UNITED NATIONS STATISTICS DIVISION

Seventh Meeting

UN Committee of Experts on Environmental-Economic Accounting

Instituto Brasileiro de Geografia e Estatistica

Rio de Janeiro, 11-13 June 2012

Trials of Environmental Asset Condition Accounts in Australia

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1. Introduction

Thank you for the opportunity to present to you some of the findings from the first year of our regional environmental asset condition accounting trials in Australia.

We are coming at environmental accounts from a policy users perspective: how do we manage our land, water and marine resources sustainably? Naturally therefore our focus is on measuring environmental asset condition.

The second policy perspective is that economic decisions affecting land, water and marine resources are made at multiple scales - enterprises up to the national level. So we want to find a method to build asset accounts that informs decisions at all these scales.

One of the primary reasons ecosystem accounting is so difficult is because despite the best intentions, science has been very bad a compiling information in a format that can inform economic decisions. Our job in these trials is to find a way of doing this, and we are delighted that the statistics profession has been so willing to assist.

These trials are testing the practical application of a science based model that places a common non-monetary measure of the condition of any environmental asset that can be applied at any scale, which can inform economic decisions.

As you will appreciate, this presents a significant scientific and technical challenge.

What I would like to do today is to take you through some examples of how we are putting together these asset condition accounts, using a common unit of measure of condition, and then give some examples of how this type of account can be used to inform policy and investment decisions.

Like many industrial economies, much of Australia's early wealth was created in a manner that has caused significant degradation of our natural capital:

- the pollution of our air;
- the over-allocation and pollution of freshwater resources;
- land degradation from excessive clearing of native forests and overgrazing; and
- the extinction of species and the loss of biodiversity.

Our challenge today is to stop further degradation and to invest in the restoration of those assets we have already degraded.

Accounting for the condition of environmental assets is complex because of the many interactions within individual ecosystems and many interactions between ecosystems. One of the more significant elements of the Australian trials therefore, is finding a practical way of establishing a scientifically credible, common unit of measure of condition. To do this we are using the science of reference condition benchmarking. I will return to this issue.

2. The measure of condition needs to be scientifically credible

Accounting for the condition of environmental assets must confront two problems: first we do not have, nor will we ever have, enough money to systematically measure everything in nature; and secondly nature is complex with many interactions within individual ecosystems and many interactions between ecosystems.

Without a common unit of measure that places diverse scientific information into an accounting framework, it is not possible to systematically link the health of the various components of the natural environment to economic decision making.

Unlike the SNA which measures stocks and flows in monetary units, there is no agreed common unit of measure for stocks and flows in ecosystems.

One of the more challenging elements of the Australian trials therefore, is establishing a scientifically credible common unit of measure of condition, using the science of reference condition benchmarking.

There are many practical and scientific reasons for using this model. It does however present a couple of significant challenges for SEEA.

Firstly, in most instances you will need to construct indices of a number of physical indicators to give a scientifically valid measure of the condition of an ecosystem or any other environmental asset.

Secondly, if you don't use a common unit of measure the accounts can't be used to inform policy or direct investments across asset boundaries.

And thirdly, for the vast majority of ecosystems, the use of a 'natural' or pre- industrial benchmark is how science already measures condition. Water quality and biodiversity conservation are the notable examples.

So for all these reasons and more, if it proves scientifically valid to do so, then in makes great sense to adopt this common unit of measure for the condition of all assets. That is what our proof of concept trials are seeking to test.

This has four implications for the SEEA accounts: combining indicators to create indices; scientific accreditation of condition measures; aggregation of indices within each asset and across different assets; and use of a reference benchmark to set the upper boundary of condition.

Indices

Firstly, it is not possible to avoid using indices to give an accurate measure of the condition of most ecosystems.

If you don't use indices, you are left with are a set of physical measures of elements of an ecosystem. That is not a measure of condition.

This presents a significant challenge for SEEA but it is unavoidable if you wish to create an asset condition account.

Accreditation

This raises the question, who then accredits the indices before they enter the asset condition accounts? If you don't have a scientific accreditation process, then the accounts won't represent a valid indicator of condition, and practitioners and policy makers simply won't use them.

This is where you need science, so somehow SEEA needs to provide a process by which this happens.

Aggregation

We then need to address the question of aggregation within each asset, because different regions or states will, by necessity, both financial and scientific, use different indicators to measure the condition of the same asset. I will give you an example of this in a minute.

Again this is a role for science. We therefore need to find a means by which science is given a formal role in this process.

3. Establishing an Upper Boundary Reference

Let me turn specifically to the fourth issue of establishing an upper boundary reference from which to base the condition measure for all assets.

There is a world of science sitting behind reference condition benchmarking, which I will not go into today, but if you are interested, we can provide it for you.[1]

The reference condition benchmark is a scientific estimate of the natural, or pre-industrial, or potential condition, of an ecosystem in the absence of significant, post-industrial human alteration.

The current condition of an asset is compared against the reference condition benchmark. This gives us a relative condition of any environmental asset, at any scale, irrespective of the unit of measure of each indicator, out of a possible score of 100.

Reference condition does not have to mean a pre-industrial benchmark date, although that is often the most convenient way to describe it. Another option is to measure an area in an undisturbed condition - what science calls a reference site. Another option is for science to simply estimate this biophysical condition using models.

Reference condition benchmarking is commonly used in science, but non-scientists are concerned that a pre-industrial benchmark implies or will be assumed to be describing targets, instead of what it actually is - an upper boundary to base a common unit of measure.

I am very aware that this is a real issue and it needs to be resolved. Reference condition does not imply a policy objective or target. It is therefore critical that we make this abundantly clear in the text. I believe the answer is to show by example how this will work, which will allay the fears people currently do have. It is our experience what when it is done well, it quickly becomes a non-issue.

So me try and ground this in reality. Picture an environmental asset - say a river. Somewhere within the national boundary there will be a river or parts of a river at the scale we are accounting for, in pristine or near pristine condition - in the mountains, in a national park, wherever.

That river sets the upper boundary for the measure of that asset in your account.

That is all reference benchmarking is doing – setting the upper boundary for a measure of condition.

It really doesn't matter if we have variations at the margin, what is important, and this is where the value lies for environmental accounting, is that in the same way monetary currencies convert infinite complexity into an easily understood and usable means of exchange, so too does a common unit of measure for the condition of environmental assets.

