

SCIENTIFIC ADVICE ON NATURAL RESOURCE MANAGEMENT:

**A REPORT TO THE NATURAL
RESOURCE MANAGEMENT
MINISTERIAL COUNCIL
BY THE COMMONWEALTH
SCIENTIFIC AND INDUSTRIAL
RESEARCH ORGANISATION
(CSIRO)
AND THE AUSTRALIAN
BUREAU OF METEOROLOGY (BOM)**

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EXECUTIVE SUMMARY

This report was requested by the Natural Resource Management Ministerial Council (NRMMC) as a means of identifying the role that science plays in underpinning the National Action Plan for Salinity and Water Quality (NAP) and the Natural Heritage Trust (NHT). NRMMC requested that particular emphasis be placed on the scientific and technical robustness of natural resources management (NRM) program strategies and plans during their implementation and new or emerging scientific advances that may enhance the effectiveness of NRM program implementation.

Since the implementation of the NAP/NHT, significant progress has been made in improving the scientific understanding of the processes that determine the quality and quantity of our natural resources and the implications this has for their management. The NAP/NHT have also fostered a greater regional and community involvement in NRM issues and, while the primary focus has been on setting the administrative and other arrangements, considerable progress has also been achieved in establishing mechanisms for the uptake of science and technology in the development of catchment management planning procedures. However, while current rates of progress are to be commended, the uptake of scientific and technical information in the NAP/NHT process will not be a straightforward task. The difficulties arise from the complexity of our natural resources systems, and the fact that the NRM program strategies and plans will need to integrate the results and findings from a wide range of different, though connected disciplines.

Natural resource management requires integration and interpretation of scientific theory and knowledge across specific scientific disciplines that have often operated in relative isolation from one another. While there is often detailed knowledge of specific research subjects and sites, and knowledge of broad scale processes, there are significant challenges in integrating current knowledge across the range of scales needed to apply it to landscape, regional and paddock scales of resolution. It is not surprising that both practitioners and users of science are having difficulty coming to grips with the complexities of managing both natural and developed ecosystems.

The success of the NAP/NHT will depend, to a large extent, on the knowledge and expertise of the agencies and individuals charged with the development and implementation of the catchment strategic plans. Consequently, this report relies on a methodology that placed a high degree of emphasis on questioning these agencies and individuals about their perceptions of the role and adequacy of scientific information, via interviews and written submissions. There was a 50% response rate to requests for input which is a good result compared to other survey methods and indicates the high level of interest within the NRM community. However, only a few educational institutions responded and this limited the advisory team's ability to ensure that all relevant scientific advances were captured.

Given the staged development of the NAP/NHT, it should also be noted that the states are at different points in the preparation of catchment management plans and thus the findings made are general and there will always be some exceptions to them. Nevertheless they do represent the views of the majority of people questioned.

It is stressed that, although the nature of the current advisory process may have highlighted gaps and criticisms, there are many examples of excellent progress at the catchment level that show the significant progress being achieved through the NAP/NHT activities. Also the potential benefits of the developing private-public partnerships have yet to be fully realised. The advisory team notes that the overall tenor of most responses could be described as critically constructive.

A key factor underpinning the NAP/NHT was that the majority of people spoken to were enthusiastic about the broad directions established by government and the progress achieved to date. In particular, the involvement of all stakeholders, including regional and community groups, the establishment of structures or agencies to facilitate the movement of scientific and technical information into the strategic planning process and the linkages between research agencies and catchment management agencies were identified as successful initiatives to date. However, the advisory team found that at this stage, the capacity, capability and understanding of how to use scientific information to its best advantage was extremely variable across the catchment management agencies. This highlights the need for the NAP/NHT management team and all organisations involved in NRM to strengthen their knowledge-transfer programs in order to build capacity in the agencies implementing NAP strategies at the regional level.

While it is acknowledged that significant advances have also been made in understanding the processes that determine the quality and quantity of our natural resources, the findings by the advisory team suggest that some of the NRM targets established under the NAP could be better underpinned by sound scientific knowledge and data, or in the absence of data, predictive models. The advisory team found that, in some areas, the processes in place to monitor and evaluate progress towards the targets is not adequate. It is proposed that this issue could be addressed through changes to the process of accreditation of catchment plans that would better assess monitoring and evaluation programs.

Against a background of increased community involvement in NAP/NHT issues, it was found that whilst many farmers are involved on catchment management committees and boards, in general, it was considered that additional attention needs to be directed to issues associated with farm economics and profitability in natural resource planning. If these issues are not fully addressed, it is unlikely that farmers, who manage the majority of catchments, will have adequate information or incentives to go ahead with land use change. The NAP/NHT market based instruments research program is one step in the right direction in this regard. There is also an opportunity to improve the linkages between the Landcare movement and the NAP/NHT.

Science relies on sound data. Studies such as the National Land and Water Resources Audit have shown that there is a wealth of many types of data available to catchment management agencies. However, a number of respondents indicated that, at the local/regional level, either good data does not exist or is hard to obtain from its custodians. Similarly, there was not clear evidence that all catchment management agencies have the capacity or commitment to ensure that new data is collected and managed in ways that will make if of use in the future. Consequently, this report highlights a number of areas in need of attention in terms of data management and use. Most of these will require some direction from the NRMCC to ensure

compliance, though in many instances, these issues have been identified and are being addressed by initiatives such as the Executive Steering Committee for Australia's Water Resources Information (ESCAWRI).

In terms of emerging science, and as would be expected at this stage of development of the catchment management plans, a number of catchment management agencies interviewed had rather vague wish lists for information and tools. This indicates some lack of understanding about the potential application of existing science and technology and emphasises the need for better communication between scientists and 'practitioners'. Some catchment management agencies did not show good awareness of recent developments in salinity mapping, investment prioritisation tools, or existing suites of predictive models. Similarly, there was limited knowledge, but significant interest in how social, economic and biophysical data could be integrated and how trade-offs could be identified and actioned.

There was also concern expressed that, although the focus of the NAP/NHT is on what can be achieved in the relatively short term, there are a number of issues that transcend geographic and catchment boundaries and require longer-term investment in R&D including, for example, impacts of salinisation on biodiversity, impacts of climate change and variability on catchments, and monitoring and evaluation methodology. Whilst R&D for some of these will be funded elsewhere, it is important that the NAP/NHT foster the underpinning science required for its ultimate success. Similarly, the NAP/NHT needs to ensure that communication channels are continually upgraded to enable the results and potential benefits of this research to be captured and conveyed to catchment and land managers.

This report indicates that the NAP/NHT have only been partly successful in enabling the flow of scientific and technical information into the catchment management planning process. The development of a focussed scientific coordinating body would rectify this deficiency.

RECOMMENDATIONS

RECOMMENDATION 1

The NRMMC task the Science and Information Working Group to review and report on the broader applicability of the final recommendations of the inquiry by the House of Representatives Standing Committee on Science and Innovation into the Commonwealth's role in managing and coordinating the application of the best science in relation to Australia's salinity problem when the Committee reports the results of its deliberations.

RECOMMENDATION 2

The NRMMC request NRM lead agencies to review and report on whether specific targets critical to the overall success of the NAP are adequately based on relevant and measurable data and what modelling and/or monitoring processes are in place to determine their achievability and provide feedback on the impacts of adopted management practices.

RECOMMENDATION 3

The NRMMC request NRM lead agencies to review and report on existing communication mechanisms between R&D providers, R&D brokers, state agencies, industry and commodity groups and catchment management agencies to identify existing and emerging mechanisms that open better channels of communication between these bodies.

RECOMMENDATION 4

The NRMMC consider mechanisms by which profitability of farm enterprises and regional employment opportunities can be incorporated into scientific and technological decision support processes in order to facilitate development of new and appropriate industries and beneficial land use changes that minimise economic and social disadvantage.

RECOMMENDATION 5

All government agencies currently holding NRM related datasets be requested to accelerate development of data collection, management and retrieval systems that are standardised, integrated and designed to allow cost-efficient data transfer.

RECOMMENDATION 6

The NRM lead agencies encourage lead NRM agencies to place additional effort and investment on monitoring and evaluating NAP/NHT targets and outcomes via the use of remote sensing and other emerging ITC technologies.

RECOMMENDATION 7

The NRM lead agencies encourage funding bodies supporting NRM research to consider funding some community participatory case studies that focus on the integration of biophysical, economic and social sciences at a sub-catchment level to demonstrate how it can be done and how the results should be used to achieve triple bottom line outcomes.

RECOMMENDATION 8

The NRM lead agencies encourage funding bodies supporting NRM research to build an overarching research/science program to include assessment of the impact of climate change and variability, integration of social and economic factors into decision-making, better information on the relationships between biodiversity and vegetation management, more emphasis on farming systems and other issues that transcend regions and catchments.

RECOMMENDATION 9

The NRM lead agencies consider jointly instituting a quarterly electronic newsletter that can act as a forum for science to be communicated to the catchment managers as well as for catchment management agencies to indicate progress, successes and failures.

RECOMMENDATION 10

The NRM lead agencies review the existing institutional arrangements for coordinating, interpreting, integrating and disseminating NRM related science and consider the benefits of strengthening the NAP/NHT through the appointment of a science leader and coordinating body to enable full-time attention to be given to overcoming many of the issues described in this report.

RECOMMENDATION 11

Future reviews of science underpinning the delivery of NRM outcomes be targeted to identify specific initiatives and outcomes rather than take the form of more general overviews as in the current instance.

Chapter 1

TERMS OF REFERENCE AND METHODOLOGY

In the context of the National Action Plan for Salinity and Water Quality (NAP), and the Natural Heritage Trust (NHT), the Natural Resource Management Ministerial Council (NRMMC) agreed in May 2002 that scientific and technical advice to Council be provided annually through a report prepared by the CSIRO and the Bureau of Meteorology, and presented to NRMMC through their representatives on the Natural Resource Management Standing Committee (NRMSC).

In October 2002, NRMMC agreed to a process for the compilation, review and publication of the scientific advice to include specifically:

- the scientific and technical robustness of natural resource management (NRM) program strategies and plans during their implementation; and
- new or emerging scientific advances that may enhance the effectiveness of NRM program implementation.

The NRMMC also specified that:

- the CSIRO and the Bureau of Meteorology should draw on advice and information from a range of scientific and technical institutions;
- the advice provided by the CSIRO and Bureau of Meteorology should be independent of the representation on the NRMSC (thus avoiding any conflict of interests); and
- the report should be publicly available.

The NRMMC Programs Committee further advised that the focus should be biophysical science rather than socioeconomics.

The NRMMC accepted the proposals from the CSIRO and Bureau of Meteorology to consult within the scientific community and with stakeholders to determine the extent to which catchment management agencies (CMAs)¹ were taking scientific knowledge into account in their plans and investment strategies. This report aims to provide advice on current best practice, scientific gaps and emerging opportunities relevant to the catchment management process. Initially it was proposed that a cross-section of catchment plans be reviewed as part of the process. However, this was not possible because few accredited plans were available at the outset of the review and the process was to a certain extent overtaken by the increasing NAP management emphasis on accelerating the investment process as the review was being undertaken.

¹ Given that jurisdictional arrangements vary between states, the report uses the term catchment management agencies (CMAs) to generically represent the catchment and regional bodies constituted with responsibility for catchment management.

METHODOLOGY

The advisory team comprised Dr Colin Chartres of CSIRO Land and Water, Dr Kathleen Bowmer of Charles Sturt University/CSIRO Land and Water, and Mr Bruce Stewart of the Bureau of Meteorology, assisted by Dr Sarah Ryan and Dr Christine Moore.

The advisory team consulted with relevant Commonwealth, State and Territory government departments, catchment management groups in NAP priority regions, key stakeholder groups, and major R&D providers including government agencies, the universities and Research and Development Corporations (RDCs). Information was obtained through written submissions lodged in response to an invitation to contribute (*Appendix 1*) and through written submissions and interviews conducted with selected agencies (*Appendix 2*).

A standard set of questions was provided as a basis for both written submissions and interviews. Stakeholders were asked to provide comment on:

- the role of science and technology in the development and implementation of NRM plans and programs;
- how well science and technology is captured in regional NRM plans and programs;
- where there are gaps and why;
- where NRM science and technology is not meeting the needs of NRM planning and implementation; and
- what new scientific and technological opportunities are emerging, particularly at the regional scale.

The responses, together with information from a Community Forum (*Appendix 3*) and a range of other priority setting and review documents (see Appendix 4) were used by the advisory team to consider:

At the catchment level:

- accredited and emerging plans and the process by which these were developed, in particular the extent to which catchment management authorities are seeking direct involvement of scientists and technical experts;
- the extent of major research projects carried out recently in the catchment;
- local networks and capacity, including linkages with research institutions within or outside the local region, the availability of agricultural consultants, landcare facilitators and others with relevant professional training; and
- local information sources and the extent of their scientific basis, if any;

Within scientific and government agencies:

- the extent of involvement by scientific institutions in the development of catchment and regional plans; and
- the match between R&D needs and R&D provision, including:

- the extent of communication and use of the most appropriate science, data and information in the development and application of NRM strategies;
- methods to facilitate inputs that reflect sound scientific principles, best practice and a shared vision of the role of science in focussing NRM efforts; and
- areas where emerging science and technology and new information could be applied to enhance the achievement of NRM goals and strategies.

COVERAGE

The NAP database² contains more than 260 projects (as at January 2004), primarily in NSW, Victoria and Queensland, representing an investment in 2002-03 of approximately \$82.85 million. It should be noted that because of limited resources available to the advisory team and because some jurisdictions commenced their involvement in the NAP process later than others, the situation in the Northern Territory, Western Australia and Tasmania has not been addressed to the degree that the advisory team would have liked. It is recommended that these jurisdictions be covered in more detail in a future review.

OTHER REVIEWS

The advisory team notes two parallel reviews of NRM.

