LG/16/22

16th Meeting of the London Group on Environmental Accounting
Santiago, 25 – 28 October 2010

A common currency for building environmental (ecosystem) accounts

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Paper prepared for the 16th meeting

of the London Group on Environmental Accounting

25 - 28 October 2010

Santiago, Chile

A Common Currency for Building Environmental (Ecosystem) Accounts

A proposed standard for Environmental (Ecosystem) Accounting for the international 'System of integrated Environmental and Economic Accounts'

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Acknowledgements

The concepts expressed in this paper have been derived from *Accounting for Nature: A Model for Building the National Environmental Accounts of Australia, 2008*, and *Accounting Metrics for Building Regionally Based National Environmental Accounts, 2009*. The authors thank members Dr Neil Byron, Dr Ronnie Harding, Prof. Quentin Grafton, Prof. Bruce Thom and Dr John Williams their contributions and review of this paper.

In addition we thank Mr Mark Eigenraam, Ms Pam Green and Dr Michael Vardon for their contributions to this paper.

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Abstract

Environmental (ecosystem) accounts that measure the health and change in condition of ecosystems are required to integrate the environment in decision making.

If you don't measure it, you can't manage it. A science-based unit of account – a common currency for ecosystems – is the missing link between science and policy.

Creating a measure for ecosystem health must address a number of challenges: no two environmental assets are the same; often different indicators are needed to measure the same asset in different locations; the cost of data collection creates significant variation in the quality of information collected; and no single indicator can provide a complete picture of ecosystem health.

There is no doubt that modern science is capable of providing this information. What is needed is a system of accounts that systematically organises that information.

A system of environmental (ecosystem) accounts should be built around a common unit of measure which is capable of assigning a value for all environmental assets and indicators of ecosystem health.

The adoption of a system of environmental (ecosystem) accounts based on reference condition benchmarks creates this common currency for ecosystem health. This means that an environmental asset, such as a forest, can have both a monetary value and an ecological value. The result is a transparent system of accounting where the impact of economic activity (both positive and negative) on environmental health can actually be measured.

1. Introduction

1. In 1993 a handbook for integrated environmental and economic accounting was published by UNEP and the World Bank[1] as a way of responding to concerns about the impact of economic growth on the health of the world's ecosystems.[2,3,4] This was updated in 2003 by the UN, EU, IMF and OEDC into a draft framework for "statistical accounts … of the interaction between the economy and the environment".[5]

2. This formed the basis of the international "System of integrated Environmental and Economic Accounts" (SEEA) which employs the same accounting concepts and account structures as the national accounts.[6] It enables stocks and flows of environmental assets to be represented in physical as well as financial units.

3. To date the emphasis in SEEA has been on measuring the economic impact of resource depletion, reflecting perhaps its origins from the Club of Rome.[2] Revealing the prices associated with stocks and flows of physical assets is an important step towards more efficient use of natural resources; it can tell us how efficiently natural resources are being used to support our economy and how this activity impacts on the stocks of those physical assets.

4. The management of our environment is not just about the rate or economic efficiency of resource depletion. We must also manage the health of ecosystems. I

5. f environmental accounting is to contribute to the sustainable management of the world's natural environment, it must be able to measure the impact economic activity is having on the health of ecosystems.

6. SEEA recognises "that the 'health' of ecosystems must be protected and enhanced if they are to exhibit the resilience that is necessary for sustainability".[7] Physical units of measure (weights, volumes, area) are not, however, capable of accounting for ecosystem health because ecosystems are " … a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit".[8]

7. In Australia, water accounts[9] are being used to evaluate economically efficient ways of returning overallocated river systems in the Murray Darling Basin to sustainable levels of extraction.[10] What these accounts are not currently able to do is measure the condition (or 'health') of this river system. They are therefore of little value in determining the primary public policy question as to what the sustainable level of extraction should be.

8. What is needed is a science-based unit of measure to account for the health of ecosystems. This is the missing link between science and policy: if you don't measure it, you can't manage it.

9. SEEA describes the difficulties in establishing environmental accounts for ecosystems:

   "*determining a suitable unit of account, deciding how to deal with the collective nature of a complete ecosystem, delineating the borderline of the ecosystem of interest and defining the extent of possible duplication when an entity interacts with more that one ecosystem.*"[11]

10. In this paper we describe a common unit of measure for ecosystem health and a process for aggregating existing scientific information to create a standard for ecosystem health based environmental accounts.[1.]

