OFFICE OF THE PRIME MINISTER'S CHIEF SCIENCE ADVISOR

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Sir Peter Gluckman's remarks for Keynote Panel on Science Advice to Governments
Canadian Science Policy Conference 2015

Ottawa, Canada
November 26, 2015

It is important, at the outset, to recognise the quickly changing nature of both policy making and science (broadly defined across the natural, physical and social sciences). It is therefore inevitable that the interaction between these domains is also changing.

There is a growing recognition – even without falling into technological determinism - that science and technology pervade nearly every part of our lives and that it is thus the reality that science has some input or should have some input into virtually every part of public policy making. Science is changing in multiple ways – the move to big data and multi-disciplinary, problem-driven approaches may be the most obvious internal changes, but from my perspective the key shift in the last 30 years has been the capacity of science to engage with complex systems; particularly societal, environmental and in human health. This is because of advances in computational power, informatics in the environmental and especially the life sciences.

But as science has done so, it has moved particularly into areas where there are inevitable unknowns, conclusions must be expressed in terms of probabilities rather than certainties and there is an inferential gap, which Heather Douglas has described so well, between what we know and what we might conclude, not to mention what actions we might take as a result. But more importantly, we need to confront the fact that the areas where science can most contribute to policy development are (almost by definition) the most contentious areas of public policy. These are questions for which there are high public values considerations and those values can be in dispute. This is the zone that Ravetz and Funtowicz termed post-normal science and of course this is exactly the area where science and policy have to interact and co-exist.

Underlying (and perhaps complicating) all of this, is the fact that science's changing relationship to society has also changed from a Mertonian isolation of the public science community to one where concepts of co-design and co-production in certain areas of policy-relevant science are an ideal standard practice. Increasingly, the multiple publics that make up a society are realising both the opportunities and the challenges that arise from science and technology, and expect a greater say in defining both their use and limitations. This challenge is manifest in multiple ways, but two of the most obvious are in the advocacy groups that rally around or against certain research agenda, and in society's utilitarian expectation of a return on investment in public science, as reflected in the political and policy domains, as the size of the publically funded scientific enterprise has grown.

But policy-making is also changing; the 24-hours news cycle, social media and the expectations of hyper-informed publics (although not necessarily reliably so), mean that the concise policy cycle defined in textbooks does not really exist.

Rather, we have an iterative process between politician, policy maker, advocates and the multiple stakeholders in our societies. Importantly, we need to recognise that policy decisions are ultimately made on a range of inputs and trade-offs – most of these inputs are highly values based, with public opinion, fiscal priorities, diplomatic consideration, political ideology and electoral contract being the most obvious.

Where does science fit into this? It would be naïve to think that science is itself free of values. We know, for instance, that there are normative decisions in what science gets done, or in the methods of analysis chosen. But the processes of reputable science aim to make explicit any biases and to limit the influence of values. By contrast, decisions about the application of science and technology are highly values laden. I would argue that science only has a privileged position if it is presented in as values-free a way as is possible and is used to elucidate policy options and their likely consequences, rather than advocating for any one of them. This is arguing that the interface is best served by brokerage rather than advocacy. In my experience, policy makers will not react favourably if scientists attempt to (or are perceived to be trying to) usurp their role.

But before we go further we also have to parse what we mean by "science advice" - as this is a source of confusion.

In my experience, many publicly funded scientists think of science advice in terms of privileged advocacy for the research community and the science system. I often find myself dispelling this assumption and instead arguing that the main purpose of science advice is to help decision makers use science-based evidence in order to make decisions across all areas of public policy.

If policy for science becomes the focus, then inherently a scepticism and mistrust can be created in the minds of decision-makers about whether the scientist is pointing out a true knowledge gap or whether this is just advocacy for more funding. Obviously science for policy and policy for science are related but this distinction needs to be kept in mind, because it affects relationships at the interface - and maintaining trusted relationships is essential.

We also need to recognise that the systems developed to deliver science advice are complex and evolve according to local history, culture and approach to public reason. A complete system needs to consider the diversity on the demand side both in need and in type; the executive branch, the legislative branch (if distinct) and the policy community all have different needs. I am going to focus mainly on the executive branch and their policy support. But increasingly we need to think about the levels of government from local to international and the interaction between these - as we know that both our grand challenges and the science needed to address them span multiple jurisdictions.

Let me summarise with some thoughts on a rough typology of science advice, in which I see at least four types:

First is a need for regulatory and technical advice within government agencies. This is generally provided by in-house experts and advisory expert panels and possibly, the "Chief Scientist" in a particular ministry. In many jurisdictions there are established protocols to inform these processes and I will not discuss these today.

But at the level of whole-of-government or at a ministerial level, there are three distinct types of advice needed and whether these are provided by individuals or panels is an important consideration.

