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Essential datasets and implications for funding NRM MER at the state scale

A report to the Natural Resources Commission
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Executive summary

Alloporus environmental (Alloporus) was asked by the NSW Natural Resources Commission (NRC) to conduct a review of approaches and funding of monitoring, evaluation and reporting (MER) for natural resource management (NRM) in NSW at the state scale.

Consideration of MER approach and funding follows logically from recent NRC recommendations to Government for a revised set of state-wide NRM targets that focus on what is most important in the landscapes of NSW. The review was also expected to generate a revised number and selection of essential datasets for a state-scale NRM MER system. This report summarizes findings and recommendations to the NRC.

Key issues
The current NRM MER system generates extensive information covering multiple natural resource assets and asset values. MER data are used in formal reporting but underused and undervalued to help understand the **consequences of resource use** and to support NRM decision-making.

Collection and storage of data is only part of what needs to be done. The true value for MER comes from the **analysis and interpretation** of the assessment and monitoring data, turning data into information and knowledge. When MER datasets are monitored and made available as data layers in a GIS, data can be combined, analyzed and interpreted to a) provide state-wide NRM reporting against revised targets and b) generate answers to evaluation questions at the state scale based on attributes of the **system as a whole**.

NRM MER will have much greater value to all stakeholders when the primary focus is on analysis and interpretation across NRM themes and supports understanding of how the system as a whole works to support the full range of assets and their values.

Whole of system measures and essential datasets
In 2012 the NRC applied a 'whole of system' approach to recommend a smaller set of revised state-wide NRM targets to government. Logically, this should result in much reduced data requirements at the state-scale. In this report Alloporus has suggested 19 datasets to cover MER for the revised targets at the state scale.

When combined with a much stronger emphasis on data analysis and interpretation of existing and future MER data the 19 datasets provide the foundation for a whole of system approach to understanding NRM interventions as well as reporting on proposed revised state-wide targets.

Generating outputs for reporting, decision support and NRM understanding from analysis ad interpretation and the use of integration measures is a powerful approach that:

- can be generated from a small number of key datasets
- provides change maps that not only flag areas of concern but also where improvements have been made
- can identify where more focused measures are needed.

- will generate information to answer the NRC's proposed suit of policy and evaluation questions; and,
- provide data to report against the revised state-wide targets.

Funding implications
State agencies provide the bulk of the NRM MER data. Alloporus believes this situation can place undue fiscal pressure on state agencies.

Whilst the lines between data users and data providers are often blurred, some form of 'user pays' model would help to redress the current imbalance. Options to involve the private sector, both in business ventures that utilize MER datasets and/or public-private partnerships that use MER data would also help resource parts of the MER system.

Technology advances have also made data collection more affordable; data access easier and provided spatial analysis and modeling tools that can use complex datasets. Any change to the funding model should leverage new technologies.

Before any shift towards a more distributed and mixed funding model can be effective, the value proposition for NRM MER needs to be more fully realized by stakeholders.

Recommendations
Overall, Alloporus considers the current situation for MER in NSW is positive and contains significant opportunity to realize the many benefits of past and current investment in MER. Even small changes to the NRM MER system, especially a stronger focus on analysis and interpretation of MER data, would yield significant cost savings and greater value to all stakeholders.

Alloporus recommends that:

1. the NRC considers the findings of this report in its future reporting to government
2. the state-wide MER datasets are consolidated using the 'whole of system' and analysis and interpretation logic described in this report
3. the NSW NRM MER system is modified to create the capability and capacity to achieve data integration and analysis across as well as within themes
4. awareness of the value proposition for NRM MER is articulated and communicated to all stakeholders to pave the way for funding decisions
5. any future NRM MER funding model is flexible, reduces reliance on agencies and combines direct allocation with user pays and private sector partnership options, and that it invests in technology solutions that reduce data capture costs and improve data access

6. the NRC consider recommending creation of whole of government **MER Systems Unit** composed of NRM integration, statistical and GIS specialists to focus the interpretation of the core MER data layers.

Context and scope

Early in 2011 the NSW Natural Resource Management Senior Officers Group (SOG) asked the Natural Resources Commission (NRC) to review existing MER datasets and indicators, and provide advice on how to best prioritise efforts under the resource condition monitoring program. The NRC provided draft advice to the SOG in December 2011.

More recently the NRC has recommended to Government a revised set of state-wide natural resource management (NRM) targets that focus on what is most important in the landscape, including recognising the critical role of people in the landscape.

Given that any revision to state-wide targets would have consequences for monitoring, evaluation and reporting (MER), the NRC engaged Alloporus to provide advice on:

- an essential set of state-wide datasets to support the revised set of state-wide targets (and also considering its previous draft advice to SOG on essential state-wide datasets)
- a potential sustainable future funding model(s) for delivering monitoring, evaluation and reporting in NSW.

