meter. Electric Conductivity of water is determined by using electrometric method and amount of Total Dissolved Solid of samples are calculated with the help of following relation.

$$TDS = K \times EC$$

Where K- value varies from 0.55 to 0.85

The amount of sodium and Potassium are estimated by flame photometer using sodium chloride and Potassium nitrate solution respectively as reagent. Amount of calcium is estimated by atomic absorption spectrometry using calcium carbonate stock solution as reagent. Chloride is estimates by titration method Using silver nitrate as reagent developed by Mohr. Nitrate is estimates using Automated Colorimeter method. Specific Ion Electrode method is used to estimate the total amount of Sulphide.

The linearity of temperature, Electric Conductivity, Total Dissolved Solid is represented by Using Origin software package developed by Origin Lab Corporation. To know the influence of Cation's on the availability of Electric Conductivity and Total Dissolved Solid is verified by using Magnesium (Mg) as cation agent.

RESULT AND DISCUSSION

Table I: Concentration of various elements in study sample

Sample Name	pH value (At Room temp.)	Sodium Na^+ (mg/L)	Potassium K^+ (mg/L)	Magnesium Mg^{+2} (mg/L)	Calcium Ca^{+2} (Mg/L)	Sulphate (mg/L)	Nitrate (mg/L)	Chloride (mg/L)
Nepal Dhara	6.7	1.00	0.50	12.165	0.123	1.466	1.104	10.0
Khanal Dhara	6.4	1.25	0.75	4.396	0.198	2.345	0.430	10.0
Lamsal Dhara	7.3	0.50	0.75	8.779	0.183	8.054	3.137	10.0
Duga Devithan Source	8.0	0.75	0.75	13.313	0.144	2.520	5.050	10.0
Sawnay Source	7.3	2.00	0.75	11.728	0.107	1.906	3.540	10.0

Source: Data computed by authors 2013

safely stated that the pH value of water sample used to studies are lies in between 6.4 to 8.0, means approximately near about neutral point (pH 7.0) and portable and good for human health (the range of pH 6 to 8 for human health by WHO 1960). The available amount sodium in all case is lies in between 0.75 mg/l to 2.00 mg/l and highest amount of sodium is found in Sawney Source. Potassium concentrations in all samples are lies between 0.50 mg/l to 0.75 mg/l.

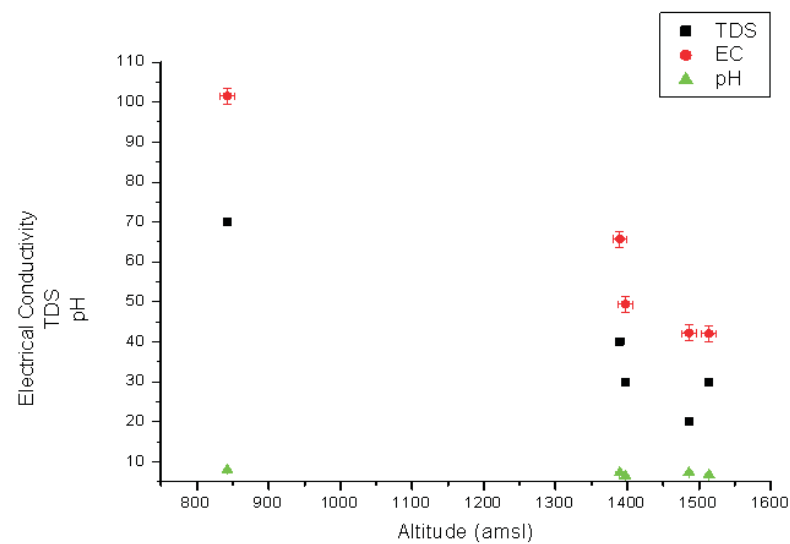
But magnesium concentrations are highly varies from sample to sample, least amount of magnesium is observed in water of Khanal Dhara that is 4.396 mg/l where as maximum amount of magnesium is recorded in water of Duga Devithan Source that is 13.313 mg/l. In case of calcium, again least amount is recorded in Sawney Dhara that is 0.107mg/l. Again in case of sulphate concentrations are varies from one sample to another and least amount of sulphate is recorded in Nepal Dhara where as maximum amount of sulphates are found in Lamsal Dhara that is 8.054mg/l.

The presence of nitrates in all sample are falls in between 0.430 mg/l for Khanal Dhara to 5.050 mg/l for Duga Devithan Source. For Duga Devithan Source is concerned the available amount of nitrate reach beyond the permissible limit for human health recommended by World Health Organization (5mg/l, WHO 1960).

