Defra Science Advisory Council (SAC)
Minutes of meeting, 15 March 2023

Actions arising

Action number	Action	Owner
01	Send SAC documents alluded to in CSA update	Secretariat
02	Link up SSEG to animal and plant welfare team (biosecurity and risk team). national biosecurity and surveillance network	Secretariat
03	Share HPAI draft report with SAC	Secretariat
04	Marian Scott to keep SAC updated in this EU foresight project.	Marian Scott
05	Contact SSEG for advice on communicating successes and how to use qualitative data	SSEG
06	Add digital twins to future agenda	Secretariat
07	SAC to liaise with Secretariat if they have example of citizen science to monitor water system.	SAC / SSEG
08	Ask SAC to suggest members for the new water committee.	Water Team
09	Innovation & EO innovation- bring back again	Secretariat
10	Bring examples of socio-ecological systems learning and how this can be transferred from other scientific areas.	SAC

1. The Chief Scientific Advisor (CSA) Update

1.1 Departmental reorganisation

A significant Machinery of Governance Change has resulted in the breakup of Business Energy Industrial Strategy (BEIS) into three new departments; Department for Business and Trade (DBT); Department for Energy Security and Net Zero (DESNZ); the Department for Science, Innovation and Technology (DSIT) which inherited the digital section from Department for Digital, Culture, Media and Sports (DCMS). Staff of interest are Michelle

Donelan as DESNZ SoS and George Freemen as Minister for Science, Research and Innovation. Paul Monks remains as CSA at DESNZ. The new GCSA is now Angela McLean.

The CSA considers DSIT as a positive development as its gives a stronger central voice for science in government, including a seat on Cabinet (and secures the cabinet committee, the National Science and Technology Committee). Potential risks are that having a separate department of science means there may be a perception that other departments no longer need science, and DSIT is the primary funder of UK Research and Innovation (UKRI) giving the DSIT ministers a lot of influence within UKRI.

1.2 Important document releases

- [Science and technology framework](#) document came out on 6th March with 10 big things to make the UK a science powerbase. This includes the priority technology, engineering biology, very relevant to Defra.
- The [Research, development and innovation (RDI) organisational landscape: an independent review](#) (aka Nurse 2 review) published on 7th March proposes 29 recommendations, with policy on R&D and need to spend in Public Sector Research Establishments relevant for SAC.
- [The Integrated Review Refresh 2023: Responding to a more contested and volatile world](#) was published on the 13th March and contains relevant sections on biosecurity, science, climate, nature and biodiversity threats. This refresh talks more about chronic risks from climate change and is more balanced in relation to China.
- [Plant and heath biosecurity strategy](#) published 9th January 2023.
- [Environment act targets](#) announced in December 2022 which was followed in January 2023 by the Office for Environmental Protection publishing '[Progress in improving the natural environment in England](#)', to which the government responded with [environmental improvement plan](#).
- [Genetic Technologies (Precision Breeding) Act](#) passed Royal ascent and is now law. It will now be followed by secondary legislation to give details on mechanisms.
- Defra is working with UKRI to develop codesigned and cofunded research programmes under the five UKRI Strategic Themes. An early example is Defra funding half of a new programme on [Land Use and Net Zero](#). The SAC commented it would be good to have UKRI programmes co-reviewed in addition to them being co-designed.

1.3 EU research Programmes

The Windsor Framework agreement has enabled discussions to begin between the UK and the EU on association with Horizon, Copernicus and Euratom. UK participation must be on fair and appropriate to reflect the lasting impact of two years of EU delays to the UK's association.

1.4 SSEG

The National Bio-surveillance Network (NBN), and wider links between environment and health, were discussed at a Social Science Expert Group meeting in July 2022. SSEG and SAC Chairs were subsequently invited to meet the NBN Team and members were invited to comment on a draft paper about the NBN.

The SAC where informed that the SSEG Public Engagement Review had been used in a current British Academy project on Science, Trust and Policymaking, undertaken at the request of the Prime Minister's Council on Science and Technology.

ACTION 01: share the papers listed by CSA

ACTION 02: link SSEG to animal and plant welfare team for biosecurity

2. SAC-ED subgroup: HPAI update

Next week the Highly Pathogenic Avian Influenza subgroup of SAC-Exotic Diseases publishes its report. This will have four major themes: host, circulation in wild birds, vaccination, and modelling future trajectories. The SAC was asked for advice on how the public may respond to the report, such as unexpected perspectives to prepare for.

