



Australian Government

Department of Industry, Innovation, Science, Research and Tertiary Education

SCIENCE ENGAGEMENT AND TROPICAL AUSTRALIA

BUILDING A PROSPEROUS AND SUSTAINABLE FUTURE FOR THE NORTH

**PREPARED BY THE EXPERT WORKING GROUP ON SCIENCE ENGAGEMENT
INTO AND FOR AUSTRALIA'S TROPICAL REGION**

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Prepared by the Expert Working Group on Science Engagement Into and For Australia's Tropical Region

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Executive summary

The *Inspiring Australia* strategy is a high-level national strategy for public engagement with the sciences and a key element of Australia's innovation agenda. The Australian government believes that, in order to help the nation 'unlock its full potential', it is necessary to examine those areas which, due to location, may have been disadvantaged in science engagement. The tropical region of Australia is one such region. It requires a different approach, and to this end, the Australian Government has established an Expert Working Group (EWG) focused on science engagement **into and for the tropical region of Australia** to support implementation of the *Inspiring Australia* strategy.

To stimulate discussion in the wider community, and building upon the *Inspiring Australia* strategy, the EWG developed a discussion paper to outline some of the challenges facing science engagement in tropical Australia and to generate new ideas. In doing so, the EWG explored some of these challenges, recent theoretical developments in science engagement and new big directions in tropical science. The EWG also conducted a tropical Australia-wide stakeholder survey and drew on the public response to a draft of this final report. From this work, the EWG considers that there are seven broad, context-driven scales or themes of science engagement that need to be addressed for tropical Australia. These are:

1. Building science literacy for all tropical Australians
2. Shifting science engagement cultures at the project and publication level
3. Building durable and trusted regional science brokerage and partnership arrangements
4. Forging effective science engagement in the Indigenous domain
5. Building science partnerships at industry/sectoral level to turbo-charge innovation
6. Ensuring science messages from the tropics engage southern Australia
7. Engaging tropical Australia in national science messages.

Considering these themes (from the individual to the national scales) has helped to contextualise science engagement issues and solutions across the tropics and has enabled the EWG to craft short to medium term recommendations for reform.

The EWG also found, however, that there are three pan-tropical, cross-cutting strategies that will need to be addressed in the longer term if transformational change is to be achieved in the tropics. These strategies relate to the science literacy of tropical Australians, the collaborative institutional frameworks for effective science engagement and the need for a collective, pan-tropical response to both these strategies and the EWG recommendations by key stakeholders, science providers, communicators and governments. The EWG has developed a preliminary narrative for these broader strategies, but their further development and implementation will require more detailed consideration in the future.

Summary of recommendations

The following recommendations (developed against the seven key themes) require implementation in the short to medium term to kick start improved science engagement in the tropical region of Australia:

No.	Recommendation
1	Establish a strong community-based network for improved science engagement by appointing (at least three) regionally based facilitators to build and deliver the required cross-agency-industry network/s and to identify opportunities for collaboration in raising science literacy.
2	State and federal promotions and rewards systems shift their focus to better recognise the importance of science engagement as a key academic endeavour – including the Australian government, CSIRO, Universities and State government research institutions.
3	Research funders including local universities, industry and not for profit organisations, the Australian Research Council (ARC), Research and Development Corporations (RDCs) and the like, alter their assessment frameworks and internal assessment capacities when they are making investments in tropical Australia to ensure projects have strong science engagement.
4	Tertiary institutions include basic science engagement competencies within science-related qualifications, including attention to Indigenous and other engagement in the tropics.
5	Research funders increase investment in multidisciplinary research teams (e.g. inclusive of the social sciences) to develop a more far reaching and engaging science culture.
6	Research funders use specialist science or knowledge brokers as part of their project approval processes for major projects in tropical Australia.
7	Stakeholders from tropical Australia be involved from the outset in decision-making processes regarding the development of major science programs for tropical Australia.
8	Recognise and/or establish regionally based science brokerage frameworks, wherever possible building on existing structures in order to secure a basis for durable and quality science brokerage and knowledge management across tropical Australia.

No.	Recommendation
9	Investors and stakeholders in the tropics apply the key recommendations of the Inspiring Australia Expert Working Group for Indigenous Engagement With Science, particularly those focused on greater recognition of Indigenous science and traditional knowledge in mainstream science programs and projects.
10	Investors and stakeholders in the tropics invest specific capacity to expand the institutional foundations for Indigenous-led science partnerships in the tropics.
11	Investors and stakeholders in the tropics ensure research program and project investment focused on Indigenous concerns in the tropics includes the resources required to enable strong Indigenous community-science partnerships.
12	The ARC Discovery Indigenous scheme and other Indigenous science engagement programs are expanded to build the capacity of Indigenous scientists in tropical Australia.
13	Investors and stakeholders grow more explicit and agreed industry research and development frameworks focused in tropical Australia, building upon existing research frameworks (e.g. North Australia Beef Research Council, Australian Fisheries Management Authority, etc) and developing new ones in priority sectors (e.g. the agriculture, health and resources sectors).
14	Tropically focused strategic research and development strategies and frameworks build strong, well-integrated social research and extension foundations, including clearer tropical Australian themes, within their research programs.
15	Research providers and science communicators in tropical Australia build a few collaborative, cohesive and engaging science communication campaigns that target high profile issues of real significance to tropical Australia.
16	Investment be directed towards developing the capacity of research institutions in tropical Australia to build cohesive and long-term science-management partnerships. These partnerships would be with governments, universities and regions across the tropical world, but more specifically within the tropical Asia-Pacific region.
17	Research providers in the tropics commence a multi-disciplinary Journal of Tropical Australia with a strong focus on well engaged science across the tropics and devoted to the sustainable social, economic and environmental development of the region.

No.	Recommendation
18	The National Office of the Chief Scientist and national research institutions like CSIRO develop more pronounced tropical Australian engagement strategies within science engagement campaigns of national importance.
19	Australian, State and Territory governments invest in trial approaches to developing cohesive pan-tropical responses to nationally important science issues, especially those with big implications for tropical Australia (e.g. climate change, biodiversity loss, etc).
20	Rapid and uniform roll out of satellite-based and urban NBN technologies currently planned to deliver significantly enhanced internet coverage across tropical Australia.

The EWG also concluded that there were three big cross cutting strategies required to more comprehensively lift science engagement across all theme areas across the tropics. While the EWG has developed preliminary narratives for these strategies, they will require stakeholders and science deliverers to invest in long-term and tenacious effort, and to work cohesively with the Australian, State and Territory governments, to transform the nature of science engagement. Consequently, these strategies need more substantive scoping, analysis and refinement in the future. They are:

- a pan-tropical narrative and alliance for science engagement
- strong engagement frameworks in the tropics
- community-wide foundations in science literacy.

Introduction and rationale

The *Inspiring Australia* strategy was released on 8 February 2010 by the then Minister for Innovation, Industry, Science and Research, Senator Kim Carr. It is a high-level national strategy for public engagement with the sciences and a key element of Australia's innovation agenda. It aims to build strong, open relationships between science and society, underpinned by effective communication of science and its benefits. At its broadest level, the strategy calls for a partnership between governments, agencies, organisations and communicators throughout Australia to work towards its implementation.

Within this context, the Australian Government believes that, in order to help Australia 'unlock its full potential', it is necessary to examine those areas which, due to location, may have been disadvantaged in science engagement. This report contends that the tropical region of Australia, representing a significant section of Australia's remote landscape, is one such region. Consequently, in thinking about science engagement and communication into and for tropical Australia, three key principles identified within the *Inspiring Australia* report seem particularly important. These are:

Principle 8—Engaging Australian Communities: It is important that Australia continue to deliver high-profile, nationwide science engagement activities providing opportunities for the entire community to participate.

Principle 9—Building Partnerships—Using Networks: Australia requires effective mechanisms to facilitate public information flow and information sharing in the sciences, utilising the knowledge and resources of existing organisations and networks.

Principle 12—Unlocking Australia's Full Potential: To ensure a more equitable Australia, a special focus is required to maximise the potential of people who may not previously have had interest in or access to science engagement activities.

