DISCUSSION

NEW ZEALAND HYDROLOGICAL SOCIETY SYMPOSIUM ON CLIMATE CHANGE, SNOW AND ICE, AND LAKES

Wellington, December 1969

The address of each principal speaker is printed elsewhere in this issue.

CLIMATE CHANGE

J. F. Gabites, N.Z. Meteorological Service, presented the following statement:

"The subject of climatic change presents a challenge to specialists in many fields. The first problem is to establish the pattern and sequence of climatic fluctuations. We are all conscious, too, that the integrated effects of weather conditions over a season are not the same every year.

Meteorologists have instrumental records going back about a century in New Zealand — and about two or three centuries in parts of the northern hemisphere — that show more subtle changes than we would notice unaided. Further back, however, the picture is blurred and has to be reconstructed through the detective work of geologists, glaciologists, botanists, and marine zoologists. This is not easy, for the changes they identify are not due to climatic factors alone.

Even when the climatic history has been established, identification of the basic causes and mechanism presents a tremendous challenge to meteorologists (both atmospheric physicists and dynamicists). Factors such as fluctuations in solar energy have been observed over too short a period. However, mathematical models of the atmospheric circulation are being progressively improved, and large computers are making it possible for us to test hypotheses on the mechanism of climatic fluctuations. Large-scale simulation experiments are likely to be conducted on an increasing scale over the next few years.

Any understanding of climatic changes that we may gain may help ecologists in their interpretation of vegetation patterns and probable changes. Engineers are interested too. Perhaps they have to design power schemes or irrigation systems with only a short record of rainfall or stream flow available. How well do these data represent longer-period

conditions? What extremes of rainfall or snow melt should be allowed for in the projected life of the structure?"

He also mentioned the discussion by J. T. Holloway in 1954 of the apparently anomalous forest patterns of the South Island. This was an outstanding contribution to the climatic history of New Zealand, although in 1962 Professor K. B. Cumberland questioned whether enough weight had been given to fire rather than climatic changes as the explanation.

R. Cochrane, Department of Geography, University of Auckland, stated that the response of biota to climatic changes is more rapid than that of soil, geomorphic, and glacial changes. Minor variations cause major changes. In a Kansas study the precipitation for approximately 50 years was below average and the basal cover of short prairie grass decreased by 90 percent. Production per acre closely followed the drought periods. Fires, even in cold areas, have an important effect in modifying vegetation.

J. F. de Lisle, N.Z. Meteorological Service, commented on the fluctuations in the instrumental record over the last 100 years in New Zealand. Little information is available of early methods and site changes, apart from the fact that early temperature screens were not ventilated and no distinction was made between precipitation measurements on windward and leeward slopes.

P. J. Grant, Hydrological Survey, Ministry of Works, outlined evidence from forests of the Urewera region indicating that precipitation effectiveness has decreased generally during the last 200–250 years. During this period there has been an overall increase in temperature and windiness, and probably an increase in the frequency of physiological drought.

Rainfall frequency changes during the present century were outlined and their significance mentioned.

The principle was stated, that the longer is the period of change the larger is likely to be the area affected in the same way, and the shorter is the period of change the smaller is likely to be the area similarly affected.

C. J. Burrow, Department of Botany, University of Canterbury, commented on correlation work in the Southern Alps between valley glacier fluctuations and radiation, precipitation, and snow boundary differences. Lichens have been used to date advances in the Mt Cook region. Advances which occurred in the mid 12th, 13th, 15th, and 16th centuries have been matched with lows in the Wilson-and-Hardy climate curve developed from stalagmite work. Throughout Canterbury there are many moraines but few good datings earlier than 9500 B.P.

A. J. Raudkivi, School of Engineering, University of Auckland, considered climate change to be a global rather than a purely New Zealand problem.

R. Cochrane agreed, but said that feed-back mechanisms are often involved, producing localized effects. Holloway's statement emphasizes that the changes which are local are of ecological significance. *G. J. Blake*, Hydrological Survey, Ministry of Works, stated that in hydrological studies the short-term fluctuations must be known if the hydrological system at any point in time is to be fully evaluated. Long-term fluctuations are of less importance.

SNOW AND ICE

A. C. Archer, Grasslands Division, Department of Scientific and Industrial Research, stated that until four years ago there were no data available on the snow resources. This was serious because influences are operating in the Southern Hemisphere which do not occur in the well studied areas of the Northern Hemisphere. Snow melt influences plant zonality, and this is evident in the Mt Cook–Ben Ohau area. Field work has been difficult, particularly the sampling of vegetation under snow. Snow sampling began in 1966, and the water equivalent accumulation with altitude was determined. No correlation was present for the ablation period. The foehn influence creates variability in the snowpack, especially in spring.

R. D. Thompson, Department of Geography, University of Manawatu, commented on budget values obtained from glaciers on the northern flanks of Mt Ruapehu by pit sampling. During the last 20–30 years the glaciers have been retreating and down-wasting, until 1968–69 when an advance representing 77,000 m^3 of water occurred.

J. Y. Morris, N.Z. Forest Service, said that he doubted whether the foehn effect is a spring phenomenon, and expressed his opinion that New Zealand snow densities were a reflection of the general warm temperatures. He also commented on the physical effect of snow avalanches on erosion, emphasizing the effectiveness of avalanche winds as an agent of erosion.

A. C. Archer answered that he thought the foehn influence was not as frequent in New Zealand as might be expected, particularly in the winter months.

