IMPROVING SCIENCE ADVICE TO GOVERNMENTS

Michael Kelly et al.

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Michael Kelly, Clive Hambler, Roger Koppl, Peter Ridd and Harry Wilkinson

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Front cover: Ferdinand Verbiest, a Jesuit scientific adviser to the Chinese emperor.

The Byzantine emperor Justinian and his court.

Contents

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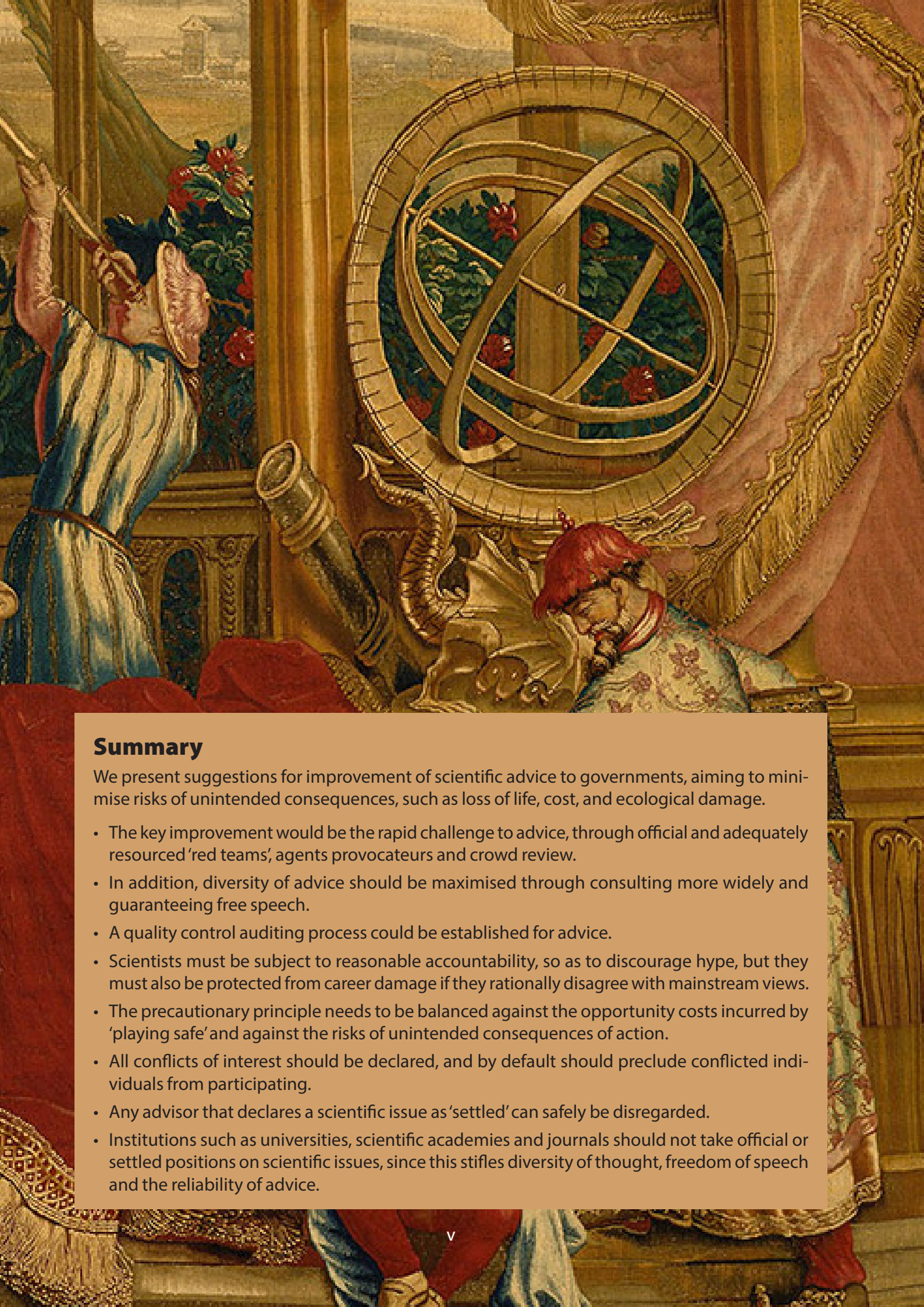
The Jesuit obsevatory at the court of the Chinese emperor



Summary

We present suggestions for improvement of scientific advice to governments, aiming to minimise risks of unintended consequences, such as loss of life, cost, and ecological damage.

- The key improvement would be the rapid challenge to advice, through official and adequately resourced 'red teams', agents provocateurs and crowd review.
- In addition, diversity of advice should be maximised through consulting more widely and guaranteeing free speech.
- A quality control auditing process could be established for advice.
- Scientists must be subject to reasonable accountability, so as to discourage hype, but they must also be protected from career damage if they rationally disagree with mainstream views.
- The precautionary principle needs to be balanced against the opportunity costs incurred by 'playing safe' and against the risks of unintended consequences of action.
- All conflicts of interest should be declared, and by default should preclude conflicted individuals from participating.
- Any advisor that declares a scientific issue as 'settled' can safely be disregarded.
- Institutions such as universities, scientific academies and journals should not take official or settled positions on scientific issues, since this stifles diversity of thought, freedom of speech and the reliability of advice.

Improving science advice to governments

Michael Kelly and Clive Hambler

Introduction

As countries around the world review their responses to the Covid-19 pandemic, one topic coming to the fore is the quality of scientific advice to governments. Among the issues already in play are the gross misuse of computer models in the absence of robust data with which to calibrate them, and the paucity of challenge to the scientific advice from scientific, economic or societal perspectives. Both these issues may have caused deaths, economic decline and societal ills (such as discrimination and poverty). We take this opportunity to review the science advice to policymakers over recent decades, in order to learn lessons and suggest improvements for the future. We focus particularly on the field of anthropogenic climate change (hereafter referred to as 'climate change' for brevity, although climate change includes natural drivers). Although this paper is UK-centric, many of the lessons apply more widely.

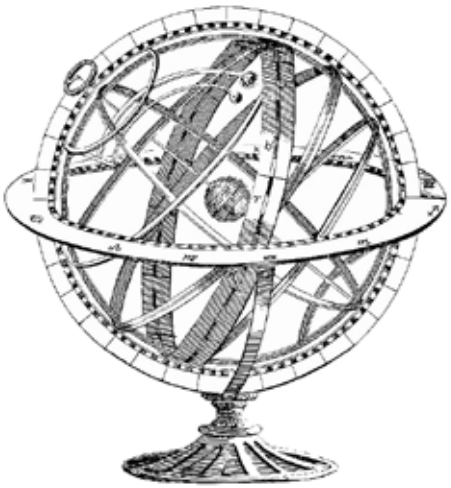
Policymakers need ready access to the fullest possible range of defensible scientific advice. Where this has the potential for high societal impacts, it should be challenged: by scientists independent of the initial advice (so-called 'red-team' reviews) and by lawyers (in a non-legal arena).

Red teams are well established in military and corporate planning.[1] Their use would give science advisers fewer incentives to exaggerate for effect, and would allow those who did so, or who omitted relevant facts or opinions, to be held to account. The key challenges would be finding, incentivising and protecting fully independent scientists, rather than just adding another layer of government-controlled, politically-aligned filtration. Scepticism must be recovered from its present position as an insult, and reinstated as a term of respect, and a core duty of universities and learned societies.

In what we describe here as 'non-consensus views', we are not including anything that is not backed by robust scientific practice – this is not a charter for the indefensible, but for exposing it. It is also important to acknowledge that politicians are elected to make decisions on the part of society, advisers are not. If the delay between advice and action in the case of Covid countermeasures is attributable to political considerations, the scientists are not responsible for it, or for any consequences.

This paper has been through a process of 'open review' on a published draft, and some of the comments received are published as appendices to it. The full set of review comments is available on the GWPF website.[2]

We begin with actions that could immediately improve advice with the current cohort of scientists, advisors and committees, despite present conflicts of interest and deficiencies. We then consider entrenching improvement through longer-term strategies.



Recommended measures for the short term

Challenging the advice to the UK Government

Whilst based on wider experience, we focus here on two case studies of scientific advice to governments: Covid-19 and climate change. There are strong similarities in the deficiencies of advice in these areas, relevant to many other topics (including, in our experience, 'biodiversity net gain', rejection of pharmaceutical interventions for Covid, and optimal vaccine deployment).

In the UK, the Scientific Advice to Government in Emergencies (SAGE) process involves convening an ad-hoc committee of experts relevant to the particular emergency, answerable directly to the Prime Minister. In the case of the Foot and Mouth outbreaks in 2003 and 2007, the committee largely involved experts in animal health. For Covid, the expertise deployed was in viral infections, public health, psychology and vaccine development.

During the Covid outbreak, there was little formal challenge to ideas produced and agreed by the SAGE Committee; although a few dissenting experts (e.g. Professors Sunetra Gupta and Carl Heneghan) were invited to comment by the then Prime Minister, Boris Johnson, they apparently had little early influence. That is not to say there was no internal debate, and there was evidently at least one highly experienced dissenting epidemiologist – Professor Mark Woolhouse – on the committee, but the basis on which the agreed advice was arrived at was never transparent.

If there had been a red team challenge to the assumptions on which the SAGE Committee were operating, the outcome might well have been very different, and the public would certainly have had more confidence that the scientific advice was sound. That is also true of the Foot and Mouth outbreaks; many in agriculture still think that far more animals were slaughtered in 2003 than was necessary to bring the situation under control.

