Integrating groundwater stress in life-cycle assessments – An evaluation of water abstraction

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Understanding groundwater abstraction effects is vital for holistic impact assessments in areas depending on groundwater resources. The objective of our study was to modify the state-of-the-art AWaRe (available water remaining), freshwater impact assessment specifically for use in LCAs in areas dependent on groundwater resources. The new method, called "AGWaRe" (available groundwater remaining), reflects groundwater availability, based on a fraction of available groundwater remaining locally relative to a reference. Furthermore, our method increases spatial resolution beyond 1770 km² grid cells and adjusts demarcations in order to improve the representation of the heterogeneity of groundwater catchments. The applicability of AGWaRe was demonstrated on three groundwater systems producing 5 million m³ water for the city of Copenhagen, namely Advanced Treatment of Groundwater, Simple Treatment of Groundwater and Infiltration of Reclaimed water. Results were normalised to compare with other effects of supplying water to an average Danish person. The normalised impacts for drinking water for one person ranged between 0.1 and 39 PE (person equivalent) for the three systems, which indicates that effects on groundwater resources differ substantially between systems. A comparative LCA of these groundwater systems shows that other impact categories range between 0 and 1 PE/person. Advanced Treatment of Groundwater generally has the lowest effect, for example <50% of the other groundwater systems in Global Warming Potential. The AGWaRe results indicate that freshwater impacts from Simple Treatment of Groundwater are up to 100 times greater than for Infiltration of Reclaimed water. Furthermore, AGWaRe exposes differences between the groundwater systems that AWaRe cannot evaluate, because one AWaRe cell covers two of the systems in question. These improvements are crucial for groundwater managers looking to include sustainability considerations in their analysis and decision-making.

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