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MODELLING COLIFORM CONCENTRATIONS IN UPLAND IMPOUNDMENTS : A MULTIVARIATE APPROACH

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Abstract

Variations in the concentration of total coliform and *E. coli* in two upland impoundments in North Yorkshire are investigated. Twenty hydrological, climatic and physio-chemical variables are related to changes in bacterial numbers. The results indicate in the short term concentration is strongly related to hydrological regime and location within the impoundment but that over a full year the importance of physio-chemical water quality parameters increases. The model presented is an improvement upon previously reported univariate models.

LIST OF FIGURES

LIST OF TABLES

Introduction

In a previous paper Kay and McDonald (1980), the authors outlined a study of reservoir self purification based upon a distance dependent decay relationship which defined the ability of two reservoir impoundments to produce a reduction in coliform bacterial concentration.

Although superior to the time dependent decay models utilised by Shiao (1976) and Andersin (1976), the distance decay function was an inadequate tool with which to predict coliform concentration within the impoundments studied. The main reasons for the inadequacy of this preliminary modelling approach was that the coliform inputs and retention times were not constant and that non-point source inputs were produced from areas around the reservoir banks. All of these effects tend to disturb the smooth logarithmic decay function and produce a high proportion of non-significant linear relationships between coliform concentration and distance from an influent stream.

The nature of the irregular input has been reported in Kay and McDonald (1978), McDonald and Kay (1980) and Thornton et al. (1980). These studies confirm the importance of stream flushing of coliform bacteria during storm hydrograph events which has been observed by Morrison and Fair (1966), Kunkle and Mieman (1968), Kunkle (1970) and Quershi and Dutka (1979). Any predictive model of coliform concentrations within an impoundment must take into account more factors than the distance of sample locations from an influent stream. The factors which should be considered include the variability of the hydrograph input and changes in bactericidal, physio-chemical water quality parameters which may be affected by stream hydrograph regime (Kay and McDonald, 1978).

The univariate linear model, considered in Kay and McDonald (1980), did not take into account the influence of a set of factors all of which may have an effect on coliform concentration. One approach to such a complex situation is to formulate a multivariate model which can produce a predictive equation based upon environmental parameters which may determine coliform concentration. This paper presents such a multivariate approach to coliform modelling in the reservoir environment..

The Study Site

The Washburn Valley contains a system of four cascading reservoirs which supply water to the city of Leeds in West Yorkshire, some 40 km to the south west (Figure 1). For the most part the area is controlled by the Yorkshire Water Authority which has developed a multiple use catchment policy. The area is under mixed agriculture and forestry and has significant formal and casual recreational use. The upper two reservoirs, Thruscross and Fewston, are the site of the studies reported in this paper. Of the total catchment area of 51.9 km^2, over 86% provides flow into the water bodies as definable point sources, the remaining 13.9% providing non-point sources adjacent to the reservoirs. Subcatchment structure, stocking rates, stocking densities and land applications are fully specified in Kay and McDonald (1980) and Table 1. The bulk of the recreational pressures have developed within the non-point source areas, as defined in Figure 2.

Sampling Programme

As noted by Geldreich et al. (1980), any sampling programme designed to monitor ecological changes within a water body must consider both the three dimensional nature of the system under study and the time dimension. With this in mind, the sampling programme was designed to take account of the spatial nature of the systems and temporal (seasonal) effects.

The three discrete limnological conditions which characterise all temperate water supply impoundments are defined in Figure 3. For each reservoir state, a sampling run was completed on each impoundment producing six data sets. The periods of sample collection, together with rainfall and reservoir levels are shown in Figure 4. Weekly samples were collected at each location on Fewston reservoir shown in Figure 1. A selection of locations on Thruscross reservoir were sampled each week, the rationale for sample site selection was discussed in Kay and McDonald (1980). These locations were chosen to reflect the expected pattern of coliform reduction with maximum rates of change close to the influent streams. Laboratory capacity constraints necessitate a balance between the areal concentration of sample locations and the number of depth samples which can be collected at each location. In this study a two level sampling system was chosen in which samples were collected at the water surface and 1 m above the reservoir bottom at each sampling location. Although not ideal for investigating thermoclinal influences, this system reflected the possible outflow locations for both reservoirs and the broad two layer stratification experienced during runs T_3 and F_3 (see Figures 3 and 4).

Methodology

An inflatable rubber dinghy fitted with a metal gantry capable of lowering a Mortimer (1940) bacterial sampler to a predetermined depth was used for sample collection. Immediately after collection each 250 ml presterilized pyrex sample bottle was placed in a dark ice chest (initial temperature $0^{\circ}C$) as recommended in Reports No. 71 (H.M.S.O., 1969). During the 12 month period of study, 1246 water samples were collected, 98% of which were analysed within the recommended 6 hours of collection (H.M.S.O., 1969). The longest elapsed time between collection and analysis was 7.1 hours and the mean time was 4.6 hours. Total coliform and E. coli enumerations were determined using the Most Probable Number multiple tube technique as outlined in H.M.S.O. (1969). Minerals Modified Glutamate Media (Oxoid) was used for presumptive enumeration of coliform bacteria. Confirmation of total coliform was completed using Lactose Ricinoleate Broth (Oxoid) incubated at $37^{\circ}C$ for 48 hours. E. coli was confirmed by inoculation of Lactose Ricinoleate Broth and Peptone Water (Oxoid) incubated at $44^{\circ}C$ for 24 hours.

