Spatially-enabled Ecosystem Accounting Theory to Practice

Richard Mount, Environmental Accounts Lead,
Environmental Information Services Branch

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Big challenge 1: need for an improved estimate of Australia's natural capital

Problems: monetary valuation methods and gaps between land parcels mean partial linking of ecosystem data to socio-economic data

Result: is partial estimate of natural capital base

- No marine areas or aquatic ecosystems; national parks at $0

Questions:

- Are there opportunities for a fresh look at this problem, perhaps through non-monetary (physical) means?
- Does the spatially oriented SEEA: EEA give us new tools to tackle it?

Big challenge 2: need for improved regional level environmental intelligence

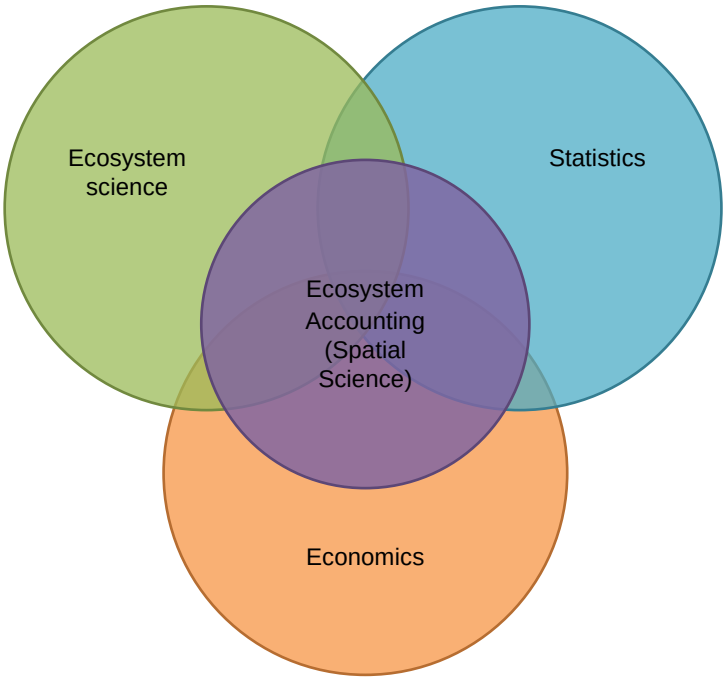
Problems: we don't really know what difference our regional scale investment in NRM makes to the environment

Result: reluctance to invest due to uncertainty and risk, which then pushes up the cost of capital

Question: How close to the regional scale could the SEEA: EEA take us in practice?

Ecosystem accounting theory

(drawing on the SEEA Experimental Ecosystems Accounting conceptual model)



Defining an ecosystem

Uses the CBD definition:

- "dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit"*

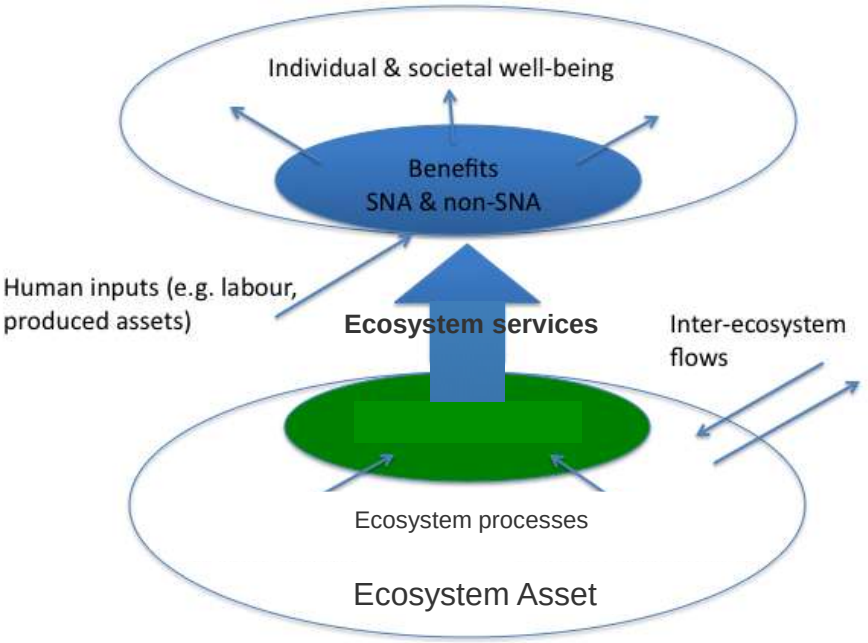
However, an "ecosystem" *per se* is not a useful construct as it does not exist as a separable, discrete entity

