CONDUCTIVITY AND ITS RELATION TO TOTAL DISSOLVED SOLIDS IN GROUND WATER OF RAJASTHAN DESERT

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Conductivity values as well as the amount of total dissolved solids (TDS) in 243 samples of ground waters obtained from the district of Barmer, Rajasthan have been experimentally determined. The regression equation of TDS upon conductivity gives results similar to those obtained by multiplying conductivity by the factor 0·64. Percentage frequency of samples occurring in different group ratios (TDS/μmhos) have been calculated and a histogram presented.

Conductivity measurements have been used in determining total dissolved solids in water or soil extracts and in ascertaining quality of irrigation waters [1,2]. It has been stated that "specific conductance in micromhos/cm multiplied by a factor which may vary from 0·55 to 0·75 is equal to dissolved residue, mg/l." For waters containing hydroxide or free acid, the factor may be much lower and for saline waters the factor may be much higher[3].

EXPERIMENTAL PROCEDURE

243 samples of ground waters from the district of Barmer, Rajasthan were used for the determination of specific conductance as well as total dissolved solids (TDS). Determinations of conductance were made with the help of a conductivity meter (manufactured by Wissenschftlich—Technische Werkstatten, Germany) at 25$\pm$0·1°C. The total dissolved solids in water samples were determined by evaporating 100 c.c. of water in a pyrex glass basin and drying it at 105°C for 2 hours.

TABLE 1

RANGE OF CONDUCTIVITY (μMHOS/CM), TOTAL DISSOLVED SOLIDS (TDS) AND CHLORIDE (Cl′) AGAINST EACH GROUP OF RATIO (TDS/μMHOS)

Ratio (TDS/μmhos)	μmhos/cm	TDS ppm	Cl′ ppm
0·40—0·45	4210—11500	2480—4928	880—3569
0·45—0·50	652—20100	328—10340	43—4447
0·50—0·55	383—11200	200—6076	35—2844
0·55—0·60	202—20900	122—12456	17—6217
0·60—0·65	675—21040	402—12786	26—6116
0·65—0·70	502—21400	330—12786	43—6542
0·70—0·75	454—19900	320—15098	70—6248
0·75—0·80	315—22400	280—17518	17—8927
0·80—0·85	960—17800	788—15088	167—5120
0·85—0·90	700—20140	626—17916	56—6258
0·90—0·95	3620—13300	3364—12562	418—5178

RESULTS

Results of conductivity and corresponding TDS for each of the 243 samples of ground waters are graphically presented in Fig. 1.

The range of conductivity (μmhos/cm), total dissolved solids (TDS) and chloride (Cl′) against each group ratio (TDS/μmhos) are shown in Table 1. The ratio was calculated by dividing total dissolved solids in ppm by conductivity in micromhos/cm.

The lowest ratio is 0·40 and the highest 0·95. None of the samples was found to contain any hydroxide or free acid. The histogram for ratio against frequency of samples is shown in Fig. 2.

The regression line of TDS upon conductivity was found to be

$$\log y = -0{\cdot}1601 + 0{\cdot}9922 \log x. \qquad (1)$$

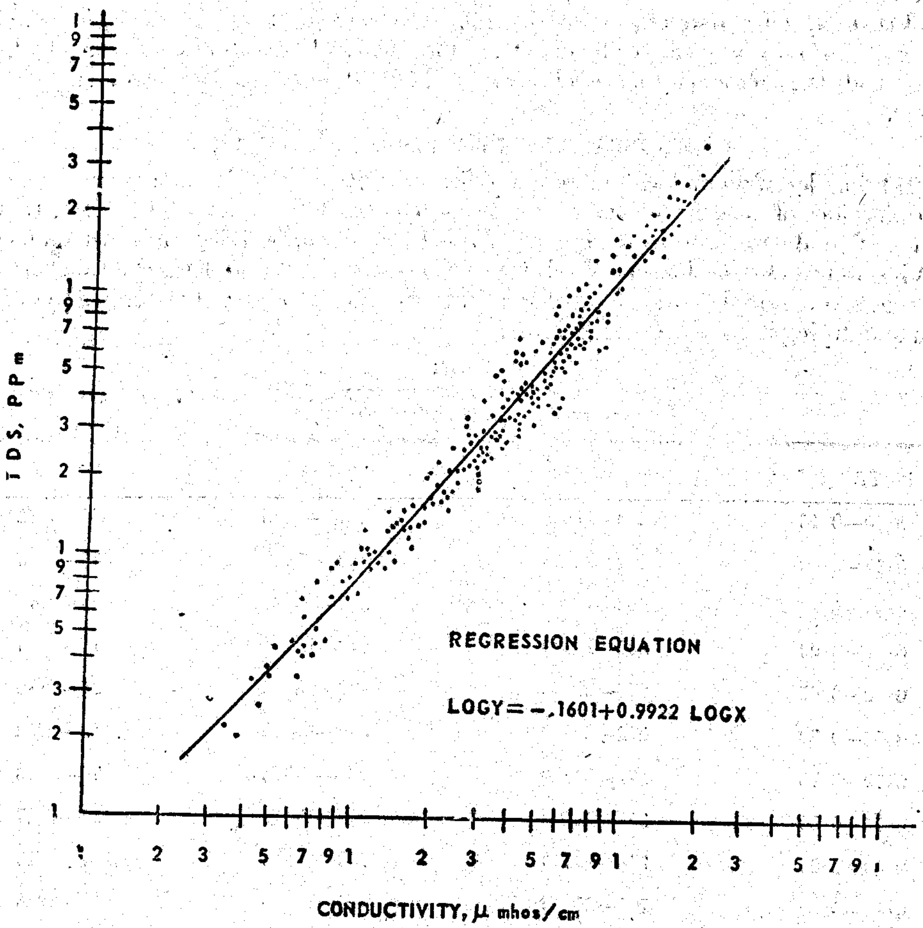

FIG. 1—Graphical representation of conductivity *versus* TDS and the regression equation Log y = 0·1601+0·9922 Log x.

where y=TDS ppm, and

x=conductivity, μmhos/cm

The standard error of regression coefficient=0·0105

5% confident limit for regression coefficient=1·0128 and 0·9716

The correlation coefficient between log y and log x was found to be 0·98. The standard error of estimate around the regression line was 0·06973. The regression equation is also shown graphically in Fig. 1.

