There is a better way: Eight recommendations on the science system in New Zealand

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Executive summary

Although there is much that is positive about the New Zealand research science and technology system, an increasing sense of dysfunction is emerging within the research community. *Ad hoc* patching of the system (including the development of new funding schemes to address funding gaps) has characterised science portfolio management since 2000. Further, the effectiveness of the policy/funder/provider separation principle is now in question and the efficacy of information sharing and joint policy development of these parties in doubt. The sense of dysfunction is compounded by inadequate public funding of research, science and technology (RS&T). If New Zealand is to become a 'Knowledge Society', public funding of RS&T must increase by at least 25% to match the OECD benchmark average percentage of GDP.

Attention must be paid to 'system coherence', the role of individual institutions, and the usefulness of using whole-of-government outcomes to manage the RS&T system. The conflicting incentives that the current RS&T funding arrangements give to universities and crown research institutes (CRIs) must be corrected so that optimum educational outcomes and research results are achieved in the long-term interests of New Zealand.

Recommendations

NZAS recommends the following initiatives in order to enhance both the productivity of New Zealand's science system and the morale of the research community:

1. Increase RS&T public funding by at least 25% to match the OECD benchmark average percentage of GDP, and thereafter maintain or increase this quantum in line with the increasing targets of leading OECD nations.
2. Reduce the current proliferation of funding instruments and merge the functions of related instruments so as to reduce transaction costs to researchers, particularly in respect of bidding processes.
3. Develop clear guidelines concerning the expectations of managers of public-funded institutions in the RS&T system because conflicting objectives and incentives exert a negative impact on the functioning and effectiveness of the whole system. (For example, we have institutions competing, when really, for a small country like New Zealand, there are only resources to support one institution with adequate infrastructure and access to modern equipment.)
4. Examine the continuing relevance of the roles of various RS&T institutions. (Analysis of many systemic problems suggests that they mainly result from a lack of clarity around the roles of different research institutions, what government expects of them, and related decisions on funding methods.)
5. Develop funding policy in a more transparent manner and signal future funding scenarios more clearly than at present.
6. Reconsider how CRIs should be funded (including funding independent of universities), especially where it is important to government that institutional memory be retained.

7. Increase resources to excellence-based research, such as is presently funded within the Marsden Fund, by as much as 200%, in order to allow our most creative and productive researchers and research leaders greater latitude to undertake original research in fields of their choice and in which they have demonstrated their ability to uncover new knowledge.
8. Reinstate research excellence as an important funding criterion in the PGS&T and similar funds.

1. Introduction

Research, science and technology (RS&T) are vital to economic development and industrial competitiveness, to effective management of human activities in relation to the environment, and effective social policy. Therefore, it is extremely important that New Zealand maintains a vibrant and active scientific and technical professional workforce. All of New Zealand's political parties are committed to the ideal of a 'Knowledge Society' and recognise the need to participate in scientific and technical development in the face of international competition. However, many researchers believe that we are not living up to our aspirations towards realising a knowledge society. Currently, the scientific and technical workforce is disillusioned about career structures and management of scarce resources. This document discusses some of the key issues facing the research community and advances proposals to restore confidence among our research community.

New Zealanders should be aware that our past and current prosperity owes much to scientists, particularly in agriculture and horticulture. It follows that New Zealand must build and retain its own in-house scientific capability because importing technology will not solve many of our local problems, nor will we be able to apply imported technology if we have no local expertise in its adaptation and application. Further, the recent degrading of research excellence as a funding criterion may invite negative consequences and it is now vital that excellence be reinstated as an important criterion in all public-funded research. New Zealand must position itself at the forefront of research in areas that relate to our natural advantages, in niche areas where we are developing scientific, technological and commercial expertise with high value addition, and in maintaining sustainable use of our environment and minimising the risks posed to our social and economic life.

2. Background

In the late 1980s and early 1990s the science system was reformed significantly as part of an attempt to control and focus government expenditure across all sectors of the public service. Several key principles underpinned the reforms. The principle that policy advice, funding and service provision should all be carried out by different organisations, in order to avoid conflict of interest and capture by any particular group, was now applied to the science system. Further, the notion that research should not be input-funded, but instead funded on the basis of desired outputs that could be contracted, was applied in the belief that the best science would be delivered if the funds were mostly contestable.

