Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

ISSN: 0972-6268	Vol. 14	No. 4	pp. 897-902	2015

Original Research Paper

Correlation Matrix of Physico-chemical Characteristics of Select Tank Waters of Tiptur Taluk in Tumkur District, Karnataka

A. M. Shivanna* and G. Nagendrappa†**
*Kalpataru First Grade Science College, Tiptur-572 201 and UOM, Mysore, Karnataka, India
**Department of Studies in Chemistry, Manasagangotri, University of Mysore-570 006, Mysore, Karnataka, India
†Corresponding author: G. Nagendrappa

Nat. Env. & Poll. Tech.
Website: www.neptjournal.com
Received: 05-01-2015
Accepted: 03-03-2015

Key Words:
Tank water samples
Tiptur taluk
Correlation coefficient
Coefficient of determination

ABSTRACT

Analysis of water quality of five tank water samples in Tiptur taluk through 18 physico-chemical parameters, namely WT, pH, DO, BOD, EC, TDS, TA, TH, CO_3^{2-}, HCO_3^-, Cl^-, SO_4^{2-}, PO_4^{3-}, NO_3^-, Na^+, K^+, Ca^{2+} and Mg^{2+} was taken up during December 2010 to November 2012. A systematic calculation of correlation coefficient among these 18 physico-chemical parameters was carried out using Microsoft excel spreadsheet. A correlation coefficient of 1.00 was found between the TA-HCO_3^- pair in Eachanur and V. Mallenahalli samples and the pair is perfectly correlated, whereas, 'r' value was 0.99 in Halkurke and Honnavalli samples and 0.97 in Albur samples. EC and TDS were perfectly correlated in Halkurke samples and for the same pair 'r' value was 0.99 in Eachanur, V. Mallenahalli and Honnavalli samples, whereas it was 0.85 in Albur samples. BOD and PO_4^{3-} were perfectly correlated in Eachanur samples. When $r > \pm 0.5$ was considered, a total of 22 positive and 3 negative correlations in Eachanur samples; 18 positive and 9 negative correlations in V. Mallenahalli samples; 31 positive and 2 negative correlations in Halkurke samples; 36 positive and 6 negative correlations in Honnavalli samples; and 18 positive and 5 negative correlations in Albur samples were found during the analysis. For a better interpretation of the results, the coefficient of determination was used in addition to 'r' value.

INTRODUCTION

Correlation analysis is one of the most widely used and reported statistical method in summarizing scientific research data obtained from water sample analyses. The correlation coefficient is a summary value of a large set of data representing the degree of linear association between two measured physico-chemical parameters and it is reducing the large amount of data to a manageable form for interpretation of association, similarity and distance between the parameters. Establishment of a constant relationship among the various constituents depend primarily on the nature of water and its source. The quality of water is described by its physical, chemical and microbial characteristics and if some correlations are possible among these parameters, then significant ones would be fairly useful to indicate the quality of water (Dhembare & Pondhe 1997). Hence, determination of the relationship between physico-chemical characteristics of the samples is important, as it simplifies the tedious analysis procedures and gives information on the water quality. Also, systematic calculation and interpretation of the correlation coefficient of the water quality parameters not only help to assess the overall water quality, but also to quantify relative concentrations of various pollutants in water and provide necessary action for implementation of rapid water quality programs. The correlation study is useful to find a predictable relationship which can be exploited in practice and is also helpful for measuring the strength and statistical significance of the relation between two or more water quality parameters (Jothivenkatachalam et al. 2010).

Correlation coefficient can be calculated using the formula,

Correlation coefficient,

$$r = \frac{\sum xy - \bar{x}\sum y}{\sqrt{\left[(\sum x^2 - \bar{x}\sum x)(\sum y^2 - \bar{y}\sum y)\right]}}$$

where $\bar{x}$ and $\bar{y}$ are the mean values of variables x and y.

Determination of correlation, signifies the extent of predictability of one variable from the other. Pearson correlation is applied to know the type and degree of association with two or more variables. The limits of correlation coefficient (r) are from +1 to 0 to -1. If r = +1, there is perfect positive correlation, if r = -1, there is perfect negative correlation but both indicate strong association. If r = 0, no association exists between the two measured variables.

