RSC
The Royal Society of Canada
The Academies of Arts, Humanities and Sciences of Canada

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La Société royale du Canada
Les Académies des arts, des lettres et des sciences du Canada

Royal Society of Canada
Position Paper
May 2015

Strengthening Government by Strengthening Scientific Advice:

Fully realizing the value of science to Canadian society

Science is essential to the economic, societal, and environmental health of Canada. Science provides key evidence and information on which government makes decisions. The Royal Society of Canada (RSC) concludes that the Government of Canada would benefit by a strengthening of the role of science in decision-making. The RSC is concerned that the ability of science to contribute to the well-being of Canadians is not being fully realized.

> We believe that expert, independent, and objective scientific advice is fundamental to policy development and decision-making.
>
> We recommend that Canada establish the office of Government Chief Scientific Advisor in accordance with the world's wealthiest economies.
>
> We recommend full implementation of Industry Canada's landmark reports on scientific advice: *Science Advice for Government Effectiveness and A Framework for Science and Technology Advice*.
>
> We urge the government to fully integrate scientific advice in decision-making by processes that are transparent and accountable to Canadians.

Policies based on independent, objective scientific evidence are policies most likely to be robust in the long term and more efficient than policies rendered in the absence of such advice. A strengthening of how scientific advice contributes to government policy is rapidly becoming a hallmark of the richest democracies in the western world. To fully realize the benefits of society's investments in science, governments should fully utilize the ultimate product of science – evidence – to strengthen policy and better inform decision-making for the benefit of all Canadians.

1. Why is scientific advice essential?

Science[1] is essential. It is a global currency whose value grows daily. It affects our lives from the moment we wake until we sleep. Our lives are delivered, controlled, and informed by science: better medical care; healthier environments; increased efficiencies in industry; secure access to financial institutions; enhanced travel; improved food safety; strengthened border security; stimulating entertainment. The list is long. Science improves the quality of life.

Science leads to the creation of evidence: factually defensible explanations of the physical, biological, and chemical worlds and of the potential consequences of utilizing these realms for human benefit. To fully realize the benefits of society's investments in science, governments should fully utilize the ultimate product of science – evidence – to strengthen policy and better inform decision-making.

2. Expertise, independence, objectivity

Legislative, policy, and regulatory decisions are often influenced by consultations and advice received from different sectors of society. These sectors are of two general types. The common type involves individuals or groups predicted to be advantaged or disadvantaged by a decision. Less commonly, decision-makers seek feedback from those who lack vested financial, political, or other interests in the outcome of a decision. Yet it is precisely this type of advice that is vital and most valuable to decision-makers in establishing robust, durable, and defensible policies. In this regard, scientific advice is at the forefront.

If scientific advice is to be useful to decision-makers, it must be expert-driven, independent, and objective. The need to involve experts is self-evident; the greater the national and international renown of a scientist, the more likely the advice will be based on the best evidence. Scientific advice must be, and must be perceived to be, independent. Advice must not be biased by those who have a vested interest in the outcome of a government decision. Biased advice ultimately serves neither decision-makers nor society.

Scientific evidence is valued and trusted because it is continually subjected to comment, criticism, and review. Most important is the evaluation of science by peers – scientific experts in the same field of research. It is peer review that distinguishes a blog entry from a scientific paper. It is peer review that determines which research papers and articles merit publication and which do not. It is peer review that distinguishes objective conclusions based on evidence from biased or speculative opinion. It is peer review that allows for broad scientific agreement or consensus to emerge. It is peer review that prevents science from being static and stale; science evolves over time but does not change from one government to the next. Scientific peer review provides the ultimate strength of scientific advice, underpinning the confidence that decision-makers can have in that advice.

3. Consensus and uncertainty: evaluating policy outcomes

A key component of expert, evidence-based scientific advice is the ability to convey information about consensus and uncertainty. Where there is a strong consensus in the scientific community, based on research in peer-reviewed publications and using national and global networks, the nature of this broad level of agreement should be conveyed to decision-makers. Of course, scientists might not agree on all aspects of a specific topic and peer-reviewed minority opinions should not be ignored. But scientific advice should always identify those areas of a research field where broad agreement exists; it is important that scientists start with what they can agree on. Scientific consensus can and has been a powerful tool for decision-making, e.g., the banning of chlorofluorocarbons or CFCs.