There is no defence in saying that SAGE committees are under pressure from ministers to act quickly. Red team challenges can take place in parallel with the main reviews, and would require only hours to complete thereafter. Ministers and the public should understand the strength of the arguments put forward by the committee and their views on the perceived weaknesses of alternative courses of action, not just their agreed output. Advice to Government must be robustly challenged from an economic and societal perspective as well as a scientific one. It would seem that during the Covid pandemic, ministers did not take serious input from experts on these other consequential considerations, and proceeded on a basis of beating the pandemic *at all costs*. We are still living through the economic and societal consequences of the actions taken as a result, not least the repeated lockdowns of society. Unlike earlier flu epidemics, the incidence of serious Covid among school-age children was very small, and school closures probably played little role in shortening the pandemic. The amount borrowed to tide the economy over the lockdown, and the vast sums spent on medical equipment, and, in particular, on personal protective equipment, looks excessive with the advantage of hindsight. Sir Peter Gluckman FRS (previously the chief scientific adviser to the New Zealand Government) points out that the emergency scientific committee reported to the head of the Civil Service in New Zealand, not a minister or the Prime Minister, and so the advice was challenged in the round in the normal way. Meanwhile, Sweden gave relatively more power to experts, and used its pre-debated contingency plans.

The House of Lords Science and Technology Select Committee held an inquiry in 2020 on the science of Covid-19. A submission by Sir Bernard Silverman FRS made strong arguments for a more formal protocol for SAGE, and called for clear challenge to its advice, so that the robustness of arguments could be tested and presented to the public.[3]

Similarly, climate change advice has been far too focussed on a narrow set of opinions that have received no serious formal challenge, despite the existence of widespread and very diverse counter-opinion in the scientific community. All areas of climate science are – and should be – contested to a greater or lesser degree, but this rarely happens.

At present, the UK has a Climate Change Committee (CCC) responsible to the Government

for advice on both mitigating and adapting to future climate change. Again, this body has no red team to challenge its many reports.

One thing a red team would have done is to insist on looking at the whole trajectory of the route to Net Zero and try to estimate the financial, material, human resources, ecological and societal costs involved. Good advice on the relative merits of energy from different sources would include the costs of back-up generation required with intermittent, diffuse renewable energy; these and other less obvious costs should be made explicit. Just to expand the electricity system (extra generation, transmission and distribution) to cope with the extra demands of electrified ground transport and both industrial and domestic heat is estimated at £1.4 trillion, with 40,000 extra professional engineers required for this project alone from now until 2050.[4] There may be an error of as much as 50% in these estimates, but certainly not a factor of 10. The electrification of heat and transport is only one part of the Net-Zero target. In spite of a decade of advice, this firm grip on the scale of the problems of getting to a Net-Zero economy by 2050 is not spelt out in any of the CCC's publications. Indeed, the competences of the committee members do not extend to these extra considerations. Moreover, there has been too much short-termism; the long-term physical-effectiveness and cost-effectiveness of carbon dioxide management should be a priority.

A key issue with red teams is to keep them from being 'stacked' with biased individuals, including political favourites or corporate shills (undeclared lobbyists). As Edmund Fordham stresses (in open review), conflicts of interest within committees such as SAGE or the CCC may not have been fully exposed and addressed – whilst the advice offered by an unofficial red team, 'Independent SAGE', was arguably even more indefensible.

However, it is often apparent from online discussion of research that there are some highly experienced and competent scientists who are dissenting - with logical criticisms of the 'mainstream'. Indeed, these scientists can often be identified conveniently by the ferocity of online bullying and ad hominem attacks on their capacity and integrity by some of the enforcers of alleged 'consensus'. In the early days of Covid, some powerful dissenting voices emerged on social media, who, despite being vilified and censored, have proved correct.

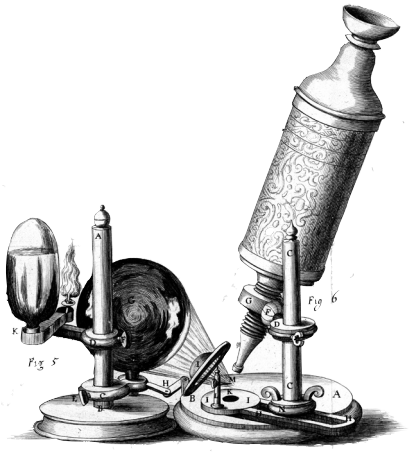
As Paul Hewison (in open review) puts it:

> A formalised role for an agent provocateur function within the decision-making process is required. This role would be performed by independent experts or emeritus professors or researchers who have no ties to the organisation giving the compelling advice to government. This independent advice must be collated by those agent provocateurs and made available independently to the decision makers together with the advice made formally through the SAGE channels.

Furthermore, Edmund Fordham (in open review) notes, there is asymmetry in resources between those issuing official advice and those seeking to challenge it, so red teams and other expert input must be adequately supported. Effective red teaming for the CCC might require legislative change to the Climate Change Act.

Red teams could also involve themselves in checking the publication record, past accuracy and claimed awards of advisors: Joe Zajac (in open review) suggests that a 'commonsense review of published work for anyone who advises government or is proposed as an advisor should take place as part of a background check.'

The public are perhaps even less aware of the diversity of scientific opinion than are politicians, because some evidence is secret at the time (and in the case of Covid, remains secret). Any lack of transparency or resistance to open comment is likely to reduce valuable public scientific input, and also to encourage distrust in scientists and politicians.



Irresponsible use of modelling

In the late 1950s, President Eisenhower called in scientists in the early stages of the flu pandemic and asked them 'How bad could it get?'. They debated and replied to the President 'We don't know.' That should have been the appropriate answer for both the Foot and Mouth, and Covid calls. In the meantime, computer models were produced, which, in the absence of any reliable data to calibrate them, gave no further refinement to the 'don't know' answer. Modelers should give a detailed description of their assumptions and the sensitivity of their predictions to errors in them. One does not need a computer model to say that the incidence of either pandemic would rise and then fall if countermeasures were to have been employed. The models, and especially the quantitative predictions, come into their own only when robust calibration with real-world data is possible and when validated by successful predictions. It is not yet clear – and unfortunately may never be – why the UK Government's preferred Covid models were so wrong: it may be they are intrinsically unreliable. Some key inputs, such as the Basic Reproduction Number (in a fully susceptible population), R_0, may have been erroneous or changing rapidly. The then Government Chief Scientist, Sir Patrick Vallance FRS, when speaking at the Fellows' Day of the Royal Academy of Engineering on 25 May 2023, was very clear that much of the early effort in future pandemics should be focussed on getting clear data on the evolving crisis. Indeed, this was the main lesson he took from the crisis. 'We don't know' remains the scientifically correct advice when key parameters are unknown and the model outputs are highly sensitive to assumptions and errors.

Much of the Covid panic was generated by the high early estimates of the infection fatality rate: a very much larger number of people had been infected than was noticed at the time, but almost the only people who were tested were people who were so ill they went to hospital. There was also confusion between case fatality rate and infection fatality rate, and false hope was given that some countermeasures could suppress or wipe out the disease. It is still not clear what, if any, validation was done of the predictive models that drove Covid policy.

Similarly, climate models have become a *cause célèbre* in their own right. It is noticeable that the most recent report of the Intergovernmental

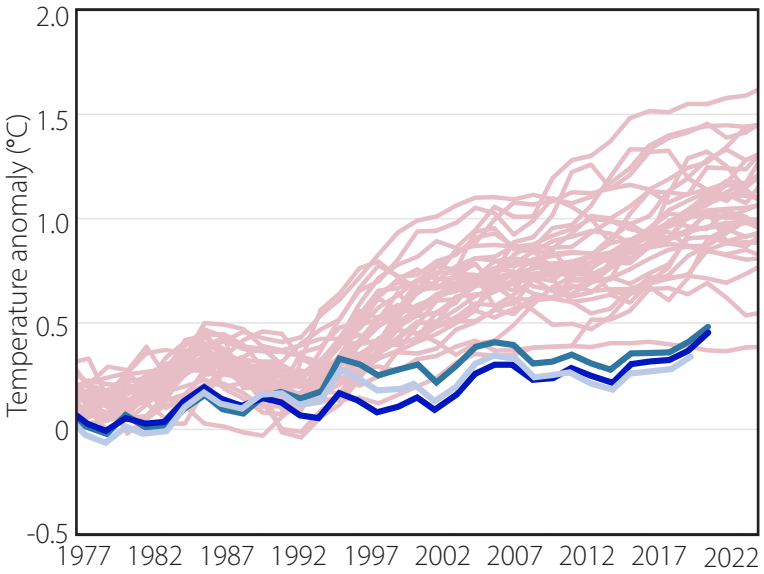


Figure 1: The model-observation discrepancy in the tropical troposphere.

Graph by John Christy, as reproduced and discussed in: https://judithcurry.com/2016/04/05/comparing-models-with-observations. The different models are shown in pink, and the observations in blue.

Panel on Climate Change (IPCC AR6, 2022) does not rely strongly on models for climate prediction, and for good reason. They have been consistently running too hot, by a factor of 2 to 3 in some parts of the atmosphere, in terms of their predicted temperature rise compared with emerging data over recent decades (Figure 1).

This gap is not narrowing, as should be the case if the models are actually modelling the evolving climate. This is a major embarrassment that would not be tolerated in any other field of science, and certainly not in engineering. If our models of fuel burn in aeroplanes were as faulty as the climate models, we would place enough fuel to get from London to New York but find ourselves running out over Iceland.

Separation of human-induced warming from the natural temperature rise from the Little Ice Age is far more difficult than portrayed by the IPCC, since experimentation, replication and falsification is simply not possible. So why are the models not taken out of the public discourse until they are fit for purpose? That would be the correct thing to do in the context of proper science. The inability to model clouds or the biota and the need to subjectively 'tune' the models to get consistency with observations are fatal flaws in any system that is supposed to be predicting future climate change.

