OFFICE OF THE PRIME MINISTER'S CHIEF SCIENCE ADVISOR
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Chief Science Advisor

Enhancing evidence-informed policy making

A report by the Prime Minister's Chief Science Advisor

July 2017

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Chief Science Advisor

July 5th 2017

The Prime Minister
Rt Hon Bill English
Wellington

Dear Prime Minister

Re: Evidence in the formulation and evaluation of policy

Since my last report[1] on this topic published in 2013, there has been an encouraging number of developments occurring at the interface of science (broadly defined as including both the natural and social sciences) and public policy in New Zealand. Most notably, these developments include: the appointment of ten departmental science advisors; the establishment of a Committee of Science Advisors (CoSA); the exploration of how to better use data and science to inform public policy development especially in the social sector; and a greater engagement of the science advisory system in disaster risk reduction and risk management. Internationally there is a growing appreciation of the importance of an effective science advisory ecosystem and considerable interest in the emergent New Zealand model. This is in part prompted by the formation of the International Network of Governmental Science Advice (INGSA) following an international meeting on the issue supported by the New Zealand Government in 2014.[2]

At the same time globally there has been increasing concern about risks to the effective interface between science and public policy. For instance, recently we have seen the rise of post-trust and post-expert rhetoric elsewhere influencing public policy decisions, a situation which New Zealand has fortunately to date largely been spared, but we cannot be complacent. There remain potential issues at the interface between science and policy, and between science and society that largely relate to matters of effective engagement, transparency and accessibility of expertise. These issues merit ongoing consideration.

The interface between scientific evidence and public policy is complex. Much of this complexity is a result of the inherently different epistemic underpinnings and processes of these two domains. In general policy makers must deal with choosing between options based on considerations that extend well beyond simply the scientific evidence. What's more, the science pertaining to the very issues for which decision-makers need it most is generally incomplete and sometime ambiguous. This challenge should not undermine the important role of scientifically derived evidence in informing policy options – but it does have important implications for how the interface between science and public policy should best be structured.

[1] Gluckman, P. 2013. *The Role of Evidence in Policy Formation and Implementation.* Office of the Prime Minister's Chief Science Advisor (http://www.pmcsa.org.nz/wp-content/uploads/The-role-of-evidence-in-policy-formation-and-implementation-report.pdf)
[2] http://www.ingsa.org/

Following discussions with both the former Prime Minister, the Rt Hon John Key, and more latterly with yourself, it was agreed that it would be appropriate for me to again review the state of New Zealand's science advisory ecosystem and to identify where progressive improvements still could be made.
As part of the preparation for this report, over the past year my Office has conducted extensive interviews with both providers of scientific advice and, importantly, with Ministers and officials who are the recipients of that advice. That feedback together with a growing body of knowledge from the international community of science advice practitioners and theorists, including via INGSA, informs this third report.

As with my previous reports, a central message is that evidence alone rarely is the basis of policy formation. It must always be acknowledged that there are many other considerations and factors at play within policy decision making. But it is important that any public policy decision is informed by what we know and do not know from robust evidential approaches. Regardless, the underlying premise must be that better decisions are more likely to be made when they are informed by evidence.

The worrisome rise of 'post-truth' polemic and the greater and easier promulgation of 'false news' that we have seen globally in recent times can be seen as threats to the democratic process, social cohesion and good governance. I believe that a commitment to protect and enhance the evidential input into the policy process is an increasingly important defence against these trends.

It is in this spirit that I commend this report for your consideration.

Yours sincerely,

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Chief Science Advisor to the Prime Minister of New Zealand

Acknowledgements

I thank Dr Louise Pinfold for her work researching this report and preparing early drafts of material from which it draws. Dr Pinfold undertook extensive semi-structured interviews with the Departmental Science Advisors and senior officials in ministries, central government agencies (Treasury and DPMC), and key government knowledge producers such as Statistics NZ, Superu and Crown Research Institutes. She also consulted the wider science community, including Universities, the NZ Association of Scientists, Royal Society of New Zealand, Universities NZ, Health Research Council, private research institutes (MOTU, NZIER) and a portion of the business community via ATEED and a regional council HBRC. All interviewees were generous with their time and contributions, without which this report would not what been possible. I also thank the Departmental Science Advisors, Dr Stephen Goldson and Ms Kristiann Allen in my office, for critical review and input throughout the preparation of this report.

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1. The context of science in society

In recent years there has been considerable and growing reflection on the interface between scientific evidence (derived from both from the broadly defined social and natural sciences) and public policy formation. In turn this interface cannot be seen in isolation from the interaction between science and the rest of society itself. This relationship is changing because the nature of science and its contribution to society is itself changing, but also because the digital age has enhanced enormously the accessibility of knowledge.

Greater accessibility of knowledge, especially through the internet, has brought both opportunities and challenges. The pervasiveness of today's communication channels promotes the dissemination of reliable, unreliable and sometimes intentionally false and biased information. It has also led to a widespread assumption that information without expert analysis and interpretation is sufficient to draw an 'informed' conclusion, adding to a growing sense of a post-trust, post-expert world. The challenge for good policy making and for engaged citizens is thus to reach through this noisy environment to distinguish relatively reliable from non-reliable information.

In addition, knowledge production itself has also changed. Science today is no longer considered a linear search for 'truth', but rather increasingly the analysis of complex systems leads to scientific conclusions expressed as probabilities rather than certainties. The explosion of scientific techniques has allowed scientists to explore new issues in the computational, life and environmental sciences, for instance, that impinge increasingly on societal values and thus inevitably on the political process.

Yet, ironically, with the enormous progress in science, there is a commensurate increase in the complexity and incompleteness of our knowledge. The very issues for which policy makers most urgently need scientific advice are the issues for which the science is often far from definitive. The sheer volume of scientific knowledge today creates a new set of challenges. In addition to the 'burden of knowledge' created by the explosion of the scientific enterprise, there is the added burden of assessing the quality of that knowledge. Indeed, some of the most important and biggest value judgements that scientists with advisory functions must now make are about the quality and sufficiency of available evidence on which to reach any conclusion. They must weigh the implications of any inferential gap between the available data and the conclusions reached.

