Northern Australia Land and Water Taskforce: 2009 Work Plan Management Proposal

Summary

CSIRO has been asked to manage and deliver the 2009 Work Plan for the Northern Australia Land and Water Taskforce (the Taskforce). The Work Plan aims to "better understand the opportunities for new, sustainable development in northern Australia and the potential impacts of these opportunities". Accordingly, CSIRO and partners will undertake research to enable the Taskforce to meet its end of year reporting requirements, based on its five terms of reference. Here we detail the means by which that research will be undertaken and delivered.

The proposed *Work Plan Project* will synthesise existing information to explore a range of development alternatives and land use change activities, and their impacts on a selection of critical sustainability criteria. First amongst these criteria is water, and its relationship with broader land management, which will form the lens through which the other criteria are viewed and analysed. By this means the project will establish and illustrate principles and guidelines for sustainable development of northern Australia, in accordance with the Taskforce terms of reference .

The project will draw on the financial and intellectual resources of CSIRO and those of its partners from universities, state departments and private industry.

The final report will emanate from contributions from the Office of Northern Australia (ONA), the Department of the Environment, Water, Heritage and the Arts (DEWHA), CSIRO and other partners described below.

The project will commence in May and be completed by 30 October 2009.

Introduction

Meeting Taskforce requirements

CSIRO has been asked to manage and deliver the 2009 Work Plan for the the Taskforce. The Work Plan aims to "better understand the opportunities for new, sustainable development in northern Australia and the potential impacts of these opportunities".

The Taskforce terms of reference (ToR) are to:

1. Identify, consistent with the provisions of the National Water Initiative (NWI), the sustainable capacity of the river systems and/or drainage basins to support increased consumptive water use
2. Identify, consistent with sustainable resource use principles and practices, economic development and diversification opportunities (including non-consumptive or in-stream uses) which rely on access to locally or regionally significant water resources
3. Identify the potential impact of such development opportunities on the natural environment and other users and the broader community
4. Identify incentive, market, regulatory or planning instruments that could be used to facilitate, control or influence development, such that it proceeds in a manner consistent with the principles of the National Water Initiative
5. Recommend governance arrangements for the effective management of surface and groundwater resources that cross jurisdictional boundaries

Consultation with stakeholder groups is a key project activity. ONA has received funds to support consultation and engagement from which a series of workshops are planned with Indigenous, conservation and industry groups. *Work Plan Project* partners will participate in these fora, which will provide structured discussion to inform project activity.

The *Work Plan Project* has been framed to meet the Taskforce's preferred method for addressing the ToR, as outlined in their Feb 2009 Mid-term Report, as well as meeting the needs of DEWHA and the National Water Commission, both of which are contributing to the project.

Consequently, the *Work Plan Project* will analyse development options and impacts according to three development themes that align with the ToR, as indicated in parentheses.

a. Biophysical: water dependencies of biophysical systems, and their responses to development (ToR1)
b. Economic-social-cultural: water dependencies of eco-socio-cultural systems, and their responses to development (ToR 2 and 3)
c. Institutional: institutional and governance arrangements to inform water-dependent development (ToR 4 and 5)

Meeting reporting requirements

These themes will be examined and communicated through a mix of synthesis (drawing on information from a wide variety of disciplinary and geographic sources) and illustrative case studies. By this means we intend to distil the principles guiding sustainable development and to provide them with a concrete application context. The case studies will illustrate the consequences of applying (and not applying) the principles of sustainable development proposed in the report.

Case studies will occur in three tiers. Mini case studies will illustrate the principles distilled from specific research questions, and will be selected for their illustrative capacity (Fig. 1; small coloured circles). Intermediate case studies will, where appropriate, illustrate the relationship amongst principles within a development theme (coloured rectangles). Three large regional case studies (western Cape York, Qld; Douglas-Daly, NT and Fitzroy, WA) will provide geographic coherence and coverage.

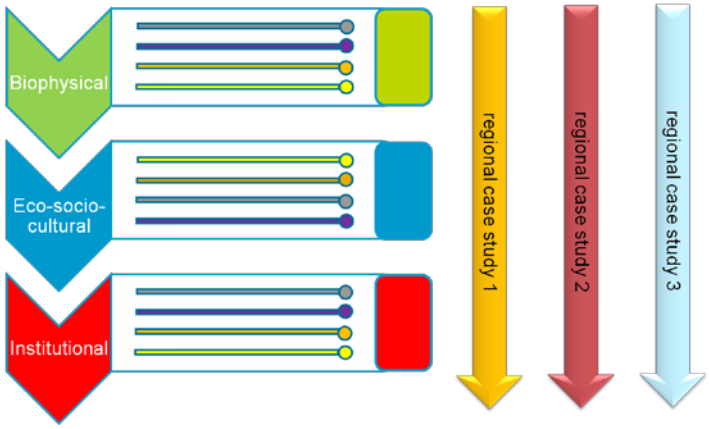

Fig 1. The relationship between project themes and case studies that illustrate development principles.

