Hazardous Substances Advisory Committee

(HSAC)

Fifth Annual Report

2016

Contents

Foreword by the Chairman Professor Stephen T Holgate CBE

I am honoured, and a little sad, to present my fifth, and final, annual report as Chairman of HSAC. My association with the committee and its predecessor, the Advisory Committee on Hazardous Substances started in 2008 and I was delighted to be re-appointed to the post, twice, in 2011 and 2014.

I arrived at a time when the committee was leaving behind its previous work on assessing individual chemicals with the implementation of REACH. I will leave this summer with the prospect of potential new directions for the committee as the UK prepares to leave the EU. Whatever the future holds I am sure the committee will continue to play its sentinel role in supporting Government, and providing complementary and independent scientific advice to protect the health of the public and the environment.

2016 started on a high note for us with the visit, in March, of Defra Minister Rory Stewart and the Defra Chief Scientific Adviser Professor Ian Boyd. At the same meeting we had a presentation from HSAC member Andrew Johnson on why we should be concerned about chemicals in the environment. The exchanges we had at this meeting will stand the committee in good stead as it prepares to make its contribution to thinking on the forthcoming Defra Green Paper on a 25 Year Environment Plan.

I am pleased too that we were able to delve deeper into the challenge of issues associated with mixtures and combination effects of chemicals. We need to, and will, do more in this important area.

It was particularly helpful that we were able to hold a workshop in September – and make time and space to think strategically about the future and to shape some future work for the committee. Two new areas of work have started to be developed as a result – on chemical monitoring of UK surface waters and on public awareness and understanding of chemicals in the environment.

Throughout the year we have worked closely with NERC to make the case for a new research programme on chemicals in the environment, culminating in a workshop in February 2017.This is an exciting opportunity to reinvigorate and galvanise the research community towards embracing new ways of capturing the impacts of chemicals on the environment and the possible downstream effects on humans.

We started the year with the re-appointment of four members for a second term: Chris Collins, Michael Depledge, Gary Hutchison and Peter Matthiessen. Mid-way through the year Michelle Baddeley, Richard Murphy and Susan Owens were also re-appointed for a second term. We ended the year with saying goodbye to Lesley Stanley at the end of a remarkable third term.

As always I would like to thank all the members of the committee, the Defra Secretariat, government officials, and all those who have attended our meetings, shared our discussions, given presentations and taken an interest in our work. Without all of them there would be no committee.

We look forward to the future in a changing world in which the effects of increasing numbers of chemicals have the capacity to harm the environment which we attach much value to.

Chapter 1 – Background

1.1 Establishment of HSAC

The HSAC came into existence as an expert scientific committee of Defra on the same day that its predecessor, the Advisory Committee on Hazardous Substances, was abolished, on 22 July 2012, with the coming into force of the Advisory Committee on Hazardous Substances (Abolition) Order 2012 (Statutory Instrument No 2012/1923).

1.2 HSAC Terms of Reference

The new Terms of Reference which Ministers conferred on the HSAC in May 2012, ahead of its establishment, are as follows:

To advise officials, UK Ministers, including Ministers in the Devolved Administrations, and other relevant bodies, on request or otherwise:

- on matters of relevance at a domestic, European and global level, relating to the protection of the environment, and human health via the environment, from potentially hazardous substances and articles, including nanomaterials; including on future issues of concern, on impacts and on wider strategic linkages;

- on the assessment of risks associated with potentially hazardous substances and articles, including nanomaterials;

- on research needs and other evidence gaps relating to potentially hazardous substances and articles, including nanomaterials; including analysing, interpreting, and assessing the quality and relevance of, evidence.

To advise officials and UK Ministers, including Ministers in the Devolved Administrations, on request or otherwise, on policy development and evaluation, including the impact of different policy options; the assessment of new regulations and deregulation, and the development of voluntary initiatives, best practice advice and formal guidance, which are relevant to its remit.

1.3 HSAC Supporting Protocols

In addition to its Terms of Reference, the HSAC has two supporting protocols to capture its relationship with the Defra Chief Scientific Adviser, and with Defra Ministers.

(i) Protocol on relationship between the Defra Chief Scientific Adviser and the Hazardous Substances Advisory Committee:

To report to, and engage with, the Defra Chief Scientific Adviser and through them, the Defra Science Advisory Council;

To support the Defra Chief Scientific Adviser, as necessary, during emergencies;

To operate in line with the Government's Principles for Scientific Advice and the Code of Practice for Scientific Advisory Committees.

(ii) Protocol on relationship between the lead Defra Minister and the Hazardous Substances Advisory Committee:

The lead Defra Minister for this committee will:

- Set Terms of Reference for the committee;
- Agree strategic work plans, receive reports and advice; and
- Receive periodic reviews of the committee's functions and value for money;
- Consult the Devolved Administrations and other Departments as appropriate, about the committee and its work.

1.4 Members of HSAC in 2016 and summary of their expertise

Member appointment date	**Summary of expertise**
Professor Michelle Baddeley June 2013 and 2016	Behavioural economics drawing on insights from psychology, sociology, neuroscience, anthropology, evolutionary biology and computer science.
Professor Chris Collins January 2013 and 2016	Environmental chemist. Fate and behaviour of pollutants in the environment, particularly soils, and the assessment of risks to human health and ecosystems.
Professor Michael Depledge January 2013 and 2016	Effects of chemicals and radiations on biota and humans, endocrine disruptors, nanomaterials and marine pollution issues.
Professor Tamara Galloway July 2014	Human and environmental health effects of legacy and emerging pollutants, including nanomaterials, plastics and endocrine disrupting chemicals.
Professor Stephen Holgate July 2008, 2011 and 2014	Clinical Professor with a special interest in asthma and allergies and causal factors such as air quality and toxic substances. Medical effects of air pollutants; Nanomaterials; Translational Medicine.
Dr Gary Hutchison January 2013 and 2016	Assessing impact of nanomaterials and endocrine disrupting chemicals on both human and environmental systems. Specialist interest in nanotoxicology, particulate air pollution and reproductive toxicology.
Professor Andrew Johnson July 2014	Environmental chemistry, chemical risk assessment, environmental fate and risks of

	chemicals including pesticides, nanomaterials and endocrine disrupting chemicals.
Dr Peter Matthiessen January 2013 and 2016	Aquatic ecotoxicology, environmental research and monitoring programmes, with a focus on endocrine disrupting chemicals. Chemical risk assessment and regulation. Ecotoxicology test methods development.
Professor Richard Murphy June 2013 and 2016	Life Cycle Assessment (LCA). Environmental and microbiological effects of wood preservatives. Use of LCA approaches to support suitability assessments.
Professor Susan Owens June 2013 and 2016	Environmental governance, particularly relations among science, expertise and policy.
Dr Lesley Stanley January 2007, 2011 and 2014	Registered Toxicologist with expertise in xenobiotic absorption, distribution, metabolism, excretion and human health effects of chemicals. Experienced in risk assessment, particularly with respect to substances found in food.
Professor John Sumpter July 2014	Aquatic ecotoxicology of a range of chemical classes including pharmaceuticals, mixtures toxicity, the effect of physical stressors on the responses of fish to chemicals.

More information on HSAC members' background and expertise is available on the HSAC website:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277647/HSAC_members_expertise.pdf

1.5 Re-appointment of three members in June 2016

Professor Michelle Baddeley, Professor Richard Murphy and Professor Susan Owens were re-appointed as HSAC members for a second, and final, three-year term from 1 June 2016.

1.6 Farewell to Dr Lesley Stanley at the end of 2016

The committee said farewell to long-standing member Lesley Stanley at the end of December, as her third term of office on ACHS/HSAC came to an end. It is a singular achievement to have given ten years of public service to the worthy cause of applying independent scientific expertise for the protection of the environment and human health.

Chapter 2 HSAC in 2016

2.1 Summary of HSAC 2016 meetings
2.2 14th HSAC meeting - 15 March 2016

2.3 15th HSAC meeting - 14 June 2016
2.4 HSAC Workshop - 27 September 2016
2.5 16th HSAC meeting - 13 December 2016

2.1 Summary of HSAC 2016 meetings

The HSAC held three regular quarterly meetings in 2016 - on 15 March, 14 June, and 13 December (its 14th, 15th, and 16th meetings). Attendance averaged about twenty-five people, and included Defra policy officials, other Departments and external interests. These meetings were open to the public and a number of organisations sent representatives, including the Royal Society of Chemistry, the Laboratory of the Government Chemist and the Chemical Industries Association.

The minutes, papers and presentations for all these meetings were published on the dedicated website for this committee – see https://www.gov.uk/government/groups/hazardous-substances-advisory-committee

The Committee also held a special workshop in September, in lieu of its regular autumn quarterly, to develop future work areas. Details of this event are reported in section 2.5 below, and at **Annex I**.

Some key highlights were:

- Attendance by Minister Rory Stewart and Defra Chief Scientific Adviser Professor Ian Boyd (March)

- Presentation by Professor Andrew Johnson on "Why be concerned about chemicals in the environment?" (March)

- Presentation by Professor Len Levy on the 2008 Interdepartmental Group on Health Risks of Chemicals report on mixtures (March)

- Presentations from Mick Hamer (Syngenta (on behalf of CIA)) and from David Santillo (Greenpeace) on mixtures/combination effects of chemicals and the follow-up discussions about the challenges of addressing the issues associated with mixtures/combination effects of chemicals (June)

- Discussions about nanomaterials read across with reference to ECHA's paper "*Usage of (eco)toxicological data for bridging data gaps between and grouping of nanoforms of the same substance*" (June)

- Our workshop which enabled us to do some strategic thinking on the future of chemicals regulation in the UK, to share views with other experts and to shape a work programme for the committee (September)

- The discussion papers from HSAC members for our workshop: Andrew Johnson on environmental long term studies, Gary Hutchison on

chemicals legislation and Mike Depledge on the future chemical environment (September)

- Discussions on the Defra/Environment Agency strategic approach to managing chemical risk in surface waters (December)

- Agreement on two new specific work strands as a follow-up to our September workshop: (i) Design for an integrated (intelligent) monitoring network for UK surface waters and the best use of that information and (ii) how to raise public awareness and understanding of, and engagement with, the issues linked to chemicals in the environment (December)

- Presentation by Susan Owens on "Chemicals legislation for water protection", a historical perspective on the evolution of water protection legislation in the UK (December)

A high level summary of each of the three quarterly meetings is provided below; more detail is available from the minutes and the papers for the meetings on the HSAC website, or from the Secretariat at chemicals.strategy@defra.gsi.gov.uk.

