Large scale drainage measures to increase freshwater supply from sandy creek deposits

– a multidisciplinary feasibility study –

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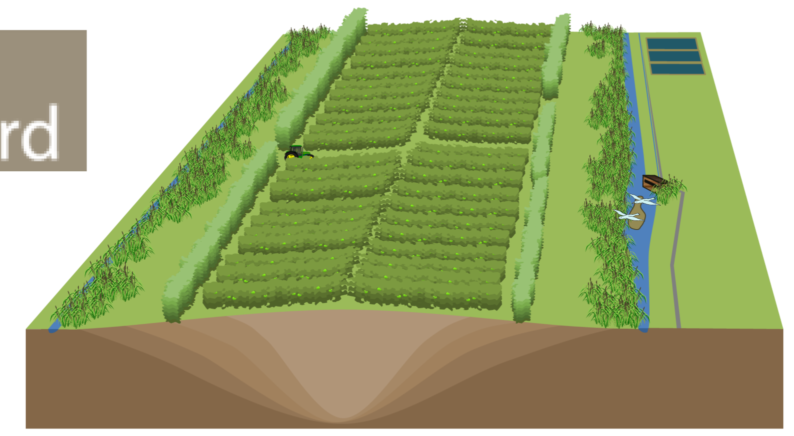


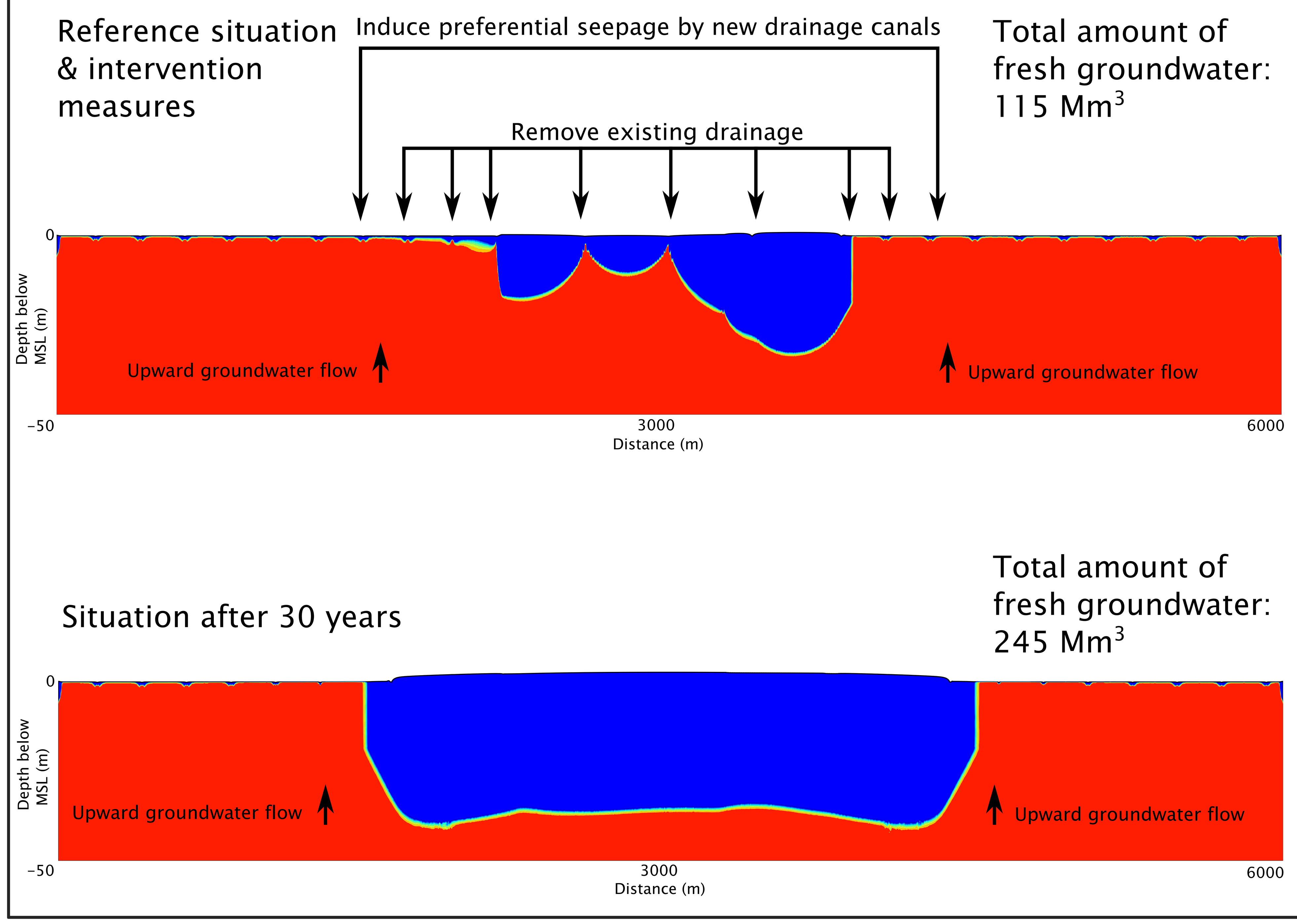
Problem statement and objective of the study

