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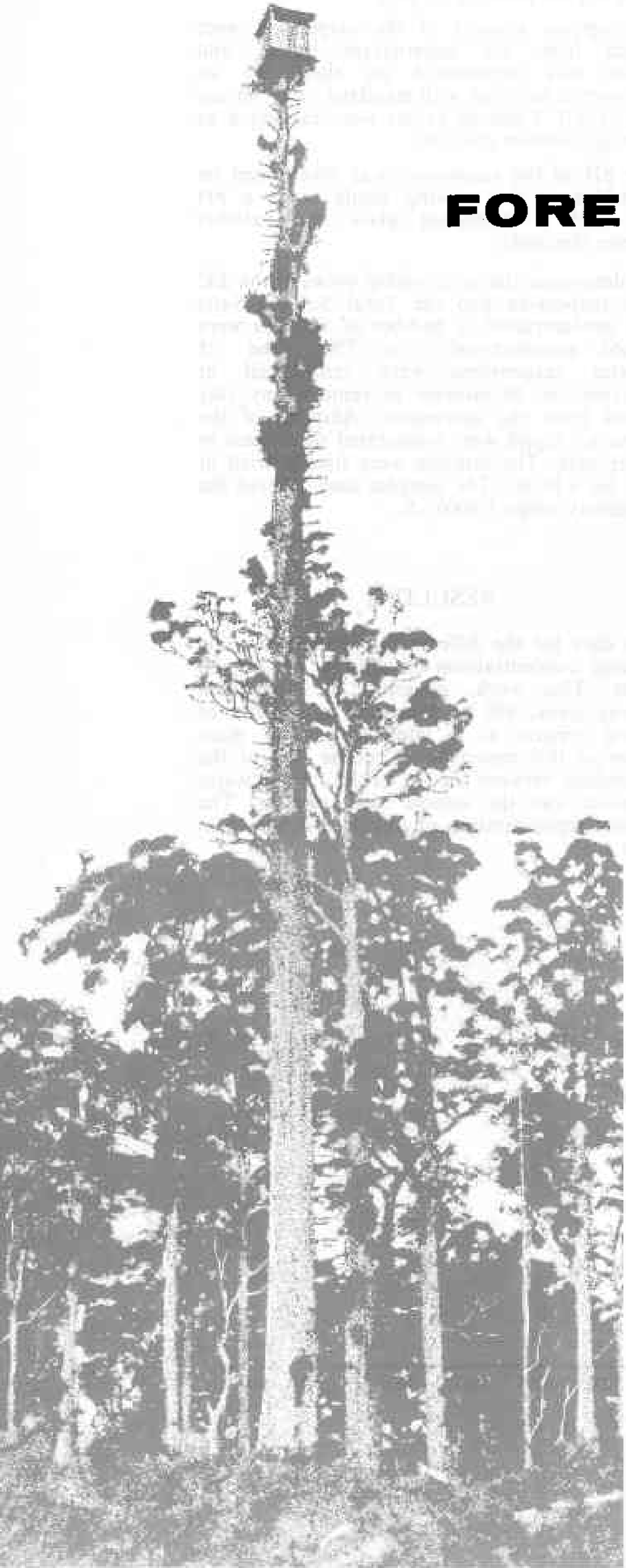

FORESTS DEPARTMENT
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THE RELATIONSHIP BETWEEN ELECTRICAL CONDUCTIVITY OF SOIL: WATER SUSPENSIONS AND SOLUBLE SALTS IN SOME WESTERN AUSTRALIAN FOREST SOILS

by

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SUMMARY

Some relationships of the 1:5 soil:water suspensions of a range of forest soils have been briefly investigated. The Electrical Conductivities of the suspensions were closely related to the Total Soluble Salts and chlorides (as NaCl) present in the soil, and the regressions relating these parameters were quadratic for Total Soluble Salts and linear for chlorides.

INTRODUCTION

In conjunction with a number of Departmental hydrology projects, a large-scale co-operative core-drilling programme was carried out to examine the distribution of soluble salts, particularly chlorides, in the subsoils of a range of forest types. The sampling programme covered the following Divisions: Manjimup (Woodchip Permit Area), Busselton (proposed pine plantation area), Kirup, Dwellingup, and Mundaring.

The aim of this study was to examine the relationships between the Electrical Conductivity (EC) of a soil:water suspension and the concentration of soluble salts and chlorides present in the soil.

EXPERIMENTAL

The core sub-samples used for analysis were collected from the shoe of the drilling bit, and generally two samples were forwarded to the laboratory:

1. a large tin containing the constant-volume shoe sample for the determination of moisture content and bulk density;
2. a small plastic vial which contained the sample for chemical analysis.

