Submission
2016 National Research Infrastructure Roadmap
Capability Issues Paper

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This submission is prepared for the expert panel by the NCRIS Groundwater Infrastructure Project.

Question

Question 1: Are there other capability areas that should be considered?

Agriculture seems to be largely absent in the Issues Paper (mentioned in passing only twice?). With forecasted population growth and potential food shortages, improving agricultural efficiency and output is a potential growth industry for Australia. Large parts of the agricultural sector (with the exception of perhaps the Cotton Industry) are surprisingly data-poor compared to other industries and its management therefore not optimised. Access to water is perhaps the single most limiting factor to expansion of Australia's agricultural sector. Reducing the impact of agriculture on the volume and quality of water resources, especially nutrient release and the depletion of groundwater resources where they are used for irrigation is also critical in preserving those resources and protecting the natural environment. Development of distributed sensor networks coupled to remote sensing and easy data access will therefore enable research on fluxes of water, nutrients and chemicals (e.g. pesticides). This will provide internationally cutting edge research and improve agricultural output while minimising environmental impacts.

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

The governance provisions appear to be broadly appropriate and based on current best practice at many of the NCRIS platforms. Collaboration between the NCRIS platforms and a common approach to data management and storage should also be considered in the future program.

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

For individual researchers this is best achieved with a competitive merit-based grant scheme (e.g. ARC). Infrastructure funding should whenever possible focus investments in Australia to build capabilities, a skilled workforce and jobs. There is merit in this proposal for major international facilities such as those used in high-energy physics and astronomy. However, much of the infrastructure funded via NCRIS would not directly benefit Australia if it were not located here, and where there is no technical advantage in using overseas facilities.

Question 4: What are the conditions or scenarios where access to international facilities should be prioritised over developing national facilities?

This should occur when international research facilities are superior to what could reasonably be expected to be developed in Australia (funds and capabilities) and can only apply to facilities not reliant on being located on or around the Australian continent.

Question 5: Should research workforce skills be considered a research infrastructure issue?

Yes definitely, it is our experience that researchers who have a deep understanding of data as well as a research interest in the data being collected will have to be an integral part of the infrastructure capability (as opposed to being external users). Not only are skilled researchers best equipped to identify data quality issues with collected or processed data, but they also ensure on-going innovation and evolution of the infrastructure and data products. It is our experience that very capable and well-trained technicians have missed critical data quality issues, as they do not generally have the ability to interpret the data in their physical context. Technical staff are also less likely to drive innovation. This issue could of course be more or less prominent depending on the research area. Researchers employed at facilities could also be tasked with providing interpretations of metadata dissemination of results to make data more readily available and lower the intellectual costs for users. The training of skilled research staff should be considered a legitimate outcome of infrastructure programs as the value of that training will outlast the physical infrastructure and will be transferable across disciplines. A skilled workforce is critical to the future wellbeing of Australia.

Question 6: How can national research infrastructure assist in training and skills development?

Work tasks in relation to research infrastructure is often highly specialised and staff with right skills are rarely available. Provisions will therefore have to be made within programs for on-the-job training such as internships and apprenticeships. Also provisions for overlapping contracts for technical and research staff will ensure that skills and information is passed on. In our experience, untimely loss of technical staff before knowledge could be passed on has led to considerable setbacks.

Question 7: What responsibility should research institutions have in supporting the development of infrastructure ready researchers and technical specialists?

Integrating the research facilities into existing activities will readily achieve this. For example, encouraging the use of NCRIS facilities in PhD or postdoctoral fellowship programs has considerable mutual benefit for both the institution in terms of researchers accessing state-of-the-art infrastructure as well as ensuring that the use of the infrastructure is optimised. This is a practice commonly adopted for University facilities. This also helps addressing the training and skills development in Question 6.

Question 8: What principles should be applied for access to national research infrastructure, and are there situations when these should not apply?

In principle access to data should be free. Access to infrastructure should be free for researchers but perhaps there should be some fees applying to industry users. Also cost recovery for consumables in relation to user access to infrastructure could be considered, especially when these

cannot be anticipated in the annual budgeting. Cost recovery is a common practice and is an accepted part of research funding (e.g. in the competitive grant schemes).

Question 9: What should the criteria and funding arrangements for defunding or decommissioning look like?

The rationale and arrangements for defunding and decommissioning outlined in the roadmap seems appropriate. Where it is NCRIS infrastructure to be decommissioned (rather than a government-owned research facility), appropriate negotiations with the facility managers and the stakeholders aimed at maximising the legacy of the facility should be carried out. This might include transitioning of the infrastructure to one of the stakeholders or a staged winding down of operations.

Question 10: What financing models should the Government consider to support investment in national research infrastructure?

Question 11: When should capabilities be expected to address standard and accreditation requirements?

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

Question 13: In considering whole of life investment including decommissioning or defunding for national research infrastructure are there examples domestic or international that should be examined?

Question 14: Are there alternative financing options, including international models that the Government could consider to support investment in national research infrastructure?