Freshwater lenses in sandy creek deposits constitute the most important source of irrigation water in the southwestern part of the Netherlands. From a freshwater supply point of view, the conventional drainage network (i.e., tile drains and ditches) is not the most optimal configuration. In an exploratory study, we investigated the hydrological, ecological and economical feasibility of a large scale intervention in the drainage network to optimize the freshwater supply.

Methodology

Using a representative cross-sectional model (Figure 1) with the MOCDENS3D code (Oude Essink, 1998), the hydrological feasibility of the intervention was investigated in a pilot area in the southwestern part of the Netherlands (Figure 2). Areas that become unsuitable (i.e., too wet) for agriculture were given an alternative function, such as a nature area or aquacultural land. The conventional situation and intervention scenario were economically evaluated in a cost-benefit analysis. A stakeholder workshop was organised to explore the potential for realisation. Finally, realisation strategy was formulated.

Results



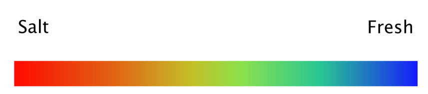
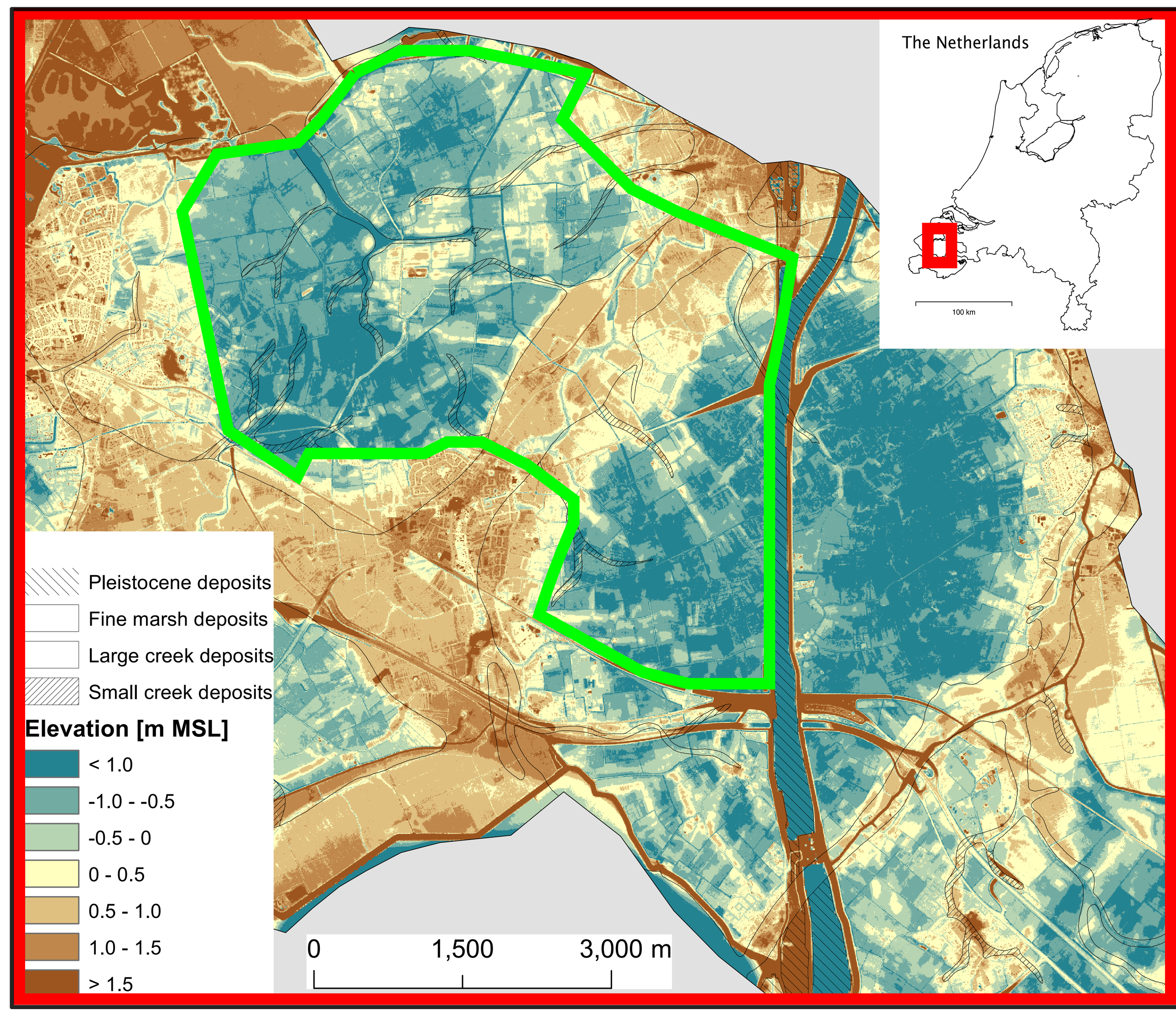


