# DEVELOPMENT NCRIS TERRESTRIAL ECOSYSTEM RESEARCH NETWORK (TERN)

# REPORT OF WORKSHOP, MANTRA HOTEL CANBERRA 21-22 APRIL 2008

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## Contents

## 1. Workshop Purpose and Background

The purpose of the workshop was to resume the processes for the development of the Terrestrial Ecosystem Research Network following the cessation of previous processes in 2007 and the review of the strategy for TERN by the NCRIS Committee 28th February 2008. The workshop sought to engage the ecosystem community to address the following issues:

- What is TERN trying to achieve?
- NCRIS guidelines and investment planning including NCRIS committee decisions regarding TERN
- How the ecosystem research community needs to organize itself to carry the infrastructure investment forward for TERN and into the longer term?
- What infrastructure is appropriately supported nationally and the collaborative arrangements required to sustain it?
- What should guide the investment priorities?
- Who should make which initial detailed investment proposals?
- What structures need to be put in place to develop detailed staged investment proposals that can perhaps be started under TERN but need further investment going forward for any NCRIS II program?
- Timetable, processes required to get investment approval and the role of the Facilitator

In preparation for the work shop the following documents were distributed to the participants who are listed in Attachment A:

- Development and Investment Guidelines which include the NCRIS Committee's decision of the 28th February 2008 regarding TERN.
- Facilitator's Working Notes for Information of Participants
- Australian Ecosystem Observation Network Facilitation Report Volume1, 26th September 2007.

The operating premise for the workshop was that the facilitation process for TERN in 2007 had collected information that underpinned the basic science case for TERN and, that the broad requirements for infrastructure investment, and in some instances for its specific application, had been defined.

The background material and investment strategies relating to NCRIS that were presented to participants are given in Attachment B.

## 2. Planning Guidelines

The NCRIS Committee has laid out a Vision, Characteristics and Set of Principles for TERN – see Investment Guidelines distributed to Workshop invitees. Given these principles and the long term need, the Community should set its goal to plan a larger national capability than can be met by the funds currently available through NCRIS ($20M). The objective, therefore would be to use the NCRIS funds to initiate the first steps to the achievement of this longer term goal. Effectively there will be 3 years remaining of the NCRIS program from any decision to invest with the current NCRIS Program finishing June 2011. To achieve a 5 year planning period would require the

current NCRIS investment to be predominant in the first 3 years with a co-investment being predominant in the last 2 years. **However, it will be essential to obtain Commonwealth /State/Territory buy-in early in the development of an investment plan to ensure institutional commitment for at least the first 5 years and with the intention of commitment for the longer term.**

The NCRIS Committee has therefore decided that in the first instance investment should be directed to promote the collaborative behaviours through national strategic planning and lever the formation of long lasting consortia of researchers and institutions implementation of data management, access and synthesis and modeling capabilities as a service to the research community. **Sustaining and developing this system beyond 2011 will be dependent upon a longer term national commitment and will be a key requirement for any viable investment plan.** It is also dependent upon having a concept of the eventual structure of TERN.

The NCRIS Committee has agreed to a process of engagement to progress the development of investment proposals for the following three priority areas of governance, modeling capability, a data management system; *and then* to engage with regard to the development of site and observation networks.

The indicative planning time-frame for development is:

- This workshop April 21-22
- First cut of specific investment proposals June 16
- Draft investment plan Aug
- NCRIS Committee Decision Sept-Oct
- TERN Implementation from 1 Jan 2009

## 3. Defining TERN

### 3.1 The Science Framework

The drivers for infrastructure investment in terrestrial ecosystems are:

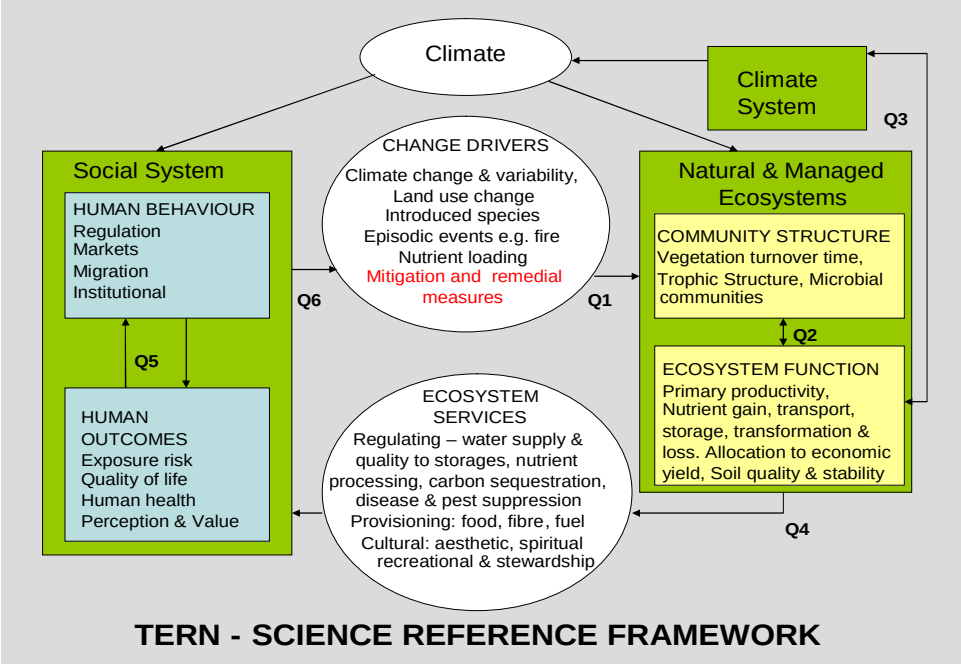
- The sensitivity of Australian natural and managed (including agricultural) ecosystems and the services they provide to the Australian population – the nation's environmental capital - due to long term pressures such as climate and land use change, introduced species and episodic events such as bush fires and storms.

- The need to understand the function and structure of ecosystems and to monitor and predict the impact of management and change including the interactions between key drivers of change such as climate change, land-use and habitat change.

- The need to use predictions to devise remedial measures to mitigate change and support development of sustainable practices.

- Terrestrial ecosystems play significant role in carbon sequestration and in green house gas emissions and the observations of terrestrial ecosystems are critical to reducing uncertainty in future climate change, scenario, in monitoring and predicting change and in adapting to impacts.

These drivers can be translated into the accompanying high level science reference framework which allows generic science questions to be posed ( see below [*]) It is the combination of the national and regional expression of this science framework which drives and the priorities for infrastructure investment and the organization of the science community to operate and derive benefit from this infrastructure.




Q1 How does natural and human induced change, both short and long- terms interact to alter ecosystem structure and function including remedial and mitigation measures?

Q2 How does biotic structure vary and be both a cause and consequence of ecological fluxes and energy?

Q3 What is the outcome for the net terrestrial $CO_2$ sink of the competing effects of $CO_2$ fertilisation, declining water availability, global warming, changing nutrient dynamics and disturbance by impacts?

Q4 How do altered community structure and ecosystem dynamics affect ecosystem services

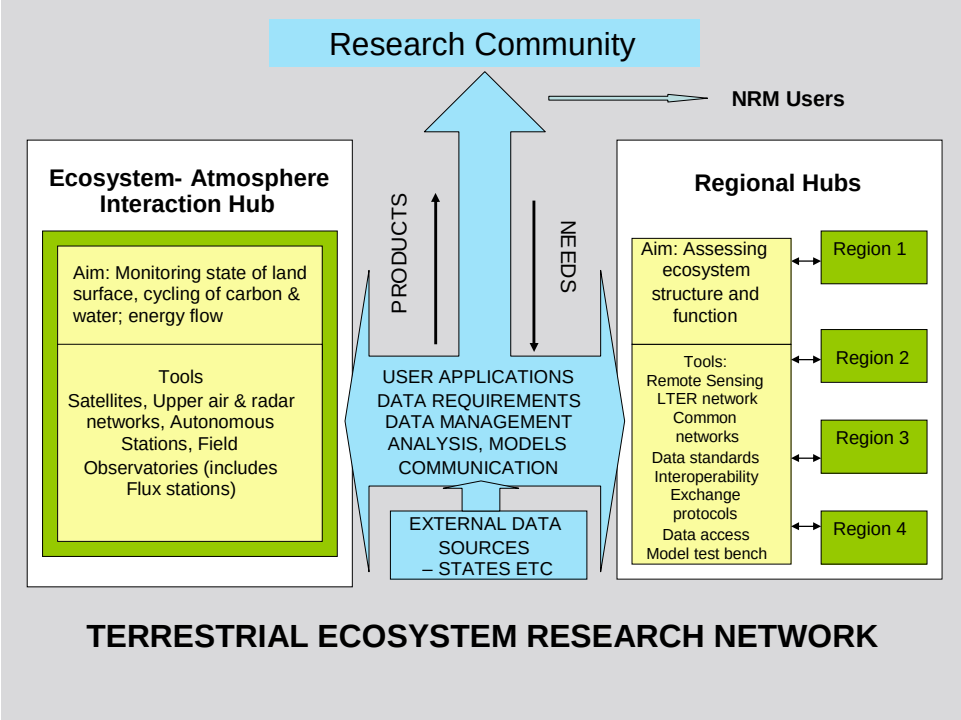
Q5 How can decision support systems modeling complex processes lead to mitigation and/or remedial measures based on human behaviour?