Then, beginning with a Foresight exercise, further changes were made to priority setting and funding allocation that are not understood by many outside or within the science system. Presently, New Zealand's universities are being subjected to radical change through the Performance-Based Research Fund (PBRF), involving centralisation through the Tertiary Education Commission. These changes are the source of concern for many scientists and science managers, apart from those university researchers who have benefited from the Centres of Research Excellence (CoRE), Partnerships for Excellence schemes, and the Marsden Fund. This concern is reflected in several recent critiques of the RS&T system (Allison 2003; Devine 2003; Winsley 2003) that propose a range of suggestions for remedial action.

Evidence of problems within the science system includes the following:

1. Long-standing and growing disquiet about the future of New Zealand science, as evidenced by surveys of scientists (Sommer & Sommer 1997, Serio & Sommer 2000) and the strong response to the PSA's Open Letter to the Minister (PSA 2004).
2. Low morale of scientists, especially of those working as individuals or in organisations where 100% of funding is regularly at risk (e.g. Kingston 2003).
3. Significant numbers of job losses and redundancies within research organisations.
4. Loss of capability in a number of areas, resulting from funding decisions made in the absence of medium-term funding plans.
5. Expanding and costly bureaucracies in scientific institutions, universities and central government.
6. Increasing volatility and lack of transparency of the funding system and constantly changing rules of engagement, coupled with relatively low salaries for scientists; that is, no compensation for the risks that a scientist takes in working for what is often the only employer in New Zealand (Kingston 2003).
7. Attempts to force whole-of-government outcomes when no one organisation (including policy agencies and funders) has the capacity to control the behaviour of other parts of the government infrastructure and there is no effective co-ordinating system.
8. Ad hoc proliferation of funding instruments that have resulted in increasing transaction costs (Ministry of Research, Science and Technology (MoRST) 2003, Winsley 2003).
9. Changes to those institutions that are funded by the Foundation for Research, Science and Technology (FRST), increasingly putting CRIs at risk, apparently in order to bring in new RS&T providers (MoRST 2003). (This problem is compounded by the implementation of the PBRF and the creation of CoREs within universities, whose funding is for a limited period (six years) after which they are expected to become independent organisations. All of these developments alter the research environment substantially and will apply increasing pressure on the Public Good Science & Technology (PGS&T) Fund.)

3. Key policy issues

NZAS contends that the key science system issues are:

1. The low total quantum of R&D investment by comparison with other OECD nations.

2. Lack of coherence across the entire RS&T system.
3. Lack of clear roles for institutions in the RS&T system.
4. Inefficient management of RS&T resources, leading to excessive transaction costs on research institutions through the proliferation of funding instruments, along with excessively expensive bidding processes and reporting requirements, in tandem with excessive use of contestability; overprescription of research and inadequate funding for excellence-based, curiosity-driven research; lack of clear strategic planning and transparent funding policy around the key research areas, thus reducing the ability of research organisations to plan for the future and fund equipment adequately.
5. Downgrading of research excellence as a funding criterion in some parts of the public good funding system, potentially leading to a decrease in the average quality of New Zealand's research effort.

Ad hoc patching of the science system (including the development of new funding schemes to address funding gaps) has characterised science portfolio management since 2000. Further, the effectiveness of the policy/funder/provider separation principle is now in question and the efficacy of information sharing and joint policy development of these parties in doubt, thus contributing to a growing sense of dysfunction within the science community. It is essential that NZAS and related organisations monitor the key system issues in order to ensure remedial action before further damage is done.

3.1 Science funding

At the root of many difficulties with the science funding system is the low total quantum of R&D funding, including that for the PGS&T. Presently, government's share of R&D funding is about 0.54% of GDP, which is substantially below that of 'benchmark' countries (MoRST 2003) and, apart from Ireland, this is the lowest investment among the benchmark countries, a group of OECD countries that are similar to New Zealand in size or nature of economy – Australia, Denmark, Finland, Ireland, Norway, and Sweden (see Table 1). The 0.8% GDP goal for government investment in RS&T by the year 2010 now appears to have been abandoned.