2.2 14th HSAC meeting – 15 March 2016

Defra Minister Rory Stewart and CSA Ian Boyd attended this meeting. The Minister received a presentation from Professor Andrew Johnson on "Why be concerned about chemicals in the environment".

The presentation covered the impact of chemicals on the environment; the magnitude of the challenge; the evidence of contamination and adverse effects in wildlife, particularly fish; various costs, including the value of the chemicals and pharmaceutical industries, the cost of regulation, and in particular the cost of water treatment to remove contaminants and protect the aquatic environment from discharges. Several chemicals-related challenges for policy makers and scientists were noted. These included endocrine disrupting chemicals, nanoparticles, increased antibiotic resistance in natural environments, and combination or mixture effects of chemicals. The presentation ended with a message about the challenge of society using and benefitting from chemicals without compromising the health of the natural environment and human health, and key to this was tackling exposure to down the drain chemicals.

Following the presentation the Minister sought the views of the committee on what they felt Government should be doing something about. The key observations made were as follows:

- A warning against weakening controls on chemicals because the costs of dealing with problems afterwards were huge.

- The need to determine if chemical mixtures adversely affected the environment and if so how to rank the risks of mixtures.

- A vision from Government on the kind of chemicals future that it wanted, against a background of a 2000-fold increase in chemicals use over the last 25 years, and only 3,500 out of 80,000 chemicals having undergone toxicity testing.

- More monitoring, including long-term, of ecosystems because the environment was good at telling us when things went wrong with chemicals.

- More systems thinking to accommodate trade-offs and consequential effects.

- The timely development of test guidelines to inform regulatory decisions to keep up with the usage of chemicals driven by the market and by innovation.

- Full life cycle approaches – e.g. the environmental footprint of plastic bags where thinking about the impacts of disposal could encourage thinking about simple but effective solutions.

Other items on the agenda included:

- Updates from Diane Benford (Food Standards Agency) and Britta Gadeberg (Public Health England) on recent activities of the Committees on Carcinogenicity, Mutagenicity and Toxicity

- An update from Peter Matthiessen on the recent SETAC Pellston Workshop on hazard/risk assessment of potential endocrine active substances. The aim of the workshop was to provide objective advice, based on the current level of scientific understanding, to enable regulators/policy makers to make considered, informed decisions on whether to select a hazard or a risk-based approach for a given substance.

- A presentation by Professor Len levy on the Interdepartmental Group on Health Risks of Chemicals (IGHRC) chemical mixtures report which was produced in 2008 as at that time there was no guidance on how to carry out risk assessment of chemical mixtures. HSAC was also briefed on the World Health Organisation International Programme on Chemical Safety Framework (published in 2011) work on chemical mixtures.

- Key Research Questions in Ecotoxicology and consideration of the next steps, in particular engagement with NERC. The key development from the HSAC paper on “key research questions in ecotoxicology” (for publication see link below) was a meeting due to take place between NERC and a HSAC team on 17th May 2016.

- Oral feedback on the 63rd meeting of the UK Chemicals Stakeholder Forum, held on 26th January 2016, was provided by the UKCSF Secretary Patrice Mongelard.

- The draft HSAC Annual Report for 2015 was signed off.

2.3 15th HSAC meeting – 14 June 2016

The main item on the agenda was combination effects of chemicals. The HSAC Chairman Stephen Holgate wanted the committee to develop its own views on this issue. In order to do this the committee needed to engage actively with others who had done work on this issue, hence the presentations at this meeting from Mick Hamer (Syngenta (on behalf of CIA) and from David Santillo (Greenpeace).

The following points were raised in discussion:

- There was not much toxicological data available on mixtures and there could be unexpected pathways of exposure. Consideration of modes of action could help prioritise substances of greater concern. Systems biology and computational modelling could also help. Epidemiology data could provide information on body burdens of chemical mixtures are their association with different diseases. Different socio-economic groups had different body burdens.

- Industry too could help by placing simpler formulations on the market. The scale of the problem was huge due to the large number of chemicals involved. Complex mixtures of nanomaterials were being designed which could have repercussions. Furthermore there was the added complication that not much seemed to be done to prevent chemicals from entering waste streams, although some sectors like textiles and electronics were taking steps to address waste streams.

- It was accepted that wildlife populations were exposed to complex mixtures and this information needed to be collected through monitoring and assessed. There was a lot of data available from the aquatic environment. As well as aquatic environments other environments such as industrial sites (e.g. oil refineries) needed to be considered.

- Historical data could give us information, e.g. looking at the effects of removing chemicals from the environment. The assumption was being made that only anthropogenic chemicals were problematic. Naturally produced chemicals, e.g. combustion products could also play a part.

- The interaction of chemicals with genes could be considered as well as the influence of other stressors such a pH and temperature. As far as possible there should be an element of future-proofing,

specifically to factor in anticipated changes over the next ten to fifteen years.

- Although this issue had been around a long time (circa 15 years) progress was disappointing, e.g. only papers on binary mixtures were still being published. There was a need to identify the mixtures that were of greatest concern. HSAC did not want to reproduce what others had done, so a re-framing of the issues was required. HSAC might want to consider eco-epidemiology studies and the assessment factors used in these studies.

Members agreed that this was a topic that HSAC should address but offer a new (multi-disciplinary) perspective (rather than get involved with, or replicate much of the detail) whilst looking at the chemicals of most concern. Stephen Holgate asked members to reflect further on the most useful way in which HSAC could enter this subject. The committee noted the suggestion from Steve Dungey that it could have the greatest impact by looking specifically at the assessment factors used in standard approaches.

Other items on the agenda included:

- Professor Andrew Johnson gave a presentation on a 3-year project, funded by Defra, to identify which of the many anthropogenic chemicals that contaminate the natural environment were likely to be causing the greatest harm. The 73 chemicals studied included metals, pharmaceuticals, persistent organic pollutants, pesticides, biocides, surfactants, plasticisers and nanoparticles. The chemicals identified were those that were prominent in the literature and considered by the scientific community to be a potential concern to freshwater ecosystems. The methodology was unique in this study as it was done by comparing median effect concentrations with UK median measured/predicted river concentrations.

- Stephen Holgate reported briefly on the positive meeting which HSAC members had had with Duncan Wingham, on 17 May, about the committee's call for a new NERC funding vehicle to address the key research questions in ecotoxicology. The fundamental research theme was "What are the consequences to individuals and populations of both humans and wildlife, of their lifetime exposure to the highly complex, ill-defined mixture of anthropogenic chemicals characteristic of today's society?"

- There were two papers discussed on Nanomaterials. The first paper by the HSAC nano subgroup was on Lifecycle analysis and value chain analysis for nanomaterials. This was agreed for publication and will be made available on the HSAC website. The second paper was on Nanomaterials read across, in particular on ECHA's paper "*Usage of (eco)toxicological data for bridging data gaps between and grouping of nanoforms of the same substance*". HSAC acknowledged that ECHA were trying to set a direction for nanomaterials read across but their

paper proposed concepts which were not achievable at present, given the state of present knowledge about nanomaterials. For example, the absence of reference materials was a real issue.

- Updates were received from Catherine Mulholland (Food Standards Agency) and Ovnair Sepai (Public Health England) on recent activities of the Committees on Carcinogenicity, Mutagenicity and Toxicity.

- At the March meeting committee members agreed that the proposed workshop on 27th September 2016 would focus on some of the key issues and challenges which members had identified for Minister Stewart. A paper was presented which set out the Secretariat's initial proposals for the workshop. It was agreed that the workshop would focus on the themes of Environmental Monitoring, Chemicals regulation and a UK vision for a chemicals future.

- Feedback on the 64th UKCSF meeting held on 26 April 2016 was provided by the UKCSF Secretary Patrice Mongelard.

- The Chairman and Patrice Mongelard both reported briefly on the on-going review of Defra's Expert Committees. A number of options were being considered: i) keep the status quo, ii) have a smallish evidence college in parallel with expert groups and iii) have a full evidence college. However, there was a lot of detail to work through.

- The re-appointment of three members: Tamara Galloway, Richard Murphy and Susan Owens, for a further three-year term from 1st June 2016, was noted.

2.4 27 September 2016 Workshop

A detailed report of this workshop is at **Annex I**. The following key possibilities for HSAC work and activities were identified:

- HSAC will need to ***continue to provide its critical friend function and may potentially evolve to become a decision-making body*** as UK withdraws from the EU. This could combine a strategic, forward-looking view with reactive practical advice. Taking a view on what constitutes 'good' evidence, advice on contentious chemicals issues, prioritising the 'key' chemical issues for the UK and scoping exploratory work on emerging issues should remain part of HSAC's role. A network of committees could be set up to provide a more flexible way to get the right expertise for specific issues arising.

- HSAC will expect to make ***routine contributions to strategic reviews*** and policy development, including the REACH review, Defra's 25 Year Environment Plan (25YEP), and EU work on a non-toxic environment strategy and on the Circular Economy package. HSAC Members were keen to grasp opportunities to develop rational strategies to focus on the greatest threats to the UK environment from chemicals.

- If the opportunity arose, HSAC might propose, advise and if necessary lead on a re-designed ***integrated UK environmental monitoring programme***. The objective would be to re-focus our monitoring regime on selected sites representative of different human activity. This would involve fewer sites than currently but integrate chemical, physical, biological and wildlife monitoring together at the same locations on a long-term basis. Integration with Charities and Citizen Science initiatives would also be explored. The aim would be to better understand and protect the natural environment than we do currently whilst using fewer resources. This could support the 25YEP and still meet our European WFD obligations should they continue.

