

# IHD BULLETIN

NEW ZEALAND

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The International Hydrological Decade Bulletin is an official publication of the New Zealand National Committee of the International Hydrological Decade and presents, twice annually, a survey of programmes, activities and findings of hydrology in New Zealand, carried out under the auspices of the IHD; and also a summary of international activities.

## NEW ZEALAND EXPERIMENTAL BASINS

A large part of New Zealand's IHD effort is concentrated on experimental basins and now, halfway through the decade, it is appropriate to review what is being studied and the progress that has been made. The research is aimed at fulfilling national needs in land-use hydrology and in making an effective contribution towards the international IHD programme. This international aspect is important and is becoming increasingly so as the decade advances. Through the publications of the IHD Secretariat, and especially through the exchanges of reports with other countries, and the contacts made thereby with individuals working in the same field, New Zealand is receiving helpful comment and assistance.

In 1965 a programme to establish 19 IHD basins to study fundamental soil-plant-water relationships was adopted. The basins were selected to cover the seven most important soils in combination with the most important vegetation types. These are:

<i>Soils</i>	<i>Vegetation</i>
Northern yellow-brown earths	Fern and scrub
Yellow-brown loams	Native forest
Yellow-brown pumice soils	Exotic pine forest
Central yellow-brown earths	Low tussock
High-country yellow-brown earths	Snow tussock
Yellow-grey earths	Montane tussock
Podzols	Introduced grasses
	Crops

The central yellow-brown earths are divided into two groups, stable and unstable; similarly the yellow-grey earths are divided

into high-rainfall and low-rainfall groups. In the vegetation types, native forest is divided into three categories: beech, podocarp and rata/kamahi.

The programme has been modified both by the addition of the Manukau City basin to study urban hydrology, and by the concentration of studies proposed for two basins on one site — Purukohukohu. Nine basins have been established and three more are under active consideration. All of these will be discussed in detail. Experimental basin research is expensive and must therefore be confined to a few sites where basic hydrological processes, and the effects of land-use changes on them, can be studied in detail and the results applied to large areas where soil and vegetation types are similar.

The purpose of the studies is:

(1) To determine the influence of man (cultural change) on water resources.

(2) To provide information on the effects of land use so that proper policy decisions can be made regarding land management.

(3) To define hydrological processes and standardize parameters in order to provide accurate data for the establishment of mathematical models for prediction purposes.

On each experimental basin, observations are made of precipitation and other climatic factors, interception, soil moisture and compaction, infiltration, ground water, solution losses, flow, erosion and sediment. Special studies are made according to the facilities (including terrain and vegetation) available at the particular basin. These include run-off plots, soil physical data and the study of special vegetation problems. Many individual research projects are being carried out, an example being the study of erosion processes.

After a calibration period, subcatchments will be deliberately mismanaged to induce erosion. Such research is to be undertaken on a pumice soil (Otutira), on the unstable mudstones (basin yet to be established) and on the yellow-grey earths of the South Island tussock country (Manorburn).

At Camp Stream research is in progress on existing alpine screes. On all basins, after calibration periods, studies will be made of the hydrological effects of changing vegetation and on some, the effects of changes in land management. Research is also being done on the hydrological role of vegetation, not only on the aerial parts of plants but also on the root zone.

### **Established Basins**

*Puketurua* is situated 20 miles north-west of Whangarei in easy rolling country. The catchment of 613 acres is gauged, as are also two subcatchments of 109 and 3.5 acres within it. Soils are

northern yellow-brown earths and the vegetation is dominantly low native scrub. The objective is to study the effect on the hydrological characteristics of a change in land use from scrub to introduced grasses and a subsequent change in land management, including the introduction of graded banks. Observations are being made of flow, rainfall and other climatic factors, soil moisture, and vegetation interception to calibrate the catchment in its present natural condition. The change to grass will be made next year.

*Manukau City.* This basin, within the boundaries of Manukau city, has 90 acres of very easy slopes. The soils have not yet been typed; vegetation comprises exotic grasses and clovers; present land use is for town milk supply. Here the change in hydrological regime caused by the urbanization of developed farm land will be studied. Observations of flow and rainfall began only recently, in about five years the area is expected to be developed for housing. Arrangements have been made for the instruments to remain in operation when this occurs.

