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European biodiesel production: current and future environmental impacts of rapeseed cultivation at pan-European scale

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The energy produced from the investment in biofuel crops needs to account for the environmental impacts on soil, water, climate change, and ecosystem services. A regionalized approach is needed to evaluate the environmental costs of large-scale biofuel production. It is pertinent to use detailed knowledge about the sustainable functioning of the soil-water-system for this evaluation. We present a regional pan-European simulation of rapeseed cultivation. Rapeseed is the European Union's dominant biofuel crop with a share of about 80% of the feedstock. The EU's biofuel directive (2003) set a target for biofuel use and recommended that 'an increase in the use of biofuels should be accompanied by a detailed analysis of the environmental, economic and social impact in order to decide whether it is advisable to increase the proportion of biofuels in relation to conventional fuels', it further advices for a biannual evaluation of the 'the sustainability of crops used for the production of biofuels, particularly land use, degree of intensity of cultivation, crop rotation and use of pesticides'. To improve the assessment of the environmental impact of biodiesel production, we performed a pan-European simulation of rapeseed cultivation at a 10 to 10 km scale with EPIC (Environmental Policy Integrated Climate (Williams, 1995). The model runs with a daily timestep and model input consists of meteorological measurements, and spatialized topographic, soil, landuse, and farm management practices data and information. Modeled rapeseed yields where satisfactory compared to yields at regional level (NUTS 2) obtained for the period from 1991 to 2003 for 27 European Union member

countries, along with consistent modeled and measured yield responses to precipitation, radiation and vapour pressure deficit at regional level. The model is currently set up so that plant nutrient stress is not occurring. This approach allows us to evaluate environmental pressures arising from rapeseed cultivation such as water and nutrient use efficiency, and nutrient leaching to the groundwater to further complete the environmental balance of biofuel production and consumption. In addition we analysed future nutrient and water needs and constraints under the IPCC climate change scenarios. This may lead to better-informed land use and policy decisions in relation to large-scale biofuel production across Europe.