OFFICE OF THE PRIME MINISTER'S CHIEF SCIENCE ADVISOR

Professor Sir Peter Gluckman, ONZ KNZM FRSNZ FMedSci FRS
Chief Science Advisor

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THE SCIENCE OF STEWARDSHIP AND THE STEWARDSHIP OF SCIENCE

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This meeting is discussing the broad role of public sector stewardship in relationship to both public policy and advancing New Zealand's broader interests. The many definitions of stewardship effectively distill to those of responsibly planning and managing resources over the long-term. I take a very broad definition that is not just about physical resources like our environment, infrastructure, human resources and public money, but also includes our soft resources like our Westminster democracy, its structures, processes and values. In a shorthand sense this latter class of stewardship can also be seen as maintaining integrity in processes, roles and, from my particular perspective, the development and use of knowledge.

In this presentation I will largely focus on the latter softer resources but before I do so let me make some comments about the more obvious aspects of science and policy-making.

Science, data and formally developed evidence are playing a greater role in the policy process globally. Hence the growing emergence of people and structures which serve the boundary roles of bridging between scientific knowledge production and policy formation. I have spoken at length in the past about the various roles of these boundary structures and I will not repeat that here. Suffice to say that there is a need to distinguish between science for policy and policy for science and that in regards the former, science advice takes three forms.

Firstly the formal and deliberative advice that expert panels can provide. However there are constraints on how that can and should be done; this relates to ensuring that the questions answered are the questions needed to be answered, and ensuring that those providing scientific advice understand the parameters of what science can and cannot do. It is critical to ensure that scientists understand the boundaries of their advice – a matter I shall return to. Such deliberative advice is generally well placed to address issues that are either technical or long-standing.

Secondly there is the need for more informal advice where science advisors both help frame questions and interpret science to the policy maker and politician on both an ongoing and ad hoc basis. In New Zealand we now have six and soon eight departmental science advisors who provide such advice but also help bridge to more deliberative advice and help lift capability within ministries.

Thirdly there is the issue of science advice to both assist with risk assessment and particularly crisis management and indeed this function is seen in the UK and some other countries as the primary role of science advisors such as myself. I think a key part of stewardship is this role of identifying hazards, making assessments of the risk they may generate and developing strategies either to manage the risk or address the consequences. There is also a need to both think about acute risks such as earthquakes or space weather or a pandemic and chronic trends; be it something like climate change or changing demography.

In my view NZ has not had a systematic approach to risk assessment beyond the security sector, natural disasters and some aspects of human and animal biosecurity.

But the establishment of the strategic risk and resilience panel, of which I am a member, and the recent organizational changes in the central agencies is a major step forward. My own view is that we need a national risk register – with both a public version as is done in the UK as well as a more comprehensive version for the agencies. I can think of nothing more important in promoting stewardship than strengthening risk assessment and management processes with all that must then follow. I shall extend this discussion of risk later in this talk.

Technical advice is generally straight forward if we are dealing with a linear question. Linear matters can be generally dealt with in a straight forward manner by technical experts: what weight will this bridge hold, is this plane fit to fly, is this vaccine effective and safe? But there is nothing special in such advice provided technical experts are available and we are lucky with both CRIs and universities in this regard.

But most of the issues that confront science advisors, policy makers and indeed the political process are not of this nature. The very questions that give angst to policy makers and politicians and where science is expected to assist are not linear. They cannot be answered in simple terms. They involve complex systems like the environment, social structures or our own behavior. While science may add a lot, there remain unknowns and a level of unpredictability. Answers must be given in probabilities not certainties. We call this type of science, post-normal science and it generally has another feature – there is a high societal values component and the values are in dispute.

Policy makers are of course used to dealing with values that are in dispute. They in large part are the basis of different political ideologies and arguments. Further inherent in policy-making is the incorporation of multiple values into decision-making process: be it public opinion, electoral contracts, fiscal priorities or even diplomatic considerations. So how should science feed into such processes?