Health and Medical Sciences

Question 15: Are the identified emerging directions and research infrastructure capabilities for Health and Medical Sciences right? Are there any missing or additional needed?

Question 16: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 17: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Health and Medical Sciences capability area?

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?

Groundwater is a critical resource for Australia, even more so in the future

Groundwater is an extremely important resource across many parts of Australia, especially where surface water is of limited supply or poor quality. It is widely used as the main source of drinking water for many cities, towns and indigenous communities. For example, groundwater in Western

Australia currently supplies about two-thirds of the state's entire water requirements, and is the major source of water used in Perth and many rural towns.

Groundwater is also an important water source in Australia for a wide range of other purposes, such as irrigation, agriculture and industrial use. In fact, irrigation accounts for just over half of all groundwater used by Australians. Many local councils and private households use bore water to maintain parks and gardens.

Groundwater from natural mineral springs is bottled and sold throughout the country, and is also used to make popular soft drinks and alcoholic beverages such as beer.

Groundwater is also used by natural ecosystems. In many parts of Australia, native fauna and flora rely solely on groundwater for their survival. Groundwater also contributes water directly to rivers and lakes as baseflow, often maintaining surface water bodies in times of drought. Because of this baseflow, there is a major indirect contribution of groundwater to water supply, culture, tourism, and ecosystem services that are provided by those rivers.

In the arid zone, groundwater sustains important natural and cultural values. Pastoral activities in many towns throughout Australia would not be viable without access to groundwater resources. Similarly, many large-scale mining projects and much of the petroleum production industry across the arid zone are wholly dependent on groundwater, much of it from non-renewable resources.

Economic value of groundwater

In 2013 Deloitte estimated that groundwater directly contributed $6.8bn/year to the Australian economy. In addition, the overall value added from groundwater to mining, food production and manufacturing was estimated to $34 billion/year (Deloitte for NCGRT, 2013).

Future groundwater trends and issues

Australia's use of groundwater has been on the rise, and this is projected to continue as surface water resources become less available in some regions due to climate change and prolonged droughts. However future use must be sustainable in light of a new suite of demands:

- Balancing surface and groundwater use in the Murray-Darling Basin
- Development of agriculture, especially in northern Australia where groundwater is dominant
- Treating impaired groundwater for economic use
- New coal seam gas and mining developments
- Maintaining Australia's unique aquatic biodiversity from underground stygofauna to groundwater dependent wetlands and mound springs
- Underground storage of water as an alternative to building dams
- Climate change, extreme events and climate variability.

Need for critical groundwater infrastructure

Australia's groundwater reserves are potentially vast but in many regions we still have little idea of the quality and sustainable use limits of this key resource. In more intensely developed regions of Australia we are still learning how to avoid or remediate contamination, understand the impacts of land use and land use change; how to link groundwater flows to ecosystem services; how to comprehend and protect biodiversity without undue impediments to development; how to manage groundwater in urban environments, and how to simultaneously manage surface and groundwater as one resource. The need to resolve planning uncertainties and groundwater conflicts across

multiple land uses such as energy, mining, urban, agriculture and environment is becoming more common. This has played out recently in Victoria where the State Government is moving to permanently legislate against unconventional gas development mainly due to concerns of the potential impacts to groundwater (http://www.premier.vic.gov.au/victoria-bans-fracking-to-protect-farmers/). It also potentially delays resolution on contested mining proposals. In the end lack of understanding translates to lost opportunities in relation to new jobs and economic growth in multiple sectors.

Since December 2009 the NCRIS Groundwater Infrastructure Project has successfully run a small, but dedicated groundwater and climate monitoring program at 7 sites across NSW, VIC, SA and NT, providing high-frequency time series of groundwater levels and climate variables for research, government, industry and public use. The first phase of the NCRIS groundwater program has been vital in: understanding how to set up a national groundwater infrastructure; developing important collaborations and enhancing the national skill base; learning to implement world leading technologies and evolve best practices; and efficiently accessing, interpreting and disseminating both groundwater data and scientific conclusions. Lessons for the future have also emerged – not only in infrastructure design and scaling, but also in building an evidence base of measuring impact in economic, social and environmental terms, over and above adding to the knowledge base.

It is very encouraging to see the need for groundwater research infrastructure convincingly argued throughout the Issues Paper. However, the future of the NCRIS groundwater infrastructure program will need to be both scaled up and wisely targeted to answer the emerging questions and future issues. The importance of high quality long term datasets cannot be over-emphasised - for example continuous groundwater data on a decadal timescale is necessary for the analysis of how inter-annual climate variability affects groundwater resources. The future sites would also be chosen to represent climatic regions (including those projected to be impacted by climate change) and relevant aquifer types (e.g. alluvial, limestone, coastal, etc.). The data collection would necessarily include data on quality as well as climate and surface water, where this constitutes an important resource within the regions, and data on key water-dependent environmental assets.