A summary of the report was presented to SAC. The HPAI global outbreak is affecting industry and pressure on veterinarian capability in the UK. The report looks at the host range of the disease within wild birds, birds that spread to poultry, and birds that spread to mammals which pose a risk to humans. Traditional surveillance has focused on the risk to poultry and this report recommends more data collection and funding to characterise the general host range and circulation. This would improve surveillance as currently five dead birds are needed for data collection in some species, need more passive and active surveillance and increase collection from smaller birds. Recommend expansion of the Great British poultry register which currently is only for premises over 50 birds and does not need to re-register every year, there are also a lot of optional data categories. The report recommends a FluMap is produced for broader range and to include a broader range of species that are circulating the virus but may not be dying.

Another recommendation is to research the receptor binding in host species which can be identified using the two known genetic markers. This includes an improvement to viral sequencing to understand the pattern of transmission between farms and wild birds. Broaden the range of labs that can assess this by allowing inactivated virus to be tested at more facilities and support getting live virus from remote locations to labs. Also recommended is to compare the current host range for previous Avian Influenza viruses to understand if the host range has changed because of demographic change or virial change.

Ultimately any adaptation strategies should be developed for the idea of having them as long-term improvements to live with this virus and be better prepared for other future disease problems. The data collection recommendations ultimately feed into the scenario modelling of how the disease will play out over the 2-year, or 10-year scales as this determines the response.

The SAC wanted to know if there are any critical species at risk of extinction because of this virus. The HPAI sub-group Chair responded that the disease should generally be included within conservation and biodiversity recovery plans.

The SAC asked if the spread of infection could be predicted by the shape of the known receptors or if theoretical biology could model the shape of receptors. The HPAI sub-group Chair responded that one receptor is known for this virus and Wendy Barclay will know about structural biology.

The report looks at spread in mammals and finds they are most likely infected from scavenging and not from spread between each other. Mink farm transmission in Spain is of most concern as ferrets have the potential to spread the virus more easily to humans. The CSA wanted to know why mammals where not being recommended for screening. Unpublished material was not included in the report, however there is research showing the virus has not become adapted for spread in mammals, also that mink range and human range are not overlapping outside of mink farms.

The report found that there is very little that can be done to reduce risk to wild birds, with one possible mitigation being carcass removal. Carcasses are often removed by scavengers who rely on this food, like kites, but are at risk of deadly infection, like badgers and raptors, and increase potential to circulate the virus. Manual carcass removal is impractical in some parts of country, so only advisable in important conservation areas. Species rely on scavenging carcasses for food so removal can impact food supply, for example kites. Another intervention explored was vaccination to reduce transmission. A program of trials on poultry is needed for winter to build upon current trials.

The SAC noted that the report's recommendation on gamebirds is sensitive. The report highlights the risks and uncertainty clearly without attributing blame and identifies a risk of infection when game birds are brought back after the hunting season ends.

The SAC foresees potential for media interest and misinformation, so it is very important to frame the questions such as protection of wild birds or protection from wild birds. Would also need to be clear that carcass removal was only to be done by experts in some situations and not the public. There is also likely to be questions around human and bird interactions through recreational feeding of birds.

ACTION 03: securely share the draft with SAC before release to comment on handling responses to the report.

3. Nutrient Neutrality

Defra policy team and Natural England presented SAC with the Nutrient Neutrality impact assessment, specifications comparing international comparisons of other member states on Nutrient Neutrality and four questions.

3.1 Innovation

The SAC encouraged more water treatment innovation within industry by providing space to allow companies to try innovating and acknowledge the risk of failure. Riskier innovative methods may be overlooked if companies are encouraged to only focus on achieving the technical achievable limits easily met with the current chemical approach. The scales of innovation needed to achieve the water goals need to be mapped out, so nature-based solutions are used appropriately and compared on their long-term benefits. The Water team responded that The Water Services Regulation Authority (OFWAT) and the Environment Agency are discussing how to provide space for innovation and that water companies are using innovation funding to help test approaches.