J. D. Coulter, N.Z. Meteorological Service, explained the use of satellite photographs to plot snow areas, but emphasized the difficulty of distinguishing between snow and cloud.

R. Cochrane, Department of Geography, University of Auckland, outlined the use of radar for snow and ice measurement in the Arctic.

G. G. Natusch, Power Division, Ministry of Works, asked Dr Thompson if he had attempted to correlate climatic conditions with his results.

R. D. Thompson replied that he felt that the positive budget of 1968–69 was related to unusual atmospheric conditions over the Tasman Sea. He added that he is working closely with the Meteorological Service.

S. Taylor, Hydrological Survey, Ministry of Works, stated that he had found that coal dust as a marker was inadequate, and that compacting of the surface introduces error. However, confetti from Fischer and Porter punched-tape water-level recorders is ideal for marking snow.

He mentioned also that he felt that water resources are more dependent on snow than on glaciers.

T. J. Chinn, Hydrological Survey, Ministry of Works, confirmed that the greatest percentage of run-off is from seasonal snow during spring. Contributions from glaciers are only important during late summer.

J. Y. Morris stated that dates for the onset of rapid thaw are unreliable. During 1968–69 the variation was over two months, demonstrating some relationship with the seasonal snow cover.

G. G. Natusch said that he thought it was important to fix a date of rapid thaw to aid the Electricity Department in its planning of operations. He paid tribute to Mr Chinn's early work on the Tasman Glacier.

C. Toebes, Hydrological Survey, Ministry of Works, stated that 90 percent of the Earth's water is stored as ice, and that New Zealand has more than 1,000 valley glaciers. The Hydrological Survey has selected the Ivory Glacier, in the western Southern Alps, for water, ice, and energy-balance studies.

G. J. Blake, Hydrological Survey, Ministry of Works, suggested that the neutron-scatterer device for moisture determination should be applied to snow and ice problems.

W. B. Morrissey, Hydrological Survey, Ministry of Works, asked how much snow was blown off Mt Cook on to the Tasman Glacier, and if the snow depth was a true indication of precipitation gradients.

T. J. Chinn replied that there is more snow at 4,000 ft than between 7,000 ft and 8,000 ft, where bare ice is evident. The total winter snowfall is blown down convex slopes from the high levels; snow records are therefore very dependent on wind movement.

LAKES

V. M. Stout, Department of Zoology, University of Canterbury, expressed admiration for Dr Fish's work, and compared his results with those from Lake Mandora, Wisconsin. A paucity of information dominates the New Zealand scene. The deep glacial lakes have very low concentrations of phosphorus and nitrogen, while some

lakes — particularly those near the coast — are becoming eutrophic (e.g., Lakes Hayes and Forsyth). Seepages and springs make measurement difficult, but accelerated eutrophication may be due to nitrogen, phosphorus, and trace elements (e.g., molybdenum) increasing the growth rate of the biota within the lake. Samples for phosphorus analysis from Lake Pearson have been collected during 1947–48 and 1967–68. The maximum phosphorus content has increased from 0.003 ppm to 0.004–0.006 ppm. This change has been accompanied by marked changes in algal composition and animal population numbers.

M. E. U. Taylor, Cawthron Institute, commented that phosphorus concentrations in stream flow are greatly increased during floods. Nitrogen concentrations also can reach 1.5 ppm, and over a 30-mile reach may vary from 0.02 ppm to 1.0 ppm if fertilizers have been applied to the land. Inflow concentrations differ from those of outflow, and bed material may have high concentrations (e.g., 1.5 ppm) even though the flow concentration may be quite low.

P. J. Grant, Hydrological Survey, Ministry of Works, asked Dr Fish whether the weight of fish produced was a direct function of the water volume in lakes.

G. R. Fish, referring to trout, replied that it cannot be treated in terms of lake volume or surface area, as trout are not found in the centre of large lakes. The closest relation is with length of shore line and other characteristics.

B. P. J. Molloy, Botany Division, Department of Scientific and Industrial Research, asked if there would be a need to save some lakes and sacrifice others.

G. R. Fish answered that a lake cannot be "written off and put into cold storage" because it is a dynamic system.

A. K. Turner, Department of Agricultural Engineering, University of Melbourne, spoke of Melbourne's efforts to get sewage to the sea by pipeline to avoid damaging lakes. He asked if there was any economic way of removing nitrogen and phosphorus from water.

G. R. Fish, in reply, quoted numerous methods, pointing out that all were costly. He said that he felt it was more important to treat the phosphorus than the nitrogen.

V. M. Stout added that the removal of phosphorus was the more expensive.

G. J. Blake, Hydrological Survey, Ministry of Works, commented on the spray irrigation of waste as a possible solution.

G. R. Fish mentioned that some phosphorus and nitrogen is 'locked' in the bottom sediment and is released only in the present of acids.

Referring to Rotorua, he said that aerial surveys have shown a large increase in weed growth at points where springs discharge.

Pollution could progress to the point where the lake could produce undesirable effects for the city of Rotorua, and it is very costly to reverse the process. Harvesting of the weed would help to remove phosphorus and nitrogen.

R. J. Pittams, Hydrological Survey, Ministry of Works, said that in his studies of the water balance of the Rotorua lakes he too had observed an excess of inflow over outflow. He felt that the flows from the Awahou and Hamurana Streams are much too great to be coming from the geomorphic catchment alone; there must be a link with neighbouring catchments through an underground system.

He mentioned also that the storm discharge observed by Dr Fish in the Puruki catchment was relatively small, and discharges some 10 times greater occur three or four times each year.