Scientific advice needs to fully acknowledge what can be reasonably concluded, based on the evidence, and what cannot. In doing so, scientists are acknowledging and being honest about a reality of science – uncertainty. The uncertainty generally lies in the accuracy and precision of scientific predictions and forecasts. Estimates of the speed of light and the force of gravity are highly accurate and precise, whereas estimates of the number of fish in Canada's coastal waters are much less so.

Uncertainty could be perceived to be a problem or weakness. It is neither. Uncertainty permeates science as it permeates human lives on a daily basis. Yet humans are able to render decisions despite uncertain outcomes; indeed we often must do so. Governments must do the same.

Scientific uncertainty is fundamentally important to convey to decision-makers because it provides the evidential basis for predicting the range of potential consequences of various policy options. Given particular levels of consensus and uncertainty, scientific advice is able to provide objective and informed evaluations of the trade-offs associated with decision options from a science perspective.

Independent scientific advisors need to be honest and objective about the facts and the weight of evidence. They need to be clear about what is known and what is not known. Governments benefit from knowing what the best possible evidence is both for and against potential decisions and where the uncertainties lie. The final decisions are political ones, but leaders need to be confident that they are based on a full consideration of the scientific evidence.

4. Communication and transparency: a Canadian model of science advice

The legitimacy of scientific evidence depends critically on communication and transparency. It relies on unrestricted analysis, review, and discussion. This importance of communication and transparency to the conduct of science is similarly fundamental to the provision of scientific advice.

Good advice allows decision-makers to confidently assess the costs and benefits associated with various policy options. Good advice allows decision-makers to put 'risk' in relation to 'reward' when making informed decisions. To facilitate this, scientists must be able communicate in language that is readily understood. Poor communication leads to poor advice.

Similarly, if decisions are made that run counter to scientific evidence, this needs to be communicated clearly to society. Government and society ultimately benefit from clarity about the weight of evidence that supports or does not support a particular policy.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) provides an illustrative example of how scientific advice can be communicated clearly and made transparent.[2] COSEWIC advises the Minister of Environment of species at risk that warrant listing under the *Species at Risk Act* (SARA). By law, COSEWIC's advice must be independent of vested interests and based on the best available information, irrespective of potential consequences of the advice. COSEWIC's advice is publicly available when it is communicated to the Minister of Environment.

The model of scientific advice provided by COSEWIC under SARA enables a clear and transparent separation of science and policy that allows the public and parliament to fully evaluate government decisions in light of the scientific evidence and advice.

5. International competitiveness requires scientific advice

A comparison of 24 political jurisdictions,[3,4] collectively accounting for more than 80% of the global Gross Domestic Product (GDP), reveals differences and similarities in how scientific advice is communicated to government.

Science and Technology Advisory Committee (STAC): The most common formal provision of advice is through a Science and Technology Advisory Committee (STAC).[5] Many STACs are responsible only for science that pertains to technological innovation and development. The narrowness of this remit has potential to produce advice influenced by vested interests, depending on committee membership.

The UK's Council for Science and Technology advises the Prime Minister on science and technology policy issues which cut across governmental department responsibilities; membership is dominated by academics and presidents of national academies or research councils. The US President's Council of Advisors on Science and Technology (the majority of members are from academia) provides advice and policy recommendations where an understanding of science, technology, and innovation are considered integral to strengthening the economy. In contrast to the UK and US STACs, most members on Canada's Science and Technology Innovation Council are from industry and business sectors. Unlike the UK and US, advice is generally communicated through a cabinet minister rather than directly to the head of government.

Chief Scientific Advisor (CSA): In contrast to STACs, Chief Scientific Advisors (CSAs) have broad science advisory mandates. Many jurisdictions have created the office of CSA in the past 50 years: UK (1966), US (1976), Australia (1989), India (1999), Canada (2004), Ireland (2004), New Zealand (2009), Czech Republic (2012), European Commission (2012), Finland (forthcoming), Japan (forthcoming).

Notwithstanding differences among countries, the general responsibilities of most CSAs are as follows:

- Provide advice, analysis, and opinion on any aspect of science;
- Provide authoritative guidance on the interpretation of scientific evidence in light of uncertainty;
- Develop international relationships;
- Advise on novel science issues, especially when scientific progress entails opportunity or threat;
- Communicate with the public to enhance societal confidence in science and technology;
- Chair the government's Science and Technology Advisory Council.