Coefficient of determination (r^2): Although correlation coefficient is a good measure of the strength of the association, but it has no literal interpretation. Coefficient of determination which is the squared value of 'r' has a very clear

meaning. It gives the measure of the proportion of variation of one variable associated with variations in the other. For example, if r = 0.8, then $r^2 = 0.64$, which means 64% variations of *y* are associated with the variations in *x* and the remaining 36% can be attributed to some other unknown factor (Richard Taylor, 1990, Trivedy & Goel 1986).

MATERIALS AND METHODS

Water samples from five tanks were collected in pre-treated, cleaned and dried polythene cans of 2 litre capacity on a monthly basis from December 2010 to November 2012. pH and temperature were recorded *in situ* and the samples were transported to the laboratory where other parameters were estimated using standard procedures as mentioned in APHA (1995). Using the measured data, correlation coefficients for all the 18 water quality parameters were calculated for each pair using Microsoft Excel.

RESULTS AND DISCUSSION

Physico-chemical Parameters

Water temperature (WT): Temperature is basically important for its effects on the chemical and biochemical reactions in the water body. Impinging solar radiation and atmospheric temperature bring interesting spatial and temporal changes in natural waters. Surface waters vary considerably in temperature between winter and summer.

pH: It is a measure of hydrogen ion concentration of water, and is an environmental factor. As it is related to a variety of different parameters, it is not possible to determine whether pH has a direct relationship with human health or not.

Dissolved oxygen (DO): DO in water is one of the most important parameters in water quality assessment. It reflects the physical and biological processes prevailing in the waters and also reflects whether the processes undergoing are aerobic or anaerobic.

Biochemical oxygen demand (BOD): It is the requirement of oxygen needed for biochemical degradation of organic materials. BOD determines the strength of sewage, effluents and other polluted waters. Low BOD indicates lower consumption of oxygen and a low level of pollution of water.

Electrical conductivity (EC): It is also an important parameter of water quality and depends on the nature and concentration of ionized salts. It is an important criterion in determining the suitability of water and wastewater for irrigation.

Total dissolved solids (TDS): In water, TDS are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese. High values of total dissolved solids and sulphate in drinking water are generally not harmful to human beings but may affect those persons who are suffering from kidney and heart diseases (Gupta et al. 2004). Plants are also adversely affected by the higher content of solids in irrigation water which increase the salinity of the soil.

Total hardness (TH): TH of water refers to reaction with soap and scale formation. Hardness of water is due to dissolution of alkaline earth metal salts from geological matter. It depends on the amount of calcium and magnesium present in water. The anions responsible for hardness are mainly bicarbonate, carbonate, sulphate, chloride, nitrate and silicates.

Total alkalinity (TA): It is estimate of the buffering capacity of water upon the addition of an acid. Most of the alkalinity in natural waters is formed due to dissolution of CO_2 in water. Alkalinity is also produced by the action of water on limestone or chalk. Bicarbonates have major control on total alkalinity and it may be used as a tool for the measurement of the productive condition of the aquatic systems (Shivanna & Nagendrappa 2014).

Carbonate and bicarbonates: These are common chemical factors in most of the water bodies and contribute to alkalinity.

Chloride (Cl^-): It occurs naturally in all types of water and is an important nutritional element in plant and animal life. It is often associated with sodium since NaCl is a common constituent of water. It is an important parameter in assessing water quality and controls the salinity of water and osmotic stress on biotic communities.

Sulphate (SO_4^{2-}): It is one of the important ions in natural waters and when present in higher quantity produces cathartic effect in human beings. Sulphate ions are derived from the discharge of domestic sewage, surface and agricultural run-off.

Phosphate (PO_4^{3-}): It is required for plant growth because its natural occurrence in reservoirs is very small. It helps in algal growth and eutrophication.

Nitrate (NO_3^-): It is naturally occurring and is a part of the nitrogen cycle. Nitrate is normally the most common form of combined inorganic and organic nitrogen in lakes and streams, moves freely through soils along with the subsurface waters.

Sodium: It is present in all natural water as sodium salts which are highly soluble in water. Most of the freshwaters derive their sodium, potassium, calcium, magnesium and other nutrients from soils and rocks which will vary with the geography of the place. High sodium levels can contribute to salinity problems in soil when the water is used for irrigation.