The great advantage of using the same principle for all assets is that the condition of different assets can be compared in a single account. Science does all that work for you, before the information is put into the accounts.

One of the other benefits of establishing a common unit of measure of condition is a fundamentally important issue that often gets lost in these national processes, and that is that environmental accounts need to inform economic decisions at all scales, not just national policy.

Millions of people make millions of decisions every day that has an impact on the environment. They can't be expected to make better decisions without environmental information that informs their economic decisions.

I cannot over-emphasise this point. It would be absurd to suggest that every unit in the economy should establish its own measure of asset condition – every individual, every enterprise, every industry sector, every level of government. Yet that is precisely what we have today.

This is why you need a national standard based on the upper boundary ‘reference’ condition. Otherwise different people at different scales will construct accounts with different boundary conditions.

4. The Regional Environmental Accounting Trials

I would now like to take you though some of the progress we have made in Australia where regional natural resource management groups are testing the construction of environmental asset condition accounts.

These trials are being led by the 56 regional natural resource management bodies we have established across the Australian continent, in partnership with the Wentworth Group and other experts from the natural resource sciences; the Australian Bureau of Statistics, the Australia Bureau of Meteorology, Australia's premier scientific research agency, the CSIRO, and a number of state government agencies.

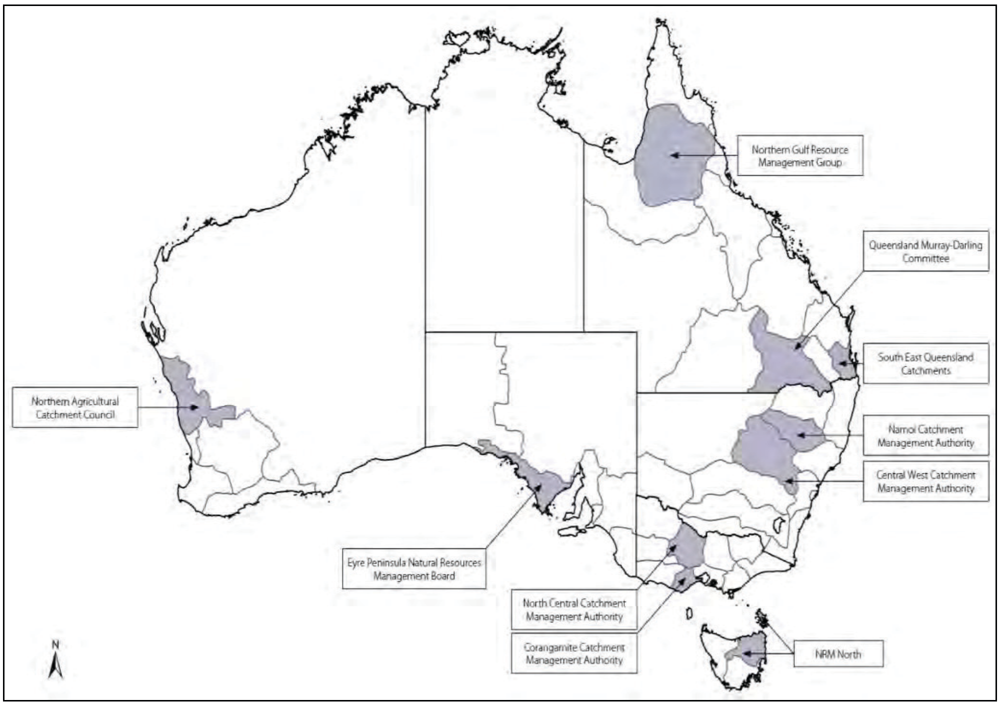

Figure 1 – Participating Natural Resource Management Regions - Stage 1 - Regional Environmental Accounts Trial

We have chosen the regional scale to test this methodology for two reasons:

1. Asset condition accounts need to be constructed at the scale at which ecosystems function – at catchment or landscape scales; and
2. It is a scale where we are most likely to have sufficient exists information from which to construct them.

The trial is using the *Accounting for Nature*[2] model developed in 2008. The trials are being conducted against five design principles:

1. Environmental accounts should enable people to understand and track the status and direction of changes to their environmental assets.
2. Indicators may vary from region to region according to agreed standards.
3. Existing data sets should be used wherever possible.
4. Measurements of condition are based on specified reference condition benchmarks against which change in indicators can be measured and compared.
5. Measurements to be generated at a regional scale should be capable of aggregation to the national (and international) scale.

We are currently half way through a "proof of concept" stage, which involves 10 of the 56 regional bodies. We aim to complete this stage by the end of this 2012.

These 10 regions cover a wide variety of landscapes across the 7.5 million square kilometres of our country and each of the regions varies in its technical capacity, its resourcing capabilities, its data sources, and its organisational arrangements. This is important, because it is one thing to test a methodology in the most highly resourced regions or agencies; the real test is whether the least resourced, most data poor regions can succeed.

We have established two expert committees to assist with the trials: a Scientific Standards and Accreditation Committee to accredit the science, and a Technical Environmental Accounting Standards Committee to ensure the information fits within an appropriate environmental-economic accounting framework.

In the past 12 months, the committees have focussed on developing a set of resources that provide advice and structure to constructing the accounts: 'Guidelines'[3] which set out a 6 step process for constructing the asset condition accounts, an 'Accreditation Manual' which sets the standards for their accreditation, and 'Technical papers' which explore some of the more challenging scientific aspects of determining condition indices for some environmental assets.

We have put this effort in at the beginning of these trials to ensure the framework used by the regions is robust and accepted by scientific and statistical communities, for the reasons discussed in section #2 above.

5. Structure of the Environmental Asset Condition Accounts

Environmental assets can be described under broad asset classes: Land, Water, Atmosphere, and Marine. Within each asset class there are a range of environmental assets.

We define an environmental asset as "any biophysical feature in nature that can be measured in time and space." [4]

In other words, an environmental asset can be just about anything that society considers to be an asset. It is a societal question, informed by science but not dictated by science.

An environmental asset can be an ecosystem such as a forest or a river system, but the accounts are not restricted to just measuring the condition of ecosystems. It can be a fishery, agricultural soils, or any other physical feature in nature, such as groundwater, or it can simply be a population of an individual species of mammal or birds.

The Asset Condition accounts are based around three sets of tables.

The most basic structure of an environmental account is a summary table, describing the environmental asset classes, displaying each individual environmental asset, and the environmental condition indices (what we call Econds) generated for that time period, and over a period of time to establish trend.