Globally there is increasing interest in the use of robustly developed knowledge to inform and evaluate policy. Indeed there is no area of government policy making where scientifically developed evidence cannot contribute to better decision-making. But whereas science advisory mechanisms in most western democracies largely grew out of the military and defence needs after the Second World War, in the past two decades there has been a growing recognition that scientific evidence has an important and broader role to play across all domains of democratic governance, from local to national and global levels. While there is no singular approach to a science advisory ecosystem, there is a growing global consensus as to the qualities it must have, which is reflected in how the NZ ecosystem is evolving.

To support this report, during the latter half of 2016 my Office conducted a stakeholder survey to update our understanding of the current state and views of the NZ ecosystem. Findings of this survey are reflected in the present report. Other inputs come from the growing global conversation led by the International Network for Government Science Advice [3] (INGSA) on these questions.

2. The context of science advice

Scientific evidence alone does not make policy. Policy making involves a broad range of considerations and democratic politicians are properly exposed to a wide variety of inputs from both formal and informal actors. Most decisions involve trade-offs as the political process must

[3] http://www.ingsa.org/

consider many societal values and interests that extend well beyond the evidence base.

Too often scientists having little knowledge of policy dynamics fail to understand the factors that influence policy decisions beyond the evidence, or they fail to put any scientific conclusion into an appropriate frame of reference (e.g. relative effect size, policy realities, etc), and this can lead to tensions. It has been said that scientists are very good at problem definition and less prepared for finding policy-acceptable solutions within the time frame of the usual policy cycle[4]. Conversely the policy community needs to reflect on what science can bring to the assessment of options for policy development and implementation. Though inherently incomplete, science will almost always be able to contribute important and essential insights to the policy development process. Properly brokered, scientific knowledge should lead to better policy decisions.

Central to this presumption is the concept of *brokerage*. This implies firstly that there is a match between what the policy maker is trying to address and the evidence base that is provided. Secondly it implies that the policy maker receives scientific input in a way that, in as far as is possible, is not filtered by predetermined biases or is designed to support predetermined decisions. Rather, the intent of brokerage is to summarise what is known, what is unknown, what caveats exist in what is known and what options might thus emerge. Brokerage also assists in consideration of the implications of each option. Brokerage is not intended to advocate directly for a specific option or weigh the broader considerations of fiscal priority, electoral contract, public opinion, or diplomatic and political implications of any option chosen. Those matters are for the policy and political process itself.

In New Zealand, as elsewhere, the emergent scientific advisory ecosystem is increasingly built around this notion of brokerage, as manifested in multiple ways. A science advisory ecosystem is not a unitary system, but comprises multiple components. These extend from science to inform technical decisions within regulatory and operational agencies, to science that informs policy options and programme evaluation. It has components that lie inside the policy community and those that are external to it. These provide a combination of both deliberative and informal inputs. Science advising operates on multiple time scales, ranging from long term technology fore-sighting and horizon-scanning to assisting with acute emergencies and crisis situations.

A healthy and politically independent research community is a critical underpinning of an effective science advisory system. In New Zealand this community comprises largely scientists within academia and the Crown Research Institutes (CRIs). Individual scientists and collaborative groupings within the research institutes and universities, professional and academic bodies, non-governmental organization (NGOs) and industry all produce and can provide policy relevant knowledge. The high level of international connectedness within our science community is also an important asset to this type of knowledge production.

It is however important to distinguish between the role of scientists as generators of knowledge from the need to have systems that collate and translate that knowledge for public and policy purposes. We have seen the growing value of highly effective science communicators and it is important that such developments continue to be encouraged. But formal public communication is but a small part of the interface between science and society. Equally, it is important that the science capital of the broader community is enhanced in other ways – for example by continued development of the *Nation of Curious Minds* programme.[5]

Over the past eight years, New Zealand has been developing a more complete and formal science advisory system to bridge between the policy

[4] Cairney, Paul. 2016 The Politics of Evidence Based Policy Making. Palgrave MacMillan http://www.palgrave.com/gb/book/9781137517807

[5] www.curiousminds.nz

community and the science community and to assist the brokerage function. These developments have generated considerable international interest and are widely regarded. The major elements of this formal science advisory system includes the Office of the Prime Minister's Chief Science Advisor (OPMCSA), departmental science advisors (DSAs), departmental chief scientists and the Committee of Science Advisors (CoSA). These roles are complemented by other ecosystem actors, most notably the Royal Society of New Zealand, but also sector bodies such as scientific societies and professional bodies. The Royal Society of New Zealand – our national academy – in particular is an source of deliberative interpretation of scientific knowledge. It has significantly enhanced its capabilities and approach. Academics and CRI scientists also play critical roles that are discussed later in this report.

This evolving ecosystem is playing an increasingly important role in areas ranging from emergency management to casting an evidentiary and scientific lens on annual budget bids in the social sector. This report focuses on specific issues that I believe merit emphasis and further consideration.

2.1 Departmental Science Advisors (DSAs)

One of the central recommendations of my 2011 and 2013 reports was the establishment of a new role within ministries or clusters of ministries: the Departmental Science Advisor (DSA). Since that time, a number of ministries have appointed science advisors: as of June 2017 these were the Ministry of Primary Industries (MPI), Ministry of Business, Innovation and Employment (MBIE – for science and innovation), Department of Conservation (DOC), Ministry for the Environment (MfE), Ministry of Health (MoH), Ministry of Education (MoE), Ministry for Social Development (MSD) and the Justice sector (encompassing Justice, Police and Corrections). They have all been appointed through an open and formal process including interview panels advising the Chief Executive. The panels have comprised appropriate senior officials (generally a deputy Chief Executive) and a DSA from another ministry or the PMCSA.

Most of these DSAs are part-time secondments of practicing researchers from universities or CRIs, with some variation in the terms of reference and conditions of appointment. This variation may affect the ability of some of the DSAs to reach their full potential and is addressed in this report. Notwithstanding this, in general the DSA position has been seen to be a very valuable addition to the advisory system and their roles continue to grow both individually and collectively.

In my view there are some obvious gaps in the current suite of appointments.

It is noted that Te Puni Kokiri (TPK) has not yet created a DSA role, despite my urging, both to better bring to bear the considerable formal research on Mātauranga Māori and other relevant research disciplines as well as providing a Māori perspective to the collaborative activity of the DSAs. This delay is disappointing. A science (or 'knowledge') advisor would be ideally situated to help unlock the importance of traditional knowledge especially in areas such as social and environmental health to input in an applicable and policy-relevant way.

