

Analysis under Uncertainty for Decision Makers: Decision Making Under Deep Uncertainty.

Prince Philip House, 3 Carlton House Terrace, SW1Y 5DG

5th March 2019

Involving the following Collaborating Organisations:



Department of
Management

Psychology

Lancaster
University



E3G

energy futures lab
An institute of Imperial College London



Government
Office for Science

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1. Introduction

On 5th March 2019, a workshop was held at Prince Philip House to discuss Analysis under Uncertainty for Decision-makers. The workshop attracted a broad set of audiences including defence, water, energy, forestry, engineering sector and academia - see Annex 2. Though over 150 individuals registered actual attendees were lower than this with an estimate of 75 attending. This document represents a summary of discussions between participants and will form the basis of other outputs from the event.

The workshop was the fifth workshop hosted by Imperial College London and Warwick University on Decision Making under Uncertainty in 3½ years. The theme for this AU4DM Network workshop focused on 'Decision Making Under Deep Uncertainty?' and sought to unpick, through a range of clinics, the types of skill sets and tools that analysts, policy makers and decision makers from all sectors and a range of domains - can use when making decisions under deep uncertainty. It also sought to allow cross-fertilisation of thinking between members as well as find out what they want from this, at present, informal network.

It was noted at the workshop that AU4DM Network activities have started to gain traction. It is starting to deliver impact via workshops and the undertaking of a number of projects with partners. The AU4DM Network Steering Group would encourage the members of the Network to find out more about these with a view to making a contribution. This can be realised by reaching out to the project leads as annotated below. If you are not a member please register as a member via the website by scrolling to the bottom of the home page: <http://au4dmnetworks.co.uk/> and then reach out to the project leads:

1. **Lighthill Risk Network** - Geoff Darch (E: gdarch@anglianwater.co.uk) Working with the insurance sector to understand and highlight why certain underwriting risk selection decisions are made in the absence of information or where there is only imperfect information available.
2. **Bringing Energy Futures to life Special Interest Group** - Richard Heap (E: Richard.Heap@es.catapult.org.uk) Working with National Grid to explore the effective generation, employment and communication of Energy Futures to decision makers, stakeholders and society. It will do this by using the National Grid Future Energy Scenarios (FES) as a case study.
3. **Development, Concepts and Doctrine Centre, MOD** - Mark Workman (E: mark.workman07@imperial.ac.uk) and Mark Burgman. Working with senior decision makers from the UK military and civil servants to better understand how to structure decisions, apply expert judgement and think about the future, risk and certainty. Will potentially result in the development of a substantive research agenda
4. **Visualisation Catalogue development DSTL/ATI** - Polina Levontin (E: polina.levontin02@imperial.ac.uk) Working with a variety of partners to develop a catalogue on effectively communicating risk and uncertainty to different audiences. This work has been primed by a workshop the team ran on behalf of the Defence Science and Technology Laboratory and Alan Turing Institute.
5. **Decision Support Catalogue** - Simon French (E: simon.french@warwick.ac.uk) Working with AU4DM Network members, Nesta and potentially RAND to develop the next iteration of the catalogue. The first version was released in May 2018 and can be found on this [link](#) on the AU4DM Network website.
6. **Decision Support Tools for Addressing Uncertainty in Climate Change Issues** - Mark Workman (E: mark.workman07@imperial.ac.uk) and Simon French. On-going work from a by invite only workshop held on 26th March exploring the way that decision support tools are employed for making decisions for managing climate risk under uncertainty over a number of timeframes and spatial scales.

7. Decision Quotient Framework Craig Smalley (E: c.smalley@imperial.ac.uk) - Decision Quality is a framework for ensuring the elements necessary for making a good decision are present at the time the decision is being made. The AU4DM Network is looking to develop a competency metric - Decision Quotient - around organisations capability to make good decisions as well as understand decision support tools.

The Network is also always looking for further collaborators and partners to work with from across industry, policy and academia. So if you have projects, ideas or problems that you would be interested in collaborating with the Network on - particularly if they have funding associated with them - then please get in touch with Mark Workman mark.workman07@imperial.ac.uk or Simon French simon.french@warwick.ac.uk

2. Workshop Details

The objectives for the workshop were as follows:

- Allow capacity to be developed for decision support tools and a community of practitioners;
- Connecting decision makers to researchers and the analyst community; and
- Realising (research) funding for the AU4DM Network community.

