Vegetation competition model for water, oxygen and light limitation: II, groundwater influence and 1-dimensional competition

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Model Upscaling and Competition

In order to use a bio-physical based SPAC model while using it to run for time series of a thousand year, we needed an upscaling method that enables one to make long simulation runs on a daily time scale, taking account of the non-linearities between light, soil water, evaporation and carbon assimilation, resulting from diurnal variation of atmospheric variables (radiation, temperature and vapour pressure deficit. The use of a lookup table with the above listed variable as entries was chosen as best suited.

With this model we can simulate competition for light and water between species.

- Light competition is driven by tree height and LAI which depend on biomass. Taller trees shade smaller ones.
- Water competition is driven by root water uptake which depends on the capability to cope with water and oxygen stress and root mass.

Results: Multi Year Dynamics, Influence of Groundwater (Fig 4 and 5)

Figures 4 and 5 show the results of model simulations of 300 years with a fixed groundwater table. The top row shows the outcomes when the dry adapted vegetation starts with a larger biomass and the bottom row the outcomes when the wet adapted vegetation starts with a larger biomass.

Figure 4 is the result of a simulation run where capillary rise is not included, which is the most common way in which vegetation models are run. The downward flux depends on soil moisture content or corresponding matrix potential. The proximity of the groundwater table causes a decreased percolation flux and higher soil moisture content. Figure 5 shows the results of a run where capillary rise is included, causing higher moisture contents. This causes higher evapotranspiration, carbon assimilation and therefore higher productivity.

Results: Multi Year Dynamics, Groundwater Moisture Gradient (Fig 6)

1000 Year long simulation runs show that the distance to groundwater and soil texture have an important influence on both the soil moisture content and the vegetation (Fig 6, capillary rise included). The runs were performed with the same vegetation types but now with a yearly background mortality rate of 0.03, to account for diseases, forest fire, storm etc..

As a result zonation develops along the groundwater gradient, resulting in high vegetation densities for the wet adapted species where the groundwater table is shallow and moisture contents are high. The wet adapted species is unstressed. Where the groundwater level becomes deeper a zone develops where both species have a similar density and both species are almost unstressed, but where soil moisture conductivity as a slight effect. Finally a dry zone where the dry adapted species dominates, but where low soil moisture conductivity and matrix potential limit growth.

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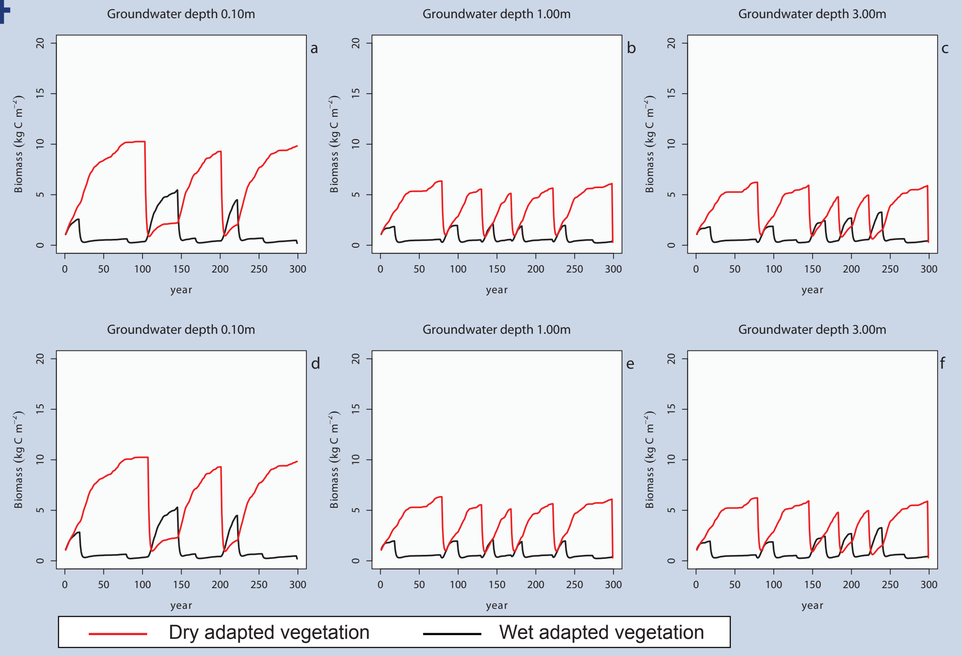