The NRC suggested that in developing the advice the Alloporus should consider:

- exisiting funding models for MER in NSW, and other jurisdictions
- the revised set of state-wide targets recently recommended to the NSW Government by the NRC
- synergies and opportunities for cost-sharing between scales, notably between agencies and CMAs using the NRCs draft table on 'MER role and function at each scale' for initial guidance
- opportunities for private-public MER partnerships, including any current international or national examples
- current Australian Government MER initiatives, and how NSW MER could leverage off these
- the role of current (and future) technology in providing cost effective and efficient solutions for MER objectives and activities
- current key, and committed to state-wide MER initiatives, for Riverstyles® spatial mapping under taken by the NSW Office of Water
- other parallel MER work undertaken by the NRC, for example identifying the priority, long-term monitoring program and datasets (and as advised by the NRC during this contract).

Approach

The brief provided by the NRC had a very wide scope. It could legitimately cover many months of desktop research and benefit both from surveys of both data users and providers and a wider stakeholder engagement exercise. However, the NRC sought early advice from a short review based on an interpretation of what is already known of the role and approach to NRM MER in NSW and other jurisdictions.

Timely advice could support the NRC recommendation to Government for a revised set of state-wide NRM targets and help to inform the SOG as it prepared to further develop implementation of the NSW MER Strategy.

Consequently material for this document was compiled in 12 working days through four sequential phases of review:

1. A search through existing technical literature and strategy documentation to identify key issues that are at the core of funding efficiency in MER drawing on
    - existing NRC reports and recommendations (including MER review work back to 2009)
    - definitions and approaches to MER from other state jurisdictions (especially Queensland, Victoria and South Australia)
    - the Federal government MERI approach
    - some known examples of innovation from overseas and the private sector

2. Exploration of the logic underpinning NRM MER in NSW under the proposal by the NRC to consolidate the state-wide NRM targets

3. Selection of essential datasets to support the MER of natural resources at the state scale under fewer state-wide targets

4. Consideration of the resourcing implications of a consolidated approach to state-wide NRM MER

This report is in four parts corresponding to each of these review phases and concludes with a summary of priority issues.

Limitations of this advice

To provide this advice Alloporus has reviewed a wide range of available information and has drawn on its own experience of observing MER strategy development in NSW and other jurisdictions, including previous advice to the NRC[1]. Given the task at hand this review was time-constrained and being based on observation and context interpretation, any advice is limited.

[1] MER Strategy Review 2008/9, MER Review 2011, Review State-wide Targets 2012

Part 1 | Key issues for MER in NSW

Alloporus reviewed documentation on MER for NRM from NSW, Queensland, Victoria, South Australia, Western Australia, the Federal government and some overseas jurisdictions (see Annex 1 for complete list of material reviewed). Special attention was given to historical and current MER thinking undertaken by agencies in NSW, and to reviews and recommendations on MER made by the NRC[2].

One objective of this selective literature review was to identify common issues, or themes that may affect cost efficient MER for NRM. This task generated useful insights into the complexities of MER at the state-scale.

The theme that emerged across all jurisdictions is that *MER for NRM means many different things to many different people*.

This is to be expected given that there are numerous natural resource asset classes, at least three "use" classes (production, protection, restoration) and a range of asset values from intrinsic to utilitarian. Numerous management practices and effects at the local scale further complicate what is already a bewildering combination of categories. A key consequence of having numerous natural resource assets, their uses, and the values communities place in them is complexity. This is because there is also a range of interactions, trade-offs, and variations in space and time as a result of human action and natural drivers. And it is this complexity that MER systems try to 'unpick', interpret and understand to provide support for decision making.

Whilst complexity explains the multitude of meanings, the aim of MER for NRM is to quantify and interpret the simple generic equation:

asset x use = value

People use natural assets and this use **changes** the extent and condition of the remaining assets as well as their current and future value. MER should be about measuring **this change** in a way that allows us to assess the return on asset use[3], anticipate future change and evaluate the effectiveness and return on investment (ROI) from interventions.

However, in the real world it is rarely so simple. The diversity of stakeholders and the natural resource values that they support are often at odds. Bias can cloud decisions and it is a key role of NRM MER data to provide objective information when there are difficult choices to be made. Curiously this objectivity seems not have the value it deserves.

[2] NRC (2010) Progress Towards Healthy Resilient Landscapes Implementing The Standard, Targets And Catchment Action Plans; NRC (2012) Finalising MER advice to the SOG - Prioritising NRM programs and datasets. Workshop Report; NRC (2012) Revising the Standard and state-wide targets for natural resource management in NSW. Recommendations Report.

[3] It is important to remember that primary producers operating in the private sector manage the bulk of our natural resource assets for commercial gain. So an understanding of the ROI in asset management from provisions in the Native Vegetation Act is as good an MER exercise as recording water quality as CEC at 1,000 measuring stations.

Alloporus has identified several key issues that may have contributed to the complexity and apparent lack of value from MER activity[4].

MER | MERI | MAERU

Key issue #1
MER has come to focus more on evaluation and reporting of program activity and investment rather than the analysis, interpretation and comparative projections of data that generate an understanding of natural resources and natural resource management.

The Australian Government set a precedent for MER in its NRM MERI Framework (2009). In trying for continuous improvement (the 'I' in MERI), MER from the Federal perspective has developed a strong focus on evaluation of the process of investment in NRM. The idea being to ensure that public funding of interventions for resource management can be assessed and evaluated. Program logic was the main tool adopted to help guide effective evaluations and it was an important step in creating accountability for investment.