A workshop agenda is available in Annex 1. The workshop can be broken up into the following seven sessions:

- General introduction to the Network by Mark Workman;
- Attendees survey results presentation by Lucas Kruitwagen - section 3.1;
- A Key Note speech by Emma Soane - section 3.2;
- A set of four clinics on:
 - 1) Expert Judgment Best Practice;
 - 2) What Does it Mean to be a Decision Quality Organisation;
 - 3) Visualisation of Uncertainty; and
 - 4) Dynamic Adaptive Pathways - see Section 4;
- Two 'Pop-Up Talk' Sessions involving 10 x 5 minute talks in total from participants discussing: (1) the problems that they have in their organisations; (2) what tools that they use to address risk and uncertainty; and (3) how they implement the outputs into strategy - see Section 5;
- A decision-making panel was convened by Nick Mabey to assess what decision-makers want from the analytical community - see Section 6; and
- Networking Drinks.

Finally, a feedback survey was sent to delegates to capture how to take the AU4DM Network's agenda forwards in the UK decision-making under uncertainty arena - see section 7.

3. Survey Results and Key Note Speech from Emma Soane, Assistant Professor of Management, London School of Economics

3.1 Workshop Attendee Survey Results

Of the 150 attendees who registered for the workshop 42 completed the online survey. The results were collated, analysed and presented by Lucas Kruitwagen. This builds on the survey undertaken last year which can be found on this [link](#).

The slide deck accompanying Lucas's presentation can be found [here](#).

3.2 Key Note Speech from Emma Soane, Assistant Professor of Management at the London School of Economics

Dr Emma Soane then delivered a keynote speech based on her work undertaking research with executives, senior business leaders and business organisations on decision making, risk and uncertainty. Emma's presentation was on "*What do you need to make a Good Decision?*"

Emma Soane's keynote speech considered how organisations create frames that drive decision making, and the implications of these frames for understanding uncertainty. She described Huber and McDaniel's decision making paradigm which suggests that organisations as systems of knowledge, hence organisations need to be designed to enable effective decision processes. Such processes need to take account of individual differences, for example people's orientation to risk taking, as well as Ward Edwards' principle that it is more important to focus on how decisions are made rather than simply the outcomes of decisions. Emma drew upon her own research to discuss how two attributes of decision processes, decision visibility and alignment between choices and organisational goals, contribute to more effective decisions and the attainment of strategic goals.

4. Clinics

A summary of the agendas covered in each of the workshop clinics can be found in the following respective sections:

4.1 Clinic 1: 'Expert Judgement Best Practise' with Mark Burgman. This clinic took ideas and contexts from the participants to identify where expert judgement is used and what the problems are that might arise from it. The session explored ways of engaging with experts to generate more **accurate and better conditioned estimate of quantities, and the outcomes of future events**. Participants were given some simple and effective strategies for improving the quality of expert inputs to decisions.

There was no presentation delivered during the session. The overarching problems and mitigation strategies around improving expert judgement are summarised below:

a. What doesn't work?

Relying on individuals...

- Overconfidence, hindsight bias
- Framing, availability bias
- Reference group, base rate neglect
- Using the person who (everyone believes) knows the most: status effect
- Undetected linguistic uncertainty

Relying on naïve groups...

- Naïve question formulation: linguistic uncertainty
- Unstructured discussion
- Dominance, group-think
- Uniformity in context, culture, styles of reasoning

b. To fix problems

Ask individuals to...

- Answer the same question in different ways (lowest, highest, most likely)
- Indicate confidence
- Examine estimates made by other people (feedback), consider counter-argument
- Revise original estimates after feedback
- Anticipate issues with conditional probabilities, base rates, ...

Then, don't rely on individuals...

- Discuss questions to eliminate linguistic uncertainty
- Make groups diverse—age, gender, background and cognitive style, culture
- Avoid group think—Delphi structures / anonymity in judgments

4.2 Clinic 2: 'What does it mean to be a Decision Quality Organisation?' with Craig Smalley, Emma Soane, Simon French and Martine Barons. This clinic proposed a Decision Quality (DQ) framework for ensuring the key elements necessary for making a good decision are present at the time the decision is being made¹. The session discussed the elements of DQ, and how it can be applied to individual decisions and at an organizational level. The advantages of achieving organisational DQ were addressed, as well as some of the potential barriers and how these may be overcome.