Transport, energy and urban science are areas that are strongly represented in science advice internationally and remain poorly supported in New Zealand, although I note that the Ministry of Transport has committed recently to starting the recruitment process for a DSA in the near future.

Perhaps the biggest void in the current portfolio of DSAs is in the area of disruptive digital technologies. Digitalisation is having a major and transformational effect on social, economic and political activities. There is an urgent need for more systematic, coordinated and pre-emptive assessment of the potential of technologies to impact on New Zealand society and business and to consider and advise on the complex policy issues that are arising. Examples of the technologies that fall in this category include machine learning, artificial intelligence, the internet of things, blockchain technologies and a

variety of related technologies. Issues related strictly to the public use of 'big data' already occupy much attention from the DSA system and are considered separately.

The security agencies are generally well engaged with science advisory systems internationally and indeed in the UK and USA were the origin of their current science advisory system. However our strategic positioning is such that DSAs are likely not needed in these departments: instead the chief defence scientist, a newly created role, is invited to be a member of CoSA and the PMCSA has the appropriate security clearances to assist where appropriate.

The place of science within the Ministry of Foreign Affairs and Trade (MFAT) is somewhat different. Here, the PMCSA currently fulfils the role of Science Envoy to promote science diplomacy but the increasing size and responsibility of both roles creates pressure. A number of countries have identified science diplomacy as a growing and distinct role. Where MFAT has the need for input on technical matters in the environment and trade spaces, it either has turned to specific scientists or to the relevant DSA: this arrangement appears to have functioned well.

2.2 The roles of DSAs

DSAs operate individually within their ministries, in ministry clusters and as a collective within the CoSA, which will be discussed below. Two main DSA clusters are currently operating – a social sector cluster and an environmental cluster. Both have been highly effective; for example in providing inputs to develop the social investment model and related cross-departmental strategies and the budget process and to developing environmental, conservation and primary sector research roadmaps respectively.

Within their own departments there is considerable variation in the ways and the extent to which the DSAs are deployed. Some (e.g. in MPI) are core parts of the senior leadership team. By contrast, others remain more remote from that early policy brainstorming phase. This is a missed opportunity to engage where their informal input into policy ideation may be of greatest value. There is also variation across the DSAs with respect to their role and input in signing off on the evidentiary components of reports to Ministers. Similarly, across the suite of DSAs, there are variable linkages to both the internal and external procurement of knowledge. Some DSAs have direct access to their Ministers, others significantly less so.

There have been examples of situations in which failure to engage DSAs appropriately has led to problems in policy development or communication. There have also been examples (albeit rare) where departments have claimed to have the support of their DSA (i.e. an endorsement of sufficiency of evidence to proceed with an initiative), whereas this was never actually sought, or where the DSA's view needs to be clarified for the benefit of the CE or Minister.

I believe that it is important that there be a more consistent view of the DSA role across ministries, while acknowledging that there must be some adaptability to meet specific needs and contexts. The Deputy States Service Commissioner is currently consulting on core and generic terms of reference for use by Ministries in establishing or renewing DSA positions. The Deputy Commissioner shares my beliefs that it is important for all the DSAs to be brought into the policy development process and that their input needs to be directly and explicitly available to Ministers (especially where the evidence is complex or where the proposed policy and evidence may be in contradiction). DSAs should have the opportunity to interact directly with the relevant Ministers, especially early in the policy scoping process.

Where ministries contract research externally it is important that DSAs take a role in quality assurance for both the contract and the resultant report. Equally, they have a critical role regarding policy-relevant research conducted internally by agencies themselves. Where the research is data driven it is critical that the expertise of a DSA is sought in ensuring appropriate techniques and interpretation of big data sets. A major role of

DSAs must be in assisting analysts to improve their understanding and capacity to engage with complex data if it is to be used as evidence.

As the role of each DSA has expanded, the current level of adequate support for their functions has become rate limiting. While in general, support to each DSA must be provided within each ministry, the growing need for DSAs to work in sectoral clusters means that either the OPMCSA requires additional support to provide clusters with necessary analytical and operational power, or the clusters themselves will need to be supported as entities. The process to develop sectoral research roadmaps in the environmental sector and the primary sector, together with the ongoing collaborative process within the social sector (eg regarding mental health) have demonstrated the potential of clustered engagement.

2.3 The Committee of Science Advisors (CoSA)

Once DSAs were appointed to several departments, the CoSA was established after discussion with the State Service Commission in late 2014. The CoSA meets about nine times per year and currently comprises the following members:

- The PMCSA
- The strategic advisor to the PMCSA[6]
- The PMCSA's chief of staff as executive officer
- The DSAs (currently nine)[7]
- The Government Statistician
- The Chief Economist of Treasury
- The Chief Scientist of MBIE
- The Chief Scientist of the Ministry of Defence

The CoSA meeting originated as a largely informal opportunity allowing the PMCSA, the DSAs and the other members to share work programmes and peer review and assist each other. While this critical informal role is sustained, increasingly a number of specific issues are either referred to CoSA by Treasury, the Department of Prime Minister and Cabinet (DPMC), or from other ministries for comment and assistance. CoSA is one of the only entities other than the sector boards to have a consistent cross-departmental view of policy developments and their potential synergies and spill-over implications, making it an important asset. In addition, MBIE increasingly uses the group as a sounding board on various aspects of policy for science.

The Deputy State Services Commissioner is invited to attend for relevant items. The President and Chief Executive of the Royal Society of NZ are invited to attend CoSA meetings, where there are no government-sensitive agenda items. The presence of the RSNZ enables a better coordination of the various roles and components of the overall science advisory ecosystem.

3. Data and policy making

One of the main issues that has occupied CoSA meetings in the past year has been the use of big data in public policy making. My Office and the CoSA have spent much time considering and providing inputs into the issues of data hygiene, data management/stewardship and analysis.

Significantly, from 2015 the social sector DSAs and the PMCSA have had increasing input into the annual government budget process by providing a scientific and evidentiary lens with which to assess the evidence supporting bids in the social sector. This role is now primarily formalised through the Social Investment Panel which comprises the PMCSA, several DSAs, treasury officials, and appropriate NGO and social sector representatives. A key role of the CoSA has been to promote and assist in the development of conceptual models as a base from which to interrogate data analytics and budget proposal evaluations. This process continues to evolve.

