Economic Valuation of Environmental Amenities Negatively Affected by Chemical Exposure

Key Insights and Challenges from Environmental Economists and Ecotoxicologists

Summary report from the joint ECHA/FRAM Workshop:

"Valuing environmental bads: a dialogue between ecotoxicologists and environmental economists on the valuation of environmental impacts of chemicals", **Helsinki 28th May 2019**

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1. Introduction

The aim of this report is to summarize the key insights and challenges in economic valuation of environmental amenities negatively affected by chemical exposure that resulted from the workshop "Valuing environmental bads: A dialogue between ecotoxicologists and environmental economists on the valuation of environmental impacts of chemicals" which was held on 28 May 2019 in Helsinki. The workshop was organized by ECHA and FRAM[1] as a side-event to the 2019 SETAC Europe meeting[2] and aimed at bringing together environmental economists and ecotoxicologists to discuss questions like:

i) What type of data on environmental impacts can ecotoxicologists provide that can be useful in economic valuation?

ii) How can complex information on environmental impacts be presented to households in Stated Preference (SP) surveys?

iii) How can we distinguish between use and non-use values of ecosystems?

iv) How does one account for the fact that certain chemicals are stigmatized so that there is a potential disconnect between the scientific (objective) and perceived (subjective) risk?

This summary report is based on inputs from the presentations that were given at the workshop (see Appendix 1-3), and discussions in groups and in plenary afterwards. The reminder of the report is organized as follows. Section 2 outlines an economic valuation framework for valuing environmental impacts of chemicals; Section 3 summarizes insights and challenges in stated preference valuation studies of environmental impacts from chemicals emerging at the workshop; and Section 4 concludes with several recommendations for new SP studies, which will be relevant e.g. for the OECD's environmental valuation initiative for chemicals. A background document to the issues discussed in the workshop is given in Appendix 1. The actual program of the workshop is reproduced in Appendix 2, while Appendix 3 provides a short overview of the presentations at the workshop.

[1] The workshop was arranged by Christoph Rheinberger of the European Chemicals Agency (ECHA) and Daniel Slunge of the FRAM Centre for Future Chemical Risk Assessment (www.FRAM.gu.se), University of Gothenburg.
[2] http://helsinki.setac.org/

2. Environmental Valuation Framework

Ideally, the Impact Pathway Approach (IPA), or Damage Function Approach (DFA) as referred to by economists, can be used to track emissions from the production and use of a chemical (or a product containing the chemical) through dispersion in different media (air, water, soils), the bioavailability of the chemicals to different plants and animals combined with dose-response function/ concentration-effect functions to detrimental effects at the molecular, organelle, cell, individual, population, community, and finally the ecosystem level. In order to understand these effects, input from ecotoxicologists is crucial.

For the purpose of impact assessment, any ecosystem impacts have to be ”translated” into impacts on the different types of ecosystem services (ES) in terms of the provisioning, regulating and cultural ES. The cultural ES includes impacts on both recreational use values and so-called non-use values.[3] Impacts on provisioning services to a large extent can be valued using market prices of e.g. commercial fisheries and agricultural produce, and regulating services can be valued using replacement costs approaches (i.e. what is the costs of providing a perfect (often hypothetical) substitute for the lost or reduced ES; e.g. manual pollination to replace the pollination services of insects). However, impacts on cultural ES will be in terms of use and non-use values of environmental goods, and need other environmental valuation methods.