Table 1 – Accounting structure: Environmental Asset Condition Summary Table

Environmental Asset Class	Environmental Asset	Econd		
		2008	2009	2010
LAND	Vegetation	40	50	
	Soils	60	65	
	Fauna	80	72	
WATER	Rivers	60	44	
	Wetlands	54	54	
	Floodplain	75	77	
	Groundwater	68	59	

The second set that sits underneath contains the asset tables for each environmental asset.

Table 2 – Environmental Asset Condition Table - Rivers

Rivers				Year 1		Year 2	
	Indicator*	Unit of Measure	Reference Condition Benchmark	2010	Condition Score	2011	Condition Score
Econd TOTAL				60			
Creek 1 Econd							
	Biological indicator	*Macroinverts*			20		
Creek 1	Water flow						
(name and length)	Water quality						
	Riparian vegetation						
Creek 2 Econd							
	Biological indicator						
Creek 2	Water flow						
(name and length)	Water quality						
	Riparian vegetation						
Creek 3 Econd							
	Biological indicator						
Creek 3	Water flow						
(name and length)	Water quality						
	Riparian vegetation						
Creek 4 Econd							
	Biological indicator						
Creek 4	Water flow						
(name and length)	Water quality						
	Riparian vegetation						

Table 3 – Data table - Rivers – Macroinvertebrate indicators for Creek 1

Creek 1	Year 1
Indicator	Year 1 measure
Macroinverts	**20**
Sample 1	10
Sample 2	20
Sample 3	20
Sample 4	40
Sample 5	16
Sample 6	20
Sample 7	18
Sample 8	18
Sample 9	18

These tables describe the Condition Scores for each indicator, and calculate the *Econds - the condition measure* - for each asset.

The third set of tables contains the raw data. This data table shows the data for the samples used to calculate the condition scores in for each indicator of the asset.

Let me give you some examples of how this accounting model can produce information to underpin policy and land use decisions.

Using reference condition methodology in a similar manner to our methodology the Norway Nature Index presents the condition of all assets on a common reference scale (in their case 0 to 1), it also describes the spatial representation of each of those assets relative to each other.

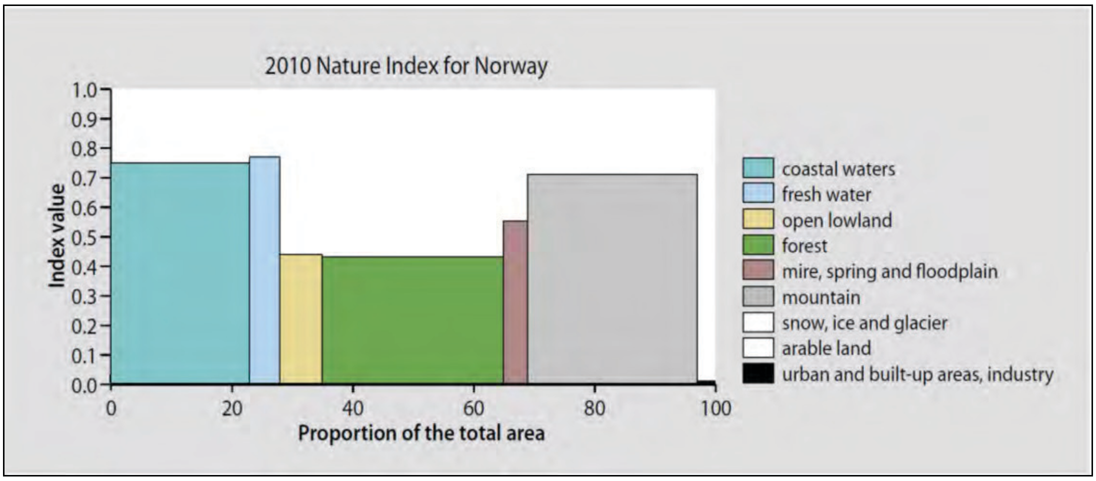

Figure 2 – The state of biological diversity in the major ecosystems of Norway (y axis) and extent of those ecosystems (x axis)[5]

Embedded in the condition accounts is the underlying information from which this type of summary can be constructed. We have applied this concept to condition information in our trials: this example is from the Namoi Catchment Authority, which shows a sample of the extent of the 77 types of native vegetation that are present across the Namoi region and the area each occupies.

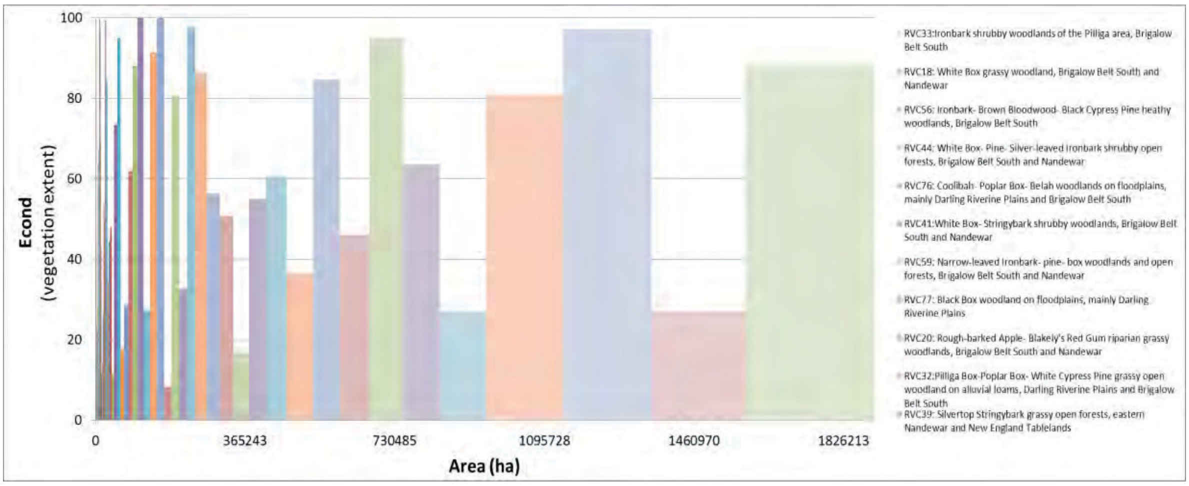

Figure 3 – Vegetation condition and total area by vegetation type in the Namoi region. Source: Namoi Catchment Management Authority

Extent versus condition measures

It is also possible to use this same account information to describe the native vegetation extent spatially. This example, also from the Namoi, shows you the location of various types of vegetation communities. However, it does not tell you the condition of each.