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[1] For the purposes of this paper we consider 'Environmental Accounts' described in *Accounting for Nature* to be synonymous with 'Ecosystem Accounts' in SEEA. For that reason, in this paper we use 'environmental (ecosystem) accounts'.

2. A Common Currency for Nature

11. National accounts are built using a national currency (a Dollar, Yuan, Euro, etc) which assigns a common value for the exchange of goods and services. Without a common currency it is not possible to construct economic accounts.

12. While it is possible to express many physical environmental assets as quantities, there is no established unit for measuring the health (quality) of ecosystems.[12,13,14,15]

13. The starting point for building a system of environmental (ecosystem) accounts is dependent on the creation of a common unit of measure that is capable of assigning a value for all environmental assets and indicators of ecosystem health.

14. Creating a measure for ecosystem health must address a number of challenges: no two environmental assets are the same; often different indicators are needed to measure the same asset in different locations; the cost of data collection creates significant variation in the quality of information collected; and no single indicator can provide a complete picture of ecosystem health.

15. In 2008, the Wentworth Group of Concerned Scientists, in association with other scientists and economists, developed a model for building a system of National Environmental Accounts. This *Accounting for Nature* model[16] creates a common unit of account for all environmental assets and indicators of ecosystem health, irrespective of the unit of measurement. It does this by using the science of reference condition benchmarks.

16. The common currency for environmental (ecosystem) accounts does not imply a monetary value: it is simply a scientific method for standardising the measurement of environmental assets so that we can compare the relative state of one asset with another and aggregate information at different scales and for different assets.

17. This methodology plots the condition of all environmental assets and indicators of ecosystem condition on a common scale (stocks), and measures how each is tracking towards or away from a healthy condition over time (flows).[2]

18. In this paper we describe a four stage process for establishing a standard for *environmental (ecosystem) accounts*:

    1. Adopt ***reference condition benchmarks*** as the scientific standard for accounting for all environmental assets and indicators of ecosystem health;
    2. Develop scientifically accredited methods for combining ***ecosystem health indicators,*** based on reference condition benchmarks;
    3. Develop ***standards for ecosystem accounts and scientific accreditation of ecosystem indicators***; and
    4. Use the ecosystem health indicators as the standard for incorporating ***environmental (ecosystem) accounts*** into the "System of integrated Environmental and Economic Accounts".

[2] For the purposes of environmental accounts in this paper we treat the condition (or health) of an environmental asset or ecosystem indicator as a 'stock', and a change in condition of that asset or indicator as a 'flow'.[2]

3. Reference Condition Benchmarks

19. This model for environmental (ecosystem) accounts is based on the science of reference condition benchmarks. Reference condition is the status of an ecosystem's components as they would be if significant human intervention had not occurred in the landscape.[17]

20. Describing the existing stock of an environmental asset against a reference condition benchmark does not imply or suggest that landscapes should be returned to this pre-disturbance condition. Reference condition benchmarks simply provide a common base to measure change against a common denominator.

21. Reference condition accounting is used extensively in the scientific literature to describe a standard or benchmark against which to compare the condition of an environmental asset or ecosystem.[18] It is also an appropriate measure for describing where ecosystems are approaching critical thresholds, which are common in complex ecosystems.[19,2021,22]

22. A reference condition score is a numerical comparison of an observed condition and that expected under a reference condition.[17] It is a number between 0 and 100, where 100 is a reference condition of an ecosystem as it would be had significant human intervention not occurred in the landscape, and 0 is where that ecosystem function is absent.

23. For example, the area of habitat is the single most effective surrogate of biodiversity.[23] One indicator of the condition of a terrestrial ecosystem is the extent of native vegetation cover. The change in percentage of native vegetation can be directly related to a change in biodiversity.[24.] If there has been a decline in native vegetation in a region by 72% against a benchmark condition, that indicator would produce a reference condition score of 28(%).

