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Long-term modelling of nitrogen turnover and critical loads in a forested catchment using the INCA model

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Abstract. Many forest ecosystems in Central Europe have reached the status of N saturation due to chronically high N deposition. In consequence, the NO_3 leaching into ground- and surface waters is often substantial. Critical loads have been defined to abate the negative consequences of the NO_3 leaching such as soil acidification and nutrient losses. The steady state mass balance method is normally used to calculate critical loads for N deposition in forest ecosystems. However, the steady state mass balance approach is limited because it does not take into account hydrology and the time until the steady state is reached. The aim of this study was to test the suitability of another approach: the dynamic model INCA (Integrated Nitrogen Model for European Catchments). Long-term effects of changing N deposition and critical loads for N were simulated using INCA for the Lehstenbach spruce catchment (Fichtelgebirge, NE Bavaria, Germany) under different hydrological conditions.

Long-term scenarios of either increasing or decreasing N deposition indicated that, in this catchment, the response of nitrate concentrations in runoff to changing N deposition is buffered by a large groundwater reservoir. The critical load simulated by the INCA model with respect to a nitrate concentration of 0.4 mg N l^{-1} as threshold value in runoff was 9.7 kg N $ha^{-1}yr^{-1}$ compared to 10 kg $ha^{-1}yr^{-1}$ for the steady state model. Under conditions of lower precipitation (520 mm) the resulting critical load was 7.7 kg N $ha^{-1}yr^{-1}$, suggesting the necessity to account for different hydrological conditions when calculating critical loads. The INCA model seems to be suitable to calculate critical loads for N in forested catchments under varying hydrological conditions e.g. as a consequence of climate change.

Keywords: forest ecosystem, N saturation, critical load, modelling, long-term scenario, nitrate leaching, critical loads reduction, INCA

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