

# Hydrology Down Under – An Overview of Hydrological Monitoring Networks of New Zealand

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**ABSTRACT:** Generally in New Zealand there is plenty of regular rainfall replenishing our waterways. Water agencies currently operate over 3000 hydrological monitoring stations in New Zealand. Data from these stations enable scientists to develop a detailed understanding of the status of water resources to ensure that the water resources are managed in an effective and sustainable way.

## 1 INTRODUCTION

Before freshwater resources, whether it be a river, lake or groundwater aquifer, are used we must first quantify and understand how big or small the resource is. To do this hydrological monitoring networks are established and maintained to enable the resource to be quantified. New Zealand has an extensive network within New Zealand but the length of record is somewhat limited to that compared to other countries around that world that have a longer history of making scientific observations.

## 2 HISTORY

Hydrological stations within networks in New Zealand can be grouped into three broad categories rainfall, river flow and groundwater levels.

### *2.1 Rainfall*

Rainfall data is the first hydrological measurement to be made in New Zealand with the settlement of Europeans in the mid 1800s.

Early rainfall stations were located in around settlements of people whether it be in towns, cities or at farm homesteads. The Meteorological Service of New Zealand has been largely responsible for the establishment of that rainfall network. In the later part of the 1900s other government agencies and local government have extended the rainfall network into more remote areas to better understand the higher flood producing rainfall.

A rationalization of the rainfall network of New Zealand led to a reduction of rainfall station in the 1980s and 1990s with the closing of a large number of manual rainfall stations.

### *2.2 River Flow*

Early river flow monitoring stations were installed and operated by the central government's Public Works Department in the early 1900s. These stations focused on the investigations into harnessing the water resources of New Zealand for the purposes of hydro electric power generation. The data from these early stations provide some of the longest continuous hydrological records in New Zealand.

From the 1920s onwards each decade saw a further increase in the number of stations being operated in New Zealand along with an increasing field of interest in the information the stations collected.

The 1930s had river flow stations being installed with the focus to understand the river flows for their ability to supply irrigation schemes across the Canterbury Plains.

The Soil Conservation and Rivers Control Act (1941) and the subsequent establishment of Catchment Boards provided a major boost to river level station numbers in New Zealand. During this time “Hydraulic Survey” parties were established at three locations across New Zealand. This era had the installation of stations to measure rivers for flood control as well as the already established stations for power and irrigation development investigations.

UNESCO’s International Hydrological Decade (1964-1975) had New Zealand establishing 74 representative basins across 90 different hydrological regions. The representative basin program and small experimental basins increased New Zealand’s river level stations to include a greater range of catchment sizes and no longer focusing primarily on the larger rivers.

The introduction of both digital recorders and computer based data processing during the 1960s helped collate and manage in a central location the increasing amount of data being collected in New Zealand.

The 1980’s had the size of New Zealand’s network growing further with a large increase in the amount of data being collected by Catchment Boards as they continue to develop their understanding of water resources from both flood control and water allocation purposes.

A reduction in central government funding in the 1990s had a number of stations in the national network closed or their operation transferred to regional organizations.

The first decade of the new millennium has increasing numbers of stations being operated in New Zealand where the drive to better understand our water resources increases as the value of water increases.

### *2.3 Groundwater Levels*

In line with the increase in groundwater use so has the development of groundwater level stations taken place. The number of groundwater level stations increased steadily from its early beginnings in the 1960s. Nearly all of the groundwater level stations in New Zealand are operated by local government in their regional networks.

## 3 MONITORING AGENCIES

Since the first hydrological observation in New Zealand an array of different central and local government agencies have been responsible for the operation of hydrological monitoring networks. The three main operators of networks today are Regional Councils, NIWA and private companies.

### *3.1 Regional Councils*

New Zealand is divided into 15 regions for the purposes of administering the Resource Management Act 1991 (RMA). Under the RMA regional councils are charged with managing the natural resources for a region and also to conduct state of the environment monitoring for the region. Regional councils operate hydrological monitoring networks with a focus on regional issues and are funded by local rates from property owners within their respective regions.

### *3.2 NIWA*

The National Institute of Water and Atmosphere (NIWA) is a central government owned research and consultancy company. NIWA operates a national hydrological monitoring network with a

focus on a representative network of New Zealand from its 14 regional offices across New Zealand. This national network that is operated by NIWA is funded by the central government through its public good science fund.

### 3.3 Private Companies

Several private companies operate hydrological monitoring networks. The stations within these networks are normally operated to ascertain the status of a particular water resource or to ensure compliance with the organization's water consents that affect that companies business. Typically these companies are normally but not limited to hydro electric power generators. These stations and their associated data are normally commercially sensitive and as a result the data may not be available to third parties.

## 4 NETWORK SIZE

The current hydrological monitoring network in New Zealand is in excess of 3000 stations and growing. Fig. 1 shows the total number of hydrological monitoring stations in New Zealand for each decade from 1840 to 2010. The trend in each type of station is similar, in early decades of each type a slow increase is observed followed by a rapid increase until reaching a plateau or saturation point which appears to only be restricted by the ability to fund the operation of the network.