24. Reference condition metrics are used as a scientific benchmark for ecosystem management for several reasons:[25]

1. *Ecosystems approaching conditions that prevailed prior to major periods of modification will generally better reflect the conditions to which persistent communities of native biota are adapted;*[26]
2. *Ecosystems are more resilient within their historical range of variation than ecosystems managed outside this range;*[27,28]
3. *It is a pragmatic approach for assessing and managing ecosystems where data for communities and species or processes are lacking, or such data cannot be collected within the constraints of rapid assessment;*[29]
4. *Ecosystems are assessed in relative rather than absolute terms, thereby avoiding the perverse situation where ecosystems that are naturally more structurally diverse or species rich are always assessed as in higher condition than ecosystems that are naturally less structurally diverse or species rich; and*
5. *There is empirical evidence to support the concept.*[30,31]

25. Whilst a number of published definitions for reference condition exist, they all feature the common ecological principle that a healthy ecosystem can be described against a standard pre-disturbance baseline. [17,25,18, 32]

26. The reference condition can be a fixed point in time,[33]observed at reference condition sites,[34] or a scientifically accredited model that estimates the naturalness of the biota in the absence of significant human alteration.[18]

4. Ecosystem Health Indicators

27. The task of accounting for the complexity of ecosystems is made possible by using the science of ecosystem health indicators. Ecosystem health indicators are quantifiable and transparent measures of the characteristics of the ecosystem that can detect change. With careful selection, they are capable of providing a simple measure for a complex system.[35]

28. The advantage of using ecosystem health indicators based on reference condition benchmarks is that it provides a context for interpreting change, and the magnitude and direction of that change.[36]

29. In order to capture the complexity of an ecosystem into numerical values, several indicators may need to be integrated to generate an index.[37] Standard accounting practices can be used to express this index, again on a scale between 0 and 100. Ecosystem condition indices could be generated by:

- using the available ecosystem indicator relative to its reference condition;
- summing a number of individual reference condition scores expressed as a percentage;[38]
- combining scientifically accredited weighted indicators;[39] or
- incorporating individual reference condition scores into scientific models, where those models best describe the complexity of the ecosystem processes being measured.[48]

30. Applying a reference condition benchmark to an ecosystem indicator converts that indicator from being simply a measure of trends in ecosystem characteristics to a valuation of ecosystem health. It is a measure of status and current deviation from healthy condition.[40]

31. Ecosystem health indicators based on reference condition benchmarks are also conducive to statistical accounting because they create a standardised numerical unit capable of addition and comparison. They can assess and compare ecosystem status across regions and across ecosystems, upscale and aggregate across multiple spatial scales.[40]

32. In the same way that nations describe their economic currencies with a title (a Dollar, Yuan, Euro, etc), it is also useful to give the unit of measure for ecosystem health a title. In this paper we call the unit of measure for ecosystem health an *Econd.*

33. An *Econd* is an accredited measure, metric or model between 0 and 100 that reflects the health of an environmental asset or an ecosystem indicator based on a reference condition benchmark.

34. Ecosystem health indicators using reference condition methodologies were pioneered through the study of rivers, where there is a complex interaction of spatial, temporal and physical variation.[41,42,43] The reference condition approach for freshwater ecosystem assessment has been adopted by many countries because it allows different water bodies in different locations, including rivers, lakes or coastal waters to be compared on a common scale.[44,45,46]

35. This reference condition approach has now also been applied to terrestrial landscapes[47,48,49,50] and marine ecosystems.[51,52,53,54.]

36. There are many examples in Australia and internationally that use reference condition based ecosystem health indicators. Examples from Europe and North America include:

- a legislated reference condition standard in EU countries (through the EU Water Framework Directive) for the ecological assessment of all EU water bodies;[55,56,] (this concept is currently being transferred across Europe to soil ecosystem assessment and monitoring);[57]
- river assessment systems in Britain (River Invertebrate Prediction and Classification System (RIVPACS))[58] and the Canadian Aquatic Biomonitoring Network;[59]
- ecosystem indices (Index of Biotic Integrity[60]) have become the standard in the United States for assessing watershed health;[61] and
- fisheries management strategies which use an 'unfished biomass' benchmark to measure the current stock relative to that reference condition, set maximum sustainable yield levels and to identify thresholds of collapse.[62]

37. Examples in Australia include:

- the Australian River Assessment System (AUSRIVAS); [63]
- the 2008 Sustainable Rivers Audit for the Murray Darling Basin;[17]
- the 2009 Great Barrier Reef Outlook Report;[64]
- farm scale assessments of native vegetation in NSW[65] and Victoria;[48] and
- the South East Queensland Ecosystem Health Monitoring Program.[38]

5. Accounting Standards and Scientific Accreditation of Indicators

38. Fundamental to the acceptance of environmental (ecosystem) accounting will be the level of confidence that the information being collected and choice of ecosystem health indicators is scientifically robust, accurate and reliable, and comparable across time and space.

39. Environmental (ecosystem) accounting standards will be required to guarantee the quality of data collection and a formal scientific accreditation process is required to ensure that the selection of indicators are suitable measures of the key environmental assets at the scale and location in which the accounts are constructed.