Q6 Which human actions influence the frequency, magnitude or form disturbance regimes across ecosystems and conversely which human actions are required to mitigate or remediate degradation.

[*] Adapted from The Decadal Plan for LTER - Integrative Science for Society and the Environment: A Plan for research, Education and Cyberinfrastructure in the US Long Term Ecological Research Network. www.lternet.edu/decadalplan/

### 3.2 Conceptual Framework

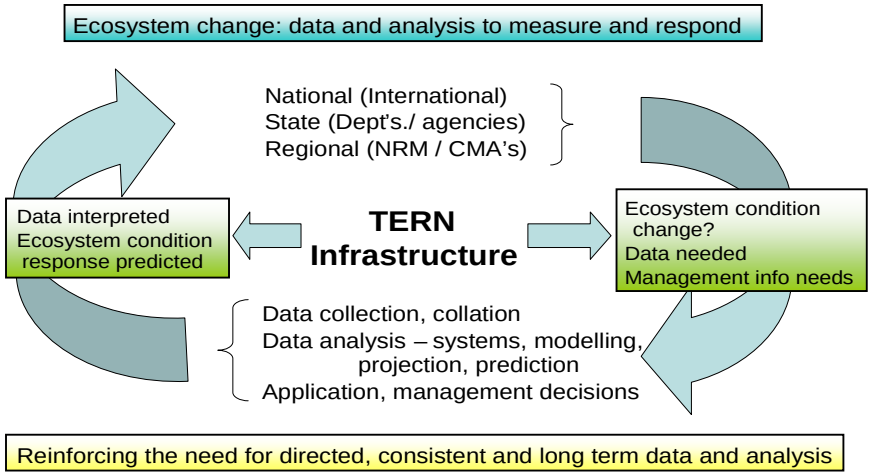
TERN is essentially a distributed set of equipment and data and information services (as illustrated below) which collectively contribute to meeting the needs of ecosystems research and other uses in Australia for terrestrial ecosystem data. The value of the investment lies in the coordinated deployment of equipment and the collection of critical data sets to address particular scientific questions of national/and or region importance. These in turn become the infrastructure for a wide range of research and applications at a variety of scales. This is represented below where the infrastructure investment represented by 'Tools' can be seen as national networks of equipment and services working to common protocols meeting the needs of particular scientific agendas linked to communities of researchers represented by Hubs and the research community and other users generally. In this way it is consistent with the principles laid down for NCRIS (National Collaborative Research Infrastructure System).




This approach to infrastructure is new to the ecosystem research community and is based on the 'ocean observing model' adopted for the NCRIS Integrated Marine Observing System. This approach to terrestrial infrastructure and its observations is less well defined than in the marine domain, principally because of the complexities of the terrestrial environment and the diverse research community and stakeholders. A crucial part of this approach is to identify those observations or tools that represent common needs and that are not, to first order, shaped by local and/or regional considerations – in this is case remote sensing and flux towers are prime examples. Then there are regional (and/or sector specific) infrastructure whose character are shaped by regional/specific requirements and needs. **The national hubs and regional hubs are interoperable and, to the extent possible, share infrastructure and cooperate in site selection to maximise available synergies.**

In this framework hubs represent the client base for the TERN infrastructure. They comprise national and regional groupings of researchers and institutions who collaborate in the establishment of the scientific rationale and are uses of the data outputs and have agreed in the investment and deployment priorities.

