OFFICE OF THE PRIME MINISTER'S SCIENCE ADVISORY COMMITTEE

Towards better use of evidence in policy formation: a discussion paper

Sir Peter Gluckman KNZM FRSNZ FRS

Chief Science Advisor to the Prime Minister

April 2011

Acknowledgements

This paper has been informed by many people over the past twelve months. There have been discussions with members of most ministries and agencies with responsibility for providing scientific advice. The Department of Prime Minister and Cabinet (DPMC) coordinated a roundtable discussion with a number of public service Chief Executives and additional discussions were held with a number of individual Chief Executives including the State Services Commissioner. Mr Maarten Wevers, Chief Executive of DPMC, and a number of his officials made many useful suggestions. Discussions were conducted with several ministers, former ministers and parliamentarians. Several Chief Executives made constructive comments on various drafts of this paper.

Particular insights were provided from consultations with the current and former UK Government Chief Scientific Advisers Sir John Beddington FRS and Lord Robert May FRS, other members of the UK Government Office for Science, and a number of current Departmental Science Advisors in that country. Senior science policy officials in the US administration, Australia, and several other jurisdictions have also been consulted. Dr Chris Tyler, Executive Director of the Centre for Science and Policy at the University of Cambridge, spent a month with my Office assisting with the project and was able to provide particular insights from his time as advisor to the House of Commons Science and Technology Select Committee. Development of the paper has been considerably assisted by my Strategy Advisor, Dr Stephen Goldson, and by Dr Alan Beedle from my Office.

I thank the Prime Minister for his support of this project.

Office of the Prime Minister's Science Advisory Committee

PO Box 108-117, Symonds Street, Auckland 1150, New Zealand

Telephone: +64 9 923 1788

Website: www.pmcsa.org.nz

Email: csa@pmcsa.org.nz

Foreword

The public good is undoubtedly advanced by knowledge-informed policy formation, evaluation and implementation. The challenge is how to do better in two related domains: the generation and application of knowledge to inform policy making, and the use of scientific approaches to the monitoring and evaluation of policy initiatives.

As Chief Science Advisor to the Prime Minister I have the brief to promote discourse that will lead New Zealand to better apply evidence-based knowledge and research across all domains of public endeavour. When I was first appointed to the role, I consulted with my counterparts overseas and it was generally noted that addressing this issue of the relationship between science and knowledge on one hand, and policy formation and implementation on the other, was one of critical importance in this increasingly complex and interconnected world. The challenges are multiple: to identify what research and information is needed, to identify appropriate sources of such knowledge, to interpret the validity, quality and relevance of the knowledge obtained, and to understand how that knowledge can improve consideration of policy options and policy formation while being cognisant of the changing nature of science and the increasingly complex interaction between science and policy formation. These issues confront all sectors of the public service.

It is important to separate as far as possible the role of expert knowledge generation and evaluation from the role of those charged with policy formation. Equally, it is important to distinguish clearly between the application of scientific advice for policy formation ('science for policy') and the formation of policy for the operation of the Crown's science and innovation system, including funding allocation ('policy for science'). This paper is concerned with the former. A purely technocratic model of policy formation is not appropriate in that knowledge is not, and cannot be, the sole determinant of how policy is developed. We live in a democracy, and governments have the responsibility to integrate dimensions beyond that covered in this paper into policy formation, including societal values, public opinion, affordability and diplomatic considerations while accommodating political processes.

Science in its classic linear model can offer direct guidance on many matters, but increasingly the nature of science itself is changing and it has to address issues of growing complexity and uncertainty in an environment where there is a plurality of legitimate social perspectives. In such situations, the interface between science and policy formation becomes more complex. Further, many decisions must be made in the absence of quality information, and research findings on matters of complexity can still leave large areas of uncertainty. In spite of this uncertainty, governments still must act. Many policy decisions can have uncertain downstream effects and on-going evaluation is needed to gauge whether such policies and initiatives should be sustained or revised. But, irrespective of these limitations, policy formed without consideration of the most relevant knowledge available is far less likely to serve the nation well.

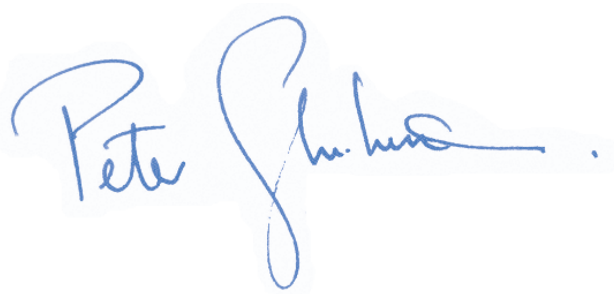
Many policies developed in isolation from the available evidence, or initiated and continued in the absence of monitoring and formal evaluation of impact and effectiveness, may well be ineffective in meeting their primary or secondary policy objectives and in some cases may even have unknown and unexpected adverse consequences. Accordingly, evidence-based approaches must also lead to greater efficiency in the provision of public services. One suspects that there are many Government-funded programmes now in place that when properly assessed would not meet objective tests of effectiveness; such evidence of non-performance would allow both the public and politicians to accept, and indeed require, redirection of effort.

It is also important to note that there are limits to scientific knowledge and to the scientific approach; governments and their advisors must be aware of such limitations, otherwise science can be misused to justify decisions that should legitimately be made on the basis of other considerations. Conversely, this limitation cannot be used as a reason to avoid the application of scientific findings where such knowledge can help define or resolve the range of options for the policy maker.

I see developing the opportunity for enhanced application of knowledge to better inform options and decisions in policy formation as a process that all parties in the House should wish to support. I reiterate that it is not evidence itself that makes good policy – rather, it provides knowledge, potential options and solutions, and a key foundational basis from which other factors can be adjudicated on by Ministers and their advisors.

To quote from a recent book[1] on the interaction between science and policy: “For those whose job is to create, interpret, and provide information to decision-makers, a challenge exists in how to connect their activities with decision-makers in ways that foster good decisions that increase the likelihood of attaining desired outcomes.” Such a challenge is not unidirectional, it is also a matter for the policy maker.