To deliver evaluations, especially for specific government programs or even individual grants, data collection and reporting has tended towards explaining 'what we are doing about NRM' (for example, recording the area revegetated, the length of fencing constructed) rather than developing the information to help us understand the:

- values placed in the resource base;
- the consequences of resource use on those values; and
- the effects of interventions on overall asset inventory, condition and value.

Alloporus suggests that this shift in collection of data to assist process evaluation has taken emphasis away from the most useful aspects of MER and, as a consequence, vital steps to effective MER are missed.

Figure 1 describes the components of MER with the commonly understood steps of monitoring, evaluation and reporting. Only to get to effective MER for understanding value and helping with decision support two additional steps are also included and a new acronym MAERU[5].

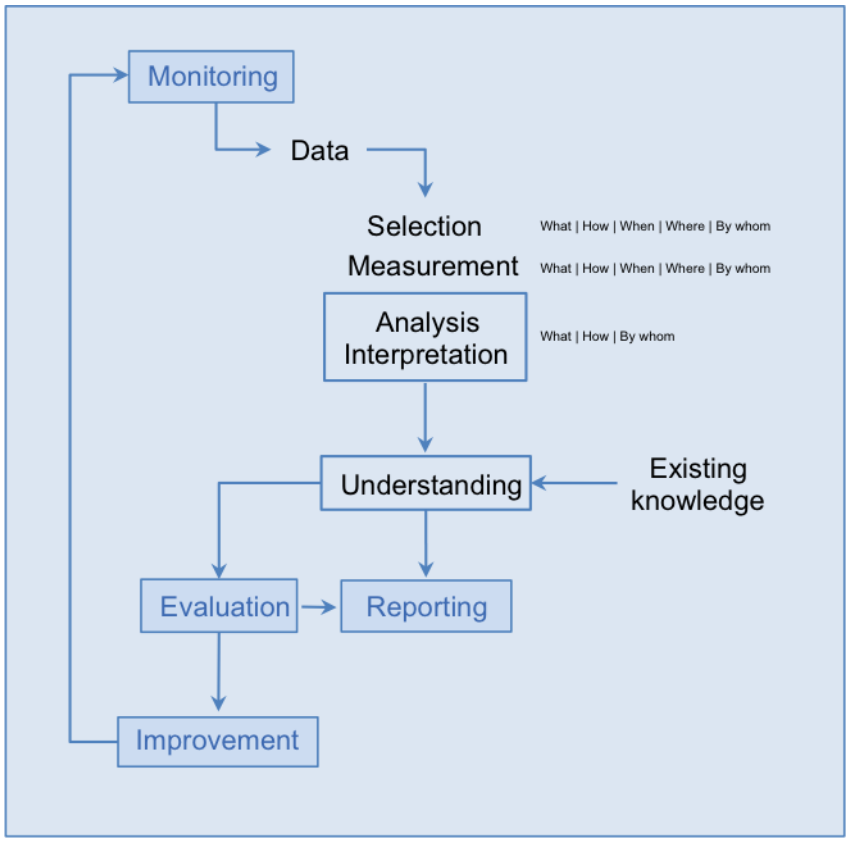
The 'A' refers to **analysis and interpretation**, the critical step in the process of progressing from data to information to knowledge. Alloporus suggests that this critical step and has been neglected to date, even though analysis and interpretation is essential to make MER data useful. Analysis and interpretation requires capability and capacity to implement and is more challenging than measurement and data collation.

[4] Although numbered these issues are not presented in order of importance
[5] Alloporus introduces MAERU only to illustrate a gap in the process and it need not go beyond this report – MER should remain the accepted acronym.

The 'U' in MAERU refers to **understanding** and the communication of 'understanding' to stakeholders. Here understanding is about the use of knowledge gained and tested through the process of analysis and interpretation of MER data and supported by the wider scientific and social science literature to help make and report on NRM decisions. In NSW there is good evidence of improvements in this aspect, for example through the CAP upgrade process. However, 'understanding' is not explicit in traditional MER terminology and definitions, and often it is assumed to occur as result of undertaking MER. However, unless this assumption is made explicit the risk is that numbers are collected but not converted to understanding through analysis and interpretation. This is especially true for matters as complex as natural resource management.

While 'process evaluation' has a vital role, MAERU attempts to highlight other critical elements in the process to develop useful information for decision makers. Governments and communities need data on **changes to the asset base** to generate the information to make the right decisions as much as they need information to assure taxpayer's money was invested wisely. Equally important as data collection, is the need to **analyse, interpret and explain** data [6].

Figure 1 Missing steps in the interpretation of MERI



[6] This would not be the first time analysis has been recommended over further data collection for example, after more than 30 years of wildlife surveys in the Kruger National Park, South Africa, it was recommended that surveys be suspended to allow staff time to analyze the accumulated data.

