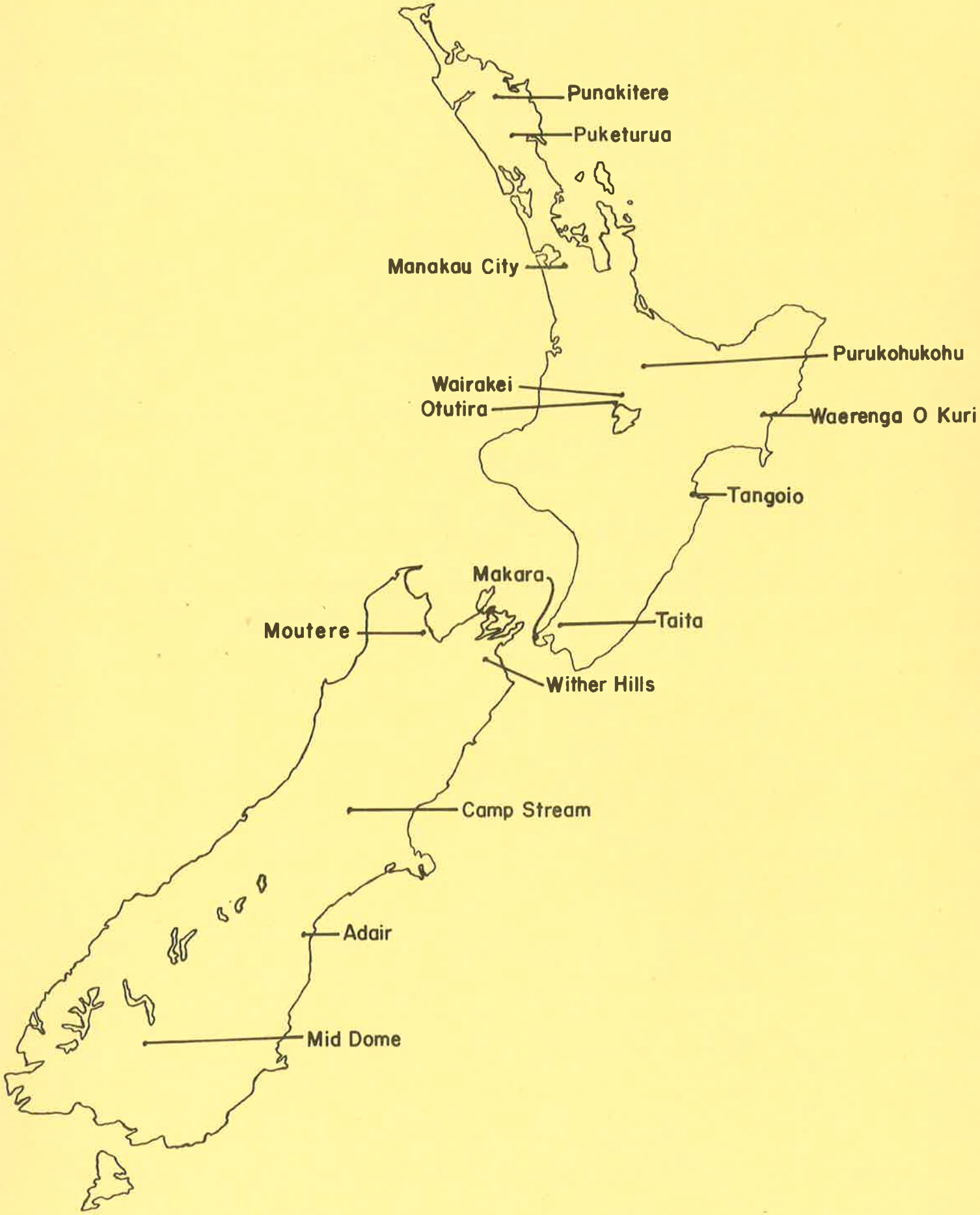
Soil Conservation and
Rivers Control Council.

A Review of Work on Reserves and Investigation Areas to 1968.

Ministry of Works
New Zealand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Mid Dome

Soil Conservation and Rivers Control Council: A review of work on reserves and investigation areas up to 31 December 1968.

Published by the Water and Soil Division of the Ministry of Works

for the National Water and Soil Conservation Organisation

Wellington, New Zealand, 1970.

Makara: (IHD basin No. 6 comprises part of the Makara Soil Conservation Reserve).

Location: 5 miles west of Wellington city.

Area: 116 acres.

Purpose: To study the hydrological effects of grazing management techniques and in some catchments the effect of afforestation on stable central yellow-brown earths.

1. **Miscellaneous trials**

(a) Poplar and willow variety trial was unsuccessful due to the extreme exposure of the area.

(b) Gravimetric soil-moisture sampling techniques determined the depth and number of samples required within a catchment.

(c) Rainfall measurement techniques required several trials because of the extreme exposure of the area. Briefly it was found that:

(i) Raingauge networks should be installed in a catchment for at least one year to establish a representative rainfall sampling site.

(ii) Raingauges tilted according to slope and aspect gave the best representative rainfall measurement.

(iii) Rainfall on any slope for any storm can be reasonably accurately calculated using rainfall data from a strategically located directional raingauge.

(iv) Large orifice raingauges give a more accurate measure of rainfall on very exposed and steep slopes.

(d) Microclimate measurements included changes in soil moisture and soil temperature on shady and sunny slopes under different pasture cover. Background information for understanding vegetation response was obtained.

(e) Chemical ploughing proved poorer than direct oversowing due to the loss of protective shelter which is provided during the establishment stage with oversowing.

(f) Strains of subterranean clover were tested and none of the lesser known or new strains were better than Mt. Barker or Tallarook strains.