Furthermore, many of the predictions of climate-induced species extinctions also depend on models. These 'species-area' and 'climate envelope' models are also strongly contested, and not only because the area of habitat loss they use as a key parameter has been predicted by the equally contentious climate models. The risk of error in such a complex system should be self-evident, as should the potential for climate change to *reduce* extinction rates, but the IPCC is not tasked with considering possible good news on extinctions, nor on crop yields or human health. However, expansion of warm zones in North America or Eurasia could increase habitat area and help build populations of some species, as well as enhancing crop yields and reducing human deaths in winter.

Whilst we have used two case studies, there are many other fields where models have been used with over-confidence and inadequate 'ground-truthing', including geothermal energy, species-extinction rates, and budgetary forecasting.

Poor-quality data inputs will defeat even a model with the right mechanism. A general problem of models is 'garbage in, garbage out' (GIGO). Yet many climate or epidemiological data sets have gaps, calibration problems, inconsistent methods and frequent revisions.

To improve the management of risk in complex problems, Philip Aiston (in open review) comments:

> Projects that are well managed are constrained to time, cost and quality where each of these constraints is subject to some form of risk… Climate modelling is inherently risky because it is complex and subject to error. Risks can be understood to reside in two basic groups: physical and non-physical. The physical can include errors in programming code and the non-physical can include human factors such as communication between Government scientists and policy makers. The human factor risk alone can result in the wrong policy being implemented by Government because this was either under-estimated or ignored. Scientists have to be honest that they are not project managers and would tend to focus on their desired outcome rather than trying to manage the risk (cost plus would be their preference). The project manager would quantify the risk in terms of probability and impact and build reasonable contingency.

As a general tool, actuaries use the concept of an 'expanding funnel of doubt', which shows the increasing uncertainty as projections move further into the future; in the open reviews of this paper, Ken Hazell has suggested scientists should adopt a similar approach, while Joe Zajac stresses the value of clarifying the 'margin of error'.

In summary, models in any field are not as good as experimentation or direct observation. Models are not factual evidence, but this has not stopped claims, in the case of future climates, that they are more reliable than real-world observations. Indeed, there is disturbing evidence the historical climate observations are being adjusted to fit the models, one hopes out of confirmation bias rather than political bias. This turns the basic assumptions of Baconian science on their head, with observations demoted below hypothesis.

The corruption of the science of public bodies and scientific journals

The United Nations, the IPCC, IPBES (The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services), and the World Health Organization are, by construction, inherently political bodies. In the scientific reports they publish, there are structural biases, financial conflicts of interest and poor accountability. There are many recorded instances where dissenting voices have been overlooked, ignored or silenced. The selection of references included in their reviews is subjective, and it may surprise politicians to see that they can even include unreliable information sources, such as popular science magazines (as happened in a report on extinction).

The IPCC's remit is explicitly biased, because it is tasked with looking only at human-caused climate costs, not benefits. Unsurprisingly therefore, the summaries for policymakers it produces are not wholly consistent with the more detailed and cautious scientific text. As a result, conscientious scientists have dissociated themselves from such political massaging of messages.

Similarly, the lack of transparency of the WHO's expert investigation into the source of the Covid outbreak greatly weakens the authority of that organisation and undoes the credibility of any science that it sponsors or chooses to use. Edmund Fordham (in open review) notes that the failure to urgently and adequately explore treatments for Covid 19 illustrates further bias.

There is no evidence of red team action as an integral part of the processes of these organisations. On a smaller scale, public bodies such as Natural England have produced reports and policies that show little evidence of expert challenge. Where, for example, was the debate on bison 'reintroduction' to England or other 'rewilding' targets?

Joe Zajac (in open review) notes that summaries of published results without such critical analysis does not meet the legal definition of science. Yet the Under-Secretary for Global Communications at the United Nations claimed 'we own the science'.

Fixing these problems is not simple; for international organisations, improvement of the processes and accountability is complicated by their staff members' possession of diplomatic immunity, by corporate capture, and by the entanglement of international relations. However, there are simple steps that could improve things. For the IPCC, for example, expanding the terms of reference to explicitly include natural variability and the benefits of warming might help bring a more balanced view to the fore.

Scientific journals have great power over academics, but are at risk of corruption. Edmund Fordham (in open review) notes the depth of the problem in medicine: both Richard Horton, Editor-in-Chief of *The Lancet*[5] and Marcia Angell,[6] former Editor-in-Chief of the *New England Journal of Medicine*, have said that much of what is published in the medical and wider scientific literature may be untrue.

Conflicts of interest, such as sponsorship by pharmaceutical companies, are rife in scientific publishing. Retraction is rare, even for clearly fraudulent or erroneous papers, and much of the scientific literature should be regarded as untrustworthy, rather than just deserving of professional scepticism.

As one anonymous commentator (in open review) notes:

> …the behaviours by institutions such as universities, scientific academies, funding bodies and journals is now so ingrained that it is virtually impossible to publish a useful rebuttal/refutation paper of many of the stories and myths surrounding certain scientifically incorrect and falsified theories…In the past…journal papers were part of a conversation with agreement, disagreement, rebuttals, and refutations and all of equal importance and the very essence of the academic debate. Now however, refutations, rebuttals and contrary data are suppressed, ignored, and do not get published. There is no more funding for open and honest research. What funding is provided is government agenda driven confirmation bias funding. The agenda and solutions are pre-selected…Governments get what they fund – nothing useful, nothing truthful and nothing honest…If policy is based on this, then the electorate are subject to the most egregious policies. Thus, in one generation the enlightenment and the scientific method will be rolled back.'

The academies and professional scientific bodies have taken unscientific stands.

In 2014, Dr Steven Koonin was asked by the American Institute of Physics to prepare a position paper on global warming. He convened a meeting with three climate scientists who were worried about the future and three who were not so worried. The transcript of that day represents the last known example of any major debate on the merits of the claims and counterclaims of what the future climate might look like.[7] What was sobering was the frank and honest admission by all participants of the known unknowns and the lack of convergence of the scientific predictions about future climate change, even after (at the time) 60 years of modelling. Since the recent publication of his own book *Unsettled: What Climate Science Tells Us, What It Doesn't, and Why It Matters*, Koonin has become persona non grata in many academies and professional bodies with which he had previous associations. As Tony Janio notes (in open review) 'stating that "The science is settled" is by definition not "scientific"'. Karl Popper identified the requirement for falsifiability if a concept is to be considered scientific, whilst Thomas Kuhn noted how scientific paradigms get replaced.

A review of the outputs of the Royal Society, the Royal Academy of Engineering, the UK Meteorological Office, the Institute of Physics, the American Association for the Advancement for Science and the various engineering professional bodies show a worrying lack of challenge to the prevailing alleged 'consensus'. If this state of affairs had applied in medicine or biology, we would still believe the consensus that stomach ulcers are caused mainly by stress or that evolution is generally 'for the good of the species'. There has simply been no attempt to do a root and branch review of climate science as a service to the world. This is unforgiveable when so much is at stake, economically and ecologically. In all branches of science, progress is rarely linear, but one seldom hears any report from the academies that concludes that the future climate may be better than the prevailing predictions. Humans, their crops, and other species thrived in the warm periods of the early Holocene, the Roman Warm Period and the Medieval Warm Period. Species-rich tropical regions are relatively stable in temperature historically (and in model predictions), and are thus are very unlikely to witness climate-related extinctions. There is evidence of warmer periods in the Holocene, up to about 4000 years ago, when coral atolls such as the Maldives were being formed underwater. Moreover, the temperate regions evidently become less habitable for most life in cooler periods and ice ages. This bias against 'beneficial scenarios' strongly suggests a pervasive form of censorship. There are many reports, and even personal experience of this censorship, with journals such as *Nature* and *Science*, and even the preprint server arXiv, commonly perceived by scientists to have a policy not to challenge climate-change orthodoxy.

Attempts have been made over a ten-year period to get some realism into the policy statements of the Royal Society and Royal Academy of Engineering. There is a book to be written about the twists and turns of both organisations to avoid speaking of the scale of the challenge of reducing UK carbon dioxide emisisons, first by 80% from 1990 levels, and now to Net Zero, by 2050. Back-of-the-envelope, but realistic, analyses are available for the problems of climate change, not least from the late Professor Sir David Mackay FRS. However, when his analysis was taken further to describe the actual engineering projects needed to achieve Net Zero, the learned societies suppressed all debate, in breach of their codes of conduct, which require them to be 100% honest when they give advice, and especially so when the advice is to governments.

In 2014, one of us (MJK) submitted a proposal to the Royal Society, seeking a two-day discussion on 'The Downsides of Decarbonising an Economy'. This idea was held up in the system of approvals for nearly three years, and then taken from the original proposers and given to others, who turned it into a discussion on 'Technologies to Decarbonise an Economy'. Unusually there was no publication of the papers presented at the discussion, only a summary written by the new organisers, who conveniently omitted any reference to the two papers submitted by MJK and another of the original applicants, while material from all the other papers was covered.