In overview of these principles it could be said that social inclusion of tropical Australians in the wider national economy should be a result of effective science engagement. A different approach is needed, and to this end, to support implementation of the *Inspiring Australia* strategy, the Australian government has established an Expert Working Group (EWG) focused on science engagement **into and for the tropical region of Australia**. This group is charged with developing strategies in alignment with Government priorities and in consultation with key regional stakeholders. To give a focus on long-term implementation, the process has an opportunity to link strongly into the Regional Development Australia (RDA) framework across northern Australia and the work of the Office of Northern Australia. RDA Boards and stakeholders across the region may be able to be supported to help progress long-term implementation actions, possibly aligning efforts through the North Australia Ministerial Forum.

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Finally, it is hoped that the EWG can work with the Australian Government, and particularly the DIISRTE, to help set a clear framework for science engagement into and for Australia's tropics.

Developments in the theory of science engagement in the tropics

To contextualise where science engagement is now and where it should be heading in tropical Australia, it is important to note where the theoretical and practical literature concerning science engagement and communication in tropical environments is heading. This section considers some key emerging contextual and theoretical themes and their relevance to tropical Australia.

The context of science engagement in tropical Australia

Some key features of the tropical north that influence the way science is undertaken and communicated are worth considering. Tropical Australia faces some distinctly different challenges that require scientifically informed solutions with a tropical-knowledge focus. These include:

- *Tropical Australia is vulnerable to climate change:* The specific implications arising from climate change for the tropics include the fact that the tropics is highly vulnerable but also holds the key to understanding and measuring the national impact of climate change. There are, for example, emerging risks in disaster management, tropical health and biosecurity and obligations to sustain globally significant natural assets like the Great Barrier Reef.
- *Australia's economic future will depend on tropical Australia:* Much effort will be required in effectively facilitating economic growth in the resources and energy, agriculture, tourism and urban development sectors while managing negative impacts.
- *Tropical Australia is not southern Australia:* With the vast majority of the nation's science funding, resources and effort residing in southern Australia, tropical Australians are often not well engaged in the nation's overall science effort. As a result, southern science concepts tend to drive northern agendas, at times leading to perverse outcomes.
- *Decision-making institutions in tropical Australia often don't have the required institutional strength to manage long-term science partnerships:* The role of science in delivering a longer term vision is often constrained by short-term funding cycles. This is exacerbated in tropical Australia as decision-making institutions face regular financial stress, stretching their capacity and permanence. This makes it difficult to build long-term/durable science partnerships.
- *Tropical Australia is an Indigenous domain:* Indigenous people (Aboriginal and Torres Strait Islander people) have control of, and/or interests in, the entire tropical Australian landscape, requiring the blending of both western scientific and traditional knowledge sets. The general view of scientists as 'knowledge takers' by Indigenous communities underpins the need for any science undertaken in Indigenous domains in the tropics to be based on clear protocols

focused on genuine engagement and the protection and appropriate sharing of intellectual property (IP).

- *Scientific education and training levels are generally lower than southern Australia:* Australian tropical science suffers from acute shortages of skilled scientists and technologists including chemists, economists, engineers, geographers, mathematicians, microbiologists, modellers, physicists, statisticians and taxonomists. Shortages are compounded by the lack of career pathways for early career researchers.
- *Trust in governments, and to a certain extent the science associated with policy, has declined over recent decades:* The trust between governments and society has been tested over recent decades across the globe (Chanley et al. 2000). Within the pioneering culture of tropical Australia, this decline in trust has particularly played out in marine-based communities, remote pastoral and agricultural regions and Indigenous communities, where biophysical science knowledge has increasingly led to policy proposals that have substantively affected the economic rights of landscape managers (see Productivity Commission 2003).
- *Tropical Australians generally have poorer access to the digital economy in the short to medium term:* Being largely comprised of remote landscapes and difficult terrain, tropical Australia generally has poorer access to the emerging digital economy, and hence the data and science required for a robust participatory democracy.
- *The development of tropical knowledge creates an economic opportunity throughout the tropical region across the globe:* Due to its location and as one of the few developed nations in the tropics, Australia has the potential to be the tropical knowledge provider of choice to much of the world. As such, science investment in tropical Australia needs to be viewed with regard to emerging strategic opportunities for the global sharing and export of tropical knowledge.

These key contextual challenges, consistent with the science communication literature, highlight the need to strengthen science capacity in tropical Australia from within and build the science/decision-making interface within the tropics. This means a step change is required in science collaboration and a critical mass and institutional capacity (people, infrastructure and networks) needs to be developed. Shifting from a centralised information dissemination model to a participatory science engagement approach is fundamental to embedding science into the development culture of tropical Australia.

Some emerging theoretical trends in science communication

Science communication and communication theory in general are very wide fields with many strands delving deep into specific issues. While not a comprehensive review, this report recognises that the science communication literature has long understood that the communication styles required in certain circumstances are very context dependent. These styles can range from simple information dissemination

right through to genuine and durable co-learning or co-research partnerships, where knowledge (and power over its use) is equally shared and respected. While all communication styles are appropriate in certain circumstances in the tropics, there are some consistently emerging themes in the science communication literature that are shaping current debate about future directions. These are overviewed below to help set some context for the balance of this report:

- *A focus on science literacy in students and adults:* Recognising the need to grow scientific understanding across the community as a foundation for a stronger civil society (e.g. see Stocklmayer et al. 2001).
- *Shifting from research to co-research and action research models:* Breaking down the divide between experts and managers to increase community knowledge, the capacity of scientists and to increase the impact of science uptake and impact on decision making.
- *Improving science integration and the strategic role of science in decision making:* Increasing collaboration among scientists, disciplinary domains and increasing the efficiency of resources allocated to science through improved strategic prioritisation in resource allocation and enhancing strategic partnerships between scientists and decision makers.
- *A shift in language from science communication to science engagement:* A general shift in the wider public participation literature from consultative decision making to power sharing in learning and decision making. This shift also reflects an increasing amount of work being done to explore better ways to engage societal segments less familiar with science (e.g. consider the Victorian government's segment analysis in Inspiring Australia 2010:9).
- *Increasing mass-media communication and professional standards in science journalism:* Increasingly and more effectively using the mass and social media to raise community awareness of science issues and overcoming institutional barriers to the effective communication of science in the media (e.g. see Goldacre 2008).
- *From hard infrastructure for science communication to soft infrastructure approaches and grass roots engagement and brokerage:* Discussion about the comparative value of hard infrastructure for science communication versus grass roots or brokered approaches (e.g. see Petit et al. 2011) and increased professional development among the science educator and within science communication networks.

These wide ranging theoretical and practical issues can inform genuine reforms in science engagement in tropical Australia. One theme, however, does seem to cut across all others. In general, there is a shift towards the need for more engaged forms of science if we are to both improve broader community trust in the scientific community and increase the impact of scientific knowledge.

Big emerging directions in science in Australia's tropics and globally

From a broad review of documentation associated with strategic issues and directions facing tropical Australia, big content themes in current and emerging science include:

- *The transformation of Indigenous livelihoods:* Supporting traditional owners and Indigenous communities across the tropics to establish stronger economic livelihoods.
- *Climate change adaptation:* Recognising the particular vulnerabilities and risks for tropical Australia from climate change, including demographic risks and opportunities.
- *Securing sustainable agriculture and pastoralism:* Implementing the key ideas and recommendations emerging from the Northern Australia Taskforce Recommendations.
- *Growth in tropical medicine:* Dealing with new and emerging tropical health risks and turning our knowledge in this area into substantial export opportunities.
- *Indigenous science and traditional ecological knowledge:* Growing the nation's understanding of the economic importance of, and empowering Indigenous control over, knowledge held by the north's traditional owners.
- *Securing conservation values and arresting biodiversity loss:* Understanding and addressing Australia's next emerging major extinction event in tropical Australia.
- *Sustainable planning and design for urban environments in the tropics:* Understanding the significant growth in urbanisation and the importance of lifestyle factors unfolding in tropical Australia and ensuring these developments are both climate and energy friendly.
- *Increasing productivity in the resources and other industry sectors:* Recognising the science and innovation needs of the resources, energy, marine and other key primary industry sectors are crucial to continuous improvements in productivity and viability.
- *Innovation and entrepreneurship:* Bringing a stronger focus to innovation right across the tropical Australian landscape.
- *People, culture and society:* Ensuring the social sciences play a much stronger role in building the future of tropical Australia than they have in the development of southern Australia.

