



Anniversary Address

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THE
**ROYAL
SOCIETY**

Advising society on science

High quality scientific advice is dependent upon high quality science. Good science is a reliable way of generating knowledge because of the way that it is done. It is based on reproducible observation and experiment, taking account of all evidence and not cherry picking data. Scientific issues are settled by the overall strength of that evidence combined with rational, consistent and objective argument. Central to science is the ability to prove that something is not true, an attribute which distinguishes science from beliefs based on religions and ideologies, which place more emphasis on faith, tradition and opinion. Good scientists are inherently sceptical, particularly of their own ideas. If an observation or an experimental result does not support a specific idea, then the idea has to be rejected or modified and then tested again. Sometimes scientific knowledge is quite tentative especially at early stages of investigation, and it is only after repeated successful testing that knowledge becomes more secure and reliable. It is failure to fully understand this process of science that can lead to problems when scientists are called upon to give advice on issues about which the science is uncertain. Sometimes society wants clear and simple answers when it is not possible to provide them.

Scientific advice should be based on the consensus view of scientists' expert in the area concerned, who are fully aware of conflicting explanations and of the evidence upon which those explanations are based. As a further check this advice needs to be challenged through peer review carried out by other expert scientists to ensure that the conclusions reached are reliable and secure. If there is no strong consensus or if knowledge is still tentative, then these uncertainties should be reflected in the advice.

These conclusions are relatively uncontroversial. However, what makes giving scientific advice more complex is the fact that the advice is being used to inform public policy, and the development of policy is not based only on the science but on a wide range of societal considerations and opinions, not all of which are as evidence based or as rational as science. When the lines between the two become blurred the science can become mired in controversy, which has not always been good either for science or

for the development of good public policy. Given these complexities I want to consider three controversial areas to see what lessons can be learnt about how scientific advice should be provided to society.

One controversial area has concerned climate science: is the world warming, is human activity responsible, and how much is it expected to warm in the future? The consensus view of the great majority of expert climate scientists is that the globe has increased in temperature by around 0.7 – 0.8°C during the last century, that this is largely due to increased greenhouse gas emissions as a consequence of human activity, and that a further rise of around 2 – 4°C can be expected during the next century. Within this mainstream consensus view there is continuing debate about some aspects of the science, especially with the difficult issue of predicting exact future temperature changes given the complexities of feedbacks within the global climate system. However, there are also those who have more extreme opinions outside this mainstream view. At one end it is argued either that little warming is taking place and that human agency has limited effect, and hence there will be no warming in the future. At the other end it is argued that global warming during the next century will be more extreme up to around 10 – 12°C. There are supporters of both these more extreme positions in the public sphere but it is the former arguments that have gained more traction, even amongst some of those who would normally respect consensus expert scientific analysis. Why is this the case?

A feature of this controversy is that those who deny that there is a problem often seem to have political or ideological views that lead them to be unhappy with the actions that would be necessary if global warming is due to human activity. These actions are likely to include measures such as greater concerted world action, curtailing the freedoms of individuals, companies and nations, and curbing some kinds of industrial activity, potentially risking economic growth. What appears to be happening is that the concerns of those worried about those types of action, have led them to attack the scientific analysis of the majority of climate scientists with scientific arguments that are rather weak and unconvincing, often involving the cherry picking of data.

Several other features have complicated the situation. One has been a failure of some climate scientists to be as open as they should in making

all their data available, for example in predicting the extent of future rises in temperature. This has led some who deny there is a problem to claim that the climate scientists data is wrong or has been manipulated. Another feature is the complexity of climate science which leads to uncertainties. In a world where people often want simple answers, uncertainty does not appeal. This allows space for poorly evidenced but confidently stated opinions, which are sometimes mixed with personal attacks and misrepresentations to attract public and political attention.

What can be learnt from the climate science and global warming controversy about giving scientific advice to society? Firstly it reinforces the points already made about the importance of relying on the consensus view of expert scientists and the need to avoid the cherry picking of data and argument. But it also emphasises the need to keep the science as far as is possible from political, ideological and religious influence. I know that can be difficult, as after all, scientists are only human, but that is what good scientific analysis needs.

A second controversial area has been the discussions around genetically modified (GM) foods, that is the introduction of genes by genetic engineering into crop plants. The consensus view of the majority of expert plant and other scientists is that in principle this is a safe approach and can lead to considerable benefits, not only commercial ones such as reducing food spoilage during transport for example, but also to help tackle global problems such as world hunger by increasing crop yields and the use of marginal habitats for crop growing. These scientists would also usually argue that precautionary checks need to be in place but in general these should be similar to those used for conventionally produced crop plants that is using a case by case specific plant basis to determine safety and effectiveness. This consensus scientific view has been accepted by the public in some countries but in others it has not. Again why is this the case?

In my view the key features of this controversy that need to be considered are peoples' sensitivities about what they eat, concerns about scientists playing at God, and worries about the influence of over bearing commercial interests. These have converged to generate deep suspicion amongst some of the public about GM foods.

Human beings have a tendency to be conservative, even fearful, about what their food contains. One anxiety I noticed was frequently expressed during public consultation exercises over GM crops was a concern at 'eating food containing genes'. This was an issue a scientist was unlikely to have considered but was a perfectly reasonable one for a member of the public to express. This concern was exacerbated by newspaper headlines calling GM crops Frankenstein Foods, conjuring up images of white coated scientists playing God and tampering with the purity of food. Another feature is often those who object to GM have political or ideological opinions which dislike the power yielded by powerful commercial corporations behind the manufacture of certain GM crops. These anti GM opinions have been adopted by some environmental NGOs who campaign against the use of GM crops, even when their use is aimed at serving the public good such as reducing vitamin deficiency in children for example.

