How low can you go?

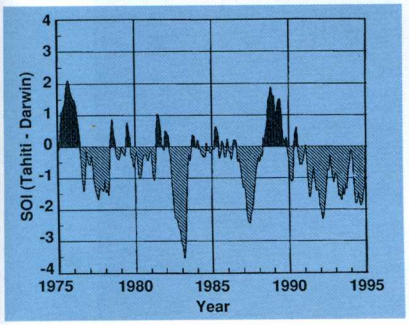
A special feature on methods to assess minimum flow requirements of rivers

THE DROUGHT conditions which existed in Auckland in 1994 and afflicted northern and eastern parts of New Zealand over the summer of 1994/95 have reminded many New Zealanders that although, from a global perspective, we have abundant rainfall (and consequently, water resources) there are pronounced regional differences. In some regions the demand for water from municipal, industrial and particularly agricultural users has placed extreme pressure on water resources, even under "normal" conditions.

Until the passing of the Resource Management Act in 1991, rights to abstract water were assessed largely on the capacity of rivers to supply the amount of water required, providing the requirements of other abstractors were not compromised. However it has long been recognised that decreasing the volume of water in rivers below a certain point can lead to undesirable effects such as reducing the amount of usable habitat available to fish and invertebrates, stressing these animals through other habitat changes (increased water temperatures, decreased dissolved oxygen), and providing a more favourable environment for nuisance growths, particularly algae. Unlike previous legislation dealing with water resources, the Resource Management Act requires that water managers specifically address these and other possible effects of abstraction.

In this special feature on low flows we have asked a number of scientists within NIWA to review methods they have developed or applied to assist in setting the minimum river flow needed to avoid significant biological effects. To set the scene, well-known climate guru, Jim Salinger reviews the meteorological conditions which can cause drought conditions in New Zealand, then Charles Pearson examines the frequency of low flows in New Zealand rivers.

Graph of the Southern Oscillation Index (SOI) from January 1975. When the SOI is -1 or less, New Zealand is in the El Niño phase of the Southern Oscillation cycle. Note that since 1991 the SOI has been largely in the El Niño phase. This has been responsible for the drought that has occurred in Gisborne and Hawkes Bay. Droughts also occurred in 1982/83 and 1987/88.



Conditions leading to drought in New Zealand

DROUGHT is a complex hydro-meteorological phenomenon. Droughts are always started by shortage of precipitation and many of the earlier definitions were based on rainfall. Current definitions include the end use of the water. Essentially, drought occurs whenever the supply of moisture from precipitation or stored in the soil or hydrological reservoirs is insufficient to fulfil the optimum water requirements of either plants, water supply for urban dwellers, inflows into hydro lakes or some other purpose.

Drought is unique amongst environmental hazards in that it creeps up gradually on the afflicted activity and consequently creates problems of recognition and perception. The meteorological features leading to drought in New Zealand are considered here.

The interaction of meteorological factors with New Zealand's rugged orography results in three main drought regions:

1. Northern and western areas of the North Island (including Wellington), Nelson, Marlborough and North Canterbury;
2. Eastern areas of the North Island;
3. Central and South Canterbury and Otago.

Drought is very infrequent in Southland and in the western areas of the South Island.

In region 1 droughts are more frequent in summer. The maximum occurrence is in February when travelling subtropical anticyclones reach their most southerly latitude and often become quasi-stationary to the west of the North Island. Droughts result when these anticyclonic systems are stronger and more persistent, and there is a lack of cyclones of tropical and subtropical origin bringing higher precipitation.

In region 2, and particularly Gisborne and Hawkes Bay, which are sheltered from westerly quarter winds, droughts are most frequent when westerly winds predominate. This is particularly so under the El Niño weather pattern, which is characterised by south westerly winds in spring and westerly winds in summer. Usually droughts in this region reach their maximum intensity in early summer and can be broken by heavy downpours from the cyclones that originate to the north of New Zealand in autumn. The intensity of the El Niño weather pattern is measured