In 2002, as a percentage of GDP, New Zealand's private-sector funded R&D was very low, at less than one-third of the benchmark average. However, the 2004 MoRST survey shows a pleasing 25% increase in private sector R&D (Statistics NZ 2004) and is corroborated by the Minister's recent announcement (May 2005) of substantial private sector investment in our Research Consortia. Between 2002 and 2004 the total R&D spend increased by over 13% from 2002, including nearly 25% in private sector investment, 8.4% in the government sector and 4.4% within universities. However, at 1.17% of GDP, our R&D investment remains well behind that of many other developed nations. For example, Australia invested 1.62% of GDP in 2002, while the OECD average was 2.26%. (NB. This figure for Australia is at variance with the figure of 1.53% in Table 1 because the two figures relate to two different surveys!)

Table 1. Comparison of New Zealand R&D funding by sector, for benchmark countries and the OECD average for 2002 (from OECD 2002; MoRST 2003).

Country	Total R&D as %GDP	Private sector % of total R&D	Private sector % of GDP	Public sector % of total R&D	Public sector % of GDP
New Zealand	1.15[1]	36.8[2]	0.43	46.4	0.54
Australia	1.53	45.9	0.70	46.1	0.71
Denmark	2.19	59.0	1.29	31.2	0.68
Finland	3.40	70.8	2.39	25.5	0.87
Ireland	1.17	66.0	0.76	22.6	0.26
Norway	1.62	51.6	0.84	39.8	0.64
Sweden	4.27	71.9	3.07	21.0	0.90
Benchmark average	2.36	60.9	1.51	31.0	0.68
OECD average	**2.26**	**63.6**	**1.44**	**28.9**	**0.64**

[1] In 2004 this is now 1.17%. [2] In 2004 this is now 40.5%.

It is imperative that government's share of R&D funding be grown rapidly to about the OECD average if New Zealand wishes to remain competitive and improve and maintain good morale within the science community. Two decades of various governments' policies, aimed at increasing private sector R&D investment, have effectively grown business investment from a very low starting point but have been associated with a marked decline in public sector investment as a percentage of GDP. If an innovation-based economy, predicated on a strong R&D sector, remains a key government objective, then government funding must increase rapidly by at least 25%. New Zealand's relatively low industry spending on R&D remains a problem that partly originates in low numbers of scientific and technically-trained people within industry management, and consequential low absorptive capacity for R&D and low capability for undertaking in-house R&D. However, government can make a great difference by adhering to more promising funding targets that match those of leading OECD nations. Ultimately, failure to match the R&D spending of our competitors will result in further reduction in our own international competitiveness and a further drop in standard of living compared with those nations that adopt more aggressive R&D investment policies.

Recommendation: *Increase public RS&T funding by at least 25% to match the OECD benchmark average percentage of GDP, and thereafter maintain or increase this quantum in line with the increasing targets of other OECD nations. (NZAS suggests that this is a modest objective on the basis of international comparisons.)*

3.2 Management of RS&T resources

New Zealand must manage its R&D quantum in a manner that enhances the performance of its scientific workforce and research organisations. We must take into account the fact that, as a small country, we often have only one institution that is equipped with the skills and infrastructure to undertake particular types of research. Exposing such institutions to the full contestability processes is extremely inefficient. Further, encouraging other institutions to compete when there is limited funding is a recipe for lowering standards across the entire system. No other nation disburses such a large fraction of its R&D investment on a contestable basis, and sometimes in a climate in which the overarching strategies are not clear (e.g. MoRST 2004). Contestability may well ensure opportunities for new ideas, but the benefits of contestability are often outweighed by the enormous amount of wasted effort and resources that go into the preparation and assessment of proposals.

In addition, the last 15 years has seen a proliferation of funding instruments, each of which has its own approaches to the

development and assessment of proposals. For research groups that must source money from multiple funding schemes, the time and effort involved in developing proposals represent a very significant real loss (particularly for those that are ultimately unsuccessful). New Zealand must develop a clear view of the roles of particular institutions and needs a much simpler range of funding instruments that allow a greater fraction of its total R&D resources to be used productively rather than being consumed in the preparation and assessment of unsuccessful bids and associated administrative inefficiencies. Therefore, we must reduce the amount of resources devoted to current bidding, reporting and other administrative tasks.