CoSA has also focused on the issues of social acceptability of the use of government administrative data for policy development and decision making. Together, we have provided

[6] Position currently held by Professor Stephen Goldson
[7] There are two departmental science advisors as well as a chief scientist within MBIE

various inputs into the development and use of New Zealand's pioneering Integrated Data Initiative (IDI) and citizen-based analytics – this is now termed the 'social investment' model. This development is at the leading edge globally of considering how big-data-derived evidence might inform policy both *ex ante* and *ex post*. It is considered in more detail in the next section and in a separate report on evidence-informed policy making in the social sector.[8]

3.1 Data and Science informed Social investment ('Citizen-based Analytics')

Arguably the biggest challenge in public policy in the last few decades has been how to make decisions about government expenditure in the social sector (i.e. in health, education, social development, justice etc). In most democracies such decisions are made based on a combination of normative argument, political ideology and electoral considerations. Despite growing expertise in 'implementation science' and social policy research (e.g. 'What Works Centres and the Campbell Collaboration[9]), the use of a firm evidence base for policy and programme development and evaluation has been inconsistent across most liberal democratic governments.

Often rigorous analysis has been impossible because multiple interventions may have been introduced at once, or the political tempo has led to a failure to obtain good baselines or undertake pilot work that could be analysed and scaled. Similarly, there has been a general reluctance to enter into formal randomised trials to evaluate a potential intervention. Staggered introduction of a programme can produce a pseudo-controlled trial.

However in New Zealand such approaches (whether formally- or pseudo-randomised) have tended to be avoided even though they are well accepted in other jurisdictions. For example there are now randomised trials testing the effects of minimal basic incomes underway in at least two European countries and three cities in Ontario Canada.[10] Even if historical data are to be used as the comparator it is critical there is a proactive assessment to ensure that appropriate baseline data exist. Failure to do this has compromised the ability to assess a number of past interventions. Part of this broad reluctance is probably due to New Zealand's comparatively short political cycle. Added to this is the problem that normative arguments are easy to make, yet may reflect diverse biases. The result can be an argument, sometimes valid and sometimes not, that one or another subpopulation or contextual circumstance would not be sufficiently represented within any trial. Herein lies the importance of expert design and interpretation.

It is also important to distinguish between instances where policy failure is the result of ineffective policy design and instances where it is a due to a problem in policy implementation. The latter may occur at either a central or provider level. One of the strengths of 'behavioural insights' and 'what works' units overseas has been to provide trial designs and meta-analyses that evaluate practical problems in policy implementation at the provider level. Implementation science is a growing discipline. Given that much of our social services are provided by the third sector there may be value in strengthening our formal capacities in this areas

[8] Gluckman, P. 2017 *Using evidence to inform social policy: The role of citizen-based analytics.* Office of the Prime Minister's Chief Science Advisor (http://www.pmcsa.org.nz/wp-content/uploads/17-06-19-Citizen-based-analytics.pdf)

[9] The What Works Network is described here: https://www.gov.uk/guidance/what-works-network
The Campbell Collaboration is described here: www.campbell.org

[10] The Government of Ontario's basic Income Pilot Study is described here: https://files.ontario.ca/170508_bi_brochure_eng_pg_by_pg_proof.pdf
Pilot studies in the Netherlands and Finland are described here: https://www.uu.nl/en/news/utrecht-university-and-city-of-utrecht-start-experiment-to-study-alternative-forms-of-social
and here: http://www.kela.fi/web/en/basic-income-experiment-2017-2018

through, for example, the newly-formed Social Investment Agency.[11]

The lack of quality information on policy effectiveness leads to general frustration at the policy level and increasingly at the political level, both in trying to decide between the many possible interventions for any type of social challenge and in stopping programmes that are suspected to be inefficient or of little impact at scale. The challenge is exacerbated by the fact that a large number of third party providers and those who access services will be affected by any decision to review a programme. If the situation gains media attention, then it also becomes a political challenge which can affect decision making. Thus, there is growing concern within the policy community about how to develop and sustain an evidence-informed approach to the social sector policy and programme development.

The development of big data and citizen-based analytics provides a conceptual way to assist with this dilemma. In theory if one knew about inputs and outcomes for all individuals in a target population one could use a number of analytical techniques to see which inputs might explain significant effects on outcomes. Alternatively it might be possible to identify subpopulations which respond differently to different inputs (such as educational opportunities or access to health information and services).

However this model makes some major assumptions. In particular, it implies a certain conceptual understanding of how such inputs are likely to directly, indirectly or interactively lead to a particular outcome. The model also assumes that the inputs will have a significant effect that can be detected against the inherent 'noise' that exists in such data sets. It is self-evident that inputs that government would be interested in are those it has some control over (education, health, justice, social welfare services etc.), yet there are many other factors that affect social outcomes – some are easier than others to measure (e.g. family status, economic status) than others (e.g. social group interactions). As the private sector has already demonstrated in its use of targeted electronic messaging, even limited data on an individual allows better targeting of services. So how can a social investment model based on government data be made viable?

A number of countries are increasingly using the capacities in big computing systems to provide a variety of services to their citizens. New Zealand is doing this as well, but has also been at the forefront of considering the use of citizen-based data to inform social sector decision making. Citizen-based analytics uses administrative, census and service databases, combining these with domain expertise from the social sciences (e.g. public health, education, or social-psychology for instance) to develop a conceptual model of how to analyse the data based on what the research tells us about the issue. Such analytics have strong potential to lead to decisions that are more evidence-informed. These in turn should lead to better social returns in the form of better health , education and economic outcomes for the individuals.

The conceptual underpinning is key – there has been enormous progress in our understandings of human development, both biological and behavioural and in the social sciences that allows much of the argument to shift from normative to scientific.

While it has long been self-evident that factors operating in one part of a life course can have impacts in the latter part of life-course, understanding these relationships is complex. For instance, they cross domains (e.g. from early childhood education to justice system interactions later in life) and when pathways may operate over extremes of the life course, assessing relative impact and effect and social benefit and cost is difficult. There are some real challenges in the data analysis; for example dealing with complex interactions, confounders or apparent but not valid causal associations, particularly if data sets are small. In addition, there is a growing range of factors that interact to influence ensuing

11 http://www.legislation.govt.nz/regulation/public/2017/0067/8.0/DLM7219210.html

outcomes and not all will be necessarily in the data set. These issues can lead to intense debate over, for instance, the relative role of poverty per se versus specific factors that may have an influence on outcomes.