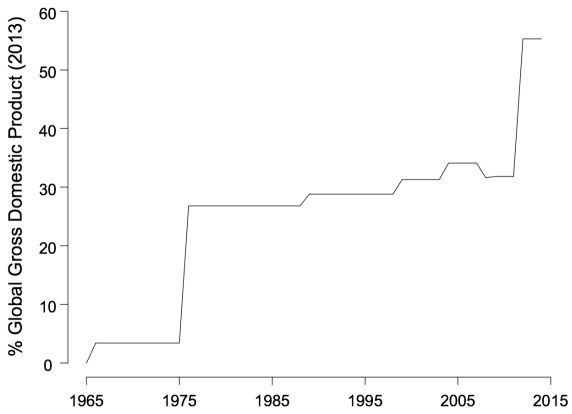
By establishing a presence of science at the cabinet level, CSAs can enhance the coordination of government-based research by strengthening inter-departmental science initiatives, thus creating greater efficiencies of resources when compared to the current 'silo' approach to government science.

Government Science Personnel: Key providers of scientific advice are scientists or science managers in government departments. This model is fundamentally important in all countries. In Canada, it is government departments that currently provide the bulk of scientific advice to government, communicated to cabinet by the responsible department minister. This primacy of advice produced by civil servants is evident in many countries, including Israel, Italy, Spain, and Sweden.[6]

National Science Academies: National academies of science have a long, distinguished history of advising decision-makers. Among the oldest (established 1660), the Royal Society regularly provides science advice to the UK government.[7] The presidents of national academies are members of the UK's advisory Council for Science and Technology. In the US, the National Academy of Sciences provides regular advice to government.[8] Indeed, in some European countries, primary responsibility for providing scientific advice rests with the national academy (Austria, Hungary, The Netherlands).[9]

6. Global increase in chief advisors

All of the key attributes of scientific advice – expertise, independence, objectivity, communication, transparency – are characteristics of the office of government Chief Scientific Advisor (CSA) in most economically prosperous western democracies. From 1965 to 2014, jurisdictions accounting for more than half of the globe's GDP had created the office of CSA. In 2014, 8 of the top 12 jurisdictions in terms of GDP[10] either had (including US, UK, India, Australia) or were developing (Japan) the position of a CSA. The link with GDP might account for the dramatic increase in this advisory position in the past half-century.[11]



Among the top-12 countries in terms of GDP, Canada was the only high-income, developed democracy[12] in 2014 to neither have a CSA nor be in the process of developing the position. Canada's government is the only legislatively accountable body worldwide to have terminated the position of CSA (in 2008).

7. Chief advisor vs. science and technology advisory committee

Provision of scientific advice by a CSA is a strategy favoured by an increasing number of the globe's wealthiest jurisdictions. This suggests that a CSA offers advantages to heads of government, national cabinets, and society not offered by Science and Technology Advisory Committees (STACs). But rather than dispense with STACs, the preferred option of most countries is to have the CSA chair a STAC.

A CSA offers considerable added value to government over and above the advice provided by a STAC. Generally speaking:

- CSAs advise on all aspects of science, STACs typically on a narrow range;
- CSAs advise heads of governments, STACs advise ministers;
- CSAs lack vested interests, STACs might not;[13]
- CSA advice is more likely to be independent and objective;
- CSAs are proactive and reactive, STACs reactive;
- CSA focus is international and national, STACs' primarily national;
- CSAs actively engage in public communication, STACs less so.

8. How would a chief scientific advisor strengthen government?

The link with GDP strongly suggests that a Government Chief Scientific Advisor strengthens government. The world's pre-eminent national academy of science – the UK's Royal Society – concludes that appointment of a CSA from outside government leads to an improvement in the use of science across government departments and assists in the development of a clear strategy for science.[14]

A Government Chief Scientific Advisor would strengthen the Canadian government in several ways. The CSA would:

- Ensure policies are based on the best available scientific evidence;
- Ensure decisions are scientifically robust, powerful, and defensible;
- Provide a strong coordinating presence of science in cabinet;
- Foster societal dialogue about science, research, and innovation;
- Promote the excellence of Canadian science internationally;
- Attract scientists to Canada and investments in Canadian science;
- Facilitate coordination of science across federal departments;
- Improve efficiencies through inter-departmental science initiatives;
- Ensure that Canada's science voice is heard in global affairs by an independent, non-partisan voice, placing Canada at the same level of governmental science credibility as countries such as the US and the UK.