Further, many research groups suffer from a persistent inability to access expensive, modern equipment, because the present full-cost funding approach does not provide the necessary up-front money for large capital items. Scientists in universities, CRIs and other institutions include cost funding for capital equipment (the depreciation element) when applying for grants, thereby allowing equipment to be replaced as it wears out (e.g. FRST 2004a). Therefore, whether or not an individual scientist has access to needed equipment depends heavily on the management of his or her institution. We must ensure greater transparency around the use of depreciation funds and clarify the processes adopted by research institutions to decide on priorities, including priorities for expensive equipment. Each institution should have a strategic plan and must undertake a range of research activities that are aligned with its quantum and source of research funding. Its staff must also be aligned with the institution's strategic positioning and funding, and the institution must either have the cash flow that enables purchase of expensive items, or have a credit rating that allows it to borrow, or else make a surplus on which it can draw for large item purchases.

Currently, most institutions are given conflicting objectives and unclear signals as to the future plans of government. Government owns the CRIs and is a major stakeholder in the universities. Nevertheless, these institutions are exposed to constantly changing rules of engagement and micro-manipulation of policy settings, without being provided with a clear big-picture perspective by government.

Presently, universities are adjusting to attempts to centralise decision-making and are discouraged from raising their fees to students. CRIs and universities struggle to retain their current level of staff and expertise that they judge necessary to fulfil their core functions, while expected to perform their core tasks as well as spin-off businesses that expose the institution to greater risk. Institutions are expected to co-operate while forced by the contestability system to treat other institutions as competitors. In many instances this climate prevents co-operation where in fact the costs of owning expensive, modern equipment could be shared. Many research institutions have ongoing cash flow problems and we hear many complaints from scientists about inadequate money for modern equipment. Setting up a new fund for infrastructure is not the answer (see Tallon 2005). The answer is to improve high-level policy settings and to deliver clear expectations of boards and CEOs concerning the management standards required.

Recommendation: *Reduce the current proliferation of funding instruments and merge the functions of related instruments so as to reduce transaction costs to researchers, particularly in respect of bidding processes.*

Develop clear guidelines concerning expectations of managers of public-funded institutions in the RS&T system because conflicting objectives and incentives affect the functioning and effectiveness of the whole system adversely.

3.3 Lack of system coherence

The science reforms were intended to align policy, research and end-user groups to deliver national benefits. Nevertheless, because no single organisation was ever charged with managing the system as a whole, the coherence necessary for an effective RS&T system never emerged (Devine 2003). Further, in the opinion of some commentators, MoRST's isolation from FRST has impeded the flow of strategic information, and decisions are sometimes made at the wrong levels (Winsley 2003). Since 2000 this problem has been exacerbated by difficulties around the development of research strategies, and gaps in stakeholder input, whereby both university and CRI scientists have virtually been excluded from high-level priority setting. At present, the only way in which scientists can provide input is through FRST's reference panels. It is this learning that seems not to flow to MoRST (Winsley 2003).

An illustration of the unfinished attempts to align policy, research and end-user groups to deliver national benefits may be found in FRST's portfolio 'Resilient, Functioning and Restored Natural Ecosystems', 'advanced' in 2004. This portfolio includes "Target Outcome 3: Biosecurity – Incursion Management: Unwanted harmful and potentially harmful organisms are either prevented from crossing New Zealand's border, or are detected and eradicated before establishing self-sustaining populations."(FRST 2004b) That is, given the resources, the science system can define New Zealand's flora and fauna and determine whether or not particular elements of our biota are foreign to New Zealand. It can help with risk assessment, determine which vectors expose New Zealand to the greatest risk and devise eradication methods. Nevertheless, the achievement of the objective, as written, is entirely the responsibility of an operational government agency.