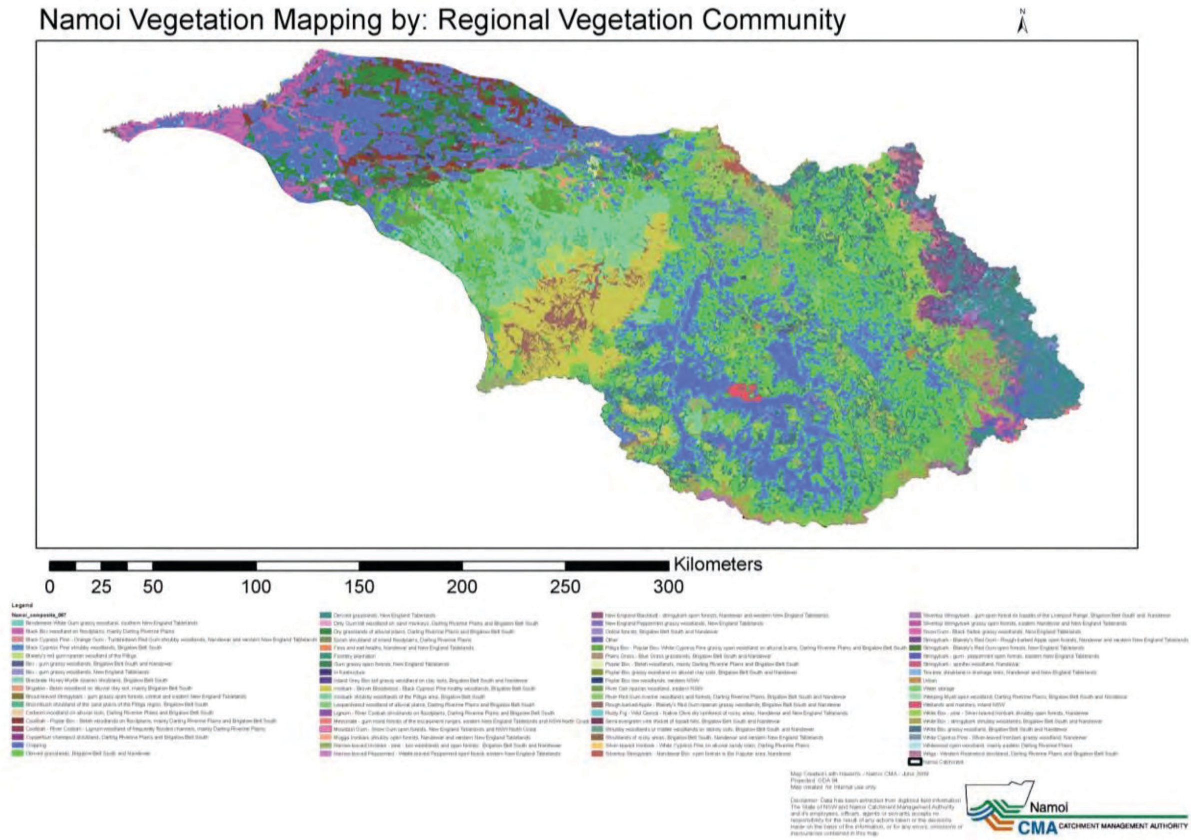

Figure 4 – Namoi vegetation mapping by regional vegetation community, Namoi Catchment Management Authority

If we were to use the same extent information when measured against its reference condition, we observe the following:

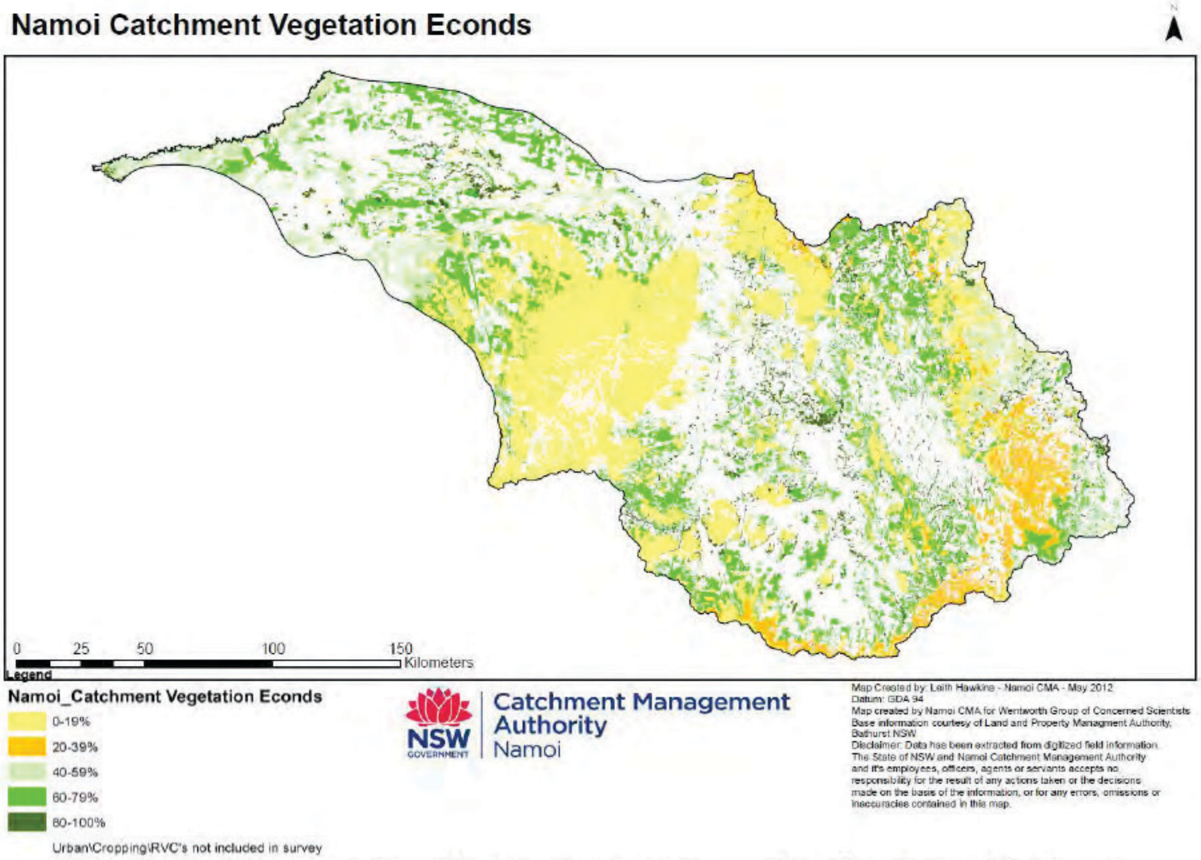

Figure 5 – Spatial representation of Namoi native vegetation condition (Econd), Namoi Catchment Management Authority

This shows the condition of the native vegetation that remains in this extensively cleared agricultural catchment.

