

Eco-hydrological effects of climate change in the coastal dunes of the Netherlands

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In the Netherlands, climate change is likely to cause dryer summers and winters that are wetter. We studied how these changes will affect: (1) the availability of soil moisture in the root zone of plants, (2) vegetation structure, (3) groundwater recharge and (4) groundwater dynamics (Witte et al., 2007).

The availability of soil moisture not only depends on climate conditions, especially precipitation and evapotranspiration, but also on site specific conditions such as soil texture, organic matter content, and inclination and exposition to the sun. The dryness of soils can be expressed in a factor called the 'soil moisture deficit', abbreviated SMD. SMD is the difference in yearly potential and actual evapotranspiration (Runhaar et al., 1997). Using the SWAP-model (Soil-Water-Atmosphere-Plant) (Van Dam et al., 2000), we computed SMD for several vegetation relevés. Subsequently, we found positive empirical relationships between SMD and: (1) the percentage of bare soil, (2) the percentage of non-rooting plant species (lichens and mosses). Since climate change will lead to a higher SMD, the fractions of bare soil, lichens and mosses are expected to increase. These changes depend on the exposition and inclination to the sun. For instance, in one of the climate scenarios the fraction of bare soil on south slopes decreased from the current 70% to 16% in 2050.

The evapotranspiration of bare soil and non-rooting species is much lower than that of vascular plants. Thus, the effect of climate change on actual evapotranspiration is tempered by a feedback on the vegetation (more bare soil and non-rooting species). The combined effect of more precipitation in winter and a tempered actual evapotranspiration is a slight increase in groundwater recharge, on a yearly basis. The dynamics in groundwater level fluctuations will increase.

We hypothesize that climate change leads to a patchier dune landscape of mainly three 'vegetation structures': bare soil, none rooting plants and deep rooting bushes and trees (that extract water from a large soil volume).