The latter were given a preliminary air drying under an infra-red lamp, and then dried for 18 hours in a vacuum oven at 45°C. Following drying, the samples were thoroughly mixed and weighed amounts were shaken with aerated, distilled water for one hour (Piper, 1947). A standard soil:water ratio of 1:5 was adopted for all samples. The whole soil was used, and no attempt was made to sieve out the gravel (>2 mm) fraction. The following analyses were carried out on these extracts:

(a) EC; (b) chloride; (c) pH.

EC of the suspension was measured with a Phillips Measuring Bridge. All values were expressed as microsiemens (μS) and corrected to a standard temperature of 25°C.

Appropriate aliquots of the suspension were pipetted from the supernatant liquid, and chloride was determined on these by an electrometric titration with standard silver nitrate (Piper, 1947). Chloride values were expressed as percentage sodium chloride.

The pH of the suspension was determined on the residue in the shaking bottle using a pH meter with a combined glass and calomel reference electrode.

To determine the relationship between the EC of the suspension and the Total Soluble Salts (TSS) concentration, a number of samples were analysed gravimetrically for TSS. The 1:5 soil:water suspensions were centrifuged at 14 000 rpm for 30 minutes to remove any clay particles from the suspension. Aliquots of the supernatant liquid were evaporated to dryness in a water bath. The samples were finally dried at 105°C for 4 hours. The samples used covered the conductivity range 1-2000 μS.

RESULTS

The data for the different areas showed some surprising concentrations of salts in the subsoil profiles. This work, covering the individual sampling areas, will be presented as a series of separate reports at a later date. The main purpose of this report is to outline two of the relationships between the EC of the 1:5 soil:water suspension and the soluble salts present. The graphical representation of this data is shown in Figure 1.

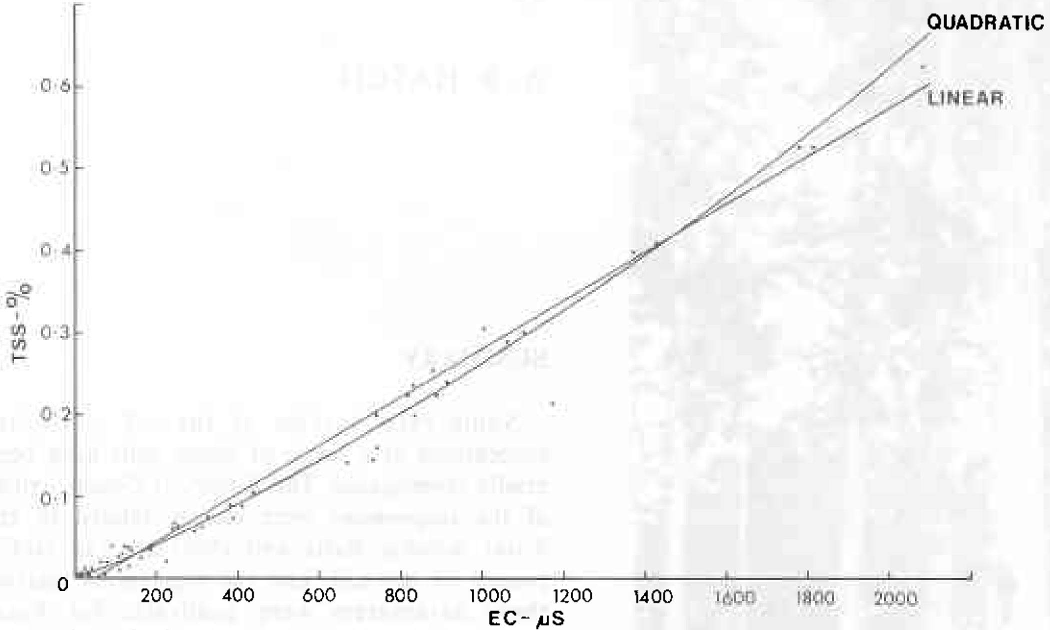

FIGURE 1: *Relationship between EC and TSS in 1:5 soil:water extracts (25°C)*

As a preliminary step, a linear regression was calculated for the data; the equation for this line was:

$$Y = (2.956 \times 10^{-4})X - (152 \times 10^{-4}) \quad (1)$$

where Y = % TSS
and X = EC (μS) of the 1:5 soil:water suspension at 25°C

The Analysis of Variance of this regression is shown in Table 1. The regression gave a very good fit for the data. However, it appeared that the data deviated from linearity in the low conductivity range, so a second regression using a quadratic term was calculated (Faddeeva, 1959). This equation was:

$$Y = (4.831 \times 10^{-8})X^2 + (2.175 \times 10^{-4})X - (14 \times 10^{-4}) \quad (2)$$

TABLE 1
EC and TSS
Linear regression
Analysis of Variance

Source	df	SS	MS	VR	
Regression (1)	1	1.489 565	1.489 565	1 769.71	***
Deviations	59	0.049 662	0.000 841 7		
Total	60	1.539 227			

R^2 = 0.968
SD = 0.029 01
r = 0.984 ***

The Analysis of Variance of this equation is shown in Table 2. The addition of the quadratic term significantly improved the regression equation, and the value of this term is shown in Table 3. Equation (2) has been used to calculate the TSS for all the soils analysed.