I thank the Prime Minister for encouraging me to approach this issue. This report is produced by my Office; its release reflects my independent role and does not reflect government policy. It is intended as an initial high-level paper to stimulate discussion amongst policy advisors and policy makers rather than to make specific recommendations. If it receives general support, then more work and consultation would be required to flesh out the detail of the measures suggested.



Sir Peter Gluckman KNZM FRSNZ FRS

[1] Pielke R Jr. *The Honest Broker: Making Sense of Science in Policy and Politics*. Cambridge University Press, 2007.

1. Preamble

Democratic societies make decisions and policy based on many inputs, including fiscal considerations, societal values, prevailing public views, and the ideals and vision of the government of the day. But democratic governments want to make good decisions and at the base of such decision making should be the use of high quality information and evidence, both in developing new policies and in evaluating current policies. Decisions made in the absence of such informed background material are, by definition, less likely to be effective or efficient and can entrench policies which may be of little value. Thus governments can become constrained by earlier policy decisions that are not easily reversible because there may be a popular or political perception that they are effective when in fact they are not.

While information and evidence do not themselves make policy, good information and evidence provide an important base for a rational assessment of options weighed up against those other criteria that politicians and their supporting policy advisors should consider. At the same time, it must also be acknowledged that many decisions that governments have to make are developed in an environment of limited available information or where the use of science is unable to resolve competing policy options.

It is hoped that this paper will stimulate Chief Executives of agencies and ministries to reflect on their responsibilities to identify what research and information is needed, how it may be obtained, how it should be interpreted and how it can be incorporated into policy advice and formation. Researchers, like all others, have their own beliefs and values; however, science has processes to minimise the ability of these human factors to bias the conclusions reached. Additionally, where possible, protocols should be developed to separate information-gathering and interpretation from actual policy formation, thereby ensuring the integrity of scientific advice proffered.

A further challenge arises from the paradox that while technological developments have contributed to many of the issues facing modern govern-

The BSE crisis in the UK

Bovine spongiform encephalopathy (BSE) is a neurodegenerative disease caused by infectious proteins called prions. Similar diseases have long been known in sheep (scrapie) and humans (Creutzfeldt-Jakob disease, CJD), but the existence of a bovine form was first recognised by the UK's Ministry of Agriculture, Fisheries & Food (MAFF) in November 1986. It took nearly 10 years for the UK government to acknowledge publicly in March 1996 that an emerging human disease, variant CJD, was almost certainly attributable to the consumption of BSE-contaminated meat products. That acknowledgment led to a 10-year ban on the export of beef from Britain and to the slaughter of over 4 million cattle, and the resulting public disquiet probably contributed to the election defeat of the Conservative government in May 1997. About 170 people are known to have died from variant CJD in the UK.

Several observers have commented that the scale and duration of the crisis were at least partly attributable to the failure of MAFF to seek appropriate and independent[a] scientific advice about the veterinary or public health implications of BSE. In fact, in the initial stages an explicit decision was made to conceal the existence of BSE and to avoid consulting or involving scientific advisors. When external scientific advice was eventually sought, its recommendations were strongly constrained and influenced by MAFF officials who were also concerned with the commercial effects of any regulatory action. "MAFF's repeated claim to the effect that policy was based on and only on sound science was a rhetorical cover for a set of covert political and commercial judgements masquerading as if they were scientific." [b]

The subsequent Phillips inquiry (2000) recommended a shift in the relationship between scientific advice and policy-making, and led to a marked strengthening of the UK's scientific advisory capability.

[a] That is, where the advice is not subject to pressures from end-users or politicians and is based on analysis of the evidence alone.

[b] van Zwanenberg P. Summary and conclusions. In: *BSE: Risk, Science and Governance* (edited by P. van Zwanenberg & E. Millstone). Oxford University Press, 2005.

ments, science and technology are at the heart of providing solutions. Examples of this include changing demography as the population ages, urbanisation, new patterns of information exchange and socialisation, changing demands for nutrition and food security, biosecurity and emerging infectious diseases, intensified agriculture, uncertain water quality and supply, growing energy demands and the issues associated with climate change. Additionally, many of the 'ungoverned spaces' of the world are effectively managed for and by science – these include the Antarctic, deep oceans, and the internet.

Governments themselves are large purchasers of information and research both directly (via ministries and agencies) and indirectly (via the academic and research systems). However, quality control of these types of purchased evidence can vary greatly. Much academic research is subjected to formal peer review, both before the provision of funding and when the results are published. In contrast, much directly purchased agency research does not go through these or equivalent processes and therefore in many cases there is no calibration as to its quality or reliability – indeed, the evidence may never be able to be assessed independently. Irrespective, poorly developed research is of questionable value in any domain and particularly so in relation to policy formation and evaluation.

Few people with extensive scientific research experience enter New Zealand government and the public service, and yet science and technology are all-pervasive in the way societies operate. In future, science and technology will increasingly affect how communities will develop, how citizens will live, how the environment will be challenged and protected, and how economies will grow. Indeed, there is a universal belief among governments that the 21st century will be one in which the health and wealth of nations will be critically dependent on how science and technology are used. This belief has become an essential component of economic strategies in OECD nations and increasingly in less developed nations.

It is also worth noting that the scientific method has important applications in scenario analysis, particularly in intermediate-term and long-term foresighting. Economics as a science now has a large modelling and empirical component. Econometric techniques are increasingly applied in the analysis of complex systems in other domains.

Across all successful democracies, there is therefore increased interest in ensuring that high-quality evidence is used for policy formation and decision-making in governments' strategic and operational roles. The United States and the European Union have recently taken steps to promote the place of science in their policy agendas and to protect the integrity of such advice. More generally, similar initiatives are taking place in many agencies across the world's democracies. This paper briefly reviews the New Zealand situation and suggests some steps that might be considered by the public service to improve further the quality of information available to Government, as well as how it could use such information. In doing so, it examines recent initiatives in the US[2] and the UK[3] to strengthen the integrity and utility of the application of scientific and technological information to policy making.