The House of Representatives of the Parliament of Australia Standing Committee on Science and Innovation is inquiring into the Commonwealth's role in managing and coordinating the application of the best science in relation to Australia's salinity problem. In its inquiry, the Committee is giving particular attention to:

- the use of the salinity science base and research data (including the development of scientific, technical and engineering knowledge) in the management, coordination and implementation of salinity programs;
- linkages between those conducting research and those implementing salinity solutions, including the coordination and dissemination of research and data access across jurisdictions and agencies, and to all relevant decision makers (including catchment management bodies and land holders); and
- the adequacy of technical and scientific support in applying salinity management options.

The NSW Government has established a Natural Resource Management (Legislative Assembly) Committee to inquire into issues in the sustainable management of natural resources in NSW covering:

- current disincentives for ecologically sustainable land and water use in NSW;
- options for the removal of any such disincentives and consequences of doing so;
- approaches to land use management on farms that both reduce salinity and mitigate the effects of drought;
- ways of increasing the up-take of such land use management practices;

² <http://www.napswq.gov.au/index.html>

- the effectiveness of management systems for ensuring that sustainability measures for the management of NRM in NSW are achieved; and
- the impact of water management arrangements on the management of salinity in NSW.

While it was not within the scope and resources of this exercise to confer on the outcomes of these parallel inquiries, the findings of the House of Representatives Standing Committee on Science and Innovation inquiry are likely to be particularly relevant, and it is recommended that these be monitored by the NRMMC.

Recommendation 1

The NRMMC task the Science and Information Working Group to review and report on the broader applicability of the final recommendations of the inquiry by the House of Representatives Standing Committee on Science and Innovation into the Commonwealth's role in managing and coordinating the application of the best science in relation to Australia's salinity problem when the Committee reports the results of its deliberations.

Other recent strategic information gathering and prioritisation processes (see Appendix 4) and an increasing number of conferences devoted to NRM and integrated catchment management issues, are evidence not only of rapidly changing policy and governance arrangements frameworks at state jurisdiction level, but also of the need, expressed by all stakeholders, to share knowledge and air issues in a similarly rapidly evolving R&D context. They also, however, highlight the potential for conflict and duplication that will need to be managed within the objective of developing a convergent, integrated approach.

In the light of recent press releases by the Institute of Public Affairs, which question the credibility of some of the science related to the Murray Darling Basin, it is critical that CMAs have access to high quality, validated research findings in order to inform their own decision making processes.

With the development of new initiatives such as the Living Murray and the National Water Initiative, it will be essential to ensure that these and existing initiatives such as the NAP and NHT are fully coordinated and consistent in their approaches. It will similarly be essential, where funding sources for various initiatives differ, such as for the Land and Water Management Plans for irrigation areas, to ensure that processes are in place to achieve adequate integration of plans, objectives, activities and actions. The National Water Initiative foreshadows a framework for allocation of water to forestry, to make it clear that dryland, river health and irrigation are intimately connected. The need for greater coherence in state and Commonwealth NRM policies is clear and will be mentioned briefly touched later. However, for the most part policy issues are considered beyond the remit of this report.

Chapter 2

THE ROLE OF SCIENCE IN NATURAL RESOURCE MANAGEMENT

The way natural resources are used and managed affects the environment, rural and urban communities, and industry. Consequently NRM is fundamental to the long-term economic viability of the agricultural sector. In 1999 the Australian Government released *Managing Natural Resources in Rural Australia for a Sustainable Future: A Discussion Paper for Developing a National Policy*³. The outcome of this paper was the development of the National Action Plan for Salinity and Water Quality (NAP). According to the NAP web page:⁴

This Action Plan identifies high priority, immediate actions to address salinity, particularly dryland salinity, and deteriorating water quality in key catchments and regions across Australia.

The development of the NAP was predicated on the fact that Australia has critical salinity and water quality problems demanding urgent attention, including the following:

- at least 2.5 million hectares (5% of cultivated land) are currently affected by dryland salinity – this could rise to 12 million hectares (22%) at the current rate of increase;
- one third of Australian rivers are in extremely poor condition – within 20 years Adelaide's drinking water will fail World Health Organisation salinity standards on two days out of five;
- land and water degradation, excluding weeds and pests, is estimated to cost up to \$3.5 billion per year. (In addition, dryland salinity has adversely affected biodiversity. For example, CSIRO estimates a resultant reduction in bird species of 50% in agricultural areas); and
- infrastructure (buildings, roads, etc) is being severely damaged in many rural urban centres.

The NAP supplements the Natural Heritage Trust that was established by the Australian Government in 1997 to help to restore and conserve Australia's environment and natural resources.

Fundamental to the development of the NAP were some key policy directions described in the Steering Committee Report to Australian governments on the public response to the NRM discussion paper (ARMCANZ/ANZECC, 2000)⁵. These included:

³ http://www.napswq.gov.au/downloads/pdf/nrm_paper.pdf

⁴ http://www.napswq.gov.au/publications/vital_resources.html

⁵ http://www.affa.gov.au/corporate_docs/publications/pdf/nrm/cttereport.pdf

- working together effectively;
- devolving to, and empowering regions;
- investing more strategically at the regional level;
- facilitating fundamental change, building on the landcare ethic;
- capacity building for improved natural resource management; and
- enhancing knowledge and information.

Determining just how scientific knowledge and research and development can be harnessed to support the above policy directions has been a major challenge for the scientific community. The situation has been further complicated by the devolution of natural resource management responsibilities from state governments to CMAs, with different types of arrangements occurring in each jurisdiction. Fundamental to this report is whether or not the connections between science providers and the users in the catchment management community are adequate, and whether mechanisms exist to ensure that scientific knowledge is being applied to ensure that major target-based natural resource management NAP goals will be achieved.

Natural resource management requires integration and interpretation of scientific theory and knowledge across specific scientific disciplines that have often operated in relative isolation from one another. While there is often detailed knowledge of specific research subjects and sites, and knowledge of broad scale processes, there are significant challenges in integrating current knowledge across the range of scales needed to apply it to landscape, regional and paddock scales of resolution. It is not surprising that both practitioners and users of science are having difficulty coming to grips with the complexities of managing both natural and primary industrial ecosystems.

This chapter attempts to define the way in which science should be used to underpin the natural resource management initiatives and planning mechanisms under the NAP and to analyse whether this is actually happening based on the responses received from those approached during the review.

UNDERSTANDING THE CAUSE-EFFECT RELATIONSHIPS IN NRM

For the purposes of the current report, it is not intended to discuss in detail the causes of land and water degradation. However, the critical issue underlying the NAP and NHT is that Australia's land and water resources are not being used within the bounds of their capability. Generally, this is clearly not the result of landowners and managers intending to cause degradation, but a response to economic conditions impacting on agriculture, including the international terms of trade and climate variability reflected in the recent drought. Whilst the majority of landowners and managers understand clearly some of the consequences of management actions, e.g. the effects of overstocking on erosion, other cause and effect relationships, such as that between recharge to groundwater and its impacts on river salinity, are far less widely understood. A critical issue is whether targets are based on the probability of achieving land-use change through assessing economic impacts on farm enterprises as well as by understanding landscape processes.

RESPONDENTS' VIEWS OF THE ROLE OF SCIENCE AND TECHNOLOGY IN CATCHMENT MANAGEMENT

One agency summarised that NRM science and technology can:

- provide data and information to ensure that investment decisions are sound;
- be applied to gain an understanding of catchment management processes and thereby ensure that strategies produce positive outcomes;
- develop simulation models to gain insights into the catchment and to predict the outcomes of different management strategies; and
- enable the development of technologies and practices for cost-effective NRM.

All groups approached in the review process agreed unequivocally on the crucial role science has to play in underpinning NRM planning, policy and implementation, the following comments being indicative:

The role of science is to provide inventories of descriptive information; to provide an underpinning connection between targets and on-the-ground plans; and to provide the framework to test options and explore possibilities.

(Researcher)

There is a considerable requirement for new science to underpin many of the specific targets and advance implementation.

(R&D agency)

We need good science to know where we're at; we need good science to take things forward and meet targets ... Good science needs to be the basis, but in going forward there will be more emphasis on other factors – social, financial, people's attitude to change, and capacity building / extension.

(CMA)

The role of NRM science and technology is ... to provide input into the development of strategies to address issues identified in our catchment management plans and to monitor the ongoing outcomes of actions, to assist the adaptive management process.

(State NRM body)

The use of science and technology is a partnership between theory, data, systems and decision making processes. Social, organisational and institutional aspects of arrangements for delivery are an important part of this mix.

(State government agency)

The role of science in the NAP is to underpin hypotheses about cause and effect and the relative impact of interventions so that the Australian government can make best use of its investments to achieve outcomes.

(Australian government agency)

UP-TAKE OF SCIENCE IN NRM PLANNING AND DELIVERY – GENERAL COMMENTS

A view expressed by several state personnel interviewed was that *'targets won't be achievable without the underpinning science.'* Some responses did suggest that considerable progress had been made over the last 15-20 years in terms of conceptual models in NRM planning and delivery and there is considerable evidence available to confirm this with respect to single issues such as acidification, salinity, water quality (including nutrients, turbidity and pesticides) and biodiversity. However, a number of academics and research providers suggested that science was not being used as widely as it should be at CMA level with respect to achieving individual and integrated outcomes, with one researcher commenting: *'Despite the extent and scope of the targets specified in the plans, the targets won't be achievable unless they have strong science behind them.'*

A different view tended to be put forward by CMAs which, in general, proffered considerable evidence of a significant reliance on scientific information at strategic planning and investment strategy levels.

CMAs in Victoria, for example, hold science planning meetings across catchments that are coordinated by agency technical specialists, and so develop generic and specific researchable topics.

Several people interviewed indicated that NSW catchment plans were fairly well based on available science. Evidence of this can be seen in the technical appendices to the NSW 'Blueprints' (as the NSW plans are generically labelled), which detail the science underpinning the plans, and which reveal the links between targets and expected outcomes.

The *Murrumbidgee Catchment Blueprint* is one of several with a companion *Technical Addendum* which supports the various targets set on water quality and flow, salinity, soil health and biodiversity. The references comprise for the most part government publications, information fact sheets, etc., but this is counterbalanced by the technical appendix that is more strongly founded in scientific literature, providing *'additional information requested by the Commonwealth to meet accreditation criteria agreed by the Natural Resource Management Ministerial Council.* It is stated that given the potential for the Blueprint to influence actions within the catchment that may fall under the Environment Protection and Biodiversity Conservation Act 1999, *'the Blueprint must go through a process of accreditation by the Federal government as part of the bilateral agreements that have been signed by the State and Federal governments'*. The Blueprint lists primary references/sources for each target, and supporting data sets. The publication of the Blueprint was preceded, and is complemented by, a number of preparatory studies for various sub-catchments. A statement is made that the Blueprint may be updated as a result of *'new or enhanced technical, scientific or socioeconomic information'* if any of the various reporting mechanisms show that targets or management actions are inappropriate, unrealistic or counterproductive, or a gap has been identified.

At least one CMA (Glenelg-Hopkins – the first plan to be accredited), recognising the importance of ‘*getting science into NRM plans*’, used a Foundation NAP grant for information gathering to ensure that past R&D in the region was captured and used in the NRM planning process. The resulting database contains 600 entries. The comment was made by the same CMA, however, that due to tight accreditation timeframes and the desire to get projects up and running quickly, underpinning data collection and longer-term R&D tended to suffer.

The potential for duplication of effort with other regions was also raised. However, as part of the accreditation process, NAP management works with regional bodies to identify areas of synergy and to foster opportunities for joint collaboration, and given the region-specific nature of the targets, the risk of duplication is considered to be small.

One research group provided an example of working directly in an area of integrated NRM planning through development of a diagnostic tool by a Cooperative Research Centre (CRC) for evaluation of NRM plans. The same group was tendering to work with regional communities and was concerned about the high transaction costs of dealing with many clients. Ownership of data also needed clarification. They offered the view that CRCs potentially have an extremely important role with respect to their research brokering capacity.

In spite of these and many other positive examples, other responses clearly indicated two sources of concern:

- that the uptake of science in NRM planning and delivery varies widely across the CMAs; and
- that in some cases investments in research are proceeding at the local level without any effort or obligation to ensure that duplication is not occurring.

TARGETS

In approaching its task, the advisory team considered it critical to consider what evidence was available to indicate that NRM targets will be met. Two key issues are:

- whether targets are representative of cause-effect relationships; and
- whether the data is readily available to measure the target and changes that may occur.

The NAP website states that:

Good progress on addressing water quality, salinity and natural resource management issues has been made with Landcare and the Natural Heritage Trust. However, the lack of agreed specific on-the-ground outcomes and targets for water quality, salinity and other natural resource management attributes has been a major barrier to guaranteeing a return on the Commonwealth’s investment.

Agreed targets and standards will need to be set between the Commonwealth and the States and Territories, either bilaterally or multilaterally, as appropriate, in consultation with the relevant community to ensure effective use of funding.

It further states that:

Regional plans will include actions to improve regional water quality, salinity and biodiversity. They will vary greatly from catchment to catchment and address the particular needs of each region, and contain targets specific to that region.

Clear targets are important steps to measure the success of efforts on salinity and water quality. Commonwealth, State and Territory Governments are collaborating on standards for salinity, water quality, water flows and natural resource management.

Communities will be helped to include scientifically-based targets in their integrated regional plans. Expert scientific and technical advice will be available to local people to ensure sustainable outcomes.

Under the Intergovernmental Agreement that established the NAP it was agreed that:

Catchment/region specific targets for salt, nutrients, associated water flow regimes and water quality, and subsequently for natural resource management aspects ... will need to be developed by the catchment/regional body with reference to the standards. These catchment/regional targets will be:

- *based on good science and economics;*
- *measurable and time-bound; and*
- *able to be practically applied at the catchment / regional level and be achievable in a cost effective way.*

As described in the National Framework for Natural Resource Management Standards and Targets (AFFA, 2002 Standards and Targets Framework endorsed by the Natural Resource Management Ministerial Council, 3 May 2002), targets can be characterised as aspirational targets, achievable resource condition targets, and targets for management actions.