40. A starting point for the criteria for establishing ecosystem health indicators would be to adopt a universally accepted scientific principle that a healthy ecosystem has three attributes:[66]

- *vigour*, which refers to the level of productivity or "pulse" of an ecosystem;
- *organisation*, which refers to the structure or number of interactions within an ecosystem (healthy ecosystems have many interactions - complex food webs - whereas disturbed systems are highly simplified and have fewer interactions); and
- *resilience*, which refers to an ecosystem's ability to recover following disturbance (healthy ecosystems "bounce back" after a disturbance, unhealthy ones do not).

41. These factors underpin our understanding of ecosystem health because they reflect those components of an ecosystem that are linked to vital processes and function.

42. At a national level, governments might establish a scientific accreditation body to:

- accredit monitoring and reporting standards (including rules for selection of indicators and consistency of ranking systems);
- oversee audits of data collection; and
- accredit state, regional and local accounts as satisfying monitoring and reporting standards.

43. At the international level, the London Group could contribute by developing guidelines for producing regional and national environmental (ecosystem) accounts using reference condition benchmarks to construct ecosystem health indicators. These guidelines could become the standard in the SEEA.

44. Initial attempts have already been made addressing these concepts in the SEEA framework. For example, the SEEA water account explores the possibility for water quality indices, including reference condition based ecosystem health indicators such as the Water Framework Directive, to populate the water quality account.[67]

6. Environmental (Ecosystem) Accounts

45. The adoption of ecosystem health indicators as the standard unit of measure for environmental (ecosystem) accounts establishes the conceptual framework for incorporating ecosystem stock and flow accounting into the System of integrated Environmental and Economic Accounts.

46. The scale of such accounts is determined by the resolution of the data collected for each indicator. With sufficient data, environmental (ecosystem) accounts can be constructed at any scale, and aggregated into property, catchment, regional, national and international accounts.

47. An accounting standard based on ecosystem health indicators produces multiple benefits for environmental accounts:

1. It measures the state (stock) and change in condition over time (flow) of an environmental asset in the context of ecosystem health (quality);
2. It provides a standard for comparison between indicators for all environmental assets and ecosystems. This makes it possible to compare an environmental asset in one locality with the same asset in another even when different indicators are used, and compare the relative health of one environmental asset to another;
3. Because reference condition scores and ecosystem health indicators numerically codify environmental information on a common scale (between 0 to 100), site specific data can be used to generate accounts at different scales including property, catchment, regional, national and international accounts;
4. It drives significant cost efficiencies in data collection, because it:
    - allows areas under intense environmental pressure to be measured with greater precision than areas under less pressure without diminishing the ability of the accounts to compare one location with another;
    - enables indicators to be determined at any scale, time and space, rather than requiring the collection of a raft of data to satisfy all user needs across a country; and

- uses the vast array of environmental information that has already been collected over the decades for various purposes; and

5. They can evolve in their sophistication over time as the quality of data improves with knowledge and technology.

48. The proposed system of environmental (ecosystem) accounts has the potential to significantly improve the quality of environmental decisions, in different ways, at multiple scales:

    1. *Information*: environmental (ecosystem) accounts provide the ability to produce regular Environmental Health Reports which describe the state and any change to the condition of key environmental assets and ecosystems over time;
    2. *Policy*: environmental (ecosystem) accounts provide a transparent system of accounting that informs policy trade-offs (both positive and negative) between economic development and environmental health; and
    3. *Investment*: the '*Econd*' environmental currency enables traditional tools, such as cost/benefit analysis and multi-criteria analysis, to evaluate the cost-effectiveness of investments in environmental management.

49. Alfieri, Havinga and Webb (2010) argue that Volume 1 of the revised SEEA should provide a framework for the economic approach to the environment, where it measures the intersection between the economy and the environment, and that Volume 2 should focus on "ecosystems, ecosystem services and their valuation as well as valuation of degradation that is the changes in quality of the environment."[68]

50. We support this proposal and suggest that:

    - Volume 1 of SEEA be called *Integrated Environmental Economic Accounts*; and
    - Volume 2 of SEEA be called *Environmental (Ecosystem) Accounts*.

51. If acceptable, Volume 2, the Environmental (Ecosystem) Accounts, would populate condition (stock) and change (flow) tables with the indices of ecosystem health.

7. Regional Environmental Accounts Trials in Australia

52. While there have been many attempts to systematically measure the condition of environmental assets and ecosystems,[69,70] few have succeeded in providing comprehensive mechanisms that regularly measure and report on the state and change in condition of environmental assets or ecosystems.