Comparing the same assets using different indicators

Another question we are testing is how the condition of the same assets can be recorded using different indicators.

Table 4 – Example river indicators used to determine river condition based on reference condition baselines. Sources: SRA Report 1[6], SEQ Healthy Waterways[7]

Murray-Darling Basin Sustainable Rivers Audit	

Fish	– Expectedness
	  – Observed to Expected ratio (OE)
	  – Observed to Predicted ratio (OP)
	– Nativeness
	  – Proportion native biomass
	  – Proportion native abundance
	  – Proportion native species

Macro-invertebrates	– Observed to Expected ratio – Observed to Expected SIGNAL ratio
Hydrology	– High-Flow Events – Low- and Zero-Flow Events – Variability – Seasonality – Gross Volume

South East Queensland Healthy Waterways Initiative	
Physical chemistry	–pH –Conductivity (EC) –Temperature maximum, range –Dissolved oxygen minimum (DO), range
Nutrient cycling	–algal $\delta^{15}N$ –N:P:C ratio
Biological / Ecosystem Processes	–includes algal growth (chlorophyll a) –$\delta^{13}C$ –Benthic metabolism respiration R24 –Gross primary production (GPP)
Macro-invertebrates	–Index of Family richness –PET richness –Stream invertebrate grade number – average level (SIGNAL) score
Fish	–Index of proportion of native species expected (PONSE) –Observed/expected (O/E50) –% Alien species

This slide shows indicators for measuring the condition of rivers in two vastly different river systems in Australia - one a low rainfall inland agricultural landscape, the other a high rainfall coastal urban ecosystem.

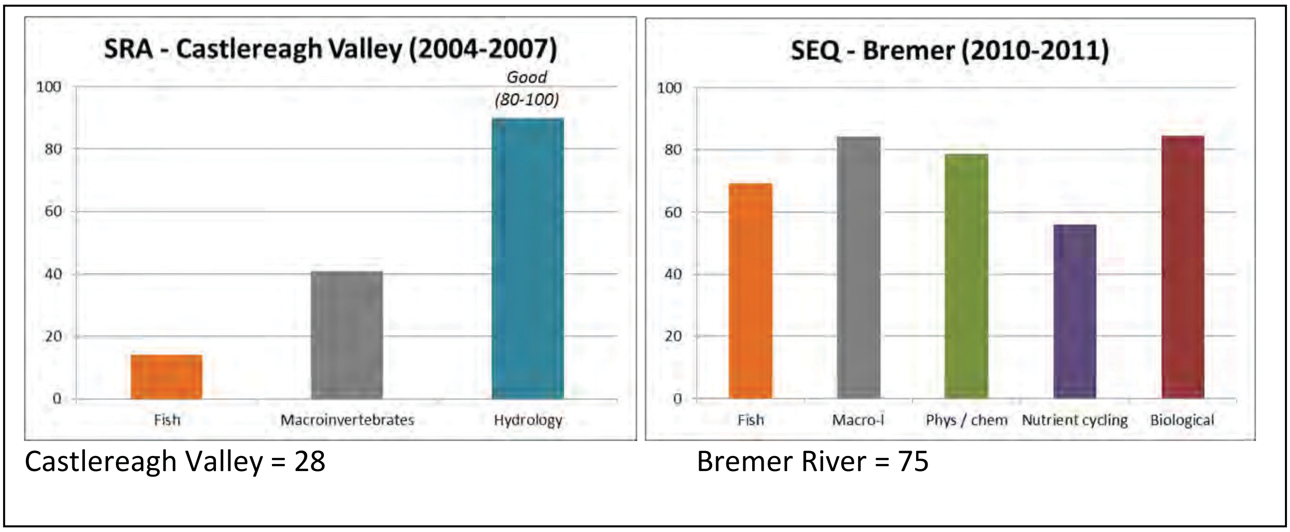

Figure 6 – Condition of rivers can be determined using different indicators where appropriate

Once an account is constructed using these indicators, the following condition scores are shown: 28 in the Castlereagh Valley River, and 75 in the Bremer River. One is in good health the other in very poor health.

Because both of these assets have assessed condition using a scientifically accredited set of indicators, and because both use a reference condition methodology as a benchmark, their overall Econd can be an accepted measure of its condition even though different indicators have been used.

Measuring Trend

Understanding the health of an environmental asset does not only require an understanding of the condition of an asset at a particular point in time. The direction and rate of change is of equal significance in environmental management.