Skewed cost base

Key issue #2
Most of the heavy lifting for the critical data collection falls on NSW agencies. This is inefficient given the potential among stakeholders who are also users of the information. Who gathers data and who uses it has significance for the funding model.

NSW agencies have developed considerable capability and capacity to collect environmental data to meet statutory requirements. Whilst not all data for NRM MER is required by legislation, the agencies have assumed responsibility to provide most of it.

Agency theme teams have become the *de facto* primary data generators and custodians and have had to make decisions on what to collect. Under the current NSW MER strategy, theme teams were established and aligned to the 13 state-wide NRM targets. Rather than make priorities across themes, theme teams have (understandably) defaulted to 'their' state-wide target – or their own expertise and 'comfort zone' that is often characterized by a preference for resource conservation and resource protection datasets. One benefit of this is that agencies have remained close to the primary data and have overcome many of the technical the challenges of collecting it.

As the regional NRM model continues to mature and devolve responsibility to more local levels;, CMAs, LGAs and primary producers are the users who are likely to benefit most from the data that agencies collect.

Even though everyone is aware that MER data costs money to collect, it is unlikely that users of MER information at local and regional scales would pay for raw data at the state scale that does not provide a foundation/baseline/point of reference for their own data collection or makes that local collection simpler and cheaper.

Finding value

Key issue #3
It is not easy to find value from MER when a) the cost base is skewed, b) time and spatial scales interact and c) a new strategy model (linked social-ecological systems thinking) is emerging in the regional NRM model. Clarity in the MER value proposition will help refine MER needs and determine the best funding model.

The value of MER will change with the proposed move to a smaller set of state-wide targets and CAPs based on systems thinking. As the NRC suggests[7], any shift from a backward looking "*collect data now, ask the evaluation questions later*" to an MER system designed to answer regional as well as state-wide evaluation and process questions is a significant one.

[7] NRC (2012) Revising the Standard and state-wide targets for natural resource management in NSW. Recommendations Report

A consequence of asking clear evaluation questions up front, is that MER data will have greater value to a larger number of stakeholders, especially as more NRM decisions are devolved to regions. As value is spread then cost can also be shared. Any revised MER system will still require base-layer data but we will need to reassess what these are to get best return on investment (see discussion in Part 2).

To determine the best funding model for MER, its value proposition needs to be clearly articulated. For example:

- What do we actually get from investment in MER (as opposed to investment in intervention)?
- What price can we put on the information and knowledge (noting what this means in the flow of data described in Figure 1)?

The optimal funding model only becomes clear when the value of the information is known and appreciated (see also Part 4).

In this sense the Australian Government's MERI Strategy is right when it refers to:

- *"investment in biophysical outcomes"* as the ends; and,
- *"investment in social, institutional and economic outcomes"*[8] as the means to achieve biophysical outcomes.

Decision makers need a reliable understanding of the links between these two elements, particularly under the new model of linked social-ecological systems thinking. In the meantime NRM MER has become concerned mostly with the investment process rather than return on investment[9] because we are not sure what the return should be.

Opportunity knocks

Key issue #4
We have more data than we currently use. There are technologies that are available now to gather even more information at low cost. Data from the private sector can also be leveraged if the right market signals are created. There is a strong opportunity to find and deliver information that has real value.

Over time, agencies have measured natural resource assets and impacts on them in many ways (through their attributes, rates of change in attributes, drivers of change, enabling conditions, interpretation & modeling and through surrogates). Some of these measurements have been ongoing for many decades. The existing MER datasets are large, cover wide areas over time and are underutilized.

[8] Australian Government (2009) NRM MERI Framework. Australian Government Natural Resource Management Monitoring, Evaluation, Reporting and Improvement Framework.
[9] Return on investment for NRM is about understanding resource use efficiency and the maintenance of environmental values and not about answering "did the policy frame work".

Given this, we probably know a lot more than we think we do.

Technology, from remote sensing to distributed data and web-enabled data collection applications, has already made MER data cheaper, with greater coverage and resolution than the past approach of point source information collected by specialists. For example, it is now possible to assess change in herbaceous layer cover in rangelands from Landsat imagery without resorting to extensive field assessments[10]. This technological capacity and capability will grow in use and accessibility.

We also have the opportunity to ask the asset managers what they think. Land use and land management survey data generate powerful predictions – ABARES NRM surveys are hugely underused data source. For example, 25% of pastoralists monitor the pasture/vegetation cover on their properties and 85% of all farmers claim that they manage their farm for long-term productive capacity of the land[11].

These general observations suggests at least two things:

- There is more data collected than we realize and with modern technology even more could be captured at minimal cost
- The twin opportunities of utilizing existing data and gathering new data cheaply may require a change in attitude towards how and why MER data are collected.

[10] Bastin, G et al (2012)
[11] McInnis, T and Wicks, S (2011)

Part 2 | The logic of 'whole of system' measures

Alloporus suggests there is a significant gap in the way that MER is currently conducted in NSW that flows through into both the structure of MER systems and the value that can be gained from investment in them at the state scale. The opportunity is to use existing data more effectively by using it to help understand whole of system responses to NRM.