(g) Yorkshire fog production trials indicated that Yorkshire fog was an important contribution to the total production of herbage. A mowing trial is being conducted which compares production of an improved strain of Yorkshire fog with ariki ryegrass. Results indicate that Yorkshire fog compares favourably provided the grazing of the Yorkshire fog is not too severe.

2. **Catchment trial**

Thirteen catchments are under measurement and the trial is designed to investigate the effect of land management practices on runoff and soil loss. Since 1965 this project has become a part of the IHD Experimental Basin programme.

Observations have been carried out as follows:

(a) *Climate measurements* have a threefold purpose:

(i) To establish typicality of climate during the measurement periods.

(ii) To provide data for estimation of potential evaporation required for water balance studies.

(iii) To provide data to the New Zealand Meteorological service.

(b) *Rainfall measurements* required accuracy (see earlier) in order to establish rainfall-runoff relationships.

(c) *Soil moisture conditions* were affected by changes in management and were reflected in flow changes. An intensive study to determine sampling techniques using a neutron scatterer was carried out. Results are not yet completely analysed.

(d) *Soil physical characteristics* work has been limited. Initial studies showed trends of increased macro and total porosity and decreased bulk density with improved management. This was attributed to more vigorous root growth and greater soil fauna activity of the improved pasture.

(e) *Soil chemical analysis* revealed an improvement in the phosphate status resulting from annual applications of 3 cwt of superphosphate. Higher calcium and pH values were still detectable six years after the application of one ton of lime.

(f) *Vegetation* markedly improved with oversowing and topdressing of the pastures which were flat weed dominant. The improved hard-grazed pastures are now white clover-ryegrass dominant, the improved lax-grazed pastures are white-clover dominant with Yorkshire fog, brown top and ryegrass sub-dominant. The hard and lax-grazed unimproved pastures are still weed dominant. The ryegrass increased gradually with improvement and hard grazing each year and is expected to continue to increase, replacing the less desirable lower-producing grass species which still persist.

(g) *Pasture production* showed very significant increases with improvement. E.g. 1966-67 figures are:

Unimproved hard-grazed 2100 lbs D.M. per acre.
Improved hard-grazed 8140 lbs D.M. per acre.
Unimproved lax-grazed 2020 lbs D.M. per acre.
Improved lax-grazed 7640 lbs D.M. per acre.

(h) *Carrying capacity* of the hard-grazed improved pastures increased rapidly from 1.8 to 5.4 E.E. per acre in 1962/3 and has since gradually increased to 7.9 in 1966/67. The unimproved hard-grazed pastures remained constant at 2.4. The improved lax-grazed pastures increased to 4.2 in 1962/3 and remained at this level. The unimproved lax-grazed pastures decreased gradually from 1.6 to 0.9 in 1966/7. This latter management presented practical problems since the herbage was not palatable. In order to obtain the required experimental level of grazing, utilization of the herbage produced was considerably lower than with hard-grazing.

(i) *Hydrological characteristics* Before March 1961 all catchments were under similar management with hard grazing, and during this period the inherent behaviour of the catchments was established. In 1966 different management practices were imposed and continue. These practices effected changes in the hydrological characteristics of the catchments; data analysis and interpretation are revealing certain significant features.

With improved pastures, compared with the unimproved hard-grazed pastures:

(i) Total annual flow decreased more on the lax-grazed improved than the hard-grazed improved.

(ii) The flow from the smaller storms in particular was reduced, and as with total flow this was more marked with the lax-grazed improved.

(iii) The flow prior to the initial peak of all hydrographs was greatly reduced.

(iv) The peak discharges were reduced, for the storms so far investigated.

(v) The depth of surface detention increased so that about three times more was needed to produce the same peak discharge than before treatment (surface detention effects under other treatments are not yet analysed).

(vi) There was observational evidence of increased vegetation interception; this could also be a factor reducing the initial flow particularly with improved lax-grazed swards.

(j) *Soil loss* did not occur on the easy unimproved or improved pasture catchments.

3. **Runoff plots**

These did not prove entirely satisfactory due to plot variations. However, after a rather long period of observation, it was established that fertilizer application alone (3 cwt superphosphate) to the weedy natural sward resulted in a denser cover on the treated plots and a reduction in total runoff.

The annual research report to 31 December 1967 has been completed and is with the publications section. One scientific paper was published during the year.

Toebes, C., Scarf, F., and Yates, M.E., 1968: Effects of cultural changes on Makara experimental basin. *Bulletin of the International Ass. of Scient. Hydro.*, 14-3-1968.

Manukau City: (IHD basin No. 20)

Location: Auckland district.

Area: Approximately 90 acres.

Purpose: The Ministry of Works, in co-operation with Manukau City Council and the University of Auckland (School of Engineering) established the basin to study the effect of urbanisation on the hydrological regimen. The basin is at present zoned rural and housing development is expected to commence in 5 years.

Mid Dome:

Location: Parawa, Southland.

Area: 1666 acres.

Purpose: Investigations into and development of methods of controlling severe sheet, scree, and gully erosion.

The development of the reserve as a cattle unit, as resolved by the Council at its meeting of 15 August 1966, was not possible because of the emergence of stock health problems. The Animal Health Division of the Department of Agriculture carried out a calf drenching trial the results of which showed an outstanding response to Thiobenzole plus Selenium but in spite of this the calves were far from being in good condition.

In anticipation of the original proposals proceeding in the near future, a land use capability survey of the reserve was completed. The requirements of the stock health trial are being coordinated with future requirements for developing the reserve as a cattle unit.