Table II: Show the variation of EC, TDS and pH with altitude (at20°C)

Sample Nome	Altitude (m.s.l)(±10)	EC (µS/cm)(±2)	TDS (mg/L)	pH (±0.1)
Duga Devithan	842.5	101.5	70	8.0
Sawney Source	1389.6	65.7	40	7.3
Khanal Dhara	1397.5	49.4	30	6.4
LamsalDhara	1486.0	42.2	20	7.3
Nepal Dhara	1514.0	42.1	30	6.7

Source: Data computerd by Authors 2013



From above results we can simply concluded that altitudes, Electric Conductivity and Total Dissolved Solid and pH are inversely related to each others. When altitude is increases then the Electric Conductivity, TDS and pH are decreases and vice versa. Because when altitude is increase then the travelling length of springs are decreases, as well as the recharge area or the source of spring is not so far from the spring. So the spring does not absorb so many minerals from the rocks of the area. It also found that at higher altitude springs water are acidic in nature as compare to

springs are located in lower altitudes.

Table III: The influence of Cations concentration on available EC and TDS on study water sample

Sample Name	Cations Concentration (mg/l)	TDS	Electrical Conductivity (μs/cm)
Duga Devithan Source	14.81	70	101.5
Khanal Dhara	5.64	30	49.4
Lamsal Dhara	13.72	40	65.7
Nepal Dhara	9.27	20	42.2
Swanay Source	13.16	30	42.3

Source: Data computed by Authors 2013

From the above table it is very clear that, amount of Cations concentration, amount of Total Dissolved Solid and Electric conductivity are proportionally or linearly related to each other. If the concentration of cations is increases then the amount of Total Dissolved and Electric Conductivity also rises. Here the

<i>The Electric conductivity and Ion factor relation</i>	
<i>Ion</i>	<i>Conductivity factor μS/cm per mg/L</i>
<i>Na⁺</i>	<i>2.13</i>
<i>, Ca²⁺</i>	<i>2.60</i>
<i>K²⁺</i>	<i>1.84</i>
<i>Mg²⁻</i>	<i>3.82</i>
<i>Cl⁻</i>	<i>2.14</i>
<i>So₄²⁻</i>	<i>1.54</i>
<i>HCo₃⁻</i> ,	<i>0.715</i>
<i>NO₃²⁻</i>	<i>1.15</i>

Source: (Barron et al TSP-07 Issue 3)

Table IV: The interrelation among Temperatures, Electric Conductivity, and Total Dissolved Solid and Water pH of study spring water sample

Sample Name	Temperature (°C)(±0.5)	EC(μS/cm)(±2)	TDS(mg/L)	pH(±0.1)	K-factor
Duga Devithan source	20	101.5	70	8.0	0.686
	25	116.5	80	8.3	0.689
	30	127.3	90	8.5	0.706
	35	136.7	100	8.7	0.731
	40	148.2	100	8.8	0.674
	45	159.7	110	8.9	0.688

Khnal Dhara	20	49.4	30	6.4	0.60729
	25	62.3	40	6.5	0.69808
	30	72.2	50	6.6	0.69252
	35	79.1	60	6.7	0.75853
	40	89.1	70	6.8	0.80367
	45	95.1	80	6.9	0.84122
Lamsal Dhara	20	42.2	20	7.3	0.47393
	25	56.6	30	7.4	0.53097
	30	69.4	40	7.5	0.57637
	35	72.4	50	7.6	0.69061
	40	80.4	60	7.7	0.74627
	45	88.3	70	7.8	0.79275
Nepal Dhara	20	42.1	30	6.6	0.71259
	25	68.6	40	6.7	0.60060
	30	75.5	50	6.8	0.66225
	35	86.7	60	6.9	0.69204
	40	97.6	70	7.0	0.71721
	45	117.9	80	7.1	0.67854
Swanay Source	20	65.7	40	7.5	0.60880
	25	75.9	50	7.6	0.65870
	30	84.4	60	7.7	0.71091
	35	90.0	70	7.8	0.77777
	40	96.9	70	7.9	0.72231
	45	107.3	80	8.0	0.74551

Source: Data computed by author based 2013

Graphical representation of temperature, Electrical Conductivity, total dissolved solid and water pH from sample