9. Recommendations

Transparent incorporation of independent scientific advice in government decision-making represents one of the greatest rewards to taxpayers in return for tax-supported investments in Canadian science. Canada should take full advantage of these investments by strengthening the scientific basis for government decision-making.

It costs a very great deal to generate scientific evidence; it also costs a very great deal not to use it. It need not be wasted.

1. The RSC recommends creation of the office of Government Chief Scientific Advisor. Doing so would put Canada in the upper echelon of economically productive western democracies. The RSC is concerned that not doing so would hinder Canada's international competitiveness and harm international perception of Canada's ability to develop sound, effective, and robust policy based on the best available scientific evidence.[15]

2. In the late 1990s, Canada's Council of Science and Technology Advisors submitted a report to cabinet entitled *Science Advice for Government Effectiveness* or *SAGE*.[16] This formed the basis for a 2002 report[17] (*A Framework for Science and Technology Advice*; hereafter, *Framework*). Both articulated a strong, rigorous framework for an effective science advisory process.

The RSC recommends full implementation of the *SAGE* and *Framework* reports. They detail the integral components of a science advisory process which ensures that: (i) ministers can be confident that science advice is based on a rigorous and objective assessment of all available science; (ii) credible science advice is considered by decision-makers; and (iii) the public and parliamentarians are confident that government is using science in the best interests of society.

3. The RSC recommends that creation of a CSA should not be done with an intent to align science or scientific advice with governmental or departmental priorities or directions. Doing so would rob science of its strengths: independence, objectivity, credibility, peer review, rigor, transparency.

10. How the academies can help

As Canada's National Academy (established 1882), the RSC has contributed advice to many Canadian governments. The advice has been provided mainly through Expert Panel reports, often in response to requests from ministers.[18] RSC advice has addressed topics such as genetically modified foods (2001), end-of-life decision-making (2011), oils-sands development (2012), and effects of climate change and fishing on marine biodiversity (2012).

The Council of Canadian Academies (CCA; established 2005), funded by the Government of Canada through Industry Canada, also has experience in providing independent, authoritative, and evidence-based expert assessments that inform public policy development. The CCA generally conducts assessments for the Government of Canada on topics proposed to it by the Assistant Deputy Minister Science and Technology Committee.[19]

The RSC can use its long-term experience with Expert Panels to assist the Government of Canada in efforts to strengthen the use of scientific advice by decision-makers. The RSC could begin by establishing an Expert Panel charged with providing recommendations to government on the responsibilities and terms of reference for the office of Government Chief Scientific Advisor. Part of the Panel's remit could be to recommend how to fully implement the *SAGE* (1999) and *Framework* (2002) Industry Canada reports on science advisory processes. (Unlike CCA assessments, the RSC can include policy recommendations in its reports.) The RSC could also assist the Government of Canada by hosting an international conference on the subject of *Science Advice to Governments*.[20]

A second key contribution of Canada's academies would be realized by strengthening their role in contributing scientific advice. The Government of Australia, for example, refers long-term issues requiring a scientific response to the Australian Council of Learned Academies to undertake in-depth interdisciplinary research. These reports are then submitted by the Academies to Australia's Chief Scientific Advisor.[21] The RSC and CCA could be much more effectively used in this manner to provide advice to the Canadian Government.

Another means of strengthening scientific advice from national academies would be the establishment of three positions on Canada's Science and Technology Advisory Committee – one for each of the RSC's academies: Academy of the Arts and Humanities, Academy of Social Sciences, and Academy of Science. This would allow the RSC to fulfil the role that national academies elsewhere, such as the UK, provide in the communication of scientific advice.

The RSC could also assist the Government of Canada by establishing a Science Policy Centre unit responsible for providing independent and authoritative advice to decision-makers. The UK's Royal Society, which has been providing scientific advice to policy-makers since 1664, has a policy unit structure upon which an RSC unit could be modelled.[22, 23]

Sources

1. In its report *Science Advice for Government Effectiveness* (CSTA 1999) to the Canadian Government, the CSTA defined "science to include the natural, health, and social sciences, mathematics, engineering, and technology. "Science advice" is defined as value-added guidance deriving from scientific theories, data, findings, and conclusions provided to inform policy and regulatory decision making.