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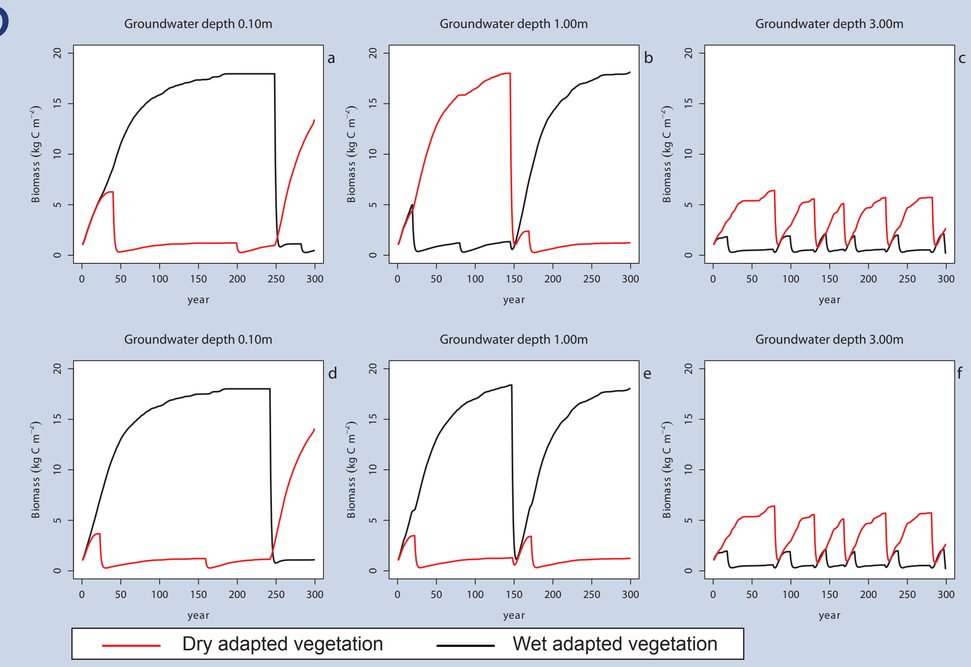

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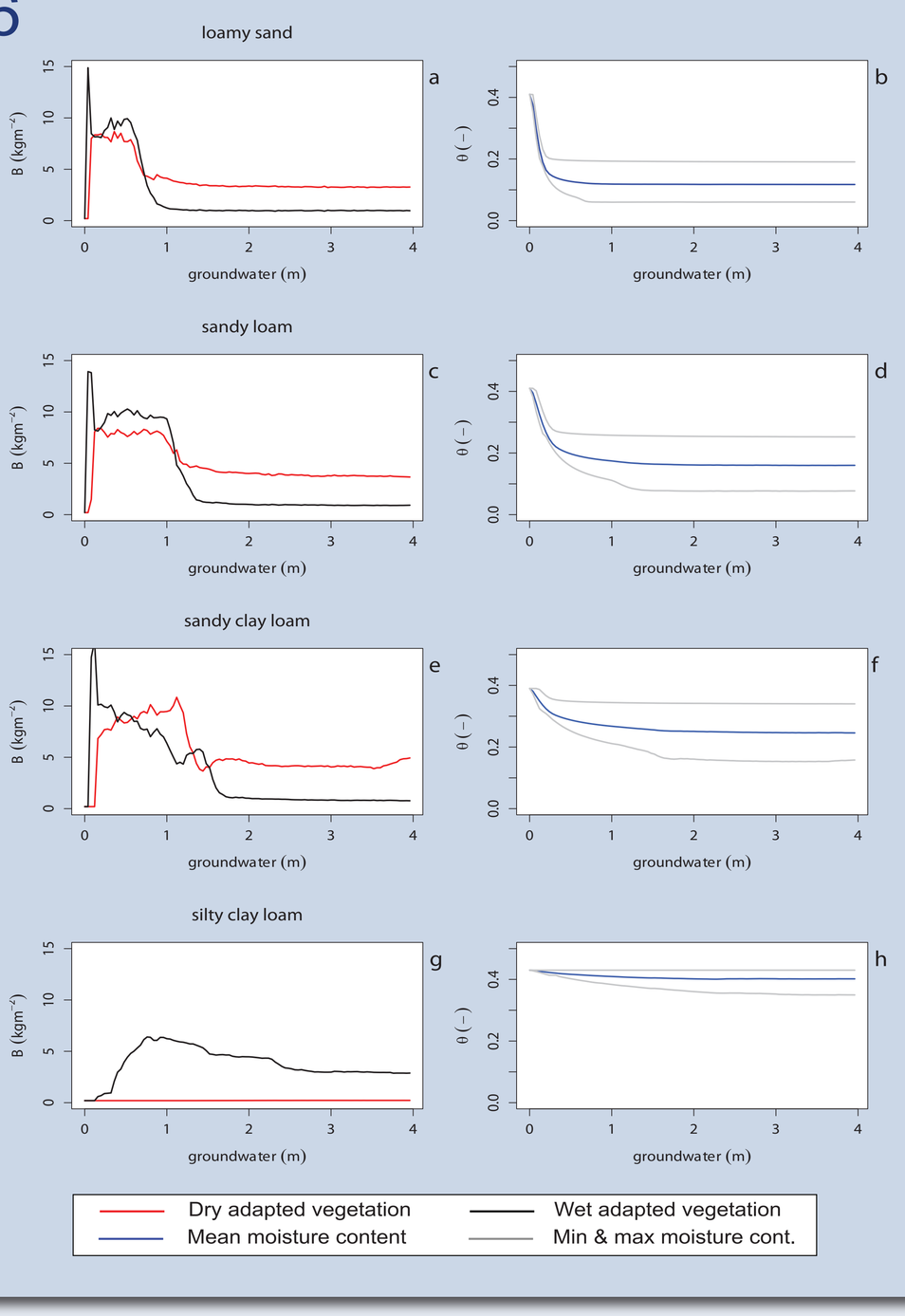

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