Citizen-based analytics, while not a panacea, offer the policy maker and the public greater clarity as to the options and their rationale and likely effects. While the balance of priorities and acceptability of certain approaches will always be the basis of political debate, such analytics should increase the quality of decisions made. Unfortunately the term 'social investment' can be misunderstood as focused on investment in a strictly financial sense. Instead, it is a metaphor to mean supporting the most effective social interventions for social outcomes identified through robust data analytics and supported by a scientific understanding of the linkages involved.

At the heart of social investment are citizen-based analytics – that is compiling data on the population in a way that allows *ex ante* and *ex post* assessment of probable deterministic relationships between inputs, environment (at levels ranging from family to physical) and outcomes. The government's IDI database is being developed to do exactly this. With it, researchers and analysts can examine government-collected data (and potentially other data sources) to look for trends and relationships between factors that may not otherwise have been known. Once linked, the data are anonymized and placed under the custodianship of Statistics NZ. This stewardship arrangement is critical as Statistics NZ has the highest level of public trust and its protocol for access to the data for research purposes ensure anonymity and privacy is protected.

Issues relating to data governance and social license are beyond this paper. But I note the role of the Data Futures Partnership as a cutting-edge approach to considering these issues, which are also explored further in my separate report on citizen-based analytics.

As a research tool the IDI is uniquely placed to support the goals of the social investment (citizen-based analytics) approach. It brings data from multiple sources together. At the moment, the biggest challenge for the further development of the IDI is to include client-level data from service providers. These types of data are often seen as the most sensitive and must be entered into the database and used in a way that continues to ensure protection and anonymity of individuals. For IDI to produce meaningful knowledge, it is not sufficient to know whether funding to a particular programme has gone to a particular agency. Rather, it is ultimately necessary to understand what services a particular individual accessed and across the board, a more holistic understanding of outcomes for such individuals.

Only through access to more complete data will meaningful programme evaluation be possible. Furthermore, the big data analytic techniques now available allow causal relationships and interactions to be analysed even when there are multiple confounding factors. However it needs to be emphasized that aimless data mining is not sufficient, nor justified. Expert input is needed in building the models to be tested, testing plausibility of proposed causal relationships, evaluating confounding effects and evaluating other assumptions made.

The key issue for such uses of the IDI is their social acceptability. It is likely that social license for data use can be obtained and maintained because the agency responsible for the data is Statistics NZ, which has high public trust. Despite such assurances, for public peace of mind, it should still be emphasized, for social investment modelling purposes, there is no need whatsoever for individuals to be identified once databases are linked. The uses of data within the IDI can be and are based on anonymized datasets.

The issue, however, gets more complex if data are held outside the IDI. Many service delivery programmes are managed at a ministry level and they do need access to data to evaluate and monitor programmes. But the same departments may also need access to data for ensuring service delivery coordination between agencies (e.g. in the case of family violence) or for compliance reasons (e.g. looking for benefit fraud). These

reasons for data collection and use are perfectly legitimate at the ministry level, but they should not be confused with the broader research uses of the data in the IDI.

These multiple uses can create complexity and uncertainty in the minds of the public as to the boundaries of data protection and privacy. As a result, negotiating social license for data use is complicated. To address this, the Government Statistician, the Data Futures Partnership, the Privacy Commissioner and my Office are collaboratively working with senior officials to recommend an assurance and governance system for data access and use. Critical in such a system is to clarify and codify the data use types and the relevant protections and provisions for each.

Both the IDI and the social investment model are still in their infancy. It will take time for key data sets to be added, but already the IDI is proving to be a valuable tool in changing the nature of the policy discourse and shifting agencies to be more proactive in ensuring that policy development is evidence-informed. Despite this, there are dangers in either understating, or in overstating, its value. There is no doubt that citizen-based analytics will become central to policy making in the social sector and New Zealand is at the forefront of this movement. Internationally the attention the work is acquiring is very significant. Already it has changed the NZ annual government budget process dramatically. But there is a concomitant need to build data analytic capability, to continue to enhance social license and to continue to reduce departmental silos.

There is also an ongoing danger of simplistic interpretation if the appropriate subject matter experts are not engaged in the analysis process from the beginning. For instance, it is easy to overstate the predictive value of citizen-based analytics. Relying on a predictive approach can sometimes wrongly focus policy efforts. Such limitations can also lead to political overstatement. I remain hopeful that, as decision makers become more familiar with both population and subpopulation analytics, these issues will become less evident.

The social investment paradigm supplements but does not displace other methods and considerations for social policy development. There will always need to be values-based judgements and some aspects of social programme delivery (e.g. crisis response, service capacity management) will always require traditional policy approaches.

3.2 Extending the systematic use of data to inform policy

The increased focus on environmental reporting with annual Tier-1 report on the environment now produced by Statistics NZ jointly with MfE[12] is a welcome step forward. It highlights the increasing importance and utility of data in policy making and evaluation in the natural resource domain. As my own recent report on Fresh Water[13] makes clear, some of the key issues in environmental reporting are having uniform standards of data and measurement and ensuring longitudinal assessment of the same measures so trends become assessable. The environmental space is highly contested with different stakeholders having very different views regarding priorities and strategy. Government has the challenge that while it has regulatory and legislative levers, much of the operational management of the natural resource sector occurs via regional and local government. There are lessons and approaches in the citizen-based analytic approach to social policy development and assessment that could be applied into the natural resource sector – particularly regarding the collection and use of data and its expert analysis.

[12] http://www.mfe.govt.nz/more/environmental-reporting
http://www.stats.govt.nz/browse_for_stats/environment/environmental-reporting-series/indicators-for-freshwater-2017.aspx
http://www.mfe.govt.nz/publications/environmental-reporting/environment-aotearoa-2015

[13] Gluckman, P. 2016. New Zealand's Fresh Waters: Values, trends, states and human impacts
http://www.pmcsa.org.nz/wp-content/uploads/PMCSA-Freshwater-Report.pdf

3.3 From data to evidence: what works in different contexts?

Accessing and appropriately analysing big data is game changer for helping us to characterise public policy problems and target interventions. But scientifically-informed data driven insights are most powerful when they can be combined with other relevant knowledge and tested in real-world situations. Recently, New Zealand has had opportunities to learn from a number of promising initiatives established in the UK and internationally to do just this. Specifically, these include:

- the network of 'What Works' Centres, which take an implementation science approach that considers contexts and other factors in the success or failure of policy objectives;
- the 'Behavioural Insights Unit', which applies social and psychological insights to how policy and programs are delivered; and
- efforts to build capacity within the civil service for better policy development and delivery.