Trials include the following:

1. **Measurement of scree movements**

This comprises seven trials at various locations. It is a long term project but because of technical problems precise measurements have not been possible. Alternative methods of measurement are being considered.

2. **Introduction of grass and legume species into depleted tussock**

Twelve trials were conducted; the Department of Agriculture advised that a summary of the results would be available in March 1968.

3. **Introduction of grass and legume species into depleted Snow Tussock**

Six trials were conducted with no results yet available.

4. **Tree Planting**

Plinus spps. have been successfully established even at high altitudes and further work over a wider range of sites, particularly on eroding snow-grass country, is proposed. The value of silvicultural work at mid-altitude levels is shown in the marked tendency for pasture species to grow close into the trunks of the trees.

5. **Willow groyne (Red Duster Catchment)**

Two further structures were established upstream of the existing structures. The established structures function efficiently and fulfil the purpose for which they were designed.

In April 1967, 11.5 inches of rain occurred during a period of 5 days causing moderate to severe damage to willow control structures, a deflection groyne and all stop banks in the Red Duster Stream. Moderate damage to 40 chains of both internal and boundary fences occurred and there was also moderate silting of the pastures on the lower country. No damage was reported on the steeper country where the improved vegetation reduced runoff to a minimum.

6. **Willow and Poplar Nursery**

Maintenance of the nursery was curtailed by a staff shortage but is now satisfactory.

7. **Control of Noxious Animals**

Subdivision fencing to retire the Red Duster Catchment completely from grazing is complete.

8. **Oversowing and topdressing**

All pastures on the lower level are in good condition. An area of 300 acres between 2,500 and 3,000 ft was topdressed in September 1967 and a denuded area on the northern boundary was seeded to try and establish better cover.

9. **Further work proposed**

(a) Scree control.
(b) Stream training.
(c) Plant introduction in snowgrass areas.
(d) Fertilizer studies in snowgrass areas related (c).
(e) Revegetation of severely eroded gullies.
(f) Plant density and plant composition changes associated with retirement from grazing.
(g) Microclimate studies associated with (c), (d), (e) and (f).
(h) Small runoff plot measurements associated with (c), (d), (e), (f) and (g).

Moutere: (IHD basin No. 8 comprises part of the Soil Conservation Reserve)

Location: Near Brightwater, Nelson.

Area: 579 acres.

Purpose: During the development of the deteriorated land which comprised this reserve it was demonstrated that improved management, improved pastures, topdressing, fencing and gully control could reduce erosion problems. Recently the main emphasis has been on the catchment trials and runoff plots and these have been part of the IHD experimental basin programme.

1. **Miscellaneous Trials**

(a) *Phosphate movement in runoff water* Small plot trials established that significant losses can occur. Because of the small plot size and because the simulated rain was applied immediately after phosphate application, there is a need to extend this investigation if results of more direct application are to be obtained.

(b) *Stream protection methods* These involved protection from grazing, planting, realignment and grading of stream channels, and mulching practices. Results showed that protection from grazing of the stream bed and steeper slopes along the stream is most important.

(c) *Agricultural type trials* These were conducted in co-operation with the Department of Agriculture and involved studies on:

(i) Trace element fertilizers.
(ii) Copper, cobalt, selenium dosing.

(iii) Application rates of lime and phosphate.
(iv) Lamb ill thrift.
(v) Chemical ploughing.
(vi) Weed control by both weedicides and stock management.
(vii) Costs of ploughing versus discing relative to the type of cover established.
(viii) Wear in sheeps teeth.

2. Catchment Trials

The aim is to investigate the effects of land management treatments on runoff and erosion. As part of the IHD programme more intensive measurements were initiated in some catchments, in order to study more precisely the changes in hydrological characteristics associated with different vegetation types and management.

In association with the catchment trials the following preparatory work was undertaken:

(a) Fencing.
(b) Roading.
(c) Water supply.
(d) Land development and regular topdressing of those catchments in improved pasture.
(e) Installation of climate station.
(f) Installation of raingauge networks to determine representativeness of the rainfall stations.
(g) Installation of gauging structures and flow recorders. Some of these were recently modified to enable more precise flow measurement in the IHD catchments.
(h) Surveys to define catchment areas, topography and sampling sites.
(i) Soil mapping.
(j) Vegetation surveys.

After an initial period (1962-1965) during which the natural behaviour of the catchments were assessed, the following treatments were applied:

(a) Set-stocked improved pastures.
(b) Set-stocked improved pastures plus contour works.
(c) Mob-stocked improved pastures.
(d) Mob-stocked improved pastures plus contour works.
(e) Gorse cover.
(f) Continuous cultivation and cropping.
(g) Burning of gorse and tree planting.

Regular and detailed records have been obtained (some since 1962) of climate, flow, rainfall, soil moisture, vegetation, grazing, soil physical and fertility properties and the extent of mass movement.

The considerable backlog in data reduction is now almost eliminated so that data analysis and interpretation similar to that being performed on the Makara data can be commenced.

3. Runoff Plots

The aim is to demonstrate the relative effects of various treatments on runoff and soil loss. Sixteen plots were installed and the present treatments are:

(a) Six plots on 7° slopes: various cropping and cultivation programmes.

(b) Six plots on 7° slopes: pasture under continuous or intermittent grazing.

(c) Six plots on 17° slopes: pasture under continuous or intermittent grazing.

Measurements of runoff, soil loss, rainfall, soil moisture, compaction, soil physical characteristics, soil fertility and vegetation are made. The treatments were applied in 1966 and it is too early to give other than tentative results.

On the cultivated plots with a ryecorn-lupin crop, grazing the crop resulted in more runoff and soil loss than non-grazing.