- Not possible to have a single standard map of Australian ecosystems

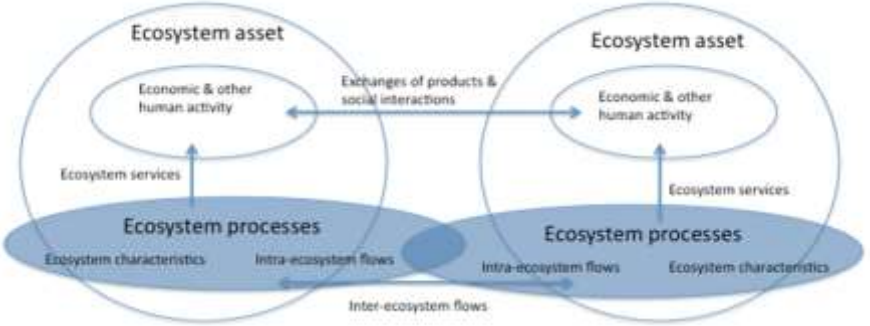
Approach proposed is to identify

- "ecosystem assets"
- "ecosystem services"

*Source: Article 2 Use of Terms, Convention on Biological Diversity, 2003

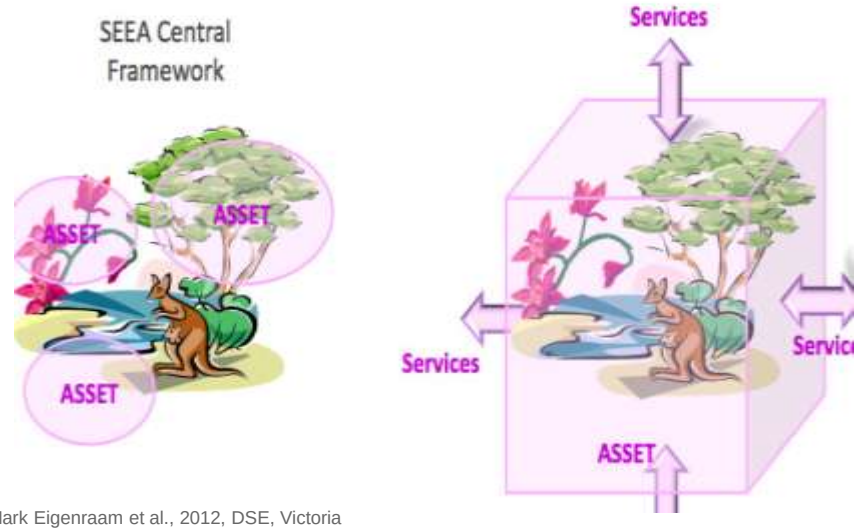


Source: adapted from SEEA: EEA, UNSD, 2012

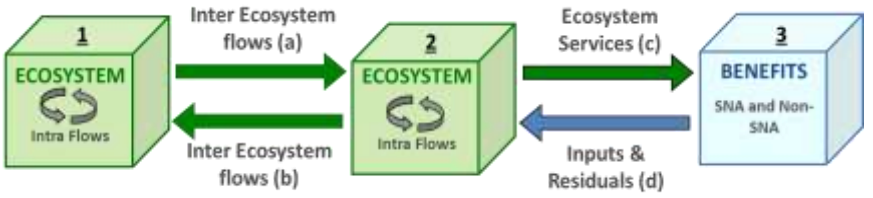


Source: adapted from SEEA: EEA, UNSD, 2013

SEEA assets



Mark Eigenraam et al., 2012, DSE, Victoria



Mark Eigenraam et al., 2013, DSE, Victoria

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Geospatial basics

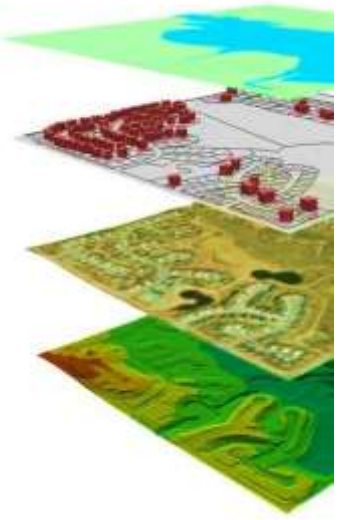
Geographic representation is concerned with the Earth's surface or near surface