*Otutira* is located 15 miles west of Taupo on the northern shore of the lake with an area of 740 acres, easy slopes, yellow-brown pumice soils, mostly covered in native scrub. The object is to study the hydrological changes brought about by conversion of scrub to improved pasture in pumice country. Later, small areas will be deliberately misused to study the effects of changes in farm management. Flow, rainfall, climate, vegetation and interception are measured, and intensive studies are being made of soil moisture and its relationship to other physical characteristics. Soil moisture is an important feature in calibrating the catchment. The calibration analysis has led to the resiting of the main flow-gauging station; this has had the effect of reducing the area of the basin to 440 acres. One small catchment of 11 acres (*Otutaru*) is in pasture, and interesting differences in flow characteristics have been recorded. Some success has been achieved in constructing a mathematical model to predict the rising limb of the hydrograph. The model incorporates parameters relative to catchment characteristics and antecedent conditions. This is preliminary, and the model is being tested on the other catchments in the basin. It is planned to convert one catchment from scrub to grass next year, by which time all basic calibration data will have been collected.

*Purukohukohu.* This basin is situated 20 miles south of Rotorua, its area of 247 acres being made up of three catchments of 120, 97 and 30 acres. Subcatchments are available within these. Two of the catchments are in improved pasture and one in native forest. Soils are yellow-brown pumice and the terrain is rolling to moderately steep. The object is to study the hydrological effect of land use — grass, exotic forest, and native forest. The catchments have been instrumented to measure flow and rainfall. A vegetation survey of the native forest has been completed and the

two grass catchments are being managed identically for calibration before converting one to exotic forest.

*Taita* is located on the eastern hills of the Hutt Valley some 15 miles north-east of Wellington. On the 220 acres of mainly steep hilly land there are four catchments ranging from 10 to 40 acres in area. The original vegetation was almost entirely beech forest, but fires over the last 100 years had converted it to a complex mosaic of secondary growth, 85 percent scrub with exotic pines and 15 percent native forest. The soils belong to the stable forms of the central yellow-brown earths. Under study is the hydrological influence of land use: scrub and native forest, exotic forest and grassland. Observations in a native scrub and forest catchment began in 1954, in an exotic forest catchment in 1962 and in the remaining two catchments in 1969, one in scrub and the other in grass. Detailed measurements are being made of flow, rainfall, climate, vegetation and soil characteristics. There have been several special studies covering such aspects as rainfall variation, interception of various types of cover, soil moisture, evapotranspiration and soil physical data. Manual water sampling and chemical analysis have been undertaken for some time and recently a water sampler was installed in the scrub catchment. After a 3-5 year calibration period it is proposed to convert this catchment to grass. Several papers and reports have been published by scientists of the Soil Bureau, Department of Scientific and Industrial Research, using data from this basin.

*Makara* is situated five miles west of Wellington on the hills bordering Cook Strait. There are 13 instrumented catchments in the 116-acre area. They range in size from 1.6 to 19.4 acres; eight are on easy slopes and five are steep to very steep. The soils are stable central yellow-brown earths and the vegetation is scrub and low-producing weedy pasture. Matters being studied are the influence on hydrological characteristics of land use (pasture versus exotic forest) and of land-management practices (pasture improvement through oversowing and topdressing or by cultivation, grazing pressures, type of grazing animal, use of contour techniques, etc.). Eight catchments were instrumented in 1956 and the remaining five in 1960-61. Flow, rainfall, climate, vegetation composition and production, soil moisture and grazing are all recorded. Special studies have included rainfall variation, soil moisture, vegetation assessment and run-off plots. The eight easy catchments were calibrated by 1961, since when pastures have been improved on some and differential grazing practices applied. The five steep catchments are still being calibrated and differential treatments should begin next year. Several scientific papers on the effects of land management have been published.