The opening session presentation by Craig Smalley on 'What is decision quality' can be found on this [link](#). Nadia Papamichai's presentation on 'What is organisational DQ? How it can be achieved and what are the benefits' can be found on this [link](#). Peter Naylor's presentation on 'What does it mean to be a Decision Quality Organisation' can be found on this [link](#). Finally, Will Hill's presentation on 'Stronger Decision Making Stories' can be found on this [link](#).

Associated Notes from the brainstorming sessions can be found below:

DQ processes currently in use:

- Some investment in training;
- Reluctance to share information;
- Elements are there but not as a process;
- Disconnect when it comes to commitment;
- Commitment doesn't get below board level;
- Key decision makers can make things happen; and
- The distribution of power can change when/how the DQ process is implemented.

Questions regarding the use of DQ tools:

- What is decision quality vs. other decision processes?
- How frequently used?
- How diverse are viewpoints?
- Are different models in use?
- How politicized is the process?
- What are the boundaries of decisions and the decision context?
- How discussable are the constraints, e.g. life/cost trade-off?

¹ It is noteworthy that the Society of Decision Professionals has developed an 'Organisational Decision Quality' assessment which might be very similar to the competency metric being discussed here (see <https://www.decisionprofessionals.com/rh-award-odq>)

- How can the DQ principles be embedded in practice?
- How do DQ processes compare with other decision processes?
- How are DQ process influenced by power (are some disenfranchised?), and by risk appetite?

Benefits:

- Should deliver more of what we want, i.e. reducing cost and greater value from the same spend;
- The more decisions affect, the more statistically likely to add value;
- Involving front line works in information gathering increases commitment; and
- Improves organizational credibility and reputation.

4.3 Clinic 3: 'Visualization of Uncertainty' with Polina Levontin, Jana Kleineberg and Joseph Lindsay Walton. The aim of this clinic was to review the state of visualisation of uncertainty, to share experiences from different fields, and to run an interactive clinic with a focus on several case studies.



The basis of the clinic was the newly compiled AU4DM Network Catalogue of Visualisations - which can be found on this [link](#).

The presentation which accompanied the clinic delivered by Polina, Jana and Jo can be found on this [link](#).

A summary of the clinic can be found below:

a. Visualisation impacts many aspects of decision-making Decision outcomes

- Correctness of decisions;
- Kinds of errors made;
- Decision time;
- Confidence in a decision;
- Willingness to make a decision;
- How much workload decision-making causes; and
- How a decision is made.

b. In visualising uncertainty, no one size fits all “We do not have a comprehensive understanding of the parameters that influence successful uncertainty visualization, nor is it easy to determine how close we are to achieving such an understanding.” (MacEachren et al., 2005)

The catalogue ...

- Briefly summarizes literature on visualisation of uncertainty in the context of decision-making and illustrates its main findings with examples;
- Concludes MacEachren et al.'s statement is still true;
- Examines implications of the lack of general theory upon which to build successful visualisations;

- Recommends a strategy to follow on a case by case basis - see **12 Step Strategy for Uncertainty Visualisation Design** - opposite; and
- Breaks down methods that can be used to build visualisations of uncertainty.

c. The catalogue proposes a framework for visualising uncertainty.

- Start by exploring the nature of uncertainty and understanding the aims of the visualisation.
- Classification of uncertainty is where the visualisation catalogue links up with the *Catalogue of Decision-Making Tools*.

4.4 Clinic 4: 'Dynamic Adaptive Pathways' with Geoff Darch. Dynamic adaptation pathways provide a technique for strategic planning that helps make decisions on which (sets of) options perform robustly over time and under uncertainty. This session described the evolution of the pathways approach, with practical examples provided. The work of the British Standards Institute in developing new guidance for adaptation pathways will be introduced. Participants will be able to discuss the use of adaptation pathways in their own work.

Geoff Darch's opening presentation on 'Introduction, need and terminology regarding Dynamic Adaptive Pathways' can be found on this [link](#). Tim Reeder's presentation on 'Development of adaptive pathways and water resources planning case study' can be found on this [link](#). Peter von Lany presentation on 'Adaptive pathways in coastal management' can be found on this [link](#). Finally, Katy Roelich's presentation on 'Adaptive pathways in transport planning' can be found on this [link](#).

Discussion notes from the session chaired by Geoff Darch can be found below.

Q1: How could you use adaptive pathways in your decision making?

