Project Description

Measuring and Modelling Sustainable Development in Australia using Inclusive Wealth

Date: October 2004

Executive Summary

Our Common Future defined sustainable development to be '… development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission, 1987:43). However, there are no adequate measurement frameworks to assess if nations are achieving sustainable development. Even now, while there is a large amount of discursive investigation into sustainable development, there are no formally identified indicators or measures. Often, conventional macroeconomic measures such as GDP or GNP are supplemented in ad hoc ways by various other indicators and reports on environmental issues, in order to make 'sustainable' development -related decisions.

For this project we follow the definition of inclusive wealth developed in Arrow et al (2003) where a nation can be seen as achieving sustainable development if social welfare (intergenerational well being) is at least maintained. Social welfare is the present value aggregation of all humans' well being, current and future (including soil, water, biodiversity, buildings, education, etc). The best available proxy for measuring social welfare is the measurement of the 'value' of all capital stocks (human, manufactured and natural). The sum of an economy's capital stocks, weighted by their shadow prices for each stock, is a measure of the country's inclusive wealth. Therefore, a country is achieving sustainable development if its measure of inclusive wealth is non-declining.

The aim of this three year project is *to pilot a framework for practically measuring and modelling inclusive wealth (as a proxy for sustainable development) in Australia, using two case studies*. The first case study region is the Goulburn-Broken Catchment (Victoria). The preferred option for the second region is the State of Victoria. This will allow comparison of scale effects on the feasibility of getting estimates within acceptable limits. The particular objective is the development of an 'operationally ready' inclusive wealth framework for Australia, based on the theoretical approach of Dasgupta and Maler (2001) and Arrow, Dasgupta and Maler (2003). The project encompasses three main sub-objectives:

- Develop inclusive production systems for *key* outputs in each case study
- Assess changes in composition of the capital stocks, including identification of critical capital stocks and attention to external exchanges and appropriate scales of data measurement
- Explore ways to assign relative values (shadow prices) to the above stocks and hence derive a measure of Inclusive Wealth.

This project is in collaboration with the Beijer International Institute of Ecological Economics (Sweden) which is undertaking a case study of the Stockholm region.

1. Introduction

The issue of how to measure sustainable development is bedevilled by partial measures and incomplete lists of indicators. Currently governments make decisions about sustainability using a suite of tools, though relying heavily on traditional economic measures, such as GDP, NNP or GNP. Since these measures were never intended to be used to judge or gauge issues of sustainability, optimality, or development, they need to be augmented with various other tools. For example in Australia the State of the Environment Report is used in conjunction with GDP and policy tools to provide a somewhat more comprehensive assessment of whether or not Australia is achieving sustainable development.

However, these tools were developed independently and do not contribute to an integrated assessment that allows for evaluation of the inevitable tradeoffs between resources (human, natural or manufactured). There is a need for governments to be provided with models that explicitly show tradeoffs and which can be used with other tools to form a more inclusive and hence better decision making capacity.

The major drawback of most environmental indices, in Australia and internationally, is that they do not adequately address the economic or ecological significance of a change in the indices concerned – how much is enough or too much, and the economic, environmental or social implications of a change. Nor are substitution possibilities between different components made explicit. A comprehensive and detailed sustainable development measure—or set of indicators—would allow sufficient aggregation as would enable both interpretation of changes over time in the aggregate measure(s) and identify degrees of substitutability between component items.

Economists have constructed measures in this spirit, based on the criterion known as "weak sustainability". By this criterion, sustainable development entails the maintenance of an overall stock of productive capital (including natural capital), where distinct capital items are weighted by appropriate dollar values, and these dollar values ("shadow prices", to be discussed below) indicate their degree of economic substitutability with each other. However, such measures—including "Green GDP" and Genuine Savings—underpinned by weak sustainability, have been criticised for making overly strong assumptions about degrees of capital substitutability. If certain environmental assets are essential in some sense to human well-being or are subject to critical ecological thresholds, weak sustainability assumptions—that all capital assets are potentially substitutable with any other in order to maintain sustainability—are called into question. "Strong sustainability" criteria are proposed instead, with more restrictive conditions on maintenance of particular natural assets.

Thus, an "ideal" measure of sustainable development would have something like the following properties.

- It would be highly aggregated, to allow analysis of "trend sustainable development" over time
- Within the single (aggregate) index, components would be substitutable according to assigned weights
- Irreversibilities and critical thresholds should be identified and accounted for.

These three conditions combine desirable elements of both weak sustainability and strong sustainability. As described in the following sections, the Inclusive Wealth measure proposed by Arrow, Dasgupta and Maler [ADM] (2003) enables these three conditions to be met.