Table 1: Average values of physico-chemical parameters measured in the studied tank waters during the study period 2010-2012.

Parameters ↓	Unit	Eachanur	V. Mallenahalli	Halkurke	Honnavalli	Albur	BIS (1991)
WT	°C	21.8-29.0	22.0-29.5	22.3-32.9	21.9-30.5	24.2-33.0	
pH	-	6.2-8.21	6.15-7.75	7.29-8.31	6.78-8.3	6.43-7.89	6.5-8.5
DO	mg/L	6.45-9.3	5.64-8.5	4.83-7.64	4.84-8.46	5.24-9.1	
BOD	mg/L	0.0-1.21	0.0-2.42	0.0-2.02	0.0-1.24	0.0-2.54	
EC	µS/cm	99.0-280	96.0-342	490-1649	572-1722	141-612	
TDS	mg/L	62.0-173	59.0-212	331-1022	366-1067	132-391	500
TH	mg/L	42.0-130	37.0-98.0	66.0-114	110-155	70.0-157	300
TA	mg/L	30.0-102	40.0-99.0	171-437	226-500	100-214	200
CO_3^{2-}	mg/L	0.0-0.0	0.0-0.0	0.0-30.0	0.0-52.0	0.0-25.0	
HCO_3^-	mg/L	30.0-102	40.0-99.0	151-422	200-450	100-214	
Cl^-	mg/L	6.0-56.7	4.3-213	29.8-106	17.0-59.0	15.0-60.2	250
SO_4^{2-}	mg/L	3.3-15.0	3.3-20.0	10.0-43.0	5.6-30.0	0.0-30.0	200
PO_4^{3-}	mg/L	0.0-0.0	0.0-0.04	0.0-0.04	0.0-0.18	0.0-0.04	
NO_3^-	mg/L	0.08-0.83	0.9-1.87	1.8-3.2	0.96-2.62	0.16-0.35	45
Na^+	mg/L	0.4-31.5	0.4-39.0	4.3-271	3.9-200.0	6.5-102	
K^+	mg/L	0.06-8.0	0.06-10.0	0.16-18.0	0.12-21.0	0.1-10.7	
Ca^{2+}	mg/L	7.0-28.0	6.0-20.0	10.8-29.6	18.0-38.5	12.8-32.5	75
Mg^{2+}	mg/L	4.1-14.6	2.6-11.7	3.9-14.0	12.6-22.0	7.3-21.4	30

Table 2: Correlation coefficients among different water quality parameters of Eachanur tank water.

	WT	pH	DO	BOD	EC	TDS	TH	TA	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	PO_4^{3-}	NO_3^-	Na^+	K^+	Ca^{2+}	Mg^{2+}
WT	1.00	-0.09	-0.16	0.40	0.54	0.53	0.33	0.06	-	0.06	0.66	0.10	-0.37	0.55	0.42	0.21	0.35	0.25
pH		1.00	0.32	-0.33	-0.42	-0.44	-0.38	-0.04	-	-0.04	-0.31	0.0	-0.10	0.03	-0.10	-0.04	-0.41	-0.32
DO			1.00	-0.02	-0.19	-0.25	0.14	0.20	-	0.20	-0.26	0.22	0.16	-0.13	-0.16	-0.35	-0.16	0.18
BOD				1.00	-0.50	0.46	-0.49	-0.73	-	-0.73	0.59	0.37	1.00	0.05	0.47	0.0	-0.47	-0.50
EC					1.00	0.99	0.71	0.64	-	0.64	0.44	0.15	-0.46	0.36	0.33	0.30	0.70	0.42
TDS						1.00	0.68	0.62	-	0.62	0.44	0.14	-0.45	0.40	0.39	0.32	0.68	0.38
TH							1.00	0.62	-	0.62	0.31	0.51	-0.35	0.13	0.10	-0.06	0.79	0.87
TA								1.00	-	1.00	-0.24	0.17	0.17	0.35	0.17	0.22	0.53	0.44
CO_3^{2-}									1.00	-	-	-	-	-	-	-	-	-
HCO_3^-										1.00	-0.24	0.17	-0.50	0.35	0.17	0.22	0.53	0.44
Cl-											1.00	0.04	-0.59	0.08	0.24	0.10	0.31	0.16
SO_4^{2-}												1.00	-0.37	0.23	0.21	-0.18	0.41	0.53
PO_4^{3-}													1.00	-0.15	0.43	-0.21	-0.39	-0.31
NO_3^-														1.00	0.72	0.41	0.16	0.05
Na^+															1.00	0.37	-0.15	-0.12
K+																1.00	0.10	-0.01
Ca^{2+}																	1.00	0.75