Aspirational targets

As part of the regional planning process, it may be valuable for regions to set out a vision or goals for NRM in their region, which could include long-term 'targets' that are aspirational statements about the desired condition of their natural resources in the longer term (e.g. 50+ years). These goals would guide regional planning, and set a context for the measurable and achievable targets required under this Framework. Examples could include: regional extent of native vegetation to be increased to 30% cover; decrease in average salinity in regional streams.

Achievable resource condition targets

Within regional plans, CMAs will be required to set specific, timebound and measurable targets, relating largely to resource condition, against the minimum set of matters for regional targets. The timeframe for achievement of these targets is likely to be 10-20 years. **These targets must be pragmatic and achievable.** They would be developed iteratively, including through a benefit/cost analysis. Examples could include: average salinity of X ECs at specific end-of-valley site by year Y; X hectares of specific native vegetation type within region at year Y maintained or regenerated; X stream sites within region in specific river condition category by year Y. Within their regional plans, CMAs may also wish to set targets for matters that are additional to the minimum set.

Management action targets

In addition, CMAs will be required, as part of their regional plans, to set short term targets (1-5 years), relating mainly to management actions or capacity building. These targets must contribute to progress towards the longer-term resource condition targets. Only some matters for management targets are specified, as the relevant management solutions to reversing resource degradation are likely to vary substantially between regions. In setting these targets, regions need to take account of national indicators, and associated guidelines and protocols for measuring and reporting, as set out in the National Framework for NRM Monitoring and Evaluation, so that they use consistent approaches where these have been identified. Examples of management action targets include: X hectares of recharge zones within region to be revegetated by year Y; X km of riparian zone to be fenced and managed for conservation and landscape function, X% of farms covering Y% of region with whole farm plans.

The perceived benefits and criticisms of target setting as a natural resource management tool have been covered in a comprehensive recent review.⁶ In the current study, those surveyed were questioned about whether there was sufficient scientific information available to inform the target setting process. The overall impression from the information gathered is that targets appear to have been established in the planning process based on a paucity of high quality data and scientific input.

It was suggested by one individual that biophysical responses to interventions are uncertain because they cannot be measured – even in highly regulated systems such as the Murray Darling Basin *‘so in many cases we need to be very sanguine as to whether targets will be achieved’*.

Others interviewed considered that targets were generally aspirational and that they were a means to an end – that end being to effect behavioural change with respect to NRM at the property level.

One person interviewed suggested that the concept of targets did not really help in answering the question *‘how does what we are intending to do affect land and water condition and is what we are doing now leading to degradation or improvement of*

⁶ Johnston (2003).

resource condition?' This is an important point in a systems approach, because meeting one specific target might be achieved, while the health of the entire system or other components of it continue to decline.

Another important comment was the observation that some mature catchment management agencies employ 35 staff whilst some of the more nascent agencies have only three employees, so the ability of the agencies to seek out and assimilate science inputs into planning, target setting and management is highly variable.

Whilst many individuals thought that there was a reasonable understanding of the cause-effect type of mechanistic processes, there was generally a divergence of opinion as to whether there is enough scientific data available to adequately inform the target setting process.

At one extreme there was opinion that the MDBC salinity targets were based on good science and that they provided a good basis for the establishment of catchment targets. Elsewhere, with respect to salinity and also generally with respect to biodiversity, targets were described as 'flabby', at best 'aspirational', and very difficult to establish. The general tenor of responses was that this was often due to poor engagement between CMAs and the scientists who had, and who understood, the available data.

Several comments were made that it was hard to engage the scientific community in target setting, so a typical response had been to set a target and see whether there was major disagreement from scientists and then modify the target appropriately. There was also scepticism from some that because of natural variability in systems, a target of a change in magnitude of 10% or 20% for a given parameter could be an absurd construct for some parameters.

With respect to biodiversity, a catchment management board commented that they did not have enough data on biodiversity so they resorted instead to setting a vegetation target, for which data was available.

In terms of catchment managers meeting targets, one interviewee considered that in NSW at least, too much of the onus was placed on the (former) NSW Departments of Land and Water Conservation and Parks and Wildlife, with resources being fed through the CMAs back to the department, so restricting the extent of scientific input that could be achieved. However, it was noted that a departmental restructure might extend scientific input, and a recent review initiated by the NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) suggests that better integration of research provision is being sought.

The same respondent reported that the majority of NSW plans were founded on a uniform recipe that included scientific information with respect to salinity, riverine ecosystems, native vegetation and biodiversity, and took account of community capacity, communication and education.

The comments highlight the concern that for the plans and targets to work, responsibility and accountability is needed at the CMA level.

One view worth consideration is that the use of performance indicators that can be easily measured has sometimes led to setting targets that are inappropriate. For example, a turbidity performance indicator may over-emphasise bank slumping rather than erosion hotspots or riparian vegetation condition. Current work (CRC for Catchment Hydrology/CSIRO Land and Water) provides information on erosion hot spots through the decision-support system SEDNET and also shows how targeting riparian rehabilitation in catchments with highest contribution to downstream loads can give a 20% reduction in suspended sediment. Similarly, easily measurable indicators such as pH may not give an adequate indication of soil health. Also there are many comments that vegetation in the landscape is not a good surrogate for biodiversity or threatened species and that there seems to be a gap on the mapping of condition, including understorey.

The combination of threats and synergistic effects of management actions may be missed if a single target framework is imposed, although in some cases focus on a single issue/target may be required (for example, management actions to achieve salinity targets are aided by the use of CATSALT in NSW).

ACCREDITATION

The NAP website states that the *'Commonwealth and States/Territories will jointly accredit individual plans in order to be confident that they will deliver the agreed outcomes. This will involve assessment of their quality including timetables, performance measures, accountability and reporting arrangements'*. Specific indications are provided for plan content.

The NRMCC in May 2002 endorsed criteria for the accreditation of NRM plans, stating in its communiqué that *'the Commonwealth and States will use these criteria for accrediting the plans'* and that the accreditation criteria *'promote a planning process that is: community owned and initiated; based on science; and foster targeted and collective action for landscape change'*.

In interviews at the Australian government level, it was indicated that the plans were not necessarily expected to be overly scientific, in that their role is to provide the strategic context for an investment strategy. Indeed, the investment strategies that are now emerging generally reflect a shift from strategic context to target-based scientific outcomes. It was commented that even the more mature regions were finding it challenging to specify the cause and effect relationships and the action and target linkages required in their investment strategies.

NAP management does not invest formally in conducting scientific audits of plans; it is considered that the resources of the portfolio agencies involved provide sufficient in-house expertise both to review plans in the accreditation process but, more importantly, it was argued, to provide on-the-ground assistance to the regions to improve their investment strategies.

The current NAP focus at the national level is on ensuring a robust state system that provides a solid strategic NRM context for the Australian and state governments to function as joint investors. Considerable Australian government resources are

therefore being contributed at this early stage to develop and foster those robust systems.

On the basis of interviews conducted with a wide range of respondents, it would seem that the accreditation process has been largely overtaken by the pace of events and the need for rapid investment under the NAP.

At the time of writing some CMAs had been involved in having plans accredited. Several agencies perceived deficiencies in the accreditation process. These included accreditation delays and consequent funding delays, insufficient clarity on the requirements for the robustness or integrity of the science required in the plan, and the variable roles taken by the states in terms of guidance and support. Many agencies pointed to time pressures as a factor contributing to the lack of adequate scientific input to plans. It was felt that there were unrealistic expectations about timeframes on the part of all parties, both in terms of accreditation drivers, and the different pace of Commonwealth, state and regional planning.

Specific suggestions were made in relation to the need to develop an agreed approach to documenting the supporting science for NRM plans so that disagreements on accreditation can be ameliorated, and to ensure that, notwithstanding the requirement to support the plans with scientific justification, there needed to be a 'simplified' version of the science available for presentation in the public domain so that it could be understood readily by the community stakeholders.

From the limited responses received concerning accreditation, no clear conclusions can be drawn with respect to the efficacy or uniformity of the accreditation process. Or concerning the extent to which the process addresses the matter of scientific and technical input to the plans.

SUMMARY POINTS

- Considerable work has been undertaken to identify key, measurable parameters which can be used as targets for the application of catchment management strategies. This is an evolving process and one that will require further scientific investigations and feedback from implementing agencies.
- Salinity and water quality targets appear better underpinned by scientific data and knowledge than biodiversity targets.
- The submissions and discussions indicated a range of situations from those where the proposed targets were underpinned by scientific knowledge and experimentation to those where there was limited specific evidence of such underpinning. Little information was forthcoming that suggested that targets, even if met, would be sufficiently robust to arrest or reverse the decline in catchment condition in many areas.
- Many targets appeared aspirational and, although they may not be met, may still have a considerable influence on land and water management behaviour.

- A lack of good scientific data at catchment level and a lack of knowledge about what data is available has hampered the establishment of robust targets and may be contributing to a duplication of the research effort.
- The accreditation process is specific concerning requirements for science to underpin NRM planning, but less specific on how this will be assessed uniformly. Institutional differences from state to state and catchment to catchment are being addressed through commitment of NAP/NHT resources to strengthen institutional systems. At the same time, there is a suggestion that the scientific robustness of targets is being overlooked in the desire to put investment strategies into place.

Recommendation 2

The NRMCC request NRM lead agencies to review and report on whether specific targets critical to the overall success of the NAP are adequately based on relevant and measurable data and what modelling and/or monitoring processes are in place to determine their achievability and provide feedback on the impacts of adopted management practices.

Chapter 3

ACCESS TO SCIENCE, SKILLS AND KNOWLEDGE

A key factor that impinges on the use of any scientific skill or knowledge is the ability of those requiring it to access it in a manner in which it best suits their needs. This is a two-way process: the providers of scientific skills and knowledge have a responsibility to make them available and accessible to potential users, and the users have a responsibility to define and promote their needs and requirements. A measure of the success of this process will be the extent to which R&D has been captured within the catchment management plans.

EXTENT OF R&D CAPTURE

Many R&D groups consulted felt that the current available catchment management plans showed that some relevant science and technology is being captured but that it is not necessarily being applied appropriately to the problems being addressed. This was attributed to a lack of shared understanding of the targets and strategies, insufficient interactions at the early planning stages between R&D agencies and the regional groups, lack of ongoing support by R&D agencies, and in summary the *'absence of a proactive mechanism for those engaged in developing programs and plans to be linked effectively with the organisations or individuals with valuable NRM knowledge.'* Certainly, the complex nature of management of the natural resources across a catchment and the tendency for the scientific and technical advances to be compartmentalised does not help the catchment managers in this task.

When asked whether NRM science and technology were being captured, there was a general view that the appropriate scientific inputs are occurring to widely varying degrees, that is from significant levels of uptake to very limited uptake.

Terms such as 'patchy' and 'chequered' were used to describe science input into catchment strategic plans. However, there was some uncertainty about whether comments were about science *per se* or the application of conventional best practice.

Whilst some comments were received from CMAs that science had provided a sound basis for understanding the relationship between, for example, clearing and salinity, there is insufficient data at local catchment level to provide a firm basis for action. *'Little of the \$300m spent annually on natural resource management R&D and its outcomes is reflected in catchment management plans. However, we cannot expect this to happen via passive osmosis.'*

One interviewee was concerned that there was no evidence from catchment management plans in the Murray Darling Basin that individual plans related to the basin as a whole. Whether the Murray Darling Basin Commission can provide strong

overarching policies and strategies under the new catchment governance arrangements has yet to be established.

Several scientists approached considered that the science that was used in the plans was very general and that few attempts had been made to tailor the nature of scientific analysis required to the natural variability that occurs in the landscape.

The following comments are indicative of responses:

On the surface, the plans show evidence of scientific input. Underneath this is not as apparent.

(RDC)

There really is no systematic science underpinning catchment management [in the State concerned]. Science is done in a piecemeal fashion and depends on specific issues and priorities at the time. There is not much in the way of novel science. [Other] catchments may be relatively sophisticated in determining priorities but do not have a conscious program or integrated science underpinning holistic catchment management.

(Researcher)

There are many instances of new methods and tools and scientific understanding held in research organisations and project teams that have not been exploited to provide a sound basis for NRM policy objectives or for strategies and programs on the ground.

(RDC)

The reasons advanced for this were several but together highlight gaps in the current process:

The role of science is to underpin planning, policy and implementation. Whether it is happening or not tends to depend on the capacity of the regional body rather than on the available science. The more advanced groups recognise science as a cornerstone of their planning.

(State government department)

The role of science is to underpin hypotheses about cause and effect. Gaps exist between the scientific and non-scientific community ... which experience difficulty in achieving a common language, let alone a common understanding.

(Australian government department)

The use of science and technology in many NRM planning projects ... has been patchy, but where innovative approaches have been used, they provide excellent examples of what can be achieved ... Involvement of science and technology varies markedly between planning processes from heavy reliance on available tools, to outright resistance to its use. The application of innovation in approach has often been largely opportunistic.

(State agency)

A common response is that plans are about delivery of management change, but they do not necessarily see this as needing to be underpinned by research. There is a strong and considered need for new science to underpin many of the specific targets, and to assist implementation.

(NGO)

Scientific knowledge and technology are central to both the development and implementation of NRM plans and programs. It is critical to ensure NRM planners and managers can make informed decisions based on the most accurate information available. Processes need to be in place to capture new information in a timely manner. Availability of resources will determine the extent to which science and technology can be captured and applied, and priority will be given to the most pressing needs. The prioritisation process should take into account the degree to which scientific knowledge and technology can assist with solutions to the problems.