53. As a consequence, those charged with managing the environment do not have the information they need to inform effective land use and environmental policy, nor make informed investment decisions.

54. In an effort to address what we consider to be one of the great failures of environmental policy, a trial of Regional Environmental (Ecosystem) Accounts is to be conducted across Australia, using the accounting principles described in the *Accounting for Nature* model.

55. The accounts will be produced regionally because it is the scale that best reflects the bio-geographic uniqueness of the Australian landscape and it is the scale at which the majority of environmental management policy is determined.

56. Regional Environmental Accounts trials will be conducted in up to 12 of the 56 natural resource management regions across Australia. They will use reference condition benchmarks to construct ecosystem health indicators as a basis for building Regional Environmental (Ecosystem) Accounts.

57. These trials aim to produce four specific products:

1. A draft manual of procedures or methods for producing regional environmental accounts;
2. A standard for using reference condition benchmarks and ecosystem health indicators for environmental (ecosystem) accounts;
3. A set of Environmental (Ecosystem) Accounts for each region; and
4. A Regional Environmental Health Report which will interpret the information discovered in the accounts.

58. These trials will be co-ordinated through a national Regional Environmental Accounts Working Group, and will be supported by a range of experts including scientists, economists, land managers, professionals in the regional natural resource management bodies and the Wentworth Group of Concerned Scientists.

59. The regional natural resource management groups have decided to run these trials because monitoring, evaluation, and reporting is an integral part of their charter, and the quality of their decisions is dependent on the quality of information they have to inform those decisions.

60. A technical environmental accounting committee will be established in each region to select indicators of each asset type (land, water, marine), access the data and produce the accounts. A scientific review process will be established to develop a standard for reference condition benchmarks and to accredit ecosystem health indicators in each region as being suitable measures of the key environmental assets of those regions.

61. The first set of regional accounts will draw on existing data wherever possible to create the environmental (ecosystem) stock accounts, and use time series information to establish historical trend (flow) accounts.

62. These trials will test, at a regional (landscape) scale, whether the Environmental (Ecosystem) Accounts framework described in this paper can be incorporated into the international System of integrated Environmental and Economic Accounts, and whether regional accounts are able to be aggregated to construct State and National Environmental (Ecosystem) Accounts.

8. Conclusion

63. Ecosystems are complex, which is why measuring environmental quality is so difficult. But if we don't have an accounting system that systematically describes the condition of ecosystems, it is not possible to measure the impact of an economic activity on that ecosystem, nor is it possible to evaluate where to best invest resources to protect or improve the health of these systems.

64. We need to manage the environment with the same discipline with which we manage our economy.

65. There is no doubt that modern science is capable of providing the required information. There are decades of science dedicated to developing methods of measuring the health of ecosystems so that different assets and different indicators can be compared.

66. These tasks are being made easier by technology. Satellites, computers, and the Internet have made it possible to choose from a range of possible ecosystem health indicators, and we are only at the beginning of this environmental information revolution. Satellites with photographic resolutions of two metres are now readily available,[71] Lidar and radar measurements are coming on line which can respectively measure forest structures and observe forest cover change through cloud.[72]

67. The science of reference condition based ecosystem indicators provides what economics already have – a common currency.

68. What is needed is a system of environmental (ecosystem) accounts that systematically organises that information and procedures to accredit the ecosystem health currency.

69. Regional natural resource management groups within Australia will trial these methods to build regional environmental accounts. The trials will use existing data, and use ecosystem indicators against a reference condition benchmark to measure the state and change in condition of their environmental assets. These trials should inform the London Group process on the practical application of environmental (ecosystem) accounting.

70. The London Group is well placed to co-ordinate and develop the international guidelines for how to build these environmental (ecosystem) accounts for SEEA. The common currency will resolve many of the barriers hindering ecosystem accounting to date.

71. Adopting a system of environmental (ecosystem) accounts based on reference condition benchmarks to create a common currency for ecosystem health will mean that an environmental asset, such as a forest, can have both a monetary value and an ecological value. This will create a transparent system of accounting where the impact of economic activity (both positive and negative) on environmental health can actually be measured.

72. The environmental accounts will offer different applications to different users; link economic activity to environmental change, compare the health of assets, determine where to invest to manage the environment, how to maximise economic outputs for least environmental impact etc. With a common currency, environmental accounts provide decision-makers access to better information. Hopefully we will make better decisions.

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