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A Review of Economic Sustainability Indicators

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A Review of Economic Sustainability Indicators

Economic Sustainability: An Assessment of Criteria and Indicator Systems for Economic Components of Sustainable Forest Management

by

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EXECUTIVE SUMMARY

The World Commission on Environment and Development (WCED) of the UN cites sustainable development as "...development that meets the needs of the present without compromising the ability of the future generations to meet their own needs..." (Bartelmus 1994). The general notion is that sustainable development can guide economic activity to maximize the overall benefits to present and future society. The concept of sustainability, now viewed as a guiding tool in resource management, encompasses the environmental, economic, and social dimensions of the economy and the environment in which we live.

The Canadian Council of Forest Ministers (CCFM) created a set of criteria and indicators to guide sustainable forest management in Canada (CCFM, 1999). The need for more accurate economic sustainability indicators within sustainable forest management has been suggested by a number of authors. With economic systems, the challenge is to measure "well-being", analyze the distribution of well-being, and ensure that well-being is not declining. Many researchers have incorporated economic sustainability indicators into their studies in attempts towards achieving economic sustainability. This paper is a critical review of the economic sustainability indicators.

This analysis of economic sustainability is divided into four sections: (1) augmented income measures that cover the measurement of well-being including market and non-market goods, (2) equity measures which highlight distributional concerns, and (3) resilience measures which help to explain how well-being in a community changes in response to shocks to its economy. Finally, a fourth group of indicators is examined that include a variety of other economic and social indicators.

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The concept of sustainability encompasses the environmental, economic, and social dimensions of the economy and the environment in which we live. While each element is essential for building a sustainable path of development within sustainable forest management, less attention has been given to defining and measuring the concept of economic sustainability. In order to adequately measure and progress towards sustainability, we must have a solid understanding as to what economic sustainability entails. Economic sustainability involves assessment of the market and non-market benefits for the economy and for the people in the area. This is intended to ensure that preservation of the productive capacity will leave future generations with a mix of goods and services that does not reduce their well-being. Economic sustainability can be defined as non-declining well-being for citizens in terms of their ability to meet their basic needs, and in terms of satisfactory social conditions of the environment in which they live. Many researchers have incorporated economic sustainability indicators into their studies in attempts towards achieving economic sustainability. This paper critically reviews the economic sustainability indicators currently used, in areas such as augmented income, equity and resilience.

SUSTAINABILITY AND THE NEED FOR INDICATORS

The concept of sustainable development holds some promise in alleviating present and future concerns for resource use and environmental quality (Bartelmus 1994). The general concept is that sustainable development can guide economic activity to maximize the overall net benefits to present and future society. However, attempts to derive one concrete definition have thus far proved to be elusive. The reason for this uncertainty could be that different economic, environmental, and social conditions in various local areas produces an enormous diversity of current and potential human living environments (Bell and Morse 1999).

The World Commission on Environment and Development (WCED) of the UN cites sustainable development as "...development that meets the needs of the present without compromising the ability of the future generations to meet their own needs..." (Bartelmus 1994). Although this definition has been incorporated in various international agreements and policy documents around the world, the fact remains that the implementation of sustainable development is difficult for our complex systems (Beckley 2000). On the other hand, the current flexibility of the definition of sustainable development is appealing because attempting to apply a narrow definition across diverse human environments could be impractical and potentially dangerous (Bell and Morse 1999). Another common definition of sustainability is non-declining well-being of a "…representative member of society for millennia into the future…" (Pezzey 1992). As Adamowicz (2001) stated, this non-declining well-being involves maintained or increased "satisfaction" or "utility" of market and non-market goods and services through time. Assessment of sustainability in any area depends on the operational definition employed and the criteria used for measurement.

A popular definition of sustainable development requires that natural capital be non-declining through time. Natural capital refers to any stock provided by nature such as minerals, forests, or groundwater (Pezzey 1992). In regards to natural resources, the value is derived from their capacity to produce usable goods and services. Once this is recognized, discussions about substitutions and tradeoffs can ensue (Solow 1992). The definition of natural capital implies one of two guides for decision-making. Strong sustainability requires maintenance of every kind of capital (natural, physical, social, human) so that alone, their levels are non-decreasing over time. This means that there is no substitution between categories of capital in production, and each capital's value is preserved. On the other hand, the concept of weak sustainability may be more realistic to achieve. It allows for substitution and technical progress between capital categories, as long as the value of the overall capital base (wealth) is maintained over time (Bartelmus 1994). Sustainability is better interpreted in its weak form for policy-making (Acutt and Mason 1998). However, this weak sustainability definition is a narrow conception of what sustainability should accomplish. For example, it does not take into account intragenerational concerns such as income distribution, even though this in an important aspect of sustainable development (Hanley 2000).

Sustainability has historically been applied to environmental systems, but a more holistic interpretation may be possible if sustainability is applied to economic systems (Beckley 2000). A holistic conception of sustainable development should contain three critical sub-elements: a growth element, a distributional element, and an environmental element. The growth component analyzes the productive capacity of the economy. This should also include non-market values, and depreciation of environmental assets. The distributional component tries to characterize the impacts of economic growth on poverty rates and concerns of income inequality. Finally, the environmental element contains ecological and environmental policies and ideas necessary for sustaining economic growth (Veeman 1989). Acutt and Mason (1998) remind us that we cannot aim for sustainability of all things; there must be tradeoffs between various components of human welfare. However, understanding tradeoffs requires the development and application of valuation methods that ensure the most sensible tradeoffs are being made.

The assessment of sustainability is often best accomplished with the use of indicators. Indicators attempt to simplify complex information for easier comprehension. They also quantify this information "...so significant changes or differences in the larger phenomena are more readily apparent and can be compared..." (Toman, Lile, and King 1998). In a 1995 discussion document, the UN Commission for Sustainable Development reminded governments and NGOs that Agenda 21 calls for the use of sustainable development indicators. These indicators are meant to assess sustainability in social, economic, and environmental systems. The UN wanted a consistent sustainability measure for international comparisons with the potential for individual national flexibility (Hanley 2000).

Although groups worldwide have tried to set sustainable development goals, there has been less effort in the selection and design of sustainability indicators. This is unfortunate, as the use of indicators can provide policy-makers with guidance and a measure for tracking sustainable development.

Good economic sustainability indicators are characterized by a number of criteria. First, these indicators should be normative measures, so as to adequately assess sustainability concerns. Second, they should be consistent with theoretical concepts of well-being or "economic welfare". Next, a good indicator should be linked to management or policy options. In addition, the quantitative value of these indicators should be able to be predicted or forecasted. For example, the International Institute of Sustainable Development's (IISD, 2000) list of indicator requirements suggests that indicators should be based on time-series data which reflect the need for examining trends of indicators over time. This allows one to see the direction an economy or community is heading towards. The indicators should be conducive to linkages with models for potential projections, and other hypothesis testing. Finally, sustainability indicators should be measurable at relatively low cost and reliable such that repeated measurements of the same indicator achieve the same quantitative result (IISD, 2000).

. If sustainable development is the planning goal, identification of suitable indicators is necessary for adequate policy development (Gustavson, Lonergan, and Ruitenbeek 1999). Economic systems provide the basis for identifying and measuring economic sustainability indicators. When studying economic sustainability, however, the scale of the analysis, or size of the region in question is a critical component of the sustainability assessment.

THE QUESTION OF SCALE

Within the sustainability literature, there is considerable debate on the scale at which sustainability should be assessed. Scale is an important issue in measuring economic sustainability, just as it is in biological assessment (Adamowicz 2001). Sustainability measures often differ by the sociopolitical jurisdiction focus, whether it is a country, province, or individual community. The scale of the indicator will be related to the policy or management context. Many indicators of sustainability have been developed and measured at large scales (e.g. CCFM 1997). National level policy assessment may be based best on the use of national indicators. Measurement at this macro level is adequate for general well-being assessments, but it may not identify communities in which well-being is particularly high or low. Also, linkages between forest management practices and social and economic factors will not be apparent at such large scales. Thus, some researchers advocate that a micro level approach to sustainability is more appropriate (Haynes and Mohomed 1999).

The debate over spatial scale for sustainability measures is largely rooted in the interdependencies between sociopolitical levels. Many regional and national long-term environmental, social, and economic functions are influenced by decisions made at the community level. Thus, broad concepts of sustainability stem from many smaller combined community effects. However, the community level decisions are not made within isolation of one another. Communities are often dependent on policies and events occurring beyond their borders (Toman et al. 1998). There are many environmental, social and economic linkages within a region that are necessary for each community's integrity and stability. Due to these significant interdependencies, some may argue that a region is a more accurate level at which to study and assess sustainability. It may be necessary, then, to use standardized measurements to enable comparisons between communities for aggregation up to the regional level (Force and Machlis 1997).

