Is a Sustainability Assessment a Shot in the Dark? How to Deal with Its Nonquantified Uncertainty?

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A sustainability assessment is indeed a moonshot, as presented in a previous viewpoint in this journal about five years ago.1 However, is it then also a shot in the dark? Sustainability assessment aims at predicting future impacts through integrated modeling of the Earth and all its cause-effect chains, this in practice for different scenarios (e.g., a world with or without a product to assess its sustainability impact).1 To the best of our knowledge, fortune telling and related professions still exist, thus predicting the future is a precarious business. This is no different story for sustainability assessment, begging the question how to deal with this uncertainty?

A straightforward solution is to quantify this uncertainty and consider it part of the assessment.1 This has been considerably elaborated in the literature, including in Environmental Science & Technology. An example is the estimation of uncertainty ranges of carbon footprints of products and the subsequent characterization of statistical differences between those spreads, pinpointing which one has a significantly lower carbon footprint. Yet, whereas some scholars vouch for always considering quantitative uncertainty evaluation, others point out its incompleteness.2 This viewpoint will focus on discussing this often overlooked incompleteness, that is, the nonquantified uncertainty, and how to deal with it. First, we present three concrete types of nonquantified uncertainty, which strongly relate with but are not limited to the field of sustainability assessment (other typologies exist but are here not explicitly considered). Second, we propose strategies how to deal with them. See Table 1.

Concerning impractical uncertainty, not for all parameters, uncertainty data can be feasibly collected or processed, especially at the scale of global cause-effect chains (e.g., the influence of driving a car on fair wages in Asia). Moreover, there are many methodological choices and assumptions, which need to be made and assumptions because of practical limitations (e.g., consider a linear increase in toxicity effect while this will be nonlinear), for which all combinations cannot be feasibly quantified. Finally, quantifying uncertainty for more qualitative levels of measurement (e.g., uncertainty values for impact on human well-being), is quite challenging.

Regarding unknown uncertainty, a lack of knowledge of the system is definitely the case for sustainability assessment as we deal with the complete Earth and its future. Scientists are still discovering new things, which in turn also increases our knowledge about things we do not know.

When it comes to accuracy uncertainty, for models of small-scale systems, confined in time a space, we can easily check and compare its outcome with a measured value. For example, compare the outcome of a river flow model with a measured water level. In the case of models of larger scale systems, as it is the case in sustainability assessment, which entails the prediction of the future on a global scale, accuracy is difficult to even grasp. First, a complete worldwide measurement of the effect is needed, which seems impractical. Second, the future is unprecedented, and measurements can only be done afterward. Third, we would in fact need to keep everything else constant to single out a specific effect from other matters, that is, distinguish background signal (e.g., increase in global temperature because of natural emissions) from that induced by the effect (e.g., increase in global temperature because of a certain factory), but we have only one Earth to empirically study.

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Table 1. Three Types of Non-Quantified Uncertainty Are Described and Explained

<table>
<thead>
<tr>
<th>Type of Uncertainty</th>
<th>Description</th>
<th>Methods to Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impractical uncertainty</td>
<td>Not quantified because of practical limitations (e.g., no data or time)</td>
<td>Plausibly decreased through aggregating knowledge of individuals</td>
</tr>
<tr>
<td>Unknown uncertainty</td>
<td>Because of lack of knowledge of the system (e.g., not knowing what the effect of a new toxic compound is on animals)</td>
<td>Plausibly decreased through aggregating knowledge of individuals</td>
</tr>
<tr>
<td>Accuracy uncertainty</td>
<td>Because of a lack in validation possibility. The entire sustainability assessment cannot be compared with empirical results (e.g., the effect of a product on the world cannot be traced because we cannot measure the change in global impact of a world with and without the product)</td>
<td>Plausibly decreased</td>
</tr>
</tbody>
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Three strategies are explained to tackle the different types; however, these strategies only have a plausible decreasing effect and will not completely outrule these types of uncertainty in practice.
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Notes
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