At each sample location temperature and dissolved oxygen were measured using an E.I.L. dissolved oxygen meter (model 15A) with Mackereth electrode and thermister temperature compensator (Edwards et al., 1974) attached to the frame of the Mortimer sampler. Specific conductance and pH were measured in the laboratory using a Pye Unicam model 290 MK2 pH meter and an L.T.H. model PB5 conductivity meter, both of which provided for automatic temperature compensation. Rainfall data was taken from the daily rainfall record kept by the reservoir managers for each impoundment. The data describing stream hydrograph input was collected using an A.O.T.T. stream stage chart recorder on the Capelshaw Beck input to Thruscross reservoir. The extent to which this one location provides a representative record of the hydrograph input to both reservoirs is discussed in Kay (1979).

Buoy locations were sampled in the same order each week. A randomized sampling system was considered and rejected on the grounds that the additional inter-location travel time would have increased the elapsed time between sample collection and analysis beyond the recommended 6 hours (H.M.S.O., 1969).

Variable Selection

Total coliform and E. coli per 100 ml were chosen as dependent variables because they are the indicator organism most widely used as a measure of the sanitary purity of reservoir water (H.M.S.O., 1969; Kay and McDonald, 1980; Thornton et al., 1980).

The selection of predictor variables was based upon a knowledge of the transport mechanisms of coliform input to these upland reservoirs (McDonald and Kay, 1980); Kay and McDonald, 1978 and a knowledge of the physio-chemical parameters of water quality which determine the bactericidal effects of the reservoir environment (Hanes et al., 1964, 1966; Scarce et al., 1964; Gameson and Saxon, 1967; Gravel et al., 1969; Mitchell, 1968; McFeters and Stuart, 1972; Poynter and Stevens, 1975; Verstraete and Voets, 1976).

The complete data set contains measurements for each variable listed in Table 2. This data was stored in S.P.S.S. system files (Nie et al., 1970) in case format, each case (row) in the data file matrix relating to one coliform enumeration (dependent variable) and its associated environmental parameters (predictor variables). The data file was structured into six subfiles each of which consisted of a data matrix containing all measurements from one run (as defined in Figure 4). This allowed the analysis of any combination of subfiles containing data on specific limnological or management condition.

The Multivariate Model

A multiple regression equation of the Form:

$$Y = a + \sum_{i=1}^{k} b_i X_i + u$$

where

Y	=	the dependent variable;
X_{1-k}	=	the independent or predictor variables;
b_{1-k}	=	the regression coefficients;
u	=	the stochastic disturbance term;
a	=	a constant;

was fitted to the Washburn Valley data set using a package program (Nie et al., 1970).

Multiple regression analysis is a parametric statistical technique and therefore it requires certain assumptions to be made regarding the characteristics of the raw data (Poole and O'Farrell, 1971). The exact degree to which the Washburn Valley data set fits the assumptions of the model is defined in Kay (1979). The only data modification considered necessary was the logarithmic transformation of total coliform and E. coli concentrations per 100 ml. This transformation increases normality in variables Y_1 and Y_2, thus decreasing skew in the stochastic disturbance term and providing more meaningful confidence limits on the prediction of the dependent variables.

It is clear from an examination of the independent variables that multicollinearity between predictor variables would be expected in this data set. This problem is present, but often not considered, when any set of environmental parameters are used to predict some ecosystem characteristic (Bateman, 1976; Dunlap, 1976). The effects of multicollinearity among independent variables is to reduce the significance of the calculated regression coefficients. If however, the collinearity pattern existing at the time of sample collection exists during the period of prediction, then accurate prediction of dependent variable values will be obtained (Malinvaud, 1970). However, the regression coefficient values would not provide a measure of the relative contribution of different predictor variables to the prediction of the dependent variable.

In this study it was decided to collect data on predictor variables despite potential multicollinearity because it was not intended to utilise all the variables in any single prediction equation. Indeed, the program system chosen allowed for different variable subsets to be selected for each prediction equation of the basis of specific inclusion criteria which allowed for the control of multicollinearity between predictors.

Variable subset selection for each regression equation was a accomplished using a forward selection stepwise regression method. The variable chosen at each inclusion step was controlled by the F and T level equation parameters. The F level (defined as $(b_i/$ standard error of $b_i)^2$) is a measure of the significance of the linear relationship between a predictor variable and the dependent variable. The variable selected for inclusion into the equation at the next program step will be the one with the largest F level provided that it is not multicollinear with the predictor variables already in the equation. The t value allows the degree of permissible multicollinearity to be set.

