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Impact-characterisation for a grey water footprint – a discussion of two new approaches

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Based on the water footprint concept of the Water Footprint Network (see e.g. Hoekstra et al., 2011), an increasing number of studies regarding virtual water or water footprints include so-called "grey water", i.e. an amount of dilution water needed to assimilate pollutions in freshwater. The inclusion of grey water into water footprints offers to aggregate freshwater consumption (blue water) and reduced water quality (grey water) at the inventory level by a common unit (litres or cubic metres of water). For "blue water", i.e. surface and groundwater which is consumed during production processes, Pfister et al. (2009) developed regional characterisation factors (a "water stress index", WSI), which include an impact weighting for a regional water consumption. Analogous, grey water may be characterised by a regionally varying "water quality stress" with two approaches: (A) as a function of regional concentrations of the substance that defines the grey water (e.g. nitrate) or (B) by precipitation, evapotranspiration water and groundwater recharge amounts.

We chose each two exemplary wheat production systems (PS; organic and conventional) in two different Austrian regions to represent the effect of the two proposed approaches. Assumptions concerning the four PS' wheat yields, precipitation, evapotranspiration, nitrogen application and regional groundwater concentrations were taken from literature and statistics (e.g. Statistics Austria, 2011; BMLFUW, 2006). Nitrate was identified to represent the most critical substance in Austrian water bodies (Austrian Environment Agency, 2007), defining the grey water demand. The rates for leached nitrate were derived from Kolbe (2002). Nitrate leaching was estimated for 12.92 and 28.50 kg NO_3-N ha-1 year-1 for the organic and the conventional systems, respectively. The characterisation factors for the two approaches are calculated by: (A) for a catchment area-based approach, a regional background concentration for the most relevant substance (e.g. nitrate) divided by its limit for a tolerable concentration in drinking water; (B) for a local approach, litres of water needed for the dilution purpose divided by available litres of dilution water. The unweighted grey water demand resulted on average in 455 litres of water per kg wheat. As a consequence of the varying input parameters and their (partial) inclusion in the characterisation factors, the two approaches resulted in varying impact-characterised grey water demands. These results ranged from 192 to 766 litres per kg wheat. As a consequence of lower specific influences, approach A results in less diverging results (from 200 to 488 litres) than approach B. Whereas approach B's impact factor is derived from the processes in the upper soil layer, approach A derives its factor from a concentration of the relevant substance in affected water bodies and is hence influenced by a more regional situation. Both approaches A and B are practicable for typical crops / rotations in regard to water pollution; for specific crops, we propose to use the less detailed and region-based approach A.