The SAC recommended that the water team investigate other innovations such as closed loops to grow algae that can be used as fertiliser. Tertiary water treatment of phosphate stripping which allows for reuse of phosphate on the land was also discussed, and the Water team confirmed that biological recovery is being explored by the water companies. The CSA suggested innovation in this area could be funded through a Shared Outcomes Fund bid.

The SAC mentioned working with UKRI and their investments into these areas such as digital twin NetworkPlus, also, the European Union foresight into water resilience report should be released in October 2023.

3.2 Nature based solutions

The SAC noted that more evidence is needed on quantifying the impact of nature-based solutions. A landscape laboratory approach could provide more evidence at different scales; the National Trust is joining up landscape scale thinking between landowners and adding in the monitoring to validate concepts. The SAC also discussed the concept of non linear ecological thresholds for recovery and suggested that this be brought into Defra thinking. The SAC wanted to clarify if the lack of science or evidence was preventing action or whether enough is currently known to begin implementing solutions. The Water team agreed that perhaps enough is already understood and that the focus of evidence gathering should be on monitoring, evaluating and validating changes in the environment which arise from interventions and would be required for nutrient neutrality credits.

The three paths that need to be followed in a joined up strategy in order to reduce nutrient pollution are to reduce pollutants at source, to regulate and change behaviour through incentives, and to treat remove or treat the pollution at receptor. The SAC also suggested that some innovative methods used to reduce easily measured pollutants like phosphate may also reduce other pollutants. The Water team responded that a large reduction in phosphorus loadings to water has already been achieved through changed to the formulation of detergents.

The SSEG Chair recommended Nature based solutions work by the British Academy which illustrates lessons from other countries. The SSEG has a new member who has lots of expertise in nature-based solutions. Water has a large cultural significance giving the topic historical importance and making it attractive to citizen science; for more information the British Academy report on environmental histories was suggested.

3.3 Industry

The SAC wanted to know what space there still is for changes in the Natural England Nutrient Mitigation Scheme. The Water team responded that the scheme is still evolving. The scheme will enable developers to purchase credits for nutrient mitigation to unlock housing across affected catchments. These credits provide mitigation rather than leading to overall improvements to the condition of protected sites.

The SAC mentioned UK CEH's ChemPop work on ecological thresholds which has found that changes in fuel types since the 1980s have resulted in the diversity of macro invertebrates in freshwater recovering to a good level. The Water team are working with UK CEH to potentially link this recovery in macro invertebrate diversity to other indications, for example the Outcome Indicator Framework linked to the 25-year plan and to biodiversity target indicators to feed into the cost benefit analysis of how a reduction in pollution links to eventual good ecological status and ecological recovery.

SAC raised concern over the timescales as to whether outcomes will be measurable in the short-term. Concern was also raised about the need to distinguish between groundwater- and surface water-dominated catchments where outcomes will differ depending on the type of intervention. Groundwater catchments will have a history of nitrogen pollution that will take a long time to resolve. The Water team agreed that legacy chemicals can cause significant pressures within groundwater fed catchments which may continue for decades irrespective of current mitigation efforts which should be considered when planning interventions at a catchment level.

ACTION 04: Marian Scott to keep SAC updated in EU foresight project.

4. Potential new policy interventions to transform the water system

The Water team presented a range of new interventions building upon those in the Environment Improvement Plan. This will inform a water evidence strategy that can help communicate research priorities and build a coherent research programme. There are also plans to set up a new water expert group following the success of the Water Expert Advisory Group which assisted in setting recent legally binding targets for the water environment.

Several priorities are set out, one being a new integrated management system for water with a catchment approach. Local level action is sometimes disconnected from national actors but this could be addressed by Defra's plans on green finance.

An uncertainty to address is the environmental impact of storm water overflows and how to prioritise them against other risks and pressures. Once high frequency water quality monitoring commences, data outputs will be very large and produce challenges for data management and analysis. There is also uncertainty around how to understand catchment level system change if some land use changes from farming to natural and semi-natural habitats, biomass production, or forestry.

The SAC asked if there are system models to guide how different actions will have impacts across the integrated water system. SAC suggested that the BEIS land use system model has collected most of the flow pathways but could be expanded to interact with land management, people and point source contamination to develop a full system model, and that UKRI could work on making this tool. The SAC mentioned that the ELMS modelling framework related to water could be integrated with Environment Improvement Plan plans. The Water team responded that a system model is not used but have been trialled in the past. The team uses conceptual models that focus on the land management rather than the water system.