TABLE 2
EC and TSS
Quadratic regression
Analysis of Variance

Source	df	SS	MS	VR	
Regression (2)	2	1.502 237	0.751 118	1 7[illegible]9.7	***
Deviations	58	0.036 990	0.000 637 8		
Total	60	1.539 227			

R^2 = 0.976
SD = 0.025 25
SE(b1) = 1.8467×10^{-5} t = 11.778 ***
SE(b2) = 1.0782×10^{-8} t = 4.481 ***

TABLE 3
EC and TSS
Quadratic regression
Analysis of Variance

Source	df	SS	MS	VR	
Regression (2) —Regression (1)	1	0.012 672	0.012 672	19.87	***

(1 and 58 df)

The soil chlorides (as NaCl) showed a very close relationship to the EC of the 1:5 soil:water extract (Fig. 2). A linear regression was fitted to this data and the equation for the two variables was:

$$Y = (2.112 \times 10^{-4})X + (17 \times 10^{-4}) \quad (3)$$

where Y = % chloride (as NaCl)
and X = EC (μS) at 25°C

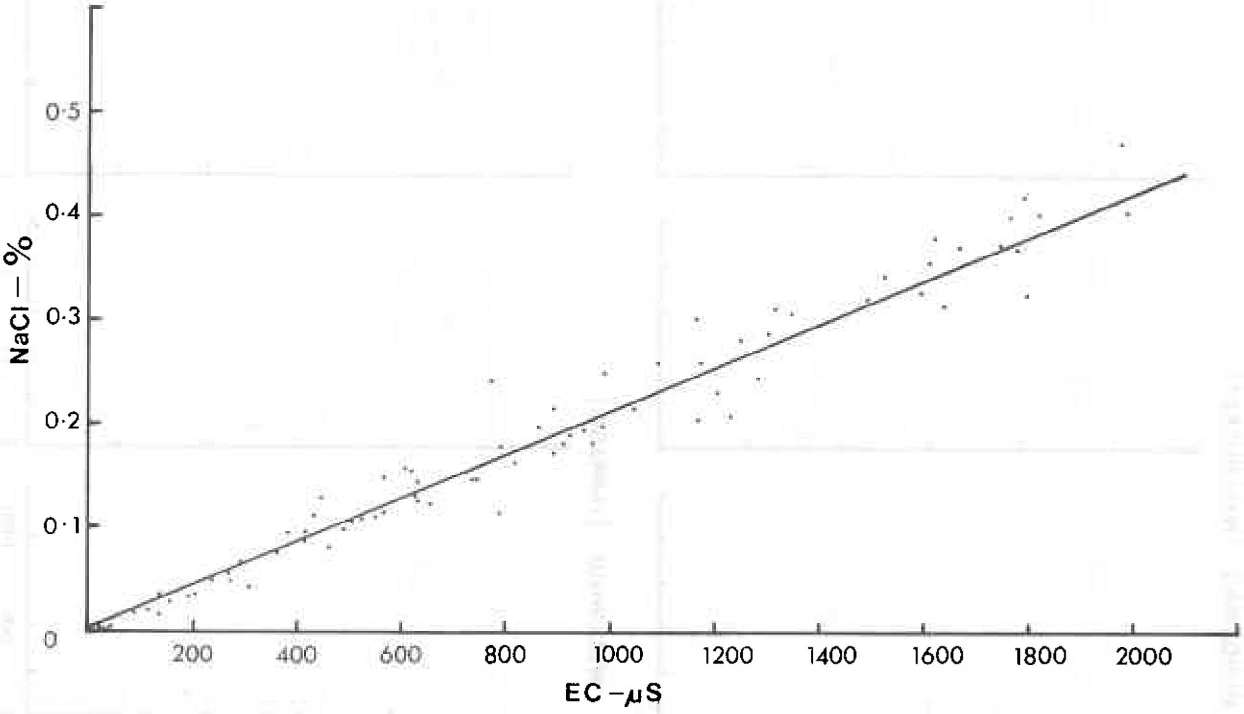

FIGURE 2: *Relationship between EC and chloride (as NaCl) in 1:5 soil:water extracts*