With the grazed pasture plots on 7° and 17° slopes there appears to be a close relationship between the

pasture length and the runoff resulting from a storm—the longer the pasture the less the runoff.

4. **Work initiated in 1968**

(a) Modification of flow measuring structures. This will prevent the loss of records from flumes being over-topped during high floods, and enable low flows to be measured more accurately.

(b) Establishment of an interception plot in gorse.

(c) Testing of techniques which will give more reliable data on pasture characteristics.

(d) An experimental programme for the runoff plots was prepared with a view to using artificial rainfall to give quicker results because insufficient data is being obtained under natural rainfall conditions. Rain does not occur frequently enough at crucial stages of growth to allow valid conclusions about the effect of land management practices on flow characteristics and soil loss. The programme was designed to study two main issues:

(i) The relationships between rainfall intensity, surface flow and vegetation characteristics.

(ii) Fertilizer movement in surface runoff.

The annual research report No. 1 (up to 1966) has been published and No. 2 (1967) and 3 (1968) have been prepared for publication.

Otutira (IHD basin No. 3)

Location: North shore of Lake Taupo (Kawakawa Bay).

Area: 843 acres.

Purpose: To study the hydrological effects of a change in land use from scrub to grass and the effect of soil conservation techniques on yellow-brown pumice soils.

Access roads are complete, flow measuring structures are installed, and a raingauge net and several climate stations are in operation. Topographical, geological and vegetation maps are complete. Interception, infiltration, groundwater and soil physical characteristics are being measured.

Flow patterns in the pumice catchment are exceedingly complex. Some boring for groundwater was carried out without success and recently a temporary flow measuring structure was installed in the middle of the catchment to measure a sizeable flow not noticed previously. Attempts to trace flow patterns are now made with a nuclear probe, on 25 holes up to 10 feet deep. Useful results are being obtained with given locations appearing to have a reasonably constant depth moisture profile.

An investigation into rainfall pattern anomalies was begun, for conclusion within a year.

Apart from the project's major objective as stated, three other self-contained projects are being carried out within the basin. These are:

(a) Processes of gully formation and development of drainage density on pumice soils.

(b) Measurement and assessment of microclimate including changes that may occur with a land use change.

(c) Measurement and assessment of humus and litter including the extent to which this material traps and stores water.

The University of Waikato initiated an intensive study on a grass catchment to study erosion processes and for this purpose they are making observations of flow, soil moisture, soil temperature and soil creep on small plots.

The Research Division of the Department of Agriculture is making a study of infiltration and soil physical characteristics.

The annual research report No. 1 (up to 1967) has been published.

Puketurua: (IHD basin No. 1)

Location: 20 miles north-west of Whangerei.

Area: 613 acres.

Purpose: To study the hydrological effects of a change in land use from scrub to grass and, subsequently, the effects of particular land management practices on the northern yellow-brown earths.

Access roads are complete, flow measuring structures are installed, a raingauge net and a central climate station are in operation, and shallow ground water is being measured near the main stream. Topographical, geological, soil and vegetation maps are also complete. Interception, infiltration and soil moisture have been measured on a trial basis.

Apart from the overall objective of this project, three other self-contained projects are being carried out. These are:

(a) Determination of interception variability within a catchment. A base interception plot is supplemented by six simple plots which will be moved from time to time.

(b) Determination of groundwater patterns in gumland soils. For this purpose eleven 50 ft bores were drilled and groundwater levels are now observed regularly. Plans are in hand to carry out tracer studies.

(c) Determination of phytomorphological characteristics of a catchment. This is the extension of a phytomorphological study to determine typical vegetation from characteristics. Some 200 observation plots have been established.

The change in land use from scrub to grass will be carried out by the Lands and Survey Department in the 1970-71 financial year.

The annual research reports No. 1 (up to 1966) and No. 2 (1967 and 1968) have been published.

Punakitere

Location: Approx. 5 miles west of Kaikohe.

Area: 46 acres.

Purpose: To study the influence of contour structures on the hydrological regimen.

A proposed programme to investigate contouring practices on gumland soils was submitted to Council and approved at the meeting of 12 December 1966.

The area was then developed so that specific contouring and stocking rate treatments could commence with the provision of a hogget flock in January 1969.

Development involved cultivation and sowing to grass, fencing, and construction of contour banks, diversion banks, grassed waterways and concrete channels. Unfortunately the April 1968 storm caused considerable damage, and the pastures had to be resown and waterways and concrete channels repaired. There was less flood damage on the areas with the banks. For the storm period to 17 April, 26 ins rain was recorded at a station 2 miles distant from the area. In June, 14½ ins rain was recorded but the grass by then was established and damage was not severe.

A wet autumn and winter favoured rush growth but grass and clover was by then so well established that with judicious management a good sward was obtained in time for commencement of the treatments.

Other agencies co-operated well with the project. The Lands and Survey Department cultivated and seeded the area twice, Grasslands Division D.S.I.R. advised on pasture management and the N.Z. Meterological Service agreed to install a climateological station.

Hydrological structures to measure flow and sediment were designed for two plots.

Purukohukohu: (IHD basin No. 4)

Location: 20 miles south of Rotorua.

Area: 280 acres, consisting of three catchments (two in introduced grasses and one in native trees).

Purpose: To study the influence of introduced grasses versus pines and pines versus native trees on the hydrological regimen on yellow brown pumice soils.

Establishment of the basin was approved in September 1968 and flow measuring and climate stations are now installed. The New Zealand Forest Service is co-operating with the research and they will also conduct experiments concerned with the International Biological Programme on this basin.

