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Waterpas: effects of water management on agriculture

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Water managers, policy makers, and farmers need tools to estimate the impact of water management on agricultural yields, economic benefits, and environmental effects to be able to make strategic and operational decisions. Historically, relationships between groundwater level and crop yields were used to calculate the reductions in crop yield due to suboptimal water status of fields in The Netherlands. Nowadays, state-of-the-art deterministic models for water flow and crop production can be coupled to simulate the effects of changing water management. The SWAP model is used to simulate water flow in the saturated and unsaturated zones of the soil and the interaction with the surface water system. Soil hydraulic characteristics are used for every distinct soil layer. Drainage to or infiltration from the surface water system is described by water fluxes depending on flow resistances and differences in hydraulic heads between the groundwater level and the surface water level in the ditches. The surface water level can be specified as a time-dependent head boundary condition, thus permitting simulation of effects of changing surface water levels. SWAP calculates groundwater levels in the field as a result of the water balance, taking into account all fluxes. In the Waterpas-model the pressure head in the topsoil at 14 cm depth, calculated by SWAP, is used to determine the bearing capacity of the soil, which is needed for the decision whether or not the field can be grazed or cut. For dairy farms an integral management model has been developed and applied to simulate decisions on grazing and cutting, and calculate farm economics. Soil physical conditions, crop yields, and farm management are simulated for 10 years, based on daily weather data.

For a dairy farm in a peat district in the central part of the Netherlands, raising of the ditch water level resulted in wetter conditions in the topsoil, and a lower bearing capacity, resulting in a reduction in net grass production, too wet soil conditions for

agricultural land use and lower economic benefit for the farmers. Higher ditch water levels increased also the variation in farm economic results between years, and thus lead to higher economic risks for the farmers. In this paper the effects for different ditch water levels and intensive and extensive dairy farming systems are quantified using the Waterpas model.

Results of the Waterpas model are used to calculate the economic effects of changing ditch water levels in a whole region. In this case study, all fields are characterised by their hydrological condition, i.e. drainage conditions. Then, different types of farms are classified, based on the distribution of the hydrological conditions of the fields, ranging from “dry” to “wet” farms. A polder with an area of 1400 ha is classified in the different farm types, using detailed GIS information. The number and area of relative wetter farms will increase by raising ditch water levels in the polder, which leads to higher costs and less income for the farmers. An income reduction of 200,000 euro per year is estimated for the polder when ditch water levels are raised from 60 to 30 cm below the soil surface. This study shows how detailed information on water flow in the saturated and unsaturated zone can be used to evaluate the effect of water management on land use and regional economics.