As Hocking (1976) notes, the exact degree of allowable multicollinearity has not been defined adequately. In this study a t value was chosen to exclude from the analysis predictor variables having intercorrelations in the range ±0.8 to ±1.0, which Kim and Kohout (1975) define as extreme multicollinearity. In addition, variables having an F value below 2 were not included. Prediction equations were produced for each data set listed in Table 3.

Results and Discussion

Table 4 presents the calculated regression equation for prediction of $\log_{10}$ total coliform and Table 5 presents the equation for $\log_{10}$ E. coli. The results of the full analysis are summarised in Table 6. An examination of the R^2 values in this table suggests that the multiple regression models presented here are a considerable improvement on the purely distance dependent decay relationships outlined in Kay and McDonald (1980). The variable subsets selected for each equation indicate the importance of variables X_8 to X_{20} which are measures of the magnitude and timing of the hydrological input to the reservoirs. This would indicate that some form of flushing mechanism is operative in the transport of enteric organisms into the reservoir environment (McDonald and Kay, 1980). It is clear from a consideration of the regression equations presented in Tables 4 and 5 that the physio-chemical parameters of water quality (variables X_1, X_2, X_4 and X_5) become more important predictors of coliform concentration when the full year's data is considered. This is due to the small range of values for each of these parameters during one run. This small numerical range would not be sufficient to establish the linear relationship between these predictor variables and the dependent variable. (In effect the F value of each predictor variable would be low and hence it would not be selected during the generation of the regression equation).

The hydrological input variables (X_8 to X_{20}) provide an index of the energy available for transportation of enteric organisms. The timing and magnitude of this energy will be similar over the whole catchment and will provide input to the impoundments from both point sources and non point sources. It is important to consider these areas adjacent to the impoundment in any upland location because they will always have the lowest elevation and will therefore be the areas of most intensive land use. This use intensity is evident from Table 1 which presents the percentage of improved land, cattle per km^2, fertilizer per km^2 and winter muck per km^2 within each of the catchment subdivisions outlined in Figure 2. It is not possible to consider this non-point source input by modelling input plume movements (Thornton et al., 1980) or considering mere distance decay relationships (Kay and McDonald, 1980). It may be argued therefore that the multivariate approach offers the best model for the prediction of impoundment coliform concentration.

The evident importance of the flushing mechanism (Thornton et al., 1980; McDonald and Kay, 1980) has catchment management implications which depend upon certain assumptions concerning the bacterial store location. If surface faecal material, within stream contributing areas and around the reservoir banks, provides the store location, then transport will occur during times of overland flow and management effort should be directed towards minimising the store size and the magnitude of overland flow events. However, if, as Matson et al. (1978) suggest, the store location is to be found in stream bed sediment and the transport mechanism is bacterial entrainment during times of high flow, then management effort should be directed towards minimising the hydrograph response of streams in the catchment. These two management strategies may be mutually exclusive, for example, the installation of field drains may reduce saturated overland flow whilst increasing the hydrograph response of catchment streams. Further research investigating the relationship between catchment hydrology and water quality is required before management strategies can be formulated with the aim of minimising impoundment coliform concentration.