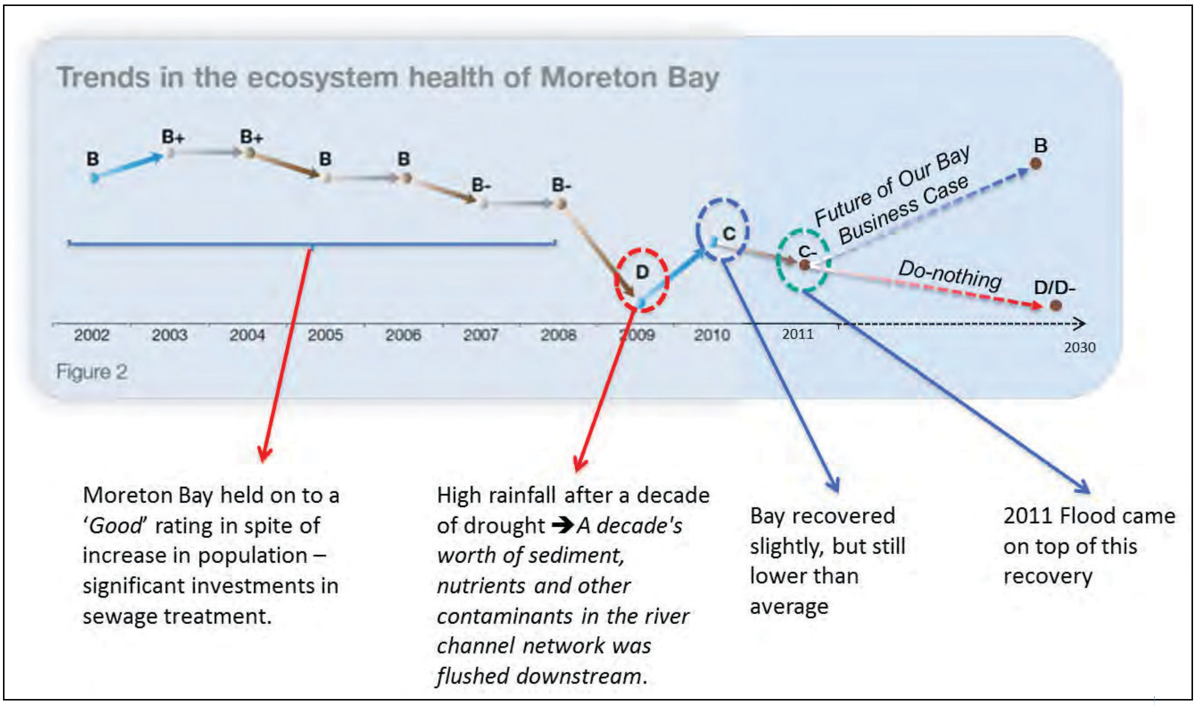

Figure 7 – Environmental Asset Condition Trends, Moreton Bay Estuary, South East Queensland.[8]

Collecting trend data takes time, and in landscapes with high climate variability such as Australia, it will be many years before a sufficient data base can be constructed to give useful trend information.

Having said that, there is a lot of information about the condition of environmental assets that does go back, in some cases, for decades. We do for example have in many river systems across Australia, historical river flows data going back many decades.

Another example is to use historical Landsat data dating back to the 1970s, many nations are using this data to measure the change in forest ecosystems.

6. Using Condition Accounts to Guide Policy Development

The second benefit of the common unit of measure is that it makes it much easier for policy makers to use condition accounts to:

- inform the setting of environmental standards and targets - across a range of assets or within an asset class;
- estimate program investment budgets; and
- assess cost effectiveness, to prioritise projects.

Let me give a simple example of native vegetation to show how condition accounts can be used to both inform policy and set investment targets.

This graph is produced from the same Namoi Catchment native vegetation condition account you saw before, but this time it shows all 77 vegetation types ranked from the most extensive to least extensive.

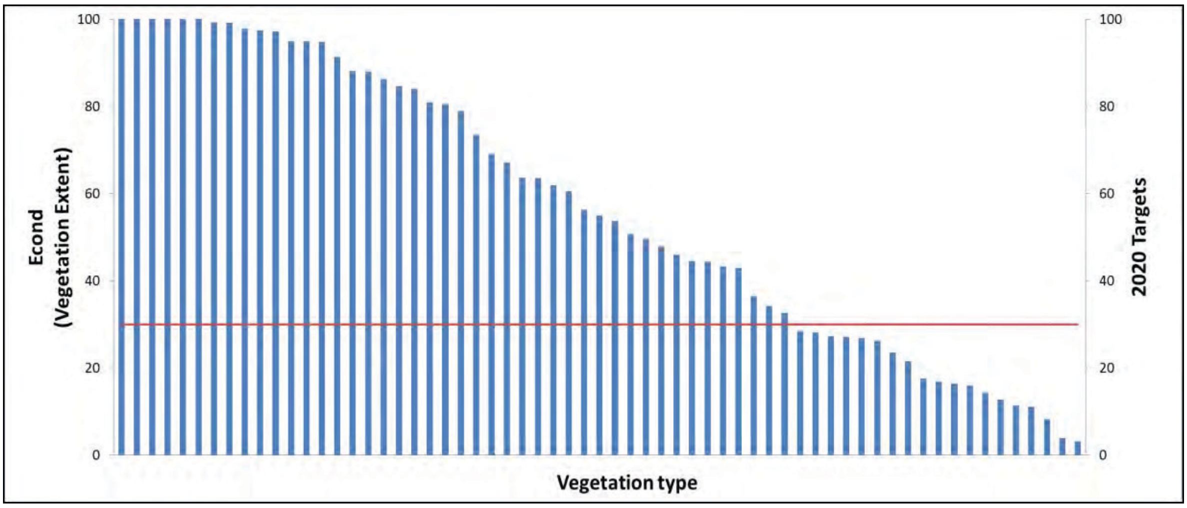

Figure 8 – Linking condition measures to policy outcomes. Source: Namoi Catchment Management Authority.

This information was used to set policy targets for prioritising investments in native vegetation management.

Their Catchment Plan process, conducted over a number of years, concluded that the Namoi valley would be a more healthy and productive environment, taking into account social and economic factors, if the 19 vegetation communities with less than 30% of their original native vegetation were restored to a 30% level.

This has now become a policy target in their Catchment Plan.

The same Namoi vegetation condition account that was used to inform that policy process, can now be used to calculate the cost of meeting their 2020 target.

By taking the current extent of each under-represented vegetation type, it is possible to calculate the area of restoration required to achieve the 30% target.

By combining this data for all 19 under-represented vegetation types, the total area targeted for restoration priority can be easily calculated.

If you were to cost the restoration of each of those hectares based on previous project expenditure, you can estimate a total restoration cost.

It is also possible to estimate the carbon sequestration value of achieving that restoration target.

We are only able to do this, because we have designed an environmental condition account which connects asset condition to policy targets and policy targets to investment decisions.

