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Making a meal out of uncertainty

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The European Food Safety Authority (EFSA)'s prepared a guidance document on uncertainty, and the lead article by Lofstedt and Bouder considers the implications the document raises for how scientists communicate the limiting factors in their scientific discoveries and insights to regulatory bodies and the public. The aim of this commentary is to echo and perhaps even amplify the sentiments of the lead article, which in essence recommends a cautionary approach to two issues: rolling out uncertainty analysis procedures across other European agencies, and making scientific uncertainties transparent for public consumption.

Keywords: uncertainty; science; transparency

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To work through the issues that will be discussed here let's imagine we are scientists. The European Food Safety Authority (EFSA) document lists six main steps for a given issue a scientist might face that requires an urgent policy response: (1) identifying uncertainties; (2) describing uncertainties; (3) assessing individual sources of uncertainty; (4) assessing the overall impact of all identified uncertainties on the assessment output, taking account of dependencies; (5) assessing the relative contribution of individual uncertainties to overall uncertainty; (6) documenting and reporting the uncertainty analysis (EFSA 2015, 20). We will return to this analytic process shortly, but suffice it to say, this negative approach is the antithesis of the usual process of scientific endeavor.

To understand the process of uncertainty analysis recommended by the EFSA, we need to also know what the conceptualization of uncertainty is. The EFSA propose an ambitious conceptualization of uncertainty, and one not quite along the lines of what might be deemed traditional by a scientific audience (Meder, Le Lec, and Osman 2013; Osman 2010):

> Uncertainty is defined as referring to all types of limitations in the knowledge available to assessors at the time an assessment is conducted and within the time and resources available for the assessment. (EFSA 2015, 3)

On this basis, one might question the practicality of carrying out the six recommended steps, based on the aforementioned conception of uncertainty. So, to consider the issues further, let's take a case in point which is discussed in the EFSA (2015) guidance document.

In 2008 the European Commission requested urgent scientific advice on the risks to human health as a result of ingestion of melamine in composite food produce, that

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in theory could have been imported from China; severe health effects had been reported in Chinese children consuming powdered milk and other milk products with melamine. Put simply the EFSA were asked to assess the possible (worst case) exposure of the European consumer from the consumption of food products containing melamine. The deadline for making the recommendation was five days from the request being made. Inevitably there were limits as to what factors were included in the scientific assessment that contributed to the EFSA's published statement in 2008.

Summarizing here, the limiting factors that were identified when preparing the report include: (1) absence of data on actual levels of melamine in powdered milk, (2) data on consumption of Chinese chocolate were not available – which contains whole milk solids, (3) no establishment of the toxicity of melamine, (4) no establishment of tolerable daily intake (TDI). Nevertheless, practical solutions were found to these limiting factors, and for some, the impact was limited on answering the main question posed. Critically, these limiting factors do not entirely correspond to the conceptualization of uncertainty the EFSA has proposed, though the EFSA (2015) use them as an illustration of the different types of uncertainty that it identifies.

Now imagine trying to implement the six steps recommended by the EFSA's uncertainty analysis to the problem of answering the question posed in this case. While trying to use a research methodology to provide evidence to answer a precise question, at the same time we would also have to report on what we don't know and describe it, as well as assessing how what it is we don't know overall will affect the outcome of our findings, and how different individual aspects of what we don't know is also likely to affect the outcome of our findings.

Not only does this process seem absurdly difficult to achieve, the rather heavy duty prescriptive uncertainty analysis seems like an unnecessary roundabout way of scrutinizing the robustness of the results generated from scientific research. Moreover, the level of analysis of uncertainty isn't nuanced. The level of analysis should be determined by the specificity of the question being answered scientifically. The broader the question, the greater the level of scrutiny required, since answering precise questions necessitates qualifying the data needed to answer them. So, what does the uncertainty analysis hope to achieve?

The analysis is designed with an end user in mind which is the decision-maker (e.g. risk manager, policy-maker) who is supposed to do something practical with the analysis.

> Thus, in general, assessors are responsible for characterising uncertainty and decision-makers are responsible for resolving the impact of uncertainty on decisions. Resolving the impact on decisions means deciding whether and in what way decision-making should be altered to take account of the uncertainty. (EFSA 2015, 14)

To assist us as the scientist, the EFSA (2015) suggests that the decision-maker specify in advance how much uncertainty is acceptable for a particular question. Again, seemingly another conceptually difficult endeavor. How does one attach an acceptable level of uncertainty regarding the findings from a research project addressing a request to assess the possible (worst case) exposure of the European consumer from the consumption of food products containing melamine? More to the point what is the acceptable level of uncertainty being attached to? The findings? The conclusion drawn from the findings? The recommendation based on the findings?

What could the uncertainty analysis hope to achieve? At the moment the scientific community is particularly alert to issues regarding the robustness and reliability of

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scientific claims, theories, findings and experimental paradigms (Gelman and Loken 2014). The idea that evidence that has practical consequences at different time scales should carry some sort of a kitemark[1] is actually part and parcel of an exercise the scientific community is engaging in to increase rigor across the board. So what would be the added value of introducing a complex and convoluted uncertainty analysis like the one suggested by the EFSA? Transparency seems to be the motivation. But one can reach levels of transparency in data that can approach obscurity, and one can conduct analyses of uncertainty that negate any answer generated.

If the real issue is trying to communicate to decision-makers and the public the extent that one can rely on the evidence generated in a response mode to a particular regulatory issue, then why not work with what is out there, rather than reinvent the wheel? There are ways of consolidating the conception of uncertainty around scientific findings, either on the basis on the most sound statistical procedures that the scientific community itself uses, through methods such as Monte Carlo simulations, or simple tools that diagrammatically convey complex information regarding uncertainty.[2] In sum, the EFSA's (2015, 2016) recommendations on uncertainty analysis don't provide a definitive answer yet.

What the EFSA's (2015, 2016) guidance documents on uncertainty have done, along with the lead article that it has inspired, is provide the impetus for scientists and decision-makers to clarify their needs. The needs broadly center on the confidence that the data generators have in the answers they produce, and the confidence that the decision-makers have in the data that inform their decisions, as well as the level of confidence in the decisions they make. So, the issue isn't really transparency, the issue is actually the different communities communicating more clearly to each other what they need, and to achieve this, what is required is to

> …firstly, focus on best practices of uncertainty analysis and secondly, examine what should be done on this topic within the European policy arena. (Lofstedt and Bouder forthcoming)

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Notes

1. The Kitemark is a UK product and service quality certification mark which is owned and operated by The British Standards Institution (BSI Group).
2. Fan chart is a tool for presenting probability distributions for a given outcome over multiple time intervals, in which the probability distributions reflect the changes in uncertainty around the particular outcome over time.

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