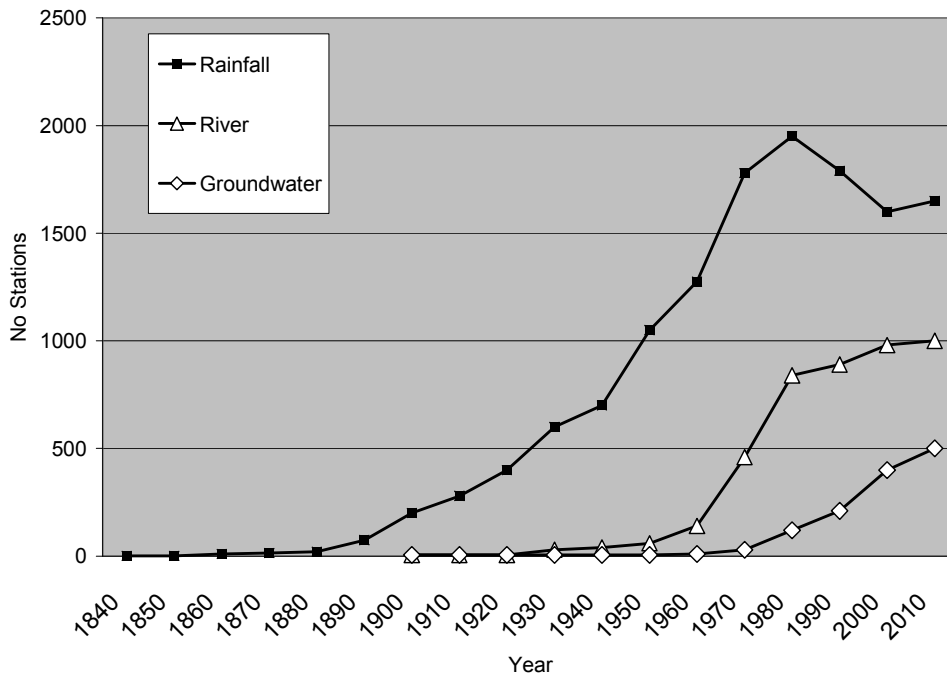


Fig. 1. Station Number in New Zealand (1840-2010)

## 5 INSTRUMENTATION

### *5.1 Rainfall*

Rainfall stations can be divided into two categories, manual and automatic.

Manual rainfall stations are typically 125mm diameter storage gauges that are observed on a regular basis depending on the location of the station to the observer. A significant number of these rainfall stations have been observed on a daily basis and form a large part of the rainfall database in New Zealand.

Automatic rainfall stations are normally a tipping bucket style rainfall connected to a digital logger. Prior to the tipping bucket, rainfall stations were equipped with automatic siphoning chart recorders.

### *5.2 Water Level*

Since the installation of water levels stations in New Zealand, large concrete and steel tower structures have emerged on all our major river systems at strategic locations. These have been equipped with very accurate float and counter weight type recorders. Early data was captured on mechanical chart recorders that have since been superseded with optical shaft encoder technology and digital loggers.

With the introduction of new technologies (e.g. pressure transducer, gas purge systems, radar and ultrasonic) New Zealand networks have experienced a move away from the traditional tower structure to these newer technologies for new installations. This has seen a large reduction in the capital cost to establish a water level recording station and also with the structure having less visual impact on the surroundings.

### *5.3 Flow Gaugings*

Most of the flow gaugings are typically completed using the standard cross section approach with a current meter in New Zealand. An array of bucket and impeller type meters have been used over the years. In more recent years current meters have started to be replaced with acoustic velocity meters. These meters have been mounted on standard gauging rods or cable suspended from cableways, bridges and boats.

Slope area gaugings have also been used to complete flood peak assessments from sites where it has not been possible to obtain current meter gaugings due to access, timing or dangerous flow conditions at the time of the high flow.

Dilution injection gaugings have also been used, at this stage it has been restricted in research for stream flow measurements where traditional gaugings have not been able to be completed due to the turbulent flow conditions.

The early 1990s has seen the introduction of acoustic Doppler profiling technology into New Zealand. There has been a significant uptake of this form of flow gauging in the last five years with nearly every major agency now using this technology alongside the traditional current meter technique.

### *5.4 Telemetry*

Early forms of telemetry were installed in New Zealand for the purposes of flood warning. These early systems were often dogged by failure either by equipment on site, or by the communications method. Reliable and affordable modern systems have enabled the wide spread introduction of telemetry from the 1980s onwards at nearly every hydrological monitoring station in New Zealand, providing real-time access to data to enable better management of water resources.

## 6 DATABASES

Several hydrological databases are kept in New Zealand. There is a national database, the Water Resource Archive, and then a series of regional databases. These databases use specialist software that has been written in New Zealand for the purpose of storing time series data.

The National Water Resources Archive is administrated by NIWA and comprises of data collected not only by NIWA but also from regional councils and private companies that make their data available. A key aspect of the national archive is the application of stringent quality control procedures ensuring national consistency to provide assurance that the data can be confidently used for scientific and planning purposes.

Each regional council typically administers its own database which contain data from their respective region. Collectively these regional databases are the biggest resource of hydrological data in New Zealand.

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