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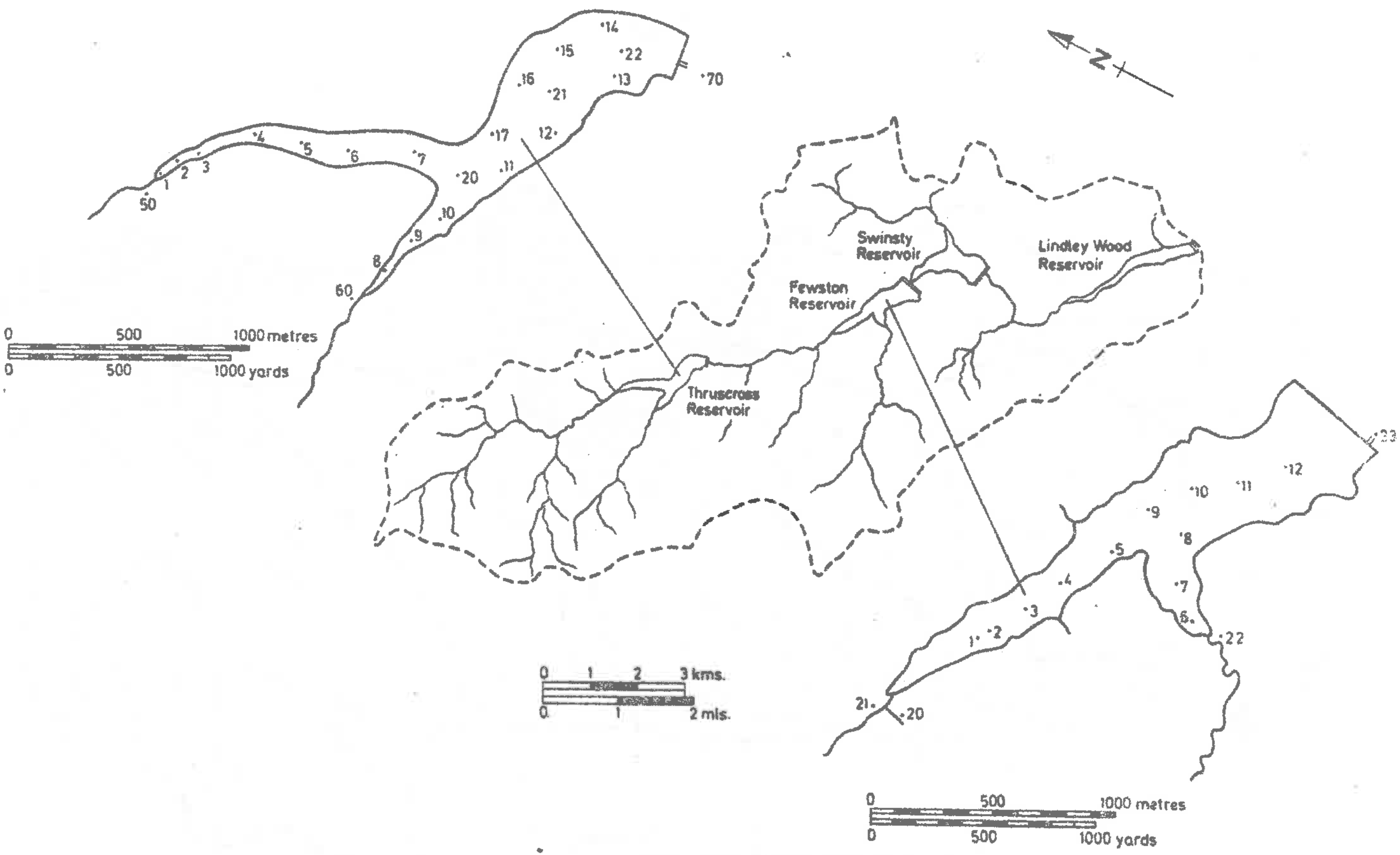
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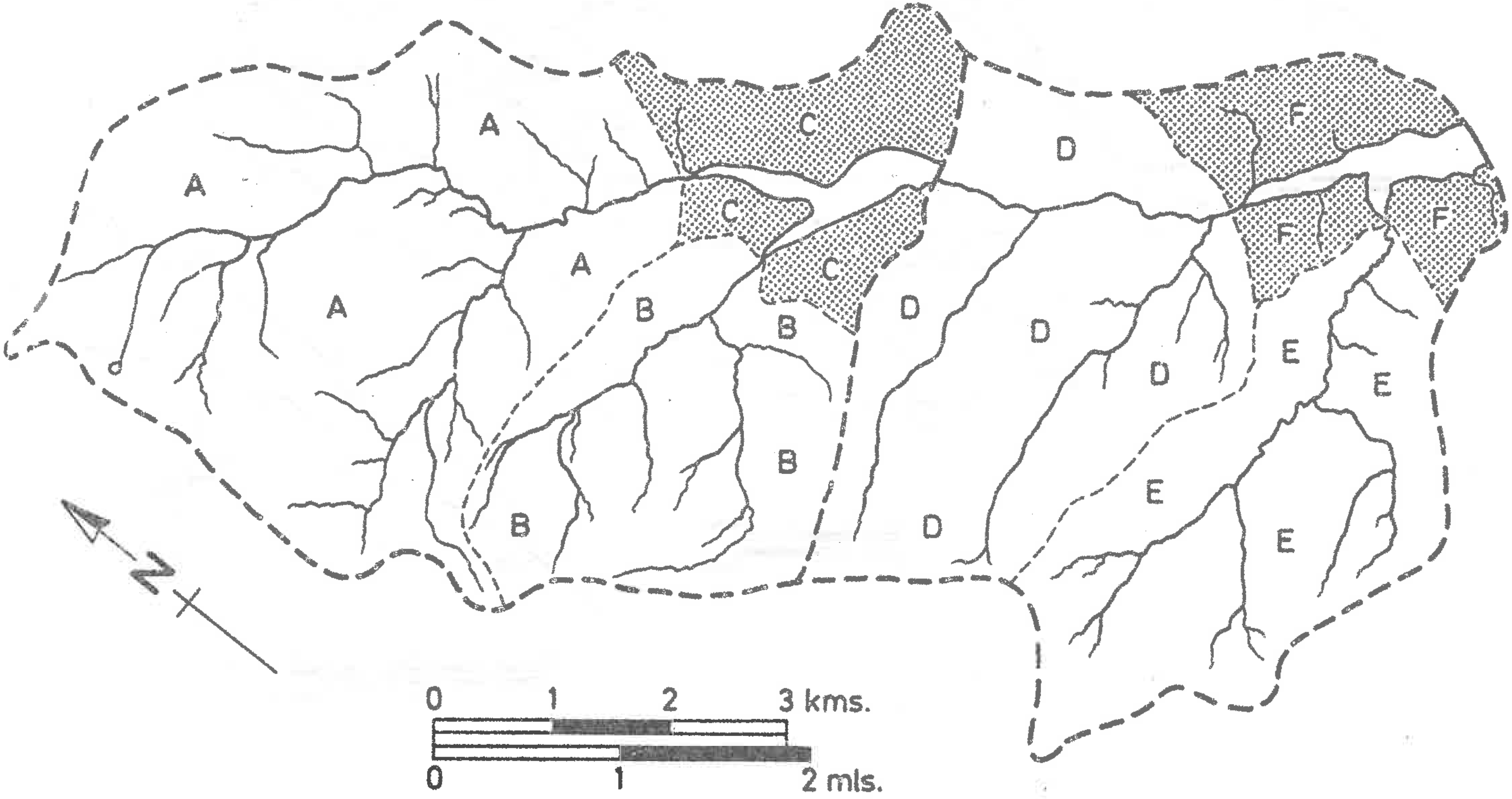
