Forest in the Rhine-Main plain – risks and adaptation measures in forestry as a consequence of the projected climate change in Hesse

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More than any other region in Hesse, the forests in the Rhine-Main region are subject to damage und risks which jeopardise the sustainability of forest functions and, in some areas, call the sustainable development of the entire forest structure in question. Already the topical climatic conditions suggest that frequent occurrence of drought stress can be expected. This will lead to a reduction in vitality and a predisposition to pest infestation, particularly for sessile oak and European beech, and hence an increase in mortality. A substantial infestation of Scots pine by mistletoe has been found on trees that already have been damaged by drought, insect infestation and air pollution.

At three forest sites comprising European beech, sessile oak and Scots pine stands, the water regime was modelled retrospectively for the period 1961-1990 and up to 2050 under different climatic scenarios to identify periods of limited water availability in the past and to predict possible future changes in the hydrology. The effects of different tree species and different forest treatments also were investigated. Future climate change was estimated for the IPCC-SRES emission scenarios A1B and B1 using the global climate model ECHAM5 and the regional model WETTREG (both dry and moist variants).

The results indicate that occasional prolonged drought occurred in the past as evident from the limited rates of evaporation and groundwater renewal. Consequently, it is assumed that the susceptibility to pest insects increased markedly. Differences in the age structure of forest stands, in addition to tree-species related differences, were found to play an important role in the development of the water regime components over time.

Assuming that climate develops according to the scenarios A1B and B1 (both dry and moist variants) up to 2050, the range in water balances simulated is large due to the uncertainty inherent in projections of precipitation development. Models of the B1 and A1B moist variants in the decade 2041-2050 showed a definite reduction in drought length, and an increase in the rate of groundwater renewal at all sites. In contrast, the dry A1B scenario showed a clear reduction in plant soil water availability, and hence an increased risk of drought stress. Groundwater would not be replenished at any site.

The consideration of different silvicultural variants show that silvicultural operations often have a greater effect on site hydrology than the climatic changes expected up to 2050. Tree species and age-specific differences were found to be comparatively less important. Thus, for stands with adequate vigour, appropriate stand densities which reduce evapotranspiration but do not encourage the spread of grass cover by opening up the stand are recommended. Silvicultural measures that adopt species mixtures to distribute the risk should be implemented to counter the considerable uncertainty still associated with the estimated change in precipitation.