The hubs have largely a regional focus because of the responsibility of the States for land management. The modern management challenge is to take actions that enhance environmental capital – managing for the long term benefit derived from ecosystem services (see diagram below). This framework above underpins the vision that TERN investment is trying to achieve through a higher level of integrative research. **However, the science that informs management at a regional level is where most impact will be felt**. It is crucial therefore to engage State agencies with the regional hubs in order to obtain maximum synergy with extant programs and integrate the benefits that can be derived from state data sets and resources.




Courtesy W. Mayer

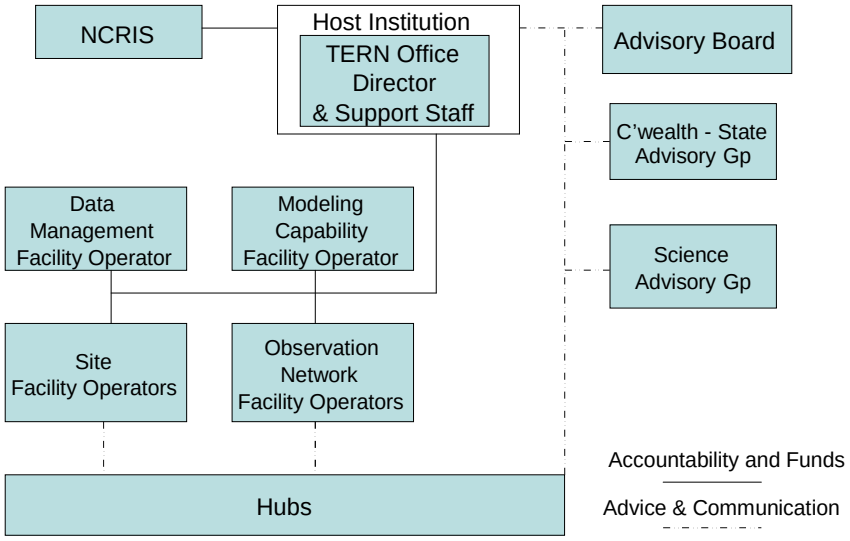
### 3.3 Governance Framework

The Governance Framework for TERN is essentially a partnership between particular institutions for the delivery of ecosystem observing infrastructure and services on behalf of the ecosystem community with each institution agreeing to a particular role (see following figure – Indicative Structure).

Nationally the program is managed and coordinated by the *TERN Office* established and operated by the *Host Institution* which contracts with the Department of Innovation, Industry Science and Research (DIISR) for the implementation of TERN. In turn, the Lead Institution through the TERN Office will enter into a TERN Funding Agreement with particular institutions (legal entities) termed Facility Operators who under the terms and conditions of the DIISR contract and the Investment Plan will operate the equipment or service (Facility) on behalf or the community.

The TERN Office operates with the advice and agreement of an *Advisory Board* which has an Independent Chair appointed by the Lead Institution in consultation with the Facility Operators and Members who are appointed for their skills and experience (relevant to their role) by the ecosystem research community operating through the hubs.

**Indicative Structure**




An alternate model to the 'host institution' is to form a company limited by guarantee comprising the member institutions which have a role in TERN. In which case, the Company contracts with DIISR and there is an Executive Officer and Corporate Board with all the associated responsibilities. The Board would be appointed by the company members under the terms of the Constitution of the Company.

The equipment or services being delivered by Operators meet the data acquisition requirements of the Hubs that form part of the national TERN system

### 3.4 Investment Elements

The major investment elements agreed by the NCRIS Committee at its February 28th meeting are

- the 'national coordination mechanisms' represented by the TERN Office and the accompanying advisory structures to ensure a strong long term planning capability in TERN.
- the 'national data, synthesis and modeling facilities' needs to address the critical issues related to data, access and interoperability, integration, systems analysis and decision support
- the sites and observation network facilities.
  - as a prerequisite to planning the 'site and observation' networks it is necessary to identify the potential hubs and their science driver to identify national and regional priorities for infrastructure.

Within the funds available there will be limited capacity to develop the site and observation networks. The initial TERN investments are proposed to be a means whereby the ecosystem research community can plan and develop the priorities investment plans and infrastructure to meet the national requirements of ecosystem research and terrestrial observation on an ongoing basis.

