The nitrogen footprint – environmentally relevant?

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Background and aims

The nitrogen (N) footprint has been proposed as a tool to highlight and quantify contributions to N-related damages to the environment and to human health [1, 2]. It may succeed in raising awareness of consumers and decision-makers, not least due to its seeming simplicity and its catchy name, familiar from siblings like the ecological, carbon, and water footprints.

However, the family of footprints has been called a "minefield" [3] since their definitions have been incoherent and inexact, leaving room for confusion and contradictions. Therefore, a task force of the UNEP-SETAC Life Cycle Initiative has proposed some common ground rules for footprints [4], for example a set of four criteria for footprints: (1) transparent documentation, (2) accurate terminology, (3) directional consistency, and (4) environmental relevance. Here, we consider how well the N footprint lives up to the latter two of these.

Method

The two criteria are defined as follows [3]. Environmental relevance is that the footprint units have "environmental equivalence", i.e., that each unit of footprint is considered equally harmful. Directional consistency is when "a smaller value is always preferable to a higher". The N footprint is defined [1] as "the total amount of Nr [reactive N, all other forms than N_2] released to the environment as a result of an entity's resource consumption". We evaluated how well the N footprint satisifes the two criteria by examining examples from agriculture.

The type and amount of damage an Nr molecule causes on its path through the N cascade depends on where, when, and in what chemical form it is released. For example, one product may be heavy in gaseous ammonia (NH_3) emissions, and another in leached nitrate (NO_3^-). Local conditions then determine how the Nr is transformed, deposited, taken up by plants, etc, and in turn how the environment is affected, for example, whether critical loads are exceeded. This illustrates that a given amount of Nr release may cause very different combinations of acidification, eutrophication, climate change, etc. Furthermore, the relative importance of these damages is not set in stone, but ultimately a question of values.

Results and conclusions

In summary, we suggest that the N footprint definition does not guarantee environmental relevance or directional consistency. Two products can have equal footprints but qualitatively different environmental effects. Which product to prefer then depends both on situation-specific details and the values held by the footprint user. We will present examples to illustrate these problems, and discuss possibilities to further develop the N footprint to address them.

References and acknowledgements

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