2. The changing nature of science and its relationship to policy making

Science can be defined as the systematic pursuit of knowledge. But it is important to note that the nature of science is itself changing as is the role of science within society. For most of the past 200 years science has largely been conducted in a linear manner. The general pattern has been that a problem or question is identified, a scientific investigation is undertaken to directly address the problem and in turn, assuming the problem is properly identified and understood, the knowledge is applied. There is a general presumption in such a model of binary outcomes that science brings precision to the answer.

But increasingly science is being applied to systems that are complex, non-linear and dynamic. These

[2] Office of Science and Technology Policy. Scientific Integrity: Memorandum for the Heads of Executive Departments and Agencies. Available from: www.whitehouse.gov/sites/default/files/microsites/ostp/scientific-integrity-memo-12172010.pdf [accessed 2011 Jan 10].

[3] Government Office for Science. The Government Chief Scientific Adviser's Guidelines on the Use of Scientific and Engineering Advice in Policy Making. Available from: http://www.bis.gov.uk/assets/bispartners/goscience/docs/g/10-669-gcsa-guidelines-scientific-engineering-advice-policy-making.pdf [accessed 2011 Jan 10].

include questions about climate, about the environment, about society and about human behaviour, all of which are central to governmental interests.[4] This type of science almost never produces absolute answers, but serves to elucidate interactions and reduce uncertainties. Precision is not the outcome, rather an assessment of probabilities. In these contexts, as Jasanoff has pointed out,[5] there are limits to how and where scientific advice can be applied usefully by government. Indeed, situations can occur where governments inappropriately turn to science to justify policy decisions that in fact cannot be elucidated in a scientific manner but rely on the collective values of the population and the government.[6] On the other hand, governments that fail to use science when science can assist in defining the range of policy options are doing their citizens a disservice.

Notwithstanding this, the linear model still frequently applies – for example in investigating issues around the safety of medicines – but increasingly the interaction between science and policy involves the more complex systems mentioned above.

The nature of scientific advice and the role of the scientific advisor must therefore vary according to the circumstances. In the more linear situation, scientific advice is largely separate from policy considerations, and that has been the historical basis of the presumption of the independence of science advice and policy formation. However, the clarity of this separation often breaks down in the increasingly non-linear world where issues and perspectives are inevitably intertwined and therefore the nature of scientific advice and input is changing.[7]

However, because science is a human process, it can have errors and scientists can have biases. There can be a danger of scientists claiming greater certainty than can be justified. Scientific advice must proceed through processes that are cognisant of, and act to limit, such potential distortions.

There are a number of conceptual models that scholars of the interaction between science and policy have used to illustrate how scientific advice has been or could be used in policy development.[8] The 'decisionist' model gives politicians the responsibility for determining policy goals proactively; the role of expert advice is to help decide on the regulatory and implementation processes that will achieve those policy goals. This model essentially ignores the potential of knowledge to inform a prior consideration of the range of policy options possible and reflects an earlier and more authoritarian form of governance. A second 'technocratic' model, originating from the mid-20th century view of scientific absolutism and linearity, essentially reverses this process – expert advice based on scientific knowledge determines policy goals, and democratic debate then focuses on the regulatory decisions that will achieve those goals in a way politically acceptable to the electorate.

Both of these conceptual models, but in particular the second, rely on three conditions that are becoming increasingly difficult to fulfil. The first of these is the need for uncritical public trust in the values and outputs of the scientific process; the second requires acceptance of the notion that science is a process that establishes incontrovertible and absolute fact; and the third requires complete separation between scientific advice and policy judgement.

At the beginning of the 21st century, policy makers and their expert advisors have found themselves to be working in an environment where the values and outputs of science are questioned by an increasingly informed, involved and vociferous society. This is for the very understandable reason that science and technology and the way people live their lives are now totally intertwined. Science and technology are now focused on complex systems, in part because it is around such complexity that governments must make decisions. Thus sci-

[4] Funtowicz and Ravetz termed this 'post-normal science'. Funtowicz SO, Ravetz JR. *Science for the post-normal age*. Futures 1993; 25: 739-755.

[5] Jasanoff S. Technologies of humility. Nature 2007; 450: 33.

[6] Pielke gives a North American example of where the abortion debate is not about the science of the embryo but is a debate about values and beliefs in which science has been used to try and justify positions by protagonists on either side of the debate. Science cannot resolve this matter; it must be resolved by political processes. See Pielke (2007).

[7] For an extensive discussion see Pielke (2007) and Jasanoff S. *The Fifth Branch: Science Advisors as Policymakers.* Harvard University Press, 1990.

[8] For example, see Millstone E. Analysing the role of science in public policy-making. In: *BSE: Risk, Science and Governance* (edited by P. van Zwanenberg & E. Millstone). Oxford University Press, 2005.

ence is increasingly important to the policy maker, not for creating certainty but rather because it can operate to define the boundaries of uncertainty within complex systems. Consequently, scientific advice and policy formation now increasingly act in a more iterative way – what has been termed the ‘co-production’ model of policy making, in which policy makers, expert advisors and society negotiate to set policy goals and regulatory decisions that are agreed to be scientifically justifiable (in terms, say, of the information available and the levels of future risk that are tolerable) as well as socially and politically acceptable.

Importantly for this paper, the iterative model of policy development requires expert advisers to be more sophisticated in the way that they communicate with policy makers and the public, for example by being explicit about the assumptions, limitations and uncertainties underlying the evidence and by presenting technological options in ways that allow the full range of their possible benefits or adverse effects to be appreciated (acting as the ‘honest brokers’ envisaged by Pielke[9]).

Within this complex interplay between science and policy there are of course limits. There are policy issues where scientific information cannot contribute significantly. Caution is also needed to avoid co-opting scientific advice as an inappropriate proxy in difficult decisions that should be made on other grounds. But on the other hand it is far more likely that some policy issues that require scientific input are addressed without any or sufficient scientific input. This is a particular risk among agencies with little or no science expertise.