Data from the station have shown that oversowing and topdressing of open low-producing pasture increases its density and

the production from it. This in turn has changed the hydrological characteristics; the total flow, peak flow and flow before the first peak all being reduced and the surface detention being increased. Land-management practices have been investigated in association with pasture improvement and the same changes in hydrological characteristics—reduced flows, etc., from improved pastures—were observed under both hard and lax grazing. The most significant difference between the two grazing intensities has been that lax grazing has given a larger reduction in total flow and a marked reduction in the number of days on which run-off occurred. This is primarily because the longer grass increased interception.

*Moutere* is situated approximately 15 miles west of Nelson with an area of 580 acres containing 12 catchments ranging in size from 6 to 16 acres, all instrumented. The soils are stable yellow-brown earths and the original vegetation is low-producing pasture with large area of scrub—spanish heath, manuka and gorse. The terrain is mostly steep. Matters being studied are the effect on the hydrological characteristics of different land use and land management practices. Observations are made of flow, rainfall, vegetation, soil moisture and physical characteristics of the soil; special studies have been made of nutrient losses. All catchments underwent a calibration period, then two were maintained in scrub; two were developed from scrub and periodically cultivated and cropped; eight were maintained in improved pasture, four of them being set stocked and the other four mob stocked. Data are now becoming available for a preliminary hydrological analysis. This indicates that, when land is developed from scrub to grass, peak discharges are more than doubled, and that while the land is cultivated the surface detention for a given discharge is considerably and significantly reduced.

*Camp Stream*. This is a tributary of Broken River in the Waimakariri catchment. It is situated in the Craigieburn Range 60 miles west of Christchurch. One catchment of 234 acres is instrumented and others are being investigated. The soils are high-country yellow-brown earths; 48 percent is covered by mountain beech, 20 percent by alpine grassland and 2 percent by subalpine scrub, the remaining 30 percent is bare rock and scree; slopes are steep to very steep, elevation 3,300 to 5,600 feet. The objective is to study the hydrological benefits from restoration of good cover; the area is also a representative snow basin where snow accumulation and run-off relationships are investigated. Observations are made of climate, snow and stream flow, also of run-off and soil loss from small plots. These are all related to changes in vegetation characteristics.

*Adair* is situated five miles west of Timaru in rolling arable country. This basin has been divided into four plots of 4 acres each. Soils are yellow-grey earths. Studies will be made of the

hydrological differences between sunny and shady aspects and also of the effect of cultural change from grass to cropping. Rainfall and other climatic observations are being made and the plots are being instrumented to measure both surface flow and interflow. All have been cultivated and sown to grass; they will be identically managed until calibrated. Intensive soil-moisture sampling is planned, based on a methodological study now in progress.

### New Basins

*Mangatu* is some 30 miles from Gisborne on the unstable yellow-brown earths where it is proposed to study the effects of exotic pines as opposed to grass. The basin is at present being established and instruments installed. This basin is expected to yield valuable information on the management of the unstable Poverty Bay hill country.

*Manorburn* is situated about 20 miles from Alexandra in Central Otago. Soils are yellow-grey earths. Here the hydrological behaviour of low tussock and its management will be studied. The area has been investigated and the establishment of an experimental basin is being negotiated.