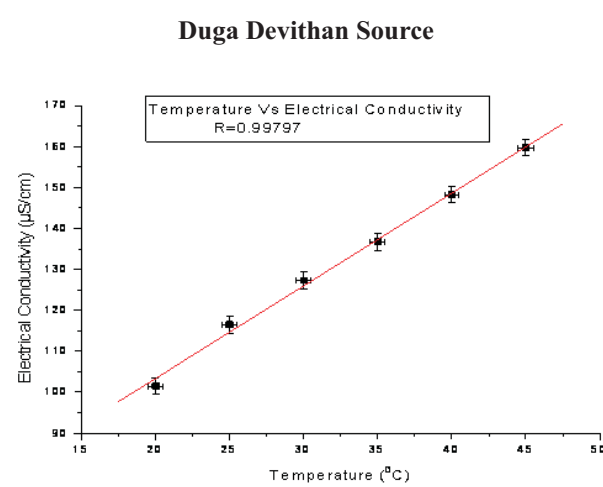


Figure 13: Temperature vs. Conductivity graph

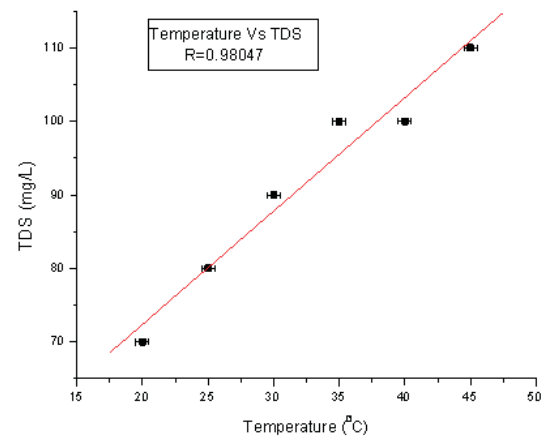


Figure 14: Temperature vs. TDS graph

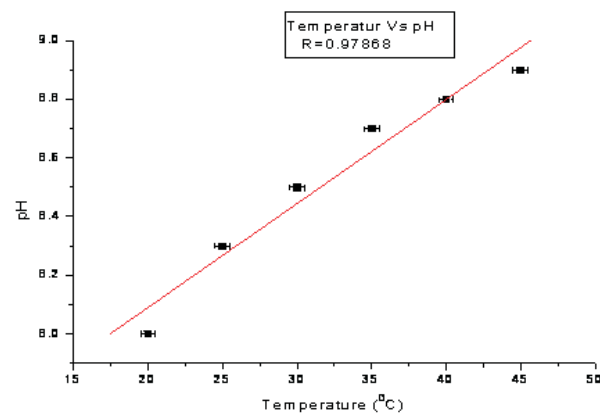


Figure 15: Temperature vs pH graph

Khanal Dhara

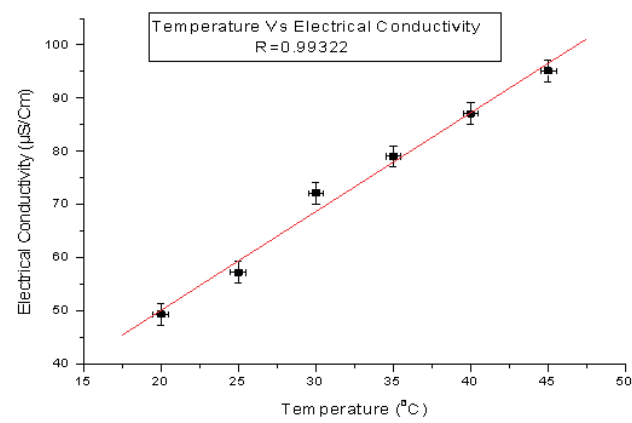


Figure 16: Temperature vs. conductivity graph

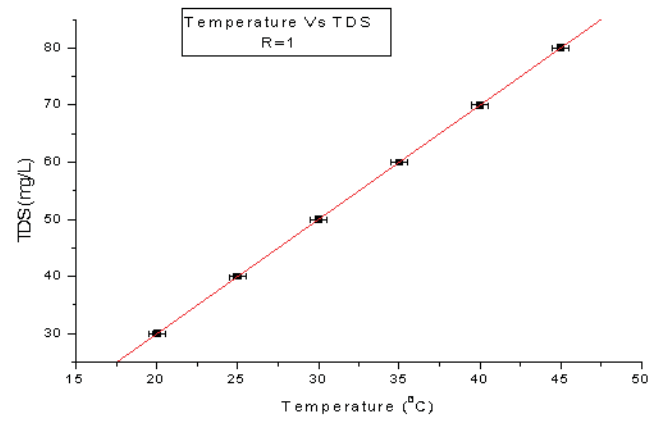


Figure 17: Temperature vs. TDS graph.