The SAC asked about funding for these projects and how to get buy-in from the water companies to achieve Defra's goals. The SAC emphasised that some water companies have good relationship with PSREs and environmental Non-Governmental Organisations and demonstrating the benefits of these collaborations to companies is important.

4.1 Research

The SAC mentioned some areas that need further research;

- how to monitor diffuse pollution from mining and spoil heaps
- the social science of reducing societal water use
- the Natural Environmental Research Council (NERC) programme on multiple stressors such as chemicals and plastics combined

- the drivers of landscape scale freshwater biodiversity decline due to the impacts on small waterbodies and very clean water
- mapping where the biodiversity is across UK
- insights from the Digital twin technology investment from the Alan Turing institute and UKRI
- upcoming research in digital twin for assessing catchment scale interventions.

A significant difficulty to overcome is how to bring together lots of data resources from companies, this has occurred in Scotland by working with the United Kingdom Water Partnership (UK WP). More discussions is needed on aquaculture for shellfish and seaweed. The Geospatial Commission within DSIT work well on building industry relationships to release data. The recent NERC freshwater call is UKRI's most significant investment for freshwater, a large part of which is the re-evaluation of a more holistic way of bringing together over 30 years of monitoring data.

The SAC suggested that machine learning could be used to interpolate from locations with plentiful and precise data into regions where data is poor. Defra are aware this has been worked on for nitrate and phosphate through a modified version of Farmscoper although the platform was not specifically designed for this type of modelling. They are also aware of United Kingdom Centre for Ecology and Hydrology (UKCEH) models.

The SAC also wanted to know about chemicals of concern and mixtures, including endocrine disruptors. The Water team responded that chemicals of concern are a priority and research is done through United Kingdom Registration, Authorisation and restriction of Chemicals (UK REACH). Also of interest is the PATH-SAFE project on antimicrobial resistance and work on microplastics. Monitoring of emerging chemical threats should be a data priority with many assessments of chemicals being carried out in a lab environment and more understanding of chemicals' impacts in the environment is needed. Defra are producing a chemical strategy from the Environmental Improvement Plan (EIP).

A discussion on digital twins explored their definition as needing to have the ability to feedback into the physical system and the terminology should not be used as a substitute for models. Natural systems often do not have the ability to be a digital twin because decisions of the model cannot make changes in realtime, however, water has the potential for models to control sluices, abstraction, flood protections, and land applications. Future catchment models will need the ability to change predicted scenarios to bring them closer to being digital twins. The Water team responded that they know of Anglia Water and Climate Resilience Demonstrator (CReDo) developing Digital Twins. The SAC would like to discuss digital twins in more detail at a future SAC to understand what is meant by this; where this can work and can't; where it has failed; and where it can be repackaged.

4.2 Data access

Defra presented a table about how the water system can be transformed by looking at all its impacts at national and local levels. The SAC noticed this table could be divided into two themes of emissions and environmental quality, and wanted to know how these themes could be brought together.

The SAC also wanted to know if citizen science will be used to meet objectives and get community involvement. The Water team know that the natural capital ecosystem assessment (NCEA) is keen to use citizen science for monitoring and potentially evaluate some of the policies. The SAC could help fill the evidence gaps with examples.

The SAC mentioned several potential solutions to data-fragmentation across sectors:

- Some solutions can be found in the UKRI projects by UKCEH and NERC.
- Covid19 showed a good working relationship and how to gain access to data, the Scottish Water CSA may have useful lessons to share.
- Icebreaker One have had some success around sharing commercially sensitive data in the Finance and energy sectors, their methods could be applied to data sharing in the water sector.
- The United Kingdom Environmental Observation Framework (UKEOF) have been working on open data and data sharing.
- Data held by PSREs are accessible however due to their complexity work is required on how to deliver better insights.
- The Geospatial Commission could access data sources and connect to the systems of landuse, ELM, resource use, nutrients used elsewhere.