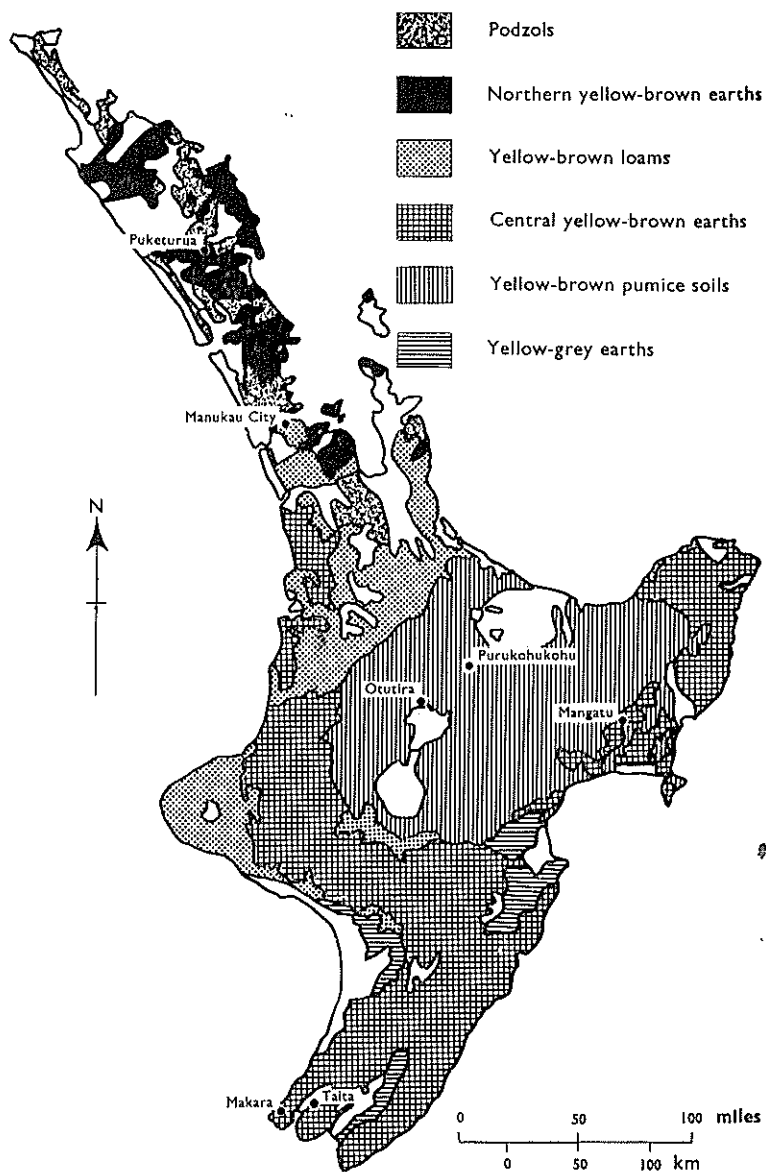
*Hawke's Bay/Wairarapa Mudstones.* A suitable site is being sought in this East Coast region on the unstable yellow-brown earths. The object will be to study the influence of land use and land-management practices on hydrological characteristics.

### Dissemination of Information

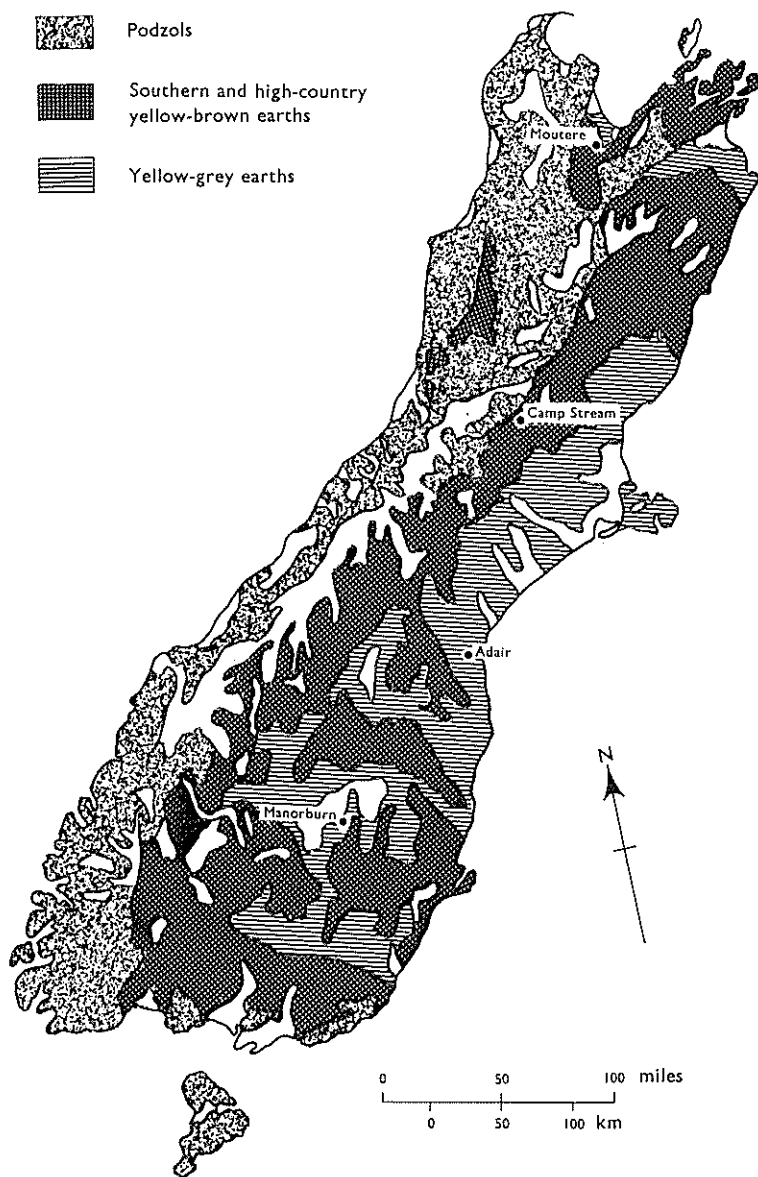
Research on experimental basins will provide information for soil conservators and engineers to aid them in preparing farm plans, in designing works and in predicting water yields. It is essential that the information be disseminated as promptly as possible. However, quick answers to urgent problems cannot be expected, for catchments must first be calibrated before land use is changed and a further period must then elapse before conclusions can be drawn. Some of the experiments will be of long duration.

