outside of the float chamber was $27\frac{1}{2}^{\circ}$ F. No freezing of the water in the float chamber occurred.

Early in 1962 a similar Casella raingauge was installed with a 44 gallon drum protection in the Mt. Cook region, but has not yet encountered sufficiently low temperatures to warrant comment.

REFERENCE

Thompson, G.E.K. 1960: Shallow Temperature Surveying in the Wairakei-Taupo Area. N.Z. J. Geol. Geophys. 3: 553.

OVERSEAS HYDRO-METEOROLOGICAL PRACTICE

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SUMMARY

The determination of the probable maximum flood involves essentially two phases. The first is a study of the hydro-meteorological conditions leading to maximum runoff. The second is the conversion of these conditions into runoff, in the form of a hydrograph. This paper is concerned principally with the first phase, and the probable maximum runoff-producing meteorological conditions are described with some detail in the case of precipitation and in outline only in the case of snowmelt.

INTRODUCTION

The paper describes in general terms the application of hydro-meteorological principles to determine probable maximum precipitation (PMP) in an area where original hydrological and meteorological data (especially upper atmosphere data) are scarce. Reference is also made to the estimation of maximum snowmelt rates.

The hydro-meteorological methods described are those evolved by the United States Weather Bureau and are applicable to any area where the necessary topographic, precipitation, streamflow, dewpoint and wind data can be obtained or simulated.

PURPOSE

The need to establish design criteria for flood protection measures and especially the desirability of establishing conformable sizes of flood discharge for spillway design on a series of dams in the same or adjoining river basins calls for the use of hydro-meteorological methods to:-

1. estimate the magnitude, seasonal variation, chronological distribution and recurrence interval of the PMP over the problem area.
2. provide estimates of the water equivalent of the snow pack in mountain regions
3. provide guides for determining the optimum rates of snowmelt.

PROBABLE MAXIMUM PRECIPITATION

Where upper-air data are lacking the most common procedure for estimating PMP is to use observed storm precipitation values and to maximize them by adjustment based on the ratio of the maximum atmospheric moisture (precipitable water) ever observed to that prevailing during the storm.

STORM DATA

Isohyetal maps of the most critical major storms are produced so that their depth-area-duration relationships can be analysed. All indications of major storms are extracted from precipitation data and stream flow hydrographs where available. After inspection the potentially more critical storms are selected for more detailed examination, and by processes of elimination considering all meteorological implications the final isohyetal maps are derived.

MOISTURE - INFLOW INDEX

The amount of precipitable water in the atmosphere is assumed to be a function of the surface dewpoint (no upper-air data available). Wind is also a factor since it will influence the rate of moisture inflow into the storm area. Inspection of the dewpoint and wind data available, consistent with the timing of the maximum 24-hour precipitation in a storm, will yield the optimum combination of 12-hour persisting representative dewpoint (the usual index of precipitable water) and the average 24-hour wind speed (24-hour instead of 12 to smooth out diurnal effects). The precipitable water for the representative dewpoint is then obtained from available tables for the estimated moisture inflow layer. The product of the precipitable water and average 24-hour wind speed in the direction of moisture inflow is the moisture-inflow index (MII) for the storm.

Since the factor for maximising storm precipitation is the ratio of the maximum MII to the MII for the storm, the seasonal variation of PMP is necessarily the seasonal variation of the MII. This is obtained by plotting the maximum monthly MII as determined from the maximum monthly 12-hour persisting dewpoints of record and the maximum monthly 24-hour average speed of winds from the direction of moisture inflow. The seasonal plot of maximum MII enables estimates of PMP to be adjusted for any month of the year.

DERIVATION OF PMP

The PMP for the project basin is estimated by adjusting the basin depth-area-duration values of each of the selected critical storms by the ratio of the maximum MII to that of the storm. The adjusted (maximized) depth-area-duration values are plotted and enveloped by curves representing the preliminary depth-area-duration curves for PMP over the project basin. Various refinements depending on meteorological considerations, sampling techniques and other factors may be necessary before the final depth-area-duration curves of PMP are presented.

APPLICATION

For flood derivation, the basic approach is the use of rainfall-runoff relations to estimate the volume of runoff to be expected from the PMP. This volume is then converted into hydrographs of flow on small and moderate sized basins by the use of unit hydrograph or related procedures. The hydrographs of larger basins are calculated by use of storage-routing techniques, combining hydrographs of the tributary basins and adding intervening inflow as required.

Since it is extremely unlikely that the PMP will occur during the useful life of an engineering project, the design engineer will modify the resulting flood having consideration of frequency of recurrence, antecedent precipitation, chronological distribution of precipitation increments, engineering factors of safety and other information that may affect the design of the project.

SNOW

Where a portion of the problem basin rises above the winter snowline, snowmelt may contribute appreciably to the probable maximum flood. This requires estimates of the depth, water-content and elevation of the snow pack, and these may be developed from snow-survey data either in the problem area or in a nearby or other basin which has characteristics of climate, physiography, moisture source and moisture inflow barriers most closely resembling those of the problem area.

The empirical procedure for estimating snowmelt runoff utilizes surface air temperature as an index and is based on the fact that the rate of snowmelt is proportional to the daily mean temperature excess above freezing temperature.

Theoretical procedures can rarely be used for estimating snowmelt because of the customary absence of field observations of the parameters in the theoretically derived formulas.

ABSTRACTS

ABSTRACTS of Some Papers Presented at the Hydrology Symposium, Annual Conference of the Meteorological Service, Wellington, 2 November, 1961.

THE PARTNERSHIP OF HYDROLOGY AND METEOROLOGY. A.P.Campbell, Soil Conservation and Rivers Control Branch, Ministry of Works, Wellington.

Hydrology is concerned with the whole of the hydrological cycle but hydrologists are not well placed to be able to measure all parts of the cycle themselves and a good partnership is required with meteorologists whose observations complete the measurements of the full cycle.

The division of responsibility leaves meteorologists measuring and recording the downward movement of precipitation and the upward movement of evapo-transpiration; that is they measure the vertical currents of the cycle while hydrologists measure the ground traversing flows or horizontal currents.

A good partnership is rewarding to both sciences because in many places only one kind of measurement is practical and this single measurement must be used to estimate the unmeasurable data. For example, in remote and mountainous country where rainfalls are always heavy and variable, river flow makes the most effective raingauge and rainfall estimation will often rely on flow measurements for confirmation. Conversely, because of expense and difficulty of taking flow measurements continuously in many places, only a limited number of flow measurement sites are practical and measurements of rainfall are used to obtain estimates of flow in other places.

Likewise, estimates of evapo-transpiration are used to fill the gap in the water balance between rainfall and runoff. The filling of this gap completes the hydrological cycle and in doing so provides a much needed check on hydrological measurements.

The partnership of hydrology and meteorology is therefore necessary to both and, as with all partnerships, frequent interchange of ideas is necessary to help understand the changing needs of the work. Accordingly, the opportunity for a day of formal discussion of mutual problems is very welcome.