Potassium: It is always lesser than sodium due to its greater resistance to weathering and formation of clay minerals and also because of its low solubility.

Calcium: It forms the most abundant cation in freshwaters. Calcium is an essential constituent of human beings.

Magnesium: In natural water it is derived from various kinds of rocks. Sewage and industrial wastes are also important contributors of magnesium, which however, is not the case in the study area.

Average values of the measured physico-chemical parameters are presented in Table 1. The correlation co-efficient (r) values between each pair of physico-chemical parameter were computed and are presented in Tables 2 to 6.

For Eachanur water samples, a total of 22 positive correlations and 3 negative correlations were found between different parameters when $r > \pm 0.5$ is considered (Table 2). pH, DO, PO_4^{3-}, Na^+ and K^+ do not exhibit significant correlation with other parameters. The other parameters which were strongly correlated ($r \geq 0.75$) include EC-TDS (0.99), TH-Ca^{2+} (0.79), TH-Mg^{2+} (0.87) and Ca^{2+}-Mg^{2+} (0.75). Higher negative correlation co-efficients ($r > -0.70$) were found between BOD-TA (-0.73) and BOD-HCO_3^- (-0.73).

Literal interpretation between water quality parameters is ascertained by taking the coefficient of determination (r^2) for those pair of parameters where 'r' ≥ 0.75.

1. The value of r^2 for BOD and PO_4^{3-} pair is 1.00. This means

Table 3: Correlation coefficient among different water quality parameters of V. Mallenahalli tank water.

	WT	pH	DO	BOD	EC	TDS	TH	TA	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	PO_4^{3-}	NO_3^-	Na^+	K^+	Ca^{2+}	Mg^{2+}
WT	1.00	-0.10	0.04	0.03	0.25	0.28	-0.19	0.32	-	0.32	0.17	0.24	0.34	-0.21	0.12	0.24	0.03	-0.26
pH		1.00	0.4	-0.22	0.39	0.33	0.39	0.36	-	0.36	0.45	0.40	-0.35	0.08	0.40	0.15	0.54	-0.03
DO			1.00	0.47	0.12	0.12	0.35	0.35	-	0.35	0.03	-0.02	-0.23	-0.08	0.29	0.26	0.48	0.01
BOD				1.00	-0.56	-0.57	-0.37	0.76	-	0.76	-0.51	-0.16	-0.70	-0.14	0.57	0.76	-0.47	-0.12
EC					1.00	0.99	0.67	0.46	-	0.58	0.26	0.26	-0.43	-0.29	0.23	-0.12	0.71	0.35
TDS						1.00	0.67	0.47	-	0.47	0.60	0.21	-0.44	-0.25	0.30	-0.11	0.69	0.38
TH							1.00	0.49	-	0.49	0.46	0.19	-0.56	-0.12	0.25	-0.17	0.83	0.72
TA								1.00	-	1.00	0.39	0.23	-0.75	-0.20	0.49	0.43	0.55	0.30
CO_3^{2-}									1.00	-	-	-	-	-	-	-	-	-
HCO_3^-										1.00	0.39	0.23	-0.75	-0.20	0.49	0.43	0.55	0.30
Cl-											1.00	0.06	-0.44	0.22	0.33	-0.12	0.61	0.10
SO_4^{2-}												1.00	0.01	-0.27	0.34	0.15	0.41	-0.15
PO_4^{3-}													1.00	0.25	-0.70	-0.16	-0.40	-0.55
NO_3^-														1.00	0.06	-0.14	-0.43	0.35
Na^+															1.00	0.24	0.37	0.09
K+																1.00	0.02	-0.13
Ca^{2+}																	1.00	0.25
Mg^{2+}																		1.00

Table 4: Correlation coefficient among different water quality parameters of Halkurke tank water.