3. The nature of evidence and its relationship to policy making

Not all evidence is of equal quality – for example, anecdotal recall of recent weather events does not have the same validity or credibility as a systematically compiled set of long-term climate records. This paper uses the term ‘evidence’ to mean knowledge arising from the scientific process – a generally self-checking but not perfect system of observation, experimentation, replication and concept formation whose purpose is to understand the natural or human world. ‘Science’ includes the social, engineering and economic disciplines as well as the natural sciences.

Policy makers may well take into account consensus-based opinion (such as from focus groups including end-users or from political processes) when formulating policy, but should be careful to distinguish such information from research-based evidence and to employ processes to reduce the risk of their own value-based biases interfering with dispassionate advice. However, given increased complexity in the systems under study, research-based evidence will tend to come with uncertainties and probability estimates around the conclusions that are reached.

Further, some proposed interventions will have a greater level of effect than others, and this is often not clearly stated in opining on policy options. Frequently data are presented in a way that does not make this clear, and yet prudence demands that fiscal and social investments are made proportionately to the impact they are likely to have.

An example from the medical sciences is instructive. A new medicine that reduces the risk of death from a disease tenfold from 1 in 10 to 1 in 100 is clearly more valuable, other things being equal, than an existing medicine that reduces the risk by 10% from 1 in 10 to 1 in 11. But for either medicine, the underlying incidence of the disease is critical in assessing the Government’s decision to fund it: if the disease is extremely rare and only occurs on average in one per million lives, from a public policy point of view neither medicine will have a high impact from a fiscal or population perspective and the decision to apply funds would be based on humanitarian rather than public policy considerations. Contrast that with a disease that affects one in ten people, in which case improving survival by tenfold would benefit a large number of people and is clearly likely to be justifiable from a public policy perspective. This simple and extreme example highlights the importance of presenting estimates of risk and benefit in absolute terms that allow the public and policy makers to understand the basis on which they are making decisions. The decision to do or not do something is very dependent on its likely impact, and how that is presented can affect its acceptance or rejection by politicians and the public. The misuse or misunderstanding of

[9] Pielke (2007).

Remediation at Mapua

From 1999 to 2008, New Zealand's Ministry for the Environment (MfE) was involved in the remediation of the contaminated agrochemical site at Mapua, Tasman District. After withdrawal of the main contractor in 2004, MfE took over the resource consents and became responsible for management of the remediation process, which was subcontracted to the publicly funded developer of the novel remediation technology adopted. The operation ran over time and over budget, and there was considerable local disquiet around possible air and water discharges of toxins. An investigation by the Parliamentary Commissioner for the Environment criticised several aspects of MfE's involvement, but in particular focused on the lack of technical capability within the project team that took over the programme's operational management. This lack of technical expertise was found to have probably contributed to the poor operation and deficient monitoring of the remediation. "If MfE is to perform operational functions, those functions need to be clearly defined and supported by the appropriate in-house technical capability."[a]

[a]Parliamentary Commissioner for the Environment. Investigation into the Remediation of the Contaminated Site at Mapua. July 2008. Available from: www.pce.parliament.nz /assets/Uploads/Reports/pdf/PCE_mapua.pdf [accessed 2011 Jan 25].

statistics in the public arena can blight healthy democracy.

In many areas of interest to government, the complexities of the physical, biological or societal systems in play are such that sophisticated scientific interpretation is needed to offer policy makers options with which to make better decisions against a background of intrinsic uncertainty. In particular, the professional skills of the research community are often required to define the limits of certainty, distinguishing between measurable risk and unmeasurable uncertainty (or 'unknown unknowns'). Climate change, environmental degradation, seismic hazards and many social issues are obvious current examples highlighting complexity associated with uncertainty, and exemplify the need for expert assessment of the evidence.

4. The situation in New Zealand

In New Zealand there are agencies that are strong users of formal scientific advice. These are generally situations where traditional linear science has value – examples include PHARMAC, some other areas of the health portfolio, and the Ministry of Fisheries. However, there is considerable variation in the protocols used to obtain such advice and no over-arching set of principles to ensure its integrity. Indeed, a number of examples exist where the lack of independence of the scientific advice and its conflation with other perspectives has noticeably biased the information available for decision-making and led to inappropriate outcomes.

Chief Executives need to be certain that they have effective processes to identify when linear research and information are needed, that they have appropriately skilled providers of that information, and that information is quality controlled and free of bias. Otherwise, the range of options to be considered becomes limited. Similarly, because science has critical value in contributing to a better understanding of complex systems and the associated creation of policy options, it is again important that Chief Executives have systems in place to ensure unbiased advice in a 'co-production' model.

In many if not all cases, such demands may well require Departmental Science Advisors (DSAs) who can act as agencies of translation between the research community and the policy process. Such capability would mean that procedures are in place to ensure the quality of research sought and its scientific interpretation. Experience overseas (e.g. the UK) has shown that formal and generally applied effective processes can be developed across most central government agencies, but that difficulties arise if there is not clear understanding by both the science and policy communities of what science can and cannot do. There needs to be agreement as to whether or not science is important to the decision being sought or whether values and other considerations are dominant. As discussed elsewhere, science advisors must also be aware that the integrity of advice requires sublimation of their own possible biases and personal agendas.[10]

Government must distinguish information that it must develop on its own account for policy formation, and needs to be collected at a central level (such as statistical information) from that derived from other approaches such as basic research that might better or more effectively be undertaken by academia, Crown Research Institutes or the private sector.[11] These alternatives raise the issue of the extent to which departments should employ active research scientists directly or whether research should be contracted to established research organisations. Each department, as appropriate to its mission and statement of intent, should have clear policies in place relating to this division and the rationale for it. When a department wishes to commission research, it is often the case that it is best carried out by established research agencies operating appropriate quality control mechanisms such as peer review rather than by embedded departmental research units. For internally performed research, departments need to be certain that adequate mechanisms exist to ensure quality – this generally will include some form of scientific evaluation before the work is commenced and at its conclusion. It is clear from experience across the scientific world that research is less likely to meet its objectives if it is not subject to some form of evaluative audit at the pre-initiation stage.