Taita: (IHD basin No. 7)

Location: Approximately 15 miles north-east of Wellington.

Area: About 200 acres, consisting of four catchments.

Purpose: To compare the hydrology of grassed versus podocarp/beech versus exotic pine catchments on the stable central yellow-brown earths. This basin is operated by the Soil Bureau, Department of Scientific and Industrial Research.

Flow measuring structures have been installed on two catchments. The flow measuring structures in catchments four and five are virtually complete. A central climate station and a raingauge network were installed and topographical, soil and vegetation maps completed. Interception studies under scrub were completed and extended to plots under native tree species. Soil moisture, soil physical characteristics and evapo-transpiration are being measured.

The annual research report No. 1 (up to 1967) has been published.

Tangoio

Location: 20 miles north of Napier.

Area: 450 acres.

Purpose: When the property was acquired it was in bad condition, five paddocks only, with derelict fences and no useful buildings. The pastures were mainly danthonia and browntop. There was a high rabbit population and reversion to manuka was rapid. Slipping was widespread with sheet erosion and under-runners. The main purpose of the acquisition was to undertake and demonstrate fertility improvement and to promote better land use with soil conservation practices.

1. **Trials completed** (some in co-operation with the Department of Agriculture) together with a brief resume of the results:

(a) *Fertilizer plot trials* use of N.P.K. Ca S Mg Mo gave inconclusive results.

(b) *Chemical renovation* spraying with paraquat resulted in clover dominance. Untreated plots became rank with unpalatable inferior grasses.

(c) *Blackberry control* three paddocks were treated with:

(i) Spray—using tordon, 245-T and T.L.
(ii) Goats at 25 per acre.
(iii) Heavy grazing with cattle and sheep.

The goat area was cleaned up best by a substantial margin. A check is being kept to determine regrowth control as regrowth is regarded as a continuing threat.

(d) *Grass grub* observations were kept on infestation and D.D.T. was used. Sample grub counts were made under various grazing systems but infestations were not severe enough to determine any

differences.

(e) *Hogget thrift* trial involved three feeding managements:

(i) Normal feed run with mob.
(ii) Mature pasture.
(iii) Immature pasture.

No conclusive trends were noted in weight gains.

(f) *Parasites in cattle* dung samples taken from 20 weaners each month for egg counts to determine the worm burden in run cattle showed that there was a seasonal rise in counts in young stock but it seemed to fade with age.

(g) *Tree planting trials* over the years several trials were laid down covering varieties, spacing and aspect but for the most part they were regarded as short term and observations were discontinued after one season. There was no special attempt to protect poles from animals other than goats. With some trials very dry seasons caused poor results.

(i) Open planting trials (1964): on sunny and shady aspects with 11 varieties of poplar and 1 willow. Conditions were very dry and losses were high. On the dry face 1.214 Matsudana and Eugenii were the best in order of thrift. On the damp aspect the initial strike was 100%. 60% still survive with the Italian varieties succeeding best.

(ii) Pole soaking trial (1965): 20 Lombardy poles were cut each week for four weeks and soaked. At the end of the fifth week those with 20 freshly cut poles were planted out. Due to subsequent favourable growing conditions no differences have been observed.

(h) *Cattle repellent trials* two series of pole plots were treated at random with bitumen based repellents. Results were inconclusive or ineffective.

2. **Trials remaining in operation during 1968**

(a) *Grazing trial* the aim was to demonstrate the conservation value of better pastures with trees under:

(i) Mob stocking 6 ewes per acre.
(ii) High set stocking 6 ewes per acre.
(iii) Low set stocking 4½ ewes per acre.

There was no significant difference between mob and set stocking at the high rate.

(b) *Slip investigations* physical information on the character and incidence of slipping on the grazing trial was recorded. Data on grazing, length, width, depth, shape, vegetative cover, slope, aspect and date were recorded. Steel peg bench marks were established to evaluate erosion of the bared surfaces with time.

(c) *Slip revegetation* treatments were:

(a) Colas emulsion undersown with standard seed mixture.

(b) Colas emulsion undersown with lucerne.

(c) Pre-wet application of colas.

(d) Dry application of colas.

(e) Jute netting undersown with standard seed mixture plus phalaris plus 4 cwt super.

(f) As for (e) but 8 cwt super.

(g) As for (e) but 2 cwt diammonium phosphate.

(h) Super and seed.

(i) Fine mesh string netting plus seed and super.

(j) Surface cultivation plus seed and super.

(k) Miniature contours plus seed and super.

Unfortunately site variability dominated results. All treatments on the northerly aspect and exposed conglomerate were materially poorer. Lucerne failed and phalaris was evident only where protected from grazing by cages and in one damp site where other growth was vigorous. Better surface conditions reflected a marked improvement in cover. Eight cwt superphosphate was superior to 4 cwt super or diammonium phosphate.

(d) *Poplar observational trials* several have been established in recent years and for most it is too early to give any results. The trials are:

(i) Variety response on shady and sunny slopes.

(ii) Varieties; 25 in number from five main groups lombardies, italians, balsams, whites and blacks.

(iii) Spacing at 5, 10, 15 and 20 trees per acre.

(iv) Dense planting for plantations and to observe effects on pasture.

(v) Block planting in gullies (a) to act as debris traps
(b) to evaluate performance
of a range of varieties under better growing conditions.

(vi) Planting material trials such as rooted trees, poles and different ages of material.

(e) *Poplar propagation and thrift* largely demonstrated by stools and rooted stock, including pruned and unpruned, cultivated and uncultivated and intensively planted cuttings. Some wilt occurred on poplars in the 1966/67 summer but samples sent to the Plant Diseases Division gave no positive diagnosis.