	WT	pH	DO	BOD	EC	TDS	TH	TA	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	PO_4^{3-}	NO_3^-	Na^+	K^+	Ca^{2+}	Mg^{2+}
WT	1.00	-0.08	-0.03	0.35	0.73	0.73	0.36	0.45	-0.21	0.48	0.60	0.56	-0.14	0.02	0.57	0.62	0.20	0.24
pH		1.00	0.10	0.32	-0.30	-0.29	-0.16	0.01	0.06	0.0	-0.54	-0.13	-0.33	0.13	-0.18	-0.08	-0.04	-0.17
DO			1.00	0.04	-0.35	-0.33	-0.37	0.28	0.02	0.28	-0.39	-0.21	0.57	0.08	-0.32	-0.06	-0.28	-0.17
BOD				1.00	0.03	0.03	0.25	-0.06	-0.37	0.01	0.02	-0.33	-0.54	-0.08	-0.03	0.08	-0.04	0.45
EC					1.00	1.00	0.44	0.59	0.01	0.60	0.82	0.74	-0.36	-0.02	0.88	0.78	0.18	0.39
TDS						1.00	0.44	0.60	0.0	0.61	0.81	0.75	-0.36	-0.01	0.88	0.79	0.17	0.40
TH							1.00	0.28	0.28	0.24	0.50	0.05	-0.24	-0.08	0.46	0.37	0.69	0.44
TA								1.00	0.16	0.99	0.31	0.28	-0.29	-0.13	0.66	0.71	0.01	0.35
CO_3^{2-}									1.00	0.03	0.08	-0.13	0.09	-0.26	0.17	0.08	0.26	0.04
HCO_3^-										1.00	0.30	0.30	-0.32	-0.10	0.65	0.71	-0.02	0.35
Cl^-											1.00	0.50	-0.27	-0.03	0.70	0.61	0.17	0.47
SO_4^{2-}												1.00	0.01	0.08	0.60	0.58	0.07	0.02
PO_4^{3-}													1.00	0.32	-0.24	-0.23	-0.16	-0.22
NO_3^-														1.00	-0.18	-0.05	-0.16	0.08
Na^+															1.00	0.88	0.12	0.48
K+																1.00	0.01	0.48
Ca^{2+}																	1.00	-0.34
Mg^{2+}																		1.00

that the values of BOD and PO_4^{3-} are 100% interdependent. Increase in PO_4^{3-} increases the algal or other weed growth and hence BOD increases. Similarly TA and HCO_3^- are 100% interdependent as r^2 is 1.

3. r^2 for EC-TDS pair is 0.98, i.e. 98% variations in TDS are associated with variations in EC and rest 2% is attributed to unknown factors.
4. r^2 for TH-Ca^{2+} is 0.62 and TH-Mg^{2+} is 0.76, i.e. 62% variation in calcium values and 76% values in magnesium are associated with variations in TH values.
5. r^2 for Ca^{2+}-Mg^{2+} is 0.56, i.e. only 56% variation in Mg^{2+} values are Ca^{2+} dependent. A significantly positive correlation of TH with TA, HCO_3^-, SO_4^{2-}, Ca^{2+} and Mg^{2+} from which it may be concluded that calcium and magnesium bicarbonates contribute more towards hardness than sulphates of these salts. Similar results were reported by Jain & Sharma (1997).

For V. Mallenahalli tank water, a total of 18 positive correlations and 9 negative correlations were found between different parameters taking those pairs where $r > \pm 0.5$ (Table 3).

Parameters WT, DO, SO_4^{2-}, NO_3^-, Na^+, K^+ and Ca^{2+} have not exhibited significant correlation with any of the parameters or it was insignificant. The high positive correlation ($r \geq 0.75$) was observed among BOD and TA (+0.76), BOD

Table 5: Correlation coefficient among different water quality parameters of Honnavalli tank water.