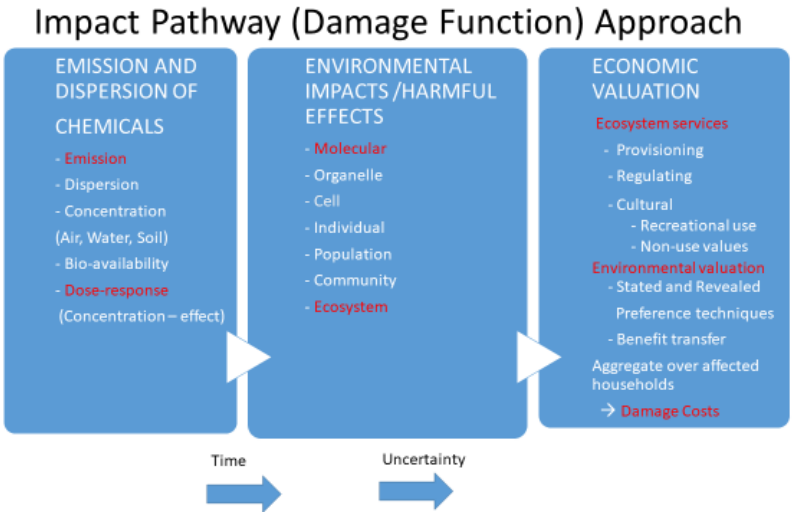

Figure 1. Impact Pathway/ Damage Function Approach applied to chemicals

[3] The latter include option values, existence values, bequest values and other altruistic values that people might have. E.g. many people are willing to contribute to the preservation of rain forests in South America, Africa or Asia even if they have no intention to visit these places.

Economists have developed two major methods that can be used to value marginal changes in ES. Revealed Preference (RP) techniques use observations on market choices to measure people's preferences. The primary advantage of RP is its reliance on actual choices, which avoids the potential problems associated with hypothetical responses such as strategic behavior or failure to properly consider behavioral constraints. However, this strength is also the primary weakness of RP as analyses are largely limited to observable states of the world. Therefore, RP are not suited to gauge preferences for attributes which either do not (yet) exist or where no variation exists. As RP studies are based on people's actual choices, it can then be concluded that they primarily reflect use values.

In contrast, stated preference (SP) approaches to nonmarket valuation rely on answers to carefully worded survey questions. Answers to those questions—in terms of monetary amounts, choices, ratings, or other indications of preference—may then be scaled following an appropriate model of preference to obtain an estimate of aggregate value. As they rely on hypothetical choices, SP studies are more flexible and hence enable the analyst to cover *both* use and non-use values of environmental impacts. Two methods are most commonly applied in SP studies. The first, direct, method uses the so-called contingent valuation approach which essentially inquires about a respondent's willingness-to-pay for a specified change in an environmental good or service; the second, indirect, approach infers such values from discrete choices among two or more options that may vary across multiple attributes.

Table 1 provides an overview of the Revealed Preference (RP) and Stated Preference (SP) methods.

Table 1. Environmental Valuation Methods

	Indirect	**Direct**
Revealed Preferences (RP)	Household Production Function (HPF) Approach: - Travel Cost (TC) - Averting Costs (AC) Hedonic Price (HP) analysis	Simulated markets Market prices Replacement Costs (RC)
Stated Preferences (SP)	Choice Experiments (CE)	Contingent Valuation (CV)

As there are very few RP and SP studies directly valuing impacts on environmental amenities and ecosystem services from exposure to hazardous chemicals, new SP studies are needed for valuation of identified impact scenarios. Meanwhile, benefit transfer techniques (i.e. Unit value, Function value, Meta analyses and Delphi techniques; see Navrud and Ready (2007) and Navrud and Strand (2018)) could be used to explore the possibilities of transferring results from existing RP and SP studies of similar type environmental impacts (from databases like the Environmental Valuation Reference Inventory www.evri.ca) as those expected from the chemical under regulatory scrutiny. Thus, SP surveys of environmental impacts from e.g. marine oil spills and contaminated soils /marine sediments (see Navrud et al. (2017) and Barton et al. (2010), respectively) could be considered. However, most of these studies consider changes in the *stocks* of chemicals, and not the *flows* of chemicals, which would be the correct measure in CBAs of regulating chemicals.

3. Insights and challenges for environmental valuation studies of chemicals

The main challenge of applying the IPA/DFA is that we often lack dose-response/ concentration-effect functions for many chemicals, and therefore resort to expert assessments of "carrying over" knowledge about effects from chemicals with similar type characteristics, e.g. in terms of persistence. Although persistence could increase the probability of environmental impacts, as argued by Cousins et al. (2019), the type and magnitude of impacts as well as their time of occurrence after exposure (which would be very important in a valuation context) could vary widely. Further, often ecotoxicologists have only studied effects at the molecular, organelle and/or cell level; and if effects on the individual organism level have been established they have often used model organisms like daphnia and zebra fish, which then need to be transferred to the exposed organisms in question. If there are reproductive effects at the individual organism level, effects at the population level of the organisms might be established, but it might still be difficult to predict effects at the ecosystem level, which would be needed to establish impacts at the ecosystem service level.

