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Regional scale hydrological and biogeochemical processes controlling high biodiversity of a groundwater fed alkaline fen

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The high floral biodiversity of groundwater fed fens and mesotrophic grasslands depends on the different chemical signatures of the shallow rainwater fed topsoil water and the slightly deeper geochemically affected groundwater. The relatively abrupt gradients between these two layers of groundwater enable the close proximity of plants that require quite different site factors and have different rooting depths. However, sulphur inflow into such botanically interesting areas is generally perceived as a major threat to biodiversity. Although in Europe atmospheric deposition of sulphur has decreased considerably over the last decades, groundwater pollution by sulphate may still continue due to pyrite oxidation in soil as a result of excessive fertilisation. Inflowing groundwater rich in sulphate can change biogeochemical cycling in nutrient-poor wetland ecosystems because of ‘so called’ internal eutrophication as well as the accumulation of dissolved sulphide, which is phytotoxic. Complementary to conventions, we propose that upwelling sulphate rich groundwater may, in fact, promote the conservation of rare and threatened alkaline fens: excessive fertilisation and pyrite oxidation also produces acidity, which invokes calcite dissolution, and increased alkalinity and hardness of the inflowing groundwater. For a very species-rich wetland nature reserve, we show that sulphate is reduced and effectively precipitated as iron sulphides, when this calcareous and sulphate rich groundwater flows upward through the organic soil of the investigated nature reserve. Also, we show that sulphate reduction occurs simultaneously with an increase in alkalinity production, which in our case results in active calcite precipitation in the soil. In spite of the occurring sulphate reduction, we found no evidence for internal eutrophication. Extremely low phosphorous concentration in the pore water could be attributed to a high C:P ratio of soil organic matter and co-precipitation with calcite. Our study shows that seepage dependent alkaline fen ecosystems can be remarkably resilient to fertilisation and pyrite oxidation induced groundwater quality changes. The profound impact, of factors that were ignored in the literature, reveals that reducing environmental complexity may significantly constrain the value of predictions.