	WT	pH	DO	BOD	EC	TDS	TH	TA	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	PO_4^{3-}	NO_3^-	Na^+	K^+	Ca^{2+}	Mg^{2+}
WT	1.00	0.18	0.36	0.53	0.06	0.05	0.01	0.03	0.34	-0.04	0.07	0.43	-0.31	-0.51	0.06	0.11	0.13	-0.18
pH		1.00	-0.16	-0.13	0.29	0.27	0.35	0.21	0.48	0.14	0.28	0.51	0.14	-0.16	0.13	-0.02	0.25	0.15
DO			1.00	0.56	0.03	0.06	-0.21	0.10	0.07	0.10	0.02	0.26	0.05	-0.49	0.22	0.18	-0.17	-0.06
BOD				1.00	0.40	0.38	-0.68	0.53	0.75	0.43	0.37	0.32	-0.72	-0.86	0.38	0.49	-0.26	-0.47
EC					1.00	0.99	-0.32	0.89	0.67	0.88	0.83	0.38	-0.30	-0.01	0.78	0.60	-0.36	0.12
TDS						1.00	-0.35	0.89	0.65	0.88	0.84	0.39	-0.23	0.02	0.78	0.60	-0.37	0.09
TH							1.00	-0.29	0.12	-0.36	-0.20	0.20	0.49	-0.06	-0.29	-0.34	0.77	0.29
TA								1.00	0.75	0.99	0.91	0.45	-0.34	-0.06	0.89	0.79	-0.39	0.21
CO_3^{2-}									1.00	0.63	0.73	0.77	-0.37	-0.29	0.61	0.46	0.06	0.13
HCO_3^-										1.00	0.89	0.34	-0.33	-0.01	0.89	0.81	-0.46	0.21
Cl^-											1.00	0.47	-0.21	-0.07	0.87	0.67	-0.40	0.37
SO_4^{2-}												1.00	-0.01	-0.27	0.51	0.26	0.12	0.14
PO_4^{3-}													1.00	0.18	-0.22	-0.51	0.14	0.53
NO_3^-														1.00	-0.07	-0.22	-0.16	0.15
Na^+															1.00	0.66	-0.52	0.40
K+																1.00	-0.36	0.09
Ca^{2+}																	1.00	-0.38
Mg^{2+}																		1.00

Table 6: correlation coefficient among different water quality parameters of Albur tank water.

	WT	pH	DO	BOD	EC	TDS	TH	TA	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	PO_4^{3-}	NO_3^-	Na^+	K^+	Ca^{2+}	Mg^{2+}
WT	1.00	-0.09	-0.31	-0.64	-0.08	-0.07	-0.05	0.08	-0.11	0.11	0.03	0.77	0.15	-0.11	0.08	0.12	-0.08	-0.02
pH		1.00	-0.53	0.21	0.30	0.28	-0.04	-0.15	0.60	0.30	0.58	0.08	-0.11	-0.19	0.59	0.2	0.03	-0.11
DO			1.00	0.18	-0.54	-0.38	-0.08	0.37	-0.39	0.47	-0.52	-0.22	-0.08	0.14	-0.23	-0.02	-0.23	0.04
BOD				1.00	0.12	0.24	-0.41	0.40	0.70	0.17	0.20	-0.01	0.05	0.39	0.53	0.13	-0.33	-0.36
EC					1.00	0.85	0.16	0.15	0.49	0.03	0.64	0.09	-0.21	-0.30	0.23	-0.24	0.17	0.12
TDS						1.00	0.24	0.18	0.54	0.06	0.69	0.19	0.18	-0.39	0.31	-0.10	0.21	0.23
TH							1.00	-0.25	0.11	-0.27	0.50	0.11	-0.08	-0.38	-0.28	-0.24	0.92	0.95
TA								1.00	0.14	0.97	-0.10	0.08	0.10	-0.04	0.44	0.32	-0.41	-0.08
CO_3^{2-}									1.00	-0.10	0.67	0.06	0.00	-0.27	0.67	0.11	0.11	0.09
HCO_3^-										1.00	-0.26	0.07	0.10	0.02	0.28	0.30	-0.44	-0.11
Cl^-											1.00	0.34	-0.23	-0.56	0.34	-0.07	0.51	0.42
SO_4^{2-}												1.00	-0.16	-0.28	0.07	-0.06	0.06	0.13
PO_4^{3-}													1.00	0.36	0.45	0.56	-0.10	-0.04
NO_3^-														1.00	-0.24	0.05	-0.28	-0.40
Na^+															1.00	0.64	-0.35	-0.19
K+																1.00	-0.35	-0.10
Ca^{2+}																	1.00	0.76
Mg^{2+}																		1.00