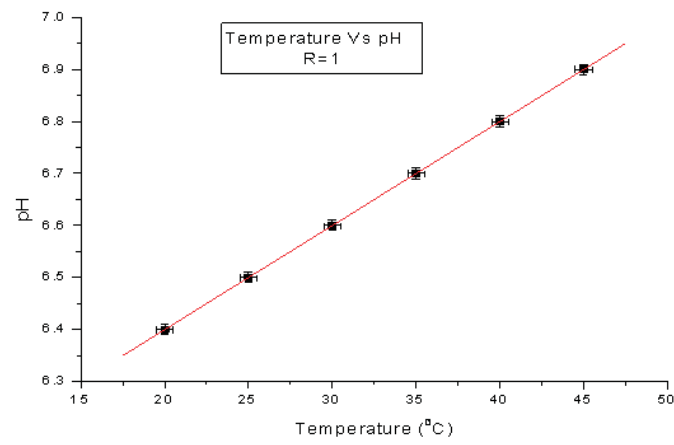


Figure 18: Temperature vs. pH graph

Lamsal Dhara

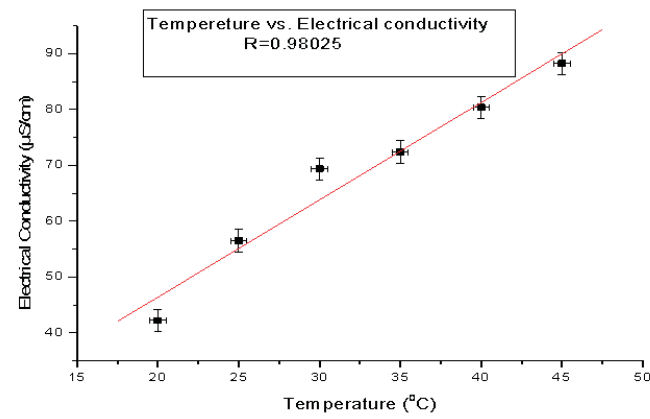


Figure 19: Temperature vs. Electrical Conductivity.

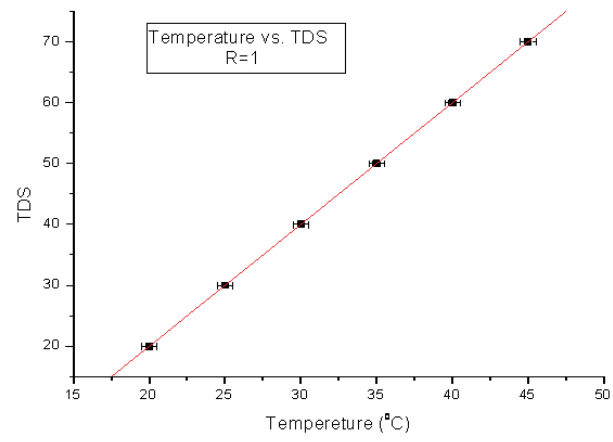


Figure 20: Temperature vs. TDS.

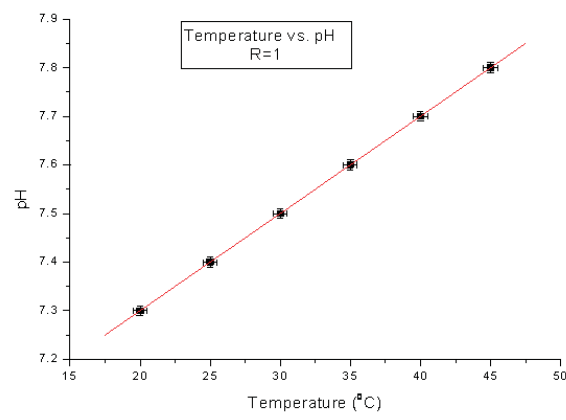


Figure 21: Temperature vs. pH

Nepal Dhara

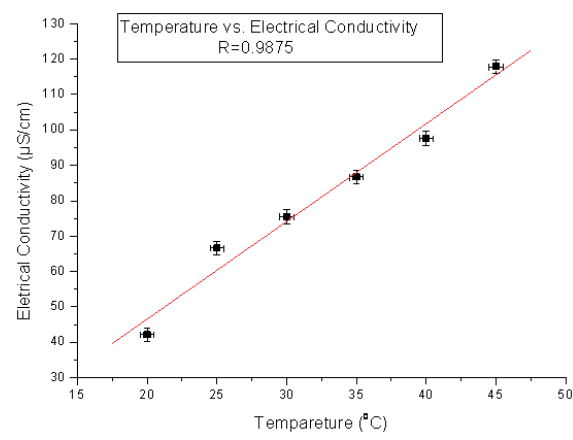


Figure 22: Temperature vs. Electrical Conductivity.