NZAS believes that the appropriateness of managing a major part of the public-funded RS&T system, based on whole-of-government outcomes, and the inability of the current RS&T management model to deliver coherence, are issues that require close examination. FRST is currently developing mechanisms (Outcome Based Investments (OBIs)) designed to facilitate the achievement of whole-of-government outcomes, and has used the Natural Ecosystems portfolio providers and end-users in their pilot programme. To this end, FRST encouraged applicants to develop a range of governance arrangements that were to meet the expectations of research partners and organisations that will be involved in the implementation of the research. FRST has evaluated these pilot processes and its expectations of OBI governance have been published (FRST 2005).

Relevant to FRST's pilot OBI process is the Parliamentary Commissioner for the Environment's (PCE) consideration of "Missing links: connecting science with environmental policy" (PCE 2004: 83–84). Among the system issues considered are a set that relate to scientific and technical input to government environmental decision-making, specifically around the scientific capacities and capabilities within central and local gov-

ernment environmental agencies. PCE (2004) suggests that MoRST is best placed to identify the range of scientific skills and capabilities required to enable environmental agencies in central and local government to function effectively, review the effectiveness of consultation between scientists, policy makers and stakeholders, and review public accessibility of scientific information for policy-making. Although in the OBI process FRST facilitates the communication element in PCE's analysis, FRST appears not to have taken into account other possible impediments to the uptake of research results (sufficient skills amongst end-users) nor recognised that there may be advantage in positioning scientists away from the political processes of environmental management.

In a recent evaluation of the Environmental Output class, MoRST (2004) noted that many end-users do not have sufficient scientific capability to use the science as it is currently presented. Based on a study of specific cases, MoRST also noted that considerable benefits accrue to New Zealand from past environmental research. Therefore, in order to clarify roles and responsibilities, the report recommends that MoRST investigates the advantages and options for increasing differentiation of research funding processes along the following lines: long-term, applied, tools, and policy research. Additionally, several reports suggest that the connection between end-users and environmental research providers (e.g. MoRST 2004) is poor. However, a review of technological learning (FRST 1998) suggested that good connections do indeed exist between many environmental end-users and research providers.

At present, no single comprehensive analysis of the role of science across all sectors is available. Evidence of a dearth of analysis appears in a report commissioned by MoRST (Evaluation of the Environmental Output Class) that concludes: "there is an absence of clear research directions for environmental research" (MoRST 2004). It remains unclear as to which organisation has the primary role in leading the development of research directions and strategies and in facilitating the input of all stakeholders (including scientists) in environmental science (and other areas?). Possibly, the present 'policy vacuum' has led FRST (2004c) to develop necessary strategy and discuss the funding needed to achieve this strategy. However, it remains doubtful that government is advised adequately of the likelihood of unintended negative consequences of recent funding and process decisions. Further, environmental scientists would be greatly reassured if there were greater evidence of strong links and concordance between, for example, PCE, MoRST and FRST, and evidence that past policy research is being reconciled and learnt from. Therefore, NZAS sees a great need for other sources of advice to government about the functioning of the public good science system.

Recommendation: *Reinstate MoRST as the primary provider of policy analysis, charged with developing science strategy and facilitating input from all stakeholders, including scientists, on priority setting. Alternatively, amalgamate MoRST and FRST so as to achieve improved information sharing and co-ordination, and reduce overheads. Develop funding policy in a more transparent manner and signal future funding scenarios more clearly than at present.*

3.4 Roles of institutions within the RS&T system

At present it is unclear that New Zealand has a coherent and agreed position on the roles and functions of its RS&T institutions. Current problems relating to the roles of our research institutions are discussed in the following sections:

3.4.1 Crown Research Institutes

The Department of Scientific and Industrial Research (DSIR), established in 1926, was modelled on the British system to administer some existing government scientific services, advise government on scientific matters, and oversee and co-ordinate government-funded research (Galbreath 1998). Over 65 years, DSIR's form and function extended well beyond that envisaged when it was first established. These changes appear to have been rather haphazard, without strong principles behind decisions as to the types of institution we need and or extent of their public funding. Even though the reforms of the late 1980s were based on consistent economic principles, the rationale for government ownership of Crown Research Institutes (CRIs) remains unclear. This problem has led to the emergence of a number of discordant features within the RS&T system.

