Submission Template

2016 National Research Infrastructure Roadmap Capability Issues Paper

Submission No: ***(to be completed by Departmental staff)***	
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Would you like your submission to remain confidential, i.e. not published on the website?	**NO**

NOTE: As one of it's Facilities, we have been involved in TERN's submission to this consultation process and support that submission. The purpose of this specific submission, is to **provide additional information and address the remote sensing and earth observation issues specifically raised in the Issues Paper**.

A 2009 study[1] commissioned by the presidents of ATSE and AAS, concludes that " *Earth observations from Space are the single most important and richest source of environmental information for Australia. They enable a wide range of essential services to be given to the community, with multi-billion dollar benefits to the nation as a whole*…". Long-term data records of such data are vitally important for evidence-driven policy development and decision-making. Australia's nearly 40 year-long satellite data records have become a highly valuable resource for research and decision making across all tiers of government. Investment into adequate archiving, curation and further use of such data should be integral to future national infrastructure that underpins research and official environmental monitoring and reporting.

Since 2010 TERN AusCover, the remote sensing and earth observation (EO) data analytics facility of the Terrestrial Ecosystem Research Network (TERN), has been contributing to the provision of some of these key information services, which underpin several government services and remote sensing and ecosystem science across Australia.

Specific Questions Addressed Here:

Question 2: Are these governance characteristics appropriate and are there other factors that should be considered for optimal governance for national research infrastructure.

These governance characteristics are appropriate. In particular, we have observed 'Collaboration and networking' to be a very important characteristic of the success of research infrastructure programs in Australia. For example, TERN AusCover is structured around a national network of

[1] https://www.science.org.au/files/userfiles/support/reports-and-plans/2015/earth-observations-from-space.pdf

collaborators in seven universities, four state/territory and three Commonwealth agencies, all which use earth observation data routinely and who each bring different expertise to the partnership. Through this network, we are able to more effectively share and use resources, problem-solve, implement standard national processes, and avoid duplication of effort in our work, to deliver high quality and relevant earth observation data products and services to the user community.

TERN AusCover has also been proactively supporting, and benefiting from investment and work from **across** NCRIS. In particular, close collaborations with the National Computation Infrastructure (NCI) programme, and other high-performance computing infrastructure systems across the country have significantly boosted our own ability to better manage and process the terabytes of satellite data that we need to routinely process into key information products, for delivery to our end-users in ecosystem science, NRM and key government programs. For example, projects such as the "Australian Geoscience DataCube (AGDC)", a collaboration between NCI, GA and CSIRO are world-leading, and are a great foundation for Australia's contribution to global earth observation programs.

Question 3: Should national research infrastructure investment assist with access to international facilities?

Yes. Particularly within the field of earth observation, the national research infrastructure can enhance or facilitate access to international infrastructure providing significant benefits to Australian research. For example TERN has had a role in facilitating Australia's access to European earth observation satellites, enabling more Australian researchers free access to international satellite infrastructure worth billions of dollars in foreign taxpayer investment. Reciprocal activities are key to these arrangements, meaning that Australia must maintain and invest into relevant and high quality infrastructure, expertise and networks to honour such international agreements.

Australia does not operate its own earth observation satellites, and is therefore dependent on international space agencies and associated science networks. Both free-, and commercial EO data support thousands of individual research projects and jobs across the country, and over a hundred state/federal routine mapping and environmental monitoring programs. A 2015 estimate of the growing economic value of EO data to Australia, concluded that it was at least $1Bn p.a., predicted to rise to $3Bn p.a. by 2025, providing over 16,000 jobs by then.[2] In addition to research and government programs that use such data, the commercial 'value–adding' sector also benefits greatly from the free and open access to such data, funded effectively by foreign tax-payers.

Question 12: Are there international or global models that represent best practice for national research infrastructure that could be considered?

In the earth observation domain, the most comprehensive model is that of the intergovernmental Group on Earth Observation (GEO) and it's planned Global Earth Observation System of Systems (GEOSS)[3], which comprises infrastructure and capacity from 102 national governments and 103 participating organisations. GEO was established to coordinate cost effective use of these

[2] http://www.crcsi.com.au/assets/Resources/CRCSI-The-Value-of-Earth-Observations-from-Space-to-Australia-Final-web.pdf
[3] https://www.earthobservations.org/index.php

technologies for societal benefits, research, capacity development and support of multiple international agreements.