We intend to produce an approachable magazine-style report rather than a dry scholarly text. This format is intended to provide the most ready access to complex cross-cutting information and themes by using a consistent, 'operational' approach to information delivery. The suggested template will report insights in the following sequence:

i. Background information describing the present status of the issue or variable
ii. Possible and likely development trajectories and impacts for the issue or variable
iii. Positive and intended activities and outcomes occurring in response to development
iv. Negative and unintended activities and outcomes occurring in response to development
v. Principles underpinning actions, incentives or regulations that promote positive actions & consequences
vi. Principles underpinning actions, incentives or regulations that discourage negative actions & consequences
vii. Critical knowledge gaps that may impede optimum application of v) and vi), above.

This format is designed to maximise the alignment between the *Work Plan Project* report and the Taskforce report. Their proposed articulation is shown below (Fig. 2).

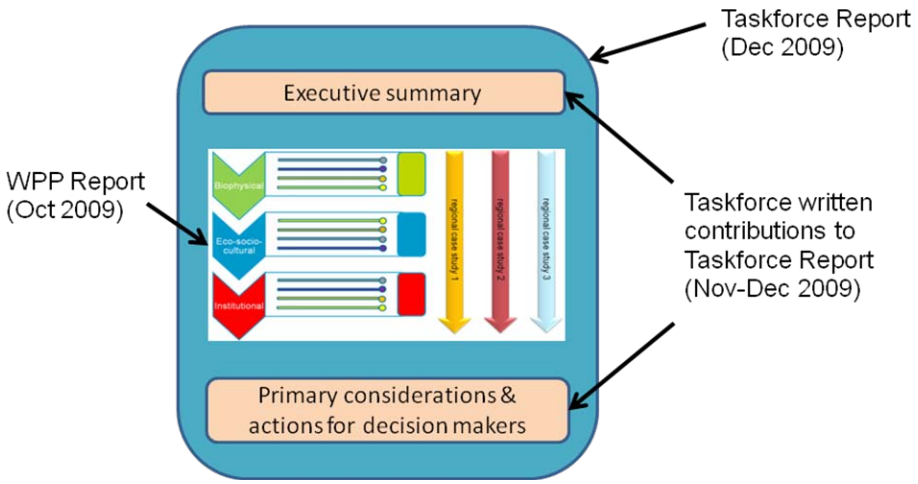

Fig. 2. Articulation of *Work Plan Project* and Taskforce reports

Basic timelines

The *Work Plan Project* report will be developed in 5 phases designed to ensure that the needs of the Taskforce and contributions to those needs are met most efficiently:

1. Review and collate existing sources of information, and identify knowledge gaps and needs (April 2009).
2. Discuss with the NALWT the nature and scope of development options for consideration, the strategic balance of the project and the preferred method for presenting results (April 2009).
3. Develop detailed time- and output-bound project plans to guide and monitor the contributions of *Work Plan Project* participants (May 2009).
4. Provide the Taskforce and its key stakeholders with monthly progress reports and, where appropriate, report drafts (June-September 2009).
5. Deliver the *Work Plan Project* report (30 October 2009).

Resource requirements

CSIRO will act as the *Work Plan Project* Manager and lead agency for analysis and reporting. It will draw together high calibre skills from a range of individuals and agencies, as well as drawing on the skills under its purview. The strategic national importance of the work makes it possible for CSIRO to co-invest in the project. The contributions anticipated from a range of sectors, as indicated by receipt of ONA and DEWHA funds, is shown in Fig. 3.

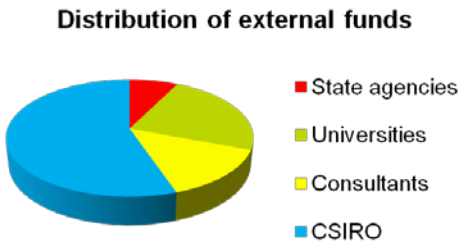

Fig. 3. Distribution of ONA and DEWHA funds to *Work Plan Project* contributors by sector.