When further justifying scale choice, it is necessary to keep in mind that many general indicators (or indicators on a larger scale) usually lack the ability to forecast conditions into the future. If an indicator gives a good picture of current conditions, but cannot be projected or measured through time, it may not be very useful in assessing the path towards sustainability. Thus, the indicator should be able to be modeled in a dynamic analysis. An effective model depends heavily on the scale of the analytical unit. Thus, for desirable indicators that can be forecasted, scale choice should be exercised with caution. In addition, even if community level assessment is chosen as the preferred scale, the indicator data may not be supported at this level. At small micro levels, data may be hard to access, expensive, or simply may not exist. At this point, a more aggregate scale such as regional or national sustainability may have to be used for more reliable results (Gustavson et al. 1999).

CANADA'S BACKGROUND ON CRITERIA AND INDICATORS

The inception of indicators in the Canadian context was heavily influenced by innovative international work. At one of its regular meetings in 1992, the UN Conference on Environment and Development (UNCED) emphasized the importance of sustainable forest management (SFM) in furthering sustainable development. The adoption of the Statement of Forest Principles and Chapter 11 of Agenda 21 established the need for the development of criteria and indicators for the implementation of SFM. With the European countries working on their own criteria and indicators under the Helsinki Process, Canada launched its own initiative for other temperate and boreal countries. The Working Group on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests, now named the Montreal Process, was formed in 1994 to develop a set of international criteria and indicators to guide SFM. (Montreal Process Working Group 1997). These indicators would encompass the environmental, social and economic facets of Canada's forested regions. Since then, seven other international working groups for the development of criteria and indicators have evolved, all under different pressures. All 8 groups have attempted to produce criteria and indicators for the international, national, sub-national, and forest management unit levels. Due to interaction between the working groups, all agree on the fundamental criteria used as a basis for SFM (CCFM 1999).

Canada regards the Montreal Process criteria and indicators as important international policy tools to sustainably regulate and manage the world's boreal and temperate forests. However, it had already become apparent that the country needed its own national indicators specific to Canada's unique forest attributes (CCFM 1997). In 1992, the Canadian Council of Forest Ministers (CCFM) had begun the process of developing SFM criteria and indicators.

CCFM used present scientific knowledge as a basis for choosing indicators so they could be implemented at the national, sub-national, regional and local scales. The 1995 document, Defining Sustainable Forest Management: A Canadian Approach to Criteria and Indicators outlined a framework of 6 criteria and 83 corresponding indicators that attempted to capture the value and importance of Canada's forests (CCFM 1999). Due to the fact that the Montreal Process criteria and indicators were created in this same time period, the CCFM modeled their indicators to parallel those in the Montreal Process. The CCFM criteria for SFM in Canada are:

> Criterion 1: Conservation of Biological Diversity
> Criterion 2: Maintenance and Enhancement of Forest Ecosystem Condition and Productivity
> Criterion 3: Conservation of Soil and Water Resources
> Criterion 4: Forest Ecosystem Contributions to Global Ecological Cycles
> Criterion 5: Multiple Benefits of Forests to Society
> Criterion 6: Accepting Society's Responsibility for Sustainable Development
>
> - CCFM 1997

The CCFM criteria are consistent with Criteria #1-6 in the Montreal Process. The seventh Montreal Process criterion relates to the country's overall ability to facilitate SFM in conjunction with the indicators in criteria #1-6. This corresponds to some of the CCFM indicators in criteria #5 and #6. A 1996 formal comparison of the CCFM and Montreal Process frameworks indicated an 80% similarity (CCFM 1999). Whereas the Montreal Process is an international framework, the particular implementation of CCFM criteria and indicators reflects the unique nature of Canada's forests and helps to define SFM in a Canadian context (Montreal Process Liaison Office 1997). Thus, Canada partially uses the CCFM indicator framework to report on their national implementation of the Montreal Process.

The Montreal Process and CCFM criteria and indicators were both created using the best national information available at the present time with regards to SFM. However, the definition and progress towards SFM is an evolving process needing continual refinement. Both frameworks recognize the need for future revision to the criteria and indicators. Canada acknowledged that its implementation of the Montreal Process criteria and indicators would "...require continuous refinement as science evolves, public values change, and new knowledge of forest ecosystems is acquired." (Montreal Process Liaison Office 1997). This was reflected in a recent CCFM report (CCFM 1999). Due to the new scientific information and availability of data, the concept of SFM has changed, thus the CCFM felt that the indicators would most likely need to be modified as well.

The indicators of economic sustainability can be found in CCFM Criteria #5 and #6 (CCFM 1997). A CCFM Evaluation Committee (CCFM 1999) made recommendations under these criteria that are of interest to this paper, as they portray the need for new economic sustainability indicators. For example, throughout criteria #5 and #6, the committee stressed the need for augmented wealth measures like green GDP. This would permit the inclusion of non-timber values and other environmental non-market goods to give a more accurate measure of wealth (under weak sustainability). The committee also proposed that the new measures should include community characteristics such as social capital measures and unemployment levels (CCFM 1999). This could adequately expand the concept and measurement of sustainability.

The Evaluation Committee made recommendations for nearly all of the 83 environmental, social, and economic indicators of sustainability (CCFM 1999). However, the economic sustainability indicators are of the most interest for the purpose of this review. The need for more accurate economic sustainability indicators has also been suggested by a number of researchers. As each has their own opinion of sustainability and expertise in different fields, the suggested economic indicators are varied.

This paper discusses the current literature on economic sustainability. The challenge behind economic sustainability is to develop policies that support economic growth while improving environmental quality and alleviating poverty and equity concerns (Veeman 1989). . A further challenge is to utilize broader conceptions of well-being and wealth to ensure that non-market environmental components are incorporated appropriately. With economic systems, the challenge is to measure well-being, analyze the distribution of well-being, and ensure that well-being is not declining This explains why this analysis of economic sustainability is divided into four groups: (1) augmented income measures which cover the measurement of well-being, (2) equity measures which highlight distributional concerns, (3) resilience measures which help to explain how well-being in a community changes in response to shocks to its economy and (4) a group of indicators which often accompany economic indicators in studies of sustainability. All of these measures attempt to describe the sustainability of the economy or community, rather than any specific industrial sector like the forest sector or energy sector (Adamowicz 2001).

AUGMENTED INCOME MEASURES

A popular economic indicator at an aggregate level has been the Gross Domestic Product (GDP). GDP is appealing because the system of national accounts is rigorously standardized across countries, provinces, and to a lesser extent, regions. A measure of economic well-being that is frequently employed is GDP per capita. A major problem with this measure is that the system of national accounts ignores the values of unpriced environmental assets. Thus a relatively new class of economic indicators involves augmenting traditional economic measures like GDP to provide a more realistic picture of the economy. Contemporary augmented income measures are loosely separated into two categories: green national product, and genuine savings.

Green National Product

Green national product, also called green accounting, supplements indicators of economic activity with environmental assets and services. This is part of a broader development of comprehensive economic indicators. These indicators reflect the fact that economic and social welfare depends on economic activities and 'near-market' and non-market activities. Nature's Numbers: Expanding the National Economic Accounts to Include the Environment provides a review of the basic theoretical principles of green accounting (Nordhaus and Kokkelenberg 1999). It addresses the question as to whether the U.S. National Income and Product Accounts (NIPA) should be expanded to incorporate environmental and natural resource activities. Nature's Numbers reports that augmented national accounts "should be" a high priority. Ideally, the development of non-market accounts would account for the value of non-market natural resources, non-market work, environmental impacts, the use of people's time, and the investments in human capital. However, due to current knowledge and methodology, recording resource and environmental flows in satellite environmental accounts may be a more wise, realistic goal at the present time. Nature's Numbers summarizes green accounting theory with respect to subsoil mineral assets, and renewable and environmental resources. As well, it discusses the potential problems associated with valuation. In relation to forest resources, augmented accounting includes adjustments to production accounts, and forest asset accounting. Necessary adjustments to the traditional accounts include valuing the benefits and costs associated with timber income, the values of near-market forest products, contributions to household production, environmental services, and public goods (Nordhaus and Kokkelenberg 1999).

Some authors attempt to calculate green national product for the economy as a whole, while others incorporate green accounting into one facet of the economy. For example, Hultkrantz (1992) analyzed the extension of Sweden's national account of income from forest resources in 1987. He focused on the inclusion of non-marketed or partially marketed forest products and environmental stocks. The augmented measure of national forest income had 11 main components: timber production, berries, mushrooms, game, recreation, biodiversity, hydrological effects, carbon fixing, depletion of exchangeable base cations, nitrogen leaking, and reindeer forage. Hultkrantz (1992) stresses that this augmented measure must include the value of change in resource stocks in order to be a consistent measure of welfare. However, changes in asset price should not be included; the changes in resource stocks should be valued at marginal net prices. Even though information from the supply side is more readily available, Hultkrantz (1992) believes that environmental assets and services should be evaluated from the demand side. (Supply side evaluation can provide large overestimates of the true value). Cost measures from the demand side should be based on the utility derived from these costs. The Hultkrantz (1992) study uses evidence of utility in the form of environmental targets and areas where critical load levels have been exceeded. Thus, Hultkrantz (1992) is limited by his own criteria to only evaluate environmental resources whose critical load levels have been surpassed, and those which are considered environmental flow services (timber and non-timber products). Thus, this augmented national income from forest resources does not include all of the services provided by the forest, such as non-use values.