Aim

The aim of this project is *to pilot a framework for practically measuring and modelling inclusive wealth (as a proxy for sustainable development) in Australia, using two case studies*. The first case study region is the Goulburn-Broken Catchment (Victoria) which was selected on the basis of available information, and a wide variety of resource use and development. The preferred option for the second region is the State of Victoria. This will allow comparison of scale effects on the feasibility of getting estimates within acceptable limits. If the State option fails, the second case study will be another equivalent region to the Goulburn Broken Catchment.

The trial project is restricted to examining the feasibility of the approach in two case studies. However, the eventual aim is a national measurement program based on a minimum sufficient representative sample of Australian areas (either regions or states).

Objectives

The overall objective of this project is the development an 'operationally ready' inclusive wealth framework for Australia, based on the theoretical approach of Dasgupta and Maler, 2001 and ADM 2003. It encompasses three main sub-objectives:

- Develop inclusive production systems for *key* outputs in each case study
- Assess changes in composition of the capital stocks, including identification of critical capital stocks and attention to external exchanges and appropriate scales of measurement
- Explore ways to assign relative values (shadow prices) to the above stocks and hence derive a measure of Inclusive Wealth.

This is a trial project and, as such, the results will be incomplete and therefore cannot, and should not, be used to directly influence policy. The project was proposed in 2001 and received CSIRO support, under the Social and Economic Integration program, in 2002. A revised version of the project was developed following a meeting of an advisory group (including CSIRO and external participants) in January 2003. This project description includes all these preceding discussions and incorporates the outcomes of a symposium on the project in October 2003 and progress made until September 2004.

This project description has four sections. Section 1, includes the aim and objectives of the project. Section 2 outlines the approach to be taken; specifically the theoretical framework and issues with implementation. Section 3 describes the procedure for project implementation. Finally section 4 outlines some project delivery information, including project personnel and participants, communication process and timelines. The appendix outlines the key project outputs and their relative timing.

2. Approach: Sustainable Development as Measured by Inclusive Wealth

What is meant by Sustainable Development?

Sustainable development is a highly contested area of discourse. The use of terminology itself can matter. We have talked of sustainability as a criterion, but we choose here to emphasise "sustainable development" in order to avoid any implication of constancy or preservation. Our interest here is to allow for growth, change and development, while defining constraints to help identify what development paths satisfy or violate an overall sustainability criterion. We endorse the greater

generality allowed for by "sustainable development" as opposed to the often more restrictive "sustainability" (pers. com. J. Chesson). Of course, sustainable development in turn has been defined in various forms and ways. It is important to clarify the definition because it will determine the type and process of measurement proposed.

The World Commission in their report *Our Common Future* famously defined sustainable development to be '… development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission, 1987:43). While there are many different ways to operationalise this definition, and it has thus been criticised for its vagueness, the intuition of and emphasis on maintaining standards of living in a society over time seems both useful and important. The criterion used for this study is that an economy can be seen as sustainable if social welfare is at least maintained. Social welfare is defined here as the aggregation of all individuals (humans) present value of their current and future utility, where utility denotes a measure of human well being (health, happiness, basic liberties, consumption of goods and services, enjoyment of the natural environment). Social welfare is the means by which we estimate the value of the assets that produce human well being, representing a present value of current and future utility—and can thus be regarded as a measure of societal wealth. Development is thus sustainable if social welfare is non-declining along the economy's growth path.

Within the economics discipline, a key alternative to using a present value ("social welfare") criterion is to use an instantaneous utility criterion, whereby development is thus unsustainable if current utility declines. This criterion is more restrictive than the social welfare criterion: it normally does not yield two-sided sustainable development tests, in the sense that while declining current utility indicates unsustainable development, there can be no assumption that non-declining utility indicates sustainable development. Moreover, it rules out development paths that may have long-run sustainable development properties; for example, a poor country may wish to reduce current consumption in order to devote resources to investment in productive capital goods, technological development or education. This violates a sustainable development rule based on current well-being (utility) but may well satisfy one based on the present-value social welfare approach.

Hence, we advocate employing a social welfare (or wealth-based) approach to the assessment of sustainable development. Before discussing how such an approach may be implemented, we move to a discussion of previous attempts to define and measure sustainable development.

Previous Approaches to Assessing Sustainable Development

As stated, even now, while there is a large amount of discursive investigation into sustainable development, there are no formally identified indicators or measures. Progressing beyond the limitations of established tools (eg. GDP, GNP) are measures such as the Genuine Progress Indicators, various "Green GDP" or "Green Net Product" measures, and now the World Bank measures of Genuine Savings, or Genuine Investment, which link use of natural resources to human wellbeing (eg Hamilton and Clemens 1999; Dasgupta and Maler 2001). Green GDP and Genuine Savings/Investment measures are related in that they derive from standard economic foundations, and are built on the foundations of what has been referred to above as weak sustainability. (The Inclusive Wealth approach discussed below belongs in this tradition, while taking it further in key directions.) Genuine Progress Indicators go further in their adjustments to GDP, and are typically regarded as being in the strong sustainable development field of indicators.