The What Works and related approaches are fast becoming an international public good through the development of toolkits and systematic reviews largely related to policy implementation.

There is also growing interest by governments to consider 'behavioural insights' approaches. In this approach, the implementation of policy ideas makes use of scientifically-derived behavioural insights to help 'nudge' individual action in desired directions. Do we want more people to use public transportation? Let's learn what factors encourage or impede individuals to use it and apply these to make it easier for people to adopt the practice. Through policy trials, likely enabling factors can be tested and optimised in different contexts. Both the UK and Australia have established behavioural insight teams within central government to support policy implementation in diverse domains.

For such evidence-informed methods to be useful requires both enhanced policy skills and institutions that generate demand as well as supply of policy relevant science. This means ensuring a well-trained civil service more broadly. There is also a more structural or institutional dimension in shaping government and departments to be willing and able to experiment and learn. Policy innovation requires a community of learners and the professional public service should be nurtured to do this.

4. The academic-policy interface

Whereas the above are all fairly recent developments through which government is increasingly evidence-led in decision making, New Zealand's science community, and in particular its academic science community, constitutes a longstanding resource of policy-relevant knowledge. However, there are still some considerable challenges in effectively tapping into this resource for science advice to government.

New Zealand policy makers appear to reach out to academia less than in many other advanced democracies. While there are many established bridges between academia and the policy community in countries such as the UK and USA, such a culture of professional exchange, appears is not so apparent here. In New Zealand, it is not common to find policy professionals with significant post-graduate research experience, although this is starting to change. Similarly, few academics have much direct experience within the policy community.

As a broad generalisation, a minority of scientists understand the complexity of policy making, imagining it to be a logical, linear progression or a simple cycle with some iteration. By the same token, policy professionals may often assume Wikipedia to be a sufficient source of knowledge on which to build major policy proposals. When they do turn to research, it is most often through the generic management consulting industry, using conventional cost-benefit approaches and related assumptions, rather than to turn to specialist expertise within academia. This situation could lead to some scientifically unsound inputs. A major argument for appointing DSAs was that they could link the NZ policy community

better to the NZ academic expert community. Consequently, a central focus on the research that underpins the present report was to understand the barriers to better interaction between the policy and academic communities.

4.1 The policy community perspective

The policy community's perspective has raised a number of factors, some of which merit specific consideration if we are to promote more academic engagement in public policy making:

- Timeliness: Policy development is most often on relatively short timelines, particularly given New Zealand's short electoral cycles. Generally, policy makers find the academic community and their institutions slow to conclude an agreement to provide inputs. By contrast, the professional consulting sector tends to be able to move fast contractually. The consulting sector is able to assign dedicated staff immediately to a problem, whereas the academic community has to fit it around other professional obligations. Also, policy makers may feel more able to interact freely with the consulting sector because they are seen as privileged clients with this sector. The academic community thus may be suitable for empirical research on a longer time horizon, but is less favoured for literature reviews and, importantly, for evaluations.

- Access: While the policy community can reach out directly to the consultant community with which it has a close relationship (often the consultants are ex-policy staff, which itself creates a narrowing perspective), it is sometimes more difficult reaching out to the academic community unless there has been prior contact between the policy analyst and the academic expert. Not infrequently, policy makers reach out to someone they know but who may not be the best placed to provide the needed expertise. The policy community may not know whom to contact and there can be layers of interface to get through (e.g. the research office, the technology transfer office) before a policy maker can work with an academic of interest. The DSAs can at least help identify and reach out to the relevant experts and to the body of national and international academic literature.

- Advocacy and brokerage: while the consultancy community is trained in the knowledge brokerage role and 'policy-speak', the professional profile of many academics is based on their roles as 'critic and conscience of society,' which can lead some policy makers to be reluctant about the product they might receive from academics. There can be a preconception within the policy community that academics will approach an issue from a particular angle or there is academic hubris that is intent on instructing the policy community rather than simply sharing expertise and knowledge.

  For example, often there can be the impression among policy makers that the academic social sciences' role as a critic and conscience could inhibit its potential role as a partner in policy development. This impression is generally unfair; many in the social science community are positioned well to evaluate and integrate policy relevant evidence. Indeed, it is very much what they do in their academic pursuits. The added challenge is to collaborate effectively with policy makers to ensure that the accumulated knowledge of the relevant research communities can be brought to bear on policy decisions, bearing in mind the responsibility to be brokers rather than advocates. Good brokerage is about assessing the evidence both as to what is known and what is not known. It must clarify the caveats and the implications including spill-over costs and benefits of the options that arise. But the ultimate policy decisions will require consideration of many other values-based dimensions that are properly the domain of the policy and political communities. The DSAs can have a major role in addressing these issues.

- Understanding policy needs: Not infrequently, a view within the policy community (which is at least partially justified) is that the academic community often addresses questions in ways that are not ideally suited to inform the policy process. For instance, either the question is not directly answered because of the academic reluctance to draw conclusions without the most robust testing, or there is the frequent call that 'more research is needed.' Instead, a preferred approach is the analysis of what is known and what is not known and the implications of each. This is something that can be addressed by better brokerage between the policy and academic community. Another issue is that while the analysis must be robust, to be policy-useful the product must be digestible and not presented as an academic treatise.

- Cost: The issue of cost was raised frequently. Because universities generally charge a flat overhead fee that does not distinguish between the costs of empirical science and evaluative and review work, there is often a perceived cost barrier regardless of the request. Compared to organisations such as consulting companies that do not have to support expensive laboratory research facilities, this is a considerable barrier to engaging the academic community. It is a barrier that, in the current model of university funding, is likely to remain. It is noteworthy that in countries where university infrastructure and indirect costs are addressed in different ways than they are in New Zealand, there appears to be greater engagement with university-based researchers.