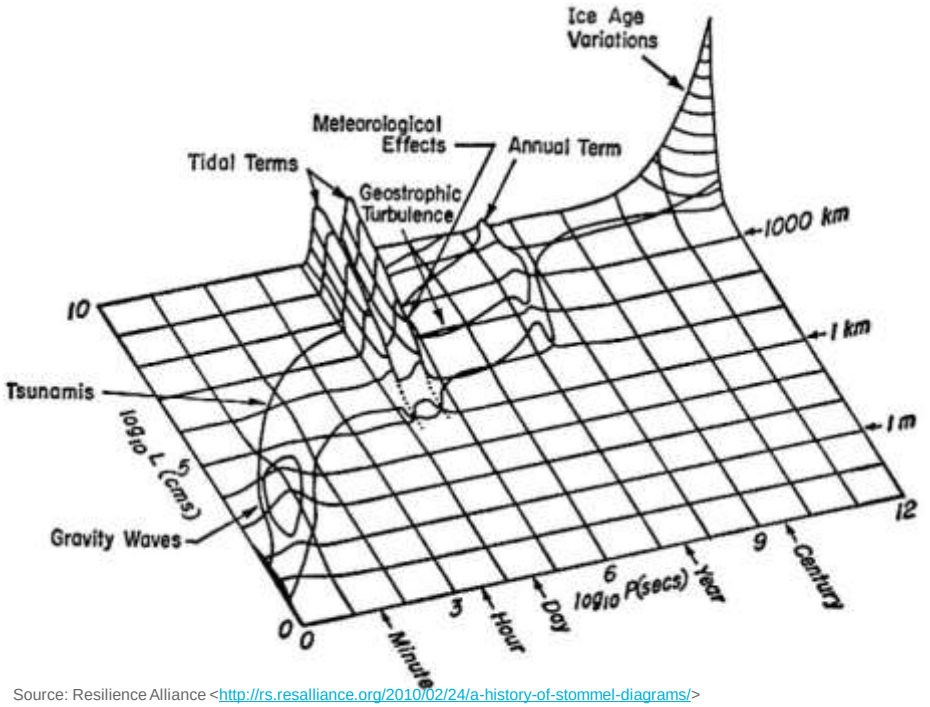
The infinite complexity of reality means choices must be made

- Geographic representations are always affected by the worldview and purpose of the chooser

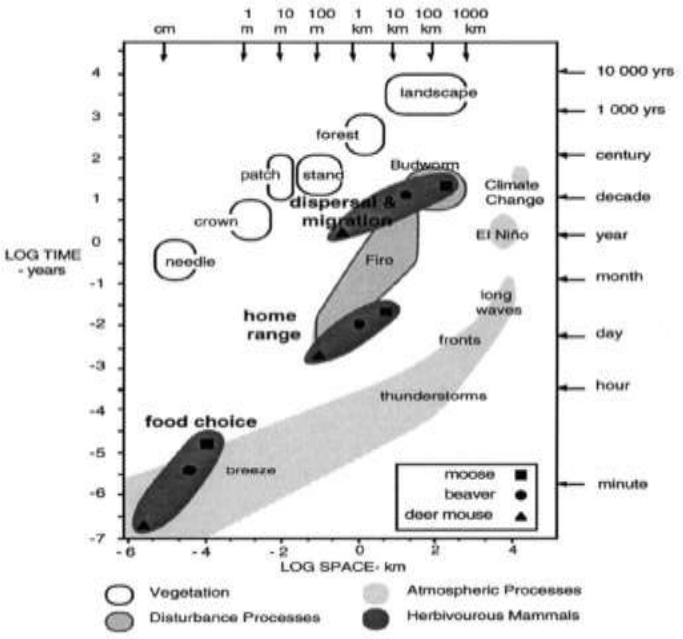
"Geographic Atom": x, y, z, t and thematic attributes