- Can allow an assessment of resilience (or a proxy, vulnerability) issues for policy debate;
- Visualisation (of the period of efficacy and implications of alternative adaptive actions?);
- Complementary to problem tree and resilience matrices; simplify complexity for action;
- Understanding of system but recognise some level of irreducibility; reveal complexity;
- Common vulnerabilities: inform contingency plans;
- Different scales: can do it quickly based on expert judgement;
- Water resource management in shorter term e.g. reservoir operation;
- Complementary to root cause analysis: understanding vulnerability paths of cascading risk;
- Police numbers, investment and intervention;
- To complement scenario testing?
- As a basis of producing evidence on adaptation as encouraged by the Taskforce on Climate-related Financial Disclosure (TCFD); and
- Exploring the wider implications of financing adaptation?

Q2: What are the potential advantages?

- Can complement (?) multi-disciplinary scenario analysis?
- Supports system(s) thinking;
- Identify 'end points' on options;
- Managing transitions;
- Repeatable;
- Systematic approach;
- If applied at a high level, help problem definition and informs understanding; allows a richer discussion of potential plans;
- Helping decide when decisions will need to be taken;

- Should facilitate more proactive decisions;
- Gives more structured 'early warning';
- Identifying and communicating choices;
- Identifies what issues are;
- Understanding available options: in parallel; in series;
- Promotes (difficult) discussion;
- Explicit about goals (implicit and explicit): bind 'buy-in' to decisions;
- Ambitious: what are the opportunities that want to take advantage of e.g. transport; and
- Framing change through disruption in positive terms.

Q3: What do you perceive as barriers to getting started with pathways? [Challenges]

- I don't make decisions but... political acceptance of high, explicit uncertainty? Preference for consensus in 'evidence'? Need for consensus in e.g. IPCC? Preference for accountability with 'evidence'? maybe it doesn't matter if uncertainty is more in future framework than 'the next decision';
- Reduce investor certainty for strategic decisions? (but makes uncertainty and management of it more explicit). Avoiding the unexpected and building longer-term confidence?
- Setting triggers for difficult to quantify / qualitative critical metrics;
- How to optimally balance uncertainties in observations and projections / modelling results, into the pathways / triggers;
- Any possibility of using the approach as a tool for (deep) uncertainty and sensitivity analysis?
- Too 'linear' a process? Can it capture systems dynamics? And non-linear tools difficult to apply/understand;
- How to 'prune' the decision tree? 'Optimal' number of adaptive pathways?
- Convince regulators to adopt this approach;
- Multiple competing objectives;
- Economic and social evaluation of pathways;
- 'Social cost' aspect. Social policy deficit; and
- How do you measure / include ethical values?

5. Pop-Up Talk Sessions I to II

The Pop-Up talk sessions by delegates are summarised below.

Session I:

This session was comprised of the following participants:

- (1) **Tobias Pforr** - University of Reading. To improve how a decentralised network of humanitarian organisations delivers relief around the world for any kind of disaster;
- (2) **Vicky Pope** - Met Office. To improve the communication of uncertainty in meteorological forecasts;
- (3) **David Viner** - Mott MacDonald. What decision support tools are used to address risk and uncertainty around climate change over different temporal and spatial timescales. **No presentation was given for this pop-up talk;**
- (4) **Emily Black** - University of Reading. Quantifying uncertainty in our products and services around agricultural livelihoods in Africa; and
- (5) **Ricardo Barcelona** - Imperial College London. Energy Investments - An adaptive approach to profiting from uncertainties.

The pop-up talks given in this session can be found in the following link [here](#).

Session II:

This session was comprised of the following participants:

- (1) **Jaime Catalina** - Red Cross. Forecast-based Financing in the Red Cross Red Crescent Movement
- (2) **Bruce Garvey** - Imperial College London. Profiling uncertainty: a multi-faceted problem?
- (3) **David Stainforth** - London School of Economics. How to make predictions/projections of future climate at the regional/local scales relevant to adaptation decisions e.g. for infrastructure construction and management
- (4) **Gianluca Pescaroli** - University College London. How to improve organisational resilience in the face of cascading disasters? and
- (5) **Sunny Modhara** - Network Rail. Decision-Making at Network Rail.

The pop-up talks given in this session can be found in the following [here](#).

