Selecting Optimal Modes Of Surface Water Control By Means Of Soil Water Models And Surface Elevation Data

M.F.P. Bierkens, P.J.T. van Bakel, and J.G. Wesseling

The Winand Staring Centre for Integrated Land
Soil and Water Research (SC-DLO)
P.O.Box 125
6700 AC Wageningen, The Netherlands
e-mail: bierkens@sc.dlo.nl

Traditionally, surface water levels of ditches in Dutch polders are controlled in a rather simple manner. During the winter time surface waters are kept at low levels to allow for additional storage of soil moisture for the coming summer and to assure a firm topsoil and a quick rise of soil temperature in early spring. During the summer the surface water levels are kept high in order to replenish the groundwater via infiltration from the ditches. In this way one hopes to prevent the water tables from falling too quickly in summer, because during this time of the year an important part of soil moisture for crop growth must be supplied by capillary rise from the phreatic surface.

A problem with this traditional mode of surface water control is that it is rather crude. It does not take account of the actual moisture conditions and groundwater levels. Moreover, surface elevations and soil properties may vary considerably within a control unit (i.e. polder). Therefore, a mode of control that is optimal for one point within the control unit, may not be optimal for the unit as a whole.

Based on above problem description a research project was started at the Winand Staring Centre with the following goals:

1. To see whether it is possible to devise a mode of surface water level control that is based on actual measurements of the groundwater levels at a single location, but that is in some manner "optimal" for the entire control unit. Here, "optimization" means maximization of the net return per hectare, i.e. the maximization of actual transpiration (crop yield) and minimization of losses through ponding or saturation of the topsoil.

2. To evaluate if the optimal mode of surface water level control produces significantly better returns than the traditional method of surface water control.

A polder in the north of the Netherlands (size approximately 500 hectares) has been chosen as our study area. The performance of six different modes of surface water control (including the traditional mode) are evaluated at twenty random locations in the study area.

Performance is measured in net return, which is obtained from the mean yearly actual transpiration (i.e. crop yield) and losses through ponding or saturation of the top soil. These parameters are calculated at the selected locations with numerical soil water models. To aggregate the results of the soil water models to net returns for the entire study area, conditional geostatistical simulations of surface elevation data are combined with stochastic nonlinear regression relationships. The geostatistical aggregation method results in a probability distribution of areal average net return for each mode. The probability distributions are used to select the optimal mode of surface water control and to check whether this selected mode is significantly better than the traditional one.