(Researcher)

There is some little linkage at a local level between identification of priorities and development of plans and locally-known science and technology. However, even at this level, those developing such strategies and plans are often not aware of the knowledge held in other organisations within the same State or Territory, let alone that held within Commonwealth organisations. The links between science and strategies/plans still exist but are weaker at the State or Territory level, while at the Commonwealth level, they hardly exist at all ... This reflects the significant failure on the part of governments to seriously address the need to harness scientific knowledge to help develop the strategies and plans that are based on the best available knowledge and science, and have the highest chance of achieving public policy objectives.

(RDC)

However, it should be acknowledged that many research agencies hire specialist knowledge brokers (for example the CRC for Freshwater Ecology – currently, and the CRC for Irrigation Futures – foreshadowed), adopt focussed catchments (CRC for Catchment Hydrology), invest in community capacity building (Land & Water Australia) or pilot programs (Landmark, MDBC). These are encouraging developments but more needs to be done. The recent Australian Government contract to Greening Australia (GA)⁷ to provide a ‘knowledge broker’ role over the next three years to support NRM is also a step in the right direction. This initiative will encourage regions to be aware of and use findings, techniques, etc. from research organisations. GA is putting together a number of activities including a ‘cut-the-corners-catalogue’ to feature relevant publications, based largely on input from research organisations.

⁷ <http://www.greeningaustralia.org.au/GA/NAT>

ACCESS TO R&D EXPERTISE

It was observed by many that there was considerable disparity between NRM plans, and that those that demonstrated a stronger scientific basis were attributable to their good access to local R&D institutions. In other less well scientifically resourced areas, the plans would be expected to – and do – contain investment targets to improve the available scientific basis.

There is evidence that science relevant to the planning process from areas other than state agencies and CSIRO is often difficult to obtain and that this is particularly the case with universities.

Some mainstream research groups, who felt that they had appropriate expertise to offer, expressed disappointment that they had not been approached by the local NRM planners. Others had provided input but then failed to see this translated into targets and strategies in the plans.

Once the final plans were produced they were analysed to see where there was a need for additional science to achieve a target and identify where the [R&D organisation] could contribute expertise. As a result of that analysis and previous work ... we put together a comprehensive portfolio of existing and new projects ... which we felt contributed to delivery of catchment targets. We have been trying to negotiate specific projects with the Boards ever since and have some that may be supported, although the common response has been that the plans are about delivery of management change, not about supporting research.

(R&D organisation)

Others again felt that the pressures on research agencies and reliance on external funding made it difficult for them to become actively involved. CMAs on the other hand commented on the difficulties that they had experienced in achieving constructive dialogue with scientists and criticised the slowness of scientific organisations to develop tools that will directly assist the regions, an overly strong focus by R&D agencies on research, and less interest in transferring existing knowledge or in communicating knowledge to the relevant decision makers.

One CMA suggested that R&D agencies should make contact with regional bodies when they are working on areas that might have impact, in order to avoid duplication of effort, and to ensure regional bodies can pick up on that work. Their research might also be able to be expanded or realigned with minimal effort to take account of a particular region's identified need/target.

It was commented that regional groups are operating at vastly different levels in terms of their ability to be informed purchasers of science, to integrate science into their plans, and to manage that information over the longer term. Even in states that have a longer history of regional and community capacity building, CMAs are at different levels of development.

There was general consensus that, despite their high enthusiasm, regional planning groups tended to be hampered by a lack of strong technical skills. Several groups

approached by the advisory team pointed to a lack of deep local knowledge in CMAs and considerable variance in the strengths and capacities of Boards, particularly with regard to robust understanding of the science required to achieve the outcomes proposed in the plans, and of the related socioeconomic and predictive understanding. In some cases the commitment and direction provided by the chair or lead organisation was seen as the key influencing factor.

The level of understanding of the value of research in improving the management of natural resources, and the awareness of new or emerging scientific advances that would enhance the effectiveness of natural resource management varies dramatically amongst individuals on regional advisory boards. There is often lack of awareness by members of regional groups that the Investment plans and Strategies prepared by them had already identified priorities for research.

(State government department)

While this is not surprising, it has the potential to make CMAs over-dependent on human capital – on dedicated individual scientists, their goodwill, and personal commitment. Catchments that are isolated from research institutions tend to suffer and have to draw on consultant R&D expertise which tends to jeopardise community confidence in the priority setting exercise. In addition, it is apparent that the extent of support and guidance from state agencies to the regional bodies varies from state to state.

The need to tap local knowledge more effectively and to achieve constructive and sustainable dialogue that feeds into the planning process between local groups and mainstream research agencies was strongly reinforced.

What we've found ... is that bringing regional scientists together has been much more worthwhile than taking a small group ... The local science has been absolutely critical ... but the regional approach is also a potential danger in that knowledge and information is locked in individuals, consultants or small groups and may disappear. The region needs continuing access to the science that went into the plan and therefore the understanding to implement beyond that.

(Australian government agency)

An emerging gap for science is how to implement plans through a multidisciplinary approach. The rush to spend money will result in poor investments. The investment in on-ground action needs to be accompanied by parallel investment in capacity building in government, NGOs, and catchment management authorities. By capacity, what is meant is knowledge of the biophysical base, institutional structures, accountability, government processes, ability to work in groups/teams, to plan, and to incorporate science.

(CMA)

A strong message was that links to local government were being overlooked, despite the strengths of local government as planners with regulatory powers, though deficient in technical capacity.

We've found getting 4-6 people in local governments in a sub-catchment is powerful for adopting NRM strategies and getting these followed through in planning.

(State agency)

APPROACHES TO PLANNING

Approaches to NRM plan development vary among CMAs. Some use consultants to put the plan together; others rely on local knowledge and linkages, particularly those well located in terms of access to R&D institutions.

One researcher commented that the plans generally show considerable knowledge (achieved through technical workshops and meetings, use of literature and commissioned reports, etc.), and some plans show considerable depth, but they seem to reflect a state government-imposed formula, which is not often overlaid with local knowledge. The lack of adequate inputs to the planning process sometimes becomes apparent in a mismatch between the targets set in the plans and the agencies nominated to deliver them.

Some plans have explicit management actions concerning research, e.g. to improve understanding of management of natural resources and the environment, and then nominate the delivering agency that is an agency not intended or equipped to conduct research.

(Researcher)

Almost all groups commented in some way on the potential for friction between the players and the difficulties of achieving dialogue between all the players, as well as the need to establish a common framework and language for such dialogue to occur. The lack of a common approach to setting targets was a concern, as was the need to recognise the potential for tension between national, higher level targets and targets identified at the community level.

Processes of change – which are essentially what we are asking rural communities to do – require sensitive negotiation and facilitation. Overly scientific explanations aren't necessarily well-received.

(CMA)

The need for better interactions at an early stage in planning is felt by all involved. This means engaging the community, regional bodies, mainstream and local R&D agencies, NGOs, industry and the state government early in the process, in order to ensure a shared vision of targets and a shared understanding of what realistically might be achieved through the application of science within specified timeframes. It was stated in this context that good science has to be followed by policy change, and NAP enables this whole package – scientific, policy, sociological – to be delivered. The challenge is in achieving and maintaining this focus.

The risk is that we are setting ourselves up for failure, and that is disempowering. Biodiversity declines will take a long time to turn around, even with concerted action. However, at local and patch scale, environments are quite responsive. The issue is to continue this for 50

years ... Sometimes more data collection is substituted for not making a decision, but the more data that is collected, the more complex and overpowering the problem seems to be. Starting simple and having a few small successes is better for building community support than getting more data. It makes the next actions easier because the community has shifted.

(NGO)

It was suggested that it was difficult for anyone, and in particular regional CMAs, to have sufficient capacity and information to assess the potential effectiveness of the interventions specified in plans to achieve particular outcomes, or to know whether a specific investment strategy would lead to a particular outcome. The extent of scientific knowledge itself was questioned, in relation to the ability to predict with any degree of certainty and credibility whether particular interventions would result in better outcomes. While it may be possible to predict and prove biophysical impacts, the flow-on socioeconomic benefits are a further dimension that many claimed was being neglected in the planning process, and in R&D itself. Monitoring and evaluation processes that are sensitive to change, and that take account of the long lag times in the impact of changes in land use, will therefore also be critical.

A common complaint, echoing the views expressed by participants in the April 2003 NRM Community Forum, was that there was generally insufficient high quality scientific data available to catchment planners and managers to assist in the planning process, or that where such data or information existed, it was not readily accessible by planners and users, for a variety of reasons. This was countered in one case by a comment that many CMAs had not made enough use of the data available through the National Land and Water Resources Audit.

Several interviewees in Australian and state government agencies observed that, in the past, the structure of science, with its reductionist focus, had not been well suited to NRM planning which needed a strongly integrated focus. One agency commented that '*NRM has undergone a significant paradigm shift in recent years. Past emphasis on single agency, issue-specific approaches to management have been replaced with landscape wide approaches to management.*' This was not helped by the structure of many universities with separation of agricultural and environmental science faculties, and an award system for academics that favours reductionist, single issue foci, with few incentives to deal with complex, longer-term integrative issues.

One state agency commented that an increasing focus on technologically-driven approaches had evolved in conjunction with improvements in knowledge and understanding of underlying biophysical processes. From a narrow focus on species level issues, interest has shifted to landscape level issues, such as habitat suitability, wildlife corridors, nutrient, hydrological and carbon cycles, climate change, and pest and disease management. The appropriate design of landscapes which address these processes has been assisted by the development of relevant tools such as computer-based statistical modelling, in combination with spatially-referenced databases and geographical information systems, providing the broad spatial information required for regional NRM planning. In addition, analyses of data have become increasingly sophisticated allowing outcomes to be utilised by planners and decision-makers.

A number of agencies are custodians of data, tools and skills. Ongoing refinement of approaches through planning processes will provide opportunities for increased interaction between custodians of these resources. Such interactions should be encouraged.

At the other extreme, the comment was made that the CMA experience of getting all the research/ers together was one of frustration as many scientists were not willing to tailor their science to fit the catchment level. *'Scientists are there to do a science project and the dictates in terms of rigour and repeatability are paramount and I'm not convinced that many scientists out there are willing to tailor their science to fit the catchment level.'* This statement was couched not so much as a criticism of scientists as a comment on the outcome of the demise of the state extension systems and the lack of ongoing linkages between scientists and farmers. *'The background decline in extension services fundamentally undermines the prospects for the CMAs'*, because they are consequently undertaking activities that would more traditionally have been done at the state agency level. A resulting dilemma for CMAs was whether they needed to function on the ground, or whether they were policy organisations. If the former, it was felt that they were ill-equipped for the extension role.

CONSULTATIVE MECHANISMS IN PRACTICE

Communication between state agencies, researchers and CMAs is of paramount concern if NAP outcomes are to be achieved. To this end, this section attempts to highlight some examples of which the advisory team was made aware, where communication is working reasonably or very well. Two practical illustrations are also included.

The NSW Department of Investment, Planning and Natural Resources is appointing four state and regional facilitators covering the thematic areas of land, water, coastal and marine, biodiversity. These facilitators will be complemented by regional and local community support officers, selected by the catchment boards, to manage networks, information flows and policy interpretation, recognising that each board requires access to a small team of specialists.

NSW Agriculture was represented on almost all Catchment Boards during plan development. Similarly, the NSW Centre for Natural Resources (part of DIPNR) has also contributed very significantly to the scientific underpinning of the catchment plans.

The Murrumbidgee Catchment Management Board has established technical teams for salinity, biodiversity, soil health, capacity building, monitoring and evaluation. Their approach encompasses NGOs, Landcare and local government, and they are developing consortia with industry bodies including the RDCs. Science for priority setting is sourced through state government and local expertise.

Southern NSW Salinity Workshops are held for District Agronomists and Livestock Officers in southern NSW. Workshop materials under development at the time of preparation of this report include the *Salinity Glove Box Guide*, a reference guide for paddock use; the *Healthy Catchment Guide*, a technical manual for frontline staff, and the *Salinity Management Training Manual*, an accredited course covering all aspects of salinity management, designed for frontline staff and landholders. The *Southern Salt Action Team* (SSAT) is a key tool in land manager capacity building and adoption of salinity provision practices. The SSAT meets every two months at different locations in the Murrumbidgee and Murray Catchments. Team members are DIPNR and NSW Agriculture staff, whose role is to provide training to government and private agricultural advisers; translate research results to paddock level actions; develop salt training programs; review salinity material; and facilitate salinity updates and discussion between salinity extension and research staff across departments

The SSATs work to the *NSW Salinity Strategy 2000* of the DIPNR and NSW Agriculture against the objective of 'working with land managers to deliver changes on the ground' through a range of training activities. They are multidisciplinary teams whose role is to 'translate output from agency technical staff to catchment and landscape level. They will, especially in priority salinity hazard landscapes, assist agency frontline staff who work with land managers and groups of land managers to develop paddock level actions, recognising that 'there is a surprising amount or existing salinity research information that requires such [translation] work'.

[Source: SSAT workshop materials]

In Victoria, the Victorian Catchment Management Council is assessing R&D needs for each CMA. Some CMAs have held workshops and forums with the R&D community, drawing together state research groups, CSIRO, universities and consultants. Others have attempted an audit of the research in their region. However, there was criticism that this process had not been reinforced by more strategic analysis or followed through with quality assessment processes.

In Queensland, 26 statewide investment projects have been established, oversights by five boards with R&D representation; a Science Coordination Working Group across four departments including regional agency representatives has been established; a regional NRM taskforce is addressing (i) information and science; (ii) communication; (iii) institutional arrangements, and includes members of the Science Coordination Working Group that is trying to inject science through the target setting process. Regions are being assisted to build relationships with R&D institutions such as CSIRO, a university or a CRC.