Although expert assessments at all steps of the IPA/DFA can be made, the uncertainty in all steps will add up to an overall uncertainty pertaining to the environmental impacts that will be subjected to economic valuation. An important question in SP surveys then is whether one asks people to value avoiding one or several environmental impact scenarios that occur with 100% certainty (and address the uncertainty afterwards in e.g. in the cost-benefit analysis

(CBA) (see e.g. Navrud et al. on valuing environmental impacts from accidental marine oil spills from ships); or whether one describes the uncertainty in the valuation scenario either as genuine uncertainty or as probabilities of different outcomes. The former is the most common approach, as we know people have difficulties in understanding probabilities. Even when outcomes are very clearly defined, as in SP studies of mortality risks to establish the so-called value per statistical life (VSL), meta analyses of SP surveys show a consistent lack of scope sensitivity, meaning that people tend to value small risk reductions similar to large risk reductions, thereby indicating that they have a hard time understanding small probabilities (see e.g. Lindhjem et al. 2011 for a discussion).

Concerning uncertainty in the environmental impacts of chemicals, there are two main ways of addressing this in SP studies:

1) Present the environmental impacts as *certain* in SP surveys, and get people to value avoiding the specified impacts. Then address scientific uncertainties afterwards in the Cost-Benefit analysis (CBA) by calculating expected benefits (i.e. impact x probability of occurrence) of regulating the chemical in CBA. This requires that people accept that the described impact scenarios can occur with certainty if no action is taken. Different impact scenarios could be described and valued, and then probabilities are assigned afterwards. This approach also assumes that the outcomes and their objective probabilities (or ranges thereof) can be established by ecotoxicologists and ecologists.
2) Present the expected impacts as *uncertain* to the respondents in SP surveys (without specifying probabilities and different outcomes), and use the results directly in CBAs of regulations, using people's subjective probabilities of possible outcomes/impacts. Alternatively, different outcomes/impacts with assigned probabilities could be presented, and people asked to value these, which then again could be used directly in a CBA.

From the discussions at the workshop, other insights and key challenges in designing and conducting SP studies of environmental impacts of chemicals transpired. These include:

i) The ability to translate risk assessments of chemicals into environmental endpoints for valuation in new SP surveys and in benefit transfer exercises. Ecotoxicologists typically look for No Observed Effect Level (NOEL), while economists are interested in the impacts at different concentrations to find the welfare optimal concentration and

resulting impacts; which would typically be higher than no effect since marginal costs of reducing emissions and concentrations increase while marginal benefits (in terms of reduced environmental damage costs) decrease as concentrations are reduced.

ii) The ability of translating impacts at the individual organism level (or even lower level) to impacts at the ecosystem level (if any). Ecotoxicologists mainly address impacts at the organism or lower levels; therefore ecologists/ ecosystem experts are needed to bridge the gap between what ecotoxicologists can provide and what the economists would need to come up with environmental impact scenarios that respondents in SP surveys could perceive and be able to value (and also as basis for benefit transfer of specific ecosystem impacts that there could be relevant valuation estimates for).

iii) The question on how to address the uncertainty about the environmental impacts (resulting from all steps of the IPA/DFA) in the economic analysis. This includes whether to present uncertainty about environmental impacts in SP surveys or address the uncertainty separately. If uncertainty is presented in SP surveys, should it be presented as probabilities of different outcomes or genuine uncertainty; and how should it be presented in Choice Experiments or Contingent Valuation surveys. Both the survey mode and mode of communicating the environmental impact scenario are important (in addition to adhering to the recent general guidance in SP surveys; see Johnston et al. 2017). In terms of survey mode, valuation workshops have been successfully applied to present complex information and uncertainty (Aanesen et al. 2015). In internet panel surveys applying CE, videos have been found to work well (Sandorf et al. 2016); also in terms of communicating uncertain environmental and health impacts from chemicals in CEs (Mourato 2019). Although videos have also been found to work well in communicating environmental impact scenarios in in-person CV surveys (Navrud 1997), it could be an even more powerful tool now in the "You Tube"-age to grab people's attention (Mourato 2019).

iv) As some chemicals (e.g. the class of endocrine disruptors) are stigmatized, mentioning them in SP surveys might lead to distorted values, as we want people to value avoiding the environmental impacts the chemicals cause rather than some perception that may be driven by fears and worries.