- Confidentiality and control: There can be a tension between academia, for whom early publication is generally important, and the traditional desire for confidentiality in the policy process. However this can be an overstated issue in that many parts of academia are accustomed to these delays when dealing with the private sector. It could be that those disciplines most likely to be dealing with the policy sector may not have similar collaborative experience with industry from which to draw. However, of much greater concern is the desire, that is sometimes expressed by the policy community, to maintain control over potential academic publication even after the policy process is complete. Provided that any academic publication is free of overt political advocacy, there is absolutely no need to limit publication except in cases of national security risk or where the research involves sensitive data or other elements with ethical or privacy implications. Again the DSAs can assist in addressing this tension and there may be value also in establishing some generic protocols to address this matter. The government's commitment to accountability and the Official Information Act mean that policy making applies to evidential inputs.

In general, it seems that many in the policy and academic communities are equally sceptical of each other. Their different perspectives represent a general lack of familiarity between these distinctive cultures. A helpful trend has been the growing recognition between the National Science Challenges and the Centres of Research Excellence of the desirability of closer relationships with the policy community.

4.2 The academic community perspective

From the academic community's perspective, the main issues include:

- Control/independence: The discussion above highlights the issues around confidentiality and control of research information. These issues are not particularly complex to deal with but require maturity and mutual understanding from both the policy community and the academic community. Unfortunately I am aware of examples where government agencies have wanted to maintain control over reports produced by academics even when there is no immediate policy issue in question. For this reason, protocols for research access and dissemination should be developed,

perhaps with the assistance of the States Services Commission and CoSA.

- Performance-Based Research Fund (PBRF) and related incentives: The academic community is largely incentivised by how they are regarded by their peers. The ability to receive research grants, invitations to speak, prizes and awards and academic promotions are all part of the culture of academic merit. The PBRF has further institutionalised this culture by rewarding institutions according to the performance of staff in these traditional activities of research (and in particular in the volume and supposed quality of academic publications). More recently the PBRF has also acknowledged the role of commercial interactions, but policy-related impacts are poorly acknowledged. Yet policy relevant research is critically needed and indeed is an increasingly important justification for the New Zealand taxpayer supporting our research community. There are real career-limiting barriers for an academic to become too engaged in policy research however. This is particularly so for more junior researchers who must meet a number of tacit career milestones. If engagement and impact on the policy process were more explicitly recognised within the academic merit system, it would encourage more interaction between policy and academic communities.

Not all researchers are housed within universities. A large number of government-funded researchers are based in CRIs. Their enabling legislation and their mode of operation mean that in general a number of the issues raised above are less prominent within relationship between CRIs and policy makers. However, the CRI model raises its own set of issues with regard to science advice to government. For one thing, CRIs do not represent the full range of disciplines within the university community, in particular policy-relevant health and social research must come from academia or private consultants. Also, with a mandate to self-fund through both private sector and public interest research, the CRI model can be at risk of a conflict of interest if ever privately contracted research reveals any risk that is in the public interest. For this reason contracting agreements must be – and generally are – managed very carefully, with an alertness to the public interest.

The Royal Society of New Zealand includes our national sciences and humanities academy. It is a source of independent self-determined reports and public education events and material, but it can also be a source of reports at the request of the policy community. A model that has been successfully piloted in recent years is the joint approach by the PMCSA and the President of the Royal Society of New Zealand to convene committees providing technical reports on potentially contentious topics. In this, the PMCSA plays the role of broker with the policy community, while the Royal Society enables the authoritative voice of the science community.

This brokering process is an important step in addressing what has been a frequent criticism of academy reports worldwide in that they do not answer the question posed, but this is sometimes as much a function of the question being poorly framed and explained. The OPMCSA and the relevant ministry negotiate the framing of the question. The President of the Royal Society then establishes an expert panel, which is then supported by a research analyst/writer from the OPMCSA. Following completion of the draft report the PMCSA arranges peer review (including international reviewers). Once finalised, the report is jointly signed off by both the PMCSA and President of the Royal Society. The result is much clearer process for framing and answering technical questions that satisfies both policy-specific needs while remaining scientifically independent. The brokerage role played by the PMCSA is extrapolated to a role played by of DSAs in brokering between the policy community and academics preparing reports at the ministry level.

The above discussion highlights the value and desirability of enhancing the linkages between the policy community and academia. The PMCSA and the DSAs have a critical role to play as individuals at the interface, but structured institutional approaches seem desirable also. The value and utility of protocols that can ensure confidence of

the policy community while respecting academic independence and integrity seem self-evident.

In many other comparable countries there is widespread use of academic secondments, internships and fellowships to provide a cadre of outside expertise within policy departments. There are also opportunities for policy professionals to spend sabbaticals within an academic context. Many other countries' key ministries now provide for limited–term fellowships for academics to spend time within agencies and the mutual value in doing so seems obvious and should be considered here.

In addition to encouraging greater exchange between the two communities, there is a broader cultural change that can be fostered at the training stage of both future scientists and future policy professionals. While universities are beginning to encourage science communication courses, there is a need for a more holistic approach that considers the broader 'civics of science' including science communication, science-in-society approaches and the philosophy and ethics of science and science-policy interactions. It would be logical to imagine that such courses should be encouraged at senior undergraduate and graduate levels and open to students in faculties of arts and humanities as well as faculties of science.

My own Office has started to explore some of these issues in a pilot voluntary exercise known as the Science Policy Exchange. This pilot endeavour brings together competitively selected early-career scientists and policy professionals for critical engagement on practical complex problems. The activities of INGSA offer further opportunities in this regard.

5. Risk management, crises and emergencies

It has been said that the most critical role for a science advisor is in crises/emergency management[14]. Depending on the situation the science advisor must be able to reach out to specific and sometimes unanticipated sources of expertise, help identify the range of issues that needs to be addressed, translate technical inputs for decision makers, and be part of the public communication and reassurance process. All of this must be done within a highly constrained timeframe and often tense operational conditions. Several natural disasters experienced by New Zealand in recent times have demonstrated the need for each of these roles.

Quite apart from the acute phase of crises, science also plays a critical role in the actuarial side of risk identification and in helping to decide on risk-reduction strategies. This has been a particularly important role of the OPMCSA and DSAs over the past year as risk identification and prevention has attracted more government attention. The PMCSA serves on the Strategic Risk and Resilience Panel (SRRP). More recently the PMCSA has been made a member of Officials Committee for Domestic and External Security Coordination (ODESC) for relevant crises. An OPMCSA staff member with appropriate security clearance has also been added to relevant Watch Groups.