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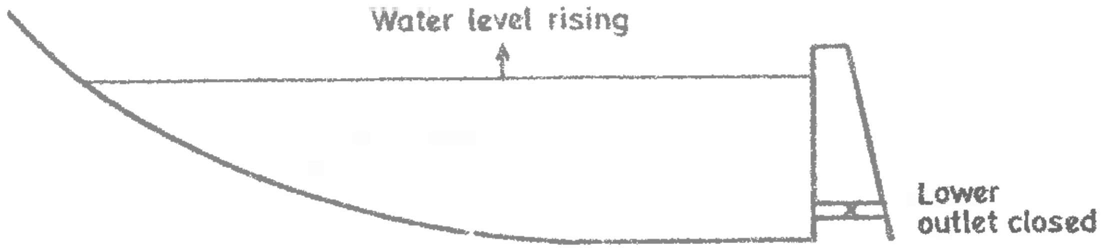
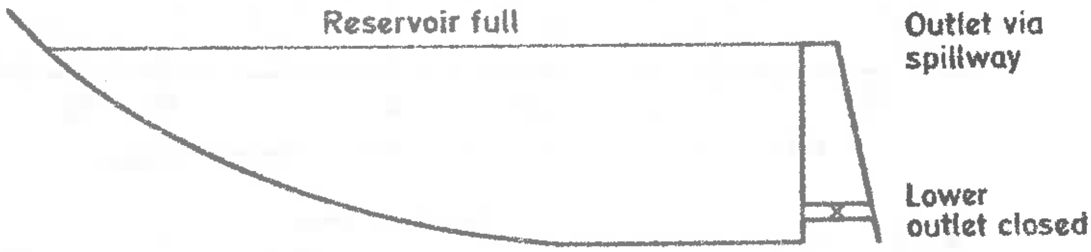
1. Autumnal filling of the depleated reservoir