My own view is that while science is not free of values, science is distinguished from other epistemologies by its processes that are designed to make explicit and mitigate bias and values from the collection and analysis of data. The best way science can assist policy making is to describe what we know, what we do not know and the inevitable inferential gap between what we know and what we conclude. It allows an assessment of options and the consequences of each option. This is what the scientist acting as an honest broker is doing while not entering into the values dimension which is the policy maker's space. This is the essential role of myself and the departmental science advisors. Other scientists can be and do become advocates for their positions. But as I will discuss later scientists who are speaking as advocates must be clear as to when they are speaking beyond the scientific consensus.

Speaking of data, good data allows a major step forward in stewardship. The more data we have the better questions we can ask and the ability to reduce the level of uncertainty, at least in some aspects, increases. In theory, this must lead to better policy making. We have invested considerably in NZ in developing an integrated government data system. But we must not be unrealistic in how fast it can deliver.

First we must develop a better understanding with the public of how the data will be protected and used. This is the key role of the data futures partnership currently being formed. This is an absolutely critical step and those involved will have a central role to play in improving long-term policy making in NZ.

Secondly we need to enhance the range of data included. We cannot just have cross-sectional data describing our environment and population. We need clarity on what programmes and interventions are being applied. Sadly enormous gaps exist for example in terms of what social programmes are actually being accessed and in what ways by particular individuals.

Thirdly we need to be able to assess the impact of any intervention. This cannot be done if *a priori* we do not collect baseline data and give real thought to how programmes will be structured, applied and monitored. Monitoring inputs may be important for audit purposes but unless good proxies for outcomes and where possible outcomes themselves are measured, assessment becomes nigh impossible. This is easy to say but has major implications – we tend not to give enough thought to implementation with our short political cycles, we often develop programmes without seeking the information that is necessary to assess outcomes.

Fourthly; we need to become more honest as a society in accepting that governments will introduce many programmes that might not work or might have a minimal effect because of the fast moving and uncertain world we live in and encourage revision and solid data analysis that can allow remedial change to occur. The problem is every programme whether it works or not has advocates because they have stakes in it —whether fiscal or political.

One important step forward in the budget process has been the increasing incorporation of formal evidence reviews. Last year for the first time, the committee of Science Advisors that I chair, was asked to review selected budget bids, a process that will be expanded in 2016. We acknowledged *ab initio* that our job was not to make judgments on the values components and therefore on whether bids would go forward, but rather to evaluate within the bids: the evidence base showing a need for intervention, the evidence base related to the proposed intervention, or alternative approaches *vis a vis* the status quo, whether the effect was evaluable and whether the implementation plan either hindered or assisted evaluation of outcomes rather than inputs and outputs.

As the government data base gets more integrated and we deal with issues of ensuring more data are added and ensuring the public is comfortable with how the data are curated and used, the potential for trend assessment and better analysis will add greatly to the quality of our stewardship.

But there is a related issue. Not all data are of high quality. This year we will have the first State of the Environment report. This is a critically important step forward. But the quality of data in many parts of this assessment inevitably will be highly variable, given the nature of the science in the multiple fields that comprise environmental science. Thus the assessment will necessarily very provisional. Such situations often give rise to the danger of cherry picking and hyperbolic statements that can be a source of much angst. As Einstein said, "not everything that is important can be measured and not everything that can be measured is important" – a point that will become highly relevant as the data age progresses.

And this allows me to segue back to the issue of risk. Risk can be seen in an actuarial sense as scientists often describe it – there is a 1 in a million or a 1 in a hundred chance of something happening. But the perception of risk by most is not simply actuarial. Saying something has a 1 in twenty chance of happening might have a very different meaning to many people than saying it has a 95% chance of not happening.

But risk perception is much more complex than simply how a risk is expressed. The science of risk perception has progressed a long way –we all have cognitive biases, both conscious and unconscious, which affect how we perceive risk. We have different perceptions depending on whether we will benefit or not from taking a risk, - for example there would likely be different perceptions of the risks of mining depending on whether one has a financial stake in the mine. . We will have a different perception of risk based on past experience and so on and our fundamental world-views influence how we look at any system. When systems are complex it is inevitable that we effectively cherry-pick to reinforce our prior positions. This why changing views on matters like climate change or evolution is so complex, even as the science is clearly pointing in a given direction.

