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Estimating the Genuine Progress Indicator (GPI) for Baltimore, MD

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ESTIMATING THE GENUINE PROGRESS INDICATOR (GPI) FOR BALTIMORE, MD

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ABSTRACT

In order to better manage progress toward improved human welfare, governments and organizations around the world have begun to report on more comprehensive indicators of environmental, social, and economic conditions. The Genuine Progress Indicator (GPI) has proven useful as a measure of economic welfare by incorporating changes in environmental conditions, resource stocks, social capital, income distribution, and other non-marketed economic activity. Studies at the local scale have also found the GPI to be an effective tool for informing debate and stimulating questions about the nature of the economic development process. In this study, the GPI methodology is applied to Baltimore City, Baltimore County, and Maryland in order to explore how sustainable economic welfare in the Baltimore region has changed from 1950-2005. A comparison among per capita GPI trends in four US cities shows Baltimore to have the highest average annual growth rate over the study period. Comparisons are made between per capita GPI and Gross Domestic Product (GDP), the most widely recognized measure of national economic performance. Analysis of the trends at all three scales show that GDP growth does not correlate well with changes in welfare as measure by GPI. This implies that Baltimore City, Baltimore County, and Maryland could be in a period of uneconomic growth, when the social and environmental costs of further economic growth outweigh the benefits of such growth.

However, the underlying methods used in sub-national applications of the GPI inevitably lead toward certain results, giving rise to an indicator framework that favors particular policy and development outcomes. This situation is defined as indicator bias. Since indicator bias can inadvertently lead society toward undesirable conditions, key assumptions that contribute to indicator bias in the GPI are tested for how they influence the final GPI results. The costs of crime, long-term environmental damage, and depletion of non-renewable natural resources categories are explored in more depth. GPI is found to be an imperfect measure of true progress, but it is believed to be an improvement over GDP for guiding modern society towards a more sustainable and desirable future. More work is needed to incorporate uncertainty, fine-tune the underlying GPI methodology, and build broad consensus about how to measure economic performance and social progress. By providing information about social, ecological, and economic conditions of the region, though, the Baltimore GPI does inform citizens and decision-makers about a wide range of impacts resulting from the modern ‘GDP growth’ paradigm.

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In loving memory of sister Melissa Laren Posner.

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Chapter 1 reviews relevant trends in thought about ecological economics, sustainable development, and indicators. The conceptual underpinnings, general background information, and the importance of indicators are described below, before more specific ideas about particular indicators are presented in Chapter 2.

1.1 Concepts of Progress

Societal definitions of progress are significant for several reasons. Definitions of progress determine how a group views itself with respect to the past, present, and future; provide guidance for a group towards some future desirable state; and determine the collective efforts that communities undertake in the name of progress (Itay, 2009). In modern society, a narrowly-defined form of economic progress dominates discussions of how humanity can best develop toward a higher state. This thesis addresses the ways in which the widespread misuse of indicator systems guides society's collective efforts toward a specious form of progress. First, a brief revival of philosophy and morality in economics is used to build an understanding of the evolution of thought about concepts of progress.

Early notions of progress stemmed from ideas about humanity moving from the past, through the present, and into the future. Belief that human history has a direction toward some meaningful purpose inspired descriptions of progress (Anderson, 1991). While education and the gathering of knowledge were recognized in ancient times as important aspects of progress, it wasn't until the Enlightenment in the 18th century that progress was stated as an explicit goal, with important consequences for the development of modern society (Itay, 2007).

At around that time, ideas about how society makes progress began to evolve in a particular direction. In The Wealth of Nations (1776), Adam Smith identified progress with economic development, describing four stages of historical progress: hunting, pasturing, farming, and commercial society. In Sketch for a Historical Picture of the Progress of the Human Mind (1795), Condorcet linked progress and optimism about future conditions to advances in technology, science, and industry. This time period, marked by rapid economic and industrial change, inspired many to ponder the nature of such developments and the implications for human progress.

The discourse of economics in the following years focused less on moral evaluations and more upon scientific inquiry and quantitative models for how the world works. Rather than focusing on human relationships and experiences, discussions of progress began to concentrate on measurable economic development. In modern times, this trend has continued to the point where the measurement of a particular form of economic growth has eclipsed other forms of progress (Anderson, 1991). The dominant theory of progress today views economic growth (i.e. growth in the value of economic output) as the source of progress and economic indicators as the tools to measure the progress of societies (Itay, 2009).