A study that incorporates economic depreciation into sustainability analysis is Tamai (2000). This author examined the sustainability of Canada's forest sector from 1970-1993 using the weak sustainability indicators of adjusted forest sector net domestic product and net investment (which is equivalent to the net savings approach). These weak sustainability measures include the appreciation or depreciation of forest resources and assets. To calculate these indicators, Tamai (2000) first estimated the economic depreciation of Canada's timber resources. These estimates were limited to the wood used for manufacturing timber; thus, there were no estimates to correct for non-market goods and services related to the forests. The author admits that the subsequent analysis of the social values associated with forest assets will understate the actual gains and losses. Although there is no consensus on how economic depreciation should be measured, Tamai (2000) chose to obtain the estimates of economic depreciation through the net price approach, and the Vincent-Hartwick approach.

The net price approach is the product of the net annual change in timber stock and the Hotelling's rent. Hotelling's rent, or the net price, represents the economic depreciation of a resource (Tamai 2000). Tamai (2000) also presented a second net price scenario that incorporated the growth stock effect into the net price calculations. Tamai (2000) found that the two net price scenarios presented almost identical results and that calculations of total timber rent (only gross annual depletion) overstated economic depreciation values compared to the net price approach.

On the other hand, the Vincent-Hartwick approach accounts for the age effect – the number of years until a forest reaches maturity. This approach values mature forests differently from immature forests, thereby accounting for the opportunity cost of letting the immature forests grow to maturity and the quality differences among the age-class distribution of the timber stocks. Economic depreciation under the Vincent-Hartwick approach is calculated as the sum of the per hectare appreciation of immature forests and the per hectare depreciation of mature forests (Tamai 2000). Due to the fact that the regulatory regimes that may limit harvests were not accounted for in the calculation of the optimal rotation ages, Tamai (2000) developed three different scenarios under the Vincent-Hartwick approach. Scenario 1 represented a situation where all existing standing timber and the capitalized forestland values were all calculated at 161 years, the oldest age-class in the sample. Scenario 2 also calculated the value of harvesting standing timber at 161 years, but determined the capitalized land site values by the estimated optimal rotation ages. Scenario 3 incorporated regeneration costs into the estimates of the land site values and the optimal rotation ages. Across all scenarios, Canada's timber resources were shown to be consistently appreciating before 1977/78, and consistently depreciating after 1982. The economic depreciation estimates under the Vincent-Hartwick approach showed that calculations of total timber rent, and even estimates under the net price approach, overstated the value of economic depreciation. This is most likely attributed to the fact that the Vincent-Hartwick approach accounts for the increasing capitalized value of immature forests (Tamai 2000). However, even though this approach may be more appropriate for measuring economic depreciation, Tamai (2000) admits it is considerably more complex.

Using the economic depreciation estimates, Tamai (2000) was able to calculate weak sustainability measures of adjusted forest sector NDP and net investment to assess the sustainability of Canada's forest sector. Adjusted net product is the sum of consumption, the change in value of natural capital, and the change in value of human-made capital (Adamowicz 2001). The adjusted forest sector NDP under the different scenarios of economic depreciation was compared to conventional domestic product (GDP and NDP) for Canada's forest industries and little difference was found during most periods of 1970-1993. The net price adjusted NDP estimates were consistently lower than conventional NDP. Adjusted NDP under the Vincent-Hartwick approach was higher than conventional NDP for most of the 1970s and in 1982/83. This difference is due to the fact that the Vincent-Hartwick calculation can show the appreciation that occurred during these time periods. Weak sustainability requires an overall non-declining capital stock assuming unlimited substitutability between natural capital and man-made capital. Although the trends are not clear, the adjusted NDP measures may narrowly suggest an upward trend, indicating sustainability (Tamai 2000).

The weak sustainability measure of net investment was also used to assess the sustainability of Canada's forest sector. In this case, net investment is calculated by subtracting the estimated value of depreciation of timber resources and man-made capital in the forest sector from the total investment in the forest sector. Net investment for the forest sector was determined by including the estimates of economic depreciation previously obtained in the analysis. Net investment calculated under the net price approach showed continuous negative investment throughout the period of 1970-1990. The Vincent-Hartwick approach resulted in net investment values fluctuating between negative and positive throughout the same time period. Although difficult to make a firm conclusion, these net investment results suggest that the Canadian forest sector was unsustainable from 1970-1993. Hence, insufficient funds were reinvested in this sector to compensate for the depreciation occurring in the forest sector (Tamai 2000).

A smaller scale attempt in this area can also be found in Gravel, Lawrance, and Ecclestone (1995). These authors provide a comparison of the present value method and the net price approach in terms of measuring the value of Ontario's timber resources. Gauthier et al.. (2000) also attempted to include forest resources in provincial accounts. This group of researchers from Laval University developed a forest resource account for the Haut-Saint-Maurice region in Quebec, Canada.

The above forest resource accounts differ in their inclusion of non-market values. However, natural resource accounts that incorporate <u>both</u> natural capital depletion and non-market values will serve as an important tool for forest management and provide an index of socioeconomic sustainability (Adamowicz 2001).

As seen above, economic depreciation requires adjustments to be made to income measures. This idea is further emphasized in Haener and Adamowicz (2000). These authors modified the net income measure within a forest resource account for a forest in northern Alberta to account for price and fire risks. These two types of risk represent potential appreciation or depreciation of forest resources. In order for net income to be a suitable indicator of sustainability, it must account for risk, which can change future net income dramatically. Haener and Adamowicz (2000) cite Brekke (1997) as stating that the uncertainty of future rents prevents a guaranteed sustained level of consumption into the future. Instead, one should strive to attain a non-declining expected value of income flows over time. Future rents can be affected by changing market and environmental conditions, which translate into many risks. However, Haener and Adamowicz (2000) only examine two possible types of risks, price and fire, as these were deemed potentially significant to the study area. As an alternative to reformulating the deterministic welfare indices relating to net income measurement, Haener and Adamowicz (2000) chose to use simulation exercises to show how risk affects sustainable income. Haener and Adamowicz (2000) used the depreciation approach and the wealth approach to calculate adjusted net income estimates using the stock changes implied by the simulations. The net income estimates under the depreciation approach fluctuated sharply over time compared to the net income generated under the wealth approach. This is due to the fact that the depreciation approach overweighs current declines in stocks, as it does not account for the forest's ability to regenerate in the future. On the other hand, the wealth approach values current stock changes by using information relating to revenue flows in the future. Thus, Haener and Adamowicz (2000) conclude that the wealth approach is more appropriate in calculating net income for renewable resources that are subject to risk. Under the wealth approach, Haener and Adamowicz (2000) also found that price risk played a more dominant role than fire risk in affecting net income estimates. The authors admit that the simulations in this study did not account for all of the necessary factors to provide exact estimates of the net income adjustments that are needed. However, their results emphasize the need to incorporate risk into net income calculations to accurately assess the sustainability of the income flows in an area (Haener and Adamowicz 2000).

In developing an augmented economic measure, Harrison (2000) took a different approach. She wanted to develop a framework that could link the economic, environmental, and social spheres of the economy. The basis of the new framework was the System of National Accounts (SNA). The SNA is a time-series framework, which is ideal when trying to evaluate concepts such as sustainability. Also, the SNA has a common numeraire of money. This is also ideal; economic alternatives are often compared through monetary channels, which in turn impact choices in the social and environmental components of the economy (Harrison 2000).

While Harrison (2000) chose a monetary framework for an augmented economic measure, Toman et al. (1998) suggests avoidance of the problems associated with monetary valuation by developing a framework based on physical flows instead. The framework proposed begins with an evaluation of the total net output of goods for resource extraction, consumption, intermediate production, and capital formation. These values are determined both inside and outside the community being examined. Total imports of natural resources, produced commodities and capital goods are also included in the framework. Total income generated by the community, and net changes in the produced capital stock are added to the above components. It is also important to account for the changes in the natural resource stocks. Similarly, environmental pollutants should also be measured for their impacts on environmental quality and ecological functions. While Toman et al. (1998) are satisfied with a framework that includes all of the above components, they admit that two problems impede its implementation. First, Input-Output models have difficulty properly accounting for the important roles played by natural resources and the environment. Second, there is a comparable lack of capability in regional environmental economics modeling. However, while this framework includes many necessary components for an adequate augmented measure, it still requires a set of criteria to evaluate the augmented framework (Toman et al. 1998). Application of a national accounting system based on physical flows that incorporates environmental concerns can be found for Norway and Denmark in Kristrom (1995).

Most researchers now agree that traditional measures of economic activity such as GDP/GNP no longer provide an adequate value of the economy. In attempting to achieve economic sustainability, new augmented measures must be utilized that incorporate environmental and even social concerns into the big picture. Inclusion of these values holds promise in producing a more accurate portrayal of the state of the economy.