While for some 'typical' emergencies (e.g. acute natural disasters), the core scientific expertise is generally pre-identified and available within New Zealand, for other types of emergencies the expertise is more distributed. Expertise is needed to ensure scientific advice to the decision makers under urgency, to ensure or interpret particular analyses to inform the situation, and to provide informed communications in a trusted manner to the public according the their changing information needs at the various stages of a given crisis.

In the case of the latter role, it may not be possible for the individual involved in the actual

[14] Sir Mark Walport in his plenary address to the first INGSA conference. Available here: https://www.youtube.com/watch?v=aak-WYvQV_E&list=PLqk2_xL-kgou1tpglGytbDXUM7idJOm_o&index=5

studies or analyses also to be the one to communicate these. This issue is particularly problematic when the CRIs are involved. On one hand, our CRIs are the major source of expertise in many policy-relevant areas, but on the other hand, CRI Chief Executives may feel compelled to limit the public role of their scientists in acute situations fear of potential liability issues. Indeed, the Chief Executives themselves are keen that there is greater clarity on how their scientific staff might be deployed for public communication in emergency situations. This is a matter that my Office is currently addressing with DPMC, the Minister of Science and Innovation, The Minister of Civil Defense and Science New Zealand, which represents the CRIs.

Given the potential range of expertise required, and the importance of scientists interacting directly with the policy community in most emergency situations that we might envisage, some countries have established formal processes to engage the science community for this purpose. A particularly salient model for New Zealand is that of the UK. Central to the UK's emergency preparedness model is SAGE (the Scientific Advisory Group for Emergencies). In major emergencies, SAGE is called into action by order of the Cabinet Office. It is chaired by the UK's Chief Science Advisor, and involves other Science Advisors relevant to the situation and other scientists (both from public and private sector). The role of SAGE is practiced along with other parts of the emergency management system of the UK on a regular basis.

In New Zealand, we have undertaken a good deal of risk identification and planning work already for the development of a possible national risk register, as exists in many European countries.

6. Horizon scanning and futures exercises

Technologies and their social contexts change rapidly. There will inevitably be opportunities, challenges and sometimes controversies arising from new technologies or modes of operation as science and innovation increasingly interact with almost all aspects of human life.

Technologies are emerging at a very fast rate particularly in the digital, transportation and life science fields of application. Many of these technologies could have profound effects on the policy-making and decision-making manoeuvrability of States, as well as on their economy, on their social organisation. Technology increasingly will have broader policy, ethical, diplomatic and trade implications. In general, New Zealand and other democratic states have found themselves in a reactive mode in managing or otherwise mediating new technologies. The exception has been those related to human reproduction or genetic integrity. It is noteworthy that, in both these cases, the challenges created by non-adaptive regulation are increasingly discussed.

In reality, the implications of many new and emerging technologies are such that more proactive policy positions seem desirable, even if these will always need to be adaptive and preliminary. Some of the technologies that may merit consideration include artificial intelligence and deep machine learning; the internet of things, advanced genetic technologies, autonomous vehicles and mind–enhancing pharmacological agents, to name but a few. Every one of these technologies and many others will be introduced in some way in some societies, with potentially profound effects internationally. Adaptive regulation or policy approaches will clearly be needed.

The digital transformation highlights how profoundly and rapidly technologies can impact on society, and this exposes the vulnerability of sovereign state to control use in most circumstances. Already, we are seeing how automation and machine learning could and indeed already is impacting on many current job sectors, and it remains most uncertain as to how education and employment training can and should adapt.

For these reasons, many countries now include horizon-scanning and technology futures scoping

and assessment as an important part of their policy toolkit. There are a number of formal and well-detailed processes that can be employed for such purposes. Yet, such exercises have been largely absent in New Zealand policy development context (except in Defence and Transport). This deficiency in long-term planning for policy making is in part a spill-over from the short length of our electoral cycles. These gaps and the skills needed to fill them have been recognised and are now being considered more generically by the Policy Project[15] being undertaken by central agencies.

More recently, New Zealand has been offered the opportunity to undertake some specific aspects of technology assessment and fore-sighting in partnership with Australia through the new Science, Technology and Innovation agreement.[16] It has been proposed that the Royal Society of NZ join with the Australian College of Learned Academies (ACOLA) in horizon scanning activities in areas identified by the Prime Ministers and reported through to their Science Advisors.

7. Other components of the ecosystem

This report was not intended to be comprehensive or to repeat matters covered in my previous reports. For example, it has not discussed at length the critical role of many scientists employed within departments like DOC or those having analytical or advisory roles within regulatory or delivery agencies such as PHARMAC and the Environmental Protection Authority (EPA).

Some countries have specific science support services for their parliamentarians. To a large extent, these are sources of brief deliberative reviews and summaries of the literature rather than targeted tools for policy development (e.g. the UK's Parliamentary Office for Science and Technology - POST). In New Zealand, an equivalent service is provided by the Parliamentary Library, which employs several scientists and which, on occasion, has contacted my own office for support and information. Additionally, the brief reports of the Royal Society of NZ are very similar to 'POST Notes' series in the UK. Where parliamentary select committees in other jurisdictions take on a more investigative role than is traditional in NZ, they are often supported by specific scientific analysts.

8. The office of the PMCSA

Finally, it is timely to consider the future of the Office of the PMCSA itself. This office was established in 2009 to play an instrumental role in developing the science advisory ecosystem. However, because the full terms of the role were initially uncertain, it was established as a part-time secondment, to be based within the appointee's home institution. This guaranteed independence but created a set of practical problems as the role has grown to be a effectively a full-time commitment and the terms of reference have evolved[17]. While this institutional structure has been made workable for the inaugural position, in the longer term, it will become difficult to maintain the required level interaction from anywhere other than Wellington. Thus, it is suggested that any future PMCSA appointment will need to be Wellington-based and effectively a full-time position. There are a number of ways in which the independence of the role can be protected. The States Services Commission and DPMC are currently working on recommendations on the future arrangements for the Office.

[15] https://www.dpmc.govt.nz/policyproject
[16] http://www.mbie.govt.nz/info-services/science-innovation/international-science-partnerships

[17] Gluckman, Peter. 2016 Annual Report of the Prime Minister's Chief Science Advisor http://www.pmcsa.org.nz/wp-content/uploads/Annual-report_10-09-2016.pdf