Project scope

General research approach

In general terms, the research strategy proposed here has a number of interacting components. These are:

1. Engagement with key stakeholders at project inception and throughout via a Project Reference Panel (comprising experts in the various fields examined in the project) and through ONA consultation fora.

   ONA will coordinate engagement with Indigenous, conservation and industry groups to ensure that the perspectives outlined above are received and considered. *Work Plan Project* staff will engage with and contribute to that process, as it will complement and inform the synthetic goals of the *Work Plan Project*. ONA will resource this activity as an addition to the work outlined in this proposal.
2. Desk-top literature review and related work to provide an information platform and analytic foundation for distilling and illustrating principles that inform sustainable development.
3. Three focal case studies across northern Australia that reflect: (i) the diversity of physical geographies; (ii) variations in the intensity of exogenous development interest; (iii) patterns of Indigenous and non-Indigenous settlement and interest; and (iv) jurisdictional complexity. These case studies will involve fieldwork and primary data collection.
4. Conferencing of project team personnel and, where appropriate, key stakeholders throughout the research process to ensure the synthesis of all research inputs and to realise any synergies across different research foci.

It is appropriate, at the outset, to state that this project will not provide simple 'solutions' to the question of sustainable development. Linked with the concept of sustainable development is a key question: development for whom? It would be improper for the *Work Plan Project* to seek to replace the democratic and other forums in which diverse national and local stakeholders debate and contest questions of land and resource ownership, management and allocation. Under the direction of the Taskforce, this project seeks to provide a firm basis for informing such discussion.

Further elucidation of the *Work Plan Project* scope and philosophy is provided below:

The *Work Plan Project* will not:	The *Work Plan Project* will:
1. Define sustainable development options. Sustainability is a concept that involves values as well as objective data. The definition of sustainability varies with the emphasis placed on environmental, social and economic goals. It is a decision space, not a decision point, with boundaries that vary according to political criteria. This project will not attempt to usurp political processes.	Clearly frame parameters within which sustainable development can occur. Provide data and insights to inform a sustainability discussion and debate. Frame and illustrate principles that can be used to assess and guide sustainable development. Establish guidelines for distinguishing more from less sustainable development according to a range of criteria. This places a wide range of development alternatives within a quantifiable 'decision space' in which their attractiveness can be determined according to a range of social, economic and environmental criteria.
2. Recommend specific regulations, governance arrangements or incentives. The role of research organisations is to provide information about the relationship between policies, regulations and governance arrangements and their consequences. Judgement about the relative attractiveness of those consequences is in the political domain. This project will not attempt to usurp political processes.	Explore a range of potential consequences arising from the application of different development principles, regulations, governance arrangements and incentives. This will provide readers with a clear view of how different policy settings will differentially affect the outcomes of development for people, industries and the environment; enabling them to make informed choices about matching preferred outcomes with relevant policy instruments.

The *Work Plan Project* will not:	The *Work Plan Project* will:
3. Identify and recommend or proscribe specific development options because: The promotion or proscription of specific development options falls into the realm of political decisions; Even if they were simply technical decisions, time and resources (dollars and data) do not permit the detailed analysis required to support a reliable prioritisation of development activities.	Establish principles of sustainable development and guidelines for: i) distinguishing more from less sustainable options, according to a range of criteria; ii) promoting and encouraging sustainable development. These will be achieved by: i) creating simple checklists for assessing development proposals; and ii) detailing incentive and governance arrangements that support favoured development options and trajectories and discourage unfavourable options and trajectories.
4. Undertake detailed regional case studies, designed to identify best-bet development or non-development options. As outlined in 1, 2 & 3 above, the report is not intended or equipped to inform specific development options or activities. That is a different task as it answers different questions and requires a distinct skill set.	Select three regional case studies to provide the best possible basis for illustrating and ground-truthing the principles developed in the project.
5. Gather significant volumes of new data . Reproduce or duplicate slabs of existing data and knowledge.	Synthesise the best available data and knowledge, by drawing on extant sources, domain expertise, and novel interactions between scientific disciplines. This will enable the report to address the key considerations of sustainable development in a compressed, structured and defensible yet timely manner. Key sources of extant detailed knowledge and data will be highlighted.
6. Generate new climate or water availability projections beyond those developed in the Northern Australia Sustainable Yields (NASY) project.	Use NASY climate and water availability projections to inform analysis of a range of water use (development) options, designed to illustrate and test the principles and boundaries of sustainable development.
7. Shirk from undertaking interpretation and analysis because of a paucity of data.	Make clear and prudent judgement calls based on the best available information, acknowledging the limitations imposed upon them by poor data. Furthermore, the project report will detail the data and analysis required to fill these critical information gaps so that subsequent analyses (such as those undertaken by the Assessment) need notbe limited by access to sound data.
8. Create a byzantine account of development theory.	Provide in the most concise manner guidelines to assess and foster sustainable development for northern Australia.