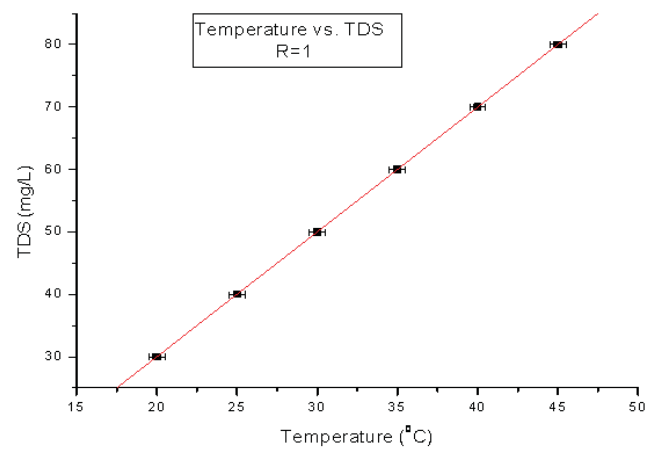


Figure 23: Temperature vs. TDS.

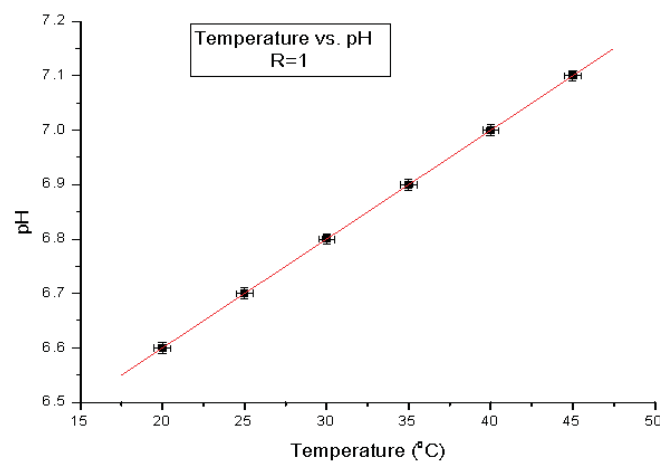


Figure 24: Temperature vs. pH

Swanay Dhara

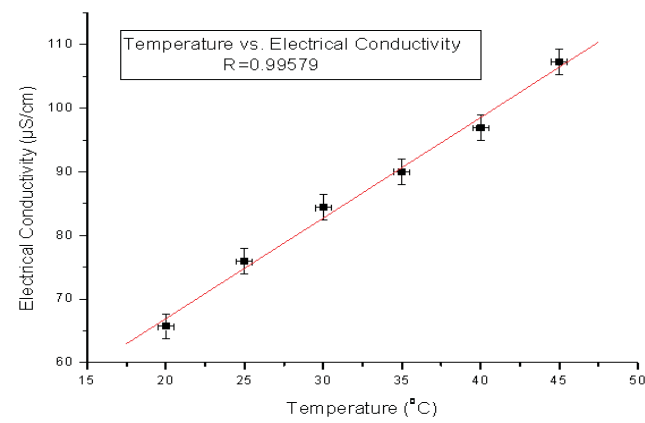


Figure 25: Temperature vs. Electrical conductivity.

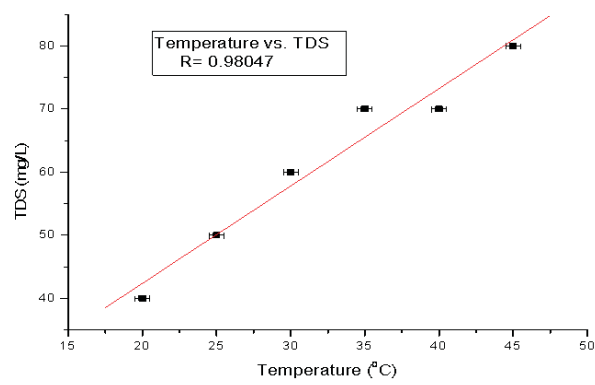


Figure 26: Temperature vs. TDS

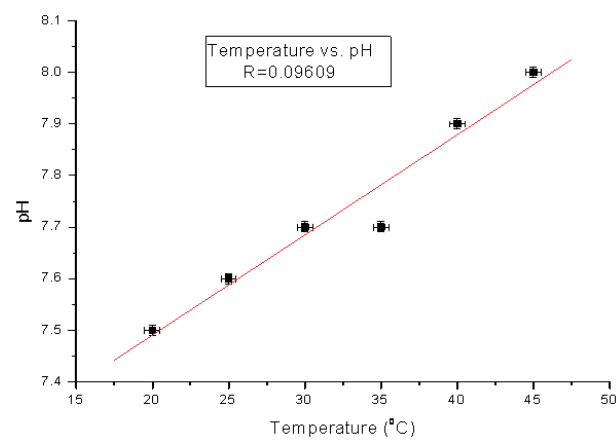


Figure 27: Temperature vs. pH.