Tobler's "Law": things closer together are more likely to be similar to each other





Source: Resilience Alliance <http://rs.resalliance.org/2010/02/24/a-history-of-stommel-diagrams/>



Source: Peterson, Allen, and Holling Ecological Resilience, Biodiversity, and Scale (Ecosystems 1998 1(1): 6–18)

Geospatial analytical challenges

In spatial analysis, **four major problems** interfere with an accurate estimation of the statistical parameter:

- boundary problem
- scale problem
- pattern problem (or spatial autocorrelation)
- modifiable areal unit problem

In spatial analysis there are **two types of areas**

- Those with "natural" boundaries – processes stop at the boundary
- Those with "arbitrary" boundaries – processes continue across the boundary

Aggregation effects

Yule and Kendal (1950)

Correlation between wheat and potato yields from agricultural regions

No. of geographic regions	Correlation
48	0.2189
24	0.2963
12	0.5757
6	0.7649
3	0.9902

Source: Longley et al., 2005, Geographic Information Systems and Science

Source: Nigel Brothers

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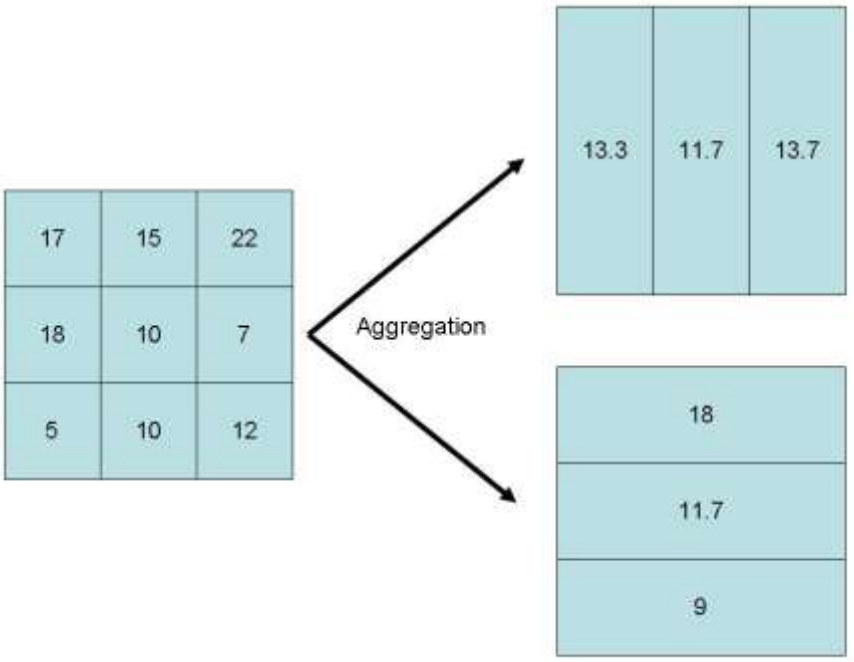
Clustering changes with scale