- HSAC could advise on ***Horizon scanning and scenario work*** on environmental loads and exposure from chemicals of concern. This would provide a sense of the scale of the problem for a Minister, and provide useful linkages with the work on the Natural Capital Committee and the 25 YEP.

- HSAC would welcome ***improved links*** with other committees, and with Research Councils, and a role as a broker between research and policy. It was noted that the Nurse Review recommended that Government Departments should play a more active role in setting out their requirements to Research Councils and HSAC could play an intermediary role here.

- HSAC members had a range of ideas on potential exploratory papers on topics that could include:

    - ***Physico-chemical properties***, to address the issue of potential global effects that are not yet on our radar.
    - ***Public engagement***, taking into account differences in environmental equity and environmental literacy among the public.
    - ***Citizen science*** / big data - could HSAC formulate questions that big data methods may be able to answer?
    - ***Personalised vulnerability*** / exposure risk among the human population.

2.5 16th HSAC meeting – 13 December 2016

This meeting was chaired in the morning by Stephen Holgate and in the afternoon Chris Collins stood in for Professor Holgate who had a Medical Research Council meeting.

The meeting also had a closed session item for the discussion on the Defra/Environment Agency strategic approach to managing chemical risk in surface waters in England. This strategy will be published in due course and all stakeholders will have the opportunity to comment on it. Some of the pointers from HSAC members were as follows:

- The strategy should address the issue of appropriate supporting monitoring programmes, in particular to include wildlife, and combine chemical and biological monitoring.

- The strategy should be very clear on how stakeholders would be engaged in its delivery. Generally there should be more transparency on how things will be done (to counterbalance the aspirational content).

- Convergence with the Defra 25 Year Environment Plan would be important.

- The strategy should address some specific 'tricky' issues, i.e. how to deal with domestic sources of metals, how to demonstrate evidence of a problem, how to do a risk assessment or cost/benefit analysis, how to select chemicals of interest, how to proceed where there are no Environmental Quality Standards, what research was needed and how to fund such work, what balance to strike between regulatory and voluntary measures, how to account for multiple stressors and for the effects of mixtures, how to deal with chemicals designed to be persistent such as wood preservatives, .

The committee discussed the follow-up to the workshop that it held last September with a view to agreeing some new activities in the short to medium term. Paper HSAC/16/15 is the completed record of the workshop, including notes of breakout group discussions, plenary discussions and the supporting papers prepared by HSAC members. Looking ahead - two new specific strands of work for HSAC were agreed, and members assigned to each area.

(i) HSAC will develop a position paper on a "Design for an integrated (intelligent) monitoring network for UK surface waters and the best use of that information"
(ii) HSAC will also reflect on the issue of how to raise public awareness and understanding of, and engagement with, the issues linked to chemicals in the environment. There were possible linkages with the concept of citizen science.

Both of these areas of work were likely to be relevant in the context of the Defra 25 Year environment Plan.

The proposed HSAC/NERC workshop early next year was also discussed. Plans for this were well advanced. The workshop is going to take place on 20 February. NERC are leading on the arrangements for it – around forty attendees are expected, from a wide cross section of interests, including academia, government, research bodies, industry and NGOs among others. The key purpose of the workshop would be to help develop a NERC funding proposal around a fundamental theme set out by HSAC – *"What are the consequences to individuals and populations of both humans and wildlife, of their lifetime exposure to the highly complex, ill-defined mixture of*

anthropogenic chemicals characteristic of today's society?" Paper HSAC/16/16 has more detail about the workshop including the purpose and intended outputs.

HSAC member Susan Owens (a former member of the Royal Commission on Environmental Pollution) gave a talk on the topic of "Chemicals legislation for water protection". This was a historical perspective on the evolution of water protection legislation in the UK. It ranged from the nineteenth century to the emergence of concerns in the 60s and 70s, to the integration with EU Policies which culminated with the Water framework Directive. Gross pollution was now less evident but new problems were more insidious and there would now be the challenge, and opportunity, of EU Exit.

Other items on the agenda included:

- Updates from Diane Benford (Food Standards Agency) and Ovnair Sepai (Public Health England) on recent activities of the Committees on Carcinogenicity, Mutagenicity and Toxicity.

- Defra 25 Year Environment Plan: Defra's overall approach to the 25 YEP will be to improve decision making to protect and improve the environment. Natural capital principles will underpin thinking to drive a more joined-up approach to managing the environment to build a nation with a healthier environment and stronger economy. There would be actions in six areas: developing data and tools; connecting people with the environment; delivering locally; delivering globally; incentivising and financing improvements; designing an effective regulatory approach.

- EU Exit: there would be ramifications for HSAC but it was not possible to give a clear picture of what these might be at the present time. It is agreed that independent scientific advice is a valuable commodity to preserve. However, the space this will occupy in a new system has not yet been shaped. This is because of uncertainty about the form which chemicals regulation will take post EU Exit and about the UK's relationship with the EU and the European Chemicals Agency in particular.

- Feedback on the 66th UKCSF meeting held on 1 November, in the form of paper HSAC/16/18, was provided by Ruth Coward.

The Committee said farewell and thank you to Lesley Stanley whose third term of office as an HSAC member would end on 31 December. Dr Stanley joined the Advisory Committee on Hazardous Substances (HSAC's predecessor) in January 2007.

Chapter 3 Publications

As a result of discussions at its meetings, and work done between meetings by individual members, in 2016 the committee was able to publish the following material in early 2017:

Annex II HSAC paper on definition of lifecycle/value chain in relation to nanomaterials and other manufactured substances

This paper is available on the HSAC website:
https://www.gov.uk/government/groups/hazardous-substances-advisory-committee#publications

Chapter 4 Further Information

4.1 HSAC Members' Declared Interests 2015

Member	Research Grants/ Contracts	Company/Organisation (Interests Declared)
Professor Michelle Baddeley	None declared	None declared
Professor Chris Collins	None declared	None declared
Professor Michael Depledge	None declared	Black Swan Ltd – Science Advisor Eden Project – Special Adviser, Fellow of Royal College of Physicians, Diadema Ltd - Director
Professor Tamara Galloway	None declared	None declared
Professor Stephen Holgate	None declared	Synairgen (Shareholder, NE Board Director and consultant) Novartis (Chair, Respiratory Advisory Board) Teva (Steering Group, Severe Eosinophilic Asthma) British Lung Foundation (Trustee, Chair of Research Committee) Medical Research Council (Chair of Joint Steering Committee, MRC/GSK EMINENT Collaboration) NC3Rs (Board Chair) CRUK (Trustee, Chair of Research Strategy Committee) Kennedy Trust (Trustee) British Association for Lung Research (President) Royal College of Physicians (Special Advisor on Air Quality)
Dr Gary Hutchison	Funding from Defra on chemicals and waste water processing	Member of Scottish Life Sciences Association, European Society of Nanomedicine, In vitro toxicology Society and Scottish Stem cell Network, UK Nanotechnology Strategy Forum

Professor Andrew Johnson	Funding from Defra on chemicals and nanoparticles	Member of SETAC (society for environmental toxicology and chemistry) Hydrology expert for the General Tribunal Parish Councillor for Crowmarsh Parish Chairman of Emery & Owen Charity (local charity in Oxfordshire)
Dr Peter Matthiessen	None declared	Fellow of SETAC (Society for Environmental Toxicology and Chemistry) Co-Chair of the OECD Validation Management Group for Ecotoxicity Tests
Professor Richard Murphy	None declared	None declared
Professor Susan Owens	None declared	Chair, Science Advisory Council, Stockholm Environment Institute Member, Social Science Expert Group, Defra Science Advisory Council
Dr Lesley Stanley	None declared	Current and recent consultancy clients: Procter and Gamble Unilever CXR Biosciences Ltd ITI Life Sciences AMVAC Corporation Halogenated Solvents Industry Association European Council of Vinyl Manufacturers COLIPA Quality Meat Scotland Food Standards Agency European Food Safety Authority The School of Pharmacy University of Oxford University of Manchester University of Dundee Other: Wiley-Blackwell (Book contract) Christian Aid (Pledged donor)
Professor John Sumpter	Defra EU Research Councils	BBSRC Industrial Partnership Grant, part funded by AstraZeneca.

4.2 Financial statement

The Chairman and other members of the HSAC do not receive salaries and serve voluntarily on the committee, in addition to their normal occupations. Members are entitled to claim daily fees for the time they spend on committee business. This covers attendance at meetings, as well as time spent on other committee-related activities. All fees paid are taxable.

Fees are liable to be increased annually, in line with recommendations from the centre, usually from 1 April. However, there was no increase notified in 2016. The fees, from April 2009, remained at £234 and £168 for the Chairman and for other members respectively.

Committee members are entitled to claim reimbursement for costs incurred in travelling (standard class) to and from meetings, which are held in London, including any necessary overnight stays, and for any necessary meals and refreshments covering the period of travel. All claims submitted require supporting receipts, i.e. for hotels, meals, rail tickets, taxis, car parking etc. which are verified by the Secretariat.

In 2016 Defra paid out £6,216.00 in fees to HSAC members, including the Chairman. This covered the three quarterly committee meetings held on 15 March, 14 June and 13 December as well as the 27 September workshop. Defra reimbursed £6,932.00 to HSAC members in travel and subsistence costs for these meetings. The total cost of the HSAC to Defra, in 2016 was £22, 935.00.

Annex I

HSAC SEPTEMBER 2016 WORKSHOP: Report

Tuesday 27 September 2016, Church House, Westminster

*NB This is a report of discussions and suggestions made at the HSAC workshop event and **should not be taken to represent the official views** of either the Hazardous Substances Advisory Committee or of Defra. Individual views have not been attributed in this record except where they relate to organisational positions.*

Background

At the 14th HSAC Meeting (March 2016) Members agreed to hold a workshop to develop future work areas and decided to focus on the topics raised in discussion that day with Defra Minister, Rory Stewart. The workshop took place, on 27th September 2016, in lieu of the autumn HSAC meeting and involved HSAC Members and additional invited stakeholders and expert guests (see attendance list and workshop programme at Annexes D and E).