A summary table of key definitions and their associated tools for measuring sustainable development are in Table 1. It should be noted that most of these tools have been applied in Australia, currently ABS is extending its national accounts to accommodate the environment through satellite accounts

(ABS 2002) a modified form of Green GDP. The World Bank has applied the Genuine Savings measure to Australia and the Genuine Progress Indicators (Hamilton 1998) have been applied, as a research project. All measures have had varying success and are still considered developmental.

Table 1. Key Definitions and Indicators of Sustainable Development

Name or Proposed Indicator	Definition of Sustainable Development	Source
Green GNP / Green GDP	Measures national income or output adjusted for the depletion of natural resources and degradation of the environment. A larger number signifies greater sustainability.	Harris and Fraser 2002
Genuine Investment/ Savings	Measures the net change in national assets including natural and human capital. A larger number signifies greater sustainability.	Hamilton and Clemens 1999
Genuine Progress Indicator	Measures the change in social well-being, through twenty five indicators, covering consumption (broader than GDP) and value of capital stocks. A larger number signifies greater sustainability.	Hamilton 1998
Inclusive Wealth	Measures an economy's capital stocks, using weights from the estimation of shadow prices for each capital component (human, natural and manufactured capital). Non-declining net (weighted) capital stocks indicate that the current set of development activities is sustainable.	ADM 2003

Sustainable Development as Measured by Inclusive Wealth

We have defended social welfare as, in principle, our preferred means of assessing sustainable development in an economy and society. Note two things about this social welfare concept. First, as a present value magnitude, it is a *stock* magnitude, analogous to the idea of social *wealth* (Dasgupta and Maler 2001). Second, social welfare as we have defined it—the present value of all future utility of all members of society—seems ridiculously hard to measure or forecast. This is one reason that other analysts have chosen current utility over social wealth as a sustainable development criterion—it seems at first blush to be more easily measurable. Two questions then arise: (1) What is the relationship between social welfare and national wealth, and (2) How can social welfare, which requires looking forward into the indefinite future, be measured in the here-and-now?

The answer to the second question is provided by the answer to the first, which turns on the developments outlined in work by ADM (2003), in which their model of Inclusive Wealth is extensively presented and developed. ADM (2003) demonstrate that properly valued, the total value of all society's assets provides a measure of society's total social welfare (answering question one) and that the goal of measuring social welfare is equivalent to the goal of measuring society's total, or inclusive, wealth (answering question 2). Since the shadow price of any capital asset balances out the value of using that asset now versus holding it for later use, including all its externalities, then shadow prices already embody forecasts of future asset values. This is the sense in which future flows of utility are embodied in current asset values, as measured by the Inclusive Wealth approach.

This Inclusive Wealth approach is the stock analogue to the Genuine Savings/Investment approach currently being employed by the World Bank. Genuine Investment measures the change in the total capital stock; Inclusive Wealth aims to measure the stock in totality. A further extension here, however, is that we attempt to incorporate risk, resilience, thresholds and irreversibilities into the measurement of Inclusive Wealth, thus taking it beyond the standard "weak sustainability"

approaches of Genuine Savings and Investment. Changes in Inclusive Wealth then provide the information necessary to assess whether development has been sustainable or not.

Summary

Inclusive Wealth is a measure that captures social welfare (in an intertemporal sense) by measuring a society's total asset base, valued at shadow prices. It allows for substitutability between individual assets over time (for some to be built up as others are run down), while at the same time incorporating adjustments for risk when (say) critical ecological thresholds are approached. As a national measure, it is designed to sustain the asset base of the whole of society, appropriately aggregated, and thus to capture the social welfare of the population of that society. (Note that this does not exclude incorporating the social welfare of Australians abroad or of tourists who may wish to visit Australia to see its natural wonders.).

We turn now to the main considerations in applying the inclusive wealth framework.

Measuring Inclusive Wealth in Australia: a regional scale pilot

An initial consideration was whether sustainable development should be assessed by industry or region. From an industry perspective, there may be good reasons to approach the assessment on such a basis (eg. the dairy industry, the timber industry) there are two problems with it. First, industries do not operate separately and several of them interact to yield net benefits and costs to society. Changes in the sustainability of one will have effects on the sustainable development of others. Second, the demise of a particular industry might well be appropriate in terms of future well being. Whaling, asbestos mining and tobacco farming are some examples. Sustainable development in Australia should not be constrained by the interests of any particular industry.

The focus of the approach is therefore on regions. This focus satisfies the theoretical requirements and meets the need for the program to feed directly into decisions that government agencies (at all levels) have to make. Conducting the assessment at area scale is necessary to reflect the intervention policies for funding and natural resource management of the main government agencies responsible for policy (AFFA, DEH, DOTARS and States). By 'region' we mean a spatial unit and an associated economy that is sufficiently closed to permit the construction of a regional economic model in which the regional transactions are not over-whelmed by imports and exports. These conditions are necessary for the estimation of shadow prices.