Sites will be identified by the hubs and equipment will be deployed to make observations for defined periods of time or more or less permanently. A characteristic feature is that priority for equipment deployment will be for the purposes of ecosystem and terrestrial observing at designated sites that have been defined of national and regional significance in meeting the broad scientific objectives identified for TERN. In keeping with NCRIS objectives, the data obtained will be made readily available to the ecosystem research community. Access to the modeling and data management services will be at low cost.

## 4. Key Characteristics of TERN Organisational Elements

The following characteristics of investment areas are a guide for consideration of investments and could include other characteristics as yet undefined. They are based on workshop discussions and other inputs to the TERN process to date.

### 4.1 TERN Office

*Role:* The Role of the TERN Office is to provide strategic coordination and management of TERN under the terms of the contract to the Department of Innovation, Industry, Science and Research and as defined in the final investment plan.

*Characteristics:*

- Strategic perspective on national infrastructure requirements to support ecosystem research and the operational requirements of such infrastructure.
- Scientific standing in the ecosystem community and capability to engage and receive advice across a diverse set of disciplines in advisory structures, universities, government research agencies and government departments at Commonwealth and State level.
- Strong communication capability to promote and communicate the role of TERN to decision makers, the scientific community, natural resource managers and agencies and the public.
- Perspective on the relative roles at national and regional level and capacity to strategically plan and coordinate the work of TERN in this context
- Strong capability in project management, financial management and ability to liase with Operators on financial an operational matters in a devolved environment.

*What will make it work*

- Collective planning by the TERN Office involving all hubs and operators
- Strong outreach and communication with Hub stakeholders.

### 4.2 Hubs

Role: Represent the regional and national interests of the scientific and NRM community in establishing the scientific case and priorities for infrastructure investment and provide the reference point for longer term planning.

*Characteristics:*

- Groupings of researchers and institutions which collaborate or have common interest in research questions in a particular region and/or research questions relating to a particular national theme.
- Members are the primary users of data and the services provided by TERN.
- A formal mechanism for synthesizing their views and a nominated representative and deputy for interacting with the TERN Office.
- Strong links to government agencies and/or natural resource management bodies where appropriate.
- Agreed to work under the TERN *modus operandi.*
- Leveraging TERN investment by linking to other major national or regional programs.
- Includes at least one 'Operator' responsible for operation of TERN equipment or service under a funding agreement with the TERN Office

*What will make it work*

- An agency or individual with employer's support prepared to undertake the necessary coordination.
- Open and free communication through periodic workshops involving the TERN Office.
- Annual collective planning by the TERN Office involving all hubs and operators
- Strong outreach and communication with Hub stakeholders.

Attachment C gives some perspectives of those at the workshop on the scientific rationale and characteristics for potential hubs

### 4.3 Facility Operators

Role: Own and operate designated equipment in trust for the purposes of TERN or provide services under TERN – this equipment or service constitutes a Facility.

*Characteristics:*
An operator:

- will be a legal entity able to enter a funding agreement with the Host Institution through the TERN Office for the operation of the Facility
- may be responsible for a set of equipment in a particular hub
- may be responsible for equipment that would be deployed nation - wide
- may provide a service that is allocable to all hubs
- will generally be a member of a hub and will have the competence to operate and maintain and/or provide the service as agreed.

### 4.3.1 Ecological Analysis and Synthesis Facility

*Role:* To provide a virtual and physical environment for inter-disciplinary integration, synthesis and modeling as national service to the ecosystem research community and natural resource managers

*Characteristics:*

- Provide an informatics canvas able to ingest, link and analyse data sets, interact with models at a range of scales and undertake gap analysis in data sets to establish collection priorities in strategic data sets.
- Provide access to fit for purpose models and decision-making tools with a predictive capability including options for cost benefit analysis.
- Strong metadata capacity and structures to facilitate data access for distributed datasets (function of database capability area?)
- Professional capability to operate maintain systems and code new developments as required
- Provide an environment for development of intellectual capacity in synthesis and facilitate conversation and learning amongst the ecosystem and natural resource managers
- Provide a national and regional focus for integrative outputs and provision of outputs with policy focus in areas such as biodiversity decline; sustainable use of natural resources and response to climate change