These themes have emerged from coordinated interactions between the Office of Northern Australia and the north's RDA Committees. Other key sources include the Northern Australian Land and Water Taskforce (2009), Garnett et al. (2008), Australia 21 (2009) and North Australia Economic Development Forum (2008). They have also

been consistently raised within the EWG and associated stakeholder survey responses.

Australia's tropics are significant on an international scale. The sum of the planet's tropical economies, the global tropical product, is projected to reach US\$40 trillion, 20 times Australia's projected GDP, by 2025. Of that \$40 trillion, between 25% and 30% will be spent on importing goods and services, and more again will be spent on developing new industries in the tropical world. With this in mind, several key international themes of significance to tropical Australia include:

- an increasing international focus on the need for engaged science to solve many unfolding social, economic and environmental problems across the globe's tropical regions
- the need for Australia, and tropical Australia in particular, to play an increasing, and scientifically informed role in building stronger governance and options for sustainable development across the tropics, but particularly in the Pacific and South East Asia
- an emerging and current international focus on the use and communication of science to give the international community an understanding on the state of the tropics. Northern universities such as James Cook University (JCU) and Charles Darwin University (CDU) are already positioning to play a lead role in this emerging agenda.

Considering different scales of science engagement in the tropics

Based on these above issues, the EWG identified at least seven broad, context-driven scales or themes of science communication and engagement that need to be addressed for tropical Australia. These are:

1. Building science literacy for all tropical Australians.
2. Shifting science engagement cultures at the project and publication level.
3. Building durable and trusted regional science brokerage and partnership arrangements.
4. Forging effective science engagement in the Indigenous domain.
5. Building science partnerships at industry/sectoral level to turbo-charge innovation.
6. Ensuring science messages from the tropics engage southern Australia.
7. Engaging tropical Australia in national science messages.

Considering these seven engagement themes (from individual to national scales) helps to contextualise science engagement issues and solutions across the tropics. Hence the following sections review the state of science engagement across these themes and outline the EWG's reform recommendations.

Theme One: Building science literacy for all tropical Australians

There are a wider range of national institutions aiming to communicate science to individuals across the nation and many of these have already been detailed by the *Developing an Evidence Base for Science Engagement Expert Working Group* (2011:7) in the *Inspiring Australia* context. Those noted include CSIRO, Questacon, the ABC and offices of the chief scientists (both national and state levels). These institutions are focused on high level science communication to the public, and generally do not have a specific or thematic focus on tropical Australia. There is considerable debate nationally about the value of large institutions of this kind in regard to their ability to deliver services beyond major metropolitan areas, and this debate is most relevant to both adults and children in tropical Australia.

Institutions focused on raising the professional development of, and resources available to, the science education community tend to have a high level of long-term influence on the ground in the tropics. Nationally, the Australian Science Teachers Association (ASTA), for example, provides a hub for all the State and Territory-based Science Teachers Associations (including WA, NT and Queensland). ASTA and its State and Territory affiliates are the key point of teacher-based professional development and promotion (e.g. National Science Week), but do not have a specific focus on science in the tropics, except as it applies within their affiliate associations (see www.asta.edu.au). It should also be noted that the Australasian Science Education Research Association Ltd's aim is to promote science education and science education research in all contexts and at all levels of education. The Association, however, does not have a specific tropical Australian focus (see www.asera.org.au).

One possible solution to better contextualising science engagement within the tropics could lie with decentralised Science Education Centres that provide an important in-situ hub or even mobile hubs for community-science education. One pre-eminent example in the tropics includes the Darwin CSIRO Science Education Centre. This centre is a partnership with the NT Department of Employment, Education and Training and CSIRO. Together with its sister centre in Townsville, the CSIRO Science Education Centres are home to programs for pre-school, primary school, middle years and senior years and they coordinate CSIRO's Double Helix Science Club, including holiday programs. They also conduct the 'Lab on Legs' program that takes science engagement to remote schools when funding allows. A series of forums for teachers and senior students by leading scientists in current topical fields of science have also been organised by the Darwin Centre (see www.csiro.au/org/psiz.html). In WA, programs such as these are organised from Perth, limiting the direct practical access that students in northern centres have. Science in the Tropics, run by JCU for Grade 11 and 12 students, is another attempt to address this issue (www.jcu.edu.au/fse/secondary/sitt/).

Mail-based outreach programs such as the CSIRO Double Helix Clubs, do have good reach into tropical Australia's more developed communities and remote and

Indigenous communities are also often well served by State based Distance Education facilities and School of the Air. They are, however, often limited in terms of their ability to provide other options for science education.

An example of better embedding practical science education with regional community knowledge and acceptance was emerging in Queensland's Wet Tropics via the K-12 Program from 2005 to 2007. The concept was focused on the practical integration of local community and scientific knowledge into the curriculum from Kindergarten to Grade 12, and integrating the baffling range of resource materials available to teachers within a professional development context. This program was seen as a very high priority by regional natural resource management stakeholders as they saw transformational change in science knowledge as being a critical strategic action in the tropics. The program only worked well, however, in a short window where strategic resources were allocated at the region scale.

The above examples outline just some of the tropical Australian initiatives aimed at improving science literacy among individuals, particularly at school level. A far more detailed account, however, can be found in a support paper developed for the EWG by a network of people associated with the WA, Qld and NT chapters of ASTA (Tropical Australian ASTA Network 2012). This paper can be secured by contacting the authors of this report.

The above suggests an inherent weakness continues due to the very low proportion of investment in capacity building and education in most government programs. The more government programs are centralised and fragmented, the more it is likely that the integration of strategic investment in building science literacy collapses. A more devolved approach to government decision making based on targeted investment in long-term strategic plans could build more stable investment foundations for building science literacy. Under centralised, grant-based programs, when projects to raise science literacy are invested in, they tend to be focused on carrying out single or isolated science awareness events or developing new education resources. This occurs despite the rich array of science based education resources already available. There is very little investment, however, in building more durable and integrated arrangements for building the professional capacity of the community of science educators and communicators and making existing resources more accessible.

Of even greater significance will be the emerging findings and recommendations of the Queensland government's recent strategic effort in relation to science, technology, engineering and mathematics education in Queensland. The Science, Technology, Engineering and Mathematics (STEM) education and skills program is specifically aimed at addressing the emerging major gap in demand for and supply of science skills and the need for a far greater science literacy in the general community. This approach has been repeated in Western Australia and the Northern Territory. This emerging work will no doubt have relevant recommendations that will resonate in tropical Australia, particularly in relation to teacher quality, resource quality and availability and school/community connectedness.

Recommendation 1

(Requires short-term to medium-term action)

Establish a strong community-based network for improved science engagement by appointing (at least three) regionally based facilitators to build and deliver the required cross-agency-industry network/s and to identify opportunities for collaboration in raising science literacy.

Key tasks would include:

- reviewing and refining currently fragmented investment in education-focused science engagement targeting tropical Australia
- refining locally relevant and meaningful curriculum resources based on tropical science which are culturally responsive and exemplify good teaching and learning practices
- convening face-to-face pan-tropical symposia to share ideas and resources and to build a community of interest to effect and sustain change
- developing a pan-tropical online resource clearing-house to capture and promote tropical science education aligned to the Australian Curriculum
- supporting the inclusion of cutting edge tropical science in pre-service and in-service teacher professional development
- supporting a systemic Indigenous junior ranger program across northern Australia
- advocating recognition for the scientists who actively promote and communicate their tropical research to the wider community
- brokering the inclusion of a school and community education component in as many tropical Australian research projects as possible
- continuing to explore and broker opportunities for co-funded education-based science engagement programs in northern Australia
- targeting and developing professional development approaches to raise the skills of teachers and other educators across the tropics
- building succession management strategies into our science education frameworks to minimise disruptions due to staff turnover.