Verification Linear Equation of EC and Temperature

Table V: Measured and calculating value of Electrical Conductivity for study sample

Sample Name	Temperature (°C)	Electric Conductivity (μS/cm) from measured value	Electrical Conductivity (μS/cm) from Equation
Duga Devithan	30	127.3	127.6
	35	136.7	138.7
	40	148.2	149.8
	45	159.7	161.0
Khanal Dhara	30	72.2	70.0
	35	79.1	77.8
	40	89.1	85.6
	45	95.1	93.4

Lamsal Dhara	30	69.4	67.8
	35	72.4	71.1
	40	80.4	78.2
	45	88.3	85.3
Nepal Dhara	30	75.5	72.9
	35	86.7	85.7
	40	97.6	94.3
	45	117.9	102.9
Swanay Source	30	84.4	83.14
	35	90.0	90.39
	40	96.9	97.64
	45	107.3	104.89

Source: Data computed by Authors 2013

Note:

The temperature and EC relation is not linear for natural water (millero 2001). However, the degree of nonlinearity is relatively small in a temperature range of environmental monitoring (0 –30 °C), and a linear equation (Sorensen, J. A. And Glass G. E 1987) is commonly used to represent the relation;

$$EC_t = EC_{25} [1 + \alpha(t - 25)]$$

Where EC_t the Electrical Conductivity at temperature t (°C) is, EC_{25} is the Electrical conductivity at temperature 25 °C and α is a temperature compensation factor. The value of α is commonly use 0.0191 (Clesceri, et al 1998). The above ver ifications show that all the water samples are followed the EC - Temperature linear equation. The EC-temperature relation is primarily controlled by the v iscosity of water (Korson, L. Hansen, D. W. & Millero F. J. 1969). Viscosity-based equation is given by:

$$EC_t = EC_{25} \left(\frac{\mu_t}{\mu_{25}} \right)^{-b}$$

Where μ_t and μ_{25} are the viscosities of pure water at temperature t and 25 °C respectively “b” is the dimension less constant.

An increase in a water temperature will cause a decrease in its viscosity a nd an increase in the mobility of the ions in water. An increase in temperature may also cause an increase in the number of ions in water due to dissociation of molecules. As the conductivity of water is dependent on these factors then an increase in the water temperature will lead to an increase in its conductivity. If conductivity will increase then TDS also increase with increase in temperature (Barron & et al TSP -07 issue 3).

CONCLUSION

From the above result, Electrical Conductivity is high in sample of Duga Devithan Source whose altitude is 842.5 mts and it is very low for the sample of Nepal Dhara whose altitude is very high about 1486 meter and pH value of Duga Devithan Source is 8.0 and for Nepal Dhara is 6.7. So we concluded that, higher attitude springs have low Electrical Conductivity and the lower altitude springs have high Electrical conductivity. It shows that springs water at higher altitude are acidic and springs water at lower altitudes are basic in nature. Because water of lower altitudes springs are passed through number of rocks in their travelling way that added the minerals responsible for basic nature of water and also responsible for rising amounts of Total Dissolve Solid and also influence the K factor variation ranges from 0.55 to 0.85 (table- IV)

Electrical Conductivity, TDS, pH are linearly increase with the rising temperature. The linearity factor R is 0.99579, 0.98047 and 0.09609 respectively for Sawney Dhara. This linearity happens because of decreasing of its viscosity and an increasing the mobility of ions in water with rising temperature. -Temperature relation are verified. We also see that K-factor values are lies between 0.55 - 0.80.

Magnesium (Mg²⁺, Cation) concentration is high for sample of Duga Devithan Source (13.313 mg/L) and low for sample of Khanal Dhara (4.396 mg/l). So the Electrical Conductivity is high for Duga Devithan Source

(101.5 μ S/L) and low for Khanal Dhara (49.4 μ S/L) due to the high conductivity factor of Mg²⁺ (3.82 μ S/cm per mg/L) in case Duga Devithan Source and Khanal Dhara.

Nitrate (NO₃⁻) concentration in Duga Devithan Source is high (5.505 mg/L) among the study sample. So this spring water act as natural source of nitrates for the soil. The chemical compositions of the entire samples are lies in the drinking water range except nitrate concentration for Duga Devithan Source it is little bit higher the permissible limit. So people can use this spring water for drinking and other purpose.