v) Chemicals could have both immediate and long-term effects. Should both be presented, and how best to present effects that occur in the long run. Including the

time perspective in the environmental impact scenario in SP surveys adds complexity, but have been tried in the context of chemicals, e.g. in a CV survey of cleaning up contaminated marine sediments (Barton et al. 2005).

vi) Environmental impacts are often described in both habitat and biodiversity quantity, whereas chemicals often leads to marginal changes in *quality*.

vii) Persistence, irreversibility and toxicity are important aspects of many chemicals that can affect people's preferences, although it may not make sense to value theses aspects directly. How can these aspects best be represented in the environmental impact scenarios in SP surveys, to give a correct picture of the environmental impacts?

viii) Addressing the combination effects of chemical mixtures (also known as "cocktail effects"). Moving from benefit assessment of regulation one chemical to address a larger group of chemicals, one need to take account of possible interactions between these chemicals in all stages of the DFA/IPA used. Both the impacts and people's valuation of these impacts might not be independent, and this need to be accounted for when constructing SP surveys and when aggregating benefits over different chemicals in benefit transfer exercises for use in CBAs of regulatory frameworks affecting many chemicals.

ix) While we are waiting for new SP studies addressing the environmental impacts of specific chemicals or groups of chemicals (and designed for benefit transfer in the context of regulating chemicals), we need to identify primary valuation studies for benefit transfer of each identified environmental impacts. There are a number of challenges in theses benefit transfer exercises:

- The frequent need for international benefit transfer in a situation with a limited number of primary studies internationally (and the need to account for international differences in cultural and institutional contexts, in addition to the uncertainty in national, spatial value transfer.
- Addressing the "scaling" issue. When there are few primary studies, it is difficult to find primary studies valuing the same level of impact, and there is a need to scale the result from the primary study up or down. This increase the uncertainty as the often implicit assumption of constant marginal values do not hold; because individual values change with the size of impact, and the size of impact could

influence the size of the affected population; especially with regards to non-use values of affected environmental amenities. This will then affect the aggregate value and thus the aggregate social benefit of regulating the hazardous chemical.

- Temporal transfer errors, both in terms of transferring values over time from existing primary studies, but also when predicting future values in CBAs with a time horizon of many decades.

4. Conclusions and suggested further work

Stated Preference (SP) methods are useful means to capture both the use and non-use values of environmental impacts of chemicals thus obtaining welfare relevant values beyond classical clean-up cost estimates. New SP studies should be constructed with benefit transfer and generalization in mind; adapting the Impact Pathway/Damage Function approach as an interdisciplinary model for linking emissions to dose/exposure for environmental amenities/ ecosystem services, then on to dose-response function and expert assessments of impacts, and finally economic assessment of the impacts using environmental valuation and benefit transfer methods. Ecologists/ecosystem experts should be involved to better link the predictions of the ecotoxicologists with the needs of the economists by establishing the environmental impact scenarios at the ecosystem level, and help ecotoxicologists to extrapolate impacts beyond the Predicted No Effect Concentration (PNEC) level, which they usually operate at.

Ways to convert impacts on model organisms like daphnia and zebrafish to population levels of those species should be explored. When chemicals affect reproduction, the link is more obvious than if there are more subtle impacts. Most environmental impacts seem, however, to be subtle and diffuse; and are often combined effects of many chemicals. This makes it difficult to single out the impacts of each chemical for a population of a single species, and further on to the ecosystem level. Transfer of impact scenarios to other species or interactions between species, ecosystems and ecosystem services, which are the starting point for valuation, also need to be explored further to design more representative environmental impact scenarios.

Survey responses are often context dependent. One particularly relevant context is the representation of risk and uncertainty. Various communication aids are available to help respondents in understanding risk and uncertainty. Split sample surveys conveying environmental impacts with and without video with animations on how chemicals affects ecosystems should be conducted in order to better document the effects and potential advantages of video in SP surveys to communicate information on environmental impacts from chemicals.

In her presentation at the workshop, Mourato (2019) suggested other avenues of research, including using choice experiments to find the insurance value people attach to avoiding toxicity of a chemical. Information on toxicity could be provided at the organism level based on studies by the ecotoxicologists, but has the disadvantage that the valuation estimates would not be linked to specific environmental/ecosystem/ecosystem service impacts. Mourato (2019) also suggest conducting both Stated and Revealed Preference studies of consumer products with different chemicals properties (e.g. pesticide-free food and toothpaste with no microplastics) in lab experiments, and comparing the results to people's actual behavior in terms of real purchases at supermarkets. Other suggestions includes exploring further how behavioral economics can be applied to chemicals by investigate how information nudges on chemicals in products (including environmental impacts) affect people's behavior, and how measures of subjective wellbeing can be used for environmental valuation (Mourato 2019).