6. Decision-maker Panel: What do Decision-makers Really Want?

A decision-maker panel was held at the end of the first day chaired by Nick Mabey. The Panel consisted of:

- **Nick Mabey**, CEO, E3G. (Chair)
- **Justin Hughes**, Founder and Managing Director, Mission Excellence.
- **Niva Thiruchelvam**, Deputy Director for Education and Skills in HM Treasury.
- **Rebecca Heaton**, Head of Sustainability and Policy, Drax Group.
- **Geoff Darch**, Water Resources Strategy Manager at Anglian Water

The following points were raised during the Panel Session:

What do you need to make a good decision?

The panel were invited to introduce themselves and to illustrate why a good decision-making process is important to their work.

Justin Hughes - is interested in the psychology of risk, how it is rationalised and how to make rapid decisions with imperfect information. He illustrated this with an example where the Red Arrows unexpectedly flew into cloud. The pilots had to switch from flying with unconscious confidence to a situation with a real risk of catastrophe. Reverting to flying individually the pilots relied on the predictability of the other pilots' behaviour, which was built-up from years of multiple scenario planning and dynamic mental rehearsal. This 'map and predict' approach developed a script for each situation enabling responses to known-unknowns. It also built up a set of priorities and fall-backs that can be applied to unknown-unknown situations.

Although the military are seen as having a command-and-control hierarchy, it is based on empowerment and decentralizing of risk. This enables any unit or leader to respond rapidly if situations change. Whilst organisations understand this, they are often uncomfortable applying it, especially when compliance is an issue, such as the oil and gas sector.

Niva Thiruchelvam - For government to make robust, large investments then a framework is needed that can deal with uncertainties. Analysts and experts are needed to help identify the primary and secondary impacts

of an issue, such artificial intelligence, and to understand the mechanisms of influence and develop mitigation measures. Pilot projects help develop proposals, and can identify local leadership, which in turn can make the schemes more flexible and responsive.

Rebecca Heaton - Decisions can be quick and high-pressure, such as buying shipments of biomass - while the ship is being loaded - or longer-term and considered, such as the future of biomass. Making rapid decisions, where each shipment is different and compliance comes with reputational risk, needs to be under-pinned by robust processes and engagement with supplies. Defining the sustainability of biomass covers a wide range of factors and requires developing consensus across stakeholders. Drax's ethics committee challenges ideas and its diversity helps avoid group-think.

Geoff Darch - makes infrastructure decisions to ensure long-term water supply but need to develop mechanisms to factor in the uncertainties about future demand, with changing population and uses, and of the sources of water due to climate change. Regulation also seeks to protect the environment, by avoiding over extraction. Dialogue with the regulator and customers is important to explore the issues and willingness to pay.

Questions / Discussion

A discussion around the role of research and academia highlighted the need for a mix of blue-skies work combined with analysis of specific issues. For energy there is a need to understand how to navigate the transition rather than just exploring specific options. A set of 'policy principles' could be developed from a whole-system approach. Understanding how policymakers use data is also important.

Similarly, disaster risk is highly studied, but more post-event analysis is needed to identify causes and to develop a 'theory of disasters'.

In public policy, political pressure often drives a quick response, but leads to a poor decision. Some issues are hard to resolve and keep coming back and require focussed research.

Funds needs to be available to allow time to make decisions better. Past events, investments and decisions should be reviewed to understand what worked and what went wrong. Also explore the political economy of risk – who is being protective, who pays and how strong is the social contract? Policy examples include flooding and heat, where the distribution of costs present big challenges.

It was noted that policymakers respond to models differently. Attitudes range from regarding them as too theoretical and uncertain and are therefore rejected, while others take the model as solid, but do not fully discuss the caveats. Over time the use of models has changed, in the 1970s models were regarded as tools, but now modelled scenarios can be treated as predictions.

It was cautioned that uncertainty in models cannot be reduced to the extent that they can make the decision. The model outputs therefore need to be considered alongside other aspects.

There is also a risk that policymakers and decision makers have very little time to make a decision and to consider the modelling caveats and the wider aspects.

Key issues were identified to help improve how policymakers understand and use models:

1. Assumptions used in the models need to be made explicit;
2. Take time to develop a response – either for making the decision or by developing background understanding to inform quick decisions; and
3. Talk about the decision and the role of models in making the decision.

Taking time to talk about a decision and the use of modelling was noted as essential. Discussion exposes the model and allows a better understanding of its significance. Decision makers need to talk with analysts to help define what information they need and where the gaps are.

When quick decisions are expected, then ongoing engagement with the decision maker is needed, to develop layers of understanding of the area, which can provide the basis for responding when presented with information.