ACKNOWLEDGEMENT

It is impossible to doing such a lengthy work by a single person and number of people and their helps make it fruitful. We extended our heartiest gratitude's to Dr. Ajay Tripathi Department of Physic (Sikkim University), Dr. Sohel Firdos Department of Geography (Sikkim University) and Dr. S. Manivannan (HoD, Department of Horticulture Sikkim University) for their readily available thoughts, discussion and encouragement. We are very much thankful to Mr. Dinesh Rai (Lab Assistant Department of Horticulture) and Mr. Tulsi Sharma (lab Assistant Department of Geography) for their consistent help during lab works. Last not the least we would like to thank Ms. Soumita Jana and Mr. Deepak Sharma and our friends and good wishers.

REFERENCES

1. Atkins, P. Paula D. J (2006) Atkins' Physical Chemistry (8th edition) in OXFORD UNIVERSITY PRESS
2. Atekwana, A. E. Rowe, S. R. Werkema, D. D. Legall, F. J. D & et al (2004) The relationship of total dissolved solids measurements to bulk electrical conductivity in an aquifer contaminated with hydrocarbon, in Journal of Applied Geophysics, Vol. 56, pp. 281–294
3. Brian, A. Pellerin, W. M. Xiaohong F. & Charles, J. V (2007) The application of electrical conductivity as a tracer for hydrograph separation in urban catchments; Hydrological Process in John Wiley & Sons, Ltd.
4. Coder, K. D & Warnell, B. D (1999) Basic Water Properties: Attributes and Reactions Essential for Tree Life, in School of Forest Resources, University of Georgia, U.S.A
5. Canadian Council of Minister of Environment (2011) Protocols Manual for Water Quality Sampling in Canada, Canada
6. David, R. H. Susan, S (1993) Electrical Conductivity in Science Activity, Spring Vol.30
7. Dahlena, J. Karlssona, S. Mattias, B. Jessika, H. Pettersson, H (2000) Determination of nitrate and other water quality parameters in groundwater from UV/Vis spectra employing partial least squares regression, in Chemosphere Vol. 40, pp. 71-77
8. Dekker A. J (1958) Solid state physics (1st edition), Macmillan publisher India ltd, New Delhi
9. Department of Health and Community Services Environmental Public Health Division (2011) Drinking Water Manual: Bacteriological Water Quality Public and Private Water Supplies, in New Foundland Laboratory, Canada
10. Deshpande, L - Water Quality Analysis Laboratory Methods, National Environmental Engineering Research Institute (NEERI), Nagpur, Council of Scientific & Industrial Research, New Delhi, Govt. of India
11. Ela, W. P (2007) Introduction to Environmental Engineering and Science, (3rd edition) Prentice Hall Publication
12. Eisenberg, D. & Kauzmann, W (1969) The Structure and Properties of Water, in Oxford University Press, Oxford, London
13. Fetter, C. W (1990) Applied hydrogeology, in Charles E. Merrill Publ. Co. USA
14. Freese, S. D. Trollip, D.L & Nozaic, D. J (2003) Manual for Testing of Water and Wastewater Treatment Chemicals, Water Research Commission, Pietermaritzburg, Russia
15. Hiscock, K. M. Dennis, P. F. Saynor, P. R. & Thomas, M. O (1996) Hydro-Chemical and stable isotope evidence for the extent and nature of the effective Chalk aquifer of north Norfolk, U.K, in J. Hydrology, vol. 180, pp. 79-107
16. Henderson, L. J (1913) The Fitness of the Environment: An Inquiry in to the Biological Significance of the Properties of Matter, in Macmillan, New York
17. Hounslow, A (1995) Water quality data: analysis and interpretation (1st edition), in Lewis publisher
18. IAPWS (2007) Thermodynamic Properties of Water and Steam in International Association for the Properties of Water and Steam, Lucerne, Switzerland
19. John, J. B. & Ashton, C (2011) The Effect of Temperature on Conductivity Measurement, in TSP-07 Issue 3. www.reagecon.com.
20. Jeelani, G. H. Nadeem, A. B. Shivanna, K & et al (2011) Geochemical characterization of surface water and springwater in SE Kashmir Valley, western Himalaya: Implications to water–rock interaction, in J. Earth Syst. Sci. Vol. 120, No. 5, October, pp. 921–932
21. Jeffrey, M. Donald, I. Siegel W. P. McKenzie, D. J. et al (2001) A geochemical survey of spring water from the main Ethiopian rift valley, southern Ethiopia: Implications for well-head protection, in Hydrogeology Journal Vol. 9 pp. 265–272
22. Kobayashi, D (1986) Separation of a snow melts hydrograph by stream conductance, in J. Hydrology, vol. 84, pp.