Genuine Savings

Genuine savings involves measuring the creation and maintenance of wealth. Savings and investment have always played a large role in economic theory. Thus, it is surprising that the depletion of resource stocks and environmental degradation have only recently been incorporated in measuring national savings. This augmented measure of savings can be used as an economic sustainability indicator (Hamilton 2000). The calculation of genuine savings consists of investment in human capital as well as produced assets, less the value of pollutant accumulation, and depletion of natural resources. Negative genuine savings is an indication that future utility is less than current utility over time on a certain optimal path (Hamilton 2000).

Pearce and Atkinson first introduced genuine savings in 1993. Since then other researchers have adopted and expanded this concept. Some of the contributions include incorporation of technological change and appreciation of human capital, improved monetary valuation of environmental depreciation, and international trade applications (where sustainability is 'imported' or 'exported'). There are many advantages to using genuine savings as a sustainability indicator. The measure of genuine savings has a reference point; any measure below zero indicates an unsustainable path of development. Like green national product, genuine savings incorporates economic, environmental, and social concerns. Savings and conventional asset depreciation represent economic behavior, while the environmental concerns are embodied in measures of environmental depreciation and environmental damage. Social concerns are more difficult to incorporate into measures like genuine savings. However, there have been efforts to include estimates of human capital appreciation and inter-personal concern. Another important feature of genuine savings (which is lacking in other sustainability indicators) is that it allows for a detailed analysis of why sustainability may or may not exist. For example, genuine savings can report to what extent potential nonsustainability is due to excessive depreciation in environmental assets, an insufficient savings rate, or under investment in human capital. Genuine savings accounts for imports and exports and how they affect sustainability. This is also absent in most sustainability indicators (Pearce 2000).

There are some disadvantages for using genuine savings as a sustainability indicator. Pearce (2000) believes that genuine savings is merely a variant of green accounting, and he notes that green national accounting has yet to have a significant impact on policy change. He also admits that other drawbacks include that genuine savings is a weak sustainability indicator and that environmental and social assets must be valued in monetary terms (Pearce 2000).

Hamilton (2000) also stresses that a high level of genuine savings does not necessarily mean a smooth development path. For example, in Southeast Asia in 1997/98, genuine savings were positive, but many investments were yielding extremely small returns. Thus, genuine savings must not only be evaluated on the level of saving, but on the quality of investments as well (Hamilton 2000).

Since it is no longer acceptable to exclude environmental and social concerns in economic decision-making, both green national accounting and genuine savings hold promise as economic sustainability indicators. It is also important to note that when estimating augmented income or any other measure of well-being, they should be reported in per capita terms because this information can be used to determine if "well-being", on average, is increasing or declining. However, using only augmented income measures as an indicator of well-being is limiting. One reason is that these measures assume that the aggregate share of income devoted to accumulation of stocks (including unpriced assets) is optimal (see Osberg and Sharpe 2001). Income measures also ignore the influence of income distribution or economic insecurity.

EQUITY MEASURES

It is recognized that the concept of welfare depends not only on individual income measures, but also on the inequality of incomes (Osberg and Sharpe 2001). However, it is very difficult to specify the relative weights to be applied to these features of an economy to assess economic well-being. One reason is that the measurement of inequality depends on the relative value which an observer places on the utility of individuals at different point along the income distribution (Atkinson 1970). For example, a Rawlsian[1] would only gain utility by observing positive changes in the well-being of the least well off in society (i.e. the poor). For others, positive weights would be sought for income gains of the non-poor, or negative weights may be applied to inequality among the non-poor. Thus, two areas of indicators could shed some light on

[1] A Rawlsian is someone who wishes to maximize the welfare of the minimum members of society. This idea has its roots in John Rawls treatise "A Theory of Justice" (1971: Harvard Univ Press).

the issue of well-being. The first is a measure of the distribution of income or some measurement of income inequality. The second involves indicators on the extent of poverty.

Income Distribution

In assessing sustainability, it is important to account for the distributional consequences of economic activity, rather than just measuring the economic net benefits in the region (Toman et al. 1998). Communities are usually comprised of very diverse populations; as such, these economic benefits may not be equally distributed (Beckley 2000). This explains why income distribution measures are advocated as empirical measures of economic well-being. One disadvantage to using income distribution as a sustainability indicator is the fact that it is difficult to transform it into a normative measure (Adamowicz 2001). In other words, we do not have a concrete yardstick that reports how much income inequality is acceptable. However, there are still many researchers who use income distribution as a sustainability indicator. There are many different ways to measure income distribution. However, each measure has its pros and cons which make it difficult to advocate for one standardized indicator of income distribution.

In a 1995 document Ontario beyond tomorrow: ideas for building a sustainable society, the Ontario government chose average family income as one indicator for measuring the province's progress towards sustainability. (Ontario Round Table on Environment and Economy 1995). Even though this measure has been used widely in the past, several researchers have questioned the reliability of results based on average income. Krugman (1994) points out that average income masks the distribution of income within a community or region. Median income may be a more reliable distributional indicator. If a region's income increases, but the benefits flow mostly to upper income families, average income will increase, suggesting a positive benefit to the whole area. However, median income may not increase, thereby reducing false positive conclusions (Krugman 1994).

Both Beckley (2000) and Force and Machlis (1997) are advocates for the use of median income as an indicator in assessing sustainability. Median income has been examined at the community or regional level. These scales are probably the most appropriate for determining the distributional impacts from economic activity. Although median income may prove to be better than average income, concerns have been raised about its use as an adequate indicator as well. Thompson (1997) suggested that median income values could be misleading as it ignores specifics about the top and bottom incomes. Toman et al. (1998) are also concerned that median income presents only a partial picture of how the local economy affects income distribution and the well-being of the people. They argue that "...at the local level, it is important to examine the spatial decomposition of important economic flows...". For example, is the region's income high due to local economic flows or do income supports or tax breaks exist that may distort the economy's actual impact on income? (Toman et al. 1998). Despite these concerns, median income is still often used as an economic sustainability indicator.

Social Accounting Matrix (SAM) models can also depict how wealth is distributed. These models account for the interaction between the economic and social facets of the economy. Alavalapati, Adamowicz, and White (1999) used SAM models to examine the economy-wide impacts of various scenarios for the forest industry. These researchers were interested in how these simulated expansions and contractions in the forest sector would impact the distribution of income among three household income groups. SAM models were used to capture the multisectoral direct and indirect effects of the proposed changes. Alavalapati et al. (1999) found that the changes had larger impacts on the high income household group than on the low income household group. The high income group reaped more of the benefits of expansion in the forest sector, and a contraction in the forest sector hurt the high income group more than the low income group. This study further indicated through a price model that additional costs or taxes associated with environmental regulation and sustainable forest management will affect low income households more than high income households. These impacts from changes in the economy can be interpreted as shifts in the income distribution (Alavalapati et al. 1999). The distributional impacts of production changes within a region, as indicated by SAM models can also be found in Leatherman and Marcouiller (1996). The allowance of various linkages through SAM models helps in determining impacts and how they manifest in various indicators.

Another measure of income distribution is the Gini coefficient of inequality. The Gini coefficient "…measures the extent to which the distribution of income (or, in some cases, consumption expenditures) among individuals or households within an economy deviates from a perfectly equal distribution." (United Nations Development Programme 1999). The World Bank Group (2000) cites Gini's original 1912 definition as:

$$Gini = \frac{1}{2n^2 ybar} \sum_{i=1}^{n} \sum_{j=1}^{n} | y_i - y_j | \qquad [1]$$

where n = the number of individuals in the sample, ybar = the arithmetic mean income, and y_i = income of individual i, i ϵ (1,2,…,n). The Gini coefficient can take values between 0 (perfect equality) and 1 (complete inequality) (World Bank Group 2000). This single number is easy to calculate and understand and income data at any scale can be used. It also has an advantage over measures like median income in that its calculation includes the cumulative proportion of income that is earned by the cumulative proportion of the population. Thus, the Gini coefficient can detect distributional changes in the middle of the income spread as well as at either extreme (Thompson 1997). The Gini coefficient is also considered a robust measure of inequality, as it meets the desirable conditions for such a measure, including scale independence. This characteristic states that the Gini coefficient is independent of the units of measurement of income. This enables comparisons to be made across distributions (Prus 2000). For example, the 1994 Gini coefficient of after-tax income in the US (0.387) was much higher than that of Canada (0.287) suggesting that income inequality was much higher in the US than in Canada in

1994 (Osberg and Sharpe 2001). Thus, the Gini coefficient is a common indicator for income distribution and it can be set in a model context for perspective and specific interpretation.

Chevan and Stokes (2000) analyzed the effects of industrial restructuring and changing population composition on changes in the distribution of income for families between 1970 and 1990. The authors wanted to test whether de-industrialization leads to increased income inequality. Their study spanned 784 public use microdata areas and metropolitan areas. The Gini coefficient represented family income, rather than individual income, as this unit of analysis was thought to determine a person's lifestyle. Chevan and Stokes (2000) used the change in employment share across 6 sectors as an key independent variable. The authors found that decreases in the share of manufacturing in an area, and shifts in employment towards the service sector increased income inequality (Gini coefficient). Most of this increase in inequality was attributed to the shifts in income in the lower quintiles. Chevan and Stokes (2000) also found that increases in unemployment increased income inequality, while employment growth caused a decline in the Gini coefficients.