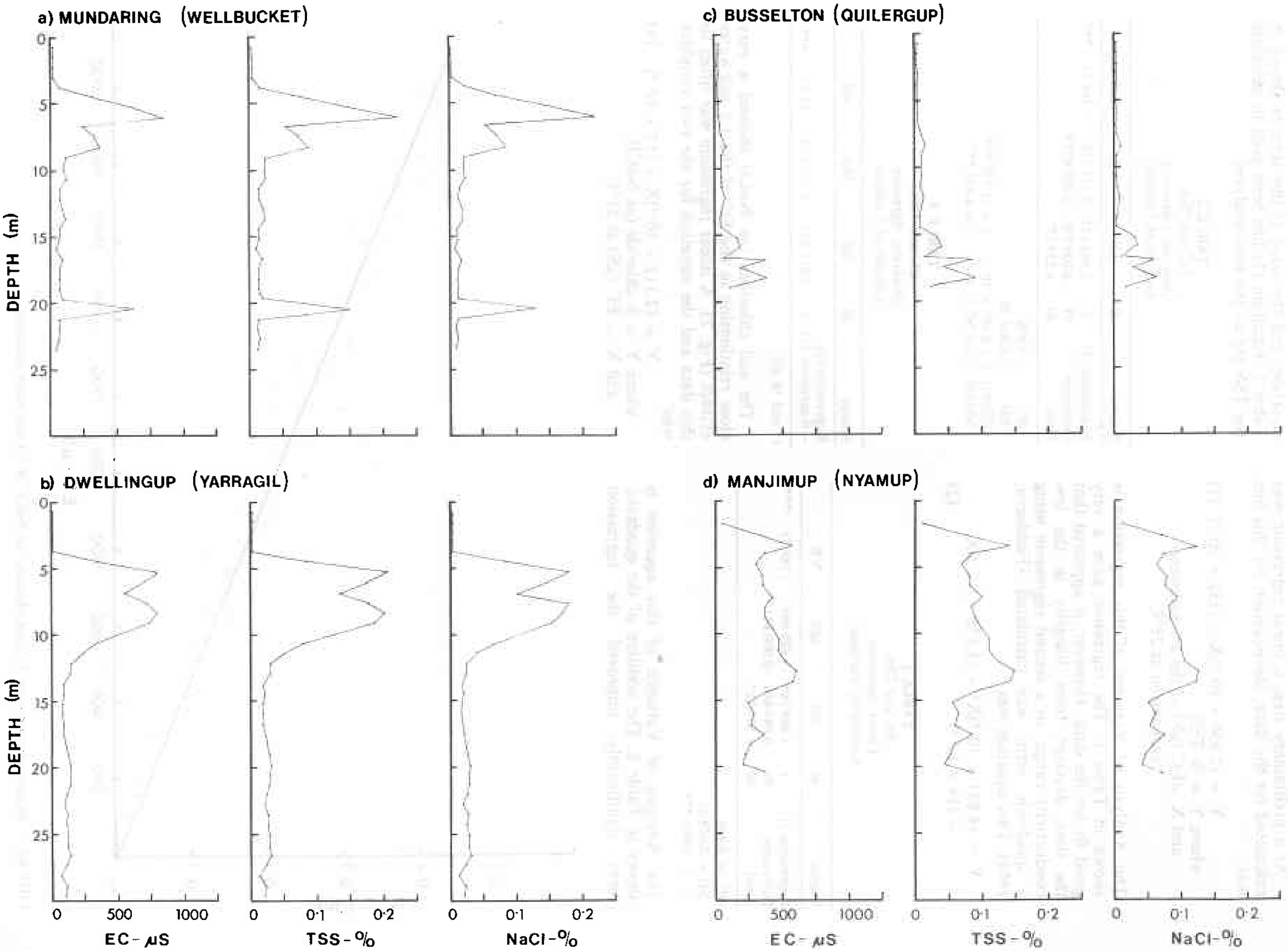

FIGURE 3: *Variation in EC, TSS and NaCl in some Western Aus[illegible]n forest soil profiles*

TABLE 4

EC and soluble chlorides
Linear regression
Analysis of Variance

Source	df	SS	MS	VR	
Regression (3)	1	1.713 464	1.713 464	34 748.81	***
Deviations	85	0.004 191	0.000 049 31		
Total	86	1.717 655			

R^2 = 0.998
SD = 0.007 022
r = 0.999 ***

The Analysis of Variance of this equation is shown in Table 4. Some examples of the distribution of these factors in several profiles are shown in Figure 3.

DISCUSSION AND CONCLUSIONS

It must be realized that these equations are applicable only to a 1:5 soil:water suspension, and also that the bulk of the data was representative of subsoil samples, so any effect of organic matter will be minimised. However, the data from the small number of surface soils examined followed the general pattern of the regression equations. In addition, the data used for the regression equations covered samples from all drilling sites, so the equations should be applicable to all future samples.

Discrepancies were observed only in the small number of subsoils which had high pH values. In these soils, the chloride values were less than would be expected from their EC values. Further analyses are being undertaken to examine the soluble anions and cations in these soils.

REFERENCES

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