DISCUSSION

The ratio, (TDS/μmhos) varied from 0·40—0·95. It was calculated that 65·8% of the samples lay within the ratio range 0·55—0·75, 17·6% within 0·40—0·55 and 16·6% within 0·75—0·95.

Table 1 shows that a lower ratio range does not necessarily show low conductivity and very high range does not necessarily show high conductivity. If we limit the ratio in the range 0·55—0·75 and consider only the average value namely 0·65 we at once incur the risk of certain amount of variation depending on the conductivity value; for example a sample having a conductivity value of 10,000 μmhos/cm, may have a TDS value between 5500—7500 ppm and the multiplication by the average factor 0·65 will constitute an error of $\pm$1000 ppm.

It will be seen that it is not possible to find out even the suitable ratio range.

The regression equation as found by the authors gives, in general, slightly better results than multiplication by the factor 0·64 but there is no real gain in accuracy since the deviations in both cases are of similar order[3].

It has been stated that nearly all irrigation waters that have been used successfully for a considerable time, have conductivity values[1] less than 2250 μmhos/cm but in our experiments 10% samples had conductivity below 1000 μmhos/cm, 17·5% between 1000—2250 μmhos/cm and the remaining 72·5% above 2250 μmhos/cm.

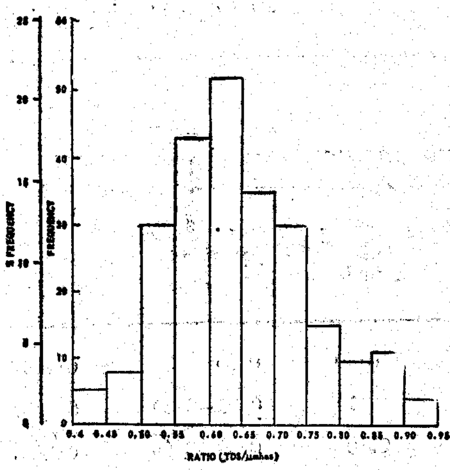

FIG.2—Histogram for the ratio TDS/μmhos *versus* frequency.

Two typical results, where maximum deviation has been noted for conductivity (*a*) below 1000 μmhos/cm and (*b*) between 1000—2250 μmhos/cm, are given in Table 2.

It has been stated[1] that "the total concentration of soluble salts in irrigation waters can be adequately expressed for purposes of diagnosis and classification in terms of electrical conductivity".

It is considered that the utility of using conductivity (that is, in determining total soluble salts) by multiplying it with 0·64 may be in order, so far as the object is only classification of water for irrigation purpose but the exact value of TDS cannot be obtained by it.

It is observed that in some cases conductivity values (μmhos/cm) when multiplied by the factor 0·64 give almost correct values of TDS (in ppm) but in other cases they show enormously large deviations from the actual value of TDS. Similar observations have been made with the use of the regression equation, though slightly better results are often obtained with it.

Darra and Mehta[4] have reported on the relationship between the electrical conductivity and total soluble salts of underground and irrigation waters in Rajasthan. They found, on the basis of analysis of 70 samples drawn from different agro-climatic regions that different multiplication factor is necessary for each of the four classes of water classified according to their conductivity values. The factors recommended by them are quoted in column 6 of Table 3 so that they can be used for the expression.

$$\mu\text{mhos/cm} \times \text{factor} = \text{TDS in ppm}$$

TABLE 2

DEVIATION FOR CONDUCTIVITY

Conductivity (μmhos/cm)	TDS (experimentally determined) ppm	TDS by regression eqn. ppm	TDS by multiplying with 0·64 ppm	Deviation from Actual TDS Value
920	808	604	588	—204 (by regression eqn.) —220 (by multiplication factor)
2150	1864	1406	1376	—458 (by regression eqn.) —488 (by multiplication factor)

TABLE 3

CLASSIFICATION OF WATER SAMPLES AND THEIR MULTIPLICATION FACTOR FOR EACH CLASS

Class of Water	Conductivity (micrombos/cm)	No. of samples	Percentage of samples	Factor Range (by authors)	Factor given by Darra and Mehta
I	upto 250	1	0·40	0·60	0·668
II	250 to 750	15	6·1	0·50—0·89	0·6699
III	750 to 2250	51	21·0	0·50—0·90	0·7223
IV	2250 to 5000 and above	176	72·5	0·40—0·95	0·7224

Our results are however based on much larger number of samples drawn from all over the district of Barmer and include samples from the desert areas also of this district.

It will be noted that the factors given by Darra and Mehta[4] lie between 0·67 and 0·72 range which covers only a narrow proportion of samples collected by us as is seen from the histogram in Fig. 2.

Another fact that emerges from Table 3 is that over 72% samples of ground waters from Barmer district have conductivity above 2250 μmhos/cm while there is practically no ground water in the district having conductivity below 250 μmhos/cm and any such occurrence is only of rare nature.

It is concluded that if the reliable value of TDS is to be obtained even approximately it should be done by the method of evaporation.

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