4.3 Water Expert Group

The CSA agreed that it could be beneficial to have a new water advisory group of approximately ten people that operates distinct from SAC. This water group should be very interdisciplinary like the biodiversity expert committee and would likely overlap with the other expert committees. SAC has been asked to consider the required expertise and send member suggestions to the water team.

ACTION 05: Water team to engage with SSEG in how to communicate successes and use qualitative data.

ACTION 06: Bring digital twins to a future SAC.

ACTION 07: SAC to liaise with Secretariat if they have example of citizen science to monitor water system.

ACTION 08: Ask SAC to suggest members for the new water committee.

ACTION 09: Bring Innovation & Earth Observation innovation to a future SAC.

5. Water Resilience

5.1 Metric of resilience

Defra introduced a topic about resilience in water to identify gaps across joint Defra and EA research. There are multiple interpretations of what a resilient catchment system should be; such as the ability to resist pressures to change; to recover back to an original state, or the ability to build back to a better state after a disaster. There is a need to measure states to determine resilience and recovery and it is important to know if the measurement is based on the original state or the function provided.

The SAC suggested Defra should prepare for a future when the necessary water supply is not available and what data is required to make water use decisions.

What is meant by a resilient water system and how this influences intervention was discussed by SAC. One interpretation could be focused on resisting specific pressures while another interpretation may manage public expectations and incentivise changes when stressors are identified. The understanding of resilience should inform what metrics need to be gathered which informs the monitoring equipment management strategy. Measurements of interventions need to be highly granular so they engage with the actors (e.g. farmers) and could be used to pay for changes.

Climate change's impact on resilience was discussed by SAC. The unpredictable nature of climate change should shift the goal of resilience to the ability to adapt across multiple stressors. Monitoring will need to occur across multiple variables to focus in on what key axes indicate something has gone wrong, for example when there is no drinking water or irrigation. The research into socio-ecological systems may not be as useful for the water system as it is better suited for unknown stressors.

5.2 Time scales

The SAC discussed the difficultly of incentivising action against legacy effect to correct choices made many decades ago, for example groundwater pollution. The timescales of these need to be considered when defining resilience.

The SAC also elaborated on how resilience can play out across timescales. Such as the difficulty working to be resilient to extreme shocks that have poor data to base decisions on. There are also systems that drift over time, from an event considered a rare shock to gradually becoming frequent. A definition for resilience would need to account for the entire system changing and therefore targets and monitoring plans should be future proofed for climate changes impact on temperature, drought and flow rates.

The SAC discussed how a system reaching a tipping point will start to show critical slow down such as the thermohaline collapse which shows as larger variation in the Atlantic

Meridional Overturning Circulation (AMOC). Nutrification in lakes also show critical slowdown. Measuring simple variables regularly provides useful metrics that make critical slowdown and tipping points detectable and predictable.

The SAC explained that scale is important in interpreting tipping points' impacts. Tipping points are very common in hydrology because they are part of the geomorphological processes for a catchment and don't always have negative repercussions. Sites evolve with nonlinearity, but you don't want the entire system to change in the same way, so scale is important, for example stream versus river catchment.

Models need to be careful not to remove data considered as noise because these can indicate tipping points (also know as hot-moments) in a catchment system. Hydrological examples of a hot-moment is changes at the base of the river to see changes in flow or oxygen levels. Here, a social-ecological framing can be useful because these catchments are not natural. It may be important to focus on the fragile environments, such as rare habitats, which can be the desirable end-states due to society focus on what is valued within the system. During a hot-moment, such as an extreme heatwave, you can persuade people to change their behaviours.

5.3 Research

SAC suggested that research by the [Stockholm resilience centre](#) about socio-ecological systems such as planetary boundaries and safe operating boundaries can help define achievable resilience goals.

The SAC wanted to know about drought resilience. Defra responded that there hasn't been a long drought for a decade or more in most of the country so these plans have not been tested for a while and corporate memory has been lost. Household water use has not changed which allows scope for reduction. The SAC were also interested in how a drought situation would affect Nutrient Neutrality when water becomes extremely recycled and proportion of wastewater in ecosystem increases. Also asked was how does drought, or lack of supply, couple with other systems such as electricity or cyber.

ACTION 10: SAC want to hear what socio-ecological systems learning can be transferred from other scientific areas. How the three points used to define resilience are used elsewhere. Challenge other use of the word reliance that it isn't being used for inaction.