Since we cannot perform a new SP study for each chemical considered for regulation, and since there is limited knowledge about their environmental impacts, we should look into the possibility of doing SP studies for *classes* of chemicals with the same type impacts to test the transferability of valuation estimates between chemicals. Environmental impacts could be very site-specific and chemical specific. Laypeople seem to be particularly worried about persistence (as do scientists). Communication of persistence is important, but valuing "persistence" per se, e.g. in a choice experiment, is difficult as the term is open for interpretation and needs to be well explained to respondents in order to produce values that would be applicable in CBAs. There is also a question on how far to the left in the IPA/DFA in figure 1 we would like to go to use as a starting point for valuation in SP surveys. As we move further to the left, people's cognitive load increases.

For CBAs of chemicals regulation, it would be good to have environmental costs on a per-ton of emission level for each chemical. However, these estimates (from dividing damage costs by emissions after having gone through the complete IPA/DFA) often depends on site-specific, pathway-specific and chemical-specific conditions (including vulnerability of site, and toxicity and persistence of chemicals), making simple unit values difficult to transfer between CBA cases. Thus, new SP studies probably need to specifically address selected chemicals and their environmental impacts. Meanwhile, when there is not sufficient time or money to do such a SP study, we can perform break-even analysis in terms of dividing the total (present value) of the costs of regulating by the size of the affected population (i.e. the "extent of the market" in terms of the number of households that experience a welfare loss) and compare the resulting estimate per household with previous valuation studies of the same type impact. Thus, this would not be a detailed benefit transfer exercise, but a CBA at the order-of-magnitude level, while we are awaiting more information about the environmental impacts of the chemicals and tailored SP studies.

As a follow-up action, a workshop similar to this one could build on the issues and challenges identified and seek to address what we already know about them, how they can or cannot be addressed, where gaps in understanding or data exist, and how we might take the next steps toward a better practice in valuing chemicals impacts on the environment. This then could lead to an overview paper for publication and/or a larger report on the topic.

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Appendix 1: Joint ECHA/FRAM issues paper

BACKGROUND

In June 2018, a pre-conference workshop to the World Congress of Environmental and Resource economists gathered a small group of regulatory and academic economists and ecotoxicologists to discuss current issues related to valuing the impacts of chemicals on human health and the environment.[4]

Monetary estimates of environmental effects of chemical pollution are scant and rarely figure in regulatory decision-making on chemicals. Valuing environmental damages caused by chemicals is a thorny task. In contrast to health impacts from chemicals, environmental impacts have mainly public good characteristics. Typically, there is no market in which market demand and supply would reflect such damages. Therefore, oil spills and other emissions of harmful chemicals into the environment have been evaluated by stated preferences (SP).[5] However, communicating the actual environmental damages has often proven to be complex and the description of the scenarios to be valued has emerged as the centerpiece of any SP study on environmental amenities (Johnston et al. 2017).

This holds particularly true for less known and/or hard-to-observe harms associated with certain chemicals of concern, in particular substances that are persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB), as well as those causing endocrine disruption.6 For example, a valuation study commissioned by the U.K. Health and Safety Executive to support the recent REACH restriction of two cyclic siloxanes7 has demonstrated that it is very difficult to describe what effects these substances have on the environment.

The workshop participants identified a poor understanding between those designing valuation surveys (economists and other social scientists) and those studying the detrimental effects of substances on various ecological endpoints (ecotoxicologists and other natural scientists) as one key challenge for improving the valuation of detrimental effects of chemicals of concern on the environment.

PROPOSED WORKSHOP

In response to the identified challenge, ECHA and the FRAM Centre for Future chemical Risk Assessment and Management strategies of the University of Gothenburg decided to organise a follow-up event in which a group of experts from both disciplines would discuss how this challenge could be overcome.