and HCO_3^- (+0.76), BOD and K^+ (+0.76), EC and TDS (+0.99), TH and Ca^{2+} (+0.83), TA and HCO_3^- (+1.00). Hardness of this water sample is due to calcium bicarbonate. Higher negative correlation co-efficient (r > -0.70) was found between TA and PO_4^{3-} (-0.75), and HCO_3^- and PO_4^{3-} (-0.75).

For those pairs of parameters where 'r' ≥ 0.75, the values of r^2 is 0.58 for the three pairs BOD-HCO_3^-, BOD-TA and BOD-K^+, 0.98 for EC-TDS pair, 0.69 for TH-Ca^{2+}, 1 for TA-HCO_3^-, 0.56 for TA- PO_4^{3-} and also for HCO_3^- and PO_4^{3-} pair.

For Halkurke water, a total of 36 positive correlations and 6 negative correlations were found between different parameters when r > ± 0.5 was taken into account (Table 4).

The high positive correlation (r ≥ 0.75) was observed among EC and TDS (+1.00), EC and Na^+ (+0.88), EC and Cl^- (+0.82), EC and K^+ (+0.78), TDS and Cl^- (+0.81), TDS and SO_4^{2-} (+0.75), TDS and K^+ (+0.79), TDS and Na^+ (+0.88), TA and HCO_3^- (+0.99), and Na^+ and K^+ (+0.88). Perfect positive correlation was exhibited between EC and TDS.

For those pairs of parameters where 'r' ≥ 0.75, r^2 is 1 for EC-TDS pair and the two parameters are 100% interdependent and they are perfectly correlated. r^2 is 0.67 for EC-Cl^- pair, 0.77 for EC-Na^+, 0.61 for EC-K^+, 0.66 for TDS-Cl^-, 0.56 for TDS-SO_4^{2-}, 0.77 for TDS-Na^+, 0.62 for TDS-K^+, 0.98 for TA-HCO_3^- and 0.77 for Na^+-K^+ pair. High negative

significant correlation ($r \geq 0.70$) was observed between BOD and PO_4^{3-} (-0.72), BOD and NO_3^-(-0.86).

For those pairs of parameters where 'r' ≥ 0.75, the values of r^2 for BOD-CO_3^{2-} pair is 0.56, 0.74 for BOD-NO_3^-, 0.98 for EC-TDS, 0.79 for EC-TA, 0.77 for EC- HCO_3^-, 0.69 for EC-Cl^-, 0.61 for EC-Na^+, 0.79 for TDS-TA, 0.77 for TDS-HCO_3^-, 0.71 for TDS-Cl^-, 0.61 for TDS-Na^+, 0.59 for TH-Ca^{2+}, 0.56 for TA-CO_3^{2-}, 0.98 for TA-HCO_3^-, 0.83 for TA-Cl^-, 0.79 for TA-Na^+, 0.62 for TA-K^+, 0.59 for CO_3^{2-}-SO_4^{2-}, 0.79 for HCO_3^--Cl^-, 0.79 for HCO_3^--Na^+, 0.66 for HCO_3^--K^+ and 0.76 for Cl^--Na^+ pair.

For Albur tank water samples, considering those parameters where $r > \pm 0.5$, a total of 18 positive correlations and 5 negative correlations were found (Table 6).

A strong positive correlation ($r \geq 0.75$) was observed among WT and SO_4^{2-} (+0.77), EC and TDS (+0.85), TH and Mg^{2+} (+0.95), TH and Ca^{2+} (+0.92), TA and HCO_3^- (+0.97), Ca^{2+} and Mg^{2+} (+0.76).

For those pairs of parameters where 'r' ≥ 0.75, r^2 value is 0.59 for WT-SO_4^{2-} pair, 0.72 for EC-TDS, 0.85 for TH-Ca^{2+} and 0.90 for TH-Mg^{2+}, 0.94 for TA-HCO_3^-, 0.58 for Ca^{2+}-Mg^{2+}.