Annual research reports are being published for the basins. In addition, summaries of observed data are published each year in the *Hydrology Annual*. Several scientific papers have been published on research on specific basins and more are to be expected. These will be mentioned in the bibliographies published in the *Hydrology Annual*. The present status of publication of research reports is given below.

<i>Basin</i>	<i>Reports published</i>	<i>Reports in press</i>
Puketurua	No. 1 up to end of 1966	No. 2 1967-8
Otutira	No. 1 up to end of 1967	No. 2 1968
Taita	No. 1 up to end of 1967	No. 2 1968
Makara	—	No. 1 1954-67
Moutere	No. 1 up to end of 1966	No. 2 and No. 3 1967 and 1968
Camp Stream	No. 1 up to end of 1966	No. 2 1967-8



North Island, New Zealand; showing location of experimental basins, and distribution of the soil types on which they are situated.



South Island, New Zealand; showing location of experimental basins, and distribution of the soil types on which they are situated.



The remaining basins — Manukau City, Purukohukohu and Adair — have been established recently and their first reports will cover the period from establishment to the end of 1969.

## Conclusion

The first half of the decade has been largely occupied with the selection, instrumentation and calibration of the basins so far established. Four experimental basins were in existence before the decade started — Taita, Makara, Moutere and Camp Stream. Work began at Makara in 1954 but the earlier years were spent in devising techniques rather than in calibration and research. The experience gained during this period, however, has facilitated the instrumentation of basins elsewhere. Research has been in progress for long enough at Makara for definite changes in hydrological characteristics to be related to land management, and at Moutere results of a preliminary nature are available on the effects of changes in land use.

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## LAKE WEEDS

The Combined Engineering and Scientific Committee on Water Resources (ESCOW) was asked by the New Zealand Electricity Department to consider the increasing infestation of aquatic weeds in the Waikato lakes. A committee consisting of Drs G. R. Fish and V. M. Stout and Messrs D. A. Ferrier and C. T. Pugh was set up to review all available data on aquatic plant research. This review, covering references to 26 papers and theses, has been completed. Copies may be obtained from the Secretary, New Zealand Institution of Engineers, P.O. Box 12-241, Wellington North.

Over the last five years weeds have become increasingly widespread; they collect on the screens of power station intakes, necessitating costly removal operations. They are also detrimental to the recreational value of the lakes. No satisfactory method for controlling the plant growth has yet been proposed. The committee found that more interest is being taken in aquatic macrophytes than is generally realized. However, the work is being done by many different agencies and there is a need for the co-ordination of freshwater research to ensure adequate concentration of effort into fields where progress is insufficient.