Currently, some CRIs are under continuing threat from *ad hoc* funding decisions that are resulting in loss of capability. Further, the culture and expectations of CRI staff, management (including boards) and government now appear to be different. The provision by CRIs of public good science is incompatible with the commercial attitudes of boards and a fixed price-for-outcomes policy of the funder. There is little recognition that environmental CRIs (and probably other CRIs) are compromised in their public good roles by the need to earn revenue privately from clients who may not have the public good in mind (e.g. the fishing industry), and government's requirement that they make a surplus of at least the Weighted Average Cost of Capital. Further, in their struggle to stay financially viable, CRIs do not have the incentive to work primarily in the public interest, but rather in their own interest. For example, Environmental CRIs have incentives to sell repeat technical services rather than to solve national environmental problems, and making the solution freely available to all.

There is also an emerging tendency for CRI scientists to have to undertake work that is not commensurate with their qualifications, performance and potential. Many CRI scientists, who regard evaluation of excellence as primarily international, have been moved to commercial or development work, often of little pure scientific merit, thus damaging their international scientific reputations and future employment opportunities. Casual observation suggests that this problem is leading to job dissatisfaction, increased staff turnover, skills loss, and increasing difficulties in recruiting well-qualified permanent staff.

A clear rationale for government ownership of CRIs needs to be developed and promulgated. Where a CRI does not meet established criteria, its resources and infrastructure should be located or absorbed into other research structures (e.g. universities or private laboratories). In the absence of clear strategic directions from government's funding and policy agencies, NZAS endorses suggestions that CRIs be largely core funded (Tallon 2005), especially where their research will only ever be done or at least be led by government, and requires institutional and research memory. Core funding would stabilise some longer-term research projects and provide job security for key staff. The remaining quantum should remain contestable in order to ensure ongoing opportunity for new ideas and new researchers. NZAS contends that certain research areas of criti-

cal importance (e.g. hazards research and some environmental research) should not operate under contestability, but instead must be supported on an ongoing basis, with regular reviews of the quality and quantity of results and the quality of links to operational research in government Departments.

3.4.2 Universities

The primary role of universities and polytechnics is teaching at the tertiary level. Teaching at the postgraduate level in universities must be informed by the creation of new knowledge and the skills necessary for its acquisition. Thus, in any world-class university, postgraduate teaching and research are linked very closely.

Public funding of science within the tertiary sector has been reducing steadily since the economic restructuring of the 1980s. This problem has resulted in escalating student-staff ratios (with reduction in staff time available for research), combined with decreasing institutional funding available to support research. Conditions of employment require academic staff to remain active in research, but the resources are often inadequate for successful outcomes. In principle, the Marsden Fund addresses these issues, but the chance of receiving a grant is very small. A very substantial increase in the Marsden Fund, so that more A-rated proposals could be funded (instead of the current 7%), would be a good solution, provided the needed funds were not appropriated from other science areas.

Universities have traditionally been the main providers of basic research, but university researchers are under increasing pressure to undertake applied research. This trend interacts with the downplaying of excellence in PGS&T funding (see section 3.5). Under the corporate management model now deployed within the universities, research is valued primarily for the external funding attracted, rather than for the scientific merit of the work. The PBRF scheme attempts to address the problem of excellence versus relevance, but essentially redistributes the inadequate existing research funds, so that it is not obvious that there will be an improvement in the position of individual researchers.

Centres of Research Excellence are indeed excellent for those lucky enough to win funding, but do nothing for anyone not involved in the few favoured areas of current interest or popularity. Absence of any assurance of continuing funding leaves Centre of Research Excellence researchers in quite a precarious position.

The core problem, as for all of science, remains the total quantum of funding. For the Tertiary sector this problem is complicated by the bulk of research funding remaining hidden within the Education vote. Extraction of this money to form the PBRF at least makes the quantum clear, even though its distribution by individual universities may not be transparent.