MER systems in many jurisdictions, including NSW, appear to be focused more on specific assets, outcomes and/or values that are highly relevant to specific stakeholders. This is understandable, given the historical nature of 'condition and trend' state-scale NRM targets across a range of specific natural resource assets. However, it appears to have been achieved at the expense of efforts to interpret data to understand whole of system responses to management decisions. This is a critical omission given that many NRM decisions involve trade-offs between asset values and that decisions have flow on effects for asset volume and condition in space and/or over time.

The value proposition for investment in MER is greatly enhanced if:

1 data are used to inform against specific targets; **and**,

2 provide an understanding of 'whole of system' responses to management actions.

The logic of this assertion is outlined in the following sections.

MER information

Effective NRM monitoring, evaluation and reporting requires information. It is necessary to obtain real-world data on context, condition and pressures for assets and asset values at a scale (grain and extent) that not only generates data reliability (confidence in the information) but also aligns to investment and management interventions (the data match how the resource is managed). Consequently the foundation of any MER strategy is the choice and collection of usable assessment and monitoring data (Figure 1).

Selection of data to understand and report on the status and management of natural resource assets at the **state scale** is difficult because:

- the potential combinations of asset classes, asset condition, uses, values and management options are large and complex,
- the extent and diversity of landscapes in which assets sit is equally daunting, and consequently,
- it is impossible to measure everything everywhere.

The solution outlined in the current NSW MER Strategy has been to select an achievable sub-set of measurements at an appropriate scale and intensity to provide sufficient understanding at a realistic cost.

However, it is easy to focus on data collection alone at the expense of analysis, interpretation, and the process of generating understanding. Using the state-wide targets as a guide to create a default category system of 13 themes aligned to and established by the available technical expertise, NSW has ended up with an extensive monitoring sub-set of over 220 datasets that cover a wide range of values. This monitoring array was chosen partly in response to legislation but was also influenced by values, available expertise, and funding allocations.

Collecting MER information

It is easy to underestimate the technical expertise required to capture and interpret reliable NRM MER data. There are many challenges in how, where and when to collect meaningful information, from the choice of measurement variable to the specific sampling method.

In the NSW MER system, agency scientists have applied their expertise to generate robust and statistically defendable information. One benefit of this strong technical focus is that many of the MER datasets are of high quality (see various reviews by the NRC). Agency staff have also leveraged technology and their expertise to overcome the problem of monitoring such a vast land area and wide range of environmental conditions[12]. Consequently there is especially good data for some NRM variables (e.g. woody vegetation extent, river discharge, fluvial geomorphology, etc.).

The downside of rigorous discipline focus is lack of integration with other values. It follows that good data coverage and quality will coincide with where there are sufficient experts in that discipline and that our areas of technical expertise can become self-perpetuating. For example, we are very good at measuring woody vegetation, but not so good at using the data to interpret NRM outcomes or to understand where our efforts to maintain or increase the extent of vegetation are supporting broader biodiversity, bio-physical or social outcomes, while continuing to meet production needs.

Focusing the MER system

Recognizing the potential inefficiencies of the category system for MER, the NRC has made recommendations to simplify and refocus the 13 state-wide targets to a goal and five state-wide targets supported by a discrete set of policy and evaluation questions[13].

It is difficult to rationalize 220+ datasets in the same proportion as the reduction in targets when each of the current datasets can be justified as a direct measure or an index of context, condition and pressure for a given asset value. This is especially so when the approach has been to create measures for each value in isolation. We have tended to think that to report on, for example,

[12] Remote sensing data analysed through SLATS to quantify spatial and temporal extent of native vegetation clearing is a good example.
[13] Natural Resources Commission (2012) Revising the Standard and state-wide targets for natural resource management in NSW. Recommendations Report.

water quality or wetland extent, it is necessary to measure them directly. There has been a "one for one" approach that has contributed to ending up with 200+ datasets.

One solution is to consider the system as a whole and take an **integration approach** to a sub-set of data that must be analyzed in combination to answer the **state-wide** policy and evaluation questions for the five revised targets.

Whole of system MER will require datasets that when a) **monitored** and b) **made available as data layers** in a GIS, can be **combined, analyzed and interpreted** to provide sufficient information for adequate state-wide NRM reporting against revised targets.

The logic is that answers to evaluation questions at the state scale can come from combining fundamental context and effect variables that describe attributes of the system as a whole. The conversion of MER information into knowledge for effective NRM comes from the **analysis and interpretation** of the assessment and monitoring data.

For example, if from a combination of rainfall, land use change and fluvial discharge data, water flows in catchment are increasing; then this will correlate with decreasing water quality. Or in catchments where woody vegetation extent, vegetation condition and soil condition all increase, water quality would improve [More examples are given in Appendix 2].

For integration to work datasets must be

- spatial
- usable as both static measures and as rates of change
- have spatial grain and extent that can be matched across multiple data layers
- interpretable as a data layer in a GIS
- amenable to additive or multiplicative modeling

The benefit of an integration approach requires the realization that NRM monitoring can provide **prediction and comparison** rather than just **trend and target** assessment. At the state-scale, MER should aim to identify large-scale patterns in variables that, when combined, say something about the whole system. This should generate sufficient information to:

- answer the NRC's proposed suit of policy and evaluation questions; and,
- report against the revised five state-wide targets.