Irrespective of this potential division, departments cannot realistically contract quality research and interpret it without access to a community of scientific advisors, either embedded within or strongly associated with the department. Quality assurance of the research process and some level of peer review of the information obtained from such activities is paramount, yet few departments have protocols in place to consistently monitor the quality and independence of scientific advice. Closely related to this, it is most important that Chief Executives themselves are able to distinguish advice based on objective analysis of science and data from advice where other considerations (such as end-user perspectives) may be appropriately or inappropriately in play. It is apparent that high quality scientific advice and thus policy formation requires clarity in such distinction.

Furthermore, as discussed above, all forms of science have challenges in terms of the certainty they can provide, and their interpretation. Departments should develop protocols on how to present probabilities, risks, uncertainties and magnitude of likely impact when offering policy advice.

Often research and data collected for the purposes of one agency have broader applicability across government. This is particularly so in the case of the environmentally focused ministries and the social agencies. The issue of the social ministries is discussed in more detail in Section 5.6, but what is apparent is that greater coherency in research function is possible and highly desirable given that Social Development, Building & Housing, Justice, Education, Health, Corrections and Te Puni Kōkiri, amongst others, have a marked commonality and overlap in terms of both problems and solutions. In general, social science research by governments tends to suffer from a lack of effective quality control processes. Therefore, the quality of research carried out by departments and agencies with operational functions is highly variable. Further, its value and associated technology are often not fully appreciated in terms of systems improvements. In spite of this, the sum of money that these ministries invest directly in research in New Zealand is substantial.

Since much governmental research is contracted out to third parties by ministries and agencies without any independent review of design, protocol or desired outcomes, the potential for indifferent research is high. This is a particular risk when the researcher contracted is an ex-member of the department and assumptions about process and quality are made on both sides.

Currently there is no register of government-contracted research, so data collected by one agency may be unknown to other agencies or even to members of the same agency. Often the same information can be of value to other agencies and

[10] See Pielke (2007) for an extensive discussion.

[11] This discussion is limited to how policy is formed, and is quite distinct from a consideration of how government purchases public good research through Vote Science and Innovation and other Votes. With respect to the latter, scientific evaluation is part of the process. In general, such systems blend scientific merit with decisions on prioritisation; this is particularly the case in applied and translational research.

also to the private or voluntary sector and yet it is unknown and irretrievable.

Although policy formation is best supported by quality data, in many cases policy must be developed against incomplete information and sometimes the proposed intervention is clearly experimental or speculative in nature. In the latter case, careful evaluation of the effectiveness of the intervention is needed on an ongoing basis, and the intervention should be designed accordingly to allow such evaluation.

Much in our social support system has been developed without a strong evidential base, and new programmes are entered into without establishing monitoring regimens or defining what success is. Often, programmes are started without adequate piloting and evaluation and even then, many programmes have features which may be successful at pilot stage and yet are not scalable.[12] An outcome of this lack of rigour may well be that an untested high cost programme is established on the basis of little or no evidence, irrespective of the best of intentions. Subsequent continuation can then become a matter of political dogma because it cannot be properly evaluated and the public and politicians have no way of gauging the cost to benefit. As a result, such programmes trap governments in long-term investments of probable marginal or even counter-effective value.

Thus it is vital, in a democracy which places high values on the quality of the social network and where public expenditure must be limited, to pay more attention when designing policies and programmes to considering how success may be monitored and how programmes as a whole can be formally evaluated for impact and effectiveness.[13] Again, this should be done using scientific methodology and the results then subjected to policy evaluation. Such knowledge should be properly communicated in an open society and would place governments in a position to better use limited resources and to minimise the risk of public backlash when considering the closure or revision of ineffective programmes.

5. Components of a suggested path forward

Broadly, improvement in the use of science-based evidence is likely to be gradual and incremental and will require 'buy-in' from many stakeholders. I have therefore limited my comments in this report to those areas where manifest gains in policy formation and governmental efficiency are likely to be achieved in the relatively short term. Clearly progress will be dependent on attitudes and approaches taken by agency heads. Other areas may need additional work – for example in establishing across-government principles for protecting the integrity of scientific advice as has recently been undertaken in both the US and the UK.

5.1. Rotation of staff and the lack of public service staff with science experience

One feature of the New Zealand public service is that it is relatively insular. Few staff rotate from the private or academic sector into or out of it and in areas where scientific expertise is needed, this is even more so. This situation contrasts with that in many other western jurisdictions. The result can be limited knowledge of the breadth of possible evidence available to the analyst as well as limits on the insights that come from broader experience.

A solution used in the US State Department is for fellowships to be provided for academics to spend a year or so contributing to scientific and technical

[12] It is well established that many pilot programmes can be highly successful but that critical elements in their success may not be scalable to real-world application. For example, the target group used at the pilot stage may be more selected and therefore not representative of the population to be addressed, or the commitment of the initial advocates may be very different to that of the programme providers once the intervention is widely implemented. This failure of scalability is often reflected in a confused evaluation literature and a subsequent inability to be dispassionate about a particular programme.

[13] As discussed in Section 3 in the context of medical treatment, it is possible for a programme to have an effect but not have a great impact if the effect size is small. To say that a programme makes a difference may be statistically correct, but is not as informative as describing the magnitude of the effects seen and whether there are particular groups of the population who will benefit. Further, a programme may have an effect without being in any way cost-effective. A good monitoring and evaluation programme will address these various aspects.

expertise within the department, thereby raising awareness of the value of scientific input. In turn, academics broaden their experience by interacting with policy makers, and these individuals on return to academia become important departmental resources. This could also extend to experts from the private sector.

There are relatively few scientifically experienced staff within the New Zealand public service, and those who do have scientific experience in general retain little on-going association with the scientific research community. In many areas the science moves fast, technologies change and sometimes paradigmatic shifts occur in the underlying thinking. Analytical techniques change and the capacity to be aware of the state of science and evidence declines as the individual becomes more distant from their original training and increasingly specialised in non-scientific matters through their roles in the State Sector and after promotion.