This approach should be complemented by government support for the development of improved learning infrastructure to deliver science education across the remote north (e.g. the proposed Science Place facility in Townsville). Finally, increasing the number of scientists based and embedded within tropical Australia will also contribute significantly to building science literacy.

Theme Two: Cultural trends in project-based science delivery

Science projects of any kind, and at any particular scale, provide one of the greatest opportunities for low conflict engagement in that they can often gain common agreement between scientists and the community about the purpose of science. Effective knowledge sharing between stakeholders, practitioners and scientists can improve the quality of science, and it increases the rigour applied in the testing of different hypotheses. Finally, effective partnerships between stakeholders and scientists at the project level are the key to science adoption (Campbell and Schofield 2007).

Long-term developments in the co-research/action research literature have been espousing the benefits of an improved collaborative culture in the conduct of science at the project level. Despite this, the culture of strong collaboration remains restricted to a limited range of more applied sciences. While big advances have occurred over recent decades through institutions like Cooperative Research Centres (CRCs) and the Commonwealth Environmental Research Facility (CERF), poor project level collaboration between scientists and stakeholders remains the norm. Projects funded and managed remotely from the tropics also often struggle to have effective and durable arrangements for stakeholder engagement.

Different strengths and weaknesses in our science management system are driving or inhibiting cultural improvements in the way that projects are conducted in tropical Australia:

- There have been some advances in the devolution of science management to the regional or local scale with an increasing emphasis on strategic collaboration. The creation of such institutional arrangements within tropical Australia tend to drive stronger cultures for project engagement and a shared vision among the parties involved.
- There have also been significant advances in access to public good information. Ready access is critical to stakeholder uptake and information use, particularly for remote tropical regions where the stock of knowledge has traditionally been small and inaccessible.
- More centrally managed or decided funding programs are inevitably based in southern Australia, and while key investment criteria often espouse the need for effective project level engagement, the procurement pathway often results in conservatism and the adoption of less engaging approaches to research project management.
- An approach based on isolated projects, rather than projects embedded in more durable programmatic structures, often results in a focus on short-term activity and does not build the recurrent infrastructure needed for effective engagement.
- Classically trained scientists often do not emerge from undergraduate/postgraduate programs with sufficient skills to understand the

need for, and best practice in, community engagement, and particularly in those engagement styles required in tropical communities.

- Current rewards, promotion and incentive systems in research and science education institutions are not sufficiently valuing excellence in collaborative approaches to science and science impact. This keeps a strong focus on scientists trying to minimise the higher transaction costs of effective engagement in favour of publication excellence. This occurs despite the potential for effective project engagement to enhance science excellence.
- Direct competition over the limited science resources in tropical Australia can inhibit collaboration needed for capacity building and long-term learning across the sector.
- The culture within peer review processes in Australia could also benefit from increasingly involving stakeholders or cross-disciplinary reviewers. This could be achieved without sacrificing the technical integrity of the overall peer review process.

An increasing cultural focus on promoting co-researcher joint authorship in formal publication processes could assist in better framing research to ensure it builds capacity and ownership and provides a stronger focus on meaningful communication.

Recommendation 2

(Requires short-term to medium-term action)

State and federal promotions and rewards systems shift their focus to better recognise the importance of science engagement as a key academic endeavour – including the Australian government, CSIRO, Universities and State government research institutions.

Recommendation 3

(Requires short-term to medium-term action)

Research funders (local university, industry and not for profit organisations, the Australian Research Council (ARC), Research and Development Corporations (RDCs) and the like, alter their assessment frameworks and internal assessment capacities when they are making investments in tropical Australia to ensure projects have strong science engagement.

Recommendation 4

(Requires medium-term action)

Tertiary institutions include basic science engagement competencies in science-related qualifications, including attention to Indigenous engagement/other engagement in the tropics.

Recommendation 5

(Requires medium-term action)

Research funders increase investment in multidisciplinary research teams (e.g. inclusive of social sciences) to develop a more far reaching and engaging science culture.

Recommendation 6

(Requires short-term to medium-term action)

Research funders use specialist science or knowledge brokers as part of their project approval processes for major projects in tropical Australia.

Theme Three: Regional science brokerage—partnership arrangements

Tropical Australia faces significant challenges and it needs to be considered whether more regional scale scientific knowledge should be developed and delivered in a collaborative and adaptive management framework. This would underpin the increasing international and national trend towards the greater devolution of decision making to more community-based approaches at regional scales.

Over the last two decades or so, tropical Australia has seen an increasing focus on devolved and collaborative regional approaches to science prioritisation and management. These approaches have mainly played out in the natural resources and environmental management domains. They could, however, be equally applied in fields as diverse as regional health, social and economic development. Examples of devolved regional approaches in the natural resources field have included:

- CSIRO and Land and Water Australia driven initiatives in the Ord Bonaparte region of Western Australia and in Queensland's Central Highlands
- the Reef and Rainforest CRCs in eastern Australia, later morphing into the Reef and Rainforest Research Centre (RRRC) managing the Australian Government-funded Marine and Tropical Research Facility and the Tropical Ecosystems (NERP) Hub
- the Desert Knowledge CRC (replaced by the CRC for Remote Economic Participation) and the Tropical Savanna CRC (replaced by the Northern NERP Hub)
- Western Australian Marine Science Institution (WAMSI) focused on science to protect and sustainably develop Western Australia's marine environment
- university-based, geographically focused institutes like the Central Queensland University (CQU) Institute of Sustainable Regional Development, the CDU Northern Institute and more recently, JCU's Cairns Institute.

There are some considerable variations among these examples in terms of purpose, durability, disciplinary focus and the degree of control devolved regionally. Indeed, government commitment to devolved regionalism in science management has tended to wax and wane over time. There has, however, been surprisingly little evaluative work with respect to the success or otherwise of these more strategic and devolved approaches to science engagement at regional or landscape scales. Stakeholders in the tropics, and often the science community itself, demonstrably favour more devolved, strategic and collaborative frameworks for science management at scales that make sense to them.

Drawing on tropical experience and the literature, it appears success in devolved regional approaches to science management and engagement include:

- building regional capacity for the brokerage of collaborative science and management versus a multitude of science providers competing for very limited and fragmented investment sources
- stakeholders and science providers agreeing on the strategic science questions, project priorities and delivery and monitoring frameworks
- a regionally coordinated but strong culture for effective engagement at project scale
- an integrated and clear synthesis of emerging project-based science messages communicated very effectively to stakeholders and investor agencies
- a strong focus on spreading science investment across the social, economic and biophysical sciences both at strategic level and within science projects
- the establishment of durable science capacities within the region
- an increased capacity to export tropical knowledge across the north and internationally
- regionally based project brokerage and partnership building between science providers and stakeholders, delivering more cost effective project teams
- cooperative linkages among regionally devolved science management institutions
- more flexible and business-oriented administrative frameworks.

In progressing such frameworks, key institutional foundations that could be built upon include:

- CDU's Northern Hub program in respect to environmental research themes in the Top End (in strong collaboration with CDU's Northern Institute)
- partnering between James Cook University's (JCU) Cairns Institute and CDU's Northern Institute in relation to broader social and institutional research themes in the tropics
- partnering between JCU and the Queensland government in fisheries and aquaculture research (the QTAAS Alliance)
- the Reef and Rainforest Research Corporation in respect to environmental research themes in relation to Northern Queensland
- broader and integrated regionally based knowledge brokerage capability should be developed to provide a stronger evidence base for sustainable development in north-west WA.

Recommendation 7

(Requires short-term to medium-term action)

Stakeholders from tropical Australia need to be more involved from the outset in decision-making processes regarding the development of major science programs for tropical Australia.

Recommendation 8

(Requires medium-term action)

Recognise and/or establish regionally based science brokerage frameworks, wherever possible building on existing structures in order to secure a basis for durable and quality science brokerage and knowledge management across tropical Australia.