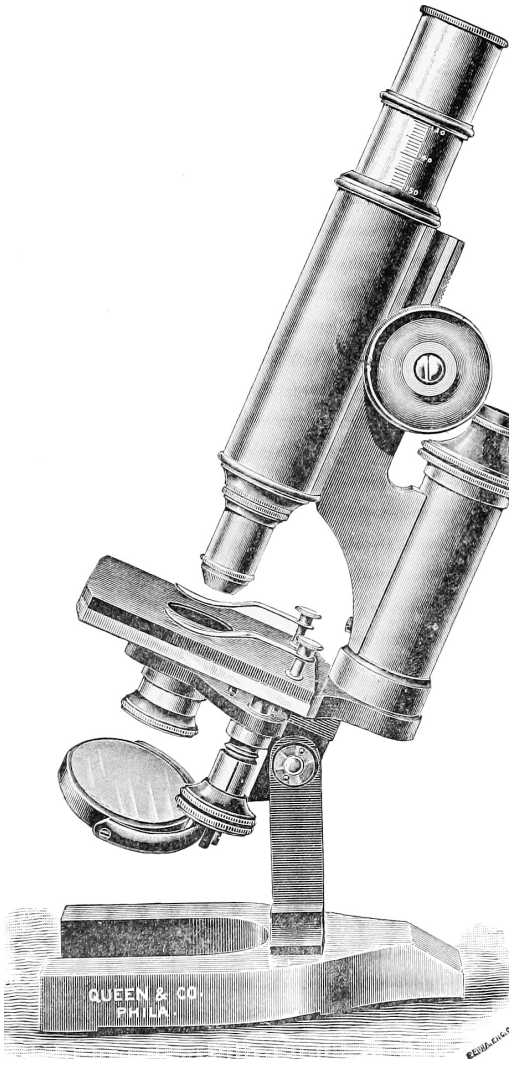
There will eventually need to be an inquiry into how so many scientific bodies abandoned their core principles of scientific integrity, taking

strong positions on unsettled science, taking people's word for things uncritically, and silencing those who tried to continue the scientific endeavour.

The US National Academies recently organised a two-day event in Washington called the 'Climate Crossroads Summit'. Its primary goal was stated to be: 'Engage with a broad set of thought leaders and stakeholders on critical crosscutting topics and pathways to action to meet the climate crisis'. As a search for the word 'crisis' in IPCC AR6 confirms, there is simply no compelling science that allows the phrase 'climate crisis' or 'climate emergency' to be invoked in this context. Yet such invocations are commonplace.

Similarly, universities have abandoned their historical role of open and disinterested enquiry on behalf of humanity.

As wokism ('political correctness') and other left-of-centre political views have become almost universal in academia, and despite the existence of powerful 'diversity' officers, universities have abandoned the previous rule of strict institutional neutrality on issues of the day, and have instead taken up political positions unrelated to their mission. They end up suppressing dissent against some alleged 'consensus', which often amounts to little more than an ideological fad. The very idea of a consensus should sound alarm bells among academics, and protecting one is certainly no part of the role of a university. Internal policies influence academic and student recruitment, encourage self-censorship and stifle honest debate. Numerous academics have been targeted by activist 'scientists' to remove them from their posts. Not all those who have been attacked survived the ordeal; examples of this include Susan Crockford,[8] Peter Ridd,[9] and Kathleen Stock.[10] Worse still, university environmental policies, for example, encourage or impose an official line in research and teaching. This perpetuates bias and causes stress and disadvantage to dissenting staff and students. The policies often go beyond what the national law requires, for example in setting internal net-zero dates and changing canteen diets to meat-free to allegedly reduce emissions. Arguably, university policies on mandatory vaccines went against international law on informed consent.



It is time for the manifold and often undeclared potential conflicts of interest of university staff to be registered and investigated, notably the many grants from, and investments in, renewable energy companies. This is already the norm with grants from fossil fuel companies. Many conflicts go selectively unnoticed or unchallenged, while other scientists are often falsely accused of conflicts of interest while working to improve the use of fossil fuels to reduce their actual consumption and environmental impact.

Edmund Fordham (in open review) notes that embedding corporations, such as pharmaceutical companies, in universities compromises academic independence, for example through conflicts of interest and non-disclosure agreements.

The former Vice Chancellor of Oxford University, Professor Sir Richard Southwood FRS, was of the strong opinion that there should be no 'official' position on climate change (or other matters of debate) in a university. Such leadership should be revived.

Cross-examine scientists and modellers when impacts may be high

In matters of pandemics, climate change, mass extinctions, meteor strikes, the geology of tsunamis and mega-volcanoes, and other issues with major implications, such as financial collapse, the scientists and economists and the relevant modellers should be cross-examined about their findings and advice to separate out any partisan views (whether implicitly held or explicitly stated). The scientists and other advisers should be encouraged to clarify and justify their assumptions, and to tease out the implications of remaining uncertainties. The results of sensitivity analyses on the effects of proposed policies should be brought into the open. Counterfactuals need to be explored. There should be clarity about what validation of models has been done, and what the results were. Independent statisticians should be consulted to verify that best practice has been used. Edmund Fordham (in open review) suggests that proponents of alternative arguments should be cross-examined on their ideas at the same time.

All such cross-examination requires lawyers briefed by red teams and expecting the evasive answers scientists may give. Further, Parliamentary Select Committees, like Congressional ones, should mostly require experts to give evidence on oath. The investigatory process should also make very clear the consequences if the advice should subsequently prove to be wrong.

Make scientists professionally, legally but proportionately liable for poor advice

An engineer who signs off (say) the designs for a stadium roof, assumes legal liability if the advice proves wrong and the roof collapses. Professional indemnity insurance is mandatory to cover such eventualities. However, on both the Covid and climate change issues, scientists have given advice and made decisions that proved to be wrong, and yet they are not in any way held to account. Sometimes there are inquiries, but no consequences. For example, the series of investigations into the Climategate affair in 2010 managed to avoid interviewing any of those who had brought the allegations, and indeed managed to avoid looking at most of the allegations entirely.[11]

If opinions can readily be shown to be false, consequences should follow. The aim is to deter pushy activist scientists and others from speaking beyond their relevant expertise. As noted anonymously (in open review), some universities have encouraged activist scientists, and some institutions pay for very poor but trendy interdisciplinary research that would not pass quality controls for pure science. Such incentives must be removed.

Holding scientists accountable is one of the most important, yet sensitive, of our proposals. Numerous commentators have highlighted this accountability deficit in relation to epidemiological and climate change advice. Of course, deterrents need to be carefully crafted, so as to be proportionate; errors can be made inadvertently. It is also very important not to stifle innovation, nor to discourage engagement with the public and policy.

Nevertheless, society should end the habit of rewarding failure, which has resulted in part from encouraging hype without accountability. Bullying and harassment of dissenting voices should also not go unpunished, and it is vital not to allow vindictive claims against individual scientists or to create a climate of fear that also suppresses free speech.

We propose that there should be a continuum of acceptable behaviours and appropriate sanctions. At the one end is a scientist making a few simple or honest mistakes. Some of these might be rectified by the established practice of enforcing published corrections or retractions. However, if a pattern of mistakes develops, and if these are not corrected, the culprit might reasonably be cut off from getting subsequent grants, promotions, honours, awards, prizes or other academic benefits. When there is repeated bias despite contradictory evidence, then a sanction might include reduced emphasis on the research element of their employment. When there is unfair treatment of dissenting authors, there should be consequences for that journal, editor or individual. For example, in the 'Snailgate' affair, a claim of climate-induced extinction of a snail in a biology journal prompted an expert rebuttal, which was quickly rejected after peer review. To the journal's embarrassment, however, the snail

was subsequently 'rediscovered' (as the rebuttal had predicted), alive and well on the same island. More importantly, it was also revealed that the journal had chosen the same reviewers to handle the rebuttal as had recommended acceptance of the original paper – a clear conflict of interest.

When misconduct is involved, for example conspiracy to prevent publication, suppression of results or fraud, then the penalty could include fines or dismissal. For example, 'Climategate' included scientists discussing wanting to 'redefine what the peer-review literature is' to prevent dissenting publication. Similarly, when scientists lie, and say one thing in a publication but appear to believe the opposite in private (as alleged with the origins of Covid), the penalty might be fines, dismissal or even imprisonment – depending on the societal consequences – consistent with proportionate deterrent for fraud in other contexts.

Edmund Fordham (in open review) suggests legal liability might include 'misfeasance in public office', but this would need to be established through test cases; he argues that conflicts of interest should always debar 'advisors' and that exemptions from liability should not be necessary if products are indeed safe.

There may have to be some relaxation of this stricture when advising in an emergency, or where there are serious national security implications, but in such cases red team scrutiny of the advice becomes vital, and must be exceptionally vigorous and robust.

Consistent language and terminology will be an important part of clear advice. For example, amongst both politicians and the public, emissions of carbon dioxide are widely misconstrued as 'pollution' with a toxin. Any deliberate ambiguity to exaggerate or confound risks should be penalised.

In open review, David Ward and Ron Calvert suggest science might benefit from a professional code of ethics, whilst Frances Daley suggests how due diligence, as used by accountants, might be adapted to scientific reviews.

In summary, it is important to allow fair assessment without unreasonable penalties against any party.

Curb the over-use of the precautionary principle

The precautionary principle – 'look before you leap' in common parlance – has morphed in recent decades into an instruction to do nothing for fear of what might happen in consequence. If this last meaning had been in place, Christopher Columbus would not have discovered America.

Modern usage of the principle contains a myriad of internal contradictions. Precautionary approaches to protect biodiversity (enshrined in international law) are often ignored in favour of those for climate action – for example when wind farms might be exterminating right whales, bats or eagles. Oil and gas come to the Earth's surface in pipes of under one metre in diameter. In contrast to this, the materials for car batteries, wind turbine nacelles, and solar panels all involve opencast mining, impacting many square kilometres; without question, this is a much greater threat to biodiversity than 'mining' for oil and gas.

A narrow precautionary approach for Covid 19 led to serious unintended consequences, but alternative precautions were not taken to protect from the harms that were likely to result from the policies. Moreover, Edmund Fordham (in open review) argues precautions 'prevented use of well-known, very safe, pharmaceuticals'; it is often not clear what the precautionary approach should be, and it may include action or inaction.