Workshop Objectives

(i) **Engaging in a strategic activity** around the theme of the future of chemicals regulation in the UK

(ii) **Sharing views** on issues of common interest and forging links with other relevant bodies, e.g. research priorities and funding, assessing evidence, the role of scientific committees in policy making etc.

(iii) **Shaping a work programme for HSAC**: to discuss potential new work areas (activities and outputs), whilst taking account of what the committee already has in its programme, for example where reactive work on nanomaterials and EDCs continue alongside more proactive work on combination effects.

Discussion Themes

The key discussion themes are outlined below. HSAC Members had prepared short discussion papers that were circulated in advance.

A. **Environmental long term studies** of ecosystems to support policy (Andrew Johnson to lead - see Annex A)

B. **Chemicals legislation** to provide robust environmental protection in post-EU Exit Britain, while keeping pace with market developments and without unnecessarily stifling innovation (Gary Hutchison to lead – see Annex B)

C. **Vision for the 'future chemical environment',** taking account of the likely increase in the use of chemicals and adoption of life cycle approaches and systems thinking (Mike Depledge to lead – see Annex C)

Key questions for discussion

Issues and evidence

1. What are the key emerging issues that are important for UK Government policy?
2. What kinds of evidence can inform policy? What are the strengths and weaknesses of the existing evidence base?
3. In which key areas do we lack evidence? What are the prospects of such evidence being provided on a meaningful timescale?
4. How can we best ensure the continuation of a strong evidence base?

HSAC role and outputs

5. HSAC contribution – what specific actions and tasks could HSAC plan, to support Government in this area?
6. What specific outputs might we aim for?
7. Which HSAC members or stakeholders could lead and support this activity, and what Secretariat support is needed?

Note of group discussions: Issues, evidence, HSAC role and outputs

1. Theme A – Environmental long term studies of ecosystems to support policy

Issues and evidence

The initial questions were “What is the evidence need?” and “What is missing from the current set up?” It was agreed that prospective chemical risk assessment cannot protect the environment from all possible harm, and that some things will inevitably slip through.

Monitoring is a way of assessing the health of the environment, to look for signs of harm that may be preventable, as well as keeping levels of known harmful chemicals under review. It is therefore not a “luxury”.

The current approach to chemical and wildlife monitoring in the UK is fragmented, reflecting the regulatory roles of public bodies for specific environmental media (freshwaters, air, marine, etc.)[1], and the specialised interests of researchers, charities and industry (e.g. the Predatory Bird Monitoring Scheme and UK Water Industry Research). Some of these schemes only collect data for a relatively small number of chemicals in a few locations and for only a few species.

Government bodies maintain some very long-running programmes, as well as occasional surveys. These activities are usually a response to legislation and their work is often focused on ensuring compliance with particular regulatory requirements, improvement programmes and investigating specific incidents. Their monitoring effort is under significant pressure due to current financial constraints (e.g. CEFAS has reduced the number of its marine monitoring locations for this reason).

To our knowledge, it seems that no-one is tasked with taking an overview of the information from all of the various programmes so that the information might be assessed in a coherent or strategic way. There is work ongoing within the Defra Group mapping out who does what in terms of monitoring and reporting. Defra also has a unit tasked with an overview role for evidence from across the Defra group, and they might be able to help in terms of taking an overview. In addition, the UK Environmental Observation Framework (UKEOF), on which Defra Group organisations participate, works to improve coordination of the observational evidence needed to understand and manage the changing natural environment.

[1] Examples mentioned include the Environment Agency (for English fresh and estuarine surface waters, sediment and biota), CEFAS (marine waters and sediments), NERC Research Centres, e.g. British Geological Survey (for metals), and potentially Natural England (though not chemical specific). Air quality is addressed by both Defra and the Department of Health. N.B. This is not an exhaustive list for the UK.

A round table discussion highlighted that several participants thought that a deeper understanding of exposures and effects was necessary and could be arrived at through monitoring focused on fewer sites but encompassing a much wider range of targets. The group felt that this should include biological sampling/survey, which could include the measurement of biomarkers for particular types of exposure and/or effect (e.g. oestrogen exposure). The effects of chemical contamination are often expressed in wildlife close to the source of pollution. In addition, biota are integrators of chemical effects and can form an important part of a cost effective surveillance programme. Such an approach could be a more efficient and effective than large chemical monitoring programmes which, whilst recording many known and pre-designated chemicals, do not assess effects or impacts. We still only measure a tiny proportion of all the anthropogenic chemicals in the environment, which makes the use of biological integrators even more important. A recent good example was the decline in bees, detected by long-term wildlife monitoring which seems to be linked to the introduction of certain types of pesticide to a particular crop.

Careful thought would be needed to decide which species/groups and biomarkers are most suitable (particularly in the terrestrial environment). Biological monitoring would need to be properly integrated with chemical monitoring, and standardised, reproducible methods would be needed to ensure the collected information is robust (especially for biomarkers). The resource/logistical costs also need to be considered (e.g. in terms of frequency of sampling and staff requirements). There may be scope to use eDNA techniques to minimise the need to physically collect specimens, which could be an area for further research. There might also be a role for citizen science (e.g. anglers monitoring river fly diversity) such as through using apps on smart phones although it was recognised that this approach would need to be used with caution i.e. data collectors may need to be trained / reliability of responses should be factored in, and could only be applied in certain situations.

Consequently, there may be scope to reduce the overall amount of chemical monitoring that is required, both in terms of spatial scale and numbers/types of chemicals analysed. For example, more effort could be focussed on chemicals identified as high priority in representative river catchments. More intensive monitoring could then be carried out if investigative work was needed (e.g. once a problem has been identified from the biota monitoring).

Whilst gross pollution and lethal events are no longer a major problem, we must remain vigilant in detecting whether long-term declines are occurring in some species. Attributing a cause to a decline will always be a complex task but a necessary one. Climate and land use are important factors, and so “monitoring” should also include other parameters such as river flows and temperature. It will also be necessary to ensure the monitoring allows the detection of trends in chemical levels. Tissue archives/biobanks might be one way of allowing retrospective analysis for this purpose.

If a much reduced geographic spread of monitoring sites is accepted in favour of a smaller number of intensely monitored sites, we recognise this may pose

difficult scientific and political questions. For sites where official monitoring ceases, citizen science schemes cannot cover all wildlife, still less chemical measurements. Also people may be concerned if monitoring is significantly reduced in their local areas.

Although not discussed in detail, it was recognised that costs will play a great part in the decision making over the extent and focus of any revised monitoring scheme. Whilst fewer sites would likely reduce costs, analysing samples for a wider range of analytes, including biological monitoring and sampling at more frequent intervals, if required, would increase costs.

HSAC role and outputs

In a discussion of HSAC's potential role, the following possibilities were identified:

- Starting with a blank piece of paper, HSAC could help develop the principles of a more holistic, smarter, intelligence-led, integrated monitoring framework for surveillance purposes, to identify long term trends associated with factors such as climate change and housing growth and emerging issues including greater use of certain chemicals and novel compounds. This could be an approach in support of the government's 25 Year Environment Plan (HSAC to submit formal response to that consultation when it is issued), and should ideally be at lower cost than the current schemes. Such approaches could be integrated within the existing networks established for regulatory and compliance purposes.

- As part of this, HSAC could identify research needs (e.g. how practical are biomarkers for environmental monitoring?), and suggest the relevant protection goals for wildlife and humans; for example, a pledge to leave the environment in a better place then we inherited it – this could feature in the 25YEP. This could include suggesting key species and media to be monitored.

- A mandate is needed so that expectations from Defra are clear. Defra's aim is to become a data-driven organisation, and it would be useful to link any further work on this topic to high level policy and the evidence statements that will shortly be circulated for comment.

- The implications of EU Exit complicate this work area, but also provide new opportunities. To what extent should the polluter pay, and does this bring its own drawbacks? Greater use of sharing environment data / databases should be encouraged.

- HSAC would need to engage with relevant Defra Groups and UKEOF stakeholders, amongst others, involved in monitoring, including Devolved Administrations; to be aware of current practice, constraints and the outcome of previous reviews. The work would also need to dovetail with the interests of other government bodies/advisory committees. HSAC secretariat support is needed to help make these

links. To ensure wider engagement, the importance of monitoring to protect human health as well as the environment should be emphasised.

- The output of any monitoring scheme needs to be fit for purpose, allowing government to make appropriate interventions when necessary and ‘digestible’ to end users, including policy makers.

- Whilst regulatory agencies are currently very capable at collecting data, there may be a need for additional resources and expertise to enable the data (including biota and biomarkers) to be mined and interpreted comprehensively to identify relationships and trends; sufficient computing power would be needed to achieve this. It was felt that greater use could be made of modelling e.g. simulating the expected discharge from water companies based on their activity. It was noted that the next generation of ecotoxicologists are not coming through in the numbers required so this could potentially leave a national skills gap in the future.

2. Theme B – Chemicals legislation

Issues and Evidence

In response to the discussion questions, the group discussed the practical issues and pros and cons of the UK exit from the EU ('hard / soft Brexit'), whether industries need to be able to export to EU and implications for REACH. This would be out of our control for a number of years but we should be ready to either fill a gap created by exit, or supplement what is there.

Emerging issues

- Need for independent advice in support of regulatory decision making
- How to ensure UK retains influential voice in EU and beyond
- How to use reducing resources to focus on big challenges
- Groupings and networks of research in EU are at risk from EU exit.

The group talked about evidence and HSAC's role as a critical friend to help Government make informed decisions. HSAC could play a strong role in supporting decision making.