2. Winter full condition



3. Summer drawdown

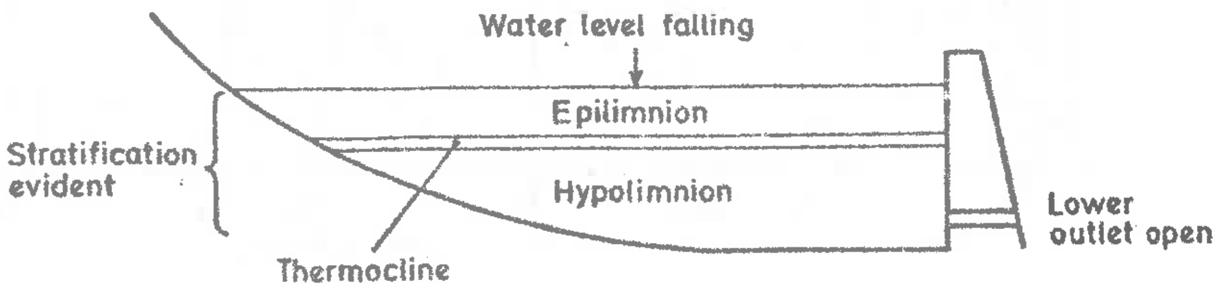


Figure 3

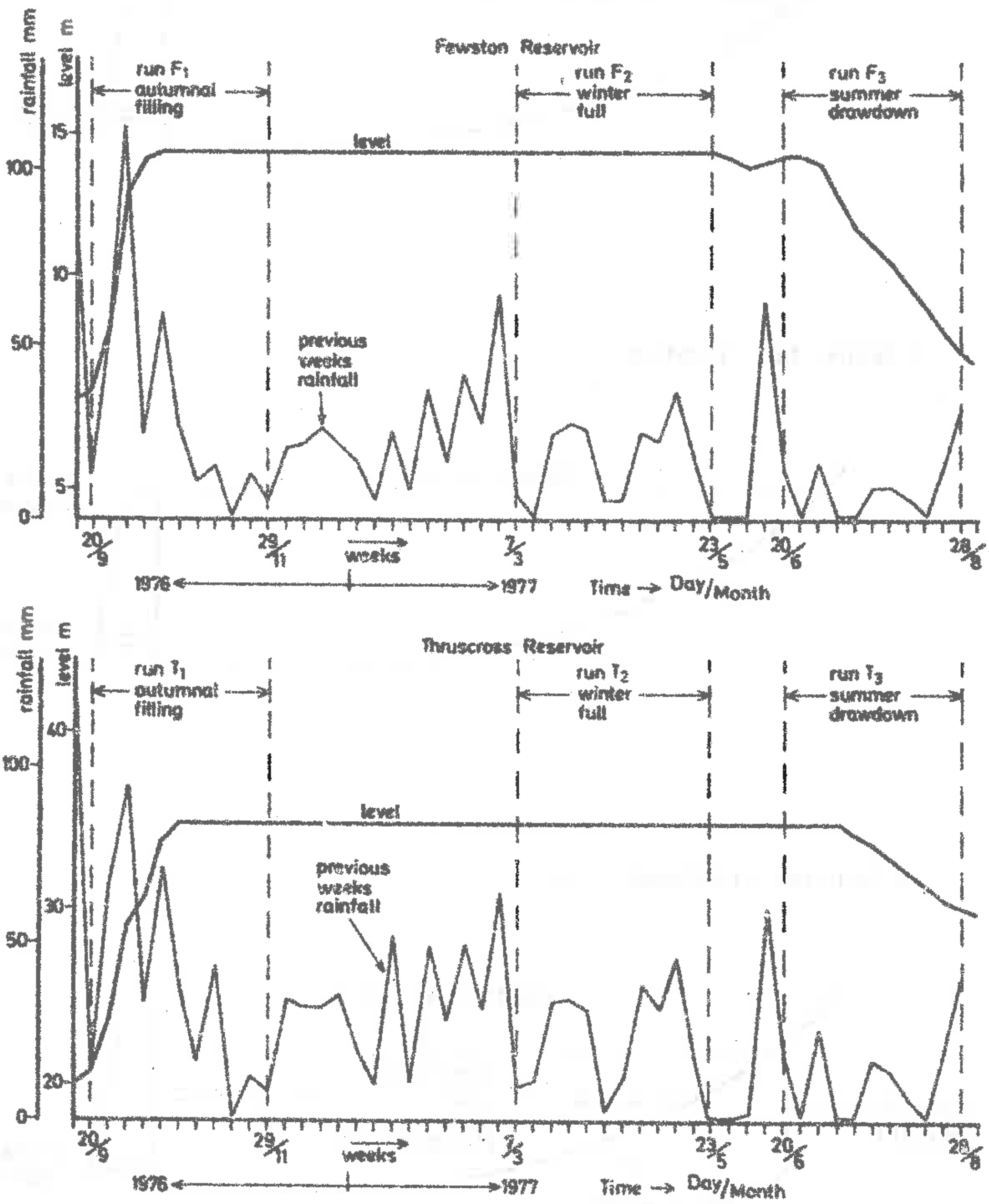

Fewston Reservoir
raintall mm
level m
run F_1 autumnal filling
run F_2 winter full
run F_3 summer drawdown
level
previous weeks rainfall
weeks
1976
1977
Time → Day/Month
Thruscross Reservoir
run T_1 autumnal filling
run T_2 winter full
run T_3 summer drawdown

Figure 4

Table 1. Agricultural land use in the areas shown in Fig. 3.

Area	Total area (km^2)	Improved land (km^2)	% Improved land	No. cattle	No. ewes	Cattle km^{-2}	Ewes km^{-2}	Fertiliser (10^3 kg·km^{-2})	Winter muck (10^3 kg·km^{-2})
A	16.3	1.1	6.7	80	1100	74	68	8.9	352
B	7.5	3.0	40.0	437	630	146	85	26.7	666
C	3.7	3.1	84.0	300	753	96	203	24.2	399
Thruscross	27.5	7.2	26.0	817	2483	113	90	22.9	503
D	11.3	5.2	46.0	361	2040	69	181	18.6	305
E	9.6	1.6	16.7	127	393	79	41	27.2	374
F	3.5	1.7	48.6	154	664	91	190	21.4	616
Fewston	24.4	8.5	34.8	642	3097	76	127	20.8	380
Total all catchments	51.9	15.7	30.2	1459	5580	93	108	21.8	436

Table 1

Y_1	L10TC	Log_{10} total coliform
Y_2	L10EC	Log_{10} E. coli
X_1	FTEMP	Field Temperature Degrees Centigrade
X_2	DO	Percentage Dissolved Oxygen
X_3	DEPTH	Depth of Sample Location in Metres
X_4	PH	Hydrogen Ion Activity
X_5	SCOND	Specific Conductance. Siemens at $25^{\circ}C$.
X_6	DISTM	Distance to Main Stream Input. Metres
X_7	DISTS	Distance to Side Stream Input. Metres.
X_8	PMRF	Previous 4 weeks' Rainfall. mm.
X_9	P2WRF	Previous 2 weeks' Rainfall. mm.
X_{10}	PWRF	Previous week's Rainfall. mm.
X_{11}	P2DRF	Previous 2 days' Rainfall. mm.
X_{12}	PDRF	Previous day's Rainfall. mm.
X_{13}	TP	Time since Previous Hydrograph Peak. Hours
X_{14}	HTP	Height of Previous Hydrograph Peak. cms.
X_{15}	NPW	Number of Hydrographs in the Previous Week
X_{16}	HTPW	Highest Stage of Previous Week. cms.
X_{17}	THTPW	Time to the Highest Peak of the Previous Week. Hours
X_{18}	NPFN	Number of Hydrographs in the Previous 2 Weeks
X_{19}	HPFN	Highest Stage of Previous 2 Weeks. cms.
X_{20}	THPFN	Time to the Highest Peak of the Previous 2 Weeks