This regional approach should keep in mind that the overall aim of the project is for a national 'roll-out' of the inclusive wealth measure, with many different regions assessed.

Choosing to develop the system on a regional scale brings in added complications, chief amongst which are inter-regional transfers of all three capitals. A number of issues need to be acknowledged, specifically (as identified by Pezzey pers. com):

- Identification and clarification of inflows and outflows from the region, eg. foreign capital and trade
- Trans-boundary externalities, eg. salt or nutrient flows
- Exogenous technical progress, eg. technology change that originates from outside the region
- Exogenous changes in export prices
- Movements of people, including immigration and emigration

These issues are particularly relevant for small regions in a large nation, ie the Goulburn Broken Catchment, but are less of an issue for larger socio-political area, ie States. Their consideration will be part of this project.

To identify and measure all forms of capital within a region at the finest level of disaggregation is impossible and unnecessary. The need is to identify the critical capital components, measure their levels and then estimate their shadow prices. Applying a systems approach to identifying and measuring key capital stocks is the first of four main considerations in the application of this theory.

(i) Identifying regional key capital stocks: a production systems approach

An important part of this project is a systematic process for identifying the key capital stocks that will be further quantified and then valued to form the measure of inclusive wealth. Currently there are no known techniques to identify, inventory and then measure key capital stocks in a region. So the team has proposed the construction of production systems for key regional outputs, as identified by the region. These key outputs need to include both the extant set as well as potentially important new future outputs. This implies the need for careful scenario analyses. The production systems will compile and examine the inputs and outputs of materials (and energy) directly attributable to the functioning of a product or service throughout the region.

In adopting this approach a number of issues need to be considered. First, how disaggregated should capital components be within the identified system? For example soil is a direct input to dairy, therefore should the constituents that make soil useful to the dairy process be included?, or externalities such as erosion, salination, etc? As we are primarily concerned with direct relationships only it is proposed that capital constituents that do not directly affect our identified outputs, should be included in the scenario description.

Second, some capitals provide more than one output, eg. soil is included in all analyses, therefore we need to ensure that there is no double counting of current capital stocks and that there is appropriate allocation between competing uses of the same capital.

(ii) Assigning values (shadow prices) and the importance of future scenarios

All capital stocks need estimated shadow prices. Shadow prices represent the marginal change in present value terms of the future well being of all peoples, derived from the capital stock, including direct and indirect uses and intrinsic, option and bequest values. Some capital components already have established market values (primarily in manufactured capital) that can be used as a first proxy to the shadow price. However, these may need to be modified to reflect any market failures or externalities. Other capital components will not have markets (non-market goods and services such as biodiversity) and their shadow prices will have to be found through other means, such as benefit transfers from past studies, 'expert' discussions or stakeholder surveys (not within this project scope currently).

There are two main issues with estimating shadow prices: (i) future scenarios need to be developed for the region, such that current and future use and demand of capitals can be estimated, (ii) different stakeholders will have different shadow prices because they will receive/ perceive alternative streams of benefits delivered by the various stocks of capital (eg. water for irrigation versus water for nature).

Explicit forecasts ('future scenarios') for the regions will be outlined, in order to assist in the process of estimating shadow prices for capital components. These future scenarios are found implicitly in people's estimation of shadow prices (eg. if you think waterways are getting more polluted, you will place a higher price on clean water). This study will make them explicit.

The second issue (not everyone has the same value for the capitals) creates a difficult problem- and one faced by all studies seeking to value non-marketed benefits. It is not possible to determine a utility function that reflects all of society's values as a whole, and therefore a crucial first step in the process is to identify who the stakeholders are and how their 'values' and future scenarios will be modelled. We propose to develop more than one estimate of IW, reflecting the range of social values in the region.

(iii) Risk and resilience

If the risk of natural capital declining in the future increases, even though natural capital itself may not be exhibiting any changes now, the relative value of the stock has decreased, and therefore wealth has declined. This is an important and under-estimated aspect of sustainable development. For example, for many decades direct performance measures of the Murray Darling Basin indicated sustainable use of resources. Only in the last couple of decades has the risk of future losses in productivity associated with changes in hydrology and salinity been adequately recognised. The risk of changes in natural capital is reflected by changes in the resilience of the systems concerned. Gradual and sudden changes are both important for sustainable regional development, but this project will have a special focus on the identification and estimation of thresholds in natural systems that demarcate significant changes from one state of natural capital to another (less valuable) state – especially non-reversible changes – and how far the system is from such thresholds. The closer to a threshold, the lower the resilience and the higher the risk of loss of capital.

In discussing the problems facing the development of the Environmental Sustainability Index of the World Economic Forum's Global Leaders for Tomorrow Environment Task Force, Esty (2001) concludes that "...because sustainability relates both to the distance a society is from critical pollution or resource consumption thresholds and how fast these thresholds are being approached, the concept of sustainability has proven hard to translate into clear signals for policymakers". We aim to develop an explicit method for incorporating changes in resilience into the IW measure.