Why does this matter? Well because virtually every issue of major contention in policy now involves post-normal science where the facts are by definition incomplete and where values are in dispute. Many policy debates can be fundamentally described in terms of the tradeoffs that have to be made between economic growth and environmental or social sustainability and support. Those on either side of those debates about where the balance should be established have genuinely held different world-views and science alone will not reconcile these to solve the debates, at least not quickly or inevitably in any deterministic way.

Indeed, the debate about climate change is not really a debate about the science, or at least it has not been for a decade, rather it is about issues of economics and particularly economics between countries and across generations. Similarly, the issue around genetically modified food is no longer really the science but how different people view and perceive what is natural –a complex topic in its own right. The Canadian Science and Technology scholar Mark Saner has cast this debate in philosophical terms, pointing out there are fundamental differences between people with consequentialist and non-consequentialist world-views. Inevitably the response of these two groups to scientific arguments will differ.

A closely related matter is that of the meaning of precaution because this has such an important set of consequences in the policy space. The precautionary principle as it was originally defined had a very different meaning to how it is popularly understood and, indeed, misused. As pointed out by the French STS scholar Michel Callon, it was originally envisaged as a framework for measured action, making it an adaptive management tool that could allow for innovation in the face of scientific uncertainty. Given the inevitable uncertainty of any new process or technology, the principle was designed to allow precautionary constraints and active management to reduce any risks. But as more was understood those constraints could be reduced, tightened, or deployed in a more refined way, as deemed necessary. In other words it was never intended to justify inaction in the presence of any uncertainty or risk.

The Popperian view is that science does not prove things, it disproves things. And a feature of post-normal science is that it never provides certainty, but deals in probabilities. As I pointed out to environmental lawyers in an address to the RMLA two weeks ago, science does not produce what lawyers expect – that is the absence of any doubt. Yet this is a difficult concept especially when it comes into contact with different world-views. An absolute view of precaution would mean nothing new ever happens, the concept of innovation would be virtually impossible. Yet depending on the issue, many will take an absolute position. But, because a position is taken at one point in time does not mean that it is fixed for all time. We must review and be prepared to review in the light of experience and new knowledge, even and especially when issues are complex and contentious.

The challenge in NZ is how to do this. The short political cycle and the lack of depth in our public discourse make the necessary conversation very difficult. The issue is also influenced by our continued identification as a 'frontier society' that makes long-term discussions more difficult. We do not have a foresight unit or any other whole of government unit devoted to long-term planning and evaluation. Yet these have been immensely valuable in other democracies-to identify trends, risks and potential options. Perhaps the strategic risk and resilience panel, by focusing on slowly emerging trends as well as acute events can help fill the gap. But foresighting is not a simple process and requires a group of dedicated analysts working with both scientists and policy makers. Even within the policy space, efforts to improve long-term discourse have been difficult – perhaps the brightest light is in the social sector, with the move towards an investment approach that depends on both a strong evidence base and taking a long-term perspective. With these comments I am of course generalizing broadly, acknowledging the longer term thinking inherent in departments such as Treasury and Defense.

So how can science help in the complex policy issues – does it have any role – despite offering 'only' post-normal probabilities rather than reductionist certainties? As I have stated elsewhere, I believe it does – it is through the honest brokerage of science, which defines what we know, what we do not know and what the North American STS scholar Heather Douglas termed the inferential gap between what the data are saying and what we eventually conclude. In doing so science can help elucidate those ultimately normative decisions about the sufficiency of evidence to justify a given course of action, and providing an assessment of the consequences of different options. Importantly science can clarify what is technical about an issue and what is a matter for the democratic and policy process. In essence just because science largely deals in probabilities not certainties does not diminish its value, rather it makes honest brokerage even more important. This is particularly true in the information age where data can easily be cherry picked, where data can be a very variable quality and we are dealing with complex systems.

The difficulties come when science inputs into policy in a way that is based on advocacy rather than brokerage. This is not an easy distinction nor is it absolute. Everyone is an advocate to some extent. The issue is to be honest about biases and when speaking beyond the data. Increasingly the scientific community is trying to establish practice in this area.

The counter argument is that advocacy by scientists has been necessary in areas such as climate change, environmental quality, water quality and so forth and that is indeed true. But as science enters the policy process the distinction between advocacy and brokerage becomes more important. Again hence the importance of boundary roles such as mine and other science advice mechanisms.

