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Modelling sulphate stream concentrations in the Black Forest catchments Schluchsee and Villingen

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Abstract. The sulphate (SO_4) released by mineralisation and desorption from soil can play an important role in determining concentrations of SO_4 in streams. The MAGIC model was calibrated for two catchments in the Black Forest, Germany (Schluchsee and Villingen) and SO_4 concentrations in the streams for the years 2016 and 2030 were predicted. Special emphasis was placed on the dynamics of soil sulphur (S) pools. At Schluchsee, 90% of soil S is stored in the organic S (S_{org}) pool, whereas at Villingen, 54% is in the inorganic (S_{inorg}) pool. The Villingen stream chemistry was modelled successfully by measured Langmuir isotherm parameters (LIPs) for S_{inorg}. Schluchsee data could not be modelled satisfactorily using measured or freely adapted LIPs only, as the S_{inorg} pool would have to be more than five times larger than what was measured. With 60.5 $mmol_c$ SO_4 m^{-2} yr^{-1} as internal soil source by mineralisation and the measured LIPs, stream data was modelled successfully. The modelling shows that in these two catchments pre-industrial concentrations of SO_4 in runoff can be reached in the next two decades if S deposition decreases as intended under currently agreed national and international legislation. S_{org} is the most likely dominant source of SO_4 released at Schluchsee. Mineralization from the S_{org} pool must be included when modelling SO_4 concentrations in the stream. As the dynamics and the controlling factors of S release by mineralisation are not yet clear, this process remains a source of uncertainty for predictions of SO_4 concentrations in streams. Future research should concentrate on dynamics of S mineralisation in the field, such that mathematical descriptions of long-term S-mineralisation can be incorporated into biogeochemical models.

Keywords: sulphate release, organic S, mineralisation, acidification, recovery, modelling, MAGIC, catchments, predictions, Germany, forest

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