Integration analyses generate interpretations that are general given they tend to identify large-scale patterns. They are not a substitute for direct measurements of specific asset values, except that with an over-arching integration approach the value specific datasets need not be state-wide. It is possible for specific asset value measurements to be focused, local, aligned to regional CAPs and generate far greater return on investment. Meanwhile at the state scale the integration

measures are reportable against the proposed smaller set of higher level state-wide NRM targets.

Summary | 'whole of system' MER

A 'whole of system' approach to NRM MER using integration measures are powerful because they:

- can be generated from a small number of key datasets
- the outputs are change maps that not only flag areas of concern and areas where improvements have been made but
- can identify where more focused measures are needed.

Part 3 | Essential datasets for a whole-of-system approach

Combining MER data into integrated indices of asset status and change makes sense if there is a small enough number of core datasets that have state-wide coverage.

When combined with other measures collected through targeted regional monitoring programs, core datasets should should allow for reporting progress against state-wide targets **and** provide sufficient information to answer the evaluation questions at the state scale. This tighter focus with a 'whole of system' logic lends itself to a smaller suite of datasets and still provide sufficient MER capability at the state-scale.

Selection criteria for MER datasets

In choosing a sub-set of datasets for this integration approach, Alloporus considered datasets that:

- will be collected anyway for other purposes than specific NRM MER (e.g. weather, topography, population, rural economic indicators, etc)
- are readily scalable[14] (e.g. SLATS)
- resolution can be easily improved with additional local data collection
- assist CMAs and LGAs in their environmental planning and reporting
- make it easy to add value to reporting with additional regional and/or local data from complementary variables

It is important to note that, in this context, a 'dataset' can be a specific measurement or index obtained through direct or indirect observation. For example, ground cover change would be a single measure that is generated from analysis of a time series of remote sensing imagery combined with ground observations to truth spectral information against cover values. Equally a 'dataset' might be a suite of variables (e.g. combinations of rainfall, temperature and humidity measurements used to define climate).

Datasets for whole of system MER

Alloporus suggests that the essential datasets for a whole of system approach to NRM MER at the state scale would include at a minimum:

1. **Climate** | rainfall, temperature, frost free days, evapotranspiration, etc…
2. **Topography** | Digital elevation model

[14] Scalable here means where the grain of sampling is fine enough to allow aggregation to larger scales and still retain meaningful information at lower resolutions.

3. **Population** | distribution, demographics
4. **Rural economic indicators** | farm cash income, farm debt-equity ratio, index economic diversity, youth net migration

5. **Land use** | land use categories, land use change
6. **Land management** | mapping of types, mapping of change, best practice
7. **Ground cover**

8. **Pests / invasive species** | weeds, feral animals, diseases

9. **Soil landscape** | mapping of soil types
10. **Soil condition**
11. **Vegetation** | woody vegetation, woody native vegetation, non-woody vegetation, non-woody native vegetation
12. **Vegetation condition**
13. **Fluvial discharge / flow**
14. **Wetland extent**
15. **Groundwater levels**

There are also regionally relevant datasets that would be needed to support this core set

16. **Oceanographic data**
17. **Offshore nutrients**
18. **Estuaries** | macrophyte extent

19. **Land manager capability**[15] | engagement, awareness, motivation

Combining datasets

The strength of this (minimal) list is realized when the datasets are combined.

For example:

1 if **land management** is nested in **land use** and then **ground cover** is overlain it will be possible to identify the combinations of use and management that deliver ground cover; then,

2 overlay with a **ground cover change** layer and it will be possible to identify those combinations of use and management that correlate with increase or with loss of ground cover; finally,

3 add the **fluvial discharge** layer and focus on flow rates above and below the areas where ground cover has changed and look for correlation.

[15] This is best in the regional context because at the state scale these are difficult metrics to collect – the base socio-economic numbers provide a suitable surrogate

Further examples are summarized in Appendix 2.

Because we need to be confident of cause, the core dataset approach does not mean that we discontinue all other measurements. Many will still be needed. The difference is that they can now be focused in space and time on where they are most needed. One output of the integration analysis will be helping to focus these supporting datasets.

Important note | correlation is not causation

The focus from 200+ down to 20+ datasets means that most values will not be measured directly at the state scale. Interpretation and reporting will rely on pattern recognition backed up by existing system knowledge and cause-effect monitoring at local scales.

This may cause concern because pattern analysis (correlation) is not causation. However, given enough data (the key benefit of modern remote and automated data collection and storage) there is rarely a consistent pattern without an underlying cause.

Whole of system thinking makes picking the cause more robust than interpretations that focus on one value at a time.

Part 4 | Resource implications

Monitoring, evaluation and reporting for NRM costs money - a useful rule of thumb is allocating 5% of program budget to MER. This is a challenge for jurisdictions because most of the financial benefits from the use of natural resource assets accrue to the private sector. Government is left to measure and report on both commercial and public good values of natural resources and the ecosystem services that are not fungible but contribute to monetary value from production.