In the final part of this talk I want to shift from the question of how can science help policy makers with stewardship to the issue of the stewardship of science – that is, maintaining the integrity of science, so that it can inform the most complex post normal issues, even (and especially) in contentious areas where trust is low

You might think superficially this would be easy but because science now engages in complex post-normal questions, the interface with major societal issues and disputed values creates real challenges within science systems. I have argued elsewhere that science is a tool of democracy, but it can also be a political tool. It can serve both sides of many debates and can be misused as a proxy for what is really a values debate because many would rather debate science than get at the heart of some of our most intractable issues by engaging with contested values. It is obviously easier to debate the science of genetically modified food rather than debating what is considered "natural" even though the latter is a perfectly valid societal debate which science cannot address. The non-consequentialist of Saner's classification would hold fast to their opinions irrespective of what the science is saying – for their view is based on a fundamentally held worldview.

In his recent book, The battle for Yellowstone, the cultural sociologist Justin Farrell points out that science could not resolve the very different views as to whether to return wolves to Yellowstone national park despite multiple hearings and extensive scientific research over many years. Fundamentally it came down to very different views between those of the 'old west' (ie ranchers and the like) and those of the ‘new west’ (of the modern environmental movement) of what natural ecosystem management meant. When science gets pulled into these ‘wicked problems’, confidence in science can get undermined, and yet it has an undeniable role in clarifying the both the knowledge and the knowledge gaps we need to know about in order to enter such contested territory.

Science faces another challenge that can influence trust in the contribution it can make – how to reclaim its lexicon. Words like chemical, organic and natural have taken on particular meanings in the vernacular such that some are revered and others distained. This can effectively pit all things ‘scientific’ against all things ‘natural’ in the popular consciousness, with the associated moral judgments that go with each of those concepts. .

It can also mean that we talk past each other. There is nothing that has mass that is chemical-free. There is fundamentally nothing different between most synthetic forms of a biologically active chemical and those isolated from nature – yet we have a large “natural industry” based on reinforcing these alleged differences. The language of science is misused all the time in advertising especially around natural supplements, cosmetics etc. Yet the use of ‘scientifically or clinically proven’ in advertising is just as common despite being almost inevitably a red flag. But scientists cannot be arrogant - our community must work to enhance science literacy within the whole of society reduce the risks of talking past each other.

In 1942 that famed sociologist of science, Robert Merton, described science as standing apart from society while informing it. Fortunately we are long past putting science on a pedestal and we now thinking in terms of a compact integrating science and society. That is there is a more sophisticated recognition of the co-evolution of science and society, whereby they must inform each other. This is reflected in a greater focus on science communication, on producing science of societal relevance, and the deliberate move to what is often called co-design and co-production. But inevitably this shift is having major impacts on the shape of public science systems; as are changes in scientific methodologies themselves, especially the use of big data, and also the changed nature of scientific collaboration and publication. All this is leading to the biggest change in the nature of public science systems in several decades. My office is leading a project on behalf of the small advanced economies initiative in trying to forecast the shape of the changes to come.

But just because the nature of science systems will change and because the relationship between science and society is changing does not mean that the nature of science itself will change. All said and done science is simply a set of formal processes by which we gain relatively reliable information about the world around us and within us. The processes are designed to minimize the risk of bias in the collection and analysis of data.

But with the greater focus of the State on its investment in science and what it gets for its money, there are inevitably concerns about protecting the core nature of public science. Trivially this can be reduced to issues of scientific freedom and the balance between investigator-led and mission-led science. These are not new issues nor will they go away. There will always be variation on perceptions of the best balance between these different activities. But fundamentally society has a right to determine what is done with its money, but if the parameters it places on research are too tightly directed (beyond ethical dictates), the knowledge produced is likely to be more incremental than disruptive and visionary. By contrast, it is a matter of societal directive to say how the products of science (new methods or technologies) are applied. Without understanding this distinction, there is potential for policy processes to undermine the integrity of science.

Science can do so much to advance society – whether through environmental, societal, or economic application. It also enriches society because of its inherent cultural values – a feature of the human condition is the desire to know more but it can only do so if science is trusted. Trust is largely a factor of how science is done, how scientists behave and how they communicate. Science can only contribute well to the stewardship of our country if we also pay attention to the stewardship of science itself.