There may be merit in State Sector Chief Executives giving greater attention to the potential of their scientific staff and assisting them to stay in contact with relevant science communities and to interact more amongst themselves. I was surprised that those who have responsibility for science do not meet regularly with their counterparts in other agencies, and until I held discussion sessions with them, many had not met each other. It also became apparent that the issue of how to generate and use evidential advice in policy formation was a matter of mutual concern, but not one they had discussed or found a common approach to deal with. By way of contrast, in the UK there is active promotion of a semi-formal Science & Engineering community within government with a central role given to the Chief Science Advisor to encourage this interaction.

A further advantage of a structured community of science advisors is that it would create a clear point of contact. Since being appointed, I have received comments both from domestic and international companies and from some international agencies that the New Zealand system is hard to interface with on scientific matters and opportunities, particularly when they fall outside the sole ambit of the Ministry of Science and Innovation. Such a community would provide a clearing house.

One recurring issue I have noted is the varied approach to the involvement of university and Crown Research Institute staff in public matters. In many cases, government departments expect these services to be provided free or at least largely subsidised by the employer. Yet the time commitments can be very large (such as those related to IPCC processes). This places scientists in an invidious position – they are squeezed between their moral/public good obligations via the opportunity and wish to help, and the requirements of their employer. Departments have in some cases been uncertain as to how to second or subcontract a person from academia or elsewhere on a part-time basis to the department. There is a need for the community of departmental Chief Executives, perhaps assisted by the State Services Commission, to consider the value of public service-wide guidelines and perhaps a proforma contract for the purchase of academic/scientist time for significant contributions to the government sector. This should recognise the true costs to the employing institutions. There is increasing managerial resistance to informal arrangements that rely on the goodwill of scientists to meet the costs of providing advice out of local funding.

The following components of this paper presume that guidelines for the purchase of academic/scientist time by government agencies can indeed be achieved. Otherwise, greater connection between the scientific community and government will not be possible.

5.2. Internal departmental scientific advice

A number of ministries and agencies collate scientific advice internally. How this is structured can be haphazard. In some departments a single individual is identified as the departmental scientist, in others responsibility is more dispersed. Essentially in no case is the function of Departmental Science Advisor established as a senior role with direct access to the leadership team.

As mentioned above, this contrasts with other jurisdictions, where scientific advice for policy formation is sourced from senior scientists embedded within government who are seconded from the academic community. These individuals provide authoritative commentary to their departments' Chief Executives on the state of scientific evidence and procure appropriate specialist expertise if and as required. Across the Westminster system of government, the most advanced use of scientific advice is in the UK. Here in every department of State other than the Treasury there is now a Departmental Science Advisor. Their terms of reference and roles vary according to the department. The appointee (or appointees) is generally employed on a limited-term secondment from their employing organisation (e.g. university or public research organisation) on a 20-80% basis, allowing some ongoing association with their home research base. In general, such appointees are very senior, many being Fellows of the Royal Society. Their terms of appointment assure the independence of their advice from the normative bureaucratic and political process. Departmental Science Advisors in some departments like DEFRA (Environment, Food & Rural Affairs) and DFID (International Development) have significant staffs, including deputies of similar standing and they are also able to contract their own research externally and internally.

An important attribute of these science advisors is that they must have the skills to transcend disciplinary boundaries and synthesise knowledge across several disciplines. In that role they are not expected to be experts in all that they confer advice upon – rather, they are mediating between the broader scientific community and policy formation, as well as providing public commentary. Their roles in general relate to the provision of strategic scientific advice, ensuring the quality of evidence to support policy formation, and participation in planning, managing and supervising the purchase of agency-required research (see below). Some Departmental Science Advisors have standing advisory committees to support their positions.

In the UK a critical role is in the provision of foresighting services to the relevant ministry. The Government Chief Scientific Advisor himself chairs a weekly meeting of all Departmental Science Advisors, and this is a valuable way of achieving cross-agency coordination of knowledge development. This is also where the foresighting occurs (which by comparison is not a strong part of the New Zealand policy structure). The Science Advisors report to both the departmental Chief Executive and the Government Chief Scientific Advisor. In Australia the long-term foresighting function for government is operated through a process coordinated by the Chief Scientist.

An important additional function of such advice is that it provides greater independence to governmental research planning and reduces the risk of knowledge avoidance, which in the long run can harm a democracy. Knowledge avoidance refers to the situation where there is a significant risk that a particular line of research might not be undertaken because the outcomes might clash with either industry or political positioning. A hypothetical example would be if fish stocks were not properly studied, then the evidence needed to support appropriate conservation and quotas would not be obtained; resulting policy decisions might well favour short-term exploitation at the risk of eventual extinction of the stock.

An examination of the New Zealand situation would suggest that there are many departments where a position equivalent to Departmental Science Advisor would be of advantage. The value in departments such as Agriculture & Forestry, Environment and the socially focused ministries is clear. Furthermore, as the intersection between science, diplomacy, trade and developmental aid becomes more apparent, the role of scientific advice is becoming ever greater across a broad range of economically focused ministries. In departments with a high requirement for science/knowledge it should be the norm that a scientist be part of the senior management team.

To reiterate, an essential point is that Science Advisors are not expected to be, nor can be, personally expert in all aspects of the domains on which they give advice. Rather they must understand the process by which scientific advice is collated and be responsible for ensuring that appropriate expertise is brought to bear in an appropriate manner to assist policy formation. Their role is more one of solicitation, translation and quality control and of bridging the cultural gap between the scientific community and the policy community.

The existence of Departmental Science Advisors does not obviate the need for a high quality Ministry of Science and Innovation, which has a distinctive set of roles and obligations, in particular relating to directing policy formation and expenditure within the science and innovation systems. Indeed, this Ministry too would benefit from input from practicing scientists and they would also play a role in stewarding such capability for specific purposes.

Officials within the Ministry of Science and Innovation generally cannot be expected to provide the type of independent scientific advice that can be procured from senior research-active scientists.