The South Australian Department of Water, Land and Biodiversity Conservation established the Centre for Natural Resource Management (CNRM) to ensure closer linkages between regional groups and researchers and to influence the NRM research in the state. Membership of the Advisory Board to the CNRM includes regional groups, government, research providers and industry. A Technical Working Group meets regularly with regional groups in a series of Regional Science Forums which discuss information and research needs and identify research priorities from a regional stakeholder perspective. The output of these forums is a set of project proposals for research required to underpin the investment strategies of the regional groups; and, over the longer term, the building of durable partnerships between the regions and research agencies. The Centre reports that:

The community engagement program being undertaken has been most beneficial for a number of reasons:

- *greater linkages, partnerships and respect between the regional groups and the research community;*
- *a greater awareness and appreciation by the regional groups of the nature and extent of the research capacity and opportunity the research community can provide in support of their regional needs and aspirations;*
- *a greater awareness and understanding by the research community of regional needs and how research can address them;*
- *identifying opportunities where regional groups can better leverage their research focussed investment strategy funding from other sources usually accessed by the research community;*
- *identifying research needs of the regions.*

The role of the **Centre for Natural Resource Management in South Australia** is to oversee the state's research component of the NAP and broker the development of research programs underpinning regional natural resource management needs and initiatives.

The Centre aims to facilitate and encourage collaboration amongst researchers, so that the research community can deliver better outcomes collectively. The Centre identifies new funding sources that may be available for NRM research from both the public and private sectors with the aim of leveraging the NAP research funds. The Centre's Investment Advisory Board has representation from the SA NAP/INRM regional groups, private sector, state and Australian governments, and the research community.

The CNRM has initiated a Regional Community Engagement Process aimed at aligning the NAP regional group's strategic investment strategies with research and development needs and solutions. At a seminar early in 2003 the five South Australian NAP regional groups tabled their innovation requirements derived from their draft investment strategies, and representatives from the research community provided an insight into the collective capabilities and technology platforms that could be utilised to develop regional needs.

Since then, a scientific/technical working group of the Centre has consulted with each regional group. The working group contains representation from the three South Australian integrated natural resource management related research organisations - the CSIRO, universities and South Australian Research and Development Institute. The working group identifies technical programs and solutions, drafts and endorses projects to deliver these, with an initial focus on:

- impacts of land use on water quality
- hydrological requirements of water independent eco systems in south-eastern South Australia
- valuation and classification systems for eco system health
- landscape and climate futures
- water and irrigation futures
- new industries
- social and economic research
- hydrological and salinity processes
- biodiversity conservation and restoration.

Programs aim to provide the R&D underpinning sustainable INRM solutions to regional problems and wealth generation opportunities.

The Centre for Natural Resources (CNR) in the NSW Department of Infrastructure, Planning and Natural Resources (DIPNR) provides specialist scientific and technical expertise, knowledge and information, and collaborates with regions and other divisions to support the delivery of government programs for natural resources management. The CNR can assemble multidisciplinary teams to respond to and help resolve emerging natural resources management issues. It also undertakes a scientific program that has been a key to the community's understanding of natural resources issues and solutions.

CNR delivers information, knowledge and science on natural resources as required, either by other areas of DIPNR or on behalf of relevant stakeholders, through:

- management and analysis of resource data sets;
- undertaking scientific modelling and mapping;
- development of decision support tools; and
- science coordination.

The Consortium for Integrated Resource Management (CIRM) operates as a formal linkage mechanism through a network of key officers from its six partner organisations – three Queensland government departments (Natural Resources and Mines, Primary Industries, and the Environment Protection Agency), two universities (University of Queensland and Griffith University) and CSIRO. It was formed in 1993 and has evolved as a mechanism for facilitating the planning and co-ordination of collaborative research initiatives. It has links to the community through its partners and through an association with Landcare and the Catchment Management Council. The CIRM Board acts as a reference group for CIRM's activities, and is composed of the CEOs of each of the partner organisations.

The benefits of implementing such a process include:

- facilitating the coordination and integration of natural resource management research among partner organisations and providing an efficient means of assisting project innovators to move new collaborative proposals forward;
- minimising the start-up or 'transaction' costs of joint projects;
- minimising the duplication of effort and resources;
- accessing established communication linkages; and
- developing and strengthening research partnerships, both with CIRM partners and beyond, including the community.

Examples of CIRM-facilitated activities include ARC-SPIRT (now ARC-Linkage) projects valued at many millions of dollars, successful establishment of the Co-operative Research Centre for Coastal Zone, Estuary and Waterway Management, several major wastewater renewal and use programs, and an international watershed project. Scoping papers have been published on social and community dimensions of natural resource management, management of aquatic ecosystems, dryland salinity risk assessment and water renewal⁸.

⁸ <http://www.nrm.qld.gov.au/science/papers/papers.html>

The Centre for Groundwater Studies is an international cooperative research and education venture with strong focus on processes of groundwater recharge, discharge, contamination, remediation and management.

It addresses major land and water resources issues in Australia and overseas through interdisciplinary research by its member organisations, agencies and companies.⁹

INDUSTRY INVOLVEMENT IN CATCHMENT MANAGEMENT PLANNING AND STRATEGIES

Australia has an excellent track record of using science to underpin the development of our rural industries. This has been facilitated through the RDCs and government funded initiatives including Landcare and Bushcare.

During the current review process, several interviewees raised the fact that a potential major weakness in the catchment management process under NAP is the fact that, in many instances, key industry groups and individual farmers appear to have been isolated from the process. Whilst it is impossible to generalise that this is the case everywhere, in catchments where this has occurred there will be serious difficulties in meeting targets and achieving behavioural change.

There has been a significant failure to make effective links between government-driven and industry-driven programs, whether in science and research or in on-ground management. There does seem to be a gradual recognition that, while governments have an important role in helping to identify public policy objectives in NRM and in supporting strategies and planning at a catchment or landscape scale, for the most part on-ground management will be implemented by individual landholders, many of whom are involved in some form of agriculture.

(RDC)

There has been only a limited attempt to link activities funded under government programs, such as the NHT and the NAPSWQ, with related industry programs, despite clear evidence that such linkage is likely to result in much higher levels of uptake and implementation of improved management.

(RDC)

If the traditional extension officer system still existed we would not be in such difficulties because what is needed for catchment management is skills in group processes and in weighing up trade-offs at levels beyond the farm boundary, not the replacement of the technical skills available in extension officers.

(Researcher)

⁹ <http://www.groundwater.com.au>

People with deep subject knowledge are working as private consultants with much more limited clientele than in the days of extension officers. Days of getting 1:1 advice on the farm are gone. The background decline in extension services fundamentally undermines the prospects for CMAs.

(RDC)

We are underfunding the development of new farming systems; we are assuming that that adopting existing knowledge will be enough.

(RDC)

There is a critical information and knowledge gap between the 'macro' landscape-scale changes that the community seeks, and the practical 'micro' property-level activities that are to contribute to delivering those desired landscape outcomes. R&D in this area must factor in a close partnership with primary producers, downstream processors and the financial institutions supporting the former.

(State department)

Discussions with representatives of farmers also indicated an apparent separation between the farming community and catchment management agencies in some cases, although many landholders hold positions on CMA boards.

Only a few people interviewed from CMAs stressed the role of economics in the acceptance or rejection of change. Whether this reflects a real dichotomy between CMAs and the farming community is uncertain because of the sampling techniques used, but it does highlight the fact that there is a tendency to forget that change is largely going to be made by individual landholders. One interviewee from Queensland argued cogently that in the Fitzroy, a key driver of the strategic planning process has been that of keeping an understanding of the economic impacts of proposed land management changes in view. Coupled with the use of the neighbourhood catchment process, this increased the likelihood of adoption of change.

It is also salient to point out that the paper produced by the NRM Science and Information Working Group highlighted the need for R&D to facilitate the understanding of the relationship between on-farm practice and catchment responses. This and other areas of integrative and underpinning R&D fundamental to the ultimate success of the NAP were not funded because of the commitment of all the NAP funds to on-ground programs.

The comment was made that industry-led quality assurance programs (Graincare, for example), approaches to best management practice (the cotton industry's pesticide BMP manual), grower action learning programs (TOPCROP, for example) development of environmental management systems, and specific capacity building initiatives such as advice on no-till cropping systems, all provide potentially very effective means of engaging landholders and finding the practical means by which they can contribute toward NRM policy objectives and strategies. A greater effort could be invested into harnessing this potential, and to the industry-driven science and technology effort managed by the rural RDCs. Such linkages do exist at local

levels and a few at the state level (the Farming for the Future Program in NSW, for example) but are lacking at the Australia-wide level.

The RDCs consulted provided examples of programs and projects which could be harnessed to act as vehicles for the delivery of local and regional priorities within NRM programs. Grower group alliances, for example, could be extended to encompass learning and delivery mechanisms for NRM science and technology developed outside the industry. The Grain and Graze R&D Program supported by the Grains R&D Corporation, Meat and Livestock Australia and Land & Water Australia was mentioned by many outside those bodies as an example of an industry led program that would improve farm productivity and profit, improve environmental management to meet public policy objectives and specifically identify how improved management can be linked to catchment targets for NRM.

SUMMARY POINTS

- There is clear evidence (and numerous examples) that state government agencies have contributed significant scientific input to the strategic planning process and that some have established structures or agencies to facilitate this process.
- In general, the longer established and better resourced catchment management agencies have used accessible science in the development of their plans.
- Linkages between federal science agencies such as the CRC for Catchment Hydrology, and CSIRO have been good in some catchments, but there are too many catchment agencies for this coverage to be achieved evenly.
- Linkages between most of the universities and the catchment management agencies are weaker and university based science relevant to catchment management and planning is often difficult to obtain in the regions, except through CRC-focussed catchments. More formalised linkages and networks could include the appointment of knowledge brokers in research provider agencies and/or in catchment groups/Boards.
- Many research agencies hire specialist knowledge brokers (CRC for Freshwater Ecology) or intend to do so (CRC for Irrigation Futures), adopt focussed catchments (CRC for Catchment Hydrology) or invest in community capacity building (Land & Water Australia) or pilot programs (Landmark, MDBC). These are encouraging developments but more needs to be done.
- Scientific input into catchment strategic plans and their implementation remains patchy and characterised by relatively simple and broad generalisations, not often tailored to local conditions.
- Inclusion of industry based bodies within the NAP processes has been successful when implemented, but is relatively limited, although farmers and land managers play significant roles in CMAs and their boards. It is important that the NAP/NHT attempt to incorporate information about profitability of farm enterprises into

technical decision making processes in order to encourage land use changes that do not disadvantage farmers financially.

- Groups such as The Centre for Natural Resources Management in South Australia, The Centre for Natural Resources in New South Wales and the Consortium for Integrated Resource Management (CIRM) in Queensland are successfully enhancing linkages between industry and CMAs.
- The challenge is for Australia to further develop the linkages between all research providers and CMAs via improved scientific brokering. If successful this could be international best-practice as was Landcare in its day.

Recommendation 3

The NRMCC request NRM lead agencies to review and report on existing communication mechanisms between R&D providers, R&D brokers, state agencies, industry and commodity groups and catchment management agencies to identify existing and emerging mechanisms that open better channels of communication between these bodies.

Recommendation 4

The NRMCC consider mechanisms by which profitability of farm enterprises and regional employment opportunities can be incorporated into scientific and technological decision support processes in order to facilitate development of new and appropriate industries and beneficial land use changes that minimise economic and social disadvantage.

Chapter 4

DATA AND INFORMATION AVAILABILITY

As indicated in previous chapters a major concern of CMAs and the Community Forum (Appendix 3) is the availability of scientific data and information that will facilitate the underpinning of management strategies and actions.

It will be critical for CMAs and communities to gain access to high quality and up-to-date information and data, practical decision-support tools, and sound technical skills and expertise across a range of discipline areas. Most regional bodies will need significant assistance to understand the nature and extent of the NRM issues they face, to access and interpret available data and research findings, and to undertake trade-off analyses. How are regional bodies to translate existing data and information about biophysical processes and socioeconomic characteristics into options for action, analyse the trade-offs and identify regional priorities?

CMAs will also need, in some cases, to establish and maintain adequate monitoring and evaluation processes. An essential supporting framework for this to occur is the provision of knowledge and information on the cause and effect (targets) relationships that operate in our environment and the availability and access to data and information that adequately describe these relationships and enable monitoring and evaluation. The aim of the NAP regions is through monitoring and evaluation to deliver baseline water quality and land condition data necessary for developing best practice water and land management and for the development of targets in the regional NRM plan. However, at the outset, it would be fair to say that all NAP regions are wrestling with the challenge of working out the types of data and information they need for different purposes, how to get it, and how to resource it.

It should, however, be noted that, to varying degrees across a range of parameters, data and information are readily available and can be easily accessed. The temporal and spatial distribution of this data and information depends on a range of factors, including the variability of the parameter and the cost of data collection. In terms of data availability and access, Australia is very well placed. However, gaps in networks and data availability become more pronounced at the regional level.

Interviews and discussions identified a number of issues about the provision of data and information to ensure that NRM investment decisions secure the best possible return on investment.

CMAs and researchers alike highlighted the vast array of scientific literature and information available, some of it conflicting, which points to the need for interpretation and packaging for the different sets of users in the NRM planning and implementation process. CMAs stated that there was uncertainty over what science could deliver. There have also been instances of inadequate access to information, which often forces CMA members to over-reliance on personal contacts.

The issues raised during the interviews and discussions by participants were in summary that:

- access to data/information is often restricted;
- data and information are not always presented in 'user friendly' forms;
- data and information from different sources are not always compatible (single parcels of information);
- relationships between the data collected and the 'target' state are not always obvious;
- there is lack of understanding about the suitability of data collected to the decisions being made (issues of time and space);
- data capture, storage and manipulation responsibilities are unclear;
- the modelling/data interface needs to be managed;
- background drivers (climate variability, vegetation condition, etc.) need to be recognised;
- there is a lack of consistency in the descriptions used to describe what data depicts;
- data systems tend to be patchy and limited in detail in many important areas (both in terms of coverage (e.g. at the regional level) and data types (e.g. social and cultural data); and
- data collection processes and procedures across jurisdictions (community based data collection activities) are inconsistent.