What can be learnt from the public debate concerning the use of GM crops? First, it is clear that there has been a failing to properly engage the public and pay attention to what they say. Scientists have to listen to the public to be completely aware of their concerns and of the questions they want answered by the scientific advice. Scientists and single interest pressure groups are not always the best individuals to frame these questions. Second, is the need for high quality debate in the mass media. Scientists need to be part of this debate from the very beginning to ensure that it is based on evidence and rational argument rather than ideology or politics. Third, scientific advice is best delivered by scientists who are impartial, rather than those who may have other motives. This can be the case for a company trying to promote use of GM, or NGOs attacking GM crops who rely on the support of individuals ideologically opposed to such technologies.

A third topical area in science policy advice is the prediction of earthquakes and the provision of that advice to the public. Members of a scientific group advising on the risks of an earthquake in the L'Aquila region of Italy were sentenced to 6 years imprisonment for manslaughter earlier this year. This is a complex case raising a number of issues including the general point about the position of scientists who give advice to society in civil and criminal law. Key to thinking about this are the broad concepts of responsibility, causation, moral fault and legal liability. It is necessary to

distil from these themes general principles that are applicable to advice given in different situations. The nature of advice given will vary according to the situation; a one size glove does not fit all. Some areas of scientific advice, such as routine predictable applications in medicine or engineering for example, are well established, and in these circumstances where causation and foreseeability are straightforward scientists should be held to account for their professional advice, in some cases in the courts. In other areas where the science is uncertain, such as predicting the likely impact of an epidemic or of an earthquake for example, such precision is not possible and the law should reflect that. However, scientists should always be as careful as possible in their analysis and their explanation of their analysis, giving the best advice they can. They need to focus on a clear explanation of the proper risk assessment so the public are fully aware of the scientists' opinions on the range of outcomes and their probabilities, and to avoid causing either inappropriate reassurance or undue caution.

An important question is what groups of scientists and scientific bodies can be relied on for giving advice to the public. It is obvious that it is best to involve those who are expert in the area, that is those with a relevant research track record and achievements respected by their peers. It can also be useful in addition to engage experienced scientific generalists, that is scientists who understand the attributes of good science and are familiar with science policy issues. A further extra helpful check is to set up expert scientist groups to peer review the original advice. The corollary is also true, that is those who are not expert and cannot properly assess the relevant specialist evidence and argument are not likely to be appropriate. Scientists giving advice need to be open and impartial, never cherry picking data and argument. They also need to explain the range of possibilities with an assessment of the probabilities of particular outcomes. Scientists also need to explain the science in a way that non-scientists can understand. Unless the advice is clearly assessable it will be of limited value to the wider society.

A range of different bodies offer scientific advice on policy issues. What are the characteristics of those bodies that should be trusted? It is always useful to look at the scientific advice from different bodies because it is good to be exposed to a range of opinions. However, some types of bodies are likely to be more reliable at giving scientific advice. In general terms the

characteristics to look for are as follows: they should be broadly based, be impartial, understand the methods and values of science, respect openness, and carry out proper peer review. More specialist organisations with more specific objectives such as lobbying groups, a commercial company or a single interest NGO, may find it more difficult to be impartial. For example, a company concerned about its income and an NGO about the views of its supporters, may find it difficult to be objective in their scientific analyses. In some cases, scientific advice is offered by more shadowy organisations who do not want to declare where their support comes from for their policy work. They are likely to be acting more as lobby groups without revealing for whom or for what they are lobbying, and so should not be relied on for giving impartial scientific advice. Similarly, organisations that are bombastic, resorting to personal attacks and misrepresentation are likely to be resorting to such tactics because they have lost the scientific argument, and so their scientific advice should be treated with caution.

In the UK, governments generally take science policy advice seriously. There are scientific advisors throughout departments and on the whole ministers pay attention to scientific opinion. With respect to climate change, although lobbyists try to influence the agenda, successive governments have listened to expert climate scientists. Concerning the issue of GM crops, there are signs of a return to the science and to re-opening the debate. We must not be complacent, but in the UK science is given its due weight and scientific advice for public policy is handled better than in many other countries.

So in summary, what is good practice for the provision of scientific advice for public policy? Scientific advice should be based on the totality of observation and experiment, be based on rational argument, and reflect the consensus views of expert scientists, views which have been rigorously peer reviewed by other independent experts. If there is no strong consensus or if knowledge is still tentative, then these uncertainties should be reflected in the advice. As far as possible, the science should be kept separate from political, ideological and religious influence. Good public advice will usually require public engagement to make sure public concerns are taken account of and the scientific questions are framed correctly, and also to ensure that the answers are clearly assessable. Scientists need to be involved from the outset of public debate to help prevent an issue becoming unhelpfully polarised, and need to

give the best advice they can, focussing on proper risk assessment. Finally, scientific bodies who can be trusted to give advice should be broadly based, impartial, understand the methods and values of science, and be completely open about its sources of income and conflicts of interest in policy work. The Royal Society has all these attributes of a reliable trustworthy body to provide scientific advice to the public. It has been doing that for 350 years and will be needed even more in the future as society becomes increasingly dependent upon science and technology.

The Royal Society

The Royal Society is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine. The Society's fundamental purpose, reflected in its founding Charters of the 1660s, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Society's strategic priorities are:

- Promoting science and its benefits
- Recognising excellence in science
- Supporting outstanding science
- Providing scientific advice for policy
- Fostering international and global cooperation
- Education and public engagement

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