A NRM MER strategy implemented with 200+ datasets is especially costly. Streamlining this effort would have cost savings from reduced data collection requirements and refocusing staff effort on data analysis and interpretation.

Refocusing on a 'whole of system' approach would also require some investment in data analysis and interpretation and the technology tools to achieve and make accessible data integration.

Cost of NRM MER in NSW

Alloporus did not have access to detailed financial reporting for the costs of NRM MER in NSW. Some information was made available on state-scale costs to cover MER for resource condition as being upwards of $3.7 million with some 80 FTE staff[16]. Native vegetation (30%) and water (43%) account for most of this amount although agencies estimate that this is insufficient funding to collect all the necessary data[17].

Whilst these figures do not cover the full costs of MER they illustrate the current funding model is a significant net cost to state government - spending that falls on the agencies as staff time and operation costs. It also shows that cost is uneven across the various datasets. It is more expensive to collect certain types of NRM MER data.

Consolidation to fewer datasets and an analysis and integration approach to the use of data will reduce overall spend. Further analysis on current and future costs is needed before a reliable estimate of savings can be made. Alloporus suggests that independent financial analysis of NRM MER would be prudent.

Technology

In the past decade the net cost of each unit of data for NRM MER has declined. Fewer person hours are needed in the field to collect data thanks to remote sensing and automated technologies for data capture. Data loggers can now capture and store vast amounts of data and many measurement devices are wireless enabled able to push data from remote locations in real time.

[16] Data supplied by NRC
[17] Data supplied by NRC

Spatial data technology has revolutionized the opportunities for measurement and reporting of natural resources. Mapping technology that was prohibitively expensive a decade ago is now available on a range of computer-based platforms such as smartphones. The potential to harness this capability in the hands of natural resource managers is, for the most part, unrealized. One emerging scenario is that in the next decade individual land managers could record any number of measurements from their management activities.

This scenario needs to be factored into the costs and saving for future NRM MER programs. In future, MER will cost less per unit of measurement and also have greater coverage and resolution.

Overall, government funding for MER in the future is likely to shift from data collection to data analysis and data quality control. Agency staff will need to become data quality assessors and modelers rather than data collectors. There will also be a need to partner with the commercial sector to generate data access and interpretation tools.

Technology options are likely to revolutionize NRM MER, especially if there are commercial incentives for tool development such as are appearing in the emerging environmental markets.

Opportunity knocks

The consolidation of NRM MER into a whole of system approach with a data analysis and integration focus creates many opportunities. For example:

- **Cost saving** | Fewer, more focused datasets will require fewer operation and staff resources
- **Technology application** | through spatial mapping and data integration tools will make data scale and coverage accessible to multiple stakeholders including those that currently do not use data in their management decisions
- **Technology for citizen science** | through online capability data can be captured at source and shared. It is even possible to leverage social media and mobilize stakeholder groups to capture information
- **Cost sharing** | When data is available, accessible and adds value it will be used. And where information is useful, it has a value that users will be prepared to pay for. Future funding models could include a user pays component so long as the user receives and has access to the value in the MER data.
- **Realising value** | The opportunity for Public-Private partnerships in generating and using MER data are greatly enhanced by technology and the 'whole of system' approach. Data custody and privacy can be more readily managed when synthesized data is released to the market.

- **Business opportunity** | The volume of data generated from MER has considerable commercial potential. Future models should not be shy of allowing MER data to create business opportunities

Future funding model

The current funding model places primary responsibility on the NRM agencies. This creates fiscal challenges and is uneven with respect to users and beneficiaries of NRM MER data.
It will be possible for a future model to have:

- A whole of government approach
- Shared data capture responsibilities involving most stakeholders
- Technology leverage to reduce data capture costs
- Investment in tools to provide stakeholder access to and use of NRM MER data ideally in commercial partnership with the private sector
- Financial returns from the use of NRM MER data in the emerging environmental markets (e.g. carbon and bio-banking)
- A component of user pays

Before a new funding model can be fully developed it will be necessary to articulate and communicate the value proposition for NRM MER. Data is only worth paying for if the value is known – in this sense it is worth considering value beyond those of legislative requirements.

The NRM MER value proposition

As previously discussed, MER is perceived to lack priority because its value is not fully understood – the process lacks a **value proposition** that is clearly articulated to all stakeholders, especially the investors.

The benefits from NRM MER are hard to capture because value

- means different things to different people,
- is complex and multi-faceted,
- changes over time
- varies in importance with stakeholder and situation
- is often a threshold problem
- requires understanding to be fully appreciated

Given this list it is unfair to ask the technical specialists to articulate the value question. Few are likely to be across all the elements in the value set. And it explains why selection of a core dataset from a premise of asset value is a tortuous process.