A further challenge is the perception and language used by different parties, particularly around climate change. NGOs regard it as an existential threat, whereas it is often referred to by politicians as a climate risk, which implies it is manageable. An emotional gulf is created with the feeling that politicians are not taking climate seriously. The challenge is how to talk about an existential risk that spans over 50 years, when there is uncertainty about the problem and how to address it.

Several of the panel members referred to devolving decisions, which led to a discussion about who owns a decision and how to define guiding values. Ownership can be delegated, but not responsibility. Liability if things go wrong lies with the responsible party, even if the authority to make decisions has been delegated. Delegation empowers people but need to know what this includes, why and the boundaries of the space – a banker can lose £10million through making risky decisions but should not be fired if the risks are within what they were 'allowed' to do.

Government is responsible to Parliament, but Parliament remains liable.

A question was raised about how to avoid duplication of effort and decision making if delegating to multiple persons or groups, such as government support for drug testing and development.

It was proposed that delegation should go as deep as humanly possible, and no further. This gets it deep into the organisation. Duplication is not necessarily a problem as long as it does not become prescriptive and reduce innovation. Institutions should design the process rather than the decision.

Developing a decision-making structure within an organisation requires profiling the main issues that affect it, such as compliance issues, and identifying predictable behaviours. This allows the focus to be on what could be done differently.

Structures need to be developed at all levels, including ensuring that non-executives understand risk. This provides the basis for developing a robust decision-making process across the organisation.

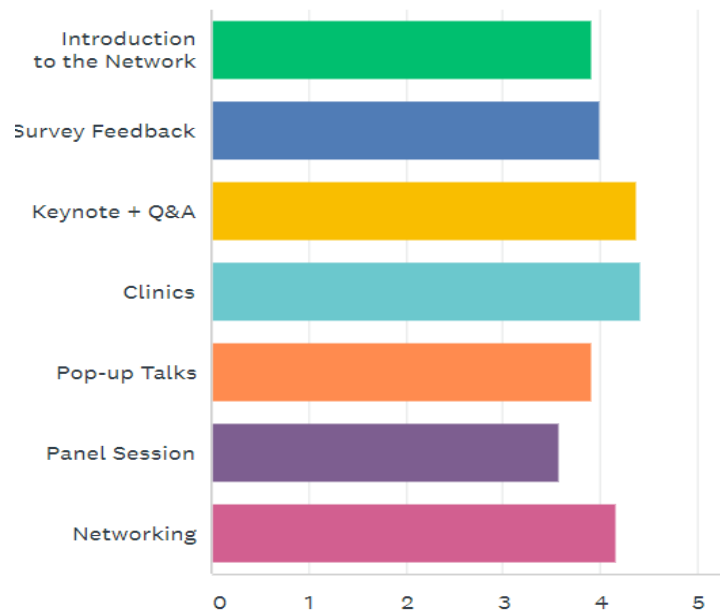
Decision making is often made in silos, either within an organisation or between sectors. For example, the water, energy, agriculture and environment sectors all view water differently. Addressing this requires working with all the parties and developing trust and a mutual understanding of the risks. Using a simulator of water supply and demand helped explore the interests of each sector and developed an understanding of the impacts and the trade-offs.

Within organisations, practical actions can help break-down silos, such as senior leaders meeting on a regular basis or sitting together. One company regularly rotated the roles of its vice-presidents so widen their experience of the whole operation. The military use 'red-teaming' and war-gaming exercises. These are low resource but allow people to gain new perspectives, such as how a competitor or customer views the issues.

7. Feedback and What Next for the Analysis under Uncertainty for Decision Makers Network

The feedback survey was sent to delegates to capture how to take the AU4DM Network's agenda forwards. The following were the main feedback from the limited number of responses we got from the survey:

On a scale of 1-5, how would you rate each aspect of the workshop, with 1 being poor, and 5 being excellent?



How can we make our events better in the future?