These frameworks:

- need to remain competitive but be continuously improved as preferred frameworks for stakeholders, research providers and governments agreeing strategic research priorities
- should play a role in devolved research program management to ensure effective stakeholder and science provider partnerships are maintained
- need to more effectively integrate the social and biophysical sciences in the determination and management of regional research priorities
- specifically craft the relationships required to build Indigenous science capacity
- have sufficient critical mass to enable the basic capacity required for the growth, development and active progression of strategic science priorities.

Theme Four: Forging stronger Indigenous engagement in the tropics

Tropical Australia is only just emerging from a long era where research was done on Indigenous Australians rather than *for* or *with* them. Indigenous forms of science and knowledge were largely discarded, or viewed as being relics worthy of research through the lens of western science. While change is coming fast, the fact remains that there is still a very poor interface between western science and scientists, Indigenous people and Indigenous science. In this regard, Indigenous knowledge relates to both the observational knowledge of long-resident peoples with an oral culture. Snively and Corsiglia (2001) explore aspects of multicultural science and pedagogy and describe a rich branch of Indigenous knowledge known to biologists and ecologists as traditional ecological knowledge (TEK). The cultural divide between these knowledge sets results in two big science engagement problems.

First remains the problem of how to position western science to inform, or be informed by, the nature-knowledge systems of Indigenous cultures (see Lewis and Aitkenhead 2001). Second, Indigenous knowledge is almost completely excluded from mainstream science education, leading to a limited understanding of the legitimate place of traditional owners in decision making in tropical Australia. Both western scientists and traditional owners, however, can now use a growing TEK literature that documents examples of time-proven, ecologically relevant and cost effective Indigenous knowledge.

What has tended to emerge as a result of this tension has been science partnerships being built from, and managed within, significant Indigenous institutions. Examples include the fire and biodiversity partnerships managed by Northern Australian Indigenous Land and Sea Management Alliance (NAILSMA) or turtle and dugong management partnerships managed by the Torres Strait Regional Authority. Several regional scale science management frameworks, however, have also steadily built strong Indigenous partnership frameworks (e.g. the CRC Tropical Savannas).

One possible key reform could be to support Indigenous institutions to partner with scientific institutions to jointly shape the most strategic science questions and to build the capacity. In this regard, real opportunities exist to build on the foundations established within the NAILSMA/CDU and the Torres Strait Regional Authority/RRRC-type alliances. These alliances need specific but limited resources to function, though they have the potential to attract and coordinate significant science investment.

While Indigenous engagement with science is one of the most significant engagement issues for the Tropical EWG, there is a sister EWG focused on Indigenous engagement. Emerging priorities and findings from this Working Group will also need to be assessed in relation to their specific relevance to the needs and priorities of Indigenous people and the science community in the tropics.

Recommendation 9

(Requires medium-term action)

Investors and stakeholders in the tropics apply the key recommendations of the Inspiring Australia Expert Working Group for Indigenous Engagement With Science, particularly those focused on greater recognition of Indigenous science and traditional knowledge in mainstream science programs and projects.

Recommendation 10

(Requires short-term to medium-term action)

Investors and stakeholders in the tropics invest specific capacity to expand the institutional foundations for Indigenous-led science partnerships in the tropics.

Recommendation 11

(Requires short-term to medium-term action)

Investors and stakeholders in the tropics ensure research program and project investment focused on Indigenous concerns in the tropics includes the resources required to enable strong Indigenous community-science partnerships.

Recommendation 12

(Requires medium-term action)

The ARC Discovery Indigenous scheme and other Indigenous science engagement programs are expanded to build the capacity of Indigenous scientists in tropical Australia.

Theme Five: Industry/sectoral engagement and innovation

Much research, development and innovation occurs within industry and other key sectors in the economy of the tropics. Important industries in the tropics at least include the resources, pastoral, tourism, marine, agriculture and construction industries. Key sectors include the economic development, health, social and cultural development and environmental management sectors. While scientific research helps to maintain productivity in these industries and sectors, support for moving from research-based knowledge into industry or sector-based innovation constitutes the critical communication pathway between science and the adoption of best practice.

This section looks briefly at how industry and other sectors coordinate science in the tropics and engage with tropical Australians in the process. Some of the key features of industry/sectoral science engagement in the tropics that need to be understood include the following:

- Much industry science is still funded through competitive grant rounds via rural research and development corporations (RDCs), the ARC and other national granting programs. Key RDCs of significance to the tropics include the Fisheries RDC, Meat and Livestock Australia (MLA) and the Rural Industries RDC. The closure of Land and Water Australia (LWA) has left a vacuum in public good and environmental aspects of land-based industries across Australia and the tropics in particular. It is important to note, however, that nearly all of these institutions are based in southern Australia. There can also be significant variability in the culture supporting effective science engagement within these institutions.
- Direct industry investment in research and innovation at the enterprise level, particularly within the tropics, is not strong and can be quite variable across industries and enterprises.
- There is a growing emphasis on celebrating and supporting innovation, but there is not a strong framework for doing that in the tropics. In Far North Queensland for example, growing cluster-based approaches to identifying and supporting industry change and innovation have shown promise, but have not been well supported through stable investment. Interestingly, Councils across the tropics are increasingly investing in recognising and celebrating innovation (e.g. the annual Cairns Regional Council Innovation Awards).
- There is a growing understanding within some industries in the tropics (e.g. the pastoral industry) that some of the big issues they face are social and cultural rather than bio-physical. RDC-based investments, however, are primarily focused on raising production or securing sustainability, but not strongly linking productivity issues back to profitability.
- There has been a significant reduction in and centralisation of government-based industry research in several sectors (particularly agriculture and pastoralism). This has been exacerbated by a two decade long shift from a government-based to a market-based extension framework across state and

territory governments. The implications reported by groups like the NT Cattlemen's Association include the demise of more action-research style approaches.

With such a range of industries and sectors in the tropics, it is perhaps best to look at what could happen in science/industry engagement through a case study. Effective science/government/end user engagement is perhaps well illustrated through the long history of co-research and management in the northern prawn fishery (see Beare et al. 2000 and Pownall 1994). In the case of the northern prawn fishery, State, Territory and Commonwealth governments have taken a more engaging approach. As a result, an industry that once faced collapse through over-exploitation is now in a stronger position since the notion of collaborative management of the fishery emerged. Further background in regard to this sector can also be found in the Inspiring Australia Marine Science Expert Working Group report.

This different approach meets the needs of governments, researchers and the northern fishing industry and communities. The difference between sustainable fisheries management compared to more conflict-ridden issues like tree clearing in pastoral lands, however, is that fisheries are a common property resource overseen by a single regulatory authority that maintains one comprehensive plan for the sustainable management of the fishery. The foundations for good engagement are enshrined in legislation. Structured committees include relevant scientific, environmental and economic representatives. Having fishing company managers and fishers on the management committees has given the industry an active role in research and monitoring.

These engagement arrangements have also been around for a long time, allowing long-term relationships and deep corporate knowledge to evolve. Both government and fishers have grown in their understanding of what is required in modern fisheries management. Much of the research undertaken in the industry depends on the investment from and voluntary participation of fishers. This has often included fishers attending training programs to learn how to identify by-catch species and how to collect high-quality scientific data. The value of industry participating in management is also demonstrated in the fishery's high rates of compliance with management changes.

The management processes and responsible attitude towards ecological issues in the fishery has helped develop an unusual culture amongst its fishers. Perhaps the most impressive feature of this fishery's progress in dealing with these issues has been its willingness to look for solutions and to actively fund programs that are breaking new ground. The northern prawn fisheries' record in dealing with difficult issues is noteworthy and the management processes that have been developed should smooth the way for its continuation and success in the future. The joint approach has helped produce excellent science that is relevant to industry and that is extensively referenced internationally. Another key feature of success has been that the partnership approach has produced clearly but jointly defined objectives for the fishery alongside clear strategic directions for research.