(iv) Social capital and equity

On the use of social capital in our estimation of sustainable development, we follow the ADM use of three forms of capital (natural capital, human capital, manufactured capital) as the asset base for inclusive wealth, and do not explicitly measure social capital. Social capital, as measured in the project, is therefore, the institutions and cultural norms that facilitate the transformation of the three capitals into production (or other utility). It has, for example, been estimated as the "Solow residual" (K-G Maler, pers. comm.) in accounting for the difference between GDP by the variances in human capital, manufactured capital and natural capital. The residual can be negative, implying a decline in social capital during the time period over which the variances were measured. However, how to account adequately for changes in social capital still needs to be resolved and one component of the project will be an explicit investigation into social capital (known to some as social capacity) and its interactions with inclusive wealth.

This project will initially focus on the interactions with the natural capital components, due to the background of the project team.

Finally, there is the issue of equity. It is possible for the total inclusive wealth of a country to increase while the poor get poorer, or the disparity between rich and poor gets larger. Therefore a comprehensive measure of sustainable development should accommodate equity. Inclusive wealth at this stage does not appropriately deal with the issue of intragenerational equity (eg. between people currently living), but it considers intergenerational equity (eg. between different generations of the

population). Further modification to the theory and possible tools are underway to include intragenerational equity and when, if, these become available they will be included in this project.

Additionally the regional models will have some spatial implications and hence could conceivably already include some descriptive equity considerations. As this is a pilot for a national program where many regional models will be put together it will enable issues of interregional equity within Australia to be considered.

3. Method

A number of discussions with project participants and feedback from various presentations and symposiums, have guided the following procedure of operationalising the inclusive wealth measure.

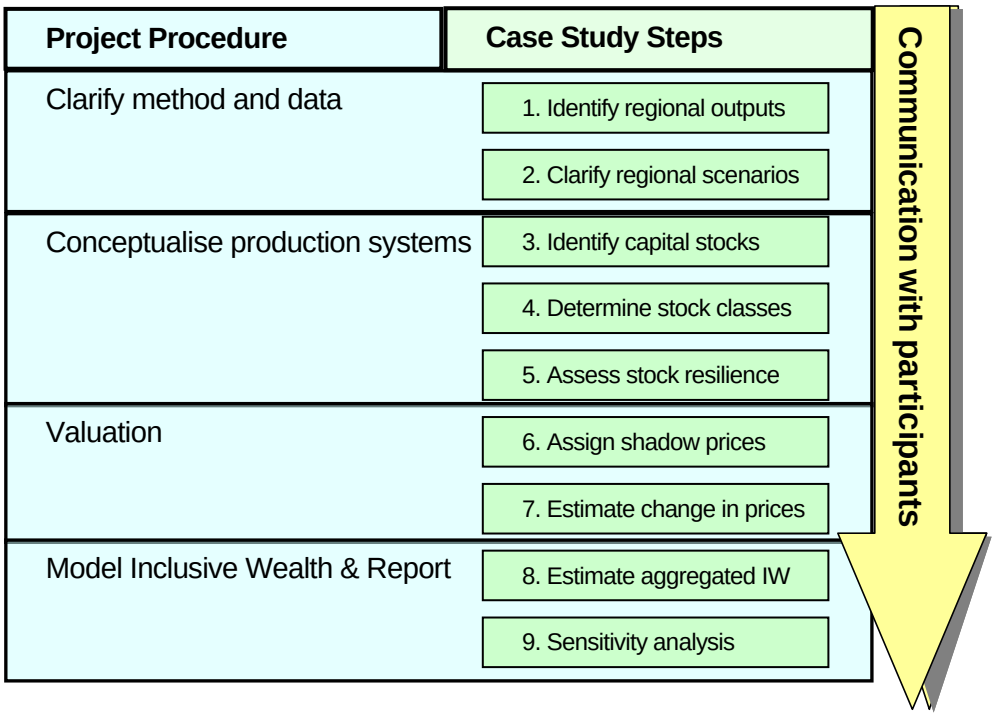

Figure 1. Procedure for modelling and measuring inclusive wealth in Australia

The Procedure

Clarify method and data

The proposed procedure will be continuously updated based on feedback from various symposiums, steering committee members, leading developers of sustainable development theory, practice and policy in Australia and continuing involvement of the Beijer Institute of Ecological Economics.

It includes two specific steps that need to be undertaken in the case studies:

Step 1: Identification of key regional outputs and future scenarios

In conjunction with the regions and their stakeholders (people with an interest in the region) determine a limited set of "key" goods and services that the region provides, now and into the future. The notion of "inclusive wealth" needs to be invoked in determining the range of goods and services (G&S) that provide value to people. For the pilot project this should not (cannot) be a complete list, but should encompass the range of key G&S (those representing major contributions to regional output, those where market failures are thought to be a significant problem, and those non-marketed natural assets) and component capital stocks.