157-165

- 23.Kumar, S. P. J (2013) Interpretation of groundwater chemistry using piper and chadha's diagrams: a comparative study from perambalur taluk, in Elixir Geoscience, Vol. 54, 12208-12211.
- 24.Korson, L. Hansen, D. W. & Millero F. J (1969) Viscosity of water at various temperatures, in J. Phys. Chem. Vol. 73, pp. 34-39
- 25.Keller, G. V. And Frischknecht, F. C (1966) Electrical Methods in Geophysical Prospecting, in Pergamon Press, Oxford
- 26.Kaustubh, M. and Himanshu, K (2012) Groundwater resources and spring hydrogeology in South Sikkim with special reference to climate change, govt. of Sikkim, Gangtok
- 27.L. S. Clesceri, L.S. A. E. Greenberg, A. E. Eaton A. D (1998) Standard Methods for the Examination of Water and Wastewater in 20th ed., American Public Health Association, Washington, D. C
- 28.Masakihayashi (2004) Temperature - in Environmental Monitoring and Assessment, vol. 96 pp. 119-128
- 29.Millero, F. J (2001) The Physical Chemistry of Natural Waters, Wiley-Interscience, New York
- 30.Moore, R. D. Richard, G. & Story, A (2008) Electrical Conductivity as an Indicator of Water Chemistry and Hydrologic Process, in Streamline Watershed Management Bulletin (spring) Vol. 11, No. 2
- 31.Negi, G. C. S. and Joshi, V (2002) Drinking Water Issues and Development of Spring Sanctuaries in a Mountain Watershed in the Indian Himalaya, in Mountain Res. Dev. Vol. 22, no. pp. 29 - 31
- 32.Pisal, A (2010) Water and environmental analysis, in PerkinElmer, Inc
- 33.R. A. Robinson, R. A. and Stokes, R. H (1965) Electrolyte Solutions, in Butter worth's, London, U.K
- 34.Sorensen, J. A. & Glass, G. E (1987) Ion and Temperature Dependence of Electrical Conductance for Natural water in Analyt.. Chem. Vol. 59, pp 1594-1597
- 35.SubhraSuchi, S. Ali, A. M. Bhattacharya, G. De, S. P. Roy, B. C. Nambiar, K.V. & Kkan, I. K. (2012) Geology and mineral resources of Sikkim, in GEOLOGICAL SURVEY OF INDIA (GSI) Govt. of India
- 36.Stanley, E. M (2010) Environmental Chemistry in CRC press, Taylor & Francis group, U.S.A
- 37.Sharap, A. K (2001) Water: Structure and Properties in Encyclopedia of Life Sciences, John Wiley & Sons, Ltd. USA
- 38.Tambe, S. Arrawatia, M. L. Bhutia, N. T & Swaroop, B (2011) Rapid cost-effective and high resolution assessment of climate-related vulnerability of rural communities of Sikkim Himalaya, India in Current Science vol. 101, no. 2, 25th July.
- 39.U.S. Environmental Protection Agency (2010) Learning about Lakefront Property in Office of Wetlands, Oceans, and Watersheds 1200 Pennsylvania, Washington, DC 20460
- 40.http://www.epa.gov/acidrain/education/site_students/phscale.html



Sudip Kumar Das

M. Sc , Department of Physic , Sikkim University, Gangtok .



Rakibul Islam

Research Scholar , Department of Geography, Sikkim University, Gangtok .

Publish Research Article
International Level Multidisciplinary Research Journal
For All Subjects

Dear Sir/Mam,

We invite unpublished Research Paper, Summary of Research Project, Theses, Books and Book Review for publication, you will be pleased to know that our journals are

Associated and Indexed, India

- * International Scientific Journal Consortium
- * OPEN J-GATE

Associated and Indexed, USA

- * EBSCO
- * Index Copernicus
- * Publication Index
- * Academic Journal Database
- * Contemporary Research Index
- * Academic Paper Database
- * Digital Journals Database
- * Current Index to Scholarly Journals
- * Elite Scientific Journal Archive
- * Directory Of Academic Resources
- * Scholar Journal Index
- * Recent Science Index
- * Scientific Resources Database
- * Directory Of Research Journal Indexing

Golden Research Thoughts
258/34 Raviwar Peth Solapur-413005, Maharashtra
Contact-9595359435
E-Mail-ayisrj@yahoo.in/ayisrj2011@gmail.com
Website : www.aygrt.isrj.net