Gannet nests: uniform point pattern

Gannet nests: clustered point pattern

Source: Richard Mount, BoM



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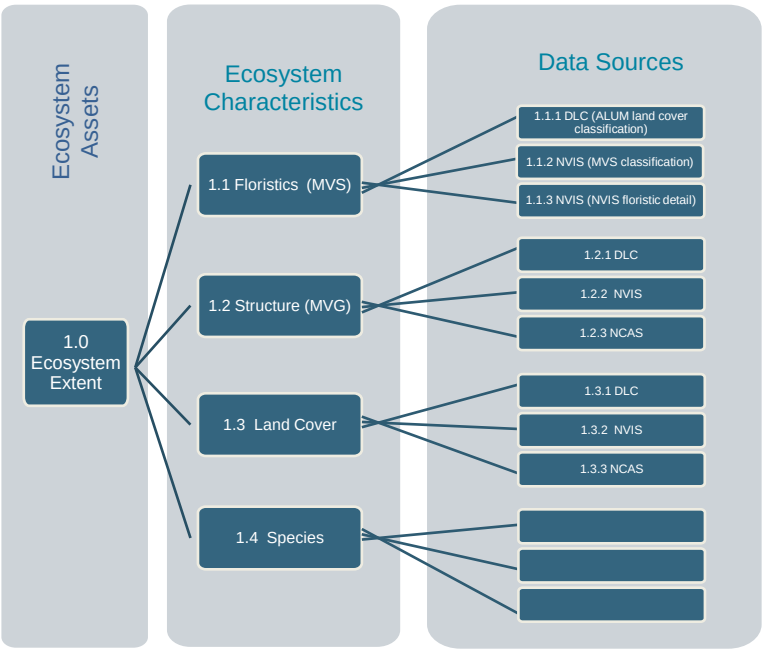
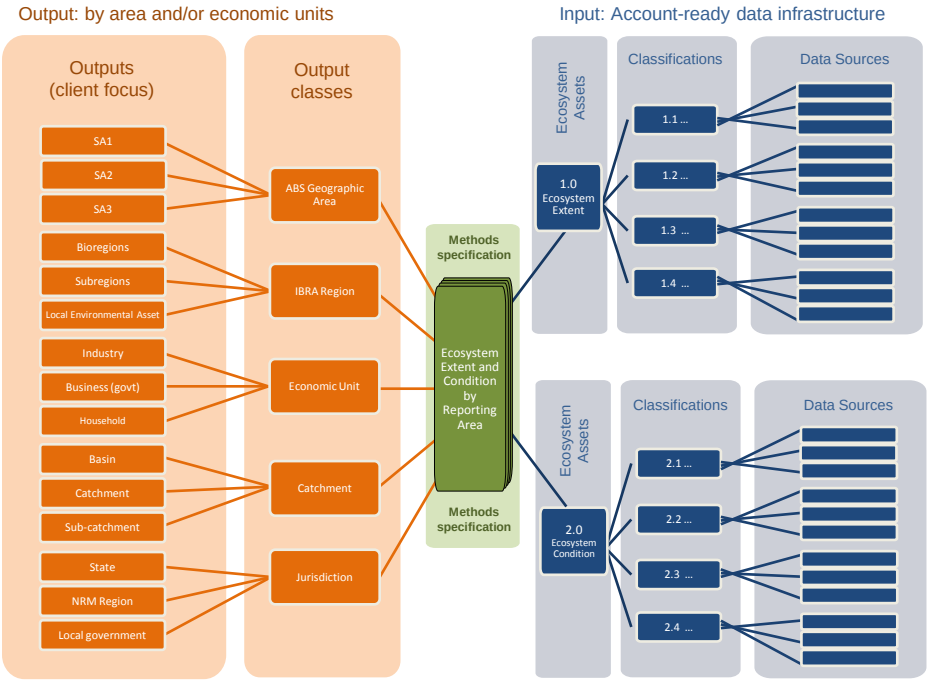
Operationalisation of ecosystem accounting

Account subject concepts

Data sources: variable quality

Products:
indicators, tables, charts, maps


Ecosystem Assets
Ecosystem Characteristics
Data Sources
1.0 Ecosystem Extent
1.1 Floristics (MVS)
1.2 Structure (MVG)
1.3 Land Cover
1.4 Species
1.1.1 DLC (ALUM land cover classification)
1.1.2 NVIS (MVS classification)
1.1.3 NVIS (NVIS floristic detail)
1.2.1 DLC
1.2.2 NVIS
1.2.3 NCAS
1.3.1 DLC
1.3.2 NVIS
1.3.3 NCAS


Output: by area and/or economic units
Input: Account-ready data infrastructure
Outputs (client focus)
Output classes
SA1
SA2
SA3
Bioregions
Subregions
Local Environmental Asset
Industry
Business (govt)
Household
Basin
Catchment
Sub-catchment
State
NRM Region
Local government
ABS Geographic Area
IBRA Region
Economic Unit
Catchment
Jurisdiction
Methods specification
Ecosystem Extent and Condition by Reporting Area
Methods specification
Ecosystem Assets
Classifications
Data Sources
1.0 Ecosystem Extent
1.1 ...
1.2 ...
1.3 ...
1.4 ...
2.0 Ecosystem Condition
2.1 ...
2.2 ...
2.3 ...
2.4 ...