Sharpe and Zyblock (1997) also explored the relationship between unemployment and income inequality in Canada. The authors wanted to determine the impact of macroeconomic performance in Canada from 1975-1994 on family income distribution. The Gini coefficient acted as a proxy for family market income, which is income obtained before transfers. Income inequality was found to be highly dependent on the business cycle and other structural factors. A strong positive relationship was detected between unemployment rates and income inequality. Sharpe et al. (1997) concluded that roughly 1/3 of the total increase in the Gini coefficients from 1975-1994 could be attributed to increases in the unemployment rate.

The above models by Chevan et al. (2000) and Sharpe et al. (1997) offer promise in being able to predict indicators through time. This may be desirable in determining an economically sustainable path of development.

Gini coefficients have also been used as a measure of income inequality to test the Kuznets inverted-U hypothesis. This theory postulates that income inequality worsens with development until the country's economy reaches a point at which inequality begins to decline (Thornton 2001). Using comparable real GDP per capita data, income quintiles, and the Gini coefficient for 96 countries, Thornton (2001) found that the Kuznets relationship between development and income inequality did in fact exist.

When examining income distribution, Krugman (1994) cautions not to place too much emphasis on the distribution of income in any given year. This exercise may be misleading, given the issue of income mobility. As people's employment and positions change over time, so does their income. Thus, families or individuals can move up and down in the income ranking, a phenomenon known as income mobility. It is known that economic welfare is more dependent on average income earned over time than on the level of income in any given year. If the distribution of income is separated into quintiles, as it often is, income mobility would see some people moving between quintiles over time. However, even with the considerable amount of income mobility in the United States, it is not enough to make the distribution of income irrelevant. There is still a very real problem of income inequality, but the recognition of income mobility is important to assessing changes in the income distribution over time (Krugman 1994).

Poverty

Measures of poverty are increasingly being used to help characterize the economic sustainability of an area. The most popular way to capture poverty in a single measure is the poverty rate. This measures the number of people with poverty status relative to the overall population of the area. The poverty rate reflects the distribution of income; thus it can complement measures of income distribution. Together, these two equity measures produce a good indication of economic distress (Stewart, Schuster, and McGinnis 1996). The use of poverty rates as a sustainability indicator can be found in Stewart et al. (1996), Force and Machlis (1997) and others.

The poverty rate is sometimes defined a slightly different manner. For example, in Beckley's (2000) study of Canadian communities, he represented the poverty rate by the percentage of families below the poverty line. Beckley (2000) also reminds the readers that the placement of the poverty line differs according to location. Major urban centres may have higher costs of living, so the cut-off for low income may be elevated relative to smaller centres or rural areas.

In a study of counties in Montana, Haynes and Mohomed (1999) used the poverty line as a basis for their measure of the proportion of people living above the poverty line. The Ontario government chose to measure poverty as the proportion of Ontario children that live in poverty. Targeting child poverty is an attempt to build a promising future for youth who may difficulties achieving their potential while living in poverty (Ontario Round Table on Environment and Economy 1995).

The poverty rate is not the only way to measure poverty in terms of economic sustainability. Although the use of the poverty rate is supported by Berck, Costello, Fortmann, and Hoffman (2000), they were unable to obtain the rate on a monthly basis for their study in California. Therefore, as indicators of state and county level poverty, they chose to use poverty program participation levels. One such program was the Aid to Families with Dependent Children - Unemployed Parent Program (AFDC-UP). In this study about changes in employment demand, Berck et al. (2000) believed that the AFDC-UP measure was superior to the poverty rate. By definition, the AFDC-UP is available to previously employed adults. Thus, participation in the program reflects the proportion of households whose well-being is most affected by cyclical economic trends. Berck et al. (2000) also examined participation in a similar poverty program – the Aid to Families with Dependent Children Family Group (AFDC-FG). This program assisted children from single parent households. Participation in the Food Stamps program was also monitored. However, this poverty program was available to any low income households, regardless of family structure or employment history. This is one example of how poverty measures are useful when using economic models. The literature suggests that relationships (positive or negative) between unemployment, employment levels, and poverty exist at different scales (Berck et al. 2000).

At the county level, Berck et al. (2000) found that there was mixed evidence that timber employment decreases caused increases in Food Stamp program participation. As well, there was very little evidence that timber employment decreases were related to increases in either ADFC-FG or AFDC-UP program participation in the short or long run (Berck et al. 2000). The incorporation of poverty measures into models of economic sustainability allows for the characterization of these relationships and for the prediction of impacts of employment changes on poverty.

When measuring sustainability on a global scale, Hammond (2000) reports two measures commonly used to determine poverty: the incidence of extreme poverty and the poverty gap ratio. The incidence of extreme poverty is a measure of the proportion of the population living on less than $1 / day. The poverty gap refers to the total shortfall of income from the poverty line, of all of the poor in the area. The poverty gap ratio is this calculation expressed as a per person percentage (Takayama 1979).

RESILIENCE MEASURES

Another group of indicators that help characterize sustainability is those measuring resilience. Resilience refers to the notion that the economic system is not overly sensitive to shocks (prices, demands, etc). Economic resilience consists of measures of employment and income diversity among economic sectors (Horne and Haynes 1999). The most common resilience measures are the unemployment rate and different measures characterizing employment, and employment diversity. The unemployment rate is the proportion of people looking for work compared to the total labour force (Stewart et al. 1996). Employment diversity refers to balanced employment across industry sectors (Ashton and Pickens 1995).

Unemployment Rate

The unemployment rate is a popular indicator used to measure economic sustainability as it can be used at any scale. As a performance indicator, it helps to determine how resilient the economy is to changes in some or all of its sectors. Stewart et al. (1996), Ashton and Pickens (1995), Force and Machlis (1997), and others have used the unemployment rate to help quantify economic change. While economic sustainability is a multi-faceted concept, the unemployment rate can be examined in relation to other indicators to characterize the sustainability of an area. The interaction between equity and resilience measures is seen in Berck et al. (2000). These authors report that substantial literature has found positive relationships between unemployment and both poverty program participation and poverty rates at the state and national levels.

Furthermore, in Gustavson et al. (1999), multi-variate correlation studies were used to determine the relationships between various sustainability indicators. While these various linkages are important to understanding economic sustainability overall, the unemployment rate fares well on its own as a single measure of economic resilience. However, when using unemployment as an economic sustainability indicator, it is important to recognize some of the disadvantages as well. Due to the nature of its calculation, the unemployment rate will not include involuntary part-time workers, underemployed workers, or discouraged workers who are no longer in the labour force. In addition when examining economic sustainability at the community level, the unemployment rate may disguise economic distress if previously unemployed workers have moved elsewhere to find work (Stewart et al. 1996). Unemployment can be reported monthly, but some authors choose to report this measure as an annual average to reduce seasonal effects.

Employment

Depending on the type of analysis being performed, there can be many components to the employment indicator when it is used to measure economic sustainability. All facets of this indicator are meant to complement other resilience measures in determining the response to economic changes. Hillier (2000) used the employment rate (instead of the unemployment rate) as a sustainability indicator for the United Kingdom. This measure is reported as the percentage of workers relative to the total population of working age. The employment rate is a common measure as it helps to determine what proportion of people have an increased ability to improve their living standards and meet their needs. This resilience measure also gives the government (at any level) an indication of where assistance could be useful. Public policy that increases employment opportunities is an important step to improving social exclusion, poverty, and decreasing dependence on welfare (Hillier 2000).

Many authors use employment alone or in conjunction with other variables to capture an area's employment picture. Note that this employment measure is based on the economy as a whole, rather than the level of employment in a particular sector. Haynes and Mohomed (1996) used the employment rate and the female labour force participation rate as two indicators of county well-being in Montana. The use of these indicators can be explained by the fact that trends are easy to report due to their sensitivity to change and regular reporting periods (Beckley 2000). In Beckley's (2000) study of nine Canadian communities, he chose indicators that included overall employment, labour force participation, the percentage of people with full & part-time employment, and the gendered divisions of labour within local markets.

Some researchers choose to use a slightly different employment measure by focusing on employment in a particular sector. In a study by Ashton and Pickens (1995) that measured rural towns' dependence on USDA Forest Service programs, the authors chose resource use employment (RUE), and direct Forest Service employment as indicators. In attempting to model sustainable development indicators in the Fraser River Basin, BC, Gustavson et al. (1999) included measures of the total employed labour force and the proportion of those employed in resource industries. Force and Machlis (1997) also chose employment-type indicators to assess socioeconomic conditions in the Upper Columbia River Basin. These authors used resource-related employment, women in the labour force, employment terms, work days (to capture seasonal employment), and the proportion of the labour force working in professional employment. Hardy Stevenson and Associates (1996) used the percentage of seasonal jobs, employment in the forest products industry and in other basic industries, employment in non-basic industries, and the changes in labour mobility as resilience measures. The firm tried to capture the impact of changes in timber harvest in Ontario (Hardy Stevenson and Associates 1996). Furthermore, a study by Berck et al. (2000) attempted to determine the impact decreased forestry employment had on the communities in the area. These authors used timber and non-timber employment to differentiate changes in sector composition. However, due to data constraints, timber employment only included employment in wood products and lumber industries. Berck et al. (2000) also used total monthly state employment as a proxy for output of goods and services. They felt that the inclusion of this indicator was important due to its integral role in determining demand for employment at the state and county levels.

