Quantifying spatially derived carrying capacity occupation: Framework for characterisation modelling and application to terrestrial acidification - DTU Orbit (25/01/2019)

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The popularity of the ecological footprint method and the planetary boundaries concept shows an increasing interest among decision makers in comparing environmental impacts to carrying capacities of natural systems. Recently, carrying capacity-based normalisation references were developed for impact categories at midpoint level in LCA. These references are operational and their meaning can easily be communicated to practitioners and decision makers. Yet, they do not capture potentially important spatial variations in carrying capacities. To overcome this weakness, we propose to integrate carrying capacity in characterisation factors (CFs) as an alternative to using carrying capacity as reference information in normalisation references. We developed a generic mathematical expression for a spatially differentiated CF, which allows expressing impact scores as occupation of carrying capacity in units of km²·year. This metric resembles that of the ecological footprint method and may be compared to the availability of land or water. The framework was applied to the terrestrial acidification impact category. The geochemical steady-state model PROFILE was used to quantify carrying capacities as deposition levels corresponding to an acceptable change of natural pH, at a 2.0 x 2.5° resolution at the global scale. Carrying capacities were then combined with atmospheric fate factors of acidifying emissions to derive CFs. These were applied to an average emission inventory for the annual electricity consumption of a household in 100 random global locations. To evaluate the consequence of using the CFs in a comparative assessment, the 100 impact scores were ranked and compared to the corresponding ranking when using existing CFs based on marginal impacts above carrying capacity on the same inventory. The difference in ranking reflects the different natures of the two sets of CFs: The existing CFs are aligned with consequential thinking and concerned with marginal changes above carrying capacity, while our derived CFs are aligned with attributional thinking and concerned with the occupation of carrying capacity. This work shows the viability of spatially derived absolute sustainability assessment, i.e., assessments where impacts are compared to sustainable levels of impacts. This can become an important supplement to the predominant relative environmental assessments, where impacts of different product systems are compared. SETAC

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