Although several domestic discussion-, and coordination activities exist in this domain[4], no analogous program exists in Australia yet, which coordinates overall investment and EO projects for land-based, marine, and atmospheric observation activities in support of both government and research purposes. At present, such activities and infrastructure investment are fragmented across NCRIS facilities (IMOS, TERN) and specific government-funded observation programs for geosciences (GA), weather and climate (BoM) and research (e.g. CSIRO, GA, CRCSI), with frequent duplication in data and infrastructure management and delivery channels to the wider use-community.

A recent, very positive development in this direction, has been the creation of a multi-agency consortium [that includes TERN AusCover participation via CSIRO], around management of the "Regional Satellite Data Hub", being established in collaboration with the European Commission and the European Space Agency, for improved regional use and access to data from their "Copernicus" satellite fleet. This needs to be celebrated, but also used as a model for building a more comprehensive program that brings all other priority EO datasets from key international partners together into a well-managed and resourced national system.

Thus GEO and the Copernicus Regional Hub could provide good models of coordination for Australia, to better manage these separate activities, and for the research community and governments to leverage off and benefit most from these separate investments into EO infrastructure.

Environment and Natural Resource Management

Question 18: Are the identified emerging directions and research infrastructure capabilities for Environment and Natural Resource Management right? Are there any missing or additional needed?

- Emerging directions - Integration

This section highlights the role of 'big data' in driving creation of hypotheses and in enabling new and improved modelling and analysis for prediction of future scenarios. It refers to 'operational' satellite data from key national agencies, including the Bureau of Meteorology and Geoscience Australia. It is important to note that such data from national agencies is also critical to the research system. National research infrastructure is needed alongside these agencies to:

(1) enable improved public and free access to these datasets,
(2) maintain highest-possible, research quality of the data, and
(3) generate the value-added data products from these 'operational' data streams. It is these value-added data products that may be of greater use to the research community and industry than the base products themselves.

For example TERN AusCover has provided much better access and validation of nearly 40 years of earth observation data derived from US NOAA satellites, which was previously not widely accessible beyond government agencies collecting and using such data mainly for internal purposes. This data

[4] http://www.aeoccg.org.au/ and http://www.aeoccg.org.au/ageoswg/

now underpins several new research programs looking to better understand and model climate variability, droughts and extreme events on Australia's agriculture and natural ecosystem productivity. Analogous examples exist for other datasets previously used mainly for state-based environmental and land-cover assessments, which through TERN AusCover facilitation and funding now cover all states and territories.

The value of national research infrastructure is also in its ability to collect and distribute national environmental data that is not within the scope or capability of existing national operational agencies such as the Bureau or Geoscience Australia. For example, we know that researchers were able to increase the accuracy of the Community Atmosphere-Biosphere-Land Exchange Model (CABLE) based on new national datasets collected and made available by TERN.[5]

- Desirable new capabilities

Page 23 of the Issues Paper reads, "*Priority areas yet to be addressed include: access to international satellite based remote sensing data; the operationalization of the sites that provide the calibration and validation data that underpins remote sensing products; and skilled personnel to develop algorithms and tools to fully exploit the data for the global satellite community*."

We strongly endorse the need for these capabilities and improved coordination among analogous programmes [e.g. IMOS], as a priority component of the national research infrastructure, which builds on TERN AusCover's already established modest activities and EO-data services.

As noted in Question 3, TERN AusCover has contributed to negotiation and facilitation for access to international satellite based remote sensing data for the terrestrial ecosystem sciences.

TERN also undertakes extensive field data collection work, that provides the calibration and validation (cal/val) data needed to produce high quality and meaningful remote sensing data products for Australia and honour our international obligations. This is greatly appreciated by our international earth observation programme partners. This not only occurs through TERN AusCover's program of fieldwork, but also through other components of TERN such as the AusPlots and SuperSites programs, who have established new nationwide monitoring plots that deliver important ecological monitoring data and deliver data for cal/val of remote sensing products.

The strong focus on collaboration and networks within TERN AusCover has also enabled it to negotiate access to other datasets from state/territory agencies, industry, and researchers nationwide to further enhance calibration and validation of datasets. One example of this is the production of Australia's first "National Biomass Library", containing field data from a vast range of on-ground vegetation surveys by multiple organisations, that has underpinned the cal/val of new national map products for vegetation height and structure (summary at: http://www.tern.org.au/Newsletter-2016-Mar-AusCover-Biomass-pg31410.html, data available at: http://www.auscover.org.au/xwiki/bin/view/Product+pages/Biomass+Plot+Library and http://www.auscover.org.au/xwiki/bin/view/Product+pages/ICESat+Vegetation+Structure).