Table 2

RESERVOIR	SUBFILE	CASES	CASES (SURFACE ONLY)	CASES (DEPTH ONLY)
FEWSTON	F_1	199	114	85
	F_2	245	140	105
	F_3	223	113	110
THRUSCROSS	T_1	170	93	77
	T_2	214	120	94
	T_3	213	105	108
TOTAL FEWSTON	$F_1 + F_2 + F_3$	667	367	300
TOTAL THRUSCROSS	$T_1 + T_2 + T_3$	597	318	279
TOTAL FEWSTON + THRUSCROSS	$F_1 + F_2 + F_3 + T_1 + T_2 + T_3$	1264	685	579

Table 3

SUBFILE IDENTIF.	CONSTANT	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}
F[illegible],2,3 A	0.[illegible]032	-0.16170	-0.01602		0.3[illegible]97		-0.[illegible]		0.010[illegible]			-0.05859	0.15[illegible]03	-0.[illegible]	0.00782			0.00668	-0.08896		
[illegible]1,2,3 A	6.49387		-0.50561		-0.33[illegible]		-0.00110			0.03699	-0.00214	0.04790		-0.00286		-0.1397[illegible]			-0.10442		0.00080
F[illegible] A	1.45352							0.[illegible]015							0.09163			0.00315	-0.78970		
F[illegible] A	20.38449		-0.11722		-0.[illegible]		-0.00[illegible]		-0.01[illegible]	0.01[illegible]			-[illegible]				-0.06332				
F3(A)	4.[illegible]	-0.2127[illegible]						-0.00[illegible]		-0.00[illegible]	0.01693			0.[illegible]	0.05006			-0.00873			
T[illegible] A	-[illegible].93970						-0.00036				-0.0[illegible]			0.00439			0.11520	0.00220			
T2 A	0.70[illegible]09							-[illegible].00079	0.010[illegible]					-0.00169							
T3 A	-2.[illegible]6064	-0.0850[illegible]			0.[illegible]	0.01[illegible]		-0.00[illegible]													
F[illegible] S	5.36[illegible]	-[illegible]3060	-0.01014		0.21079	-0.00[illegible]	-0.00[illegible]		0.[illegible]076			-[illegible]	0.[illegible]4018	-0.[illegible]	0.01269			0.00571		-0.0843[illegible]	-0.[illegible]
T[illegible] S	1.32612				-0.25742	0.02[illegible]		-0.00[illegible]	0.0[illegible]		-0.0[illegible]				-0.028[illegible]	0.10622					
[illegible] S	-2.[illegible]				0.[illegible]			[illegible].00024						0.00470	0.13227				-1.19251		
F2.S	3.202[illegible]		-0.01650				-0.00024			0.01573			0.03[illegible]						0.01751		
[illegible] S	3.[illegible]	-[illegible].1537[illegible]						-[illegible].00078						0.00316	0.05264			-0.01127			
[illegible](S)	-4.24208				0.9[illegible]044		0.00307				-0.02[illegible]			-[illegible].00183			0.06177	0.00241		0.0[illegible]619	
T[illegible](S)	0.91[illegible]67							-0.00077	0.00902												
[illegible](S)	-0.524[illegible]	-[illegible].09501				0.0[illegible]079		-0.000[illegible]													
T123(D)	4.4[illegible]937	-0.1636[illegible]						-0.00[illegible]44	0.00948			-0.000[illegible]					0.06185			-[illegible].12675	-0.[illegible]
[illegible]123(D)	2.26114		[illegible].00038	-0.00078						0.03056	0.00029			-0.001[illegible]5						-0.08[illegible]	
F1(D)	0.8326[illegible]	-0.0[illegible]862				0.0130[illegible]		-0.00055	0.00224				0.06818			-0.06546					0.[illegible]
F2(D)	10.81082		-0.05356				-0.00029													-0.02572	
F3(D)	6.3573[illegible]	-0.15453				-0.018[illegible]	-0.0[illegible]036											-0.00429			
T1(D)	-0.92502		0.02643									-0.18267					0.05419				
T2(D)	0.41647							-0.000[illegible]	0.01217					-0.00150							
T3(D)	-2.[illegible]8677					0.04408			-0.00722										[illegible].44732		