These issues are addressed below under the following headings:

- availability and specificity of data and information;
- access to data and information;
- data quality and collection standards;
- presentation of data and information (scale issues);
- relationships between data, information and targets;
- managing the modelling/data interface;
- sharing and transfer of data and information; and
- monitoring and evaluation.

AVAILABILITY AND SPECIFICITY OF DATA AND INFORMATION

Discussions and submissions gave a mixed response in relation to the availability of relevant data. For example, it was stated that a good understanding of the water use characteristics of individual crop and pasture species common to NSW rural land use systems exists. However, the main bodies of data that appear to be missing include seasonal contributions to ground water, whole catchment hydrology and interactions in time and space between land uses.

While on the one hand it was argued that much local information, including indigenous knowledge, was not being captured, others argued that the knowledge base in the regions was often inadequate, visible in the lack of detail on plan implementation.

Many regions may need help with implementation. There is much to be done in improving local data and knowledge of local hydrology, cropping options ...

(Researcher)

R&D agencies indicated in general that in the local communities and CMAs there was inadequate understanding of the data, a suspicion of data in community decision making where adverse individual outcomes might be involved, and a failure at the national or state level to develop a longer term strategic approach to data collection.

As against this, it was acknowledged that existing data, notably that emerging from the National Land and Water Resources Audit, was being inadequately or variably utilised from state to state:

As a result of greater availability of resources for natural resources audits and major initiatives such as the CRAs (Comprehensive Regional Assessments) associated with RFA (Regional Forest Agreement) processes, mean that data is more generally available and of a finer resolution to support data-driven planning tools and approaches.

(State government department)

The real contribution science can make, above information and knowledge, is the modelling capacity ... modelling and conceptual thinking behind the modelling needs to be used in the next generation of priority setting. It's not always more data that's needed, or more science, but better promotion of existing knowledge and how it can be used.

(Australian government agency)

Data and information were seen to be available at the larger national scale, but were not necessarily available at the regional/catchment scale necessary for use within catchment management plans. Catchments are variable, and all catchment agencies would say that more data gives more confidence about prediction. For example, because of the lack of long-term groundwater monitoring data outside of the irrigation areas, the predictions are less confident for the northern regions of the MDB than for southern regions.

It was acknowledged that:

Science and technology may not be region specific. There may be a lack of alignment of scientific knowledge with the specific regional problem. Current knowledge will need adaptation as a means of acquiring new, region-specific knowledge, and this knowledge itself will need progressive adaptation over time.

(Researcher)

Increased flexibility of tools is needed to allow for selection of relevant approaches in different contexts. For example in western NSW, NRM issues are generally related to broad scale agricultural practices and there is a general history of poor resourcing of data collection relative to

the vast areas of land concerned, data systems are patchy and limited in detail.

(State government department)

It's ludicrous to set targets of 10% of this or 20% of that - we have no idea. Variability is enormous. Just look at variations in rainfall alone ... What is lacking is catchment-specific data. Now that state governments are having to plan actions and invest money in particular catchments, choices of strategies become difficult because of the question over the applicability of generic data to the particular catchment ... Catchments are variable, and all catchment [bodies] would say that more data gives more confidence about prediction.

(CMA)

Another respondent stated that providing catchment (or region) specific biophysical templates that are integrative and of sufficient resolution to be of practical value is something that we are yet to achieve. The individual was particularly concerned at the lack of time series data with which to appraise change, and associated relations to landscape evolution (especially when framed in terms of differing phases of system response to disturbance, which is far from uniform). Degrees of sensitivity to change are often system specific, so averaged data are virtually meaningless. Of particular concern is the communication of these data to end users, especially if they are community groups concerned with on-the-ground applications (such as rehabilitation initiatives). The example was provided that, for some states, particularly NSW, there will be some years to go before vegetation maps are available that are suitable for detailed planning. The only other comprehensive flora and fauna data is for birds. Soil data is also very coarse.

ACCESS TO DATA AND INFORMATION

CMAs expressed the view that they had difficulties in locating and easily accessing relevant data, that there was a lack of region-specific data, or that data was not being shared or was not available freely (and sometimes not free of charge, even within the state). This has the potential to lead to friction between CMAs and government agencies if not addressed. Some plans therefore explicitly include a management action or target of obtaining more data/information.

The National Land and Water Resources Audit reports have highlighted the significant benefits that could be derived from developing theme based and geographically referenced datasets that can be integrated across regions, states and the nation. A number of initiatives have already been taken to identify and promote the availability of NRM related information (for example, CANRI¹⁰ in NSW, WALIS¹¹ in WA, online atlases). In addition, the National Land and Water Resources Audit has

¹⁰ <http://www.canri.nsw.gov.au>

¹¹ <http://www.walis.wa.gov.au>

developed a Natural Resources Information Management Toolkit to assist in building information management systems (including monitoring and evaluation work at the regional level).¹²

Often the data were available, but accessibility and/or user-unfriendly formatting limit usefulness.

One CMA noted that it had experienced difficulty in pinning research agencies down to precise data/information, attributing this to the fear within the R&D agency of being held liable for adverse outcomes, which preferred therefore to provide information on the likely outcomes of a particular decision/strategy rather than give assistance in setting the target to achieve the particular outcome.

A number of individuals and groups consulted, recognising the gaps above, put forward the concept of knowledge brokers, that is '*scientifically literate professionals who have a passion for integrating existing knowledge rather than creating new knowledge*', who understand government processes, science and community needs and work profession to profession. A critical role for such knowledge brokers would be to achieve greater emphasis on the planning frameworks and processes through which innovative solutions are applied – to encourage decision makers in planning processes to make use of tools and scientific approaches that already exist.

A possible role for RDCs to act as brokers between science and the regions, in a national clearing house concept, was suggested, while several groups also suggested a role for Landcare facilitators in assisting to bridge this gap. (It is worth noting that other groups felt that Landcare associations had tended to be left out of NRM plans, were under-represented on boards, that Landcare integration was not happening well, and that there were tensions and lack of clarity over the role of Landcare officers).

DATA QUALITY AND COLLECTION STANDARDS

Several of the groups interviewed raised the issue of varying data quality and data collection standards (including definitions) both between states and in different groups collecting data and information within states. There was general concern with the integration of the disparate data sets into a single adequate information set.

Increasingly data is also being collected by community-based groups, and for this data to be effectively used it must be accepted by the scientific community. A greater level of trust within the scientific community in accepting community-gathered data for monitoring purposes needs to be engendered.

In terms of economies of scale and the best use of scarce resources, it is equally not advisable for a plethora of groups to commence data collection exercises.

¹² <http://www.nlwra.gov.au/toolkit/default.htm>

PRESENTATION OF DATA AND INFORMATION (SCALE ISSUES)

The availability of data sets in GIS-based formats (especially nationally-based information) was seen as an essential source of information in support of catchment management plans.

One CMA has implemented an indicator approach to assess catchment condition from national-scale attribute data. This approach is preferred to detailed process modelling because the complex interactions between biophysical processes in catchments cannot be modelled credibly using existing data. National-scale data are generalised from detailed data and highlight the predominant processes that drive catchment condition. The major benefit of national-scale data is that, when used with decision support systems, a variety of condition assessments can be reviewed in a wide spatial and conceptual context that small area assessments cannot provide. The GIS-based decision support system, 'ASSESS', is being used to produce maps of single attributes, or of composite indices based on an aggregation of indicators. For example, the conditions of water, land and biological components are ranked for sub-catchments in regions or for the nation.

RELATIONSHIPS BETWEEN DATA, INFORMATION AND TARGETS

Some of the groups interviewed identified the lack of scientific data as an inhibiting factor in the derivation of targets. They suggested that they were stifled in the way they could set targets by the type of scientific data they could access.

We would have liked, for instance, to set a biodiversity target, but we couldn't find enough scientific data on biodiversity in our region, so we set a vegetation target. That's something we do have data to back up ... Data is hard to access - it would be nice to have a data index. At one stage we had enormous trouble. We set a riverine health target which encompassed native fish numbers and a riverine health index, to take into account algal blooms and general health of vegetation along the corridor. For a long time there, to access any scientific data on fish numbers was really difficult. Until we set a target, and someone put up their hand and violently disagreed with it and said they had scientific evidence to prove otherwise, then we said 'you beauty, now we've got something we can use'.

Under the NSW State Salinity Strategy and National Action Plan, a range of salinity mitigation and prevention strategies are proposed for catchments at risk. These strategies will often be implemented with the aim of meeting salinity and water quality targets. From their experiences with the Decade of Landcare and the first years of the Natural Heritage Trust, they note that it is important that we do not confuse *activity* with *effectiveness*. Despite the diverse implementation of on-ground works, there is an extreme paucity of data on whether these works did anything to control salinity or mitigate its impacts. Given the large uncertainty of modelling, there is no

substitute for monitoring the effectiveness of specific activities. Otherwise decision-making may be based on anecdote and assertion, rather than data.

MANAGING THE MODELLING/DATA INTERFACE

There was general agreement that, because of a lack of regionally specific data in many instances, one of the roles of data and information was to develop models that can inform land use decision-making in areas that lack locally specific data.

Some respondents were concerned about the use of generalised relationships in modelling applications, especially relating to water budgeting and sediment flux work. There was unease work at catchment scales is seldom done, so extrapolating up to regional scale syntheses is often unsound.

We seldom work at catchment scales. Extrapolating this data is risky and often unsound. [There is] lack of time series data with which to appraise change, and associated relations to landscape evolution, especially when framed in terms of differing phases of system response to disturbance, which is far from uniform ... Of particular concern is the communication of these data to end users, especially if they are community groups concerned with on-the-ground applications.

(Researcher)

It was also stated that the use of models is an important part of the interpretation with the aim of separating short-term climatic and engineering effects from the long-term effects of land use change.

SHARING AND TRANSFER OF DATA AND INFORMATION

A number of groups interviewed indicated similarly to the researcher above that mechanisms need to be maintained and improved to promote the sharing and transfer of knowledge and data, and to assist the processes of capacity building, partnership formation and integration, on a nationally consistent and ongoing basis.

All groups recognised that a process of linking the key data collection agencies will provide a cost-effective approach to data access and will leverage significant additional funds now and in future years. One respondent noted that a number of agencies and organisations are custodians of data, tools and skills. For example, NSW has the CANRI database system.¹³ Ongoing refinement of approaches through planning projects will provide opportunities for increased interaction between custodians of these resources.

¹³ <http://www.canri.nsw.gov.au>

MONITORING AND EVALUATION

Many respondents highlighted the need for outcomes to be incorporated into decision-making processes in an ongoing way, noting that this would require monitoring and evaluation of outcomes. Ongoing monitoring and evaluation will feed back into an adaptive planning process that will achieve greater focus and enable better decision-making concerning further action and investment priorities. A criticism of the current plans was that their strategies and investments were sufficiently clear, but the environmental outcomes were less tangible, pointing to the need for an analytical framework to be put in place nationally for monitoring and evaluation.

The comment was made that some plans are fairly static, with targets at the top level tending to be overly ambitious and all-embracing. Although implementation strategies tended to be more realistic, monitoring and evaluation was on the whole, not addressed. A more dynamic approach to planning is required to ensure a focus on outcomes and incorporation of ongoing monitoring and evaluation strategies to feed back into the planning cycle.

A similar view was expressed by one R&D agency that commented on the lack of a large-scale approach to determining a scientific basis for measuring sustainability through long-term, coordinated monitoring and evaluation programs, at the scale of the catchments concerned.

Better scientific underpinning is needed for the concept of sustainability. Most plans embody it in some way, but none reflect the difficulties it presents. Some plans acknowledge the need for improving river environments, reflecting acceptance of the rebuilding concept. Robust indicators are needed to identify trends in river health. These need to be based on measurable ecosystem processes, or relate to ecological indicators. None of the plans provides an overview of how their monitoring processes (where presented) will enable large-scale trends in catchment condition to be identified. The best plans largely defer this responsibility to another agency, in the hope that the agency will get the science right.

The same researcher commented that the plans showed little awareness of the increasing array of modelling tools and sensitivity analyses and seemed to place emphasis on trying to get management activities in place for all key indicators simultaneously, 'as a way of keeping people happy', and suggested that there would be great value in proposing a large-scale restoration project that involved sensitivity analyses and economic assessment to establish areas or threats that will deliver the most effective management outcome. 'A lot of serious science is needed to underpin this approach.'

Another researcher made the similar comment that most plans acknowledged the need for sustainable resource use, but contained 'no large-scale approaches to determining a scientific basis for measuring sustainability in the form of long-term, coordinated monitoring and evaluation programs, at the scale of the catchments concerned', concluding that 'In the main, there seems to be little justification for the targets that have been set.'

The view was endorsed by at least one CMA, conscious also, however, of the practical difficulties posed by monitoring and evaluation when the information sought needs to suits landholders as well as the scientific community.

We need some scientific evidence to set targets, and we need some scientific knowledge about how we're going to monitor and evaluate our shifts towards the targets. We need benchmarks, we need a target to end up at, and we need some coordination of that scientific evidence so that we have a picture in our own eyes of what it will look like when we start reaching that target.