Tasks include:

a) Based on published information and interviews with key people; identify key regional outputs (goods and services) from the regions

b) Identify key goods and services taking into account: significance of outputs to society, the economy, the wider ecosystem and the nation.

Step 2: Clarification of regional future scenarios

Two scenarios for each region's future need to be determined to understand current and future "key" goods and services. It is proposed that this will include scenarios of 'a business as usual' (BAU) and a 'policy implementation' future. These futures will be used to check that there are no significant capital stocks that are important now and in the near future that should be included in the analysis. The scenarios will also be necessary for the 'valuing' of the stocks.

Tasks include

a) Identifying stakeholder groups and define their relationship with the catchments and broader Australian population

b) Identify a future scenario for each region, based on literature reviews and discussions with catchment boards/ authorities.

Conceptualise production systems

The production systems envisaged would form an integrated regional model that reflects product (output) transformations and input substitutions, the latter being critical to transformation among the different forms of capital. Also of importance in the specified production systems is the consideration of uncertainty, substitutability, temporal and spatial dynamics, externalities and interactions. This includes three steps which need to be undertaken for each case study.

Step 3: Identify capital stocks

The trial project cannot measure and model all capital stocks and therefore a process of identifying critical capital stocks, which will focus the investigation, is necessary. This is a broad-brush step, potentially subjective, which identifies the minimum sufficient list of capital to be part of an inclusive wealth measure. Critical capital components are those which are:

- Important to production systems
- Important to the functioning of the region
- Have future value
- Distorted from market prices

- Approaching a threshold
- Have some data availability

Step 4: Determine stock classes

Once stocks have been identified and are mutually exclusive (in definition and measurement) each stock needs to be identified in terms of a quantity within a class (sometimes a quality representation) component, before valuation can occur. It is proposed that the stock classes will be selected to reflect significant differences in either or both price and resilience. The classes need to be defined precisely to ensure that allocation of capital into the classes is repeatable across assessors and over time.

Step 5 Assess stock resilience

Each capital stock needs to be assessed in terms of its vulnerability or resilience. We do this by assessing its loss or gain of resilience with respect to a change in stock quantity or shadow price. It is important to remember here that resilience is only significant if a threshold:

- is likely to occur within the identified scenarios
- impacts on value or changes wellbeing
- crossing it necessarily means that you can not go back to past conditions as easily (ie. non-convex in nature)

Valuation

Explore the possibility of measuring and allocating shadow prices to each stock class, enabling the consideration of marginal changes in the stocks and acknowledging risk and resilience issues. This is a difficult and contentious part of the project, regarded by some as unachievable. However, it should be noted that ideally, this valuation component is intended to be a retrospective analysis, eg. 1991 and 2001. Various participants to the project have stressed the importance at this stage to use the best available data and undertake relative valuation measures only. There are two steps in this stage.

Step 6. Assign shadow prices

The shadow price assigned to each of the stock classes should reflect the net present value of the future possible flows from the stock by each of the identified regional flows . Four techniques have been identified to estimate shadow prices:

- market prices (for stocks that are readily traded in an open market, eg. cows in a dairy production flow)
- adjusted market prices (for stocks traded in a limited market, eg. converted bioregion class (land) in horticulture)
- econometric production functions (for stocks included in a primarily marketed production function, eg. water in agricultural production)
- use of information from elsewhere (ie. benefit transfer for stocks that have no market characteristics, eg. native vegetation in bioregions and have been valued elsewhere)

Tasks include:

a) Identify known market values and how close they represent ‘shadow prices’

b) Consider steps to adjust market values to reflect various stakeholder groups shadow prices

c) Identify critical components with no prices and investigate non-market valuation methods (eg. benefit transfers and contingent valuation tools)

Step 7: Estimate change in prices

Significant changes in shadow prices occur due to external influences (exogenous). These need to be taken into account and deducted from the estimation of stock value as capital gains. Therefore estimation of capital gains for all the critical capital stocks needs to be undertaken.

Model Inclusive Wealth and Report

Develop a model, which provides estimates of inclusive wealth incorporating inter-capital conversions and changes in one form of capital to others. Once achieved, this will allow assessment of the consequences of alternative patterns of resource allocation on inclusive wealth (ie could we have done better?).

Additionally, an inclusive wealth model is important as the end goal but it will not be the only output of the project. Outputs will be provided at a number of levels, for example: 1) The integrated measure of Inclusive Wealth. 2) "Warning lights" – the capital components to worry about, based on the assessments of non-substitutability and of resilience, thresholds, etc. 3) the assessment and allocation of shadow prices. 4) the construction of production systems for key goods and services. 5) the individual measures of capital components. 6) statement of appropriate application of the framework at the national level and a potential implementation process. Full list of currently identified outputs is provided in Appendix A.

This involves two steps to be undertaken by each case study.