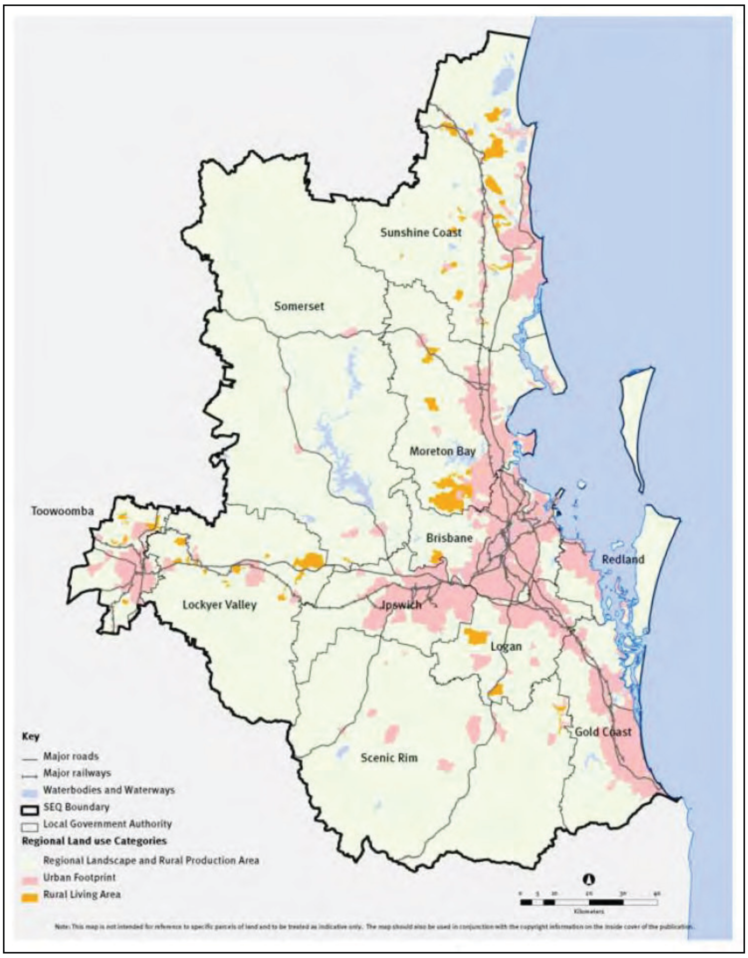

Figure 9 – Healthy Waterways Strategy South East Queensland, regional map

7. Using Condition Accounts to Improve Investment Decisions

Finally, let me describe how asset condition accounts can be used to improve investment decisions aimed at maintaining the condition of natural capital, using a highly urbanised area around the city of Brisbane in south east Queensland.

The region around Brisbane is facing significant social, economic and environmental pressures from a rapidly growing population.

In the last 8 years, the population has grown by over 600,000 people, to 3.2 million people, and is expected to add another 1.3 million by 2030.

The infrastructure investment program for this region over the next 20 years is $134billion.

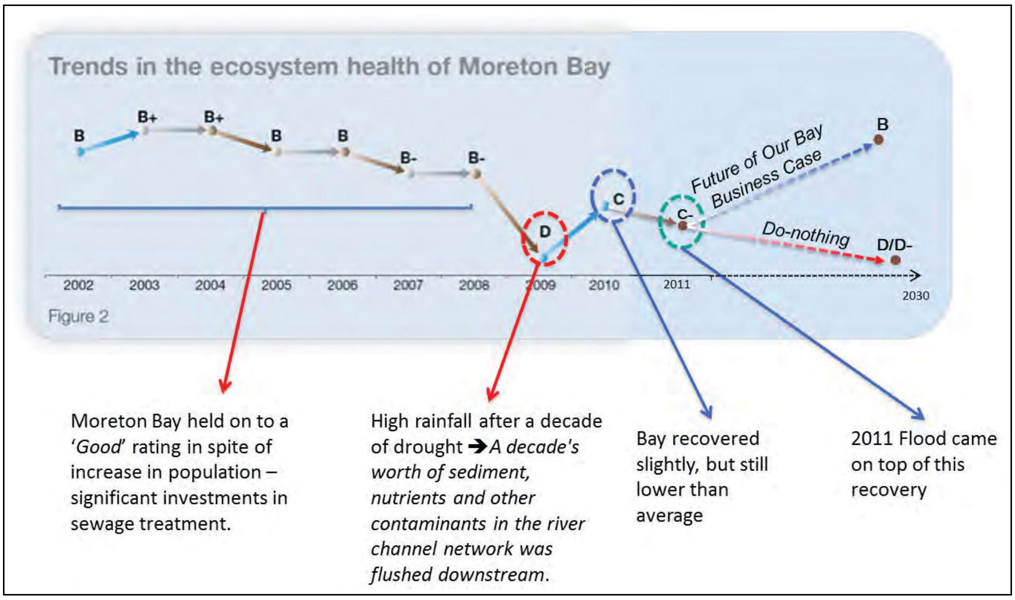

Figure 10 – Environmental Asset Condition Trends, Moreton Bay Estuary, South East Queensland.[9]

The increased pollution caused by urban development is placing significant pressures on the condition of the waterways flowing into the Ramsar listed Morton Bay estuary.

SEQ Catchments, the regional NRM body for this region, has produced an infrastructure investment plan for maintaining the condition of its natural capital, using the asset condition accounts that have been developed over the past decade.

The Catchment Authority was able to use the information in their asset condition accounts, insert the time series information into their hydrological and other modeling tools, and cost the infrastructure investments needed to satisfy their policy objective of maintaining the waterways in their current condition.

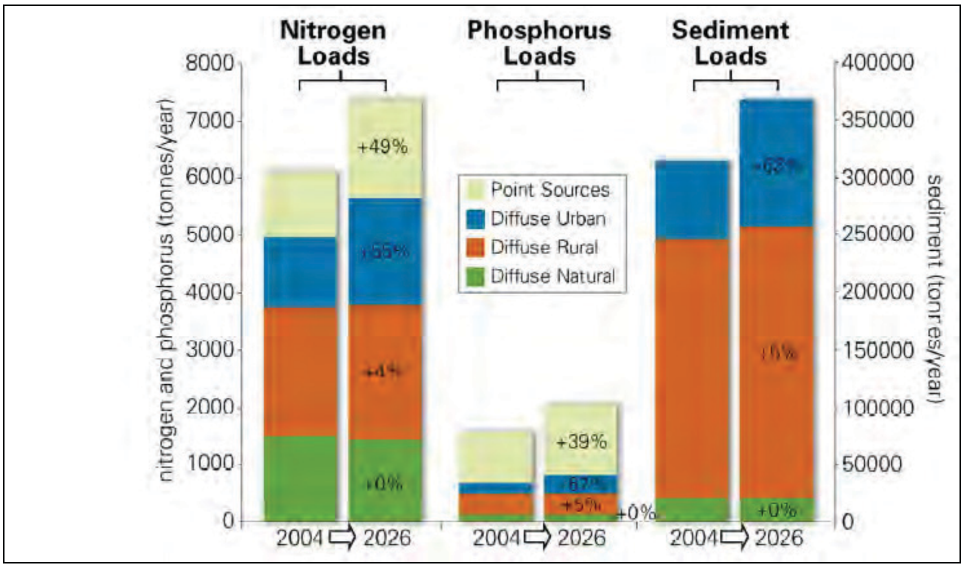

Figure 11 – Predicted changes to point source and diffuse source pollutant loads resulting from population growth, South East Queensland Healthy Waterways Strategy 2007 – 2012.