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Spatial ecosystem accounting challenges in practice

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Ecosystem asset boundary selection problem

Sources: Google Earth and ABS Victorian Land Accounts

Experimental vegetation (structural) connectivity index

Riparian vegetation examples below analysis resolution: south-west Western Australia

Draft visualisation of the connectivity network in south-west Western Australia, ERIN, SEWPaC

Geospatial plus time series analysis

Land Accounts

- Time series for flow tables
- t_1 x t_2 x t_3 x …t_n; ~30 classes for each time
- Extremely high number of potential analyses
  - then order of magnitude more for ecosystem accounts

Responses

- Spatial scatterplot charts
- Temporal 'signatures' of ecosystem change
- Data 'cubes'; OLAP; space and time user extraction capability

Emerging "Number Machines"
(spatial accounting production systems)

EnSym (DSE, Victoria)

Regional Ecosystem Modelling

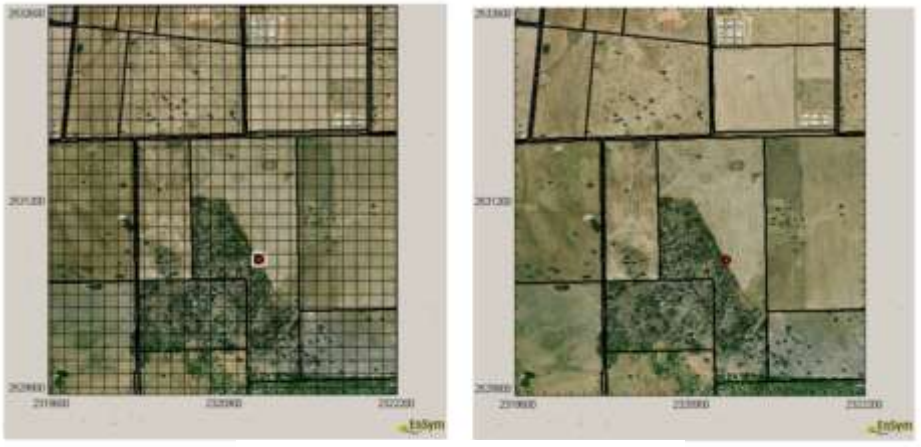
Murray-Darling Basin (MDBA-BoM)

Biocarbon (CSIRO, BoM)

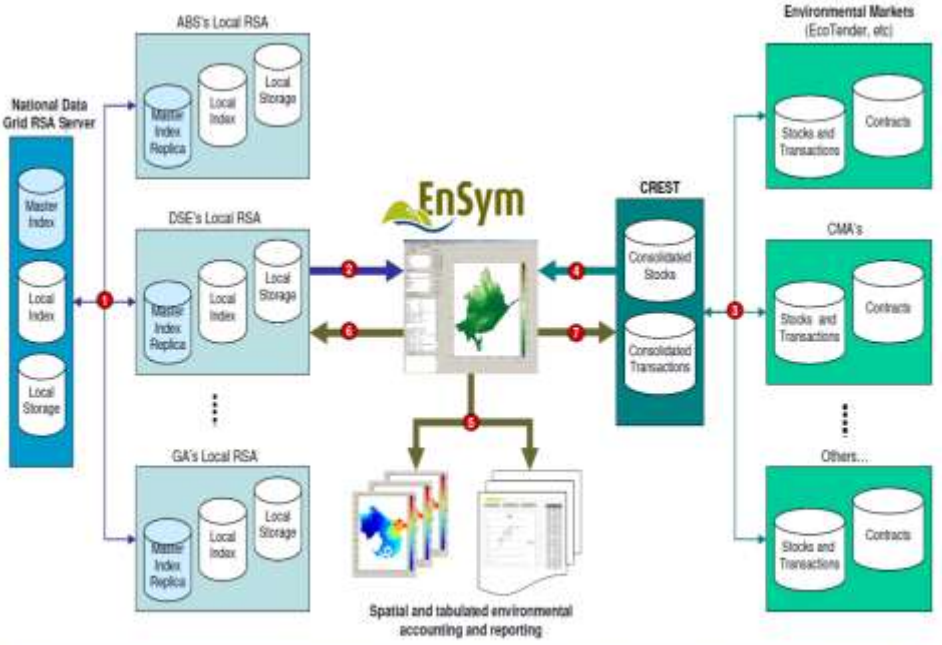
NRM (Wentworth Group trials)