In contrast, the pastoral sector in northern Australia feels it had negative experiences with engagement regarding the science on vegetation management, largely as this research is often carried out within or for various government agencies. There has tended to be no durable collaborative research framework where governments, the industry, other sectors (e.g., the conservation sector) jointly determine the strategic research questions, share the learnings emerging from the science and jointly determine the monitoring and management responses. The end result has been the growth of significant industry distrust of the science and the environmental science community, and conflict between the pastoral sector with governments and the conservation sector (Productivity Commission 2003).

Drawing on what is happening in the tropics and these above examples, it would seem that some key emerging principles for effective science, industry and sectoral engagement include:

- the need for collaborative management frameworks between governments, industry and the science and wider community, creating the foundations for long-term adaptive management
- the need for stronger relationships and strategic program development and monitoring between R&D Corporations and industries/sectors
- the need for significant devolution of science for the tropics and into the tropics
- the need to invest more in social and institutional aspects of industry and innovation
- the need to build effective engagement, communication and extension foundations into research funding across all sectors.

Recommendation 13

(Requires short-term to medium-term action)

Investors and stakeholders (in particular governments and RDCs) continue to build more explicit and agreed Industry Research and Development (R&D) frameworks focused in tropical Australia, particularly building upon existing research frameworks (e.g. North Australia Beef Research Council, Australian Fisheries Management Authority (AFMA), etc) and developing new ones in emerging priorities (e.g. the agriculture, health and resources sectors).

Recommendation 14

(Requires short-term to medium-term action)

Tropically focused strategic research and development strategies and frameworks build strong, well-integrated social research and extension foundations, including clearer tropical Australian themes, within their research programs.

Theme Six: Tropical science messages to engage southern Australia

While it is important that the national science agenda is able to engage and influence decision-making processes in tropical Australia, it is perhaps even more important that the tropical science agenda emerging within northern Australia can influence the nation or secure national policy responses. Science engagement is as much about those of us that live in the tropics ensuring the rest of the nation hears, and can respond to, scientific evidence behind significant issues emerging *within* the tropics.

Many science messages that are currently emerging from within tropical Australia need to be translated into cohesive national or state/territory-wide policy or investment responses and in some cases require some form of behavioural change from all Australians or even those in the international community. Some big emerging themes of national, if not international significance, include:

- *Climate change:* Evidence is emerging of the possibilities for significant impacts emerging from climate change in tropical Australia. Rising sea levels may amplify inundation events in the Torres Strait, and Far North Queensland is increasingly coming to terms with the impacts that would emerge from predicted increases in the frequency of intense cyclones. Tropical Australia, however, is not a significant emitter of greenhouse gas emissions. This means our science from within the tropics implores cohesive national and international responses.
- *Food security and northern Australia:* Emerging science concerning sustainable use of water in northern Australia (i.e. Northern Australia Land and Water Taskforce 2009) has big implications for those that consider that the tropics might resolve water limits in the south. The recent Royal Society report (Royal Society 2009) into future food security also highlights why scientifically informed messages from within tropical Australia need a cohesive national response.
- *Tropical health risks and demographic change in tropical Australia:* Tropical Australia has some very specific public health and demographic change challenges distinct from temperate Australia. The emerging health sciences from within tropical Australia are best placed to manage these challenges in situ, but also present knowledge and export technology opportunities for the wider tropics (e.g. mosquito borne disease research). Other key current research areas of national and international importance include: the health impact of climate change, preventative health issues emerging across tropical Australia, Indigenous health, and finally biosecurity risks across tropical Australian borders.
- *An unfolding extinction event:* The biodiversity sciences in tropical Australia are showing the emerging risk of a slowly unfolding extinction event across the tropical landscape, perpetrated by a complex interconnected set of landscape scale pressures (fire regimes, changing climate, feral animals and pest weeds, grazing pressures, etc). Any chance of halting this decline will require the engagement of national policy, funding and science institutions. At this stage,

despite the existence of a high level of knowledge of the problems and potential solutions, cohesive engagement between stakeholders and the science community has not yet emerged in a way that is likely to lead to a cohesive national or state/territory action.

- *The increasingly important role of the social sciences:* The social sciences have frequently been marginalised in many decision-making domains dominated by the physical sciences, often with serious consequences for the efficacy of the choices being made and implemented (Dale et al. 2005). New and emerging work from within tropical Australia is challenging this, and could have both national and international implications in a world facing major future challenges.

There are some good examples where the tropical science community has joined forces with key stakeholders and jointly mapped out a cohesive national science message that has resulted in a truly influential national policy or community response. There are also, however, several examples where this is not yet happening effectively. As a result of poor engagement frameworks, science carried out within the tropics is not having the national level impact that it could and should be having.

One effective example of a strategic tropical science partnership that resulted in national action (including the investment of \$200 million for improvements in Reef Water Quality) can be found in the origins of the Australian Government's Reef Rescue Program. A national campaign (borne from a strong, stable science/stakeholder partnership) was focused on reducing agricultural runoff from the Great Barrier Reef along the east coast of tropical Australia. This campaign emerged from a very strong and coordinated set of grass roots science/community partnerships (delivered through the vehicle of locally managed Water Quality Improvement Plans). There was also a structured partnership between different tropical/sub-regions, industry sectoral bodies and the science community (both university-based and CSIRO). The leaders of the campaign established a clear structural relationship with both the Australian and Queensland governments via the Reef Water Quality Partnership Framework, an arrangement that reported direct to an Intergovernmental Working Group and focused on the core science messages. The campaign also built strong grass roots support for action at the farmer and community scale, jointly via regional natural resource management and industry bodies (Eberhard et al. 2009 and Robinson et al. 2010). The resultant Reef Rescue Program has now been operating effectively for four years and has delivered significant improvements in agricultural practice across the tropical east coast.

Some precedents are now emerging that suggest there is great value in the Australian, Territory and State governments supporting the emergence of big strategic science/stakeholder partnerships in the tropics where issues of national or even international significance are at stake. Such partnerships also need to eventually have defined multi-lateral pathways for Government engagement and response, and in many cases, the new North Australia Ministerial Forum might provide opportunities here.

Once emerging strategic issues are identified as being of pan-tropical or national significance, there would be value in Australian, State and Territory governments jointly responding to, investing in and supporting such emerging community/science partnerships from an early stage. In part, this could be done via scoping investment as required, but could also be achieved by establishing structured partnership arrangements for progressing science understanding and solutions for implementation.

There may also be a strong potential role here for Chief Scientist Offices to champion campaigns associated with strategic tropical Australian science agenda of national significance, in partnership with the required stakeholders and science providers from tropical Australia.

Building an integrated science framework across tropical Australia

The way strategic approaches to science are integrated and managed across tropical Australia also determines the capacity of the Australian tropics to develop genuinely pan-tropical science messages that are influential at the national scale and beyond. To achieve this, however, pan-tropical science engagement arrangements need to be in place. At present, such frameworks at least include:

- a recently approved Northern Collaborative Research Network focused on building the capacity of CDU and collaborative linkages across the tropics (e.g. JCU, CDU and Deakin University)
- CSIRO focusing its collective attention across northern Australia over recent years, particularly looking to integrate the efforts of several Divisions
- frameworks for cooperation between universities (e.g. Vice Chancellor's Forums etc).

At the pan-tropical level, there may not yet be clear frameworks for the integration of the science direction and effort of CSIRO and the university sector. Also, cross linkages between Western Australian science institutions and those in the Northern Territory and Queensland are not particularly strong. It should also be noted however, that while clear frameworks need to exist among science institutions within tropical Australia, these frameworks still need to have strong collaborative links into those southern Australian science institutions with strong track records and capacities in tropical Australia.

Finally, a stronger pan-tropical collaborative science framework could enable better engagement with tropical Australian communities (perhaps via a network of tropical Regional Development Australia (RDA) committees and governments (perhaps through a structured relationship with the North Australia Ministerial Forum). This sort of approach would also provide a strong basis for the brokerage of tropical knowledge into Australia's emerging approaches to the expansion of science diplomacy in the wider tropical region of the world.

Recommendation 15

(Requires medium-term action)

Research providers and science communicators in tropical Australia build a few collaborative, cohesive and engaging science communication campaigns that target high profile issues of real significance to tropical Australia.

