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*A STUDY OF THE HYDROLOGICAL AND
SEDIMENTOLOGICAL CHARACTERISTICS OF
TWO CATCHMENTS OF CONTRASTING
LAND USE*

*A thesis presented in partial fulfillment of the
requirements for the degree of Master of
Agricultural Science in Soil Science
at Massey University*

Brian James Bargh

1976

ERRATA: Changes on page headed ABSTRACT
and pages 48 and 62 as follows:-

p. headed ABSTRACT , 4th paragraph, 3rd line to read

'and 1.22×10^2 kg / ha from the Tuapaka and
Ballance Catchments, respectively.'

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ABSTRACT

The hydrological and sedimentological characteristics of two catchments of contrasting land use were studied for a period of one year. Both catchments were situated in the Northern Taranaki Ranges, near the Manawatu Gorge, some 27 km from Palmerston North, New Zealand. The 10 ha Ballance Catchment has native forest vegetation, whereas the 180 ha Tuapaka Catchment is part of a mixed sheep and cattle farm.

The water balance estimated for the catchments indicated that a small amount of deep percolation occurred in both. Streamflow and rainfall were recorded at both catchments. During the study year approximately 26% and 14% of total rainfall was discharged as streamflow from the Tuapaka and Ballance Catchments, respectively. Throughfall and stemflow were also recorded at Ballance. The average monthly throughfall was 54% of total rainfall; the equivalent stemflow was 16% of total rainfall.

An attempt was made to identify and quantify the inputs of phosphorus (P) and nitrogen (N) forms to the two catchments. Phosphate fertilizer application, N-fixation by clovers, and rainfall, were considered as the inputs of P and N forms in the Tuapaka Catchment. In the Ballance Catchment, rainfall was assumed to be the only input of P and N forms.

The output of suspended sediment, dissolved material, and P and N forms, was measured during the study year. The output of sediment was 1.4×10^3 kg/ha and 1.6×10^2 kg/ha from the Tuapaka and Ballance Catchments, respectively. The output of dissolved material from the Tuapaka Catchment was only 13% of the sediment output. Significant quantities of P and N output were associated with suspended sediment. Of the annual loss of total P (1.6 kg/ha) from the Tuapaka Catchment, 76% was in the particulate form. At Ballance, 52% of the annual loss of total P (0.2 kg/ha) was in particulate form.

Within the bounds of error, the Ballance Catchment appeared to be slightly conservative of P and strongly conservative of N. At the Tuapaka Catchment, however, inputs of P and N balanced outputs, within the bounds of error. It is difficult, if not impossible, to determine whether a particular catchment is conservative for P and N unless adequate attention is paid to the errors involved.

The differences obtained for the output of sediment and P and N forms, from the two catchments, are interpreted in terms of the effects of agricultural activities, particularly vegetation differences, on the inputs of particulate and dissolved phases to the streams.

ACKNOWLEDGEMENTS

Grateful acknowledgement is made to Mr D.G. Bowler, Dr P.W. O'Connor, and Professor J.K. Syers for their enthusiasm, advice, and encouragement throughout this study. The writer also gratefully acknowledges the advice from other members of the Soil Science Department, Massey University (M.U.), particularly the technical staff (Miss Ann Lyttle, Mr Mike Guildford, and Mr Lance Currie), and Dr V.E. Neall (for supervision of the geology section of this thesis) and Dr A.N. Sharpley.

Thanks are extended to ; Mr R.G. Heerdegen (Geography Department, M.U.) for rainfall data ; Mr E. Roberts (Agronomy Department, M.U.); Mr I.M. Ritchie Ministry of Agriculture and Fisheries, Palmerston North) for supervision of the vegetation section of this thesis ; Mr F.T. Pinkney (Ministry of Works and Development, Palmerston North) for the use of sediment sampling equipment ; Mr J. Høglund (D.S.I.R., Grasslands Division, Palmerston North) and the typist, Mrs Judy Munro.

Special thanks are extended to Mr Peter R. Stephens for his advice and help, and for supplying several photographs of the study catchments used in this thesis, and to my wife Robyn for her invaluable assistance with field work, cartography, and hours of copying.

