CHAPTER 18

Technological Advances

18.1 INTRODUCTION

The combined efforts of the hydrologist and meteorologist have contributed to advances in the techniques of simulating the hydrological cycle within the Okanagan Basin. Such simulations are particularly difficult in this semi arid portion of the Province where average evaporation losses from the main valley lakes are approximately equal to the average net runoff.

The related problem of vegetation management has been briefly studied with respect to forest hydrology but the extension of these studies to include detailed weather forecasting as well as weather modification have not been attempted.

Because of the importance of these various subjects to water management they are briefly discussed below.

18.2 Seasonal Volumetric Forecasts

Over the last 35 years inflow forecast procedures have been developed by the British Columbia Resources Service for many of the major river basins in British Columbia.

The original simple correlations of snow water content versus inflow for the April to July period to Okanagan Lake have been refined through the use of the computer to include other hydrological data. The independent variables can be classified into three categories namely factors having an influence on the dependent variable (inflow) prior to the start of the snow accumulation period in January, those during the accumulation period which normally ends about April 1 and finally, the unpredictable subsequent weather pattern. Only the first two are known at the start of the runoff period and inflow forecasts are made on the assumption that the ensuing weather during the melt period will be normal. Variations of this carried out in the United States provides a range of inflows based on climatic probabilities.

This type of approach has been used to a limited extent in Canada where a certain historic weather pattern is assumed to occur and the normal forecast modified accordingly using a daily water budget model. The following conclusions are made with respect to a forecasting water budget model in Chapter 10 of Technical Supplement II - Water Quantity Computer Models.

"The weather pattern after March 1 can, in extreme conditions, increase the runoff by over 100 percent or decrease the runoff by some 30 to 40 percent. These extremes have a recurrence interval of about one in 100 years. These large inherent forecast errors can be given bounds and can be recognized as the true uncertainties under which the system is being operated. The uncertainty of forecast decreases appreciably as the melt season progresses and the outcome of the operation of the system can be more certain. The forecasts can be used in conjunction with some lake operating scheme such as that proposed in the following Chapter to minimize the damage resulting from either floods or droughts."

The computer model achieves a water balance through the season and indicates how much water is going to fast runoff, groundwater base flow, soil moisture and eventual evapotranspiration, and lake storage. The calculations show that the runoff from summer rain is very much a function of the residual snowpack. Rain on snow results in runoff, whereas rain on soil usually gives a small or zero runoff contribution.

The initial soil moisture deficit can be estimated by running the model through the winter period. This estimate of soil moisture deficit can then be upgraded after the first few weeks of early runoff data are available. The variability of soil moisture deficit is from 41 kaf to 219 kaf for the region above 4,000 feet. Below 4,000 feet there is a huge deficit which is generally never satisfied. Certainly the catchment below 4,000 feet contributes only small amounts to basin runoff and this contribution appears to come from areas which are effectively impervious and not subject to a water balance.

Another problem area at present is a systematic over-reduction from late melt-season rain. This error may be due to over-estimates of rain by the currently used meteorological stations. Such an error may be either in amount or in areal distribution. It can be corrected by a fairly constant decrease of rain, either in amount or contributing area. The reconstitutions illustrated show a small error for seasonal volumes because the seasonal volumes are brought more into line by adjusting the initial soil moisture deficit, the average adjustment being 101 kaf. Therefore, a better estimate of volume error is given by the unexplained variation in the initial soil moisture deficit."

The foregoing illustrates the complexities of the hydrology of the Okanagan Basin and the difficulties that have been experienced in "tuning in" a model which will simulate historic conditions over a number of years.

Through the development of the above mentioned model as well as a Budgeting Hydrologic Model (Chapter 9 - Technical Supplement 2) the state of the art has been advanced and it is evident there is a need for better soil moisture data as well as actual evaporation (including transpiration). A third requirement of particular interest to water management would be detailed weather forecasts of temperature and precipitation particularly for the higher elevation areas of the Basin.

18.3 VEGETATION MANAGEMENT

The Okanagan Basin Study has been limited to the effect of various forest harvesting cycles on the runoff of Pearson and Tree Farm Licence #9 Area (includes Terrace, Shorts, and Whiteman Creeks) under present operational procedures. A related study of water quality in a developed basin (Kelowna Creek) and a relatively undeveloped tributary (Lambly Creek) is inconclusive and this is probably due to the lack of sensitivity of the tributary water quantity model.

The pilot studies in tributary streams emphasize the need for more sensitive modelling which hopefully can be realized in the future through the improved monitoring system now in operation or planned.

With better water quantity and quality modelling it will be possible to assess the affect of alternate methods of forest harvesting. A related problem is the recommendation contained in the Final Report to establish green belts in the selected areas of the Basin to reduce nutrient loadings from erosion.

18.4 WEATHER MODIFICATIONS

An ability to modify clouds by the artificial addition of freezing nuclei upon which cloud particles can grow has been demonstrated in controlled experiments involving individual clouds. Although there is not general agreement as to the effectiveness of various field efforts, area experiments in some regions appear to have produced increases in precipitation of 10 to 20 percent at an acceptable level of statistical significance but in other places no significant increase and even decreases have been reported.

Techniques differ but often involve silver iodide crystals generated at ground level and allowed to diffuse naturally to cloud level. Success depends upon moisture and temperature levels within the clouds. Another approach involves seeding from aircraft using crushed dry-ice, silver iodide or some other material. Individual instability cells (cumulus clouds) may be targeted but it is more common to make a more general application to frontal clouds.

In the Okanagan the annual peak of the precipitation curve normally fans in December or January as a result of frontal activity involving Pacific air masses aloft, although it is closely followed by June precipitation which has a heavier instability component. Thus, augmenting the winter snowpack, and thereby snowmelt runoff, by seeding frontal clouds would appear to be the approach most likely to increase water supply by precipitation enhancement.

Apart from the meteorological and technical problems associated with the development of weather modification schemes there are economic, ecological, social and legal limitations to the implementation of specific programs. Cost-benefit considerations must be applied not only to the operation itself but to the potential costs to one form of land use or activity in terms of the benefits to some other sector. Animals and vegetation could be effected if normal patterns were significantly altered. Effects on recreational uses of land and on use of private property in seeded areas would require consideration.

In many of the areas mentioned above one can conceive of benefits as well as disbenefits and it is likely that each proposal would require an independent investigation. In general one would expect weather modification projects to operate under strong sanctions against the aggravation of extremes and therefore the primary effect would be to increase precipitation in dry years and to with-hold effort during wet years. A few abnormal months late in the season could make such a target difficult to achieve in some cases.

At this point one must consider weather modification to increase precipitation as a technique having some potential but bring primarily in the experimental stage. Undoubtedly pressures will increase toward managing atmospheric water resources in this way as demand for water grows.