3. **Future trial proposals**

(a) Assessing the influence of sheep and cattle grazing and treading on the vegetation and soil physical characteristics.

(b) A demonstration project in which the reserve will be managed along conservation lines. Stock productivity will be upgraded, spaced tree planting will be increased and cover improved through oversowing, topdressing and judicious grazing including the use of cattle.

Waerenga-O-Kuri

Location: 13 miles north-west of Gisborne.

Area: 1000 acres.

Purpose: To study the effect of land management practices and erosion control on the stability and productivity of the land.

Trials carried out are:

1. **Erosion control**

(a) By structures: using gully checks, flumes, water retention structures and gully wall stabilisation.

(b) By grasses: several species have been tested to revegetate bare slopes and gully bottoms. Present work is mainly confined to testing the establishment requirements of Phalaris spps. which show promise; superphosphate has definitely assisted establishment; S/AM produced a fleeting response and subsequent slump and potash produced a nil response.

(c) By trees: this work involves testing the suitability of available species and the establishment requirements of poplar and willow varieties. Periphery planting of eroding areas is being tested.

2. **Poplars and willows**

(a) Propagation of selected varieties from Palmerston North including new varieties for first stage testing in the district.

(b) Variety testing in the nursery and on the farm was carried out to show the responses when material is planted as wands, rooted stock or poles. Differences in varietal response to different soil types has been noted. For example, 1455 has performed better on pumice soils than on the heavier clay soils whilst 174/51 has performed better on the clay soils.

(c) Establishment and growth responses to differences in treatment involving soaking, exposure, age and size of material, fertilizer and vegetation control. To date, poplar poles and cuttings have given virtually no response to a range of fertilizers in the established stages. Spraying to control vegetation around poles, and other trials have produced variable responses which show promise but differences are so far insufficient to make firm recommendations.

(d) Testing of formulations under field conditions for cattle repellency properties.

3. **Erosion processes**

The Poverty Bay Catchment Board is studying earth flow by measuring movement and observing other erosion factors.

4. **Farmlet grazing trial**

Three farmlets are under set stocking, low mob stocking and high mob stocking, respectively.

Treatments have been:

(i) Set stock at 7½ ewes per acre.
(ii) Mob stock at 7½ ewes per acre.
(iii) Mob stock at 8½ ewes per acre.

Mob stocking was superior to set stocking. Mob stocking at the higher rate of 8½ ewes per acre showed no significent fall-off in average production per animal compared with mob stocking at 7½ ewes per acre. Experience indicates that it is difficult to get good results from mob stocking on 8 paddocks.

5. **Other trials and demonstrations**

(a) Fencing: long term testing of live fences, combined live and electric fences, and progressive developments of the "Pearse" fence are being undertaken.

(b) In co-operation with the Department of Agriculture various trials have been carried out in fertilizers, trace elements, hogget ill thrift, trace element dosing, chemical ploughing and pasture improvement.

(c) Graded banks are being demonstrated and investigated on a pilot scale on both easy and hill slopes. A semi-eroded area of 10 acres was cultivated and smoothed to eliminate ponding areas, followed by the installation of graded banks and the sowing to pasture in February 1967. The pasture established well and no slumping occurred. In the summer 1967-8 the surface cracked severely but light rain followed and closed the cracks and no stability problems occurred.

(d) Drainage: this is a demonstration trial but is also assisting towards main gully stabilisation.

6. **Carrying capacity since acquisition of property**

When taken over in 1947 the farm carried about 1500 ewe equivalents and produced approximately 10,000 lbs wool. Despite 300 acres being retired from grazing in 1967 the farm wintered 3600 ewe equivalents and produced 28,000 lbs wool. Most of this increase occurred during the last decade. Between the 1958 and 1967 winters, breeding ewes increased from 12 to 2180 and cattle from 39 to 185.

Wairakei

Location: Wairakei Village, 6 miles north of Taupo.

Area: 379 acres.

Purpose: To study the effects of land development and subsequent management practices on runoff and soil loss on newly developed pumice land as it became consolidated.

The Department of Agriculture controls this reserve and is maintaining conservation trials as requested.

The trials are:

1. **Soil conservation demonstration**

The aim of this trial is to show the difference from an erosion and sward point of view, between set stocking and mob stocking associated with spaced planting. This is necessarily a long term project and to date no differences have been observed.

2. **Tree Nursery**

As growth at Wairakei was considered too slow for the production of good vigorous material for extensive plantings the nursery was not extended. Material available from the nursery is used only to meet farm requirements.

3. **Willow varieties**

Of 25 varieties tested the following were outstandingly superior in growth: Piperi, Fragilis, Surprise and Vitellena. Nigricans, Tewes, Booth and Matsudana were also worthy of note.

4. **Time of planting poplars**

Plantings over a three year period showed that poles were equally as satisfactory as rooted trees during the months May to August inclusive. Planting in other months is not advised.

5. **Variety by manure and by cultivation (poplar trial)**

I.78 was the most vigorous grower. Phosphate and potash had no effect on growth. The application of S/AM. to supply nitrogen increased vigour significantly as did cultivation at the base of the trees.

6. **Poplar stock planting trial**

This trial showed that little value was to be gained by planting out rooted trees in place of poles of the same age. The poles should preferably be vigorous one year old stock. Savings in cartage and planting time can accrue by using suitable poles.

7. **Poplar variety trials**

Two trials on contrasting aspects showed that the Italian Hybrids I.78 made the greatest increase in growth. I.488, which was slightly slower establishing, gained gradually in growth and now appears slightly superior to I.30, I.214 and I.455. Yunnanensis was extremely slow to establish but are now the largest trees in these poplar trials. Simonii failed to survive.