CONTENTS

Acknowledgements

Contents

List of Figures

List of Plates

		PAGE
SECTION 1	INTRODUCTION	1
SECTION 2	LITERATURE REVIEW	4
2:A	Hydrological Characteristics of Catchments	
2:B	Sediment Yield	5
2:C	The Nature of Sediment and its Relationship to Phosphorus and Nitrogen	
SECTION 3	CATCHMENT DESCRIPTION	12
3:A	Catchment Location	
3:B	Climate	
3:B:1	General	
3:B:2	Rainfall	13
3:B:3	Wind	
3:B:4	Temperature	
3:B:5	Water Balance	
3:C	Geology and Soils	16
3:C:1	General	
3:C:2	Geology of Tuapaka Catchment	
3:C:3	Soils of Tuapaka Catchment	17
3:C:4	Geology of Ballance Catchment	19
3:C:5	Soils of Ballance Catchment	
3:D	Vegetation	20
3:D:1	General	
3:D:2	Present Vegetation	21
3:D:3	Pasture and Stock Management at Tuapaka	22
3:E	Erosion	23
3:E:1	General	
3:E:2	Tuapaka Catchment erosion	
3:E:3	Ballance Catchment erosion	

SECTION 4	METHODS	24
4:A	Rainfall	
4:A:1	Tuapaka Catchment	
4:A:2	Ballance Catchment	
4:B	Stream Discharge Measurement	27
4:B:1	Tuapaka Catchment	
4:B:2	Ballance Catchment	
4:C	Sediment Discharge Measurement	
4:D	Bedload Measurement	28
4:E	Particle Size Analysis	
4:F	Stream Water Nutrient Analysis	
4:F:1	Phosphorus	29
4:F:2	Nitrogen	
4:F:3	Organic Carbon	
4:G	Data Processing	
SECTION 5	RESULTS AND DISCUSSION	30
5:A	Hydrological Characteristics	
5:A:1	Drainage Pattern	
5:A:2	Hypsometric Analysis	33
5:A:3	Bifurcation Ratio	
5:A:4	Slope	
5:B	Inputs of Water	33
5:B:1	Total Rainfall	
5:B:2	Throughfall	35
5:B:3	Stemflow	36
5:C	Outputs of Water	37
5:C:1	Streamflow - Tuapaka	
5:C:2	Streamflow - Ballance	
5:C:3	A Comparison of Streamflows Between Study Catchments	
5:C:4	Evapotranspiration and Deep Percolation Losses	
5:D	Phosphorus and Nitrogen Inputs	43
5:D:1	Inputs in Rainfall	
5:D:2	Nutrients in Throughfall and Stemflow	44
5:D:3	Fertilizer Inputs	45
5:D:4	Inputs from N - fixing Species	

5:E	Output of Sediment and Phosphorus and Nitrogen Forms	
5:E:1	Sediment	55
5:E:1:1	Standardisation of Sampling Method for Sediment	
5:E:1:2	Sediment - Tuapaka	
5:E:1:3	Sediment - Ballance	
5:E:1:4	Sediment Sources	56
5:E:1:5	Particle Size Distribution	58
5:E:1:6	Pattern of Sediment Output	
5:E:1:7	Organic Carbon Content of Sediment	60
5:E:1:8	Dissolved Load Output	61
5:E:2	Phosphorus and Nitrogen Output	63
5:E:2:1	Phosphorus Output	
5:E:2:2	Nitrogen Output	67
5:E:3	Errors in Sediment and Nutrient Input and Output	71
SECTION 6	SUMMARY AND CONCLUSIONS	72
APPENDICES		75
BIBLIOGRAPHY		80

LIST OF FIGURES

Figure		Page
1	Location Map	9
2	Tuapaka Catchment - Drainage and Relief	14
3	Tuapaka Catchment - Geology, Soils and Erosion	
4	Ballance Catchment - Geology, Soils and Drainage	18
5	Area - Shape Curves	32
6	Hypsometric Curves	32
7	Sediment Rating Curve; Tuapaka	49
8	Sediment Rating Curve; Ballance	50
9	Tuapaka: Large Storm Hydrograph Showing Suspended Sediment and Nutrient Concentrations	51
10	Tuapaka: Small Storm Hydrograph	52
11	Ballance: Medium Storm Hydrograph Showing Suspended Sediment and Nutrient Concentrations	53
12	Ballance : Small Storm Hydrograph	54
13	Particle Size Distribution of Alluvial Materials: Tuapaka	57
14	Particle Size Distribution of Alluvial Materials: Ballance	57