Worthy of consideration is the potential to coordinate with and build upon the existing OZFLUX network (which focusses on the energy, carbon and water exchange between the atmosphere and ecosystems), and with the TERN (Terrestrial Ecosystem Research Network) infrastructure. This could establish a multidisciplinary environmental observation and infrastructure network, and the value of the combined infrastructure network could exceed the sum of the individual components.

Currently, groundwater and surface water is collected by State and Territory agencies, through collaboration with the Bureau of Meteorology. However, the density of data that is collected is generally not sufficient for detailed understanding of the groundwater resources, their interaction with surface water resources and environmental assets. Current approaches to water resource management are therefore often simplistic, and not based on best scientific knowledge. There is a need to collect data at a much higher density at a select number of sites. This would enable improved understanding of water resources and the interaction with ecosystems, and would greatly increase the value of the broader (lower density) existing water resource network. For example, linking of groundwater and surface water observation networks is being piloted in the USA, and has already led to vastly improved understanding of the connections between these important water

resources (http://onlinelibrary.wiley.com/doi/10.1029/2012EO480002/epdf). Such an expansion would require coordination (including co-funding and in-kind support) with state water departments to avoid duplication and combine the effort. It seems logical that data storage and online dissemination is done by existing institutions already doing this type of work well, such as Bureau of Meteorology (BOM), which has a government mandate for standardising and disseminating groundwater data across Australia. Alternatively a new combined national database needs to be created for Australian environmental georeferenced data.

The Issues Paper correctly captures the need for cross-disciplinary approaches and integrated data. As much as feasible, field infrastructure dedicated for monitoring environmental parameters (e.g. climatic, hydrologic, environmental and ecological) should be co-located to allow for integration. This would be facilitated by an inter-facility working group. However, there may be situations where optimal monitoring locations for one discipline (e.g. atmospheric) does not coincide with the optimal location for another (e.g. groundwater where locations are dictated by aquifer conditions). Some flexibility should be allowed for these discipline specific needs.

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

There is a very strong case for this for instance in the marine and atmospheric disciplines. For the terrestrial disciplines, such as groundwater, the scope is more limited, due to the geographical restrictions to the continent. However, with climate change being a global challenge there is scope for the Australian research community to collaborate with existing catchment infrastructure programs overseas such as the highly instrumented catchments developed in USA and EU (e.g. TERENO in Germany: http://teodoor.icg.kfa-juelich.de/overview-en/welcome_to_tereno; the HOBE site in Denmark: http://www.hobecenter.dk/; and the Plynlimon site in the UK: http://www.ceh.ac.uk/our-science/monitoring-site/plynlimon-critical-zone-observatory). These sites and programs should also be closely studied in the planning phases for new Australian infrastructure to ensure best practice and facilities providing the best opportunity for cutting edge research and environmental and natural resource management.

There is also a moral argument to be made for Australia to support developing countries in the Asia-pacific with similar local monitoring programmes. This will have economic benefits for the Asia-pacific region and in the end Australia.

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 integration of disciplines within this sector needs to continue to be emphasised. Groundwater is an integral part of the natural environment, yet is poorly understood. The development of well-targeted groundwater monitoring infrastructure will have immense benefits to the other NCRIS initiatives in the Natural Resource Management capability area.

Advanced Physics, Chemistry, Mathematics and Materials

Question 21: Are the identified emerging directions and research infrastructure capabilities for Advanced Physics, Chemistry, Mathematics and Materials right? Are there any missing or additional needed?

Question 22: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 23: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Advanced Physics, Chemistry, Mathematics and Materials capability area?

Understanding Cultures and Communities

Question 24: Are the identified emerging directions and research infrastructure capabilities for Understanding Cultures and Communities right? Are there any missing or additional needed?

Question 25: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 26: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Understanding Cultures and Communities capability area?

National Security

Question 27: Are the identified emerging directions and research infrastructure capabilities for National Security right? Are there any missing or additional needed?

Question 28: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 29: Is there anything else that needs to be included or considered in the 2016 Roadmap for the National Security capability area?

Underpinning Research Infrastructure

Question 30: Are the identified emerging directions and research infrastructure capabilities for Underpinning Research Infrastructure right? Are there any missing or additional needed?

Question 31: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 32: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Underpinning Research Infrastructure capability area?

Data for Research and Discoverability

Question 33 Are the identified emerging directions and research infrastructure capabilities for Data for Research and Discoverability right? Are there any missing or additional needed?

Question 34: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

Question 35: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Data for Research and Discoverability capability area?

We believe it is desirable to be ambitious about big data, but considering the challenges of managing big databases the initial focus should be on data in related fields. I.e. Geographically distributed (e.g. data which is georeferenced) environmental data (e.g. biosphere, hydrosphere, mineralogical, etc.) should have agreed formats and reside in databases where they can easily be combined for analysis and discovery.

Other comments

If you believe that there are issues not addressed in this Issues Paper or the associated questions, please provide your comments under this heading noting the overall 20 page limit of submissions.