In summary, the changes being made to the way universities receive research funding, in isolation from CRIs, may be setting up future problems for the entire RS&T system. For example, the creation of CoREs, with funding for a limited number of years, and the establishment of the PBRF for universities, will force more institutions into competing for PGS&T Funding (MoRST 2003). However, the extent of any concentration of research capability within universities must be evaluated, clarified and placed within a broad understanding of the roles of different institutions in the New Zealand RS&T system.

3.4.3 CRIs and the education system

Several problems are created by the current separation between research in universities and CRIs. The current competitive nature of the research funding system in New Zealand, combined with our small population, means that we do not always make the best use of our scientists in teaching the younger generation. It is clear that universities are not the centres of all scientific expertise in New Zealand because concentrations of expertise exist within the CRIs.

Insistence on a particular institution collaborating with others, when the consequences of collaboration include inadequate funding for its own staff, cannot prove successful. In reality, the major competitors (the CRIs and the universities) do not compete on an equal footing. The current boom in demand for tertiary education means that university staff are under much less pressure to secure and retain research funds than CRI staff, whose jobs are imperilled with every funding decision that leads to reallocation.

The often-suggested transfer of more research to universities poses a competition problem for other providers. University research usually depends on student labour, and the use of facilities partially subsidized by use for teaching. However, the traditional staff supervisor/student thesis research model is often ill-suited to producing the rapid results, or repetitive accumulation of data, which are often the basis of applied research. Worse, such research often provides poor training for students. For PGS&T and similar programmes, student participation should be permitted only when adequate training is assured.

These problems could be addressed, either by amalgamating universities and CRIs, or by funding CRIs independently, so that co-operation between research and teaching organisations flourishes. Evaluation of the best course of action would have to be carried out alongside the evaluation of the role of CRIs and universities. If a reassessment shows that stand-alone CRIs are needed for specific purposes, then this conclusion would inform decisions on the best method of funding them, such that they continue to support the expertise, plant and equipment necessary to make a credible contribution to their area of research in the national interest and collaborate fully with universities in teaching and research.

Recommendations: *Examine and clarify the roles of New Zealand's RS&T institutions.*

Reconsider how research institutions should be funded (including funding independent of universities), especially where it is important to government that institutional memory is retained.

Reduce the current level of contestability and identify research areas of critical need (e.g. hazards research and some environmental research) that must be supported on an ongoing basis. Implement regular independent reviews to ensure accountability.

Increase resources to excellence-based research, such as is presently funded within the Marsden Fund, in order to allow our most creative and productive researchers and research leaders greater latitude to undertake original research in fields of their choice and in which they have demonstrated their abil-

ity to uncover new knowledge. (NZAS believes that resources to excellence-based research should be increased significantly – by as much as 200%.)

3.5 Importance of excellence in research funding

FRST's downgrading of the role of excellence and abandoning of an independent external review process (see FRST 2000d) in PGS&T investment decision-making is of great concern. Much of New Zealand's research investment could be wasted if excellence (as judged by scientific peers) is not reinstated as the primary funding criterion. Downgrading the importance of excellence in funding decision-making will invite two negative outcomes. First, the effectiveness of, and regard for, FRST-funded research may erode. For example, environmental research (indeed all research) must be of the highest possible quality if it is to assist in wise decision-making, as it must stand up in New Zealand's, often adversarial, environmental management processes.

A second unintended consequence may be a reduction in the standard of staff put forward by CRIs. When staff performance is not reviewed from outside the organisation, past experience in both universities and CRIs shows that difficult performance issues tend to be swept under the carpet.

Recommendation: *Reinstate research excellence as an important funding criterion in the PGS&T and similar funds.*

4. Concluding remarks

This article is the product of extensive debate within the NZAS Council about the state of New Zealand's science system. NZAS believes that New Zealand produces much science that is world-class, but in recent years has become increasingly concerned about a range of systemic problems and their impact on both the nation's research effort and on the morale and careers of its researchers. We see this document as a vehicle for clarifying our own position on the key science system issues and for promulgating our position widely within the research community, with Ministers and other senior decision-makers. We invite feedback on the opinions articulated here and intend to represent the considered views of the research community with government in the near future. In undertaking to represent the research community at senior levels, our overarching objectives are to achieve world-class research and ensure that science becomes once more an attractive profession for young people.

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