8. **Bamboo varieties**

The eight varieties in this trial all grew well particularly in the nursery. Where grown in competition with grass they spread but lacked the vigour of those in the nursery. Selected varieties should be able to play a part in erosion control (and shelter) on the pumice soils.

9. **Graded bank demonstration**

After actively-eroding areas in the head of the catchment were retired and planted no runoff reached the banks on the flats below.

Wither Hills

Location: 2 miles south of Blenheim Post Office.

Area: 404 acres.

Purpose: To control erosion, reduce or prevent flooding and spread of debris on to the bottom lands and to develop a permanent productive system of farming.

1. **Existing trials**

   (a) *Chemical ploughing* Results show that considerable improvement in vegetation and carrying capacity has been achieved at a reasonable cost. Carrying capacity has been increased from 0.8 to 2.6 ewe equivalents per acre.

   (b) *Mulching trial* This is to investigate revegetation of the steep batters left after cutting water control terraces, access roads, etc. The most costly treatment (hay and netting) has generally proved the most effective. The investigation of other materials and methods is being considered.

   (c) *Tree establishment* This is a pilot trial and has indicated that planting trees in the bottom of an eight inch furrow is the most promising planting technique.

   (d) *Tree variety trial* The aim is to discover the most suitable trees for the Wither Hills soils. Results have indicated vast variation but it is too early to make recommendations on the most suitable varieties or species.

2. **New trials**

In 1968 Council approved the following proposals:

   (a) To develop the reserve in accordance with the land use capability survey. Stock carrying capacity of the area is to be increased and the consequent increased grazing pressure is to be matched with necessary erosion and runoff control works.

   (b) To carry out trials to evaluate grazing management systems on lucerne-phalaris pastures, in respect of soil erosion, infiltration, physical and chemical changes in the soil, and production, including live weight gains.

In agreeing to these proposals Council stipulated certain conditions:

   (i) Planning for the whole of the reserve was to be based on cattle grazing. This has been undertaken in co-operation with various organisations.

   (ii) In respect of the grazing systems trials, a statement of the roles of the various organisations involved and the control of the operation of the trials was to be submitted with the proposals. This trial has now been established by the Grasslands Division and reserves staff.

   (iii) Consideration was to be given to the introduction of additional suitable grasses to supplement all lucerne-phalaris pastures on the reserve. During 1967-8 the value of lucerne-phalaris pastures was shown by a block which formerly carried 0.4 E.E. per acre. In 3 years since development by dozing, cultivation, and sowing this block had reached an average of 5.6 E.E. per acre.

   (iv) Fences erected to control cattle only were not to be constructed to a standard higher than necessary for this purpose.

   (v) All the trials are to be subject to review 3 years after commencement.

Representative basin programme

Since 1962 Council has supported the representative basin programme which is designed to determine the hydrological characterisation of natural areas by studying sample catchments (representative basins) of New Zealand. The sampling is obtained by dividing the country into 90 hydrological regions and selecting one catchment in each region for study. Data from the representative basins is used for

(a) Extending short records of the stations.

(b) Development of prediction equations on a national or regional basis.

(c) Determining the effect on the hydrology of natural changes (climate and/or geomorphological changes).

(d) Carrying out research on hydrological processes in natural areas.

At December 1968, 46 representative basins were in full operation with a further 13 in various stages of completion. In 1965 UNESCO published an inventory of New Zealand Representative Basins, and a detailed description of hydrological regions including methods of sampling has been published. (Toebes, C., and Palmer, B., 1969: Hydrological regions of New Zealand. Miscellaneous Hydrological Publication No. 4.)

A further publication describing methods of selecting representative basins and their characteristics is in press. (Toebes, C., and Morrissey, W.B., 1970: Representative Basins of New Zealand. Miscellaneous Hydrological Publication No. 7.)

Miscellaneous soil conservation trials

In Auckland, Napier, Wanganui and Christchurch Ministry of Works districts many tree trials have been established. Interim reports on these are being received but it is too early to provide conclusive results. Most trials concern the relative response of a range of varieties to different soil types and climatic environments.

Some trials were laid down to investigate problems of revegetating and/or improving the cover of eroding areas.

Napier and Wanganui District staff in co-operation with the Manawatu, Rangitikei, Wairarapa, Hawkes Bay and Poverty Bay Catchment Boards laid down and observed a variety of animal repellent and tree protection trials. The results of the 1967 trials and interim results for 1968 have been circulated to interested parties. Outstanding protection was achieved with the use of plastic sleeves ("Netlon").

The plant materials centre continued its routine programme of variety testing selection, increase and release. Council recently approved the establishment of a centre on a new and a larger site.

Miscellaneous hydrological experiments

(a) **Interception project** In 1967 a research programme consisting of type sampling and data extension was instigated to discover more about the process of interception of precipitation by vegetation. Initially seven major vegetation types are being sampled with automatic samplers in various locations.

These are:

native forest–kauri–Trounson Kauri Park, Northland;
exotic forest–pinus radiata–Rotorua;
regenerating hardwoods–Otutira experimental basin;
native scrub–manuka–Puketurua experimental basin;
exotic scrub–gorse–Moutere experimental basin;
native grass–chionchoa spp.–Mckenzie basin, Canterbury;
exotic pasture grass–perennial rye–in abeyance meanwhile.

Additional studies are being carried out on native forest in the Taita experimental basin and on beech in the Camp Stream experimental basin.

Two papers have been published so far:

Blake, G.J., and Taylor, J.L., 1967: Interception and phytomorphology. *Journal of Hydrol.* 6 (2).
Aldridge, R., and Jackson, R.J., 1968: Interception of rainfall by Manuka at Taita, New Zealand. *N.Z. Journal of Sc.* 11 (2).