SUMMARY POINTS

- Data and information were seen to be available at the larger national scale, but were not necessarily available at the regional/catchment scale necessary for application in the individual Catchment Management Plans. Therefore, issues include whose role/responsibility it is to collect the finer detailed data needed for resource management at the catchment scale and what the optimum process is for doing so.
- There remains an ongoing need for a long-term strategic approach to the collection, maintenance and use of key spatial data layers (climate, vegetation, salinity, soils, groundwater, river condition and the like).
- The National Land and Water Resources Audit has developed a Natural Resources Information Management Toolkit to assist in building information management systems (including monitoring and evaluation work at the regional level). This and other initiatives such as CANRI and WALIS (p.40) should enable improved access to NRM related data and information.
- There is a great opportunity to draw on emerging information technologies to provide a common, spatial, framework for storing, organising and retrieving data.
- In the majority of cases, seven years of data will be insufficient to show if there has been a definite biophysical response to a given action. Therefore, it will be important to link the targets, based on material budgets, to a predictive/explanatory modelling exercise and to continuous monitoring of real levels over time.
- There is currently inadequate biophysical and economic data available on which to assess the risks and impacts of management decisions.
- Data from research will be at specific scales, from specifically designed experiments or from experiments performed under specific conditions. The transportability and reliability of results needs to be understood.
- Tools need to be developed that: (i) allow the capture, manipulation and presentation of data at regional scales to reflect where NRM issues occur in the landscape and their extent; (ii) support ongoing refinement of technologies (ie. geographic information systems and higher capacity systems) needed to cope

with data capture, storage and manipulation; and (iii) provide opportunities for priorities for on-ground delivery to be assessed relative to priorities at regional scales. Such tools and the predictive models they provide help address problems arising from the fact that surveys are costly and time consuming and can rarely survey all localities within a region.

- Computer-based statistical modelling, in combination with spatially referenced databases and geographical information systems, is often used to link fauna and flora survey data to remotely mapped environmental attributes. This provides the broad spatial information on species distribution required for regional NRM planning.
- Innovative tools also assist decision-making by increasing efficiency of information management. Analyses of data have become increasingly sophisticated allowing outcomes to be utilised by planners and decision-makers.
- User-defined systems, data gathering programs in particular, and to a lesser extent planning approaches, have tended to be developed without end users in mind. There remains a need for greater tailoring of technology-based processes, tools and approaches to the data and the social and institutional contexts in which they will be used.
- Explicit links between monitored data and management response need to be made. Monitoring must not only track changes in condition but also provide insight into any causes of problems and opportunities for improvement in management and land use practice.

Recommendation 5

All government agencies currently holding NRM related datasets be requested to accelerate development of data collection, management and retrieval systems that are standardised, integrated and designed to allow cost-efficient data transfer.

Such systems should, for example, be targeted to facilitate:

- promotion of the collection and collation of geo-referenced data sets to agreed standards (based on protocols and standards agreed for catchment monitoring);
- support for the development of integrated and accessible data management and reporting systems building on and linking with the Australian Natural Resources Data Library and related data access systems in states and territories;
- assurance that data sets collected to national standards are 'captured' within the National Land and Water Resources Audit framework; similarly monitoring should use methods approved for use by the Monitoring and Evaluation Working Group of the NRMMC, wherever feasible;

- access to, and provision of guidance on the use of data which is packaged for less sophisticated GIS users;
- guidance on the application of assessment tools that use various data sets to provide information upon which to base management responses and priority setting;
- development of guidelines for managing the expected volume of information and data that will be generated by monitoring and evaluation, for use in regional plans and in the overall National Action Plan;
- development of guidance principles such that an information infrastructure context can be identified (e.g. existing Commonwealth, state and territory maintained databases) or established, consistent with current national and international standards (ANZECC/ARMCANZ, 2000). New standards may be required where none currently exist. Such standards will need to be applied to data management, monitoring (for precision, temporal scale and spatial distribution) and to reporting; and
- brokering of access to, and use of this information.

Recommendation 6

The NRMMC encourage lead NRM agencies to place additional effort and investment on monitoring and evaluating NAP/NHT targets and outcomes via the use of remote sensing and other emerging ITC technologies.

Chapter 5

CURRENT BEST PRACTICE AND EMERGING OPPORTUNITIES

The preceding chapters have focussed on what might be termed institutional constraints and gaps in the NRM planning process. In identifying research gaps – sometimes very specifically – many agencies and individuals also presented positive indications of both generic and specific research opportunities. It was suggested that *‘everyone can produce “shopping lists” of research opportunities. What are perhaps lacking are their harmonisation and a national strategic approach.’*

It is stressed that the authors of this report have not reviewed the emerging science discussed in this chapter. Rather the approach is to indicate areas that may be of value to the NAP/NHT and catchment management agencies.

Furthermore, the critical challenge is not in undertaking this research; it lies in overcoming the constraints outlined in the previous chapters so that the research tools and outcomes can be channelled more effectively to the regional bodies that will need to employ them.

It was clear that there is a considerable amount of highly targeted, locally specific work occurring that ought to feed into the regional planning process. Examples from one Australian government agency were:

- the 5 Steps to Tackling Salinity brief - providing a basis for developing practical options for landholders and catchment managers (Dent, 2003) ;
- the Bowen study - that will enable landholders to manage saltwater intrusion, irrigation leaching, sodic soils and other salinity-related problems while maintaining the longer-term productivity of their irrigated land (Baskaran et al, 2001);
- the South Australian Salinity Mapping and Management Support Project (a NAP project) – targeting specific salinity-related issues across five distinct regions in SA; and
- the Alstonville plateau study – where mapping, combined with management rules such as licensing restrictions and buffer zones, had been incorporated into the Water Sharing Plan for the aquifer (Budd et al, 2000).

It was *‘hoped that these findings will be incorporated into future integrated NRM plans’*, but the question that remains unanswered is by what mechanism such transfer of knowledge and information will occur.

BIG PICTURE, LONGER TERM, INTERDISCIPLINARY RESEARCH

At the outset it is appropriate to state that many R&D agencies expressed concern over the failure of NRM plans to address 'big picture', longer term issues – acidity, climate change, sodicity – against the imperative of getting plans up and running, describing this as '*a short-sightedness in seeking to address longer term, higher risk and cutting edge research that is perceived to have little relevance to immediate needs*'. The comment was made, underlining the tensions between government and community priorities, that regional groups appear less interested in longer term research and more in short term projects funded under NAP. In addition, it was observed that there is '*scant attention to the interrelationships between the different regions and their contribution to the national picture.*' The demands and drivers creating potential for this to occur have been assessed in the previous chapters.

Interdisciplinary science linked to policy, through better integration of the biophysical, social and economic, as well as the integration of data and knowledge to a systematic whole approach, was the ideal expressed by many:

... Integration, in bringing vast quantities of information and knowledge together in such a way that it can represent what we're trying to manage on a systematic basis ... to give people tools to predict or forecast what the likely consequences of their actions will be, in an investment or decision making capacity, from the regional to the national level.

(Australian government agency)

The lack of integration of socioeconomic, and the need for more multidisciplinary and interdisciplinary approaches to planning were considered key omissions leading to a concern that much investment will not have impact. In addition, there is greater potential for cross-catchment issues to be addressed.

Many groups consulted emphasised the fact that socioeconomic understanding of natural management changes was poor, not only within NRM bodies, but also in terms of the integration of socioeconomic understanding of natural resource management changes into the whole research and development spectrum in order to effect policy change:

There is little evidence of hard information about trade-offs in the triple bottom line, which is not surprising since it is a new and emerging research area. Many groups moving to larger integration are now talking explicitly about bringing together socioeconomic and biophysical models.

(Researcher)

A critical issue facing planners and researchers alike is that natural resource management involves more than the application of biophysical research, but has a significant 'people dimension' that necessitates a more integrated socioeconomic approach.

We collectively seem to grapple with NRM at a landscape scale, and unless thought is given to how to translate knowledge on the macro problems into micro level attempts at solutions (however imperfectly), then all we're doing is documenting - often with a great deal of scientific rigour – over successive decades a steady decline in different aspects of environmental quality ... While many NRM problems may be defined and tangible at landscape scales, solutions have to be more 'micro' in nature, as people own, operate in, and so impact on 'micro' properties. Fostering change has to be targeted at those who own the resources and manage them. Natural resource management is basically behaviour management.

(Researcher)

NRM/Catchment plans are to change people's behaviour and they are therefore about community involvement ... At the end of the day, no matter how good or bad the science is, it's the behaviour change that's important. Broadly we understand the impacts on ecosystems; to change the impact we have to change behaviour.

(CMA)

The key for all regions will be to fund land use and land management options that are more profitable than existing options and have reduced impact on natural resources.

(State department)

Social research needs to play a critical role in helping regional groups as they identify and refine their investment priorities, communicate with landholders, choose from the mix of policy options available, and evaluate the achievement of their objectives.

(Australian government agency)

Specific suggestions for research with a socioeconomic component were:

- novel markets to drive revegetation at large scale (carbon, biodiversity and water quality credits, etc.);
- market based instruments for salinity, water quality and biodiversity;
- systems modelling, especially integrating socioeconomics;
- incentives for landholders to conserve biodiversity that will contribute effectively to regional scale conservation;
- better analysis of the relationship between socio-political context and appropriate mix of systematic planning tools and approaches;
- transdisciplinary approaches to the planning task (truly integrated approaches);
- improved communication of results of research between researchers and practitioners, including encouraging uptake and implementation of derived knowledge as a science in its own right;
- greater attention to pilot projects for trialling and refinement of tools and approaches;
- science to underpin delivery of stewardship schemes for biodiversity conservation and other NRM across the landscape, especially on farms, addressing

- particularly the integration of site-based assessment of biodiversity (and biodiversity benefits of actions) with regional planning tools and priorities; and
- involvement of indigenous communities.

Recommendation 7

The NRMCC encourage funding bodies supporting NRM research to consider funding some community participatory case studies that focus on the integration of biophysical, economic and social sciences at a sub-catchment level to demonstrate how it can be done and how the results should be used to achieve triple bottom line outcomes.

TOOLS

It was pointed out that tools for data analysis are becoming increasingly sophisticated, allowing outcomes to be utilised by planners and decision makers, while individual activities can be assessed in the context of landscape condition. A common concern in the research community is that much more could be done to encourage regional groups to make better use of existing modelling and measurement tools and to utilise opportunities to apply predictive models, including computer-based statistical modelling, in combination with spatially referenced databases and geographical information systems. New technologies include remote sensing, microtechnology for remote monitoring and satellite imagery, for example. Tools for remotely monitoring and evaluating ecosystem health have application to the assessment of the effectiveness of actions at regional scale.

As outlined by one contributor, precision agriculture offers a significant opportunity to better match land use to land capability. Spatially explicit and quantitative methods of farming systems are being developed. The Landmark project established by the MDBC, for example, has been able to quantify and map the impacts of different farming practices at a catchment scale in relation to water use, soil acidification, erosion risk, and conservation of biodiversity, and is an indication of how a range of technologies make it possible to address a range of NRM issues in a quantitative and spatial matter, and hence to identify particular regions of a catchment that should be targeted for particular NRM activities.

There is an opportunity to develop and/or apply more flexible and accessible decision-support tools and systems that enable regional extrapolation, the objective being to provide rapid feedback to land managers when they experiment with changing practices.

Communication tools were also identified as an area of opportunity, specifically in the context of the under-utilisation of information systems and opportunities for web based delivery of information.

BIOPHYSICAL SCIENCE AND RELATED OPPORTUNITIES

The list of suggestions that was received for further research was generally poorly focussed (e.g. non-specific requests for work on salinisation). However, in some instances, there already exist more definitive and comprehensive analyses at state level, for example as undertaken by the NSW Salinity Research and Development Steering Committee. Furthermore the NRM Science and Information Working Group (2003) prepared a paper that highlighted the areas of underpinning R&D needed by the NAP/NHT. This paper highlighted national and regional R&D needs and included five areas of required focus:

Sustainable Agriculture and Land Use

- tools for integrating catchment objectives and targets with profitable land use options for rural industries;
- better engagement between industry and the NAP and NHT; and
- insights into how better to handle land use change.

Biodiversity Conservation

- tools to establish biodiversity objective and priorities; and
- better regionally specific management practices to improve the condition and trend of biodiversity.

Climate Change and Variability

- tools for decision makers to anticipate, mitigate and/or adapt to impacts of climate variability and change; and
- better understanding and prediction of climate and weather influences on catchment processes.

Monitoring and Indicators

- cost effective, user-friendly, system-based natural resource monitoring systems to support the implementation of the NAP and NHT; and
- better assessment of trends in catchment processes and the impact of NAP/NHT programs, incorporating an advanced appreciation of catchment processes.

Managing Knowledge for Change

- integrated knowledge management framework and a clearing house to deliver R&D outputs to meet the needs of catchment managers; and
- enhanced exchange of knowledge between regional, state, territory and Commonwealth interests, optimising R&D resources and ensuring ready access to information.

Recommendation 8

The NRMMA encourage funding bodies supporting NRM research to build an overarching research/science program to include assessment of the impact of climate change and variability, integration of social and economic factors into decision-making, better information on the relationships between biodiversity and vegetation management, more emphasis on farming systems and other issues that transcend regions and catchments.

The advisory team gained an impression from the interviews and written responses that in many cases the CMA practitioners were not aware of some of the most recent scientific R&D that might be of use to them. Whether this was because it had not been communicated widely, or whether they did not value its efficacy was not certain. In contrast discussions with CSIRO, state agency and university/CRC staff clearly highlighted a number of areas that hold great promise for the NAP/NHT.

These included:

- improved methods developed by CSIRO and other agencies including the serial biological concentration method for managing saline drainage effluent, advances in methods for monitoring water infiltration, the success of the Heartlands initiative and methods for prioritising investment strategies within and between catchments;
- opportunities to take environmental stewardship into account afforded by environmental management systems (EMS) approaches;
- the role of market-based instruments as a salinity management tool currently being investigated in specific projects established by the NAP; and
- major advances made in the last few years in terms of accuracy and reduced costs from airborne geophysical mapping of salinity and groundwater.

However, some of the above developments can be regarded as work in progress. Consequently, the key issue now is to ensure that as new research matures there are mechanisms in place to make it available to practitioners. The onus for this lies partly with the researchers, but also with the NAP/NHT management team and state agencies in terms of making sure communication channels are improved. Clearly, there is an increasing need for centres such as South Australia's Centre for Natural Resource Management in ensuring that this happens. Given that the CMAs essentially comprise a fourth layer of government, it is important that attention is given to building their capacity across a range of areas.