So within this, the second type of advice is what I call deliberative advice. Here a panel of scientists or experts addresses a question over some considerable time. In many countries such advice is primarily given by academies or purpose-built panels. But there can be challenges with this: is the academy proffering unrequested advice, is the academy answering the question set by the policy maker, is it answering the question in a way that serves the academy or the policy process? There is often a mismatch between demand and supply. A boundary role such as a science advisor may be needed to mediate this interface.

A third type of advice is evident when one talks to those who are science advisors. We find that the bulk of activity is not in preparing formal advice of a technical nature, but rather it is in providing informal advice – this ranges from brain-storming at the beginning of a policy process, and ensuring science is not misused in the process to providing summative commentary. Such informal advice is just not possible by committee but that does not mean it cannot be informed and peer reviewed by others. If you think about ministerial and prime ministerial behavior, this informal role is critical.

Finally, the fourth in my rough typology is the particular form of advice that is needed in emergencies and at times of crisis when the role of science advising effectively becomes part of the decision process. The recent APEC leaders' declaration pointed out the need for integrated science advice during and surrounding emergencies. This followed an APEC CSAs and Equivalent meeting, which I co-chaired in KL recently – there was no Canadian representation at the meeting this year, but we will look forward to welcoming a Canadian delegate next year.

In my own case, I was appointed the first Chief Science Advisor to the NZ Prime Minister in mid-2009. When the role was announced, many from within the science community assumed the job would essentially be their lobbyist in government. But when we worked through the effective terms of reference, which we have refined over time, we placed three things at the top of the list.

First among these was improving the use of evidence in developing and evaluating public policy across the whole of government.

In turn this led to a second role in advancing NZ's interests through science diplomacy and that is reflected in my formal secondary appointment as Science Envoy through the Ministry of Foreign Affairs and Trade.

Thirdly, the role is expected to develop the relationship between science and society – from helping to open up the space for public understanding of and dialogue about science, promoting more robust and proactive science communication, to leading improvements in the STEM education pathway.

Only then is there the fourth role of being a sounding board on classical science and innovation policy. In New Zealand, there is a Minister of science and innovation who oversees a ministry with both policy and funding programme delivery roles. I work closely and constructively with the minister with but I am careful to respect the terms of this position.

There is also an important internal ambassadorial role to all parts of the science and innovation ecosystem.

As for providing technical scientific advice - occasionally I prepare a deliberative report for the PM, generally on his request, in which case I either draw a panel of experts together or more recently work jointly with the President of the Royal Society of NZ to convene a panel.

Then there is time on cross departmental matters, relevant boards of which perhaps the most important is the National Strategic Risk and Resilience Panel which is working to improve the nation's capacity to manage all types of risk from natural disasters to those of a more human nature.

And a major task is now chairing the committee of departmental science advisors, positions which I helped to establish across a range of government ministries. I mentor and liaise with each individually.

This Committee Of Science Advisors also includes the Chief Economist from Treasury, the Government Statistician and, as observers, the President of the Royal Society of NZ and a deputy head of the public service commission. As well as networking and providing mutual support and peer review of their respective activities to lift the use of evidence within their ministries, the committee is increasingly assigned tasks by the Government, including a request to provide independent review of the evidential support for a number of budget bids from within the social sector.

Diverse as they are, these responsibilities are nevertheless linked by underlying principles of science advice. Indeed, I decided that from the outset I would talk and write about the principles that I thought should act under, which I think helps promote trust in the work of my Office. These are summarised on our website and in numerous essays and in a paper in Nature.

In concluding, let me simply emphasise those principles that I think are generic across all science advisory models.

I believe it is important the boundary role is established with enough statutory independence and is neither seen as a political nor bureaucratic employment. It needs to report to the top. In my case I report directly to and meet regularly with the PM and his staff. The Cabinet office has also appointed a senior policy official to liaise with me. I

meet other senior ministers frequently at either my request or theirs, and with the senior officials of many ministries.

Next, I think it is essential to recognise that science informs policy but does not make it. My role is to be an honest broker rather than an advocate. I think this is a key distinction between those in formalised boundary roles like science advisors, and individual academics or academic bodies. We may all wish to see a certain path followed, and academics can often use their public position to advocate one way or another, despite guidance such as the Singapore Statement on research integrity, which is designed above all to protect the privilege of science.

We must also recognise the limits of science. We need to be proactive in engaging the policy community as well as the science community. The demand side for science advice needs nurturing – there can be scepticism, and addressing this is a key part of the boundary role.

But the key requirement above all else is to maintain trust. There are five groups of stakeholders: politicians, policy makers, the media, the public, and the science community. Boundary roles will fail if they do not sustain the trust of all of these.

So what are the criteria of success? It is difficult to know. In a sense, effectiveness can only be seen in the actions of a government and even then, attributing these to forms of advice is impossible. Perhaps success can best be seen in functional and bi-directional channels of access between the science and policy communities. But to be effective, these channels most often need navigators and interpreters.