Figure 1: The hydrological feasibility of the new drainage network. The intervention comprises two large scale measures: 1) the removal of existing drainage in an area in order to increase groundwater levels and increase the freshwater lens here, and 2) the introduction of two large drainage canals that induce preferential seepage of the saline groundwater. In this way, the amount of fresh groundwater is approximately doubled in 30 years. In the higher elevated areas, the increase of the groundwater table does not lead to unsuitable (i.e., too wet) agricultural circumstances because the groundwater table is relatively deep (> 2 m below the surface) here. In certain lower elevated areas, groundwater levels become too high for conventional agriculture. Here, other land use such as aquaculture or nature conservation is projected (see Figures 2 and 3).



Land use

Current situation		New situation	
Wheat, potatoes	60%	Nature conservation areas and aquaculture	18%
Cauliflower, cabbage, broccoli, etc.	20%	Orchard (apples, pears)	82%
Orchard (apples, pears)	20%		

Figure 2: The pilot area (in green) in the southwestern part of the Netherlands is depicted in a combined map of the elevation and surface geology. The pilot area amounts ~1600 ha. For this area, the current and 'new' land use was determined (see table above). The orchard area was determined from the total extra available amount of fresh groundwater in the scenario with the new drainage network. This extra amount of water was calculated from the cross sectional model (Figure 1). Note that orchards have the largest rendabilty per unit area.