In addition, TERN AusCover and the wider Australian remote sensing community is recognised by international partners for its expertise and skilled personnel to develop algorithms and tools to

[5] Haverd et al. (2013) Multiple observation types reduce uncertainty in Australia's terrestrial carbon and water cycles. *Biogeosciences*, 10, 2011-2040. Doi: 10.5194/bg-10-2011-2013

exploit the data for the Australian and global satellite community. Part of the reasoning behind TERN AusCover's network structure was to ensure that it could tap into the extensive expertise in this field that resides in numerous universities and agencies across Australia. By creating its network as it has, TERN AusCover is able to capitalise upon this expertise for the benefit of the wider research community, including our international partners.

P24 "*Australia requires continuing access to satellite based and proximal remote sensing to enable automated large scale collection of environmental data. This includes in situ, airborne and satellite based observations; measurement platforms; and observatory and analytical infrastructure.*"

While ongoing efforts to maintain access for vital EO data for science and operational government programs are vitally important, we consider that a significant gap exists in terms of local science and technological capabilities into design and implementation of our own custom sensors and instruments for Australia's unique landscapes. One key area of new activity across universities and research agencies in the development of low-cost "cubeSATs", for research and testing of new technologies. It is unclear if this new technology is appropriate for use as national research infrastructure, but infrastructure investment could enable coordination of activities in this space to reduce duplication of effort and maximise collaboration and utility of such devices for wide-ranging uses (*cf* UAS coordination noted under Question 20). If coupled with work-force development into the area of 'ground to space' sensors, these activities could in-turn lead to enhanced space-industry technology development for Australia.

Question 19: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

As outlined above, there is some level of investment and coordination already into earth observation from space data use and research, as well as general coordination among government agencies. The specific collaborations are too numerous to list, but include activities with NASA, the ESA, JAXA, CEOS, GEOSS, GEO BON, UN, and others.
In the absence of a national space agency in Australia, a way to further enhance research as well as indigenous 'space industry' development may be to join another multi-national partnership such as the European Space Agency, as an associated member. The precedent exists with Canada who is an associated member of ESA, and has derived significant scientific and industrial benefits from such a partnership.

Question 20: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Environment and Natural Resource Management capability area?

The discussion in this area regularly mentions technology and sensor-networks as a key focus of future infrastructure investment. We approach this discussion with enthusiasm but also caution. We recognise the potential of such capabilities to deliver data and other services more efficiently than current operations, and also new possibilities that may arise as a result of technological innovation. Our work in supporting the testing of UAVs for environmental monitoring is an example of this (http://conf2016.uas4rs.org.au/).

However any new technology must be driven by a solid science-, and applications rationale, properly tested, verified, calibrated and validated before it can be deployed at a large scale as part of our research infrastructure. Appropriate operating procedures, minimum data standards, data

processing techniques and more, must be established before any new technology can be deemed 'operational' for the purposes of national research infrastructure, and to ensure that the resulting data and other products or services can be viewed with trust and confidence. In our experience so far, the best way to achieve this is to coordinate and facilitate collaborative processes that draw the relevant experts and practitioners together to solve the problems and establish the best operating procedures. This coordination role is a key contribution TERN makes as part of the existing national research infrastructure.

Other comments

In general, global examples show that the establishment of (modest) space infrastructure and industry development programs can have significant stimulatory effects on new government/private investment, and establishment of local high-technology industries and new types of local jobs (e.g. South Africa, Canada, Brazil, Argentina, Mexico, etc.). In Australia, such programs, when combined with relevant education and science policy drivers, could also stimulate new interest in the basic sciences and engineering careers as a side-benefit, and importantly, provide local graduates with local jobs.

When combined with TERN AusCover's extensive experience in remote sensing data application and efficient BigData processing and delivery, establishment of a coordinated national capability around earth observation for use in Australia could also enable creation of new SME's that can offer niche applications, data services and users in fields such as detection and tracking of river and coastal vegetation, water quality, sedimentation, biodiversity, biosecurity monitoring, crop-stress detection, mine-site reclamation monitoring, and more.