In many of the studies above, employment in a certain sector, such as the forest industry, was used as an economic sustainability indicator. However, this may portray an inaccurate picture of employment overall. For example, in the forest sector, technical change will inevitably reduce the number of jobs available in this sector, but this does not necessarily translate into reduced employment in the overall economy. As Krugman (1998) states "…the effect of a productivity increase <u>in a given industry</u> on the number of jobs <u>in that industry</u> is very different from the effect of a productivity increase in <u>the economy as a whole</u> on the <u>total</u> number of jobs." It is agreed upon that a shift in the industrial structure of employment may occur as a result of technical change. However, this does not mean there has to be a net loss in the number of jobs. The explanation of this can be tied back to ever-increasing consumer demand. The United States has observed that productivity gains in one sector often lead to increased employment in other sectors. If these other sectors do not experience the same magnitude of technical change, employment here will increase to accommodate increased consumer demands for products and services. If production can increase by adding more workers, it will likely increase employment (Krugman 1998). This evidence decreases the credibility of using sector-specific employment as a measure of economic sustainability. According to Krugman's (1998) theory, sector-specific employment would give the wrong signal to policy-makers.

Employment Diversity

Employment diversification plays a relatively large role in economic development, especially in smaller communities. As mentioned above, employment diversity refers to the mix of employment across sectors. It can be stated with some certainty that "…counties with high employment diversity are better able to cope with changing economic conditions than less diverse counties over time." (Ashton and Pickens 1995). Resilience can be measured according to the employment diversity index (Horne and Haynes 1999). This index can be calculated using industrial employment or earnings. The Shannon-Weaver entropy index procedure is commonly used as the vehicle for this calculation (Stewart et al. 1996). In a study of small, resource-dependent communities in the U.S., Ashton and Pickens (1995) used variables such as existing industries, the value of production and employment by each industry, and total employment and unemployment to partially calculate this index. Ashton and Pickens (1995) also identified the variables that quantified economic change, which may influence changes in employment diversity. Due to uncertainty as to what affects employment diversity, 44 causal variables were identified. These included changes in employment, unemployment, and changes in jobs by sector. The study concluded that diverse economies tended to have more constant levels of employment over time in each sector. They also found that even with stable resource related employment in a county, an absence of jobs in other sectors classified the economy as less diverse. This made these counties more vulnerable to changes in the economy. Ashton and Pickens (1995) also discovered that short-term economic change had little impact on the employment diversity unless the short-term changes took place in smaller sectors of the economy. In terms of measuring sustainability, high employment diversity is sometimes thought to be indicative of higher resilience of the area in relation to economic shocks (Stewart et al. 1996).

However, like many economic sustainability indicators, employment diversity is not without faults. For example, a study done by Attaran in 1986 showed only a weak relationship between diverse economies and less unemployment. Overall, the study concluded that there was only very weak support for the claim that employment diversity leads to more resilient communities. However, as mentioned above, Attaran stresses that the industrial mix in the region is more crucial than the level of diversity. For example, in forest-dependent communities, industries that follow different business cycle trends as those driving the wood product industry should be encouraged more than industries whose trends are similar (Ashton and Pickens 1995). Diversity <u>is</u> important in relation to technical change. Technical change affects individual sectors differently, thus diversity would help to balance employment expansions or contractions among the different sectors.

SUPPLEMENTARY INDICATORS OF INTEREST

While this paper has focussed on economic sustainability indicators, it is worth noting that there are a number of indicators used to define sustainability that are related to economic indicators; however these supplementary indicators are measured in different ways. For example, Beckley and Burkosky (1999) cited Kusel's attempt to create an aggregate measure of community capacity. This term refers to the measurement of community well-being as a whole and represents the potential for creating opportunities and improving well-being. In addition to measuring physical capital, Kusel also included human and social capital. Human capital refers to the education, skills, and experiences of the citizens, while social capital is the willingness and abilities of the residents to collectively work towards community goals. Kusel combined subjective and objective assessments, making this measure of community capacity appealing for multidimensional sustainability monitoring (Beckley and Burkosky 1999). Human capital was also used by Beckley (2000) in his study of community sustainability. However, Beckley admits that human capital is difficult to measure. Statistics Canada only reports educational attainment, which omits many other aspects of human capital such as on-the-job training (Beckley 2000).

In measuring socioeconomic well-being in Montana counties, Haynes and Mohomed (1999) included a variety of social sustainability indicators, which are listed in Appendix 1. Even though both social and economic indicators are used to measure sustainability, economic well-being and social well-being do not always move in tandem. For example, the Index of Social Health in the United States declined steadily from 1973-1995, yet GDP grew each year in this time period (Haynes and Mohomed 1999).

A study by Force and Machlis (1997) compiled a list of social indicators to use in an assessment of ecosystem management in the Upper Columbia River Basin. While a few resilience and equity indicators were included, a large majority of indicators were social indicators. These can be found in Appendix 1.

The appendix also lists many other sustainability studies that combine economic indicators with other social and ecological indicators of interest. These studies vary in scale, from local sustainability, to national or global scales. Reporting on these indicators can indicate if a community or country is on the right path of development. It also enables identification of areas where corrective action may be required (Hammond 2000).

Aside from supplementary indicators of interest in relation to economic sustainability, one last measure of economic progress is worth noting. The Genuine Progress Indicator (GPI) is suggested as a measure of progress towards economic sustainability. The idea behind the GPI suggests that the conventional GDP measure should be augmented with various social and environmental costs and benefits to give a more holistic value of the economy. The GPI includes 20 categories that traditional measures of GDP ignores. These categories include things such as loss of leisure, environmental degradation, crime, and the value of the household economy. Even though valuation of these added costs is varied and sometimes crude, advocates of the GPI feel that this valuation is better than excluding them altogether (Cobb, Halstead, and Rowe 1995). The GPI is criticized by some for its composition as an aggregate index. There may exist more problems with using a composite index, rather than single economic sustainability indicators.

CONCLUSION

From the studies surveyed, there are a wide variety of indicators used in attempts to quantify sustainability. However, in order to be a useful indicator, it needs to be measurable (for a reasonable cost), normative and quantitative. A good indicator should also be able to forecast conditions into the future. In addition to all these criteria, the indicators chosen should be responsive and “forecastable” to changes in different management strategies and public policy, so they can reflect how economic changes affect sustainability concerns. This in turn, requires that the indicator reflect the theory behind the concepts of well-being or "economic welfare".

A challenge for social researchers is to link sociological indicators with ecological and other variables. "To date such linkages have been weak, in part because there is so much statistical 'noise' going on in models that attempt to quantify community sustainability" (Beckley 2000). It is important to keep in mind that social indicators themselves do not provide an indication as to why conditions may be changing. Social indicators are best used in the creation of a baseline description with which continued collection can identify trends that can be monitored (Force and Machlis 1997). Combining social indicators with economic sustainability indicators only enhances their power.

One of the key conclusions arising from this review is that economic sustainability should be evaluated for the economic unit (community, region, province, etc.) and not for a particular industrial sector (forestry, agriculture, etc.). Just as ecological sustainability indicators should take into account disturbances from various sectors (energy, forestry, etc.), so should economic indicators assess overall economic condition. This concept, however, raises challenges for sustainable forest management. It is possible that one sector (the forestry sector for example) attempts to make management changes to improve economic sustainability but that these changes are counteracted by changes in other industrial sectors or by factors arising outside of the region. A single industry or sector should not be responsible for achieving sustainability when other agents are also influencing economic conditions. In order to truly evaluate economic well being, however, this economy-wide perspective is important, and other sectoral measures may provide misleading information regarding economic sustainability.

Another challenge in the use of indicators will be the availability of suitable information with which to calculate or describe the indicator of interest. For example, indexes such as augmented income measures require information on non-market values. To address local or regional levels of sustainability, data would be required at the local or regional level. These information requirements rarely, if ever, are met. This points to the need to allocate sufficient financial and labour resources to generate the necessary information and to continue to generate this information to allow examination of temporal trends. This lack of information may be one of the reasons why so few regional studies of economic sustainability exist.

On the other hand, there are existing databases in Canada that meet some of the requirements for economic sustainability indicators. For example, the national census is one source of information at a disaggregate level that with some reorganization of the information, may prove useful in understanding some of the economic dimensions of sustainability. Since the census is a recurring data collection exercise, it meets some of the requirements for generating trends of indicators. This database could be particularly useful in generating indicators relating to inequality (e.g. income distribution). Much of the census information, however, is not available at the individual level, and adjustments will have to be made to generate useable information. This points to the fact that tradeoffs exist between data accessibility and the usefulness of the indicators or measures that result from using inadequate data.