Step 8: Estimate aggregated Inclusive Wealth

Once values of stock classes have been gained, each stock needs to be aggregated to form a single stock value. It is envisaged that most stocks will have multiple stock classes (eg. Human capital with various income, age and education classes) and associated shadow prices, the method of combining these stocks and prices to form an estimate of firstly stock values (ie. Human, Natural and Manufactured Capital) and then a measure of IW is contentious. To achieve a measure of IW a combination of stock weightings and their classes as well as accounting for exogenous catchment flows, ie. external subsidies, governmental payments, trade flows, etc. needs to be undertaken.

IW is a linear summation of HC, MC and NC weighted by their shadow prices. However, within each of these capital stocks are numerous classes and each of these needs to be weighted and combined.

Step 9: Sensitivity Analysis

Due to the feasibility nature of this project it is necessary to conduct and understand the limitations of the inclusive wealth application. To this end a comprehensive sensitivity analysis will be undertaken to test the key aspects of this study including:

- estimates of prices of stocks (ie. range of shadow prices for each stock class)
- exogenous changes, eg. market changes
- climate change influences on stocks and on production functions
- relationships between capital stocks
- catchment vs, State scale sensitivities (assuming both scales are attempted)

Matching objectives to outputs

Earlier we stated that there was a single objective and three sub-objectives for this project, Table 2 lists these objectives and how they will be dealt with in the proposed procedure.

Table 2. Matching objectives to the procedure

Objective	**Proposed Process**
Development of an 'operationally ready' inclusive wealth framework for Australia, based on the theoretical approach of Dasgupta and Maler, 2001 and Arrow et al (2003)	Steps 1-9
Sub-objectives	
Develop inclusive production systems for *key* regional outputs in each region	Steps 3-5
Assess changes in composition of the capital stocks, including identification of critical capital stocks and attention to inter-regional exchanges and appropriate scales of measurement	Steps 3-8
Explore ways to assign relative values (shadow prices) to the above stocks and hence derive a measure of Inclusive Wealth.	Step 6-7

4. Project Delivery

There are three areas of project delivery that are important to the success of this project, first, the project personnel and participants, second, the method of communicating to interested people and keeping them involved and third, the timeline to achieving this project.

Participants and project personnel

Participants in the Australian project include; Goulburn-Broken Catchment Management Authority, various regional bodies, Department of Environment and Heritage Australia (DEH), Department of Treasury, Agriculture, Forestry and Fisheries Australia (AFFA), Bureau of Rural Science, Australian Bureau of Agricultural Resource Economics (ABARE), Productivity Commission, Department of Transport and Regional Development (for manufactured capital), Education Science and Training (for human capital), CSIRO, Universities and The Beijer Institute for Ecological Economics (Sweden). The four Australian Academies are mounting a 5-year program on Sustainable Development under a Joint Academies Committee on Sustainability, and this project will serve as one appropriate umbrella project for the program, bringing in the expertise from all four Academies. With the Goulburn-Broken Catchment Management Authority as the primary contact for the first case study.

This pilot project has been made possible through funding under the CSIRO Science Investment Program in the area of social and economic integration. The leader of the CSIRO proposal is Dr Brian Walker (Sustainable Ecosystems). Dr Michael Harris (Sydney University) has been appointed as part-time project researcher (2 days a week) and Dr Leonie Pearson has joined CSIRO full time on the project.

A Project Steering Committee has been identified to provide guidance on day-to-day management issues. This committee includes Steve Hatfield Dodds (CSIRO), Brian Fisher (ABARE), Jean Chesson (BRS), Mike Young (CSIRO), Brian Walker (CSIRO), Leonie Pearson (CSIRO) and Michael Harris (Sydney University).

Communication

Communication will occur throughout the project and a strategy has been developed in CSIRO to best manage the needs and requirements of the participants and the project objectives. This communication strategy is integrated into this project description, specifically communication will include:

- Medium for information to be provided to participants at regular periods throughout the project (bi annual newsletter and webpage www.csiro.au/MMSD)
- Measuring and Modelling Sustainable Development in Australia Symposium, Oct 14-15, 2003
- Published papers and reports
- Presentations at conferences and seminars

Timeline

The project will cover a period of three years (Jul 2003 – Jun 2006). Each step will take varying time, depending on the case study.

References

ABS 2002. Australian national Accounts: National Incomes, expenditure and Product, June 2002, cat. no. 5206.0 Australian Bureau of Statistics, Canberra.

Arrow KJ, Dasgupta P and Maler K-G. 2003. Evaluating projects and assessing sustainable development in imperfect economies. Working paper of the Beijer International Institute of Ecological Economics, Stockholm, Sweden.

Anon. 2001. Integrated Environmental and Economic Accounting. An Operational Manual. Studies in Methods, Handbook of National Accounting. Series F No. 78. United Nations, New York.