2. Hutchings, J.A., and M. Festa-Bianchet. 2009. Canadian species at risk (2006-2008), with particular emphasis on fishes. *Environmental Reviews* 17: 53-65.

3. The jurisdictions in the comparator selected group are Australia, Brazil, Canada, China, Cuba, El Salvador, European Union (Czech Republic, Finland, France, Germany, Ireland, Italy, and United Kingdom are also considered separately), India, Israel, Japan, New Zealand, Norway, Russia, South Africa, South Korea, Switzerland, United States. The group includes both large and small countries, single and collective entities, and both well-established and emerging globally significant economies.

4. en.wikipedia.org/wiki/List_of_countries_by_GDP_%28nominal%29

5. In addition to the three examples in the text, other examples of STACs include *Science Engineering and Innovation Council* (Australia) and *Science and Technology Advisory Council* (European Commission).

6. www.theguardian.com/science/political-science/2014/jun/23/evidence-based-union-a-new-alliance-for-science-advice-in-europe

7. https://royalsociety.org/policy/publications/

8. www.nas.edu/publications/index.html

9. www.theguardian.com/science/political-science/2014/jun/23/evidence-based-union-a-new-alliance-for-science-advice-in-europe

10. Ranks according to the International Monetary Fund are: 1-United States; 2-China; 3-Japan; 4-Germany (European Union or EU); 5-France (EU); 6-UK (EU); 7-Brazil; 8-Russia; 9-Italy (EU); 10-India; 11-Canada; 12-Australia (http://en.wikipedia.org/wiki/List_of_countries_by_GDP_%28nominal%29)

11. Countries with a Chief Scientific Advisor (CSA) from 1965 to September 2014. Jurisdictions examined include Australia, Canada, European Commission (EC), India, Ireland, Israel, Japan, New Zealand, United Kingdom (UK), and United States. (EC members Ireland and UK established CSAs prior to the 28-member EC's CSA appointment in 2012.) The most recently elected EC is seeking additional means to strengthen the role of science in policy-making, including the role of CSA established by the EC's previous President.

12. The list of free, high-income, developed democracies is based on information provided by *Freedom House* (freedomhouse.org) and the World Bank in 2013 (http://richleebruce.com/economics/1st-world.html)

13. The independence, objectivity and vested interests of STACs is likely to very much depend on membership; some STACs are dominated by industry (e.g. Canada's Science, Technology and Innovation Council), others by academics (e.g. the US President's Council of Advisors on Science and Technology).

14. https://royalsociety.org/~/media/Royal_Society_Content/policy/publications/2006/8324.pdf

15. Canada's approach to science advice has been criticized by many commentators, including New York Times (http://www.nytimes.com/2013/09/22/opinion/sunday/silencing-scientists.html?_r=0) and *Nature* (http://www.nature.com/nature/journal/v483/n7387/full/483006a.html)

16. publications.gc.ca/site/eng/84765/publication.html

17. http://publications.gc.ca/site/eng/91669/publication.html

18. rsc-src.ca/en/expert-panels/rsc-reports

19. http://www.scienceadvice.ca/en/about/funding.aspx

20. A 2014 meeting on the same topic, recently held in New Zealand, provides an example of the topics that would be covered by such a symposium (http://www.globalscienceadvice.org/science-and-diplomacy/).

21. http://www.chiefscientist.gov.au/2012/01/new-pmseic-structure/)

22. https://royalsociety.org/policy/

23. Acknowledgements: The Royal Society of Canada (RSC) acknowledges Prof. Jeffrey Hutchings (Department of Biology, Dalhousie University) who led the writing of this Position Paper under the auspices of the RSC's Standing Committee on Interventions in the Public Interest. Elements of the text were reviewed and commented upon by Sir Peter Gluckman (Chief Science Advisor to the Prime Minister of New Zealand: 2009-present), Prof. Anne Glover (Chief Scientific Advisor to the President of the European Commission: 2012-2014), and Prof. Nils Chr. Stenseth (President, Norwegian Academy of Science and Letters: 2009-2010, 2013-2014).