REFERENCES

Acutt, Melinda, and Pamela Mason (eds.). 1998. *Environmental Valuation, Economic Policy and Sustainability*. Edward Elgar Publishing Inc. Northampton, Massachusetts, USA.

Adamowicz, W.L. 2001. *Indicators of 'Economic Sustainability'*. Presentation at "Integrating Socio-economic and Ecological Indicators of Sustainability: Bridging Boundaries between Groups and Fields of Expertise" conference held February 11-13, 2001, Trois-Rivieres, Quebec.

Alavalapati, J.R.R., Adamowicz, W.L., and W.A. White. 1999. Distributive Impacts of Forest Resource Policies in Alberta. *Forest Science* 45(3): 342-348.

Ashton, P.G., and J.B. Pickens. 1995. Employment Diversity and Economic Performance in Small, Resource-Dependent Communities near Western National Forests. *Society & Natural Resources* 8: 231-241.

Atkinson, A.B. 1970. On the measurement of inequality. *Journal of Economic Theory* 2(3): 244-263.

Bartelmus, Peter. 1994. *Environment, Growth, and Development: The Concepts and Strategies of Sustainability*. Routledge. New York, NY, USA.

Beckley, T.M. 2000. *Sustainability for Whom? Social Indicators for Forest-dependent Communities in Canada*. Sustainable Forest Management Network Final Project Report 2000-34.

Beckley, T.M., and T.M. Burkosky. 1999. *Social Indicator Approaches to Assessing and Monitoring Forest Community Sustainability*. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-360.

Bell, Simon and Stephen Morse. 1999. *Sustainability Indicators: Measuring the Immeasurable*. Earthscan Publications Ltd. London, England, UK.

Berck, Peter, Costello, Christopher, Fortmann, Louise, and Sandra Hoffman. 2000. *Poverty and Employment in Timber-Dependent Counties*. Resources for the Future Discussion Paper 00-52. [online]. Available: http://www.rff.org/nat_resources/forests.htm

Canadian Council of Forest Ministers. 1997. *Criteria and Indicators of Sustainable Forest Management in Canada: Technical Report*. Cat. Fo75-3/6-1997E.

Canadian Council of Forest Ministers. 1999. *Reevaluation of the 83 Indicators in the CCFM Framework of Criteria and Indicators of Sustainable Forest Management in Canada: Report of the C&I Evaluation Committee to the CCFM C&I Task Force.* (August, 1999 Draft).

Chevan, A., and R. Stokes. 2000. Growth in Family Income Inequality, 1970-1990: Industrial Restructuring and Demographic Change. *Demography* 37(3): 365-380.

Cobb, C., Halstead, T., and J. Rowe. 1995. If the GDP is Up, Why is America So Down? *Atlantic Monthly* 276(4): 59-78.

Force, J. E., and G.R. Machlis. 1997. The Human Ecosystem Part II: Social Indicators in Ecosystem Management. *Society & Natural Resources* 10: 369-382.

Gauthier, Caroline C., Saphores, Jean-Daniel M., and Luc Bouthillier. 2000. *Conception D'Un Système De Comptabilité Verte Pour Une Économie Dépendante De La Forêt: Application à la Region du Haut-Saint-Maurice*. Département d'Économie et GREEN, Université Laval, Ste Foy, Québec.

Gravel, G., Lawrance, G., and S. Ecclestone. 1995. Valuing Ontario's Timber Resource Stock. pp. 47-54 In *Environmental Perspectives: Studies and Statistics*. Statistics Canada – Cat. No. 11-528E, no. 2.

Gustavson, K.R., Lonergan, S.C., and H.J. Ruitenbeek. 1999. Selection and modeling of sustainable development indicators: a case study of the Fraser River Basin, British Columbia. *Ecological Economics* 28: 117-132.

Haener, M.K., and V.L. Adamowicz. 2000. Incorporation of Risk in Regional Forest Resource Accounts. *Ecological Economics* 33: 439-455.

Hamilton, Kirk. 2000. Genuine Saving as a Sustainability Indicator. pp. 65-77 In *OECD Proceedings: Frameworks to Measure Sustainable Development, An OECD Expert Workshop*, September 2-3, 1999, Paris, France. Paris, France: OECD.

Hammond, Brian. 2000. Measuring Development Progress: A Working Set of Core Indicators. pp. 117-123 In *OECD Proceedings: Frameworks to Measure Sustainable Development, An OECD Expert Workshop*, September 2-3, 1999, Paris, France. Paris, France: OECD.

Hanley, N. 2000. Macroeconomic Measures of Sustainability. *Journal of Economic Surveys* 14(1): 1-30.

Hardy Stevenson and Associates Ltd. 1996. *Timber Supply and Community Socio-Economic Sustainability in Ontario*. Submitted to the Forest Resource Assessment Project, Ministry of Natural Resources.

Harrison, Anne. 2000. A Framework for Measuring Sustainable Development. pp. 19-28 In *OECD Proceedings: Frameworks to Measure Sustainable Development, An OECD Expert Workshop*, September 2-3, 1999, Paris, France. Paris, France: OECD.

Haynes, D.C., and A. Mohomed. 1999. Social and Economic Indicators for Montana Counties. *Consumer Interests Annual* 45: 27-32.

Hillier, Hillary. 2000. Headline Indicators of Sustainable Development in the United Kingdom. pp.105-115 In *OECD Proceedings: Frameworks to Measure Sustainable Development, An OECD Expert Workshop*, September 2-3, 1999, Paris, France. Paris, France: OECD.

Horne, Amy L., and Richard W. Haynes. 1999. *Developing Measures of Socioeconomic Resiliency in the Interior Columbia Basin*. Gen. Tech. Rep. PNW-GTR-453. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Hultkrantz, L. 1992. National Account of Timber and Forest Environmental Resources in Sweden. *Environmental and Resource Economics* 2: 283-305.

International Institute of Sustainable Development. 2000. *Measurement and Indicators for Sustainable Development.* [online]. Available: http://www.iisd.org/measure/faqcriteria.htm

Kriström, Bengt. 1995. Accounting for the Environment in Scandinavia. pp. 155-168 In J. Walter Milon and Jason F. Shogren (eds.) *Integrating Economic and Ecological Indicators: Practicing Methods for Environmental Policy Analysis*. Praeger Publishers, Westport, Connecticut, USA.

Krugman, Paul. 1994. *Peddling Prosperity*. W.W.Norton & Company. New York, NY, USA.

Krugman, Paul. 1998. *The Accidental Theorist*. W.W.Norton & Company. New York, NY, USA.

Leatherman, J.C., and D.W. Marcouiller. 1996. Persistent Poverty and Natural Resource Dependence: Rural Development Policy Analysis that Incorporates Income Distribution. *Journal of Regional Analysis and Policy* 26(2): 73-93.

Montréal Process Liaison Office. 1997. *Canada's Report on the Montréal Process Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests*. Cat. No.: Fo42-238/1-1997E.

Montréal Process Working Group. 1997. *The Montréal Process Progress Report: Progress on Implementation of the Montreal Process on Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests*.

Nordhaus, William D., and Edward C. Kokkelenberg (eds). 1999. *Nature's Numbers*. National Academy Press. Washington, D.C., USA.

Ontario Round Table on Environment and Economy. 1995. *Ontario Beyond Tomorrow: Ideas for Building a Sustainable Society*. Ont. Round Table Environ. Econ., Toronto, Ontario.

Osberg, L. and A. Sharpe. 2001. *The index of economic well-being: An overview.* Paper presented at the National Conference on Sustainable Development Indicators, National Round Table on the Environment and Economy, March 27, 2001, Ottawa, ON. [online]. Available: http://www.csls.ca

Pearce, David. 2000. The Policy Relevance and Uses of Aggregate Indicators: Genuine Savings. pp. 79-82 In *OECD Proceedings: Frameworks to Measure Sustainable Development, An OECD Expert Workshop*, September 2-3, 1999, Paris, France. Paris, France: OECD.

Pezzey, J. 1992. Sustainability: An Interdisciplinary Guide. *Environmental Values* 1: 321-362.

Prus, S.G. 2000. Income Inequality as a Canadian Cohort Ages: An Analysis of the Later Life Course. *Research on Aging* 22(3): 211-237.

Sharpe, A., and M. Zyblock. 1997. Macroeconomic Performance and Income Distribution in Canada. *North American Journal of Economics & Finance* 8(2): 167-199.

Solow, Robert. 1992. *An Almost Practical Step Toward Sustainability*. Paper presented on the Occasion of the Fortieth Anniversary of Resources for the Future, Washington, D.C., USA.

Stewart, Walter L., Schuster, Ervin G., and Wendy J. McGinnis. 1996. *Economic Indicator Maps for Rural Development in the East*. Gen. Tech. Rep. INT-GTR-329. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Takayama, N. 1979. Poverty, Income, Inequality, and Their Measures: Professor Sen's Axiomatic Approach Reconsidered. *Econometrica* 47(3): 747-760.