5.3. Use of external scientific advice

Increasingly, governments are turning to advisory experts or expert groups/committees to assist in handling particular sets of scientific questions. New Zealand has some such standing committees of this nature, but compared to other countries we do not use external advice to the same extent, nor do we have a consistent protocol on how to engage to obtain this advice. As New Zealand becomes more focused on becoming a smart and healthy society with a smart economy, the need for such external expert input will grow. However, several issues are likely to emerge in this process, and steps need to be taken early on to ensure that the scientific advice is:

- focused on the data and its appropriate interpretation;
- unbiased with respect to its use of data;
- open about what is known and not known;
- able to communicate in terms of probabilities and magnitude of effect;
- free from conflicts of interest, provided apolitically and independent of any particular end-user perspective.[14]

Again, external advisors need to be clear about the distinction between, on one hand, providing scientific advice to underpin policy formation and, on the other, policy making itself, which can involve additional political, ethical, economic and social dimensions. Equally, they should be able to contribute to the interaction between these two domains in a 'co-production' framework. Chief Executives need to be clear when tasking scientific advice from advisory groups to define what is meant to be achieved.

The UK has the most extensive set of advisory groups. These have been of variable quality and in some cases have generated controversy. As a result, the UK's Chief Scientific Advisor has established a set of generic guidelines for all such committees across the UK civil service.[15] Similarly, our Ministry of Fisheries has been notable for working towards the establishment of a Research Standard for New Zealand Fisheries Science Information to deal with the almost inevitable conflict between industry and independent advice about fish stocks and quotas. During this process a comprehensive review of international best practice[16] was arrived at.

It appears rational that there should be a similar set of generic protocols and guidelines as a basis for external scientific advice within the New Zealand policy formation process. My Office may be the appropriate place from which to develop these in consultation with Chief Executives and the State Services Commission.

5.4. Scientific advice from the Crown Research Institutes

A potential and unique problem can exist with the Crown Research Institutes, which should be a major source of advice to the Crown in their areas of expertise and indeed this is now called for in their revised Statements of Core Purpose. In some cases, however, CRIs have entered into contracts with the private sector that limit their capacity to give such advice (e.g. around land use), and indeed they can find themselves being contracted to give advice contrary to the Crown's wider interests. In general entry into such contracts is often unwise and academia has shown them to be unnecessary. Academia enters into many private sector contracts and yet essentially none limit institutional ability to publish, subject to IP protection. On the basis of the now altered expectation of the CRIs, they must now take greater care in future arrangements to avoid compromising their ability to serve the Crown as important and independent advisors.

[14] End-users have a very important place in policy formation, but that should not be conflated with the need for policy makers to understand the scientific basis of an issue and the range of options that emerge. Other perspectives including those of end-users narrow those options.

[15] Government Office for Science. Principles of Scientific Advice to Government. Available from: www.bis.gov.uk/go-science/principles-of-scientific-advice-to-government [accessed 2011 Jan 10].
Government Office for Science. Code of Practice for Scientific Advisory Committees. Available from: http://www.bis.gov.uk/assets/bispartners/goscience/docs/c/cop-scientific-advisory-committees.pdf [accessed 2011 Jan 10].

[16] Ministry of Fisheries. Review of International Guidelines for Science Quality Assurance and Peer Review. Version 2.2, September 2010.

5.5. Direct purchase of agency research

Many departments purchase 'research'. They may undertake the research internally (e.g. Conservation) or they may contract to a third party – generally a consultancy or a university or a Crown Research Institute. There is a large volume of such activity, and while it is difficult to separate it entirely from policy analysis and development, it is likely that this research costs many tens of millions of dollars per annum. There are risks in the contracting process of either overfunding or underfunding. The latter may seem paradoxical, but as in other forms of science funding there is always the risk of government departments putting up disproportionately ambitious contracts for the amount of money being offered rather than defining the project by its objectives and then costing for quality. This can lead to the exclusion of large science agencies in favour of cheaper 'consultancy' research, or alternatively for some research to be undertaken but to be of insufficient depth or power to be of value. Such research is generally a waste of money – it cannot inform policy options as it is unable to reduce uncertainty.

As with other forms of research, a level of quality assurance and peer review should be required of all internally purchased research, although such review need not be of the sophistication of traditional contestable activity. The development of such a requirement would be the logical responsibility of a Departmental Science Advisor and a departmental science advisory committee. In related departments and agencies this activity could be shared. For major projects (such as the New Zealand Longitudinal Study), peer review could be contracted to the Health Research Council, Marsden Council or the Science Board of the Ministry of Science and Innovation.

All such contracted research must conclude with formal reports – this is currently not always the case and many projects appear not to have a formal output. This is not efficient or cost-effective and is a waste of investment. This requirement for a report should be absolute and should not be contentious.

Further, such reports in general should be broadly accessible. There is no overall register of internally purchased research and the reports that arise or the data sets available, and thus they are not always known by or available to other departments, to NGOs and to the private sector, where much of the information would be of broader value than to the purchasing agency itself. A government-wide register of datasets and research report summaries should be maintained, and where appropriate (which should be the default position unless there are security or other overriding requirements) should be in the public domain.

5.6. Social science research

As mentioned in Section 4, there are sets of government ministries with overlapping interests where activity in one department will affect outcomes of interest to another. This is particularly so in those ministries associated with social outcomes – for example decisions around early childhood education can have implications for Health, Education, Justice, Social Development and Labour. Further, these agencies largely rely on complex data sets that integrate population approaches at different scales. The complexities of interactions affecting the human condition create real challenges for social science. The importance of well evaluated interventions both at the pilot stage and after scale-up is critical, as the costs and implications of inferior science or wrong data leading to policy decisions are immense. Social science is often deprecated as being anecdotal (and indeed this can be the case), but excellent social science, if done well, can be immensely valuable. That said, this is an area more than any other where inept science or a scientific vacuum can lead to policy decisions based on dogma and ideology rather than on the knowledge needed to lead to better outcomes. All governments, irrespective of ideology, want the best outcomes from their investment in social development and they need data that they can use within their ideological frame of reference.