EnSym, DSE, Victoria

Aggregation of 'analytical units' (1 Ha/yr) into land parcels for Land Account

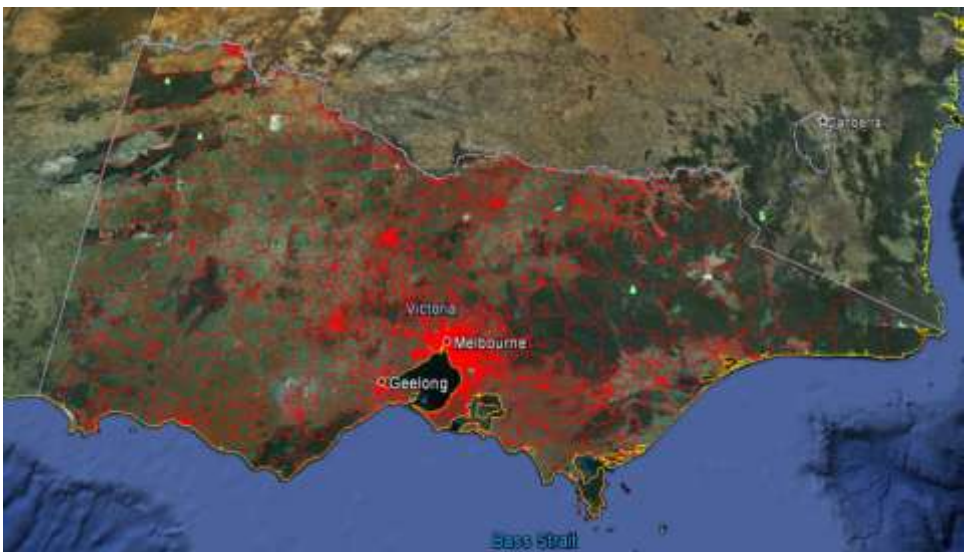


Source: Mark Eigenraam et al., 2012, DSE, Victoria



1) ABS and other custodians of reference data and overlays (e.g., GA) upload their grid data to their Local RSA (Raster Storage Archive) server. The data are indexed and advertised through the National Data Grid (NDG) RSA Server to all local RSA instances.