Lord Lilley (in a private communication) has pointed out that in his experience there is a serious asymmetry facing a minister in responding to projected problems. If he or she takes an unnecessarily tough/costly approach, and the problem does not materialise, they can claim success; that is, they prevented it. No-one can prove that they could have achieved that result at lower cost by doing less. By contrast, if they take a less tough/costly approach than some are advocating, and the problem does occur, they will be blamed for not doing enough. So the incentives are always to overreact and act on the most pessimistic advice. Indeed, it could be argued that this was not only the optimum course for politicans but objectively the most rational one for society. This may be another form of the precautionary principle, which Lord Nigel Lawson also noted has become counter-productive. Lord Lilley is

not sure how/whether the odds could be made less asymmetrical. We suggest that revealing the enormous opportunity costs involved may be the antidote to the precautionary principle: for example, species extinctions that could definitely be avoided versus those possibly prevented.

Professor Judith Curry discusses a more holistic approach to precaution in her book *Climate Uncertainty and Risk*. She essentially argues for much broader risk and cost-benefit analyses, agile modifications of policy as uncertainty is reduced, and less emphasis on extremely improbable catastrophic events. Unintended consequences from policies are likely when attempting to tackle complex ('wicked') problems such as climate change, thus introducing new risks. Alternative principles should be considered:

- The proportionality principle, in which action does not go beyond what is necessary to obtain the objectives.
- The proactionary principle, which considers the benefits of taking risks in order to speed up adaptation and development, and manages the risk through remediation and compensation.

Graham Rabbitts (in open review) reminds us of a more rational use of the precautionary principle. The Habitat Regulations (1994) were part of the UK's response to the EU's Habitats Directive, and stated:

> [The precautionary principle] can be applied to all forms of environmental risk. It suggests that where there are real threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent such damage that are likely to be cost effective. It does not however imply that the suggested cause of such damage must be eradicated unless proved to be harmless and it cannot be used as a licence to invent hypothetical consequences. Moreover, it is important, when considering the information available, to take account of the associated balance of likely costs and benefits. When the risks of serious or irreversible environmental damage are high, and the cost penalties are low, the precautionary principle justifies a decisive response. In other circumstances, where a lesser risk is associated with a precautionary response that is likely to be very expensive, it could well be better to promote further scientific research than to embark upon premature action.[12]

John Cullen (in open review) has reminded us that the precautionary principle is also a potential threat when invoked to 'do something' rather than do nothing. It could therefore encourage risky activity, such as geoengineering of the climate, or introduction of lockdowns.

Confront the media and NGOs on false scientific coverage

The population receives information on matters of scientific importance from universities and other bodies through the media, both mainstream and, more recently, social. The financial reward structure of universities now encourages self-promotion through proactive media releases. 'Comms Officers' are engaged to hype findings to the public and politicians. In both the Covid pandemic and climate change this resulted in errors, or deceptions, or even censorship, preventing the complete story being told in an unbiased manner. Such falsehoods are rarely corrected and become accepted through repetition.

Even if these problems are exposed, they are hard to correct. Complaints against broadcasters can take years to reach a decision, usually involving a multi-stage process.

If heterodox scientists try to engage with the 'public understanding of science' mafia, they are

often ignored, censored or bullied. Censorship makes it hard for politicians, and the public, to be presented with the full range of scientific opinion. In the few cases where corrections are made to published scientific claims, they are usually given rather less exposure than the original ones. This needs to change in order to ensure that truth will out.

Censorship and bias imposed by governments, and by 'fact-checkers', has delayed discoveries about Covid. Enhancements to 'online safety' need to be extremely carefully crafted so as not to impede free scientific debate.

Whilst the institutions and resources and motivation to challenge advice have declined, well-resourced NGOs and activists have risen in influence. As noted anonymously in open review:

> Various government funded facilities have closed which in the past provided independent impartial scientific and technical advice to government as well as carrying out fundamental research....This has been replaced by activism and NGOs offering unsolicited pressure, lobbying and opinions which are not based on science…[however,] for an ordinary academic scientist to stand against this tide of activism is dangerous and can result in losing your job and career, being cancelled, or having your funding removed or conference cancelled by administrators and so on.'

Protect the scientists

Scientists who speak out on scientific controversies are often hounded by colleagues and the media. Their students and even their institutions may be targeted too. Politicians may expect such hounding (although it is rightly frowned upon), but there is no reason why someone expressing a tenable point of view on some scientific matter should be subject to the same abuse.

Research grants continue to flow to those reinforcing 'consensus' or politically expedient views, rather than to those challenging prevailing thinking – even if privately many scientists have their doubts. So there is no career incentive to go against many 'consensus' views. When one of the authors of this paper (MJK) tried to publish a paper on 'Intrinsic unmanufacturability at the nanoscale' it took nine attempts, with all sorts of referees saying that the scientific arguments were 'just management speak', or that 'too many people are having fun with nanoscience to start pouring cold water over it', or that 'physics is an intrinsically positive subject'. One would not put a thesis student on this subject for fear of encountering bigoted examiners: this should not be the case.

Action therefore needs to be taken to protect the holders of heterodox views, through laws similar to the US Whistleblower Protection Act. They should be rewarded too, and more generously than those who merely scramble to confirm or enforce some alleged 'consensus'.

It is our opinion that there is much that is not scientifically rigorous about much of the climate science literature today, including the IPCC and IPBES reports. It would be salutary if the wider public were aware of the paper by Ioannides, entitled 'Why most research findings are false' to jolt the presumption that any view expressed by a scientists is true.[13]

The fact that the scientific leadership is not speaking out about this, is an abdication of professional responsibility. Politicians would be surprised at the diversity of views actually held by practising scientists in frontier fields including climate change; they should not be - as that is the intrinsic nature of science which becomes lore once experiments have repeatedly given consistent findings. The 'appeal to authority' or to 'consensus science' (a contradiction in terms) is often a sign of weak arguments needing support by bullying.

Longer-term improvements in scientific advice

Eliminate bias and indoctrination in scientific education and schools

Lord Lilley asked Her Late Majesty's Government whether any peer-reviewed scientific studies or reports by the IPCC predict the extermination of the human race in the next century as a result of climate change. Lord Callanan, for the Government, replied:

> We are not aware of any peer-reviewed scientific studies that predict the end of the human race in the next century as a result of climate change…The evidence does not point to humanity going extinct because of climate change.

This is unsurprising. In geological history there have been periods with flourishing flora and fauna in temperatures approximately 5°C warmer than today and at carbon dioxide levels more than double. Greenhouses are often supplied with extra carbon dioxide and warmth to provide conditions more like the evolved optimum for many plant species. Over the last several thousand years global temperatures have been warmer than now, as evidenced by higher sea levels. All along, there have likely been many more deaths because of excessive cold than excessive heat.

Yet despite this, there are numerous reports of young people saying they expect to die from climate change. We must therefore ensure that education at all levels stresses the essential nature of the scientific process – the ongoing challenge of theories with evidence from experiments and observation. The scientific process cannot be centred on the results of simulations that are constrained by the prior assumptions within the relevant models.

The scientists and advisors of the future are being handicapped at an early age. Indoctrination of school children includes formal teaching of the scientifically-biased curriculum, and insidious propaganda from extremist pressure groups, with the brainwashing forceful enough to have generated 'eco-anxiety'.

The fact that Net Zero is accepted as the official line in science and education is a travesty – its origin was never the result of a series of experiments, but rather the political agreements from international governmental conferences, catalysed by vociferous activist scientists. Students can be bullied, pilloried or poorly assessed if they challenge the accepted line. It is interesting to watch the surprise of students when they are exposed to alternative views and the evidence to support them.

The authors are physical scientists who perform controlled experiments. We think that many of the problems above are worse in the social sciences, both the strength of politically biased positions dictating scientific insights and the sanction against those who refuse to toe the line.[14]

Reduce groupthink in academia

It is easy, and lazy to 'go with the flow' on a day-to-day basis. It takes courage bordering on recklessness to set out to challenge the consensus. There has been a recognisable and systematic downgrading of challenge and sceptical review in academia over the last 40 years.

The recent emphasis on research proposals having societal and political impact has spilled over to make media headlines a measure of success. As a result, the pushy and arrogant are rewarded, with insufficient emphasis placed on the provisional nature of most results at the frontiers of science. This is one of several areas where the funding agencies can incentivise good behaviour. The UK's Research Excellence Framework (used as a benchmarking exercise to distribute much future funding) has direct responsibility for the sharp increase in hyperbole.

Behind the cloak of anonymity, there are individuals and cabals gatekeeping access to the pages of the mainstream scientific literature. The 'Climategate' emails from the Climatic Research Unit at the University of East Anglia made explicit reference to using this practice to keep their critics out of the journals. To repeat, many very experienced scientists perceive journals such as Nature and Science as unwilling to publish challenges to the current consensus view on man-made carbon dioxide being the ultimate source of climate problems. In March 2023, the

Editor-in-Chief of *Science* tweeted using the term 'deniers'.

Recently, Dr Patrick Brown has generated discussion about how he evaded (or exploited) perceived editorial bias to get papers into a high-ranking journal, although *Nature*, the publication concerned, has denied such bias. In Dr Brown's version of events, omission of explanations other than climate change gave a 'cleaner' narrative on changing wildfire frequency, and he suggests this may have increased the attractiveness of his paper to the journal. More subtle effects may also have an influence. For example, there can be self-censorship, in the shape of simply not submitting to such journals at all. It is quite possible that through such influences, debate on a putative lab leak origin for Covid were suppressed, and the learning of valuable lessons was delayed.

As a counter-balance to the current academic publishing system, traditional and famous scientific journals may need to be supplanted by open access with open review. This will reduce the problem of conflicts of interest, but will require assessments such as the Research Excellence Framework to find ways to evaluate and give credit to less conventional publishers and publications (including preprints).

It is tragically apparent from cases in hospitals and universities that institutions will often act in the short term to protect themselves from 'reputational damage', even if this is hugely counter-productive in the long term. once whistleblowers finally break cover when the failings become too extreme to bear.