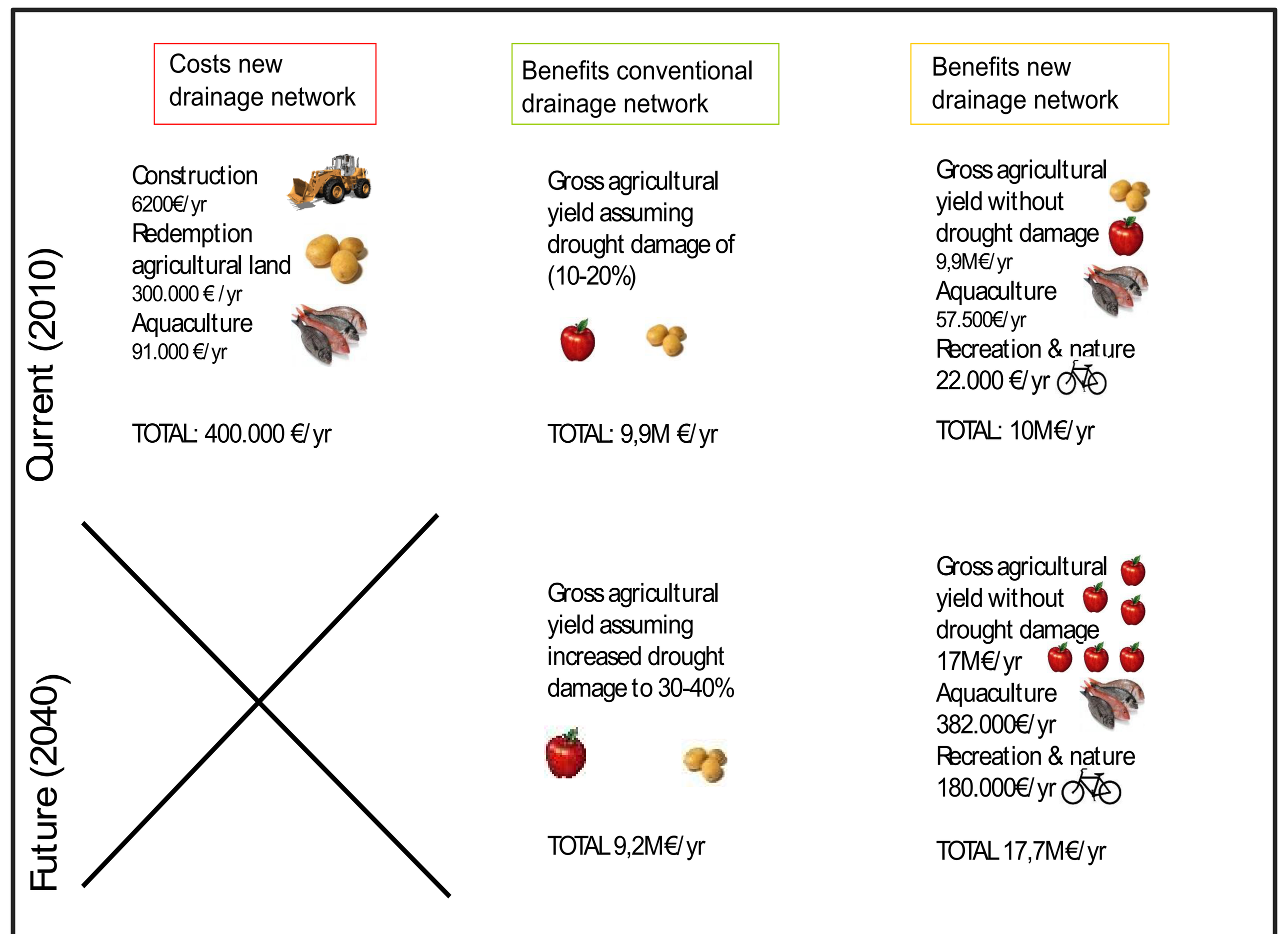


Figure 3: A cost-benefit analysis of the conventional and new drainage network, for both the current (upper boxes) situation and future (lower boxes) scenario. In the current situation, the nett benefits with the new drainage network are slightly lower compared to the conventional drainage network because of the investment costs. In de future scenario, the nett benefits with the new drainage network are significantly higher compared to the conventional network. On the one hand, this is caused by the difference in future yield losses due to droughts. A yield loss of 30-40% was assumed in the conventional drainage network, whereas there are no yield losses in the new drainage network (i.e., there is sufficient irrigation water). On the other hand, the rendability per unit area is higher for orchards then for wheat and potatoes.

Realisation strategy

1) Further investigate the hydrological and economical feasibility of the new drainage network.

2) For all stakeholders, formulate their demands and compose a statement of requirements.

3) For all stakeholders, formulate their willingness and compose declarations of intent.

4) Develop mandatory finance and realisation plans.

5) Realize the new drainage network.

Figure 4: Together with important stakeholders, the pilot area was chosen. Subsequently, a brief realization strategy was formulated.

References

Delta Water Award, ideas on a new level. http://www.deltawateraward.com/ **(in Dutch)**
Oude Essink, G.H.P., 1998, MOC3D adapted to simulate 3D density-dependent groundwater flow. Proc. MODFLOW'98 Conference, Golden, Colorado, USA: 291-303.