ABS Victorian Land Accounts



Victorian Experimental Ecosystem Accounts

Table 4 – Latrobe – Gippsland

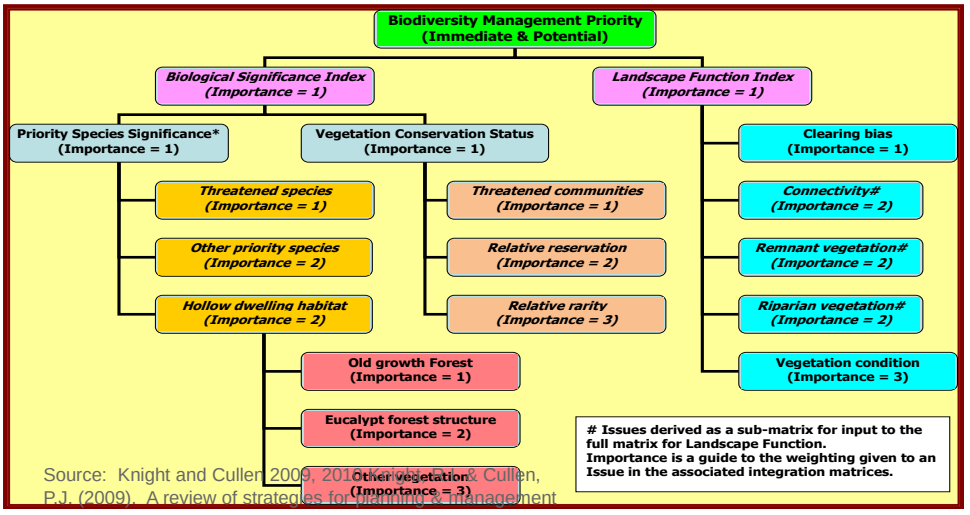
Vegetation type (NVIS)	1750 Extent (Ha)	1750 Mean condition/Ha	2005 Extent (Ha)	2005 Mean condition/Ha
Native vegetation				
Acacia Forests and Woodlands	15,134	1.00	15,095	0.69
Acacia Open Woodlands				
Acacia Shrublands	9,386	1.00	7,690	0.63
Callitris Forests and Woodlands				
Casuarina Forests and Woodlands	15	1.00	15	0.72
Chenopod Shrublands, Samphire Shrublands and Forblands	1,585	1.00	1,284	0.58
Eucalypt Open Forests	2,719,123	1.00	2,212,247	0.67
Eucalypt Open Woodlands	62,128	1.00	60,314	0.61
Eucalypt Tall Open Forests	53,434	1.00	53,407	0.71
Eucalypt Woodlands	819,180	1.00	428,821	0.56
Heathlands	59,616	1.00	43,602	0.66
Low Closed Forests and Tall Closed Shrublands	99,715	1.00	23,389	0.47
Mallee Open Woodlands and Sparse Mallee Shrublands	6,281	1.00		
Mallee Woodlands and Shrublands				
Mangroves	1,638	1.00	1,061	0.53
Melaleuca Forests and Woodlands				
Naturally bare - sand, rock, claypan, mudflat	3,111	1.00	2,977	0.38
Other Forests and Woodlands	52,416	1.00	48,567	0.70
Other Grasslands, Herblands, Sedgelands and Rushlands	25,433	1.00	18,590	0.55
Other Open Woodlands				
Other Shrublands	57,335	1.00	47,282	0.63
Rainforests and Vine Thickets	21,557	1.00	18,819	0.69
Tussock Grasslands	35,783	1.00	2,775	0.30
Unclassified native vegetation	31,682	1.00	4,233	0.59
Total native vegetation	4,074,552	1.00	2,990,168	0.65

Source: Mark Eigenraam et al., 2013, Experimental Ecosystem Accounts. DSE, Victoria

Regional Ecosystem Modelling, Tasmania

10 m data resolution (atomistic planning units)

Coverage of entire state



Source: Knight and Cullen, 2009, 2010; Knight, D.L. & Cullen, P.J. (2009). A review of strategies for planning & management

In conclusion… ecosystem accounting in practice

Looking for the 'sweet spots': need to match the input data to the required outputs while striving to:

- meet the accounting conceptual model
- apply best-practice geospatial methods
  - boundary, scale, pattern and MAUP issues

Major challenges are to

- establish good quality ecosystem conceptual models
- establish good quality ecosystem 'number machines'
  - Biodiversity, ecosystem functioning
- link the ecosystem data to the socio-economic data

Where to go for more information

For more information about the Bureau's environmental information role:

- visit www.bom.gov.au/environment
- contact environment@bom.gov.au

References

ABS, 13/12/2012, Land Account: Victoria, Experimental Estimates, 2012

Eigenraam, Chua and Hasker, 2012, *Land and Ecosystem services: measurement and accounting in practice*, DSE, Victoria

Eigenraam, M., Chua, J. & Hasker, J. (2013). *Environmental-Economic Accounting: Victorian Experimental Ecosystem Accounts, Version 1.0*. Department of Sustainability and Environment, State of Victoria.

Knight and Cullen 2009, 2010 Knight, R.I. & Cullen, P.J. (2009). A review of strategies for planning & management of the natural resources of biodiversity, freshwater, land & soils in the Tasmanian midlands. A report of the Caring for Our Country project 'Using landscape ecology to prioritise property management actions in Tasmania'. Natural Resource Planning, Hobart, Tasmania.

Knight, R.I. & Cullen, P.J. (2010). Specifications for a Regional Ecosystem Model of natural resources in the Tasmanian Midlands. A report of the Caring for Our Country Project 'Using landscape ecology to prioritise property management actions in Tasmania'. Natural Resource Planning, Hobart, Tasmania.

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Thank you…

Questions?

Richard Mount
Environmental Information Services Branch
Bureau of Meteorology
0427 020 277
r.mount@bom.gov.au