Chesson, J. 2003. "Reporting on the Social Objective of Ecologically Sustainable Development" proceedings of 'The social dimensions of the triple bottom line in rural Australia' a seminar held 26 February 2003, Canberra.

Common, Michael S. and Kali Sanyal. 1998. "Measuring the depreciation of Australia's non-renewable resources: a cautionary tale." Ecological Economics, Vol 26, 23-30.

Dasgupta, P and Maler K-M. 2001. Wealth as a criterion for Sustainable Development. Beijer Institute Discussion paper # 139.

Esty, D C. 2001. Toward data-driven environmentalism: The Environmental Sustainability Index. The Environmental Law Reporter. 31: 10603 – 10612. Environmental Law Institute, Washington, DC.

Hamilton, C. 1998. "Measuring Changes in Economic Welfare: The Genuine Progress Indicator for Australia". In R. Eckersley ed. Measuring Progress: Is life getting better? CSIRO Publishing, Australia pp 69-93.

Hamilton, K and Clemens M. 1999. Genuine savings rates in developing countries. World Bank Economic Review. 13(2): 333-356

Hamilton, K. 2000. Sustaining Economic Welfare: Estimating Changes in Per Capita Wealth, The World Bank Policy Research Working Paper #2498.

Lange, G.-M. and Wright, M. 2002 Sustainable Development in Mineral Economics: the example of Botswana, The Centre for Environmental Economics and Policy in Africa Discussion Paper Series, No 3, CEEPA, University of Pretoria, Pretoria.

Pearce, D. Hamilton K. and Atkinson G. 1996. Measuring sustainable development: progress on indicators. Environment and Development Economics 1: 85-101.

Pezzey, John C. V. and Michael A. Toman (2002, forthcoming). "Progress and problems in the economics of sustainability". In T. Tietenberg and H. Folmer, eds., International Yearbook of Environmental and Resource Economics 2002/3. Cheltenham: Edward Elgar.

Solow R M. 1992. An almost practical step toward sustainability. 40th Anniversary Lecture, Resources for the Future, Washington DC.

Weitzman, Martin L. (1997). "Sustainability and technical progress." Scandinavian Journal of Economics, Vol 99 No 1, 1-13.

Weitzman, Martin L. (1999). "Pricing the limits to growth from mineral depletion." Quarterly Journal of Economics, Vol 114 No 2, 691-706.

World Commission (1987) "Our Common Future", New York, Oxford University Press.

Appendix A: Project Outputs

Time	Output	Avenue of dispersal	Collaborators
Nov 2003	Paper: Project Description- updated	Symposium delegates MMSD working papers	LP, MH, BW
Dec 2003	Paper: IW in the Australian context, including regional issues and theoretical extensions, especially distribution/ sectoral issues and stakeholders and their locations	Ecological Economics MMSD working papers	MH, LP, BW
Dec 2003	Article: What is sustainable development for the region? How is it measured and what are we doing to get it right!	Shepparton News	Regions, LP, MH, BW
Feb 2004	Conf: AARES	AARES Conference Proceedings MMSD working papers	MH, LP
Feb 2004	Conf: BTRE	Published conference proceedings	LP, MH
Aug 2004	Paper: Defining Sustainable Development and using IW to measure Australia's progress	ECOS	LP, MH, BW
Apr	Workshop: Inclusive Wealth and Accounting Prices		LP, MH
Jul 2004	Paper: Human and Social Capital in IW	Beijer Institute Working paper ANZSEE (Dec)	LP, SHD, MH, (BW?)
Nov 2004	Paper: Inclusive Production Functions: roles, rules and considerations	MMSD working papers	MH, LP, BW
Nov 2004	Conf: JACS Sustainable Conference??	Working paper	MH, LP, BW
Jan 2005	Paper: Inclusive national accounts: SEEA1 and IW (compare and contrast)	ABS discussion paper	B Harrison, MH, LP
Feb 2005	Conf: AARES	Ag. Prod functions HC in regional Vic.	MH LP
Apr 2005	Paper: Measuring SD in the GB	Treiste	LP, BW, MH
Jul 2005	Paper (Build on Apr 2005): Comparative assessment of IW in Australia and International regions (with results)	Jnl of Environmental Resource Economics Jnl of Environmental Economics and Management	MH, LP, KGM and BW
Dec 2005	Paper: Measuring IW in Australia: data requirements, what it tells us about our environment?	AFFA, DOTARS & EA discussion paper	T Brearly/ M Hyman, J Chesson, etc BW, MH, LP
Jan 2006	Paper: Using a model of IW to assess policy implications for SD in Australia	Productivity Commission & DOTARS (?) research paper	N Byron, BW, MH, LP
Feb 2006	Conf: AARES		
Jun 2006	Conf: World Congress of Environmental Resource Economists	Working paper	LP, MH, BW, ?
Jun 2006	Report: MMSD Project	CSIRO	BW, LP, MH

[1] System of Integrated Environmental and Economic Accounts (SEEA)