(b) **Water resources project – Northland**

Subsequent to an earlier study which provisionally determined in parts of Northland, the occurrence of low flows with a probability of occurrence once in ten years, a more detailed research project was undertaken in 1968 to assess low flow values in the entire region and to determine the relationship between rock type, antecedent rainfall and minimum flow.

The study was completed and important conclusions are:

(i) Droughts occur frequently enough to be a problem in Northland and this should be recognised in future planning of urban, industrial and rural water supply schemes.

(ii) Catchments in the Waipoua and Whangerei (hydrological) regions have the greatest potential for water supply schemes.

(iii) Future development of farming on the easy hill country of the Hokianga region could be restricted by inadequate water supply.

A paper on the above is in press.

Waugh, J.R.,: Drought in Northland–A study on water supply. *Miscellaneous Hydrological Publication* No. 6.

(c) **Water balance study Rotorua Lakes**

Lakes without an open outlet in the Rotorua area have caused flooding problems for many years during long sustained wet periods. Some of these lakes are of interest for hydro-electric development. Eutrophication has also created an interest in a knowledge of the waterbalance.

Because of important and complex losses by seepage and underground flow simple procedures are not applicable.

In 1967 a more detailed study of the lakes was begun. Continuous recording of lake levels, rainfall measurements and incidental measurement of seepage flows has led to a provisional water balance for lakes Rotorua, Rotoehu, and Rotoiti. Additional work proposed is:

(i) Classification of storm patterns.

(ii) Establishment of true lake evaporation.

(iii) Investigations of response of a change in lake level to groundwater storage.

(iv) Flow and tracer gauging of spring behaviour.

One scientific paper has been published so far:

Pittams, R.J., 1968: Preliminary water balance studies of the Rotorua lakes. *J. Hydrol.* (N.Z.) 7 (1).

(d) **Groundwater study Heretaunga Plains**

For domestic, agricultural and industrial purposes a population of 83,000 draws its water supplies from the ground water of the plains. An investigation into the water balance of the plain with particular emphasis on locating recharge areas and yield has been in progress since 1961. Six automatic water level recorders have been installed on deep wells and seven on unconfined aquifers. Rainfall observations are made on a routine basis and discharge measurements were made during 1961, 1964 and 1968.

Results so far indicate that losses from the Ngaruroro river, between Maraekakaho and Fernhill, constitute the major source of recharge of the groundwater system of the Heretaunga Plains and that, during summer, about 55% of the catchment water yield contributes to the ground waters of the Heretaunga Plains.

One scientific paper, detailing results, was published in 1965:

Grant, P.J., 1965: The groundwaters of the Heretaunga Plains. *J. Hydrol.* (N.Z.) 4 (2).

(e) **Upper Taieri water balance and Taieri river water resources.**

The aims are to ultimately define the water resources of the Taieri river from the headwaters to the sea. As an initial part of the survey, long term records (historic and synthetic) of precipitation, evaporation and flow are being derived. Aspects of climatic change are to be investigated.

The project was begun late in 1967 and flow and rainfall stations have been installed. Historic data have been analysed and synthetic data are being generated at present.

The study is based on representative basins with short term observations elsewhere.

Results showing complete waterbalances for the upper Taieri since 1908 are expected to be completed within six months; water balances for sub-catchments are available now.

(f) **Rainfall patterns in remote regions**

Rainfall data have been collected for over 10 years in co-operation with the New Zealand Forest Service using 36 storage gauges in the Ruahine and Kaweka ranges. These data are now being analysed to indicate rainfall patterns.

(g) **Sampling techniques using radioactive sources**

The International Atomic Energy Agency has developed a portable gauge utilizing a radioactive source to give direct readings of sediment concentration. A United States firm (Parametrics Inc.) has developed a recording gauge of the same type to be installed in a fixed location. The International Atomic Energy Agency has requested the New Zealand Government to test these guages and report on their use. The government has approved the proposal for the Ministry of Works to carry out this work and the IAEA has made funds available.

The work has been carried out in association with the Rangitikei Catchment Board in the Porewa catchment.

The parametrics gauge has been installed at Scotts Bridge gauging station. Calibration by means of the conventional point sampler was successfully undertaken, but a fault developed in the recording system and the experiment is momentarily suspended. The object of this test is, after calibration, to find a way to estimate the mean sediment concentration in a stream using a single point sample.

The IAEA sampler can be used for sampling by wading or by suspension as are conventional samplers. On

receipt the apparatus was unsuitable for either method and the necessary equipment was designed and manufactured in N.Z.

The apparatus is presently under test in the Wanganui district. Calibration has been successfully carried out and the best use for measuring the mean sediment concentration in a stream is being studied.

(h) Dimensionless and synthetic unit hydrographs for water resources survey

Unit hydrographs are a measure of catchment characteristics. For water resources projects, synthetic hydrographs for catchments with no flow record can be derived using the dimensionless unit hydrograph for the appropriate hydrological region.

Investigations are in hand to establish indices of regional characteristics in the Otago and Southland area and to establish unit hydrographs for all representative basins in this area. It is expected that synthetic hydrographs could be derived for catchments without a flow record.

The study was commenced in June 1968 and no results are available as yet.

(i) Other miscellaneous hydrological experiments

(i) Phytomorphological survey.
(ii) Methods of determination of geomorphological characteristics.
(iii) Channel morphology and development.
(iv) Lake Roxburgh sediment survey.
(v) Determination of seasonal snowline.
(vi) Water quality.

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