Plate 3.3 Water Equivalent of the Snow Cover

Introduction

The water equivalent of the snow cover describes the amount of water stored in the snow cover for a period of days, weeks or months. For the water management it conveys far more information than the depth of snow. As a term of the water balance, it is relevant to small basins as well as to the large catchments. Thus the snow situation in spring in the head watersheds of the Rhine River provides vital information to the management of the Ijisselmeer in the Netherlands. The amount of summer inflow into this drinking water reservoir is influenced to a great extent by the water stored in the snow cover of the Swiss Alps.

The water equivalent of the snow cover differs from one spring to another, depending on the precipitation and temperature conditions in the preceeding winter. Similarly, the amounts of melt water inflow from the snow cover into the reservoir lakes during the summer periods are also variable. For this reason, energy management experts are highly interested in obtaining data on the water storage in the snow cover [5].

Definitions and data basis

The water equivalent of the snow cover refers to a hypothetical water column resulting from a total melting of the snow cover without any runoff or evaporation. The water equivalent is mostly indicated in millimeters. In wintertime, it is usually measured at the beginning and in the middle of the month but at a few stations at weekly intervals. For reasons of comparability, the present measurements were reduced to term-values on the 1st and the 15th day of each month. The reduction was achieved by means of a model based on [4].

Experience has shown the spatial variation of the snow depth within the snow measurement plot to be rather great, whereas the spatial variation of the snow density is comparatively small. It is for this reason that the snow density (kg/m^3), measured at any point within the snow measurement plot, is multiplied by the snow depth (m) at the fixed gauge. 1 mm of the water equivalent corresponds to 1 kg/m^2 accordingly.

In 1943, the Swiss Federal Institute of Technology of Zurich, in collaboration with a number of hydro power companies, initiated the first regular observations of the water equivalent. Continually, the measurement network was developed in cooperation with the Federal Institute for Snow and Avalanche Research (FISAR). Today it consists of approximately sixty stations between 800 and 2600 m a.s.l. (cf. map 3.1). The water equivalent values are published in [1]. Long-term general views on the water equivalent are compiled in [3] and [6].

Variations of the water equivalent

Diagrams depicting the variations of the water equivalent during the months of November to June (July) are the central part of the map. The small-scale map refers to the positions of the 53 stations a diagram is available for. In addition, it indicates the FISAR region a station is assigned to. Furthermore, it distinguishes between stations providing only average values, and stations which also provide minimum and maximum water equivalents. The latter were in operation from at least 1960/61 to 1984/85.

For the diagrams, the stations are classified according to FISAR regions. The indicated water equivalents of the snow cover refer to the term values mentioned before. Information concerning the general conditions of every station is given by both the altitude and the sunshine duration. In some years, the difference between sun-exposed and shady stations can be very great within the melting period. In other years, however, the melt energy originates primarily from warm, moist air and the variations are much smaller.

Due to the dense information the water equivalents measured at individual points are revealing, the depiction in diagrams was preferred. The depths of snow, on the contrary, being most significant to the ski-tourism for instance, are often depicted in a synoptic way [7,8].

Water equivalent and prediction of discharge

In Switzerland, various methods are used to calculate (seasonal) discharge forecasts [2]. Besides methods which explicitly use the relevant water equivalent of the whole basin as a reference point for a forecast period, most methods use the water equivalents for selected stations as so-called index values. These index values provide a great deal of information concerning the water storage of a catchment. Generally, however, they can not be equated with the average water equivalent of the whole catchment. Rather, they are a statistical indication relating the long-term water equivalent series to the long-term runoff series. Consequently, a predictive model can be deduced. The mean forecast potential of such a model is often very high. As different applications have revealed, up to 80 % of the variance of summer discharge can be explained by the index value of the water equivalent [6]. It is important to recognise, however, that conditions of extreme precipitation will negatively affect the predictive capacity of the model.

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