- The possibility to attend a couple of clinics
- This workshop felt a bit similar to the one last year -- it wasn't clear (with the exception of the clinics, which were clearly on different topics) how anything had moved on. The panel session lacked direction. The venue was nice and the keynote very good.
- sharing/discussion of some "emerging best practice" case studies
- Would like more on methods and tools with comparisons and case studies
- When I was given the agenda, I was excited about the clinics as all the topics are so relevant and interesting. I looked forward to take part but they were held in parallel so I have to decide which one I really want to go. I picked the visualisation clinic and the delivery of the workshop was not what I expected. The clinic started with bunch of slides in text and the style was a combination of speed-dating (keep changing tables) and lecture. The physical setting could be better to accommodate this style. The pace was too quick - if I was briefed it's a speed-dating style discussion then I thought we could have done better in the given 5 minutes. It's a visualisation clinic but there were not enough visual impacts to showcasing the most recent development in visualisation tools and how these tools helped to interpret uncertainties. Maybe I got the gist wrong from the agenda. But the first half of the workshop was too descriptive and not enough demonstrating the issue of visualisation tools/ uncertainty in "visual" way. Second half I moved to "Adaptive pathway" as my colleague wasn't able to come due to the event was oversubscribed. The discussion (off-loading) was quite insightful especially the exchange between the participants and the speakers. Instead of having 4 clinics held at the same time, I think it can be two clinics in the morning and two in the afternoon. Allow a reflection session with the entire audience after the clinics. Cut the pop-up talks into 5. Alternatively, turn the pop-up talks into speed-dating style, they happen at the same time and allow the audience to move around to each topics. Trying to do a good clinic/breakout session and a full-scale pop-up talk would be too much going on in a day.
- I think at this stage the group could be more focussed. There were some really excellent speakers and great quality content but there could be a bit more quality control. I'm not sure there were enough specialists to warrant parallel sessions, I would rather have seen single sessions and a more tightly edited programme. I did learn a lot though.
- I felt that many of the pop-up talks would have benefited from spending 30 seconds introducing the context of what they were saying. Some dived straight in and assumed everyone knew what they were talking about; I was probably not the only one who didn't!

What would you like from the AU4DM network going forward?

- These workshops are invaluable to gain different perspectives on decision making under uncertainty and I hope they continue
- to be kept informed of initiatives that share good ideas and successful applications of decision making under uncertainty
- Perhaps more frequent regional meetings
- More case studies and papers
- I think a more focussed network in support of the annual events. Closer ties with the international group seem like a good idea. I wonder if this will emerge naturally as Deep Uncertainty methods become more widespread and taken up in industry/govt. But I would like to thank and encourage the organisers, there was a lot of good quality material yesterday and everything else was still thought-provoking.
- To understand how different organisations deal with and quantify uncertainties encountered in the decision making process.
- We have to maintain the network, simple to say harder in practice

Annex 1: Agenda

Analysis under Uncertainty for Decision Makers Annual Workshop - Decision Making Under Deep Uncertainty dated 5th March 2019 at Prince Phillip House, London.

0830	Breakfast and Registration
0900	Welcome and Introduction Setting the scene: (1) Reflect on the previous conference; and (2) Survey feedback.
0930	Keynote speech: “What do you need to make a Good Decision?” <ul style="list-style-type: none"> • <i>Dr Emma Soane</i>, Assistant Professor of Management.
1015	Clinics* x 4
1130	Break
1200	Clinics* x 4
1315	Lunch
1400	Pop-up talks session I: 5 x 10 min talks by attendees
1500	Break
1530	Pop-up talks session II: 5 x 10 min talks by attendees
1630	Panel Session: “What do you need to make a Good Decision?” <ul style="list-style-type: none"> • <i>Nick Mabey</i>, CEO, E3G. (Chair) • <i>Justin Hughes</i>, Founder and Managing Director, Mission Excellence. • <i>Niva Thiruchelvam</i>, Deputy Director for Education and Skills in HM Treasury. • <i>Rebecca Heaton</i>, Head of Sustainability and Policy, Drax Group. • <i>Geoff Darch</i>, Water Resources Strategy Manager at Anglian Water
1730	Networking Drinks
1900	Close