The fact that the UK Parliament has had to pass legislation to protect free speech in universities is the clearest evidence of just how far the underlying principles of academic integrity have been compromised. Bullying, harassment and more subtle coercion are rife. Terms such as 'climate denier' or 'climate criminal' are actually a form of hate speech, intend to suppress free speech; bullies using them should be punished.

The authors are not the first to draw attention to issues around scientific integrity, as for example the paper by Marc A. Edwards and Siddhartha Roy entitled 'Academic research in the 21st century: Maintaining scientific integrity in a climate of perverse incentives and hypercompetition'.[15] This is a comprehensive take on the pressures under which scientists operate today. Another highly relevant paper to this discussion is the warning from the USA about the politicisation of science by Cory Clark entitled 'Use it and lose it: exerting scientific authority for political ends undermines scientific authority'.[16]

A real clean up is needed, and it will likely take a decade until new patterns of behaviour are embedded.

The need to reform the scientific advisor system to include challenge

The position of Chief Scientific Advisor within individual government departments is a mixed blessing. In a few, such as health and defence, they have been of some decades' standing but in most of the others the system has worked to thwart much of their impact – or give too much impact. Just as there has been a 'nudge unit' to help shape action to change personal behaviour as a part of policy interventions, a science unit, mainly of outsiders on call, should be able to assist these scientific advisors and ensure that their advice is really given due consideration. This can be evidenced by minutes of relevant meetings, in which advice is challenged and (hopefully) found robust, and with all the appropriate caveats mentioned explicitly. It is no good the politicians saying they want clear and decisive advice upon which to act, as it is precisely the job of the politicians to decide, using the breadth of scientific advice in conjunction with the relevant economic and societal inputs.[17]

Governments and politicians need to play their part in improving the advice they get. They need to make time to read more information and to engage more carefully with dissent. They need to provide the opportunities and incentives for scientists to do more critical thinking. They should not weaponise a preferred selection of science to political ends, nor permit scientists to do so. Those in opposition need to oppose, even by playing devils' advocates, rather than going along with an alleged consensus. Crucially, governments need to facilitate a formal and powerful red team process of challenge, which will lower the risks inevitable in policies based on science. As Tony Janio notes (in open review), it must be explained to politicians that the scientific method isn't just 'what an expert says', but a process, and 'science' is never fixed. Science is a moving body of knowledge: empiricism; observation; experimentation, and crucially testable hypotheses. Belief in 'the science' or 'consensus' is appealing - but a misunderstanding.

This report makes the assumption that governments want the best advice. As Edmund Fordham (in open review) notes, unfortunately this may not always be so. Professor Carl Heneghan was subject to UK government surveillance, in which the emphasis on evidence and the medical imperative to tell patients the truth about uncertainty relating to Covid was seen as 'disinformation'. Similarly, Dr Jay Bhattacharya has established there was US government suppression of expert scientific debate about Covid on social media, and states that 'censorship kills'. Addressing such political behaviour is a complex topic in itself, but ensuring free speech and transparency of the advice should enable the public to assess the evidence and responses and use the democratic process to get greater benefits from science.

Conclusions

The dependence on 'government scientific advisors' is really only about 50 years old. Further back, the advice was informal, based on friendships between individual politicians and scientists, such as the relationships between Frederick Lindeman, Lord Cherwell and Winston Churchill in Britain before and during World War II.

With reference to a pandemic as a scientific emergency in real time, and climate change a possible emergency on a long timescale, there are many lessons to be learned to improve the quality and impact of the scientific advice to governments. Some, but not all, of these lessons are set out in this paper.

Care will be required not to have unintended consequences from attempts to improve advice. As noted anonymously (in open review): 'recovering scepticism could easily be turned around and be used to silence the very people that are needed to challenge the dogma or consensus.' True 'impartiality' will be hard to find and maintain. 'In early versions of the ISO9000 Quality Assurance Standard, auditing of suppliers, customers and the process were used to improve the operations and the quality of the results overall. This approach could be applied to any research paper or report. The data quality, methods and conclusions from any supplier of advice could be audited separately and the audit trail itself published for full transparency and potentially rapid refutation.

It is to be hoped that the academies and universities internationally will take the lead in implementing our recommendations, rather than in resisting them - in part to atone for their roles in bringing about the problems we have just described.

Acknowledgements

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The cases of Covid-19 and climate change

Roger Koppl

Both Covid and climate change have been described as 'emergencies.' Emergencies are extraordinary. Thus, the very word 'emergency' suggests not only that something, somehow, must be done, but also that the things to be done are extraordinary. Beware, therefore, when politicians, government experts, journalists, and university professors declare something to be an 'emergency'. Such declarations are dangerous. They open the door to extraordinary policies that may well do more harm than good. The word 'emergency' encourages us to be afraid, to turn to authorities for help, to set aside normal life, all while discouraging thought. But we should think before acting in new and extraordinary ways.

One might object that we should respect the experts crying 'emergency' because they know better. They're the experts! The problem is that experts are people, and people respond to incentives. That's a problem because experts have an incentive to predict doom whether the 'emergency' is real or imaginary. Consider the March 2022 Parliamentary testimony of Graham Medley, the head of SAGE's modelling committee. 'The position we have is that the worst thing for me as the chair of the committee would be for the Government to say, 'Why didn't you tell us it could be that bad? You know? So, inevitably we were always going to have a worst case, which is above reality.' Consider the incentives Medley describes. The Prime Minister or the President of the United States comes to you for advice in an uncertain situation. Do you reassure them that all is well? Or do you predict doom and gloom if certain corrective actions are not taken? What if you predict doom and gloom and corrective actions are taken? If things go well, you saved the day. If things go badly, you say how much worse if would have been but for the corrective action you prescribed. You look good in either event. What if you are reassuring and don't sound the alarm, but things go badly? You will be blamed and shamed for failing to understand the gravity of the situation. To avoid this risk, predict doom.

This tilt toward doomsterism was evident in the Covid crisis. In the US we had mask mandates,

Cardinal Richelieu, adviser to the French Monarchy

lockdowns, and vaccine requirements, all justified by the doom and gloom pronouncements of the experts. The state of California, for example, produced a television ad with a patient on a ventilator and the warning that 'Even without symptoms, you can spread COVID-19. And people can die. People like your mom'.[1] If you don't do what we say, your mother will die, die, die. Such fearmongering is shameful. And it may induce us to substitute fear for rational reflection.

Unfortunately, the same fearmongering is practiced with climate change. President Biden, along with many others, has described climate change as an 'existential threat to the planet'.[2] He has articulated several 'groundbreaking goals' to address this threat including: 'Reducing US greenhouse gas emissions 50–52% below 2005 levels in 2030', 'Reaching 100% carbon pollution-free electricity by 2035', and 'Achieving a net-zero emissions economy by 2050'.Such ambitious goals are dangerous and costly. To reduce carbon emissions so much, so fast, for example, is probably impossible. The effort, however, would require a massive overhaul of the physical infrastructure of industrial production, which would, in turn, require the scrapping of old equipment and techniques now deemed less than 'green.' But that means abandoning productive equipment and, therefore, production. It means throwing away productive capacity. To quickly ditch enough old technology to cut emissions by half would make us poorer. It's going backward, not forward.

A massive reduction in emissions by 2030 would also require limits on the mobility of the people, likely in the form of '15-minute cities,' such as that planned for the Astoria Queens neighbourhood of New York.[3] The idea of a 15-minute city sounds great…at first. Everything you might need should be within a short walk or bicycle ride of no more than 15 minutes or so. Sounds great. But what if my family lives further away than that? Will I, or will I not be allowed to visit them whenever I please? Defenders of the concept will protest that the idea is merely to have many small local shops nearby, not to imprison you in your neighbourhood. But it will be hard for local governments to resist such restrictions when the national government is measuring performance by the number of miles driven per month by the average person or some other similar metric. And, in fact, Oxfordshire in the UK has passed a measure to impose precisely such restrictions beginning, it is projected, sometime in 2024.

The idea of a 15-minute city is a one-size-fits-all solution. No store should be so big that many customers must travel more than 15 minutes to get there. But what, then, happens to 'big box' stores such as Walmart and Ikea? Households with modest budgets willingly travel for more than 15 minutes to reach them because they have so much to offer, including low prices, an important consideration for anyone on a budget. They have a large variety of offerings, and may provide services such as play areas for children and low-cost eateries. But the 15-minutes city would sweep that all away in a futile effort to reduce greenhouse gas emissions. Consumers would get less for more. Again, that's going backward, not forward.

We should remember how hard it is to be green. It has been over a decade since a study in *Nature Climate Change*[4] showed that 'each unit of electricity generated by non-fossil-fuel sources displaced less than one-tenth of a unit of fossil-fuel-generated electricity'. Thus, grand goals, such as 'Net Zero' by 2050 or halving emissions by 2030, are an invitation to institute extraordinary measures that do little or nothing to promote 'green' outcomes.

The lessons are, then, to be wary when officials declare an emergency, to resist ambitious 'groundbreaking goals' on climate issues, and to be suspicious of one-size-fits-all policies that may not even achieve their putative ends.

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Reaction to Kelly and Hambler

Peter Ridd

Kelly and Hamber make many important points including:

- the general loss of trustworthiness of many science institutions
- the widespread problems in reproducibility of more recent scientific research as reported by eminent scientists such as John Ioannidis
- the fundamental need to reintroduce a guaranteed debate about scientific advice (Red-Blue teams).

In the final analysis, there is a quality assurance problem throughout many areas of science. The systems used within the various institutions are failing to produce reliable results, resulting in bad government policy decisions and a legitimate loss of trust in scientists. For example, a recent Rasmussen Poll in the US found that 60% of Americans agreed with the statement that climate change has become a religion that 'actually has nothing to do with the climate' and is really about power and control.