F123(A)	2.68746		-0.00216		-0.04278			0.00008		0.01523			0.05074	-0.00190			0.05899			-0.10693	
T123(A)	-0.55972		-0.00970			0.02780		-0.00040	0.00681	0.00403	-0.00609	-0.02176	0.07498		-0.02373			0.00517			-0.00244
F1(A)	3.13516				0.31067					0.00411											
F2(A)	0.62553						-0.00026			0.01048			0.07547								
F3(A)	4.37431	-0.17089						-0.00093			0.02151			0.00231				-0.00763			
T1(A)	4.90283				-0.49021		-0.00019			0.02444			-0.07044	0.00988							-0.01595
T2(A)	0.07574							-0.00066	0.01078							[illegible]			-0.09775		
T3(A)	-1.95230	-0.09219			0.52821	0.01583		-0.00038													
F123(S)	0.32961		0.00405		-0.22704	-0.04660	-0.00008			0.03233		-0.05526	0.08145	-0.00583	0.03625	0.14993		0.00847		-0.14321	
T123(S)	14.26978		-0.01898			-0.10176		-0.00037	0.03179		-0.00621	0.13999	-0.38824	-0.00674	0.02469	0.46261			-0.20610		0.00369
F1(S)	0.73488				0.24518					0.00397											
F2(S)	0.40408									0.01086			0.07221								
F3(S)	3.64062	-0.14565						-0.00068						0.00310	0.04655			-0.01057			
T1(S)	-0.81938		0.02046							0.00367											
T2(S)	1.50701							-0.00069						-0.00129							
T3(S)	-1.64706	-0.11749			0.78366			-0.00042													
F123(D)	2.05847			0.00703	-0.04595				0.00112	0.01223		0.0272[illegible]					0.06792			-0.10564	
T123(D)	-1.03766		-0.01145	-0.01324		0.03162		-0.00008	0.00960	0.00453	-0.01154		0.04508		-0.02925			0.00723			-0.00364
F1(D)	0.05781					0.01402				0.00214			0.04551								
F2(D)	0.85447							-0.00068					0.07984			0.18787					0.00356
F3(D)	6.29089	-0.14379				-0.02166	-0.00040											-0.00310			
T1(D)	3.21448		-0.05751			0.01539		-0.00010		0.01654		0.10065									
T2(D)	-0.31202							-0.00063	0.01138									0.01413			0.00749
T3(D)	-2.57951				0.33771	0.01475			-0.00702				0.06533			0.12750			0.49688		

Table 5

DATA SET	DEPENDENT VARIABLE	ALL DATA					SURFACE DATA					DEPTH DATA				
		No.	R^2	S.E.	F	SIG.	No.	R^2	S.E.	F	SIG.	No.	R^2	S.E.	F	SIG
F_{1-3}	L10TC	11	0.94	0.21	349	0.001	13	0.85	0.37	45	0.001	7	0.99	0.01	229661	0.001
	L10EC	8	0.99	0.05	7042	0.001	12	0.97	0.17	245	0.001	7	0.99	0.04	9017	0.001
T_{1-3}	L10TC	10	0.99	0.03	8449	0.001	7	0.51	0.55	13	0.001	6	0.99	0.01	142500	0.001
	L10EC	11	0.56	0.53	21	0.001	12	0.97	0.14	231	0.001	11	0.65	0.47	14	0.001
F_1	L10TC	4	0.97	0.08	573	0.001	5	0.99	0.03	3045	0.001	7	0.97	0.09	97	0.001
	L10EC	2	0.44	0.39	24	0.001	2	0.36	0.43	9	0.001	4	0.80	0.24	23	0.001
F_2	L10TC	7	0.52	0.51	10	0.001	5	0.41	0.56	5	0.01	3	0.47	0.53	8	0.001
	L10EC	3	0.37	0.60	14	0.001	2	0.30	0.64	8	0.001	3	0.47	0.57	8	0.001
F_3	L10TC	7	0.56	0.46	13	0.001	5	0.65	0.45	10	0.001	4	0.44	0.49	8	0.001
	L10EC	5	0.51	0.47	15	0.001	5	0.63	0.46	9	0.001	4	0.41	0.47	7	0.001
T_1	L10TC	5	0.97	0.11	270	0.001	6	0.97	0.10	160	0.001	3	0.98	0.08	326	0.001
	L10EC	6	0.82	0.40	34	0.001	2	0.53	0.63	15	0.001	7	0.98	0.13	137	0.001
T_2	L10TC	3	0.60	0.42	29	0.001	3	0.63	0.42	18	0.001	3	0.54	0.45	9	0.001
	L10EC	4	0.47	0.47	12	0.001	2	0.44	0.50	13	0.001	3	0.38	0.50	5	0.025
T_3	L10TC	4	0.47	0.47	13	0.001	3	0.64	0.47	11	0.001	3	0.27	0.44	4	0.025
	L10EC	4	0.45	0.45	12	0.001	3	0.59	0.47	9	0.001	5	0.41	0.40	5	0.01

No. = Number of Variables used in each Equation

S.E. = Standard Error

SIG. = Significance Level

Table 6

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