*What will make it work?*

- Establish a community of interest but being open and flexible as to *modus operandi*
- Analysis systems must be fit for purpose
- Systems view of the world –working across disciplines

- Capable of data mining and determining key attributes for analysis in response to questions

- Close relationship with Data Management Capability

- Capability to project capability and opportunities across hubs

- Single place allowing interaction with distributed data centres

- Steering Committee to have broad expertise to assess proposals and report on outputs under IP arrangements

**4.3.2 Data Management System Facility**

Role: Through a distributed model, provide a single framework for data and information management and discovery for ecosystem data generated by TERN infrastructure. Broker access and incorporate into the system data sets from external sources (eg State agencies) to facilitate development of a "one stop shop" for ecosystem data.

*Characteristics:*

- Provide an entry point for access to core national ecosystem data sets based on the NCRIS Australian National Data System (ANDS).

- Provide national coordination and foster a data sharing culture through a central desk.

- Identify core ecosystem data sets and develop metadata standards, protocols and systems to facilitate discovery, quality assurance, access and interoperability.

- Develop capacity to receive real – time data and mange quality assurance issues.

- Manage IP issues – protect individual/institution IP rights through appropriate protocols – e.g. DEWHA protocol regarding relinquishment and ownership of data.

- Undertake negotiations with State agencies and national data coordinators to provide data to facilitate a 'one stop shop' for access/use of data.

*What will make it work?*

- Create a community of users across the hubs and other interested parties recognizing current efforts in data coordination.

- Interact with ANDS:
  - to access service, expertise and support to facilitate the development of the necessary systems
  - to sustain the community to build a federated solution to research data management and to obtain the necessary community agreements

- to access the registry and discovery services and other national operational services on which data federation depends.

- Undertake the necessary data mapping
  - Who has the data and are custodians? Where does the data reside and is it 'point of truth'? What standards have been implemented and where? Does the community use consistent metadata standards? What international standards are they based on? What are the conditions of use? Who is allowed to view and use the data? What legal protocols, policies, standards process and guidelines exist to govern the use and management of the data? What mechanisms are in place to discover, share and access data? What long term strategies for the management of the data exist, if any?

- Within TERN, build on other investments and particularly link with synthesis and modeling capability

- Establish data person presence within TERN hubs as part of the data management system.

- Remote sensing needs to be treated separately given specialist nature, role of derived products and size or resource.

**Attachment A: TERN workshop participants 21-22 April 2008**

| | |
|---|---|
| Professor Mark ADAMS *(day 1)* | School of Biological, Earth and Environmental Science, UNSW |
| Ms Jesusa AGUILAR | Assistant Manager, NCRIS |
| Dr Stefan ARNDT | School of Forestry and Ecosystem Science, University of Melbourne |
| A/Professor Jason BERINGER | School of Geographical and Environmental Science, Monash University |
| Dr Neil BURROWS | Science Division, WA Department of Environment and Conservation |
| Dr Josep CANADELL (Pep) | Global Carbon Project, CSIRO Marine & Atmospheric Research |
| Dr Tim CLANCY | Bureau of Rural Sciences, Department of Agriculture, Forestrey and Fisheries |
| Professor Peter DAVIES | Centre of Excellence in Natural Resource Management, UWA |
| Dr Ben GAWNE | Murray Darling Freshwater Research Centre, Albury |
| Dr Roger GIFFORD | Chair National Committee for Earth Systems Science, Australian Academy of Sciences |
| Professor Peter GRACE | Director, Institute for Sustainable Resources Queensland University of Technology, Rivers Institute Griffiths University |
| Dr Alex HELD | CSIRO Marine and Atmospheric Research |
| Ms Pia HERBERT | Senior Policy Officer, Networks Policy, Multimedia Victoria |
| Ms Kylie HEY | Natural Resource Sciences, Qld Natural Resources |
| Mr Adam HOOD | Department of Sustainability and Environment, Victoria |
| Dr Lindsay HUTLEY | School of Science & Primary Industry, Faculty of Education, Health & Science, Charles Darwin University |
| Professor Simon JONES (day 2 only) | Geospatial Science, RMIT |
| Dr Ray LEUNING | CSIRO Marine and Atmospheric Research |
| Dr Michael LIDDELL | School of Pharmacy and Molecular Sciences, James Cook University |
| Professor David LINDENMAYER *(day 2)* | Fenner School of the Environment, ANU |
| Professor Andrew LOWE *(day 2)* | State Herbarium of South Australia & Biological Survey & Monitoring , Science & Conservation Directorate, Department for Environment & Heritage |
| Professor Mervyn LYNCH | Remote Sensing Centre, Curtin University of Technology |