Specific research questions to be addressed by the *Work Plan Project* are detailed overleaf.

Specific research questions

1. *Water dependencies of biophysical systems, and their responses to development*
    a. What is the sustainable capacity of rivers to support increased consumptive water use, for each drainage basin or part thereof?
    b. What is the impact on and of agricultural development of/on water availability?
    c. Assess land suitability for agricultural and other development opportunities
    d. What are the ecosystem needs of tropical water systems?
    e. What are the critical data and knowledge gaps regarding impacts of and on water?
    f. How can we use information on the water supply to promote the Commonwealth Government's water reform agenda, especially where water markets do not exist?

2. *Water dependencies of eco-socio-cultural systems, and their responses to development*
    a. Identify development and diversification opportunities, including non-consumptive or in-stream uses that rely on access to significant water resources.
    b. Identify the impact of those opportunities on the natural environment, other water uses and the broader community.
    c. What drives and limits economic development, including future infrastructure plans?
    d. What are the impacts of conservation based activities on financial returns and employment opportunities for the conservation and cultural economy?
    e. How do hard, soft and natural infrastructures contribute to economic development?
    f. What are the options and outcomes for indigenous employment, especially as related to conservation, mining, culture, irrigation/agriculture [and] manufacturing industries/and service industries?
    g. What would a sustainable economic activity look like? How would you know in advance? What goes wrong/happens when a development is not sustainable? (Illustrative case studies would be helpful). What would best practice look like?
    h. What regulatory instruments or approaches would be useful to ensure that development is sustainable? What measures or attributes of sustainability could be used to rank/quantify development proposals?

3. *Institutional and governance arrangements to inform water-dependent development*
    a. Identify the incentive, market and regulatory approaches that would encourage development consistent with the principles of the NWI.
    b. Audit/catalogue the existing development incentives and controls in different jurisdictions. Compare and contrast these and highlight conflicts and problems.
    c. Illustrate governance arrangements that help to effectively manage water across jurisdictional boundaries.
    d. Provide case studies that illustrate the efficacy of jurisdictional planning and regulatory frameworks to ensure compliance with the NWI.
    e. Illustrate improved systems of governance for effective management of northern waters.
    f. Catalogue and describe Indigenous governance systems and approaches to cross-cultural legal and institutional arrangements, and the role of Indigenous Land Use Agreements in water development.
    g. Examine international examples of integrated river basin initiatives, and assess their relevance to northern Australia.

The research approaches that will answer these questions are detailed below.

Specific research approaches

1. Water dependencies of biophysical systems, and their responses to development

These questions relate to critical matters of water resources, land capability and use and their impact on and by tropical water systems, and the consequences of all of these for aquatic and terrestrial biodiversity. While each of these matters impacts on and is impacted by social and economic factors, the inter-relationships between these factors are not outlined here. They are dealt with explicitly in the second theme, *Water dependencies of eco-socio-cultural systems, and their responses to development,* but will occur as an integrated assessment in the final report.

A. What is the sustainable capacity of rivers to support increased consumptive water use, for each drainage basin or part thereof?

   Foundation knowledge of water supply will be provided by the NASY team (under a DEWHA contract) led by Dr Richard Cresswell, to the teams considering the wide range of water supply-related questions outlined above and below.

   In addition to providing related teams with processed data on water availability, the NASY team will also undertake 'independent' research to:

   i. Further enumerate the status of water availability in Northern Australia, in accordance with known climate projections.
   ii. Further develop options for future development that were not possible given NASY constraints.
   iii. Identify requirements for water-availability modelling that provide knowledge at a finer-scale resolution than currently possible, to better support decisions on specific development options.
   iv. Provide more detailed assessments of water availability in areas of particular interest (i.e. Wenlock, Douglas-Daly, Fitzroy).