Similar correlation study had been taken up by several researchers like, Sanjay Kumar et al. (1994), Jain & Sharma (1997), Dhembare & Pondhe (1997), Mohapatra et al. (2001), Mahuye Dasgupta & Purohit (2001), Sunitha et al. (2005), Venkata Subramani et al. (2006), Gawas et al. (2007), Vijaya Bhaskar & Nagendrappa (2008).

CONCLUSION

After comparing the average of two years water quality parameters with those of standard values, it is clear that the waters of Halkurke and Honnavalli tanks were of not good quality since their TDS and TA values exceeded the desirable limits set by standard agencies. Correlation studies helped to reduce large amount of data into manageable form. It is reflected from the entire discussion of this paper. Out of 18 water quality parameters, TDS and TA have shown higher number of positive correlations and the waters of these two tanks are unfit for drinking as well as irrigation. Waters of other three tanks are within safer limits as the physico-chemical variables were within the desirable levels. Also, in these waters, less number of correlations are observed.

ACKNOWLEDGEMENT

Authors are grateful to the Principal, Kalpataru First Grade Science College and Kalaparu Vidya Samsthe, Tiptur, for their support and encouragement and also thankful to The University of Mysore, Mysore, for giving the research opportunity.

REFERENCES

APHA 1995. Standard Methods for Examination of Water and Wastewater. 19th edition, American Public Health Association, Washington, DC.

BIS 1991. Specifications for Drinking Water. IS:10500, Bureau of Indian Standards, New Delhi.

Dhembare, A.J. and Pondhe, G.M. 1997. Correlation of ground water quality parameters of Sonai area (Maharashtra). Poll. Res., 16(3): 189-190.

Gawas, A.D., Lokhande, P.B. and Mujawar, H.A. 2007. Characterization of wastewater by correlation and regression method. IJEP, 27(12): 1117-1120.

Gupta, S., Kumar, A., Ojha, C.K. and Singh, G. 2004. Chemical analysis of ground water Sanganer area, Jaipur in Rajasthan. J. Environ. Sci. & Engg., 46(1): 74-78.

Jain, C.K. and Sharma, M.K. 1997. Relationship among water quality parameters of ground water of Jammu district. Poll. Res., 16(4): 241-246.

Jothivenkatachalam, K., Nithya, A. and ChandraMohan, S. 2010. Correlation analysis of drinking water quality in and around Perur block of Coimbatore district TamilNadu, India. Rasayan Journal of Chemistry, 3(4): 649-654.

Mahuye Dasgupta Adak and Purohit, K.M. 2001. Correlation coefficient of some physico-chemical characteristics of surface and ground waters of Rajgangpur, Part-II. IJEP, 21(4): 295-301.

Mohapatra, D., Das, B. and Chakravortty, V. 2001. A correlation study on physico-chemical characteristics of ground water in Paradip areas. Poll. Res., 20(3): 401-406.

Richard Taylor 1990. Interpretation of the correlation coefficient: A basic review. Journal of Diagnostic Medical Sonography, 1: 35-39.

Sanjay Kumar, Nikhil Garg and Krishna Gopal 1994. Relationship between electrical conductivity and cationic and anionic contents in ground water. IJEP, 14(8): 595-603.

Shivanna, A. M. and Nagendrappa, G. 2014. Hydrochemistry and physico-chemical parameters of Karadi tank, Tiptur Tahsil, Karnataka, Indian. J. Environmental Protection, 34(5): 392-400.

Sunitha, V., Sudarshan, V. and Rajeshwara Reddy, B. 2005. Hydrochemistry of ground water, Gooty area, Ananthapur district, A.P. Poll. Res., 24(1): 217-224.

Trivedy, R.K. and Goel, P.K. 1986. Chemical and Biological Methods for Water Pollution Studies. Environmental publication, Karad, India.

Venkata Subramani, R., Meenambal, T. and Livingston Peter Goldwyn 2006. Correlation study on physico-chemical characteristics of ground waters in Coimbatore district. Poll. Res., 5(2): 371-374.

Vijaybhaskar, C. and Nagendrappa, G. 2008. A comparative study of ground water quality and water quality index of certain selected areas situated around Tumkur city. Current World Environment, 3(1): 75-82.