This does not mean that the public do not worry about climate. But it shows that they do not believe that climate science is proper science – like Newton's laws of motion or other facets of science upon which we regularly stake our lives. The public has noted the gross exaggerations, failed predictions, and ostracism of dissenters of climate science.

For science institutions, this should be a red flag. There is a revolution afoot, and their position of power (and trust) is in danger.

However, the major scientific institutions are in denial, and reform is unlikely to come from within the scientific establishment. There are now too many vested interests, and careers might be ruined by a genuine Red-Blue team challenge to important science issues such as climate or Covid.

Kelly and Hambler conclude with the hope that 'the academies and universities internationally will take the lead in implementing our recommendations'. This is unlikely to happen, or if they do, they will implement sham Red-Blue teams. The science institutions deny there is a systemic problem and will use their power to bully any government politician that recommends Red-Blue teams. If we don't believe 'The Science', we are branded 'deniers', and are accused of causing 'harm'. The political power of the science institutions is waning, but is still enormous. They are far more powerful than the average politician.

It is interesting to see that the questions of 'how to make our science institutions trustworthy again' has become a hot topic in the last couple of years. We are very far from an answer, although this report is a great contribution. This is a quality assurance problem, and quality assurance systems for industry took a century to develop. Henry Royce (of Rolls Royce) was an early innovator in this regard, but it was the Japanese that largely developed the remarkable quality assurance systems we use in industry today. Industrial quality assurance systems are probably very different to what will ultimately be required for making scientific advice to government as reliable as a Rolls Royce aircraft engine – but we can hardly do worse than our present hopeless systems.

In the past I have argued for an 'independent' organisation that would be tasked with auditing science used for public policy.[1] It would work in a similar way to the government audit offices, which make sure that state finances are not corruptly used. However, I now think that the science institutions are so wholly corrupted by groupthink, ideology, and self-interest that it would be difficult to form a genuinely independent body. Very quickly the organisation would likely be captured by the organisations that it was meant to audit.

Although an independent science audit office is possibly a long-term strategy, in the first instance, a better option might be to leave the funding of a small number of science audits, and the all-important selection of science auditors, to politicians, namely the ministers in charge of the departments that use scientific advice. This may sound scandalous. How can we trust politicians to do a scientist's job? But in the final analysis, on some important topics, I trust politicians more than scientific institutions – which is saying something. Science institutions have proven they use their position as 'truth-keepers' badly, and have become universally ideological. There are a few politicians who are capable of selecting highly

experienced scientists to do genuine audits. So, some form of challenge could take place, if there is political will. The Ministers need a budget commitment – a few million pounds would often be enough – to commission regular audits. Of course, most politicians will be incapable of doing this, and audits will be useless if the politicians involved were not genuine in attempting to get to the truth.

However, we only need a few audits (Red-Blue teams) to succeed to prove the point, and to make the institutions realise that they have lost their power to control politics. Only at that stage will there be any chance of the science institutions accepting that they have lost the confidence of the people, must reform, and start to implement genuine quality assurance systems that make groupthink and other perverse incentives less likely.

The widespread untrustworthiness of science institutions is now a problem that can only be solved by our politicians. This is a very unpleasant thought.

But at least the questions are being asked and there is widespread understanding that there is a big problem.

Note

1. Larcombe, P. and Ridd, P., 2018. The need for a formalised system of quality control for environmental policy-science. *Marine Pollution Bulletin* 143; 50–57.

John Dee, court astronomer for, and advisor to, Elizabeth I

A review of the literature on scientific advice to government

Harry Wilkinson

Introduction

Politicians have long claimed their policies are led by 'the science' and follow an evidence-based approach. Likewise, scientists frequently issue calls for the greater use of 'evidence-based policymaking', and have been quick to criticise politicians who have strayed from what they believe is a more *scientific* approach.

This situation is unlikely to change any time soon; both politicians and scientists understandably want to take credit for positive outcomes, but shift the blame for failings. This dynamic is all too visible in the UK's Covid inquiry, which stands to go on for years, but achieve little.

Fortunately, there is a wealth of academic research looking at how scientific advice to government can be improved. Ongoing controversies suggest these lessons haven't been learnt, but that leaves plenty of room for improvement.

This short review looks at models of good practice from the academic literature, examines how advice on the Covid-19 pandemic and climate change have been delivered, and assesses what lessons governments and public agencies can learn from these controversies.

These lessons will be vital in future crises and need to be re-emphasised as scientific controversies become an increasing part of the growing political polarisation seen in Western societies.

Approaches to scientific advice

An important account of the interaction between science and politics is given in *The Honest Broker* (Pielke Jr, 2007). Roger Pielke Jr develops a typology of four ideal roles that scientific advisors often end up playing:

The first is that of the *pure scientist*. This person has no interest in the decision-making process, just in sharing information. They see their role as to inform the policymaker, allowing them to draw whatever policy conclusions they see fit.

Then we have the *science arbiter,* who acts as a resource to answer questions that the decision maker thinks are relevant but does not tell the decision-maker what he or she ought to prefer.

Next, the *issue advocate*. They tell the decision maker what he or she ought to prefer by making the case for one alternative over others. This can be more open or closed depending on how prescriptive the policy advice is.

Finally, the *honest broker,* who provides the decision maker with information on a set of policy alternatives and then lets them make the decision. Such brokering can be comprehensive or limited – but defines any limits on transparent parameters. The defining characteristic of the honest broker, in Pielke Jr's words (p. 2):

> …is an effort to expand (or at least clarify) the scope of choice for decision-making in a way that allows for the decision-maker to reduce choice based on his or her own preferences and values.

While Pielke Jr recognises that scientists often have to play more than one of these roles, and that the lines between them can often become blurred, he emphasises the importance of transparency in how they are played and reflects (p. 9) that society has a notable shortage of 'honest brokers of policy alternatives'. These honest brokers, he argues, guard against the weaponisation of science for political objectives and encourage innovative policies that can overcome political and economic problems.

This being said, it is clear to Pielke Jr that scientists do not have the 'luxury' of remaining above the fray and keeping politics and science separate (p. 10):

> We should not view science as an activity to be kept separate from policy and politics but, instead, as a key resource for facilitating complicated decisions that involve competing interests in society.

This recognition of competing interests is vital. Such interests are inevitable, but through their identification, greater care and reflectivity can be given to distinguishing appropriate roles for scientists and political decision makers.

While not removing themselves from the political process, the *honest brokering* of policy options allows scientists and the advice they give to retain greater credibility and allow for the easier identification of competing interest groups.

Brinks and Ibert (2023) develop an alternative typology that looks specifically at scientific advice in crisis situations. This reflects the different roles scientists need to play during an unfolding crisis, and the various identities they inhabit, rather than only distinguishing by the mode of their advice. They identify five different types of scientific advisor during a crisis:

- *Trouble shooter* (p.6): These are classical crisis managers whose expertise lies in managing the specific dynamics of crisis situations. They are familiar with these situations from previous crises, and consider themselves generalists who can process any contextual information quickly. They are likely to already have an established relationship with policymakers.
- *Emergency experts* (p. 7): This type is dominated by emergency service professionals who are on the front line of unfolding crises. Their influence on policymakers is limted, and largely restricted to the acute phase of an unfolding crisis. However, crisis management consultants have increasingly incorporated knowledge first gained by blue light organisations into their advice.
- *Situative experts* (p. 7): These experts become relevant to the crisis owing to their knowledge domain, for example: 'criminalists who are consulted to help in negotiations with a blackmailer or software engineers who are asked for a technical assessment during a cyberattack.' Due to their temporary involvement in crisis management, their relationship with policymakers is often weak, although certain individuals may develop a track record, which means they get called on repeatedly.
- *Accidental experts* (p. 8): This category encompasses experts who become involved despite their specialist knowledge being completely detached from crisis management in normal situations. They either have idiosyncratic knowledge, perhaps related to the specific locale involved, or they possess knowledge that is indispensable in an acute situation. They may quickly reach the bounds of their specialism, and their involvement in crisis management is likely to be temporary.
- *Trusted advisor* (p. 8): These are leading institutional experts in their fields. They have well-established relationships with policymakers, and are likely to be called upon in all stages of the crisis. Nevertheless, their influence is likely to be limited during the acute phase, as their expertise is not in crisis management itself. They have an important role to play in preventing future crises and learning appropriate lessons in their aftermath.

Brinks and Ibert acknowledge that during a crisis a wider circle of scientific advisors is called upon than in normal times. They argue that these 'post-normal' situations require particular forms of advice (as described above), and that during an acute crisis there is a need for expert decision-making to be given greater weight than is normal in democratic societies. This is relatively uncontroversial, but for crises that continue for some time, the boundary of what defines a crisis and when it finishes is likely to become contentious.

It is also important for experts to stick to their core competencies when there can be a significant temptation for overreach and the misapplication of expertise. Doyle, Paton and Johnston (2015) examined disaster responses to volcanic crises in New Zealand and found that 'Response agencies became inappropriately over reliant on science agencies for management information'. This tended to happen in the context of 'limited formalised inter-organisational networking', which facilitated '*ad-hoc* interaction[s] between science and response agencies' (p. 2).

This overreliance on science agencies is recognised by Donavan (2021), who describes how interdisciplinary approaches to the management of disasters are often dominated by science bodies and government institutions. This occurs despite the widespread recognition that 'hazards become disasters largely as a result of social factors – particularly vulnerability, which is induced by poverty, weak governance, infrastructure problems and a wide range of demographic and political, economic and cultural factors.'

