STOCHASTIC DYNAMIC PROGRAMMING FOR SALINITY MANAGEMENT IN RESERVOIR OPERATION

by

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ABSTRACT

A stochastic dynamic programming technique for the optimal operation of a reservoir to control salinity in the reservoir and thereby also in the releases, and to meet irrigation and municipal demands is developed. The technique defines the optimal policy for releases to meet salinity and irrigation water supply requirements. The problem for which the approach was specifically developed is characterised by the presence of a strongly stratified, essentially two-layer, condition in a reservoir used to supply irrigation water. The two-layer condition exists over the winter months when cold and heavy saline flows enter the reservoir and flow to the bottom of the reservoir. The two-layer condition continues until mixing of the reservoir occurs in early summer. While the reservoir is stratified, it is possible to flush the saline water out of the reservoir by low level intakes. This flushing reduces the overall salinity level in the reservoir when mixing occurs at the end of winter, and thereby reduces the salinity of irrigation water withdrawn from the reservoir over the summer. However, removing the saline bottom layer also reduces the volume of water available for irrigation. Hence there are limitations on the amount that can be withdrawn to reduce the salinity. The technique is an approach to optimising the performance of the reservoir to meet irrigation demands, while minimising salt concentration in the irrigation water.

Stochastic dynamic programming is used to reflect the uncertainty in the inflows while chance-constraints are used to control the level of salt in the reservoir at the beginning of the irrigation season. Three different conditions or assumptions are considered in modelling the probabilistic nature of the salt inflows to the reservoir: 1) salt load is directly related to the volume of inflow, 2) salt load is independent of the volume of the inflow, and 3) salt load is conditioned on the volume of inflow. The model is demonstrated by application to the Wellington Reservoir in Western Australia for the case in which the salt load is conditioned on the inflow. The results of the application of the model for a range of different combinations of maximum allowable salt concentration and probability of exceeding that are compared to each other and to the release policy generated in an earlier simulation analysis undertaken to manage the salinity question.

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