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|---|---|
| Dr Joshua MADIN | Department of Biological Sciences, Macquarie University |
| Dr Gerry MAYNES | Natural Resource Management – Data Tech Biodiversity Services, Department of Agriculture, Fisheries and Forestry |
| Dr Neil MCKENZIE | CSIRO Land and Water |
| Professor Wayne MEYER | Natural Resources Centre, University of Adelaide |
| Professor Kerrie MENGERSEN *(day 1 and day 2 AM only)* | Research Professor, School of Mathematical Sciences, Queensland University of Technology |
| Dr Patrick MOSS | School of Geography, Planning and Architecture, University of Queensland *(on behalf of Prof Stuart Phinn/Prof Hugh Possingham)* |
| Dr John NELDNER *(day 1 and day 2 AM only)* | Environmental Protection Agency, Queensland |
| Professor Tony NORTON | School of Agricultural Science, University of Tasmania |
| Professor Andrew PARFITT | Pro-Vice Chancellor IT, University of South Australia |
| Professor Richard PEARSON | School of Marine and Tropical Biology, James Cook University |
| Dr Trevor POWELL | NCRIS TERN Facilitator |
| Mr Nadeem SAMNAKAY *(day 1)* | Knowledge and Adoption Officer – Landscapes, Land & Water Australia |
| Ms Alex SAWICKI | Department of Primary Industries, Victoria |
| Dr Richard SILBERSTEIN | CSIRO Land and Water |
| Mr Anthony SWIREPIK | Assistant Director, Adaptation and Science Branch, Department of Climate Change |
| Dr Sally TROY *(day 1)* | A/g Assistant Secretary, Environment Research and Information Branch, Department of Environment, Water Heritage and the Arts |
| Professor Mark WESTOBY | Department of Biological Sciences, Macquarie University |
| Dr Chris WESTON | School of Forest and Ecosystem Science, University of Melbourne |
| Mr David WILSON | Manager, NCRIS |
| Dr Ted WOLFE | Emeritus Professor and Member, E H Graham Centre for Agricultural Innovation, Charles Sturt University |

**Apologies**

Professor Stuart BUNN, Australian Rivers Institute, Griffith University

Dr Helen CLEUGH, CSIRO Marine & Atmospheric Research

Dr Mike GRACE, Chemistry, Monash University

Dr Pauline GRIERSON, FNAS School of Plant Biology, UWA

Professor Sam LAKE, Biological Sciences, Monash University

Professor Deirdre LEMERLE, E H Graham Centre for Agricultural Innovation, Charles Sturt University

Dr Brendan MACKEY, Fenner Schol of Environment, ANU

Dr Craig MACFARLANE, CSIRO Forest Biosciences

Professor Ralph MACNALLY, Australian Centre for Biodiversity, Monash

Ms Jo MUMMERY, Department of Climate Change

Professor Stuart PHINN, School of Geography, Planning and Architecture, UQ

Professor Hugh POSSINGHAM, Ecology Centre, UQ

Dr Michael RAUPACH, CSIRO Marine & Atmospheric Research

Dr Susanne SCHMIDT, Faculty of Biological & Chemical Sciences, UQ

Professor Will STEFFEN, Fenner School of Environment, ANU

Professor Jann WILLIAMS, UTAS

## NCRIS Value - Roadmap

- …investment in research infrastructure … with the aim of maximising the contributions … to *economic development*, *national security*, *social wellbeing* and *environmental sustainability*;
- Infrastructure … focused in areas where Australia is, or has the potential to be, *world-class* … and provide *international leadership*;
- …. Funding and eligibility rules should encourage *collaboration and co-investment*…
- Due regard be given to the *whole-of-life costs* of major infrastructure, with funding available for operational costs where appropriate; and
- The Strategy should seek to enable the *fuller participation* of Australian researchers *in the international research system*.