Recommendation 16

(Requires medium-term action)

Investment be directed towards developing the capacity of research institutions in tropical Australia to build cohesive and long-term science-management partnerships. These partnerships would be with governments, universities and regions across the tropical world, but more specifically within the tropical Asia-Pacific region.

Recommendation 17

(Requires medium-term action)

Research providers in the tropics commence a multi-disciplinary Journal of Tropical Australia with a strong focus on well engaged science across the tropics and devoted to the sustainable social, economic and environmental development of the region.

Theme Seven: Engaging tropical Australia in high-level science messages

While it is important that science from within the tropics influences the national and international science and policy agenda, it is equally important that tropical Australians are effectively engaged to understand, and appropriately respond to, international and national science messages of importance to their long-term wellbeing. Key contemporary international and national themes of significance again include climate change, food and water security, energy and the health agenda.

There are some weaknesses in the overall communication of big, strategic scientific themes at national scale, leading to individuals and institutions being under-informed about the need for cohesive policy responses and/or the individual behavioural changes required. Overall limitations in science communication concerning international scientific consensus on climate change is often raised as an example of importance to tropical Australian communities. Additionally, good international science engagement frameworks around major initiatives like the Square Kilometre Array (SKA), while very successful in southern Australia (ANZSKA 2011), have had little penetration in the tropics.

A structured example of where a national science problem was better engaged in tropical Australia exists in the context of the Australian Government's Northern Australia Land and Water Taskforce. The Taskforce concept was originally established by the Australian Government to solve a southern Australian problem; the diminishing availability of water resources resulting from poor management of the south's most significant river systems. There was potential for the Taskforce to originally be focused on the needs of southern Australia, but strong stakeholder engagement by government in the early days of the Taskforce's operation resulted in more regionally engaged and scientifically informed messages emerging. Carriage of the implementation of the key recommendations emerging from the Taskforce report now resides with the Australian Government's Office of Northern Australia.

Improving this national engagement theme in tropical Australia could cover several important areas:

- *The communication and engagement capacities of major science institutions:* As the climate change example has suggested, major science institutions of relevance to tropical Australia (e.g. CSIRO, the Office of the Chief Scientist, etc), need enhanced resourcing and capacities to ensure a cohesive message is reaching tropical Australia on critical national science messages.
- *Better structured Government engagement with communities in the tropics:* Government policy making, informed by science, but imposed through poor engagement can damage the trust communities in the tropics have in science and scientists. Better science engagement needs to be structured within improved government engagement systems.

- *Increasing the science engagement capacity and literacy of tropical Australia:* Problems with the communication of national science messages are exacerbated in tropical Australia because of limited resources within many decision-making institutions and lower levels of science literacy.
- *Enhancing the access tropical Australians have to the digital economy:* The need to fast-track the roll out of the National Broadband Network and expansion of the digital economy in tropical Australia will assist with science engagement, particularly as well informed social media and internet networks continue to blossom across the tropics and in Indigenous communities.
- *Improving the quality and integrity of science journalism:* The media clearly has a significant role in better informing the wider community on key international and national science messages.
- *Enhancing the role of the Office of Chief Scientist at National, State and Territory levels:* At the national level, focused science engagement campaigns around select strategic science issues will require policy responses and behavioural change from across the community (e.g. climate change, managing pandemic risks, etc). Where such issues have a clear implication for tropical Australians, these campaigns could be purpose designed to address tropical Australian needs. It would seem the Office of the Chief Scientist nationally and in the states could be the ideal vehicle for resourcing and enabling such campaigns. These offices in turn, however, would themselves need to link to integrated science partnerships within tropical Australia.

The Northern Australian Taskforce experience provides an example of how the science required to address a southern Australian problem (declining water availability) could be played out in partnership with tropical Australians. Key features of this approach included the Australian Government having a defined Departmental management point, strong partnership links to the Office of Northern Australia, a structured stakeholder Taskforce, agreed scientific Terms of Reference and strong research leadership within a research institution like CSIRO. There were also clear intergovernmental mechanisms (via the North Australian Ministerial Forum) to take key emerging agenda forward. While broader community linkages into and beyond the Taskforce were required, aspects of the model are worth building upon.

Recommendation 18

(Requires medium-term action)

The National Office of the Chief Scientist and national research institutions like CSIRO develop more pronounced tropical Australian engagement strategies within science engagement campaigns of national importance.

Recommendation 19

(Requires short-term to medium-term action)

Australian, State and Territory governments invest in trial approaches to developing cohesive pan-tropical responses to nationally important science issues, especially those with big implications for tropical Australia (e.g. climate change, biodiversity loss, etc).

Recommendation 20

(Requires short-term to medium-term action)

Rapid and uniform roll out of satellite-based and urban NBN technologies currently planned to deliver significantly enhanced internet coverage across tropical Australia.

Cross cutting strategies for long-term transformational change

Using the seven themes outlined above in this report, the EWG concluded that there were three big cross cutting strategies needed to comprehensively lift science engagement across all themes across the tropics. These need long-term and tenacious effort to transform the nature of science engagement, and they need more substantive scoping, analysis and refinement in the future.

A pan-tropical narrative and alliance for science engagement

Tropical Australia is on the verge of unprecedented social, economic and environmental opportunities. It also faces some major challenges (e.g. rapid economic expansion in a multi-speed economy, climate change, community fragmentation and unfolding tropical health issues). Securing these opportunities and limiting the negative costs will require world-class research, development and innovation. Securing effective science engagement however, will be the key to us achieving a prosperous future. Because of the growing national importance of tropical Australia, the science engagement challenge includes:

- all Australians in the tropics owning the key science messages affecting their future prosperity
- science from tropical Australia being understood, and acted upon, by governments and the general population in non-tropical Australia
- empowered negotiation by tropical Australia with governments, industry and philanthropic sectors regarding the policy and investment settings for the science and engagement required to underpin the sustainable development of the tropics
- increasing the proportion of tropical Australians with graduate and postgraduate science, technology, engineering and mathematics (STEM) qualifications
- building infrastructure, planning and governance arrangements to support science engagement.

Making progress on all these fronts will require a strong pan-tropical alliance (or council) focused on ensuring firstly a common tropical agenda that can be adopted by tropical Australian stakeholders, brokering science engagement into and beyond the tropics, and ensuring science engagement is very strong within and across our tropical regions. Such an alliance would need the strong involvement of the national, state and territory Chief Scientists, but also critically would need to involve leadership from:

- key industry and community sectors (particularly Indigenous and resources sectors)
- the science education and communication sectors (and particularly the ABC and SBS)

- research and research brokerage institutions and RDA Boards.

The purpose of such an alliance would be to:

- gather the grass roots information, opinion, opportunities and issues
- develop, adopt and promote a clear narrative for the benefits of effective science engagement for tropical Australia
- work to build strong science engagement capacity within and across tropical Australia
- work closely with governments to shape key policy agendas on science engagement
- better inform the bigger emerging options for social, economic and environmental development in northern Australia, South East Asia and the Pacific.

Such an alliance would need to develop strong partnerships with major media institutions to be effective (e.g. ABC, SBS, the Australian Science Media Centre, etc). A pan-tropical science engagement alliance would also need strong outreach and links into our near northern neighbours (particularly Indonesia and other parts of SE Asia, PNG and South Pacific nations). Another key role would be to collectively strategise and negotiate advances in science engagement in the tropics, perhaps through formalised structures such as the current North Australian Ministerial Forum.

Strong science engagement frameworks across the tropics

Genuine development in the tropics requires the full integration of science with decision making at different scales and within key sectors. Over recent decades outstanding models that work have emerged (e.g. northern CRCs, RRRC, the science partnerships coordinated by NAILSMA, the North Australia Beef Research Committee, arrangements in the northern prawn fishery, etc). There is now general agreement across tropical Australia about engagement frameworks that work well and those that don't. Despite this, many major research investment programs of relevance to the tropics weaken these engagement frameworks. Apart from limiting research effectiveness, such programs do not empower the tropical Australian community to drive their own innovation and to export their expertise.