Evidence and evidence gaps

- Academic science includes blue skies research, while regulatory science requires the 'bread and butter' work necessary for test guidelines
- Access to industry evidence could be seen as lacking / a weakness (industry may be reluctant to publish due to commercially sensitivity or incomplete data)
- Weakness in evidence of population data – decisions on short term ecotox basis / test outcomes important. For example, we need to be clear whether evidence relates to an effect that can be demonstrated in the laboratory, or to real world effects.
- Resolution of gaps in evidence base identified globally (Defra funding for test guidelines is no longer available)
- Loss of opportunity to gain funding such as Horizon 2020
- Expert groups need to identify / prioritise the information gaps
- Better coordination between expert committees is needed

Strengths

- Network of advisory committees
- Long term environmental data sets exist
- Flexibility in acceptance of different types of evidence

Building the evidence base

- Need to build scientific relationships outside of EU e.g. China, USA, India, Japan (biotechnology). (Short – longer term)
- Need to build on informal networks of academic community

- Look at engagement with OECD as a means to retain links

HSAC Role and outputs

HSAC's remit may need to evolve over the next few years in response to policy needs, but should continue to provide independent scientific advice to government to support chemical regulation / nationally and internationally.

As we withdraw / lose influence in EU, HSAC should continue to play a role of identification of problem chemicals. The role could include the following:

- Ensuring any new UK-specific regulatory regime does not lead (perhaps inadvertently) to dilution of environmental protection.
- Taking a view on what constitutes 'good' evidence (need reproducibility of studies to provide quality assurance)
- Advice on contentious chemicals issues from other bodies e.g. WHO, ECHA (e.g. glyphosate for ECP)
- Prioritising the 'key' chemical issues for the UK strategically
- Twin track approach
    - long term forward looking view
    - more reactive practical advice for decision making
- Better cross working between existing advice committees: e.g. setting up working parties under a 'host' committee, but drawing experts from other expert groups e.g. glyphosate, to discuss and provide more flexible advice on specific issues
- HSAC role could be either to assess evidence or working in collaboration with other groups to look at a situation or a chemicals – e.g. with the Committee on Mutagenicity.

Membership may need to be reviewed, depending on the 'ask' that HSAC needs to respond to:

- Regulatory advice – does HSAC need legal expertise?
- Involving socioeconomic academics would provide a longer term broader perspective
- Role for a lay member – with specialism?

3. Theme C: Vision for the 'future chemical environment'

Issues and Evidence

Mike Depledge's discussion paper (Annex C) had posed the following questions:

1) Is there evidence that the current environmental chemical milieu adversely affects ecosystems, natural biota and human health?

- There was a consensus that this was the case.
- We need to think not just about biota but the physicochemical properties of the planet – e.g. could nanomaterials in the ocean surface have potential consequences for light penetration and photosynthesis.
- Cause and effect does not always have to be demonstrated before acting on concerns about adverse or beneficial impacts of a project – some evidence is based on associations. A weight of evidence approach is often required.

2) How are levels of environmental chemical exposure likely to change over the next 10—20 years?

- Chemical production is increasing, and although regulation offsets some of the adverse impacts, the increase will mean that overall exposure to diffuse mixtures of chemicals will continue to rise.

3) *What kinds of chemicals will be of greatest concern and to which organisms, over the next 10-20 years?*

- One example could be the perfluorinated compounds, e.g. PFOA / PFOS – highly mobile, ubiquitous chemicals in multiple (3000) compounds, which are thought to affect immune response in children and thyroid function in adults, but it will be important to find out the mechanism that causes the effect.
- Similarly with Bisphenol A, which has been associated with diabetes, heart attacks, strokes and other illnesses.
- Brominated flame retardants (BFRs) – researchers are starting to find 'new' BFRS, which are not currently controlled, in house dust (in UK), serum (in Sweden), and breast milk (in Denmark). They are believed to be highly persistent.
- Some of these substances (e.g. perfluorinated chemicals and brominated flame retardants) have already been restricted or banned under the Stockholm Convention, but may still have an impact due to their persistent nature. Other types of BRFs and PFCs are not currently controlled, with a slow incremental process of adding other substances into the control system.
- Data in US (NHANES) as well as elsewhere show many chemicals accumulating over time in humans. With the ageing demographic,

higher body burdens of chemicals mixtures are now being attained. Is it possible to identify chemical threats to humans by monitoring chemicals accumulation in biota, together with changes in biodiversity? What else – e.g. diseases emerging in Finland / Russia along border, rise of allergic diseases. Innate immunity in children brought up on farms is greater than in urban settings. What role might chemicals play in this?

4) *What levels of environmental chemical exposure are we (a) willing to accept and (b) would we prefer to achieve, over the next 10-20 years?*

- Who is responsible for deciding what is acceptable? There are different world views and tolerances of risk. The group discussed inequality (health inequality) in exposure to chemicals and vulnerability to chemicals. Understanding of mechanisms is also important, and a realistic approach recognising that exposure is to multiple rather than single chemicals, often over the life course.
- Is there a need for a more precautionary approach? A founding principle of minimising chemical release into the environment could be incorporated in all chemical legislation, as a means of demonstrating "good practice". Should there be an obligation to protect human health that takes precedence over economic benefits? UK's approach was seen as sometimes less precautionary compared to EU, e.g. on neonicotinoids.
- The public have a high expectation that they will be protected from adverse impacts, e.g. they expect products on sale to be safe.

5) What new procedures, technologies and governance arrangements do we need to put in place to realise our objectives and achieve effective environmental chemical management?

Monitoring

- Monitoring is very important but we don't always know what we are looking for. More discussion needed on how to capture this.
- Current testing processes are inadequate to model the real world response, e.g. do not look at responses under stress or in the presence of other environmental perturbations. Nor do we take into account chemicals exposure across the lifecourse – we could look at more in future.
- Look at applying monitoring to testing strategies to avoid the chemicals going into the environment in the first place.
- In Europe there is a large project looking at chemicals in human tissue, led by DG Research / DG Env, and EEA. Sampling strategy is to look at current large cohorts and covers a range of substances including PFOA.
- Biobank uses volunteers from different categories, collecting blood / tissue / milk samples.
- Could we improve the use of the national data sets such as national bird counts – e.g. to link trends such as decline of swallows to potential causes.

Governance and decision making issues

- Can lessons be learnt from the past – e.g. the RCEP report on lead (a neurotoxin), which said that levels were too high in blood, and recommended removing it from petrol. There are important questions about precaution and proportionality. The group agreed that we don't need to always have knowledge of all mechanisms when there is a weight of evidence.
- Probability is missing from decisions – toxicity assessments always based on current assessment, although there is some use of threshold methods / assumptions where there is no data, e.g. for genotoxicity.
- People power is under used. There is a lack of awareness of issues among public - e.g. air pollution, but once people are aware they feel strongly about pollution. There should be a step change in the way in which the public are informed about exposure to chemicals – pointing out, in a balanced way, the risks and benefits over the long term. Government is now being taken to court by ClientEarth on air pollution – to enforce what government has itself agreed to do.
- Could decisions be better future-proofed? Benefits and disbenefits can't be compared well because disbenefits are not known and may occur in future.
- Much more attention (scientific, political and public) needs to be focussed on what kind of environmental conditions and levels of chemicals exposure we are aiming to achieve over the next 10 to 20 years.

Legislation and policy

- The EU regulatory system is designed to follow a risk assessment through, with stages of authorisation, restriction etc. The systems are there and have great potential but not fully functioning yet – e.g. 'new' brominated flame retardants which have substituted for the original harmful chemicals are now themselves being found in breastmilk. Monitoring obligations in REACH are limited.
- Currently, there is some pressure to substitute if substances are on a Candidate List of Substances of Very High Concern but on the other hand there is financial pressure to keep substance on market.
- Chemicals are a global issue – China is trying to control chemicals with a version of REACH, but how well does this work? – use of pharmaceuticals and agrochemicals is thought to be largely uncontrolled in many global areas.
- There is an important link to the circular economy – chemicals in products can be a significant barrier to the drive to recirculate materials in the economy.

HSAC role and outputs:

The group discussed HSAC's role and the potential range of opportunities for HSAC to provide input and influence. One suggestion was to develop some

kind of manifesto or list of things HSAC would like to see happen to counterbalance the increasing impacts of chemicals in the environment.

Specific possible activities for the Committee were discussed:

- Brief scoping / thinking piece on physicochemical issues, to address the issue of potential global effects that are not yet on our radar.
- Exploratory paper on the burden of proof / 'gratuitous' use of chemicals for non-essential uses. Should people have to make the case for using chemicals?
- Exploratory paper on public engagement, looking at different equities and environmental literacy among the public. Focus on chemicals in products / choice editing role versus role of consumers in decision making, e.g. by using an app on chemicals in products (similar to PHE app on sugar).
- Focus on citizen science / big data and increasing ability to drill down. Could HSAC formulate questions that big data methods may be able to answer?

In addition, HSAC would expect to routinely feed into the following ongoing strategic reviews / policy development areas:

- REACH review
- Development of the non-toxic environment strategy
- Circular economy and chemicals
- Defra's 25 Year Environment Plan

It was noted that the role of HSAC would depend on its future remit, which may evolve as a result of Defra's review of expert committees. The group felt that since the loss of RCEP no other organisation in UK government was in a position to take a strategic 'critical friend' role in the broad area of environmental pollution. It would make sense to recreate a committee looking at a bigger picture, with a broader remit covering environmental pollution impacts which would be better able to address interdisciplinary effects e.g. impacts of climate change. HSAC's connectivity with other bodies was felt to have been limited, with no mechanism for bringing in people / teaming up. It was noted that the Research Councils were also moving towards a challenge-led agenda.

4. Discussion on views from others

Susan Owens led this discussion and asked participants to comment on how it might be fruitful for their organisations to interact with HSAC, and which other bodies (not represented at the Workshop) the Committee might usefully build links with. HSAC's meeting schedule was generally four times per year, with some activities in between. Within this framework, the Committee would welcome conversations and collaboration for synergistic outcomes.

Key points from organisations that were represented at the workshop:

Connections with others

CEFAS collect and provide to Defra information on the marine environment. This activity is high cost so collaboration is actively sought. Defra is the policy client. HSAC could help bridge the gap between academia and regulation, where there is typically a long lag between having evidence and developing toxicity test guidelines, for example. Meetings or networks could help, with Defra's involvement as a central point.