A working list of the tangible values of NRM MER are:

1. Option picking | An evidence based ability to identify resource use and management options at a range of scales

2. Risk management | The ability of information to reduce uncertainty including the ability to predict future scenarios that will impact on asset extent and condition with and without resource management

3. Decision support | A framework to help make trade-off decisions on what really matters to people and to revisit those decisions in an adaptive way

4. Opportunity | Information to help identify current and future resource use and values

5. Due diligence | Information to support investment decisions for asset development

6. Reporting on condition and trend | Inventory and condition of natural resource assets at a range of scales

In this list asset and value are not just monetary or restricted to production options. It includes all asset classes and values. The challenge in taking the value proposition literally is that it can be difficult to determine the units of non-economic value.

Conclusions and recommendations

The approach to NRM MER described here is a major shift. It lifts the ideas of whole of system and resilience thinking to the state scale without losing the ability to report against revised state-wide targets. It also provides a powerful predictive tool to set baselines and locate potential areas of future concern and intervention.

Implementation will not be easy. Along with a shift of emphasis from data collection towards more interpretation, prediction and comparison, there are technical challenges in accessing and making the data layers integrate without diluting data quality and coverage. In short, it is a significant **practical test of whole of government approach**.

Despite the challenges of data integration for MER, Alloporus believes the benefits of making the transition should be realized. Indeed this will become essential as food supply and security, fossil fuel and fertilizer costs, and the ongoing vagaries of the Australian climate affect the economic and social fabric of NSW.

Overall, Alloporus considers the **current situation for MER in NSW is positive** and contains **significant opportunity** to realize the many benefits of investment in MER. In practice, this means making adjustments to the current arrangements, rather than radical overhaul to achieve an effective and efficient MER system. Even small, well-chosen adjustments to the NRM MER system could yield significant cost savings and greater value to all stakeholders.

Consequently Alloporus recommends that:

1. the NRC considers the findings of this report in its future recommendations to government

2. the state-wide MER datasets are consolidated using the 'whole of system' and analysis and interpretation logic described in this report

3. the NSW MER system is modified to create the capability and capacity to achieve data integration and analysis across as well as within themes

4. awareness of the value proposition for NRM MER is articulated and communicated to all stakeholders to pave the way for funding decisions

5. any future NRM MER funding model is flexible, reduces reliance on agencies and combines direct allocation with user pays and private sector partnership options, and that it invests in technology solutions that reduce data capture costs and improve data access

6. the NRC consider recommending a dedicated **MER Systems Unit** composed of integration, statistical and GIS specialists to work with the interpretation of the core MER data layers. Along with modeling, tool develop and data support to agencies, CMAs and local government, the unit could provide output for

- SoE reporting
- Reporting against state-wide targets
- Base layer input to CMA CAPs
- 'Flashpoint' prediction
- Feedback into specific theme teams

Appendix 1

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Appendix 2

Examples of data integration for 'whole of system' MER

		State scale datasets															Regional			
		National				Management				Biophysical										
Revised state-wide target	Spatial index	Climate	Topography	Population	Rural economic indicators	Land use	Land management	Ground cover	Pests / invasives	Soil landscape	Soil condition	Vegetation	Vegetation condition	Fluvial discharge / flow	Wetland extent	Groundwater levels	Oceanographic data	Offshore nutrients	Estuaries	Land manager capability
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Improve the capacity and engagement of natural resource managers	Change in land management			◆		○	○	◆									○	◆	◆	
	Extent of pests/invasives	◆	○	◆		○	○	◆	◆											
	Soil condition	◆	○	◆						○	◆									
	Farm viability	◆	○	◆	◆															
	Local capability	◆	○	◆	◆															◆

		State scale datasets															Regional				
		National				Management				Biophysical											
Revised state-wide target	Spatial index	Climate	Topography	Population	Rural economic indicators	Land use	Land management	Ground cover	Pests / invasives	Soil landscape	Soil condition	Vegetation	Vegetation condition	Fluvial discharge / flow	Wetland extent	Groundwater levels	Oceanographic data	Offshore nutrients	Estuaries		Land manager capability
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		19
Improve soil condition	Soil condition directly	◆	○							○	◆										
	Land management effect	◆	○		◆	○	○	◆		○											◆
	Ground cover benefit	◆	○			□	□	◆		○	◆										
Improve the condition of aquatic ecosystems	Land management effect	◆	○			○	◆							◆	□				◆		◆
	Wetland maintenance	◆	○											◆	◆						
	Recharge to groundwater	◆	○											◆	□	◆	□	□	□	□	□
	Effect of population	◆	○	◆		◆	◆							◆	◆	◆	□	□	◆	□	□
	Invasives	◆	○						◆					◆	□				◆		◆

		State scale datasets															Regional			
		National				Management				Biophysical										
Revised state-wide target	Spatial index	Climate	Topography	Population	Rural economic indicators	Land use	Land management	Ground cover	Pests / invasives	Soil landscape	Soil condition	Vegetation	Vegetation condition	Fluvial discharge / flow	Wetland extent	Groundwater levels	Oceanographic data	Offshore nutrients	Estuaries	Land manager capability
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Improve the devolution of decision-making to the most capable local level	Trouble spots	◆	□	◆	◆	◆														◆
	Invasives	◆	O	◆					◆										◆	◆
	Land use change			◆	◆	◆														

Key:
O Static measures or parameters that vary little over time
◆ Monitored parameters