LIST OF TABLES

<i>Table</i>		<i>Page</i>
1	<i>Drainage Analysis of Study Catchments</i>	30
2	<i>Summary of Hydrological Characteristics</i>	31
3	<i>Summary of Rainfall, Throughfall, Stemflow and Streamflow for the Study Catchments</i>	34
4	<i>Phosphorus and Nitrogen Concentrations and Inputs in Rainfall, Throughfall and Stemflow</i>	42
5	<i>Output of Suspended Sediment, Bedload, and Dissolved Load for Study Year</i>	46
6	<i>Output of Suspended Sediment, Dissolved Load, P and N from the Tuapaka Catchment</i>	47
7	<i>Output of Suspended Sediment, Dissolved Load, P and N from the Ballance Catchment</i>	48
8	<i>Errors in Measured Inputs and Outputs of P and N Forms and Suspended Sediment</i>	62
9	<i>Total P Losses in the Export of Animals and Animal Products from the Tuapaka Catchment</i>	66

LISTS OF PLATES

<i>Plate</i>		<i>Page</i>
1	<i>Oblique View of Tuapaka</i>	3
2	<i>Oblique View of Ballance</i>	3
3	<i>Vertical View of Tuapaka</i>	10
4	<i>Vertical View of Ballance</i>	11
5	<i>Tuapaka Weir</i>	25
6	<i>Ballance Flume</i>	25
7	<i>Standard Raingauge Used in Study</i>	26
8	<i>Stemflow Collection Tubing</i>	26

SECTION 1

INTRODUCTION

Deterioration in the quality of natural waters is a problem of increasing concern in New Zealand and overseas. Interference with agricultural and recreational activities, and a reduction in the consumptive value of waters are just three of the undesirable side-effects of sediment and nutrient enrichment of waters.

Sediment is regarded by some workers as the major pollutant of surface waters (Wadleigh, 1968). Sediment originates from two sources: (i) the natural and man-accelerated processes of erosion of soils and geological materials, and (ii) the direct or indirect discharge of industrial, municipal, or agricultural wastes to watercourses. Both sources produce a variety of sediment materials. Sediments from natural and man-accelerated erosion include inert boulders, gravel, sands, silts, and colloidal materials such as clays, organics, and amorphous materials. Although sediment production is a natural process, it is suspected that most sediment results from the activities of man (Grissinger and McDowell, 1970).

Soil conservation practices can reduce the sediment loading of waters, the losses of valuable topsoil, and the flooding of downstream areas. Conservation practices by themselves, however, will not always reduce nutrient inputs, particularly dissolved components, to waters.

Nutrients, particularly phosphorus (P) and nitrogen (N), are frequently implicated as major factors in the undesirable side effects of eutrophication (Vollenweider, 1968; Ryden et al., 1973). Phosphorus and nitrogen, are frequently associated with sediment both directly and also indirectly through sorption-desorption reactions (Taylor and Kunishi, 1971; Schuman et al., 1973a, 1973b; Burwell et al., 1974).

The objectives of this study were to determine and compare the properties of two catchments of contrasting land use, and to examine the reasons for differences in their hydrological behaviour. Methods in current use or modified versions of them, were employed to measure or estimate inputs and outputs of P and N forms, and the output of sediment.

The small catchment technique (Borman and Likens, 1967) used in this study provides a means of estimating inputs and outputs, and certain interactions, at an ecosystem level. By choosing a catchment in native forest and one in pasture, comparative data can be obtained. It was hoped that such a study would provide new approaches and information, and point to directions for future research.

It is recognised that catchment studies involving water, sediment, and nutrient discharge should be conducted over reasonably long periods of time to minimise short-term effects, particularly climatic variation. Nevertheless, a short-term study, such as that reported in this thesis, gives an opportunity for the development of techniques and the collection and interpretation of comparative data. If treated with caution, useful information can be obtained for the behaviour of two catchments in the same study year.

PLATE 1. OBLIQUE VIEW OF TUAPAKA
CATCHMENT TAKEN ABOVE THE
MANAWATU RIVER LOOKING S.E.
TOWARD THE CATCHMENT HEAD.

(Photo: Mr P.R. Stephens, 1975)

PLATE 2. OBLIQUE VIEW OF BALLANCE
CATCHMENT TAKEN ABOVE THE
MANAWATU RIVER LOOKING
WEST TOWARD CATCHMENT
HEAD.

(Photo: Mr P.R. Stephens, 1975)