Tamai, Satoshi. 2000. *Sustainability of Canada's Forest Sector: Estimating Economic Depreciation of Canada's Timber Resources*. Master's thesis. University of Alberta. Edmonton, Alberta.

Thompson, J.J. 1997. A Tool for Measuring Income Inequality. *Nieman Reports* 51(1): 42-43.

Thornton, J. 2001. The Kuznets Inverted-U Hypothesis: Panel Data Evidence from 96 Countries. *Applied Economics Letters* 8: 15-16.

Toman, Michael A., Lile, Ronald, and Dennis King. 1998. *Assessing Sustainability: Some Conceptual and Empirical Challenges*. Resources for the Future Discussion Paper 98-42. [online]. Available: http://www.rff.org/disc_papers/1998.html

United Nations Development Programme. 1999. *Human Development 1999*. Oxford University Press. New York, NY, USA.

Veeman, T.S. 1989. Sustainable Development: Its Economic Meaning and Policy Implications. *Canadian Journal of Agricultural Economics* 37: 875-886.

World Bank Group. 2000. *Inequality, Poverty, and Socio-economic Performance*. [online]. Available: http://www.worldbank.org/wbp/inequal/methods/measure.htm

APPENDIX 1 – ECONOMIC SUSTAINABILITY INDICATOR SUMMARY CHART

			AUTHOR	
Indicator Measure	**Hanley (2000)**	**Haynes *et al* (1999)**	**Vanhoudt (2000)**	**Hanson *et al* (1997)**
Augmented Income	• Environmentally Adjusted NNP • Genuine Savings • Constant natural capital			
Equity		• Per capita income • % of persons above the poverty line	• Income inequality (Gini coefficient)	• Income inequality (Gini coefficient)
Resilience		• Employment rate • Female labour force participation rate		
Supplementary Indicators of Interest		• % of college grads • Teen pregnancy • Infant mortality • Dependency ratio • Housing w/plumbing		

			AUTHOR	
Indicator Measure	**Hultkrantz (1992)**	**Gustavson *et al* (1999)**	**Daniels *et al* (1991)**	**Berck (2000)**
Augmented Income	• Extension of national accounts to include forest resources	• Population (for per capita measures)		
Equity		• Gini coefficient	• Wood products wage income • Total wage income • Factor payments remaining in the community	• Poverty (welfare caseloads) • Food stamp program participation
Resilience		• Total employed labour force • Total labour force • Proportion employed in resource industries • Unemployment rate	• Wood products employment • Total employment	• Unemployment rate • Timber & non-timber employment • Total state employment
Supplementary Indicators of Interest		• Urban partition • Crime rate • Net in-migration rate • Per capita value added from manufacturing • Bankruptcy rate • Religious diversity index[1]		

[1] Additional indicators from Gustavson *et al* (1999): Respiratory disease rate, Cancer rate, Live Birth rate, Age standardized mortality rate of death by external cause, Proportion of 15+ pop'n with some university education, Per capita water consumption, Ethnic diversity index, Proportion connected to the water supply, Ratio of forest land area planted to harvested, Ratio of timber area billed to area harvested, Total area of cropland.

			AUTHOR	
Indicator Measure	**Toman *et al* (1998)**	**Leatherman *et al* (1996)**	**Hamilton (2000)**	**Pearce (2000)**
Augmented Income	• Resource account (based on physical flows) • Gross & net product • Savings rate		• Genuine savings	• Green accounting • Genuine savings
Equity	• Median income • Income distribution (changes in educational achievement coupled w/trends in sectoral activity)	• Income distribution (household groups – low, medium, high)		
Resilience	• Unemployment rate • Economic diversity (sectoral growth, changes in regional activity)			
Supplementary Indicators of Interest	• Infant mortality • School violence			

			AUTHOR	
Indicator Measure	**Harrison (2000)**	**Force *et al* (1997)**	**Beckley (1995)**	**Ashton *et al* (1995)**
Augmented Income	• Augmented System of National Accounts	• Local gov't finances • Material production • Agricultural product • Total population • Total industry earnings		
Equity		• Median household income • Poverty rate	• Income • Poverty	
Resilience		• Unemployment • Resource related employment • % professional & skilled employment • Work days (seasonal workers)	• Employment	• Employment diversity • Employment (absolute & % change) • Employment change • Unemployment
Supplementary Indicators of Interest		• % occupied housing heated w/wood • % federal land • Pop'n density on non-federal land • Library loans • Rural pop'n[2]	• Quality of employment • Social cohesion • Local empowerment	• Population

[2] Additional indicators for Force *et al* (1997): Value of bank deposits, Votes by political party, Major religion of family, Infant mortality, Physicians, Law enforcement, Religious adherents, High school graduates, Voting rate, Irrigated land, Median age, Dependency ratio, Women in labour force, Sex ratio, Ethnic/racial composition, Household composition, Crime, Divorce rate, Elected positions, College graduates, Elderly pop'n, Home ownership.

			AUTHOR	
Indicator Measure	**Hillier (2000)**	**Horne *et al* (1999)**	**Tamai (2000)**	**Alavalapati *et al* (1999)**
Augmented Income	• Investment (total & social)		• Adjusted forest sector NDP (incorporation of economic depreciation of timber stock)	
Equity		• Income among economic sectors		• Income distribution (SAM models)
Resilience	• Employment	• Diversity of employment		
Supplementary Indicators of Interest	• Educational qualifications • Avg life expectancy • Housing quality • Crime • Emissions of GHGs • Air Pollution • Road traffic • River quality • Bird pop'n • Land re-use after development • Waste	• Pop'n density • Lifestyle diversity (education, affluence, family life cycle, mobility, race, ethnicity, degree of urbanization)		

			AUTHOR	
Indicator Measure	**Hammond (2000)**	**Haener *et al* (2000)**	**Gauthier *et al* (2000)**	**Chevan *et al* (2000)**
Augmented Income	• GNP per capita • Aid (% of GNP) • External debt (% of GNP) • Investment (% of GNP) • Trade (% of GNP)	• Net income with price and fire risk	• Green accounting	
Equity	• % pop'n below poverty line • Poverty gap ratio • Inequality (poorest 5th share of national consumption)			• Income inequality (Gini coefficient)
Resilience				
Supplementary Indicators of Interest	• Child malnutrition • Net enrolment in primary education • Completion of 4th grade literacy rate • Ratio of girls to boys in primary & secondary education[3]			

[3] Additional indicators from Hammond (2000): Ratio of literate females to males, Infant mortality rate, Under 5 mortality rate, Maternal mortality ratio, Births attended by skilled personnel, Contraceptive prevalence rate, HIV prevalence in 15-24 yr old pregnant women, Total fertility rate, Pop'n w/access to safe water, Intensity of freshwater use, Land area protected, Carbon dioxide emissions, Energy emissions, Life expectancy at birth.

			AUTHOR	
Indicator Measure	**Beckley (2000)**	**Stewart *et al* (1996)**	**Hardy Stevenson & Associates Ltd (1996)**	**Sharpe *et al* (1997)**
Augmented Income	• Population (for per capita measures)			
Equity	• Median income • Income distribution across gender • Poverty rate	• Per capita income • Poverty rate		• Income inequality (Gini coefficient)
Resilience	• Employment • Unemployment • Labour force participation • Gendered divisions of labour w/in local labour markets • % of people w/full & part-time employment • Real estate values & housing costs	• Unemployment • Direct "wildland industry" dependency • Economic diversity • Timber dependency • Recreation dependency • "Wildland industry" earnings change	• Economic base • Employment & labour mobility • Strength and diversity of local and regional economy • Housing prices	• Unemployment rate
Supplementary Indicators of Interest	• Education	• Rural population • Net migration	• Pop'n (median age) • Local finances & services • Lifestyle • Culture and intrinsic values[4]	

[4] Additional indicators for Hardy Stevenson and Associates Ltd. (1996): Community social institutions, Local gov't and leadership, Provincial and regional timber demand trends, Forest products industry characteristics, Local/district timber supply and resource management.

		AUTHOR	
Indicator Measure	**Thornton (2001)**	**Cobb *et al* (1995)**	**Government of Alberta (2001)**
Augmented Income			• Gross Domestic Product • Resource sustainability (non-renewable resource reserves, timber harvest below AAC, Land productivity
Equity	• Income inequality (Gini coefficient)		• Family income distribution (LICO) • Albertans needing help • Children in families above LICO
Resilience			• Job growth
Supplementary Indicators of Interest		• Genuine Progress Indicator	• Life expectancy at birth • Health status • Educational attainment • Literacy levels • Skill development • Business innovation[5]

[5] Additional indicators for Gov't of Alberta (2001): Value-added industries, Infrastructure capacity, Gov't spending, Taxation load, Provincial credit rating, Net debt, Workplace climate, Export trade, Crime rate, Air quality, Water quality, Land quality, Heritage appreciation, Intergovernmental relations.