As environmental economists and ecotoxicologists are two completely separated scientific communities, and in order to maximize efficiencies, a half-day workshop in the afternoon of May 28 is planned during the 2019 SETAC Europe Annual Meeting which will be held from 26–30 May in

[4] A summary report of the workshop can be found here: https://fram.gu.se/digitalAssets/1705/1705202_wcere_pre-conference_ws_chemicals-report.pdf

[5] It should be noted that many of these studies were conducted because the U.S. court system requires monetary estimates as an input for determining punitive damages. Whereas the studies have produced some numbers, the reliability of those numbers may at times be questionable.

[6] PBT/vPvB substances can give rise to specific concerns that may arise due to their potential to accumulate in parts of the environment and that the effects of such accumulation are unpredictable in the long-term; such accumulation is in practice difficult to reverse as cessation of emission will not necessarily result in a reduction of environmental concentrations.

[7] The EU has banned the use of Cyclotetrasiloxane (D4) and Cyclopentasiloxane (D5) in rinse-off cosmetic products, with contents of 0.1% or more of either substance, because these substances are either PBT (D4), or vPvB (D5).

Helsinki. The workshop will be organized on the conference premises as a satellite meeting, accompanying the actual SETAC meeting.

OBJECTIVES AND TOPICS OF THE WORKSHOP

The workshop aims to initialize a broader discourse between the two disciplines, and will help to advance the field of environmental valuation in general and its application to harmful effects of chemicals on the environment in particular.[8] The workshop will also help ecotoxicologists better understand the types of information that researchers from other disciplines and decision-makers find useful.

Topics of interest are manifold and relate in particular to the description of the expected environmental impacts, the relevant endpoints and the mechanisms through which such impacts could be altered. In their *Contemporary Guidance for Stated Preference Studies*, Johnston et al. (2017:327) recommend:

> " *SP questionnaires should clearly present the baseline (or status quo) condition(s), the mechanism of change, and the change(s) to be valued and should elicit evidence that these pieces of information are understood, accepted, and viewed as credible by respondents. Both objective information and subjective (respondent) perceptions of this information should be considered. Temporal, spatial, uncertainty, and risk dimensions, and whether the baseline and change(s) are individual or household specific, should be identified*."

This recommendation lends itself for identifying various discussion points, including the following questions:

- What actually are the environmental impacts we are talking about? What data can ecotoxicologists produce that can be useful in economic valuation?
- How can environmental impacts be described to survey respondents (typically laypeople) without fear-mongering or downplaying possible environmental impacts? How to deal with uncertain and heterogeneous damages?
- How can one distinguish between use and non-use values of ecosystems that are negatively impacted by chemicals?
- How does one account for the fact that certain chemicals are stigmatized so that there is a potential disconnect between scientific (objective) and perceived (subjective) risk?

Obviously, there are many more questions to be explored and a thorough workshop preparation will be key to facilitate a constructive discussion.

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[8] An ad-hoc inquiry among a group of renowned valuation experts resulted in an overwhelmingly positive feedback on the idea of having the proposed workshop.

Appendix 2: Workshop program and list of participant

Valuing environmental bads:

A dialogue between ecotoxicologists and environmental economists on the valuation of environmental impacts of chemicals

Side-event to the 2019 SETAC Europe meeting
14:00–18:00, Tuesday 28th May 2019
Room 216, Messukeskus Expo and Convention Centre
Messuaukio 1, 00520 Helsinki, Finland

Purpose:

The workshop aims to initialize a dialogue between ecotoxicologists and environmental economists on issues that arise in the valuation of harmful but often 'less obvious' environmental impacts of chemicals.

Draft agenda (as of April-16-2019):

Item	Indicative timings
Arrival	*13:30 - 14:00*
1. Introduction / welcome / objectives *Daniel Slunge*	14:00 - 14:10
2. What type of information is needed in regulatory decision-making? *Christoph Rheinberger*	14:10 - 14:20
3. Presentation on state-of-play and key problems in studies valuing environmental impacts of chemicals (incl. time for Q&As) *Ståle Navrud*	14:20 - 14:50
4. Presentation on what type of data on environmental impacts can be generated by ecotoxicologists (incl. time for Q&As) *Bethanie Carney Almroth*	14:50 - 15:10
5. 1st discussion slot, possible points to touch upon: • Spectrum of certainty for substances and effects	15:10 – 16:00