B. What is the impact on and of agricultural development of/on water availability?

   i. The present footprint of land and water use by agriculture will be established.
   ii. Agricultural systems analyses will enable projections of the impacts on and of agricultural development on the environment, and will include examination of potential yields, profitability and markets. Relative impacts of mosaic and broad-scale agriculture will be examined. Potential contributions to issues such as food security will be discussed.
   iii. The influence of pests and diseases on agriculture and of agricultural pests and diseases on the environment will be enumerated, and the potential for technical solutions examined, including irrigation requirements and impacts. This will require configuration, calibration and use of the Agricultural Production Systems Simulator (APSIM), and subsequent value chain analyses.

C. Assess land suitability for agricultural and other development opportunities

   Understanding the capability and current use of soils and landscapes is fundamental to the consideration of agricultural and industrial options and related infrastructure needs (addressed in theme 2). It also has implications for the management of land and water for non-consumptive uses, as well as issues such as defence.

   i. Present land use will be interpreted and mapped.
   ii. Land capability mapping will be provided at a large scale for northern Australia and at a finer scale for selected development 'hotspots', to afford a deeper analysis of development options and impacts. Interaction between land use change, soil characteristics and water requirements and availability will be quantified.
   iii. Land suitability will be assessed following specification of proposed land use options. The assessment process will draw on existing data acquired from ASRIS (Australian Soil Resource Information System) and relevant State agencies (DAFWA, DRDPIFR, and QDPIF). Data will be configured for use with formal models such as APSIM and, where this is not possible, conceptual models.

D. What are the ecosystem needs of tropical water systems?

The ecosystem needs of tropical water systems will be examined from terrestrial, aquatic and marine perspectives. These are outlined below. Please note that they are described separately for conceptual simplicity, but that the functional linkages between them will be accorded special attention.

Aquatic and marine ecosystems

i. The current status and water use/needs of aquatic ecosystems will be described.

ii. The impact of development alternatives on the status of the region's aquatic biodiversity (fresh and marine), determined according to extractive and conservation criteria, will be examined for a range of water and climate projections. Key interactions between terrestrial and aquatic systems will be elucidated.

This will require analysis of flow regimes, means of controlling flow regimes and impacts of flow on aquatic species.

Key questions that will be addressed include:

a. Establishing the point at which changes in water regime lead to 'flips' of the system to undesirable states (e.g. algal blooms, invasive fish species, etc). Changes in water regime include perturbations caused by or including volume extraction, climate change, water quality and land use change, particularly as it relates to habitat area and quality (floodplains and wetlands). Recently published work on flow classification of Australian rivers will assist with establishing these ecosystem needs for freshwater systems.

b. Identifying critical gaps in knowledge of ecosystem needs of aquatic systems, particularly as they relate to the application of ANZECC guidelines for water quality. In particular, review the extent to which existing guidelines have been tailored to address known natural regional and local variability.

c. The impact of changes in water regimes and water quality on marine environments, especially those with heritage significance, will be outlined.

Terrestrial ecosystems

We will review the potential impacts of development opportunities on the terrestrial biodiversity of northern Australia, using the best available knowledge to identify information gaps, and making particular reference to principles of sustainable development.

We propose to undertake a review of key issues, using relevant northern case studies where appropriate, and summarise the ecological assets, cultural values, impacts and opportunities for each broad savanna region (e.g. Gulf Plains, Cape York, etc). In particular we will examine the following topics in the context of future water availability and use options:

i. Terrestrial conservation - a review of current information on condition and trend in savanna biodiversity drawing on State of the Environment reporting, Australian Collaborative Rangeland Information System biodiversity review, current research on northern Australian biodiversity pattern and change, and information on values, threatening processes and threatened species, such as those listed on the EPBC Act or the IUCN red list.

ii. Terrestrial conservation and industry (carbon/mining) - a review of current information with respect to conflicts and impacts of fire management, carbon economy and mineral expansion in northern Australia. Case studies may include Kimberley fire project (AWC), WALFA project, Cape York Peninsula (CYSF fire mapping) and Mt Isa region (Xstrata and fire planning).

iii. Terrestrial conservation and soils/landscapes - a review of the possible impacts of intensive land use change in productive hotspots. As with southern Australia, focus on catchments with the most productive soils and landscapes may be in conflict with biodiversity hotspots, magnifying the possible negative effect of development. Case studies may include the wetlands of the Gulf of Carpentaria and focus on regions of high productivity (i.e. basalt and clay soils of Einasleigh Uplands and Barkly Tableland).

iv. Terrestrial conservation and agricultural options - a review of the possible impacts of intensification of agricultural land use and general pastoral intensification, with particular reference to tree clearing

and fragmentation, and water capture and diversion. Case studies may include Daly Basin, Pigeon Hole (Heytesbury), Ord River and the Brigalow Belt.

v. Terrestrial conservation and climate - a review of the possible impact of climate change projections on terrestrial biodiversity with particular reference to the compounding effect of land use intensification and change as discussed in the sections above. Case studies may include small mammals and savanna birds, both of which have functional and family groups that may be under particular threat.