## Research infrastructure vs research

- NCRIS is explicitly about major, multi-institutional infrastructure
  - Its presence can *lower the effective costs of subsequent research*
  - Can *allow research* to be done that would otherwise be impossible
  - But *research and some infrastructure not covered*
- Explicit NCRIS interest in what is more appropriate to *ARC* and *LEIF* funding
  - A plan that seeks funding that does not fit NCRIS will *lower overall funding potential*

## Time scales

- NCRIS relates to current 5 years
  - But strong expectations of an analogous successor if the experience of this round supports the need
- Scope for thinking about an infrastructure roll-out strategy that spans more than 5 years
  - Allowing for upscaling in the future
    - Linking to options framework
  - Absolute priority vs time priority?
- TERN strategy >> TERN NCRIS strategy?

## People as infrastructure

- Roadmap recognizes that people may be a key part of infrastructure
  - And allows for funding, especially to afford better access

## Some planning realities

- NCRIS will not cover all 'claims' on the table
  - Platforms for Collaboration options
- NCRIS will favour clear evidence of sound collective planning across the community
- Possible ways to minimise trade-offs
  - Focus NCRIS on core compliant infrastructure & maximise *effective* leverage
  - Plan roll-out over 6-7 years, rather than 5
  - Identify area
  - Rely on some 'overs' and 'unders' in managing key uncertainties, and base bid on the expected cost of a portfolio of investments, using options principles.

## Key questions

- Does the proposed investment have a hard core, to which other features might be added – later, and/or via other funding sources?
- What are the synergies with other parts of the package?
- Does the rollout lend itself to phasing?
  - What are the trade-offs with longer timing?
  - How would the early parts be 'optimised'?
  - Can scalability be made a strength of the proposal?
  - Any uncertainties that affect expected costs?

## NCRIS Plan Requirements

- Rationale & investment description
  - concept and role; focus; investments
- Access and Pricing
  - how scientific community accesses
- Ownership and management
  - relation to science community, governance framework
- Implementation Strategy & Business case
- Appendices
  - Assets & Detailed Investment Plans
  - Organisation & key personnel
  - Income statements
  - Risk management

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## ATTACHMENT C Workshop Output on Key Features of Potential Hubs

### *Group 1 – Queensland/Northern Australia*

- Drivers – land use change, climate change, fire
- Tropics – biodiversity, water, carbon (total greenhouse gas budget, CO2 equivalence
- Scale – catchment/regional and continent level
- Leverage/build on – TraCK, NATT (CERF program), MTSRF, healthy water initiatives
- Geographical locations – Darwin, Townsville/wet tropics and SE Qld

### *Group 2 – South East Australia*

- Ecosystems changing/declining – not just measure; get ahead of problem, how to improve
- Management capability – multiple benefits
- Lower Murray – connections between river flow/flood plain/susceptibility to anthropogenic impacts; processes/exchanges of H2O/CO2/nutrients
- SE Forest – similar focus on exchanges
- Other – aquatic and faunal diversity; understanding interchanges; catastrophic events; NSW/Tas using existing ecosystem plots; connecting activities in these States
- General aspects – long term observations important; understanding/addressing change; co-investment invaluable; datasets very important – connect into national capability; interdependencies across the sites

### *Group 3 – South West Australia*

- Drivers – biodiversity hotspots; climate change; significant existing activity/resources in biodiversity, agriculture
- Vegetative conditioning – ongoing monitoring; many needs (habitat etc); management interventions; carbon fluxes; habitats for various species
- Ground based and remote sensing
- Build on existing investments – NRM, State govt funding, especially in water/catchment issues
- Focus on LTER-type site – investment in major type of 'kit'; target specific area that covers eg water/catchment, or biodiversity hot spot; help entrain State govt investment
- Datasets – focus on observations on ground from small plot sizes to larger/space-sensed level
- Remote sensing – go across spatial levels, depending on source; WA has large product databases, variety of products that can feed into 'ACEAS' capability
- Targeted investment in e.g. catchment/freshwater; biodiversity global hotspots

### *Group 4 – Continental*

- Remote sensing link
- Data collected needs to be related to models at this level

- 3 areas:
    - Gas exchange/water vapour – short time interval measurements, resulting in large datastreams
    - On-ground focus (can't be done via remote sensing) – nitrogen/phosphorous change, longer scale measurement
    - 'Contexts' – trajectories of ecosystems; healthy environments