• What data can ecotoxicologists produce that can be useful in economic valuation? • Intermediate vs final welfare outcomes • How can valuation studies be made most useful for regulatory decision-making processes?	
Coffee break	*16:00 - 16:20*
6. Brief report of practical experiences from valuation studies on D4/D5 and decaBDE (incl. time for Q&As) *Susana Mourato*	16:20 – 16:40
7. 2nd discussion slot, possible points to touch upon: • Description of impacts to laypeople • Uncertainties about causal relationships • Risk attitudes and feelings • Stigmatization of certain chemicals	16:40 - 17:45
8. Summary, next steps and close *Matti Vainio*	17:45 - 18:00
Close	*18:00*

Participants

Name	Affiliation	Background
Amie Svard	EC DG Grow	Econ
Bethanie Carnie Almroth	FRAM, University of Gothenburg	Ecotox
Chris Collins	University of Reading	Ecotox
Christina Rudén	Stockholm University	Ecotox
Christoph Rheinberger	ECHA	Econ
Daniel Slunge	FRAM, University of Gothenburg	Econ
Evgenia Stoyanova	ECHA	Econ
Iida Lehtimäki	ECHA	Ecotox
Jette Bredahl Jacobson	University of Copenhagen	Econ
Johanna Peltola-Thies	ECHA	Ecotox
John Sumpter	Brunel University	Ecotox
Kalle Kivela	ECHA	Econ
Lorraine Maltby	University of Sheffield	Ecotox
Marie-Ange Baucher	OECD	Ecotox
Martin Scheringer	ETH Zürich	Ecotox
Matti Vainio	ECHA	Econ
Oliver Warwick	PFA Ltd.	Ecotox
Peter Simpson	ECHA	Ecotox
Silke Gabbert	Wageningen University & Research	Econ
Ståle Navrud	Norwegian University of Life Sciences	Econ
Susana Mourato	London School of Economics & Political Science	Econ
Thomas Backhaus	FRAM, University of Gothenburg	Ecotox

Appendix 3: Overview of presentations held at the workshop

Monetary estimates of environmental effects of chemical pollution are scant and rarely figure in regulatory decision-making on chemicals. To discuss how environmental impacts of chemicals can be valued and used in decision-making FRAM and ECHA invited ten ecotoxicologists and ten environmental economists to a workshop in connection to the SETAC conference on May 28th.

Key issues

- *A collaboration between environmental economists and ecotoxicologists can generate more robust and salient data for regulatory decision-making than what each discipline can produce separately.*
- *While ecotoxicologists focus on estimating "no effect levels" economists value damages. These and other conceptual differences are important to understand in order to create bridges between the two disciplines.*
- *The surveys used by economists for environmental valuation can benefit from further input from ecotoxicologists.*
- *More work needed to move from valuing the effects of one single chemical to pollution from chemical mixtures more broadly.*
- *Developing a joint multi country survey could be one of several possible next steps.*

Christoph Rheinberger (ECHA), kicked off the workshop by outlining key challenges faced in valuing environmental impacts in recent REACH restriction proposals (e.g. on D4/D5 in wash-off products and microplastics). In most cases there are no clear emission-damage relationships with which specific substances could be causally linked to specific endpoints. Read across from better known substances is often used. While data gaps make a full quantitative risk assessment and economic valuation difficult, a qualitative risk characterization is often possible. Rheinberger saw opportunities for risk assessors and economists to collaborate for a more robust impact assessment.

Ståle Navrud, professor of environmental economics at the Norwegian University of Life Sciences, presented an overview of studies valuing environmental impacts of chemicals. Challenges include how to convert expert judgement in Risk Assessments (RA) and Environmental Impact Assessments (EIA) for use in scenarios for stated preference surveys of households; and how to scale up from local studies to a regional and global level.

Bethanie Carney Almroth, associate professor in ecotoxicology and zoophysiology at the University of Gothenburg, presented on the type of data on environmental impacts that can be generated by ecotoxicologists. She noted that it is often difficult to scale up assessments of effects on individual species (or molecules) to broader ecosystem effects.

Susana Mourato, professor of environmental economics at the London School of Economics and Political Science, presented lessons learned from a valuation survey on reduction in D4, D5 and Deca-BDE. A key challenge is how to convey complex information and uncertain causal pathways in a short survey? Respondents typically browse through questionnaire quickly and only recall a small proportion of what they read. The same situation occurs in real markets: consumers make decisions on small expenses with little information. One possibility may be to convey information via short videos. This possibility should be explored further.