Annex 2: Participants list

Salvador Acha	Imperial College London	Ajay Gambhir	Imperial College
Prue Addison	University of Oxford	Bruce Garvey	Strategy Foresight Ltd
Anthony Alexander	University of Sussex	Ugo Gasparino	RWE Generation UK
Alaoma Alozie	Imperial College	Rommel Govindarajan	Flames UK
Camilla Audia	University of Sussex (Brighton)	Kristen Guida	London Climate Change Partnership
Martine Barons	University of Warwick	Jason Hancox	Smith Institute
Ron Bates	Rolls-Royce plc	Richard Heap	Energy Systems Catapult
Ausilio Bauen	Imperial College	Keith Hermiston	Defence Science and Technology Laboratory
Adam Bell	BEIS	Will Hill	Stronger Stories
Jonathan Best	Wellcome	Michael Hobson	Department for Transport
Daniel Black	db+a	Julie-Anne Hogbin	Environmental Defense Fund
Muriel Bonjean Stanton	University of Leeds	Alison Hopkin	HR Wallingford
Charles Boulton	Charles Boulton Ltd	Justin Hughes	Mission Excellence
Pablo Brito-Parada	Imperial College London	Ruth Hughes	Natural Environment Research Council
Mark Calverley	Blue Ocean Consulting Ltd	Lorraine Hutt	EA
Robert Carlsson	Infrastructure and Projects Authority	Kalyani Inampudi	Wase
Barry Clive	Photonic Power Ltd	Catalina Jaime	Red Cross Red Crescent Climate Centre
Humphrey Crick	Natural England	Chonnetia Jones	Wellcome
Daniel Crow	Imperial College	Sanjoy Khataniar	Schlumberger
Geoff Darch	Anglian Water	Jana Kleineberg	Kleineberg Illustration & Design
James Derbyshire	Middlesex University	Melina Koutsis	Start Network
Jason Dinsdale	Environment Agency	Lucas Kruitwagen	Smith School of Enterprise and the Environment
Charles Donovan	Imperial Business School	Jenny Kwok	Thames Water Utility Ltd
Geoff Down	National Grid System Operator	Adrien Lebrun	Pivot Power
Tohid Erfani	University College London	Polina Levontin	Imperial College
Charles Featherston	Government Office for Science	Sarah Livermore	Committee on Climate Change
Valentina Ferretti	London School of Economics and Political Science	Jason Lowe	Met Office and University of Leeds
Simon French	University of Warwick		

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Rick Lupton	University of Bath	Olga Shashkina	Global Security and Disaster Management Ltd.
Nick Mabey	E3G		
Jim Maltby	DSTL (MOD)	Francis Shaw	Sustainable Energy Transitions
Michele Manici	Vodafone Group plc	Daniel Silk	Dstl
Wendy Matthews	Central Government	Mike Simpson	HR Wallingford
Marissa McBride	Imperial College London	Pradeep Singh	University of Bremen
Silole Menezes	freelance	Margarita Skarkou	Barclays UK Ventures
Prathyush Menon	University of Exeter	Craig Smalley	Imperial College
Giulia Micale	The Conduit	Emma Soane	LSE
Richard Millar	Committee on Climate Change		London School of Economics and Political Science
Axel Miller	SAMS	David Stainforth	
Sunny Modhara	Network Rail	Mike Steel	Environment Agency
Alex Murray	IPA, Cabinet Office	Ine Steenmans	UCL
Mark Naylor	University of Edinburgh	Marcus Stewart	National Grid SO
Peter Naylor	Shell	Elena Tarnavsky	University of Reading
Nadia Papamichail	The University of Manchester	Izzeddin Teeti	KCL
		Alison Telford	Network Rail
Bryony Parrish	Science Policy Research Unit, University of Sussex	Peter Thompson	World Update
Andres Penuela- Fernandez	University of Bristol	Anh Tran	Coventry University
		Lawrence Tse	Imperial Consultant
Gianluca Pescaroli	University College London	Sandy Tung	100 resilient cities
Miroslav Petkov	S&P		Southampton Business School
Maria Peytcheva	Freelance	Ramesh Vahidi	
Tobias Pforr	University of Reading	Zulandi Van Der Westhuizen	Private
Edward Pope	Met Office	Ans Vercammen	Imperial College London
Vicky Pope	Met Office	David Viner	Mott MacDonald
Meysam Qadrdan	Cardiff University		VNG Consulting Ltd and King's College London
Tanya Rahman	IIED	Emma Visman	
Sam Reed	BEIS	Peter Von Lany	Jacobs
Tim Reeder	Trioss Global	Jo Walton	University of Sussex
Katy Roelich	University of Leeds		SOAS/Imperial College London
Pamela Rueda Cediel	University of Minnesota	Shuai Wang	
Gloria Salmoral	Cranfield University	Judith Ward	Sustainability First
Christopher Sandom	University of Sussex	Tanya Warnaars	Centre for Ecology & Hydrology

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Chris Watson	SKDhonsi	Dapeng Yu	Loughborough University
Tim Woodcock	MOD		
Mike Woolgar	WSP UK Ltd		
Mark Workman	Foresight Transitions		