2. Water dependencies of eco-socio-cultural systems, and their responses to development

A. Identify development and diversification opportunities, including non-consumptive or in-stream uses, that rely on access to locally or regionally significant water resources. (Agricultural and related developments are covered in Theme 1, above). This may include opportunities such as carbon economies, payment for ecosystem services, tourism (including eco- and cultural-based), recreational and commercial fishing, art and craft, etc.

B. What drives and limits economic development, including future infrastructure plans and issues of human and animal health and security? Why have previous development plans (e.g. for agriculture) failed to meet expectations?

C. How do hard, soft and natural infrastructures contribute to economic development?

This component of the work will be approached via a number of discrete steps – beginning with explicit recognition of NWI principles. The key steps are:

i. Establish the objectives of Northern Australian development and as a corollary what are the performance criteria and metrics. In water resource terms, the NWI articulates many of these: i.e. provision for the environment, the nature of property rights, water accounting conventions, pricing, accounting for externalities and promoting trade where appropriate. Additional metrics sensitive to cultural and societal values will be evaluated.

   We acknowledge that there are catchment dynamics specific to Northern Australia, however the history of the MDB provides a cogent reminder that sustainable use and accepted cross jurisdictional sharing is advanced when the environment is an *a priori* entitlement holder, enabling iterative identification of the impact of consumptive pools on total and proportional allocation.

ii. Establish the boundaries and data reliability of the water resource management region, likely to be at basin scale, and the appropriate intra-catchment development regions. A multi-attribute evaluation of potential development regions will determine the appropriate units of analysis for each catchment. Evaluation will be guided by the performance criteria and aim to maximise development diversity whilst maintaining water resource and social integrity.

iii. Identify water dependent development and diversification opportunities, including non-consumptive (including conservation) or in-stream uses for each development region. Consumptive use developments will be limited to those catchments that can reliably establish the non-consumptive environmental pool. (For details on agricultural development, see below.)

iv. Assess land suitability for the above opportunities, including accounting for impacts on existing users, salinity, soil conditions and water dependent ecosystems. Catchments with insufficient data will be limited to non-consumptive uses.

v. The nature and distribution of consumptive water entitlements and the specification of periodic allocations will depend on identified development opportunities and catchment characteristics. Research will evaluate the role of private and public entitlements and infrastructure investments for each distribution region.

vi. Public and private funds are scarce requiring prioritisation of investment. A synthesis of the research will contribute to a systematic procedure for prioritising multi attribute development investments specific to each development region. The reliability of catchment data, in concert with identified impediments and drivers (for example infrastructure) will aid in assessing the timing and sequencing of investments to promote development.

D. Identify the impact of those opportunities on the natural environment, other water uses, and the broader community.

The focal case studies, as well as a desktop review of the literature with a particular emphasis of northern Australian water development projects will enable the identification of major environmental, cultural and social impacts of new economic development options. This work will consider direct impacts on the natural and social environments, and also the impacts on other water uses and the opportunity costs of realising such development options.

E. What are the impacts of conservation based activities on financial returns and employment opportunities for the conservation and cultural economy?

Through desk-top harvesting of available data, consideration of the available literature and review of relevant case studies, a quantitative analysis and projection of the extent of employment and economic opportunities from the conservation and cultural economy will be made. Reference to the spatial distribution of the conservation estate and biodiversity 'hotspots' across northern Australia will enable an analysis of the extent to which these opportunities are limited to particular locations and regions. Finally, a detailed review of the case study literature and that concerned with Indigenous involvement in conservation and conservation management will inform an analysis about the size, possible benefit and management of the conservation and cultural economy.

The economic and employment returns of conservation activities for regional economies and Indigenous and non-Indigenous communities is dependent, to a significant degree, on the manner in which conservation activities are planned, structured and managed. Economic benefits can be optimised with careful management. Based on a desk-top review of the case study literature, the key potential economic opportunities, and the means of optimising them, will be identified.

F. What are the options and outcomes for Indigenous employment and contributions to the Indigenous hybrid economy, especially as related to conservation, mining, culture, irrigation/agriculture, tourism, manufacturing, ecosystem and other services?