Although there was little comment on the need for scientific capacity building from the CMAs, there have been other positive advances in this area. These include the stress that Land & Water Australia is currently putting on knowledge brokering processes, the refocussing of research into 'integrated landscapes' at Griffith University, a greater focus on water issues at Charles Sturt and Melbourne Universities, the development of the National Institute for the Environment at ANU,

the programs of the CRC for Plant-based Management of Dryland Salinity, the focussed catchment work and the development of the Murray Flows Assessment Tool used by the CRC for Freshwater Ecology for the Living Murray Process, the application of CRC Catchment Hydrology tools in catchment management, particularly in south-east Queensland, as well as decision support modelling tools for the agriculture and irrigation industries (e.g. APSIM¹⁴, SWAGMAN¹⁵, MAIZEMAN¹⁶, RICECHECK¹⁷ and the myriad outputs from the now completed National Dryland Salinity Program¹⁸.)

It is hard not to draw the conclusion therefore, that although there are a wide range of new scientific opportunities ripe for application in the field, that these are only being picked up sporadically by the CMAs, often as a result of individual researcher/CMA contacts. This suggests that a more broadly focussed method of conveying new research ideas and outcomes from the research community to the 'practitioner' community is required to foster transfer of technology and know-how.

Recommendation 9

The NRM lead agencies consider jointly instituting a quarterly electronic newsletter that can act as a forum for science to be communicated to the catchment managers as well as for catchment management agencies to indicate progress, successes and failures.

SUMMARY POINTS

- A considerable amount of highly targeted, locally specific work is occurring that ought to feed into the regional planning process, and a wide range of new scientific opportunities is ripe for application in the field.
- Relevant science and technology is not all being adequately captured and utilised in plans because of inadequate mechanisms to ensure appropriate linkages between government, R&D agencies, RDCs/industry, and local planners. Greater attention is required to the problem of achieving and resourcing the collaboration. While some states have established sound consultative mechanisms, the approach is far from uniform.
- Given the size of the NAP/NHT and its significant objectives, there is a striking lack of full-time scientific leadership and overview. Far more attention should be focussed on this area to develop a sense of scientific cohesion and support for CMAs. Otherwise, there is a real probability that investment will be targeted on

¹⁴ <http://www.apsim.info/apsim/>

¹⁵ Godwin et al (2002).

¹⁶ Humphreys et al (2003).

¹⁷ Lacy et al (2003).

¹⁸ <http://www.ndsp.gov.au>

the wrong areas. The current structures at state level focus more on administrative issues, project investment and compliance. Whilst each jurisdiction has clearly worked hard on trying to ensure that scientific robustness of the NAP/NHT programs is maintained, the lack of cross-jurisdiction coordination means that this is often done in relative isolation and/or the focus is often moved away from science to delivery.

- The development of a science coordinating body, possibly under a Chief Scientist and staffed by full- or part-time secondments from each state could provide a means to attend to and rectify many of the deficiencies noted in this report. Such a body could also take on and further develop and implement the existing recommendations of the NRM Science and Information and Monitoring and Evaluation Working Groups. The body would not need to be centrally located. Indeed there would be major advantages in having the science staff located with the state-based NAP/NHT personnel. However, having individuals who could further assist with the brokerage of information between R&D providers and the CMAs as well as provide advice on how more effective methods of predictive modelling and monitoring and evaluation can be achieved would considerably strengthen NAP/NHT outcomes.
- Skills, knowledge and capacity vary widely among CMAs, and are compounded by a lack of clarity of roles, particularly with regard to program implementation and policy change.
- Constraints are apparent in problems of data access, data interpretation, data specificity, and the extent and uptake of local knowledge, highlighting a lack of knowledge brokering mechanisms.
- There is reluctance to address long-term, strategic research issues, to utilise interdisciplinary science, and to apply more flexible decision support tools.
- There is insufficient integration of the socioeconomic dimension that is necessary to effect the behaviour change that accompanies successful natural resource management change.
- There are numerous needs and opportunities for science to support the catchment management process; the challenge is to encourage the development of programs which can facilitate this by bringing together current excellent work.

Recommendation 10

The NRM lead agencies review the existing institutional arrangements for coordinating, interpreting, integrating and disseminating NRM related science and consider the benefits of strengthening the NAP/NHT through the appointment of a science leader and coordinating body to enable full-time attention to be given to overcoming many of the issues described in the report.

FUTURE ADVICE

As specified by NRMMC, the CSIRO and Bureau of Meteorology are to provide annual scientific advice to the Council on the scientific and technical robustness of NRM program strategies and plans during their implementation and on new or emerging scientific advances. The advisory team agrees that it was appropriate for the first review in this process to be one which took stock in broad terms of the extent to which scientific inputs were occurring appropriately to the development of NRM plans under the NAP.

However, the scope of the task is very substantial, reflecting the diversity of the issues and rapid change in policy and science and technology. Significant shifts have occurred during this review and the pace of change is expected to continue.

The advisory team acknowledges the value of NRMMC receiving an ongoing external appraisal of the quality of the science underpinning the NAP, and an overview of the effectiveness with which science is connecting to the regional process. The advisory team recommends that this advice be targeted in future years on specific issues identified in this report, and on the extent of uptake of particular scientific opportunities in the NRM planning process. Environmental management systems and market-based incentives are two areas where advances would be expected to be made in the management of salinity. Monitoring and evaluation will similarly become increasingly important as investment strategies are implemented and on-the-ground actions to achieve targets are put in place. A more consistent approach to predictive and evaluative tools is anticipated.

Recommendation 11

Future reviews of science underpinning the delivery of NRM outcomes be targeted to identify specific initiatives and outcomes rather take the form of more general overviews as in the current instance.

APPENDIX 1

COVERAGE

The following were invited to participate in the advisory process:

Department of Agriculture, Forestry and Fisheries
Albury Water
Australian Local Government Association
Australian National University
Burdekin Dry Tropics Regional Strategy Group
Bureau of Rural Sciences
Central Queensland University
Central West Catchment Management Authority
Centre for Groundwater Studies
Charles Sturt University
CRC for Catchment Hydrology
CRC for Coastal Zone Estuary and Waterway Management
CRC for Freshwater Ecology
CSIRO Entomology
CSIRO Forestry and Forest Products
CSIRO Land and Water
CSIRO Sustainable Ecosystems
Deakin University
Department of Conservation and Land Management, Western Australia
Department of Environment and Heritage, South Australia
Department of Infrastructure, Planning and Environment, Northern Territory
Department of Infrastructure, Planning and Natural Resources, NSW
Department of Natural Resources and Mines, Queensland
Department of Primary Industries and Resources, South Australia
Department of Primary Industries, Queensland
Department of Primary Industries, Water and Environment, Tasmania
Department of Sustainability and the Environment, Victoria
Department of Water, Land and Biodiversity Conservation, South Australia
Edith Cowan University
Environment ACT
Department of the Environment and Heritage
Environment Protection Agency, Queensland
Fitzroy Basin Association
GeoScience Australia
Glenelg-Hopkins Catchment Management Authority
Goulburn Broken Catchment Management Authority
Greening Australia
Griffith University
Hunter Catchment Management Trust
James Cook University
La Trobe University
Lachlan Catchment Management Board
Land & Water Australia

Lower Murray Darling Catchment Management Authority
Macquarie University
Murdoch University
Murray-Darling Basin Commission
Murrumbidgee Catchment Management Board
National Farmers Federation
National Institute of Environment, Australian National University
National Parks and Wildlife Service, NSW
Nature Conservation Council
North-East Catchment Management Board, Victoria
Northern Territory University
NSW Agriculture
Royal Melbourne Institute of Technology
South Australian Research and Development Institute
South Coast Regional Initiative Planning Team Management Committee
South East Natural Resource Consultative Committee
Tasmanian Institute of Agricultural Research
The University of Adelaide
The University of Melbourne
The University of New England
The University of Newcastle
The University of Queensland
The University of Sydney
University of Ballarat
University of Canberra
University of New South Wales
University of Southern Queensland
University of Tasmania
University of Western Australia
University of Wollongong
World Wide Fund for Nature, Australia

APPENDIX 2

CONTRIBUTORS

Contributions, in the form of interviews or written submissions, were received from the following:

Department of Agriculture, Forestry and Fisheries
Albury Water
Burdekin Dry Tropics Regional Strategy Group
Bureau of Meteorology Research Centre
Bureau of Rural Sciences
Centre for Groundwater Studies
Centre for Natural Resource Management, South Australia
CRC for Catchment Hydrology
CSIRO Entomology
CSIRO Land and Water
CSIRO Sustainable Ecosystems
Department of Infrastructure, Planning and Natural Resources, NSW
Department of Natural Resources and Mines, Queensland
Department of Primary Industries and Resources, South Australia
Department of Primary Industries, Victoria
Department of Sustainability and the Environment, Victoria
Department of the Premier and Cabinet, Western Australia
Department of Water, Land and Biodiversity Conservation, South Australia
Department of the Environment and Heritage
Fitzroy Basin Association
Glenelg-Hopkins Catchment Management Authority and Board
Grains Research and Development Corporation
Greening Australia
Land & Water Australia
Lower Murray Darling Catchment Management Board
Macquarie University
Murray Darling Basin Commission
Murrumbidgee Catchment Management Board
Nature Conservation Council
North East Catchment Management Board, Victoria
Northern Adelaide and Barossa Catchment Water Management Authority
NSW Agriculture
NSW National Parks and Wildlife Service
NSW Southern Salt Action Team
South East Natural Resources Consultative Committee
Tumut Landcare
University of Melbourne
World Wide Fund for Nature, Australia

APPENDIX 3

NRM COMMUNITY FORUM

In April 2003, the first NRM Community Forum was held in conjunction with the NRM Ministerial Council meeting in Brisbane. The Forum assembled 85 community organisation representatives, including 64 from regional NRM groups, 10 from indigenous groups, and 11 from national NRM groups. The purpose of the Forum was to provide an opportunity for NRM community organisation representatives to exchange views and provide advice to Ministers responsible for natural resource management. The overarching theme for the Forum was regional natural resource management in a national context, its objective being to reinforce the need for an integrated regional approach to natural resource management.

Members of the advisory team from CSIRO and the Bureau of Meteorology participated in the NRM Community Forum and the Report of the Forum¹⁹ was an input to the process of compiling this report. The forum provided the opportunity to obtain the views of relevant stakeholders on the overall effectiveness of research in contributing to the attainment of NRM goals, including:

- areas or issues where natural resource management decisions may be being made, and plans implemented, on the basis of inadequate or incomplete scientific understanding;
- areas where existing knowledge is poorly communicated or understood;
- issues which would benefit from research investment;
- areas where biophysical science and related social science and economic insights and skills are inadequately drawn upon or poorly integrated with each other and with a range of other necessary tools and measures;
- obstacles to effective use of research including identification of complementary measures which may be needed (such as pilots, extension activities, training of agronomists etc); and
- the need for community capacity building.

The critical role of science in NRM was highlighted by the keynote speaker of the Forum²⁰, who stated: *There is going to have to be a greater emphasis on the science and research underpinning the decision-making and NRM policy ... It is no longer good enough to say that the science underpinning decisions in one region is valid across all regions ... Our community is not going to continue to believe we are delivering if decisions that cannot be supported by research continue to override the catchment/regional planning process. It is simply a waste of the community's time if political decisions affect the landscape irrespective of what the local science is saying.*

Prior to the Forum, a set of questions was sent to all participants asking them to identify the main issues facing their community in the context of the move towards an integrated regional approach to NRM.

¹⁹ <http://www.deh.gov.au/nrm/forum/index.html>

²⁰ Betsy Turner, Queensland Murray-Darling Basin Committee.

Responses to the specific question of how the best available economic, social and biophysical scientific information could be incorporated into NRM planning and practice indicated that CMAs felt critically distanced from the data and information they recognised that they needed, as reflected in:

- the availability of relevant and appropriate research data, information, decision support systems, etc. and, where such data/information were available, a perceived difficulty of access;
- a lack of regionally based R&D institutions and consequent difficulty of access to regional R&D providers and facilitators, one CMA suggesting that this contributed to a failure of researchers and policy managers to understand each others' perspectives;
- the need for centralised or 'regionalised' facilitation of access to data and information; and
- access to trained personnel and resources at the regional or local level to interpret and use data and information, and information brokers to facilitate information exchange.

Comments included:

Economic and social data is not readily available, especially at a detailed regional scale. Funding for the gathering of data should be identified at the appropriate level, and should not be in direct competition with reasonable on-ground implementation ... Efforts should be made to capture evidence/data that has emerged from previously funded projects.

(ACT NRM Committee)

The amount of information required to solve many of the natural resource management problems is huge. We do not today have a black box decision making tool to answer all questions ... To maintain the best available information means there is a need for a regional repository which holds more than a set of simple information.

(Glenelg-Hopkins Catchment Management Authority, Victoria)

There is a problem with much data and information not being available in a very user friendly form. Whilst in some cases this cannot be addressed we do need to, now, establish protocols and processes for the collection and storage of data and information thus ensuring in the future it can be used with ease. Wherever possible data and information needs to be scale 'relevant', if this occurs there will be increased likelihood of it being adapted by end users.

(Queensland Regional NRM Groups Collective)

[Information] needs to be edited, categorised and disseminated to local and regional NRM managers; theories, models and initial results need to be differentiated from robust, tested results; links to policy, legislation, strategies and funded initiatives should be included.

(Tasmanian Regional NRM Groups)

[The issues] are often too complex for the regional management boards to understand. Firstly, these boards must include regional members who are capable of understanding biodiversity issues and incorporating them into landscape management. Secondly, every effort must be made to constantly provide biodiversity information to the boards, keeping it as simple as possible and increasing their understanding of how biodiversity concerns fit within the process at each step.

(World Wide Fund for Nature Australia)

APPENDIX 4

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