That investment comes to $570 million over 15 years.

Table 5 – Long-term annual marginal abatement costs (TSS loads)[10]

Actions (including low and high cost estimates where available)	Amount of action (ha unless otherwise stated)	Cumulative load (tonnes/pa)	Cumulative cost ($/pa)
Gully treatment (low)	800 km	100,000	$5,000,000
Filter strips or buffer zones (low)	60,000	126,460	$6,991,115
Diversion banks (low)	20,000	135,770	$8,192,105
Diversion banks (high)	5,000	138,098	$8,842,641
Minimum tillage (low)	5,000	140,499	$9,849,261
Road runoff management (high)	2,000	140,989	$10,065,228
Livestock exclusion (low)	5,000	143,194	$12,245,973
Riparian projection or revegetation (low)	12,000	148,956	$18,564,445
Filter strips or buffer zones (high)	5,000	151,161	$21,124,450
Minimum tillage (high)	2,500	152,361	$22,621,473
Bioretention basins (detached house developments)	All greenfield development	154,246	$25,128,523
Bioretention basins (attached house developments)	All greenfield development	154,355	$25,325,813
Livestock exclusion (high)	1,000	154,796	$26,164,926

Source: MainStream analysis

This is a lot of money – it would consume one year of the entire budget of the Australian government's national environment program. But when seen though the perspective of maintaining the condition of natural capital, this $570 million investment, represents less than half of one percent (0.43%) of the infrastructure program budget for the region.

A scientifically credible set of environmental assets condition accounts, collected regularly over a sufficient time to establish trend, can not only provide decision makers with information to underpin the setting of evidence based policy targets, it can also be used to formulate an investment package to deliver those targets, and, where in the landscape to target those investments.

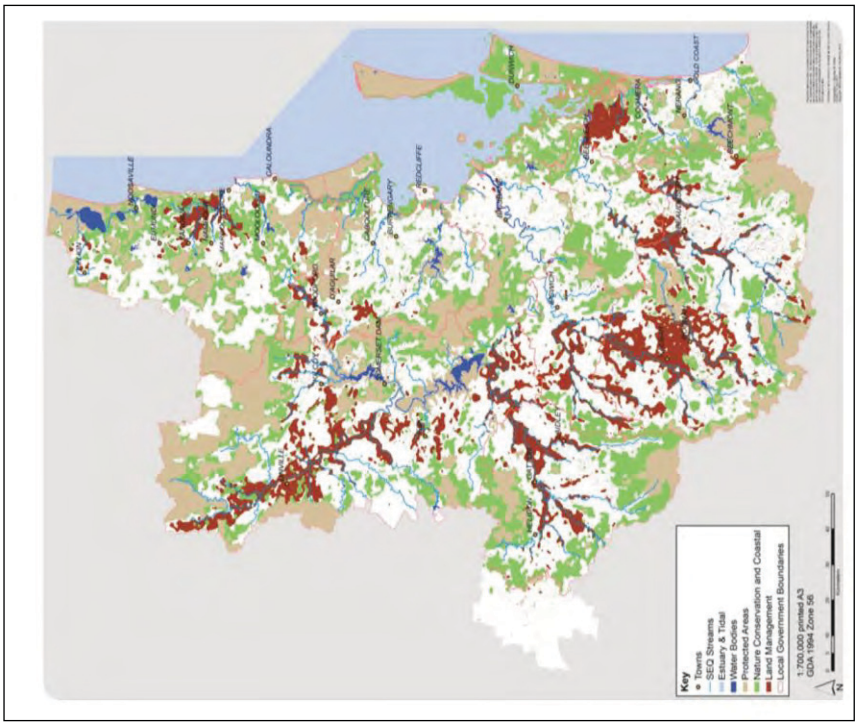

Figure 12 – Identified 'hot spots' for land management, South East Queensland Healthy Waterways Strategy.[11]

And, it will be the same condition accounts that will monitor the progress of those investments into the future.

8. Conclusion

In summary, the industrialisation of our economies has caused and, without corrective action, will continue to cause the degradation of our natural capital, and that in turn will deplete the services that ecosystems provide to humanity.

To manage the environment you need to measure degradation. To measure degradation, you need to measure condition, and for that you need science.

This means that the SEEA accounting framework for measuring asset condition needs to accommodate the science that is required to give you a quality measure of condition.

Our method does present some significant challenges to SEEA:

1. The need to incorporate indices in an account to accurately assess asset condition;
2. The need for a formal scientific process to accredit these indices;
3. The practical need to use different indicators in different locations to measure the same asset; and
4. The misunderstanding in the non-scientific community that the use of reference condition benchmarking to establish the upper boundary to create a common measure of condition implies a policy objective, when it does not.

The reason we are doing the trials is to test the practical application of these principles in the real world, at the scale at which ecosystems function.

We still have work to do to further test these concepts and expect to be in a position to report on the results of our first proof of concept stage by the end of this year.

Thank you.

Acknowledgements

Board and staff of the Regional Natural Resources bodies participating in the trials, the Australian Bureau of Statistics, the Australian Bureau of Meteorology, the CSIRO, and the Department of Sustainability and Environment, the secretariat of the Wentworth Group of Concerned Scientists, and funding support from the Ian Potter Foundation.

Members of the Australian Regional Natural Resources Management Groups Environmental Accounts Trials Steering Committee, Members of the Scientific Standards and Accreditation Committee, and Members of the Technical Environmental Accounting Standards Committee.

Examples used in this paper are based on information provided by the SEQ Catchments in Queensland and the Namoi Catchment Management Authority in New South Wales.

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[9] Source: Assoc. Prof. Eva Abal, Convenor, Science Integration Panel, Presentation to SEQ NRM CEO's & Regional Planning Committees, Dec 2011

[10] Mainstream Economics and Policy, 2011. *Sharing the load: A collaborative approach to investing in South East Queensland's waterways*

[11] Source: SEQ Catchments