NERC Research Centres undertake monitoring activities and work with others to improve coordination via the Environmental Observations Framework. Long term monitoring is a national capability and there is an opportunity to influence at this time through discussion with Centres. NERC has a range of funding mechanisms, mostly relatively short term (up to 5 years), from discovery science through to translation of existing research, e.g. systematic reviews. NERC seeks input from the research and user community to develop its strategic research agenda and HSAC could engage with this process. For example, NERC has recently funded research relevant to HSAC on nanotechnology and development of eDNA techniques following signals from the community. If there is a new or emerging chemical threat or research priority HSAC could flag this up by feeding in the Committee's view, evidencing a need for research. Longer term engagement with HSAC would be positive to help NERC stay aware of current and future issues.

It was suggested that ***trade associations*** could be an important avenue for engagement with chemical producers. HSAC could find common purpose with these groups, particularly at this time when many trade bodies were calling for REACH to be retained. Experts within member companies (toxicologists, chemists) can also engage on a technical level.

HSAC could also engage with the ***other advisory committees*** in Defra and other Departments. NERC also has a number of advisory bodies. The ***Natural Capital Committee*** was working on a vision of 'what would we like environment to be like in 25 years', and what measures to put in place to achieve this vision. There was a need for consensus on the monitoring framework that would be needed to underpin this. It would be worth engaging with the NCC as chemicals were not currently on their radar. Nominated members could act as key contact points, to share information on what is happening on other groups' agendas. HSAC could also host visitors or

honorary members from other committees. Other committees' agendas could be examined to identify any areas of overlap or shared interest.

The ***Expert Committee on Pesticides*** was an example of contact points working well. The evidence gap on glyphosate issues was a concern to both committees, and could be treated through a joint working group for this particular substance.

UK Exit from the EU

There was a discussion of the implications of the UK's exit from the EU, including for the role of the Committee. REACH was seen as a significant success, where NGOs had worked together to influence the outcome and businesses now wanted to continue to operate under the REACH system.

CHEM Trust focus a lot of their work at the EU level and would continue to see this as the optimal place to influence, although a number of other UK NGOs now had a reduced focus on chemicals compared to other areas of environmental policy. CHEM Trust see a risk to REACH associated with EU Exit.

The REACH system relied on the European Chemicals Agency so was thought by some to be potentially inoperable on a UK basis when the UK leaves the EU, although by 2018 the final REACH registration deadline would have been achieved. Defra was analysing the question of what would be needed in the UK to replicate the system and maintain environmental standards.

Defra Ministers were also still championing the 25 Year Environment Plan (25YEP), the development of which would now have to take account of the UK's exit from the EU.

Connecting research and policy

Many participants felt that there was more work to do in this area. Communication between the policy makers and regulators and the science community was a perennial problem. Policymakers were unlikely to access peer-reviewed academic research, and there was a need for a new model to close this gap.

Possible means of connecting academic experts with regulators were discussed. The following were suggested as examples of successful practice in this area:

- The Scottish Government has taken in some senior research fellows, bringing a synthesis of ideas directly to policy makers.

- The Food Standards Agency's Committees on Mutagenicity, Toxicity etc are asked specific questions then the policy is based on that specific scientific advice. The Committees' roles are to bring together different strands of evidence. FSA relies on committee to bring this together

rather than having to weigh up individual research sources, and finds this to be a successful model.

- Public Health England has Health Protection Research Units (HPRUs) – where academic leads work in an area alongside the policy lead. This allows steering of the research to be policy focused, and generates feedback e.g. if more independent review is needed.

- The University of Cambridge has an interdisciplinary Centre for Science and Policy (CSaP). People from the world of policy (broadly defined) can apply to become a CSaP Policy Fellow. Policy Fellows identify questions of interest in advance, and visit Cambridge for an intensive week during which they meet relevant academics on a one-to-one basis, spending an hour with each. A separate Policy Leaders Fellowship scheme addresses the needs of the most senior policy makers. Policy Leaders meet once a term in Cambridge for roundtable discussions as well as one-to-one meetings with researchers.

- Secondments were also used by Government and others, but these should work both ways e.g. Defra into Agency as well as the other way round.

Building further platforms for exchange between academia and policy makers was thought to be a good idea. Advisory committees such as HSAC could have a 'brokering' role in this relationship, helping to forge connections more systematically. Many academics are willing to serve on such committees, and it is helpful if their contribution is recognised as research impact.

5. Discussion: HSAC Next steps

Mike Depledge led this discussion. He reminded the workshop that HSAC will remain responsive to Defra's requests, but can also decide itself to cover other areas more proactively. Some suggestions had already been made in the discussion groups on the specific themes (see notes above). Participants suggested the additional ***potential areas of activity*** for HSAC:

- Undertake an analysis of future scenarios to 2050 focusing on environmental loads and exposure. This would provide a sense of the scale of the problem for a Minister, and would provide synergy with NCC engagement and Defra's 25YEP. Would need to take account of any existing EEA or other work in the field.
- Horizon scanning role on chemically-related issues that could emerge in the future – for example, epigenetic modification.
- Immunotoxicity issues with PFCs - already a public health issue which we cannot keep on ignoring.
- Exploratory work on personalised vulnerability / exposure risk, recognising that vulnerability to chemicals is not uniform among the population.
- Review and redesign UK environmental monitoring regime as discussed by Theme B discussion group.
- Grasp the opportunity provided by EU Exit for a 'clean sheet of paper' on how we could develop chemicals policy to achieve more effective and efficient chemical use and management without diluting environmental protection.
- Ensuring chemicals issues are properly represented in the 25YEP, so that a life-cycle approach is embedded at strategic level.
- Future strategies on food and farming could provide further opportunities to get chemicals more centrally / strategically treated.
- Possibility of running a scientific conference for a week on chemical awareness.
- HSAC role in prioritisation of the most important areas for gathering new evidence.
- HSAC Guide / advice on producing / using new chemicals.

Mechanisms

HSAC could consider its role in reviewing and connecting to information from elsewhere (i.e. in Europe and elsewhere in the World), an issue raised by Rory Stewart when he visited HSAC as Environment Minister in April 2016. Following UK's exit from EU, should we have stronger ties with EPA / China / Japan? Members could use institutions / academic global strategies to make these connections.

HSAC could improve links with other committees and the outside world, perhaps improving the way it publicises its activities. This would help communication and allow HSAC to link with other experts. The Committee could become more media savvy to invite more responses and interactions.

Members are free to tweet as HSAC Members for example. The gov.uk HSAC page is up to date but limited in functionality.

There was a discussion about whether HSAC could have a role in increasing public awareness about chemicals. NERC had a public engagement focus for the coming year so could potentially provide support if HSAC wanted to pursue this. HSAC's role could be to form a plan / interact / foster / promote citizen science activities, exploring the potential for crowd sourcing of data. An example of the latest technologies from the air pollution field is carbon monoxide monitors linked to iPhones. If looking at the scope to increase consumer awareness, it would be important to consider who is listened to by consumers.

A greater link with the Research Councils could be developed – with MRC, EPSRC, ESRC, as well as NERC (HSAC could invite a NERC representative to provide an update at a meeting).

Andrew Johnson talked through data on the estimated 2016 EA spend on monitoring activities and ideas to review and improve the monitoring regime to make it more targetted while remaining still scientifically valid (see notes of discussion Theme B above). A revised programme should integrate chemical, wildlife and physical monitoring to both flag up and help diagnose any unpredicted potential impacts. Participants agreed that it was important to do this from first principles and design. The funding pot would shrink without money from regulation, so rather than looking for efficiencies, the aim should be a more visionary piece on how it might be designed differently. A change in approach that could measure something different could transform the ecological discipline in the same way that cohort studies have transformed medical research. HSAC could start the process in partnership with the EA but bringing in the wider environmental community to test and if necessary re-shape the design would be vital in the construction of a robust monitoring scheme.

Annex A: Environmental long term studies of ecosystems to support policy

The biggest impacts on British wildlife from specific chemicals post-war came from soil acidification releasing aluminium which killed fish in upland streams and lakes, OC pesticides causing declines in predatory birds and TBT destroying mollusc populations in freshwater marinas and in coastal harbours. These events had not been expected, and out-flanked the then UK environmental protection scheme. Our current UK strategy to protect the natural environment from chemicals is outlined below and includes a lot of long-term monitoring as follows:

A. Prospective risk assessments are carried out on substances under several pieces of EU legislation (e.g. REACH, Plant Protection Product and Biocidal Product Regulations), which can involve product authorisation prior to their use. Sector-specific legislation also applies (e.g. Industrial Emissions and Hazardous Waste Directives).
B. Establish safe levels for chemicals (EQS) in water based on a hazard assessment using laboratory ecotoxicity studies. Done in partnership with European colleagues and enter into law via the water framework directive
C. Monitor British rivers to ensure levels of chemicals in the water column do not exceed their EQS (mainly started in 1989)
D. Bio-monitor fish in many rivers to ensure their tissue burden does not exceed EQS for Hg, HCB, HBCD (recently established in 2014)
E. Ensure rivers reach or maintain a good ecological status monitored by presence/absence of benthic diatoms (particularly sensitive to PO_4), presence/absence of macro-invertebrate families (sensitive to basic and specific water quality), most records start in 2000, and more recently to examine diversity of fish species present (sensitive to habitat and chemicals). We do monitor fish abundance (mainly 2000 onwards) in many rivers but this data has not been used with respect to addressing water quality and chemical contaminants

We are not aware of systematic monitoring of the terrestrial environment to examine its response to chemicals other than in the Countryside Survey, carried out every 5 to 10 years in which species diversity, habitat quality and some chemicals in soil are surveyed. To comply with OSPAR and MSFD, CEFAS monitors water and sediment in the UK marine environment for chemicals but sampling of estuaries seems less systematic. Other than these schemes managed by Defra and its partners, a number of ‘ad hoc’ schemes also exist in the UK:

- Freshwater environment – Fish tissue archive (CEH) which collects, analyses and stores fish from the Thames, Anglian and Midlands rivers, has run since 2007. Cardiff University Otter Project (CU) – similar approach but for retrieved dead otters provided by the public, running since 1992.