The close relationships of emergency management agencies, science agencies and government bodies is often at the heart of

breakdowns in public trust with scientific advice. This has led to calls (Alom 2022) for the complete independence of scientific advice from government. However, this demand is rejected by those who point to the inherent political nature of science advice. Freedman (2020) argues that while 'it remains vital to protect the independence of the experts…to get the best out of their advice early and active political engagement is required rather than an arms-length relationship.'

Moore and MacKenzie (2020) also point to the need for more disciplinary diversity, including a greater number of social scientists who are able to develop a broader understanding of the impacts of policy choices on various parts of society. They also welcome more openness about disagreement, explaining how 'inclusive deliberative processes can also help participants separate good arguments from bad ones and identify better solutions or more diverse options.'

The use of 'red teams' has also been suggested as a way to improve the quality of scientific advice (Lakens 2020) and avoid faulty conclusions. This involves the development of a formalised 'Devil's advocacy', in which groups of scientists are established to scrutinise and criticise research output – in a way that can 'build criticism into the process'. The approach has been used in a military context, where there is a particular recognition of the danger of 'groupthink' and the importance of the use of 'Devil's advocacy' (Murdough 2021). Murdough presents a process of 'Divergence-Covergence', in which initially, debate and creative thinking lead to divergent solutions, before a process of convergence:

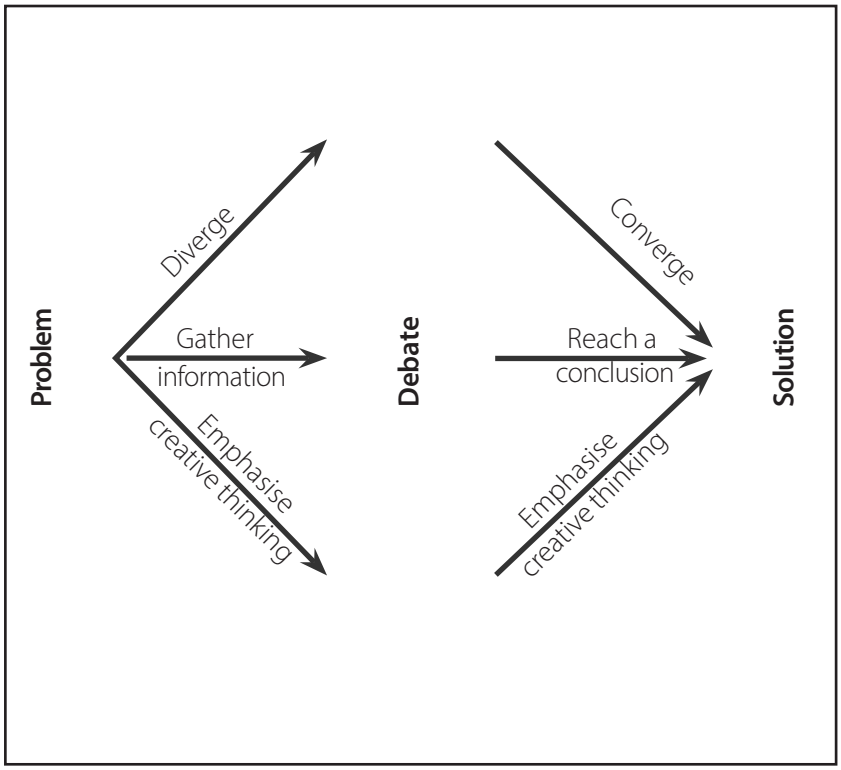


Figure 2: Divergence–Convergence

Redrawn from: US Department of the Army, *The Red Team Handbook 3* (9th edn 2020).

Scientific advice during the COVID-19 pandemic

The COVID-19 pandemic, unprecedented in recent times, put the processes of government scientific advice under intense pressure. We saw, as in previous crisis situations, democratic norms give way to an increased role for expert advice. This also happened alongside a reluctance for politicians to take ownership of decision-making, and competing claims about what 'following the science' entailed. Both the performance of governments, and that of their scientific advisers have since been analysed in detail, and several key problems identified.

Freedman (2020) says politicians faced particular difficulties because the expert advice available was poorly suited to the characteristics of the COVID-19 pandemic, warning that:

> The challenge for experts in government is often described as one of speaking unwelcome truths to a resistant power. Yet, just as problematic can be instances where the advice is welcome and so left unchallenged. (p. 514)

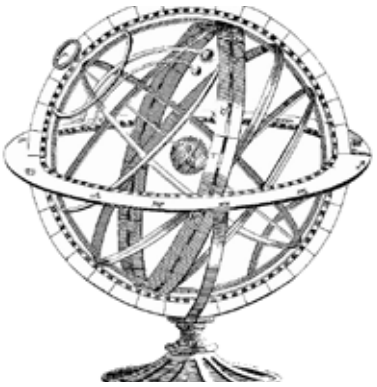
This warning accompanied an acknowledgement that a key criticism of UK Government ministers – that they ignored scientific advisers in imposing a lockdown too late – was in fact inaccurate, as they were indeed following the scientific advice (p. 515). The view that initial science advice was poor is shared by Boin et al. (2020), who have pointed out that 'international guidelines turned out to be inadequate', as they hardly mentioned non-pharmaceutical interventions, such as face masks and social distancing, and failed to appreciate how significant the public behavioural response to the virus would be.

This analysis is not shared by all. Michie et al. (2022) allege that SPI-M – the Scientific Pandemic Influenza Group on Modelling – did not look at lockdown scenarios, such as those tried in East Asia and Italy, simply because those options hadn't been presented to them and they were only allowed to respond to questions the Government posed. However, they agreed with many commentators that a lack of transparency of the scientific advice process hindered the pandemic response. An example of this given was the failure of the Joint Committee on Vaccination and Immunisation for most of 2021 to follow its own Terms of Reference by publishing minutes within six weeks.

Schultz and Ward (2021) looked at the French pandemic response, and in particular public perceptions of scientists and government. Unsurprisingly, perceptions of scientists were more favourable than of the Government. 67% of those who had heard of the Scientific Council on COVID-19, the body set up by President Macron to provide scientific advice on managing the pandemic, said it had been useful. In contrast, only 36% said they were satisfied with the Government's actions to date at that point.

The relative popularity of scientists served to inadvertently hamper the policymaking process. Even in countries where politicians had a relatively greater role in determining the response to the pandemic, 'they rarely failed to support their decision with a reference to 'expert advice'" (Boin et al., 2020). This justification served to suppress discussion of the trade-offs involved with particular decisions, and suppressed the acknowledgement that alternative courses of action were available.

As the pandemic progressed, a greater public debate emerged about whether the continuation of lockdowns could be justified in the presence of their broader ongoing societal impacts. Economists such as Jessop (2020) argued that, while, at the start of the pandemic, a lockdown was justified using a traditional cost-benefit analysis, as it wore on, the harms started to outweigh the benefits, as spare capacity in the UK's NHS rose and the risk of it being overwhelmed reduced. He also pointed to lockdown harms, such as lives lost, by delayed treatments for other conditions and the damage to the broader economy.



Scientific advice on climate change

While the COVID-19 pandemic was undoubtedly an acute crisis, physical science evidence from the most recent IPCC Assessment Report (IPCC, 2023), alongside economic analyses showing that the relative economic and societal impacts of extreme weather are decreasing rather than increasing (Formetta and Feyen, 2019), suggests that this is not the case for climate change – at least in most places most of the time. The fact that this scientific evidence would be disputed by much of the public speaks to a failure of science communication.

Activists and politicians instead have a tendency to speak of a 'climate crisis'. But we do have and have had plenty of time to think about how to respond to prospective changes in the climate. There is no excuse not to have a thoughtful and prolonged exchange between scientists and politicians about how to deal with it.

However, this has not happened. The politicisation of scientific advice on climate change has been going on for some time, and has become ingrained. Even before *The Honest Broker* was published, Roger Pielke Jr had been concerned by the polarisation of scientists, and in particular by their reaction to Bjorn Lomborg's book *The Sceptical Environmentalist*. In a 2004 paper, he noted that many scientists criticised the book simply because it might embolden critics of decarbonisation – rather than because they disputed any of the factual evidence presented. They were acting too often as 'issue advocates', without presenting policy alternatives or accepting their legitimacy.

In particular, the IPCC process has been used to promote a particular policy outcome and strengthen international decarbonisation efforts. Despite the 'physical science' (Working Group I) element of the assessment reports remaining a broadly reliable summary of academic output, sections of these reports advising policymakers have been open to political manipulation.

Machin and Ruser (2019) have warned specifically about the use of emblematic numbers, such as the '97% of scientists' who are said to agree with a particular claim about climate change, or the internationally agreed 1.5°C warming limit. They say:

> Emblematic numbers provide putatively accurate, easily graspable units of comparison. Their use, however, belies the complexity of climate change and scientific data and threatens to mask the political decisions that operate behind them.

Rather than starting with the scientific evidence and moving towards policy outcomes, the development of the 1.5°C target appears to have happened the other way round. Emerging from political negotiations at the Paris climate conference (Cointe and Guillemot, 2023), scientists were then asked to provide the scientific evidence to justify the policy.

Conclusions

The principles behind good scientific advice are straightforward. Recognising interests, allowing internal challenge, encouraging debate, presenting a range of policy options, utilising a range of specialisms and enhancing transparency are all simple enough ideas. However, they become harder to follow in the messy world of government and politics.

Moreoever, scientists are only human. Yong (2021) reminds us that:

> Science is undoubtedly political, whether scientists want it to be or not, because it is an inextricably human enterprise.

He also warns about the 'naive desire for science to remain above politics'. That idealism hindered the COVID-19 response, rather than improving it.

Unfortunately, when it comes to climate change, many scientists have decided that the goal of preventing further anthropogenic climate change is more important than following good scientific practice. Rather than have the desired effect, this behaviour is undermining the case for rational climate policies.

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