In Australia's tropics, achieving real social and economic outcomes requires the development and maintenance of clear integrative engagement frameworks in key sectors (e.g. the resources, fisheries, health and beef industries), at key sub-regional scales (e.g. north Qld, the NT and north-west WA) and between the science and Indigenous communities. Managed well, these engagement frameworks or partnerships can create the basis for sound community wide messaging on key scientific issues of importance to Australia's tropics. It is also from within these engagement frameworks that research turns into innovation, and innovation turns into real economic, social and environmental outcomes.

The delivery arrangements required by these frameworks are also often very similar, enabling some common or shared approaches across the tropics to emerge. Progressing such frameworks enables us to take science engagement from theory to practice, while not doing so is expensive in northern Australia. Knowing this, a wider range of reforms are required to build and maintain effective models of science engagement at the right scale/sectors that work within tropical Australia. There is, however, a double value arising from science engagement partnerships of this kind within the tropics. They:

- drive innovation within our key foundation industries, regions and sectors (e.g. resources, agriculture, tourism, health, Indigenous domains)
- add an entirely new layer to our economic foundations by creating the basis for brokering tropical knowledge into exportable services and technologies across the world's tropical regions.

The Australian, State and Territory governments need to work closely with the tropical Australian community to map out priority sectors and regions that require the development of strong and durable science engagement partnerships. From there, all governments will need to work closely with these sectors and communities to progressively re-shape these arrangements for the long term. Effective and shared investment is needed in infrastructure for engagement that facilitates science communication and brokering, information sharing, translation and use in different spheres of society, building community ownership and brokerage (connecting science to innovation).

In addition to this, as much of the potential for tropical knowledge export from northern Australia will require key linkages into our nation's aid-based relationships with developing countries, a stronger regional presence and alliance between AusAID and our nodes of well engaged tropical expertise are required. Reform will also require the development of funding models based on co-research principles.

Community-wide foundations in science capacity

Tropical Australia's future fundamentally relies on the capacity of all individuals and institutions to understand and respond to tropical scientific knowledge. Our future economic and social development in the tropics is dependent on dramatically improving the region's foundation or core science skills, particularly in Science, Technology, Engineering and Mathematics (STEM). These are the skills required for the resources boom, growing innovation in the agricultural, fishing and health sectors, the management of our nature-based tourism assets and our emerging tropical expertise economy.

Australia is not performing well on international benchmarking and the recent Trends in International Mathematics and Science Study (TIMSS) reports indicate the tropics lag well behind national figures. As such, concerns around science education in schools and STEM qualifications are more significant in the tropics. In particular, the tropics are struggling to keep and attract skilled workers. Many capable people who

grow up in the region move south to secure skills and employment and those who come from the south often move north on a transitory basis. Tropical Australia needs to develop strategies to resolve such shortfalls. Furthermore the region's growing income gap would be significantly addressed by raising these skill levels across all sectors of our community (including Indigenous communities).

If we raise the proportion of tropical Australians with advanced STEM qualifications and science capacities of students and civil society, we may increase the positive influence of science in the community. A community that values the sciences will retain scientists and attract new ones as well.

Given these factors, tropical Australia needs a creative science engagement agenda that will:

- keep a core focus on what works and doesn't work in raising STEM skills and in strengthening existing nodes of good practice in the tropics (e.g. the Curriculum to the Classroom Unit Plans in the National Curriculum and expansion of the programs like Science Spark)
- build science capacity across society in the tropics, particularly families, communities and businesses (e.g. strategic placement of scientists in business to turn innovation into practice)
- reform science investment models to increase science engagement at project scale
- continue to improve the quality of teaching and pre-service training in the science domain
- attract many more of our brightest students into careers in science and science teaching and develop strategies that help keep them in the tropics
- dramatically improve the interactions between pupils, communities and real world science (including better linkages to authentic student assessment). This provides a focus for the development of powerful local science narratives.

Australians in the tropics will need to secure these outcomes via investment and policy change focused on creating career pathways and export markets, using science to improve the quality of life in the tropics, building science capacity, encouraging STEM uptake and excellence, science showcasing and strengthening education providers. Equally, many reforms can be driven from within the tropics and achieved by better integrating existing education and science engagement programs and resources.

Conclusions

Tropical Australia is disadvantaged in the quality and impact of science engagement, weakening its ability to make genuine economic, social and environmental progress at the same rate as other parts of the nation. This directly impacts on the daily lives of all tropical Australians.

Following literature analysis, stakeholder input and discussion within the Expert Working Group, this report outlines seven key themes and associated short to medium term recommendations. We consider that implementation of these recommendations needs real attention if science engagement is to become stronger in tropical Australia. Three bigger, longer term, cross-cutting reforms also need long-term action to enable the tropics to fulfil its potential and confront the issues of the future.

Appendix 1: Overview of key survey issues

Sectors that responded

- RDAs
- non-government bodies
- museums and art galleries
- natural resource management bodies
- peak industry bodies (seafood/mining)
- statutory authorities
- no responses received from government agencies
- 25% survey response secured

Content analysis of key responses

Big science engagement opportunities	
New knowledge in ecosystem health and biodiversity	7
Increasing science literacy in the community	3
New innovations in sustainable agriculture	2
Major collaborative science approaches	2
Opportunities to understand the value of engagement	2
Carbon futures and climate change	2
Health and livelihood of Indigenous people	1
Wider understanding of the opportunities in the mining sector	1
New technology opportunities	1
Willingness of the media to engage	1
Bio-security opportunities	1
Potential for good baseline information	1

Big science engagement opportunities	
Traditional and science knowledge integration	1
Opportunities for knowledge export to the north	1

Barriers to effective science engagement	
Limits in capacity to engage (scientist and communities)	8
Lack of common language/poor communication of risk	6
Journalistic cultures	6
Short-term funding/competitive culture	6
Distances from research centres	5
Political cycles/processes/division within the community	4
Ad hockery in strategic science	3
Limited understanding/recognition of the opportunities	3
Institutional rewards systems	3
Data availability/poor knowledge management	2
Culture of rationalism in science	2
Poor regulatory frameworks	2
Lack of trust in scientists	2
Poor science literacy	1
Information overload	1

What's working well in science engagement	
Stakeholder driven governance systems/collaboration (two way science)	10

What's working well in science engagement	
Use of new technology	2
Traditional and science knowledge integration	2
Big picture policy drivers	1
Increased regional science capacity	1
Conferences, events, extension workshops	1
Peer-reviewed science	1
Increases in science literacy	1
Strong non-government organisations (NGOs)	1
Information dissemination in the biomedical sciences	1
Baseline information	1

Strategies for improvement	
Invest in science engagement capacity/wide public awareness	9
Empowerment of regions/long-term collaboration	7
Revise research rewards systems/career paths/science culture	4
Strategic approaches to science management	4
Building science literacy in schools/Science Ambassadors	3
Effective use of new technologies	3
Using big issues like climate change/focal species	2
Expanding co-research projects	2
A tropical Australian journal	1
Recognising traditional owner knowledge	1

Strategies for improvement	
Science engagement centres/science by doing	1
Improved access to maps and data	1
Integrate science and decision making	1
Export tropical knowledge	1
Use of high profile technology demos	1
Improve the regulatory frameworks	1
Build the case for science engagement in the tropics	1

Appendix 2: Survey tool

Name of survey respondent:
The organisation you represent:
Your position/title:
What do you consider to be the big science communication and engagement issues and opportunities facing Tropical Australia?
-
What are the barriers facing effective science communication and engagement in Australia's Tropics?
-
What is working well in science communication and engagement in Australia's Tropics?
-
What important strategies do you think Tropical Australians should pursue to tackle barriers and opportunities in science communication and engagement?
-
What strategies do you think the Commonwealth or other governments should pursue to tackle barriers and opportunities in science communication and engagement in the Tropics?
-
Are there other important stakeholders that you think we should be contacting or existing documents you think we should look at in supporting the Tropical Australian Working Group?
-
Other comments?
-

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