- Terrestrial environment – Predatory Birds Monitoring Scheme (CEH) – retrieved dead birds of prey provided by the public are analysed for chemical contamination and stored, running since 1966.

- Marine environment – Cetacean strandings Investigation Programme (ZSL and CEFAS) – retrieved dead whales are examined for chemical contamination, running since 1990.

Are we doing the right thing, could HSAC suggest better, more cost-effective approaches?

What is the right strategy? Should we:

(a) Monitor the things we want to protect (biological communities and human health) and then try to 'diagnose' why they aren't as good as they should be or

(b) Focus on the pressures we believe to be most likely to pose a risk. In this case, we are assuming that we have a good understanding of the pressure-impact relationship and that this strategy will automatically lead to the avoidance of impacts.

Professor Andrew Johnson

Annex B: Legislation of chemicals in the environment

In the current context about 70% of our environmental safeguards and legislation is European legislation – and this is now at risk.

There is a vast array of environmental and safety standards which apply to products sold in the EU. Under the bilateral agreement model, the UK would still need to ensure UK manufactured products comply with these standards in order to retain access to the EU market. It is likely that the UK would be subject to the same requirements under this model, particularly as the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Directive already impacts upon non-EU manufacturers since its requirements apply at the point of entry of products into the EU. It is possible that the UK could be allowed to perform a regulatory role in EU conformity assessment certification (as Canada has negotiated under its proposed bilateral agreement with the EU). There are also a number of international agreements that will continue to have an impact on UK product standards such as the Stockholm Convention on Persistent Organic Pollutants (2001) to which the UK is independently a party.

Considering the wider context there are a number of options that may be open to the UK following the decision to leave the European Union.

1. The UK could seek to remain a member of the European Economic Area (EEA) and the European Free Trade Association (EFTA) in an approach similar to that taken by Norway;
2. The UK could seek to remain only a member of the EFTA, in an approach similar to that taken by Switzerland; or
3. The UK could seek to operate outside the EU entirely and not seek to be part of the EEA or the EFTA.

Under the Norwegian model, the UK would have to retain, or re-enact, most EU environmental legislation to ensure full access to the EU market. This would include areas such as integrated environmental permitting, water and air quality, waste management and REACH. Switzerland is not compelled to comply with the majority of European environmental legislation, although as part of its policy of cooperation with the EU many of its laws have been harmonised with EU standards.

If the UK were to take the Swiss Approach, then there would likely be extensive revisions to the environmental regulatory landscape. UK businesses, trading with the EU, would still be compelled to comply with European environmental legislation relating to manufacturing such as limits on hazardous substances, chemical safety, labelling and packaging. In particular, businesses would be required to comply with legislation such as REACH; the Restriction of Hazardous Substances (RoHS) Directive; the Classification, Labelling and Packaging of substances and mixtures (CLP) Regulation and the Waste Electrical and Electronic Equipment (WEEE) Directive.

If the UK does not seek to become a part of the EEA or the EFTA, then it would not be required to comply with any European legislation such as the REACH and the CLP Regulation. As such the European legislation currently enacted would need to be removed thus the UK Parliament would need to review, and possibly decide to repeal, national legislation implementing European Directives. What would this mean for environmental protection in the UK?

The UK has an integrated Environmental Permitting regime which regulates the environmental impacts of industrial processes (and in particular impacts on air, water and energy use). This partly derives from the EU Integrated Pollution Prevention and Control (IPPC) regime, now found in the EU Industrial Emissions Directive. It is likely that the structure of the environmental permitting regime would not change greatly following dissociation from the EU, not least because the EU IPPC regime was largely adopted on the basis of the UK model.

UK waste policy and legislation has been predominantly driven at EU level, particularly in relation to policies surrounding recycling, hazardous waste and prohibitions on landfilling. However the UK's contaminated land regime does not derive from EU legislation. Contaminated land is generally dealt with upon redevelopment within the planning system, and the Contaminated Land regime provides a regulatory back up for problematic contaminated land based on the polluter pays principle. All in all the future prospects for legislation and control of chemicals in the environment may become an important issue for government, industry and science in the future and thus an important issue to discuss sooner rather than later.

There are a number of issues that Defra and the scientific community are concerned about in relation to chemicals in the environment. The committee has provided much attention in recent years to definitions of nanomaterials, their monitoring and exposure in the environment and their potential impact in waste streams. Pharmaceuticals and antibiotic use, on both a local and global scale, be that in fresh water or land are a real concern. There is real concern, based on current human and veterinary consumption, about the long term impact for environmental systems and potential future contribution to increased AMR.

Key issues for discussion:

1. What should the UK legislative landscape look like after leaving the European Union?
2. Is there a need to improve training of experts and create new infrastructure to monitor and enforce chemicals regulation in the UK?
3. Can we improve current approaches to assessing chemicals in the environment by improved assessment of modes of action and exposure routes?
4. Legislation of mixtures of chemicals entering the environment – how do we improve our modelling and monitoring and assess cumulative effects?

5. REACH and the implications for industries making nanomaterials, nano objects and devices?
6. How do we better use academic research to speed up and improve legislation and monitoring of chemicals in the environment?
7. Can the read across approach to hazard assessment and risk be enhanced particularly in the context of complex chemical mixtures?
8. Where do we see a need for new legislation and what can be addressed using existing frameworks?

Dr Gary Hutchison

Annex C: Environmental Chemical Futures

Humans, like other animals, have experienced exposure to an enormous range of potentially toxic chemicals in the environment throughout evolutionary history. This has led to the natural selection of a suite of biological mechanisms that minimise chemical toxicity through metabolic transformations, storage and excretion. Nonetheless, in some circumstances, natural toxins, heavy metals, noxious gases and other substances can overwhelm defences leading to disease, and in some cases, death.

With the advent of the industrial revolution and the growth of the human populations from ca. 1 billion in 1800 to ca. 7.4 billion today, the variety of chemicals in the environment has increased enormously. Overall global chemical production has risen more than 2500 fold over just the last 75 years. Many of the substances that we and other organisms now encounter are entirely novel, including numerous industrial organic compounds, pesticides and pharmaceutical agents. An increasing weight of evidence indicates that body burdens of mixtures of environment chemicals are associated with a greater likelihood of developing disease. There is therefore a pressing need to assess and where necessary, minimise dangers to all natural biota. Scientists are constantly exploring new avenues of research to identify the chemical mechanisms that result in damage and to improve the ways of dealing with chemical hazards and risks.

Past environmental releases of chemicals have occurred largely unnoticed and unplanned. With growing awareness come questions regarding our willingness to accept that current and future generations of humans, animals and plants will to be exposed to ever more complex mixtures of chemicals across the life course. As the global population rises further and lives longer, and as the agricultural and manufacturing sectors try to meet their needs, chemical releases into ecosystems are likely to continue largely unabated. Additions from pharmaceutical use, from the energy and transport sectors, and through the introduction of new technologies (e.g. nanotechnology, synthetic biology) will undoubtedly further enrich the environmental chemical “milieu” in which we and other organisms spend our lives.

The workshop will consider these issues and try to identify ways to assess and minimise hazards and risks. Examples of questions that will be addressed include: Is there evidence that the current environmental chemical milieu adversely affects ecosystems, natural biota and human health?; How are levels of environmental chemical exposure likely to change over the next 10—20 years?; What kinds of chemicals will be of greatest concern and to which organisms, over the next 10-20 years?; What levels of environmental chemical exposure are we (a) willing to accept and (b) would we prefer to achieve, over the next 10-20 years?; What new procedures, technologies and governance arrangements do we need to put in place to realise our objectives and achieve effective environmental chemical management?

Professor Mike Depledge (July, 2016)

Annex D: List of attendees

HSAC Chair and Members

Stephen Holgate (Chairman)
Michelle Baddeley
Christopher Collins
Mike Depledge (Theme C leader, session chair)
Gary Hutchison (Theme B leader)
Andrew Johnson
Peter Matthiessen
Richard Murphy
Susan Owens (Theme A leader, session chair)
Lesley Stanley

Other invitees

Diane Benford (FSA)
Caroline Culshaw (NERC)
Bill Cushley (ECP)
Steve Dungey (EA) – am only
Selvarani Elahi (LGC)
Andrea Caitens (HSE)
Nigel Haigh (IEEP)
Ioanna Katsiadaki (CEFAS)
Paul Leinster
Ovnair Sepai (PHE)
Michael Warhurst (CHEM Trust)

Defra

Laura Eden
Gabrielle Edwards
Kay Williams
Lada Tvaruzek

HSAC Secretariat

Ruth Coward
Patrice Mongelard
Hasmitta Stewart

Annex E: Workshop Programme

10:00	**Opening** by Chairman - purpose, aim, expectations, introductions on behalf of HSAC and from the external stakeholder participants.
10:30	**Discuss themes: Issues and evidence**: 3 tables of 10 to discuss the key generic questions and any specific questions for one of the three themes, with rapporteurs recording discussion on flipchart paper. (60 min). Discussions to be led by HSAC members (Andrew Johnson, Gary Hutchison, Mike Depledge)
11:30	**Coffee**
11:45	**Discuss themes: HSAC role and outputs:** In the same discussion groups, move on to the second set of questions, with rapporteurs recording discussion on flipchart paper. (45 min)
12:30	**Brief feedback** from rapporteurs (5-10 min each), and Chair to summarise and wrap up for lunch.
13:00	**Lunch**
14:00	**Views from others:** (Susan Owens to lead discussion) Wider stakeholder views on how other groups can interact with HSAC and feed into outputs related to the themes.
15:00	**Developing HSAC work programme:** (Mike Depledge to lead discussion) Agreeing concrete next steps for the Committee, where possible agreeing specific actions and responsibilities for taking work forward.
16:00	**Summary and next steps**: Chair to recap on discussions, relating outcomes to thinking on the future of chemicals regulation in the UK.
16:15	**CLOSE**

Annex II

HSAC paper on definition of lifecycle/value chain in relation to nanomaterials and other manufactured substances

Recommendation on a UK position on the definition of lifecycle/value chain in relation to nanomaterials and other manufactured substances

The UK is keen to use advances in nanotechnology to improve the environment, for example in the contexts of environmental sensing, pollutant remediation and the development of more environmentally friendly substances. There is, however, a lack of clarity in how nanomaterials interact with the environment and the terminology surrounding the assessment of such interactions. Across Europe the terms Life Cycle and Value Chain are used without clear definition and often interchangeably.
The purpose of this paper is to help policy makers to understand the terms Life Cycle and Value Chain as they relate to chemicals in the environment. It aims to clarify the distinct meanings of the two terms and recommend their appropriate use in different contexts, particularly those focused on economic or environmental policy, and the implications thereof.