Social science is not well constituted within the New Zealand science system and across or within those ministries and agencies that need such information to develop policy options. Yet it is within the social domains that the Crown invests heavily on the basis of perceived benefit. There is a significant level of disconnect between departments, inconsistent use of academic data which itself needs to be carefully evaluated for its objectivity, and a variable capacity to share information. There are few highly qualified social scientists within these agencies.

This is a domain where a foundation of good science is needed, not only to evaluate issues but

Driver education: misplaced confidence

It would appear intuitive that formal driving education within the school curriculum would reduce the high rate of road accidents that teenagers experience. Indeed there has been much advocacy for such programmes over the years in various countries – from politicians, families of road victims and insurance companies. But when such programmes were introduced in both Europe and the US, it became evident that these initiatives either had no beneficial effect on, or even actually increased, the accident rates of young people.

Formal evaluation with controls showed that driver education does lead to earlier licensing, but provided no evidence that driver education reduces road crash involvement and suggested that it may lead to a modest but potentially important increase in the proportion of teenagers involved in traffic crashes. An earlier study from New Zealand in the 1980s reached similar conclusions.

This negative view of such programmes was initially vehemently rejected by some advocacy groups, but the scientific view became compelling and has been integrated into policy. The data do not even support driver education as a rationale for accelerating the passage through graduated licensing systems. Why does this counterintuitive outcome occur? In part because it leads young people to wanting to get their driver licence at an earlier age, and in part because it can lead to over-confidence in people who are already at a stage of their lives when they are most likely to engage in risk-taking activities.

This is a classic example of why an evidence base is desirable even when what seems like 'obviously sensible' new programmes are introduced, and of why programmes should be introduced in a pilot fashion capable of evaluation. The assumption that formal driver education would be of value led to investment in programmes which in fact did more harm than good.

also to perform formal evaluation of interventions, both at the pilot and the generalised level. As mentioned in Section 4, not all pilot projects scale up effectively (this is a common reality) and many social interventions are established either without pilots, without proper evaluation, or even without there being clarity as to what are the key elements for success. Sometimes adverse consequences occur, as discussed in the Box above. This is particularly likely when programmes are developed without formal independent evaluation processes and are 'sold' politically by their advocates. The default position should be to require formal quality evaluation in all new interventions.

One solution might be for the Crown to shift some resources from individual ministries to create a social sciences research purchasing and monitoring unit. Such a unit could be governed by the relevant Chief Executives but managed/advised by experienced social scientists who would ensure quality of contracting (both within and beyond government). The unit could also manage peer review, assess outputs and maintain a research register. The proposed entity would be small, as it would not undertake the research itself[17] but would purchase all such research on behalf of the Crown to ensure quality in the research purchased, monitor and interpret the reports generated, and avoid duplication. Often research could serve more than one client department. The unit could therefore maintain a social sciences research register and ensure broad access to the data (see Section 4). It could also recommend to Chief Executives potential research activities to consider and appropriate evaluative tools for new programmes.

Another possibility might be for the purchase agency to be combined with discretionary research funding administered through the Ministry of Science and Innovation, analogous to the purchase function the Health Research Council already carries out on behalf of some other agencies. How-

[17] In this regard, it would be quite distinct from the social sciences Crown Research Institute that briefly existed in the 1990s. In contrast to that CRI, which like other CRIs was seen as generating its own research agenda and undertaking the research, what is envisaged is a focus on quality assurance, which is critically needed given the volumes of social science research undertaken and the impact of that research on the public purse.

ever, the potential diversity of research areas involved, the essential requirement for the work to be 'owned' by the relevant Chief Executives, and the need for the structural decisions to be made independent of provider considerations, mean that the former option may be preferable.

Irrespective of the operational approach chosen, such a development would reduce waste and improve the quality and efficiency of the research needed for Government to undertake its responsibilities in the social agenda.

5.7. A joined-up approach across government

It is clear from discussion above that there is wide variation across the New Zealand public service in how agencies plan for, obtain, interpret, use and communicate scientific advice. My view is that there would be merit in developing a set of guidelines setting out best practice in the use of scientific advice in policy making. A move towards commonality of approach is likely to yield efficiencies in evidence gathering and application to policy making and evaluation, and remove gaps and duplications in the information base available to government. In keeping with experience overseas, my Office may be appropriately placed to assist with the development of such guidelines.

6. Links to other governmental reforms

There is a growing awareness that in many aspects of government policy formation, but particularly in the social sciences, there are major opportunities for improved use of government funds for greater effect. Too many programmes are started without prior evidence or analysis of their possible impacts or value for money, and only irregularly has there been a formal evaluation and impact assessment of the work conducted. Such shortcomings need to be resolved via the establishment of routine requirements for such analyses.

There are many aspects of this report that can be linked to other government initiatives, including the Scott review of expenditure on policy advice, the move to more open government, the introduction of regulatory impact statements and the general need to ensure value for money from government expenditure. The potential for efficiencies in government expenditure and outcomes is manifold. Better informed programme development and monitoring after implementation must lead to programmes more likely to meet their policy objectives. The identification of ineffective or unscalable programmes at an early stage must improve the efficiency of government and outcomes for the nation. Objective evidence on the effectiveness of extant programmes will assist the government of the day to obtain public support for decisions around whether to continue or terminate them. The research activities of government departments can be better coordinated and quality controlled, and the resulting data can be made available to a broader range of users to assist their decision-making, whether in the public, private or voluntary sectors.

The change of emphasis for Crown Research Institutes also puts them in a stronger position to provide expert and specialist advice to government agencies as required (e.g. on water use and quality, or biosecurity).

7. Summary

There is a broad consensus that science and innovation are critical to addressing our productivity gap and in advancing New Zealand's social and environmental conditions. Science and technology are at the heart of every aspect of New Zealanders' lives, the challenges faced and the solutions needed. It is essential that all stages of policy formation and evaluation use knowledge optimally to achieve the best outcomes. This should be true of a government of any political orientation.

It is clear that there are deficits in how Government obtains and uses knowledge and evidence and this must affect the quality of policy formation.

This paper suggests a collection of relatively low cost measures and an attitudinal shift that could, over time, advance the quality of policy advice and thus assist the capacity of Government to improve our national condition.