Achieving improvements in levels of Indigenous employment has proven exceedingly difficult. Underlying cultural, linguistic, geographic and training impediments have largely proved intractable. The research will comprise two aspects. First, a quantitative analysis of the economic value of each of these sectors will be undertaken, including an analysis of the current and projected employment. Second, a review of select case-study literature, and in particular the 'grey' literature, will provide insights into how Indigenous employment in conservation, mining, culture, irrigation/agriculture and manufacturing might be optimised, including recommendations for training and education.

G. What would a sustainable economic activity look like? How would you know in advance? What goes wrong/happens when a development is not sustainable? How could it take account of Indigenous values of water? What would best practice look like?

H. What regulatory instruments or approaches would be useful to ensure that development is sustainable? What measures or attributes of sustainability could be used to rank/quantify development proposals?

There are two key aspects to answering 2g -h. First, the concept of sustainable economic development needs to be operationalised. In order to do this, a review of the literature will be used to identify the key characteristics of sustainable economic development and the major approaches to its achievement. The focal case studies will be used to identify the distance between this 'best practice' and the approaches currently being used in northern Australian jurisdictions. This work will provide the foundation for further synthetic work which will be concerned with identifying and describing the optimal approaches which can be used in northern Australian contexts to promote economically sustainable development.

3. Institutional and governance arrangements to inform water-dependent development

A. Identify the incentive, market and regulatory approaches that would encourage development consistent with the principles of the NWI.

B. Audit/catalogue the existing development incentives and controls in different jurisdictions. Compare and contrast these and highlight conflicts and problems.

   Having identified the full range of incentive, market and regulatory approaches that are relevant to water resource decision-making which is consistent with the NWI, an audit of compliance with NWI principles will be undertaken. (CSIRO has recently completed an audit of NWI compliance in other jurisdictions). This work will be undertaken on a desk-top basis, with additional 'ground-truthing' achieved through the three focal case studies.

C. Illustrate governance arrangements that help to effectively manage water across jurisdictional boundaries

D. Provide case studies that illustrate the efficacy of jurisdictional planning and regulatory frameworks to ensure compliance with the NWI

   To address questions 3c & d, a review of the literature, both Australian and international, concerning cross-jurisdictional water management will be undertaken. This will enable the development of a checklist of effective institutional and governance arrangements for managing water across boundaries. Once this work is complete, the three focal case studies will be used to discern the extent to which 'best practice' is in operation in northern contexts and the likely compliance with NWI principles.

E. Illustrate improved systems of governance for effective management of northern waters

   The work described above will be synthesised and workshopped among key science leaders, as well as with the Project Reference Panel, to identify a range of possible improvements to water resource governance in northern Australia.

F. Catalogue and describe Indigenous governance systems and approaches to cross-cultural legal and institutional arrangements, and the role of Indigenous Land Use Agreements in water development

   There are three discrete aspects to the work required to fulfil this term of reference: (i) Indigenous approaches to natural (including water) resource governance and management, (ii) barriers to effective Indigenous participation in national and state governance and institutional arrangements for water resource allocation and management, and (iii) review of existing governance arrangements, identifying the potential to improve their efficacy in Indigenous domains. This work can primarily proceed through literature and case study review.

G. Examine international examples of integrated river basin initiatives, and assess their relevance to northern Australia.

   A review of the international literature will be undertaken with a view to identify and describe best practice integrated river basin management. The relevance of these approaches to northern Australian contexts will be assessed and, where appropriate, incorporated in the advice provided.

Work task leader's biographies

Peter Stone

Dr Peter Stone will manage the project. He is a Senior Principal Research Scientist and Deputy Chief of CSIRO Sustainable Ecosystems (CSE). He was formerly responsible for the general management of CSE's Tropical Landscapes and Agricultural Research Programs. The Programs operate in Australia and overseas to address complex issues in natural resource management, such as balancing agricultural production and livelihoods with the maintenance of ecosystem function and biodiversity protection.

Dr Stone has worked in a range of governmental and industrial science roles, has held senior management positions in listed and private companies and has provided consulting services in several countries. He has worked throughout the food value chain, in production, processing and international marketing.

He has helped to form and lead a number of major partnerships between science, community, industry and government collaborators that have tackled major land use issues such as erosion, water quality, salinity and biodiversity management, often in a rural production context. A consistent theme of his work has been facilitating the exchange of actionable biophysical, social and economic knowledge amongst a range of end users.