Definitions

A number of definitions of the terms Value Chain and Life Cycle (and the related term Life Cycle Assessment) are available. The list below is not meant to be exhaustive but exemplifies some of the clearer ones available from reputable sources.

'Value Chain'

The Cambridge Business English Dictionary[2] defines Product Value Chain as "all the activities involved in making and selling a product, and any service provided after it has been bought, which together create the product's value".
A similar definition is provided by Investopedia:[3] "A high-level model of how businesses receive raw materials as input, add value to the raw materials through various processes, and sell finished products to customers".
These definitions indicate that the term Value Chain is limited in its scope as it stops with the purchase of the product and does not address subsequent events such as the use, disposal and ultimate fate of the material. Thus, interactions with the environment are not considered in a Value Chain analysis.

'Life Cycle'

ISO 14040 "Environmental management -- Life cycle assessment -- Principles and framework"[4] defines Life Cycle as "consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal" and Life Cycle Assessment (LCA) as "compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle"

[2] http://dictionary.cambridge.org/dictionary/english/product-value-chain
[3] http://www.investopedia.com/terms/v/valuechain.asp
[4] https://www.iso.org/obp/ui/#iso:std:37456:en

It goes on to describe LCA as a technique for assessing the potential environmental issues associated with a product (or service), by: compiling an inventory of relevant inputs and outputs, evaluating the potential environmental impacts associated with those inputs and outputs, interpreting the results of the inventory and impact phases in relation to the objectives of the study.

In an LCA, a cradle-to-grave systems analysis of the production, use and disposal of a product or service is usually undertaken, providing a comprehensive evaluation of all upstream and downstream energy inputs, resource consumptions and environmental emissions. The LCA approach is therefore, in principle, preferable to Value Chain analysis when the environmental impact of products or services is to be considered. However, LCAs can be costly and time-consuming due to the usually high requirement for extensive inventory data, thus limiting their use in both the public and private sectors. Streamlined techniques for conducting LCAs are available to reduce the cost and time involved and to encourage a broader audience to begin using LCA.

It should be noted that the concept of LCA, often referred to as Life Cycle Thinking, can also be applied to the social and economic pillars of sustainability in the guise of social LCA [5] and Life Cycle Costing[6]. The social LCA and Life Cycle Costing approaches consider systems and system boundaries equivalent to those used in an environmental LCA to assess a given process or service; however, in these cases the inventory is populated with data relevant to the social or economic dimensions. The impact categories in social LCA are clearly different from those in environmental LCA and will include attributes such as working conditions, health & safety, cultural heritage and governance, which can be difficult to quantify. As the name implies, Life Cycle Costing considers the economic costs associated with a product or service throughout its life cycle. Social LCA is currently under active development and has several aspects that are the subject of debate and controversy; it cannot, therefore, yet be regarded as a mature methodology.
Ultimately, there is interest in combining LCA, social LCA and Life Cycle Costing into an overarching, integrated assessment known as Life Cycle Sustainability Assessment[7] as illustrated in Fig 1 below[8].

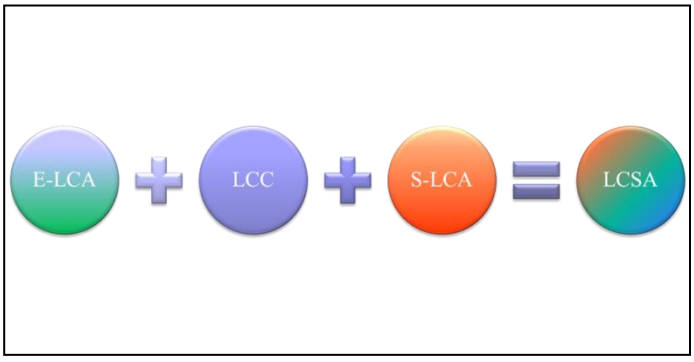

Figure 1. Combination of 'traditional' environmental LCA with Life Cycle costing and social LCA to give Life cycle Sustainability Assessment (after UNEP, 2011[7]).

[5] http://www.unep.org/pdf/DTIE_PDFS/DTIx1164xPA-guidelines_sLCA.pdf
[6] http://ec.europa.eu/environment/gpp/lcc.htm
[7] http://www.unep.org/pdf/UNEP_LifecycleInit_Dec_FINAL.pdf
[8] http://www.lifecycleinitiative.org/starting-life-cycle-thinking/life-cycle-approaches/life-cycle-sustainability-assessment/

Comments

There is a clear difference between the meaning of the terms Value Chain and Life Cycle, and between the approaches to which they relate. Value chain generally focuses on 'value added' up to the point of sale to the customer, in other words, the point at which the commercial value of the product has been maximised. The value chain is measured relatively easily in terms of the prices paid by producers for the inputs and by the final consumers up to the point of sale. It does not take into account additional monetary costs associated with disposal and remediation, which would potentially have a detrimental impact on the overall value of the product and the environment more generally, including long-term consequences for human health. Value chain analysis is useful in indicating where the biggest increments of value are added across the product's generation e.g. in extraction of raw materials, pre-manufactures, manufacturing or final assembly etc. as seen in Fig 2.

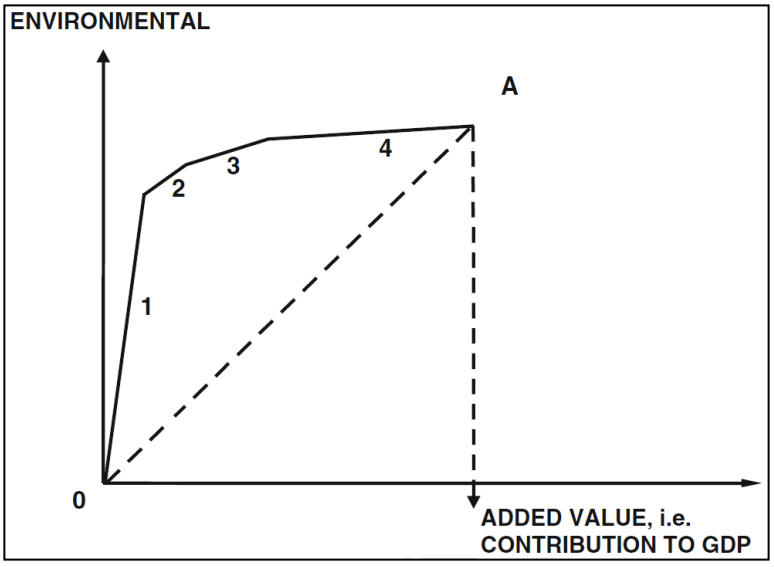

Figure 2. Accumulation of added value (i.e. contribution to GDP) and environmental impact along a supply chain for a manufactured product.

1. Resource extraction
2. Processing & refining
3. Manufacturing
4. Retail & distribution

(A = finished product in use)

(after Clift, 2003[9])

Some of these additional costs will be incurred in monetary terms by producers in the process of disposal and remediation. There are, however, further costs, which usually are not monetised, specifically the "negative externalities" i.e. the indirect hidden costs imposed on those people who are not directly involved in the exchange of value. For example, the environmental impacts of nanomaterial production may have implications for human health and wellbeing. As for any polluting production, the polluter does not pay, unless there is government intervention (e.g. in the form of regulation, taxes, or artificial markets in the form of pollution permits). A properly conducted LCA can take into account monetary costs, including aspects of a product's cost and value from the acquisition of the raw material to the ultimate disposal and, where relevant, environmental degradation of the product. Both LCA and Value Chain approaches are useful, as they have overlapping scopes yet assess different endpoints. Neither, however, addresses the negative externalities imposed on wider society if the production of nanomaterials is associated with

[9]Clift, R (2003). Metrics for supply chain sustainability. Clean Tech Environ Policy 5, 240–247 DOI 10.1007/s10098-003-0220-0

increased pollution (unless data is known however this often leads to an environmental impact assessment through monetised metrics). Some of these negative impacts could also have implications for the government's fiscal positions if they lead to increased pressures on health spending in the long-term. These indirect impacts are often subject to high degrees of uncertainty.

Recommendation

When deciding whether to adopt a LCA or Value Chain approach to evaluating the economic and environmental impact of a nanomaterial or other manufactured substance, it is important to ensure that the most appropriate approach is used depending on the specific context. Both approaches have value, but only if they are used consistently and correctly. In particular, there may be the temptation to use whichever approach will generate data conveying the best impression; for example, value chain will usually capture the maximum economic benefit from a product and is therefore likely to be preferred by departments with a strong focus on economic returns such as the Department for Business, Energy & Industrial Strategy.

Within the overall responsibility of Defra, HSAC's remit is to consider the environmental impact of substances across their entire life cycle and it should, therefore, usually consider a full LCA not just a value chain analysis. By the same token, given Defra's remit, the committee recommends that the LCA approach is used as widely as possible when assessing new and emerging hazards, including those relating to nanomaterials.

HSAC Working Group on Nanomaterials

Professor Michelle Baddeley
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Professor Richard Murphy
Dr Lesley Stanley

February 2017