Dr Stone has authored >200 publications in academic, popular and commercial fora, including internationally available books, book chapters, research papers and newspaper articles. He has also developed computer software products that are widely used by growers, agribusiness and the education sector, both within Australia and abroad. His achievements have been recognised via academic and industry awards and membership of national and international industrial and scientific committees.

Richard Cresswell

Dr Richard Cresswell is a Senior Research Scientist in Hydrogeochemistry with the Surface Water and Groundwater Interactions research group which is within the Hydrology research program of CSIRO Land & Water. He is leading CSIRO's Northern Australia Sustainable Yields Assessment, and co-ordinates CLW's projects within the CRC for Landscape Environments and Mineral Exploration (LEME). He has 18 years research experience in radio-isotope analyses and their application across a range of disciplines: archaeology, meteoritics, bio-medicine, geology and hydrogeochemistry. He has led major research projects for the Commonwealth Bureau of Rural Sciences and the Grains R&D Corp. Richard is author of 32 scientific papers, 3 Book Chapters, more than 43 Conference papers and 20 Technical Reports. His achievements have been recognised by a variety of awards, including Executive Director's Award, Bureau of Rural Sciences; Alison Furbank Award for Scientific Communication, Bureau of Rural Sciences; Australia Day Award, Department of Agriculture, Fisheries and Forestry.

John Ward

Dr John Ward is a senior research scientist of the Policy and Economic Research Unit, a team of CSIRO geographers and ecological economists. The unit is a research element of the Division of Sustainable Ecosystems and specialises in the analysis and development of natural resource policy principles and their application to whole of catchment management. He holds a science degree in developmental biology, an honours degree in environmental science and a PhD in natural resource economics. He has extensive industry experience, managing his own forestry, timber processing and building company for twenty years. The company was at the vanguard of conservation based forestry in the Philippines, Pacific Islands and northern NSW. John has extensive experience in the application of experimental and behavioural economics to design and test natural resource governance and associated policy instruments. Projects for the CRC Catchment Hydrology, National Market Based Instrument program and the MDBC have evaluated the environmental and economic effects of water trading and auctions for conservation procurement. Recent research has involved the development of psychometric attitudinal scales associated with economic decision making and the evaluation of policies for urban managed aquifer recharge. Internationally, John has just completed a spatial analysis of the Niger River Basin for the Challenge Programme, quantifying adaptive capacities to climate change and the role of water in reducing poverty.

Nick Abel

Nick Abel is a CSIRO Principal Research Scientist who leads a program of research on environmental policy and planning for sustainable regional development. He holds an honours degree in biology, a masters degree in rural and regional planning, and a PhD in development studies. He has used ecological and economic theory and methods in a teaching, research and regional development career spanning forty years and eight countries. He led a major participative research project assessing the values attributed to landscapes of Western New South Wales by graziers, Indigenous peoples,

conservationists, and the minerals and tourism industries. He then led policymaker workshops to develop options for institutional changes that would support multiple land uses across the region (http://www.cse.csiro.au/research/aglands/nswrangelands/index.htm). He also led, with SJ Cork, the first ecosystem services project in Australia (http://www.ecosystemservicesproject.org/), since when the concept has applied widely in Australia and overseas. His current research is on adaptations to climatic change by local governments on the Queensland coast, and on the economic and institutional relationships between coastal farming and estuarine fishing in New South Wales. All Nick's projects have been designed and implemented with practical outcomes in mind - institutional changes to support sustainable, adaptable and equitable resource use. Nick is CSIRO's representative on the board of the Resilience Alliance, an international network seeking practical ways of building the resilience and adaptive capacities of regions around the globe (http://www.resalliance.org/1.php).

Marcus Lane

Marcus Lane is a CSIRO Senior Principal Research Scientist who leads the Social and Economic Sciences (SES) program in the Division of Sustainable Ecosystems. SES comprises approximately 90 social and economic scientists all of whom are working in diverse natural resource domains, including inter alia water resource management, climate change and coastal management. Lane holds an honours degree in environmental science, a postgraduate qualification in education, and a PhD in environmental planning. His major scientific foci are: natural resource management and governance, Indigenous lands management, environment and development in the Pacific and environmental policy analysis. His works has spanned all Australian states and territories as well nine countries around the world. Lane's published science comprises approximately 60 refereed journal articles, 20 book chapters and seven books and monographs. He holds honorary positions at the University of Queensland and Griffith University.