The narrow interpretation of economic growth as representative of general societal progress causes serious problems. Most importantly, the connection between economic growth and other forms of progress is not necessarily complementary. In fact, high economic growth rates are often achieved at the expense of other forms of progress. In numerous cases, social and environmental costs are incurred as a direct result of the pursuit of economic growth. The pursuit of measured economic growth is not set within the human, social and, environmental contexts for progress, yet this growth is still accepted as the primary way to make progress. Placing the dialogue about indicators within a larger context of the historical and philosophical debate about 'progress' provides perspective to the current fixation with economic growth (Anderson, 1991).

1.2 Sustainable Development

Effective measurement of human welfare and environmental conditions is considered an essential part of achieving sustainable development – development that improves the quality of human life while staying within the carrying capacity of the supporting ecosystems (Costanza et al. 2009). As a result, governments and organizations around the world have begun to measure progress in the context of a broader, more comprehensive understanding of well-being that includes environmental, social, and economic components. This effort to monitor changes in environmental, social, and economic conditions is ultimately aimed at better management of progress towards improved human welfare (Bohringer and Jochem, 2007).

Manfred Max-Neef (1992) developed a non-hierarchical matrix of human needs that presents the dynamic relationships among needs. This framework moves beyond the historical focus of development on the value of having, to include needs that are existential (needs for doing and interacting) and axiological (needs for participation and freedom) (Daly and Farley, 2004). Meeting human needs is an appropriate approach to development that improves the entire human lot. When focusing on needs, measurements of the quantity of economic output in a given time do not make sense when used alone as indicators of progress. Qualitative information about the type of growth as well as the impact of that growth is needed in order to determine whether the growth is economic, or uneconomic. Uneconomic growth is defined as growth with environmental, social, and economic costs that outweigh the environmental, social, and economic benefits. In a period of uneconomic growth, a narrow measure of economic output could grow while real economic welfare decreases.

Sustainable development aims to improve human welfare through more balanced progress toward goals such as economic growth, environmental responsibility, and social equity. As public concern for sustainability continues to grow, local and national governments will likely be called upon to pursue more sustainable development practices (Zeemering, 2009). The rising popularity of sustainable development as a policy goal has contributed to renewed interest in the area of indicators and measures of progress. Comprehensive sustainability plans and assessments, as well as the implementation of sustainability programs, will require appropriate and effective indicators to guide development toward a sustainable and desirable future.

Traditional, "neoclassical economics" and the more recently emerged "ecological economics" treat development and the concept of progress in different ways. The comparisons made in the following Table 1 are based on work by Bagstad (2008) and summarize the approach of ecological economics that is adopted in this thesis.

Table 1 : Progress according to neoclassical and ecological economics.

	Neoclassical economics	Ecological economics
Definition of progress	– Increased consumption of goods and services – "More is better" principle (Frank, 1994)	– Increased quality of life – Meeting of human needs – Sustainable and desirable economy
Underlying belief system	Unlimited resources and substitutability between capitals	Belief that material and energy sources and sinks on a finite planet limit the desirable economic scale
Goal	1) Efficient allocation of resources 2) Fair distribution of resources	1) Sustainable scale for economy 2) Fair distribution of resources within and between generations 3) Efficient allocation of resources
"Measuring stick"	Gross Domestic Product (GDP)	Genuine Progress Indicator (GPI), others

1.3 Indicators and Measures of Progress

Bartelmus (2008) provides a generic definition of an indicator as a "simple average of a statistical variable or ratio of variables that provides an image beyond the immediate attribute or observation of the variable or ratio itself" (pg. 72). He acknowledges the subjective nature in selecting which statistics to pay attention to, and also in using and interpreting indicators. And he agrees that indicators are an essential early step toward assessing environmental, economic, and social conditions. Indicators are useful in the ways they reduce overwhelming amounts of data to more concisely represent the biophysical world. Bartelmus (2008) identifies three general purposes of indicators:

- To monitor environmental, economic, and social conditions and to provide early warning and alerts.
- To assist and guide in formulating policy.
- To evaluate policy performance.

The following additional purposes of indicators make for a more complete list:

- To enable a community to predict, respond to, and manage changing conditions.
- To inform the decisions of private firm in the market.

Indicators are an essential, though often-overlooked, part of the way society makes progress. An agreed-upon definition of progress requires some way of knowing whether society is better or worse off than in the past (Osberg, 2001). In order to actually make progress, to advance towards a higher state, society needs to define a collective goal, determine how to achieve the goal, *and* have indicators to provide information about progress toward or away from the goal. Flawed indicators or the misrepresentation of actual conditions (for example, by misusing indicators to represent things they do not accurately measure), can lead society away from a goal rather than towards it.

Indicators can fit into ecological economics models of the world by providing information about how human well-being is influenced by a.) economic production, b.) four different forms of capital (natural, human, social, and built or manufactured capital), and c.) consumption and investment. These relationships are depicted in Figure 1: The role of indicators in a four-capital ecological economic model.

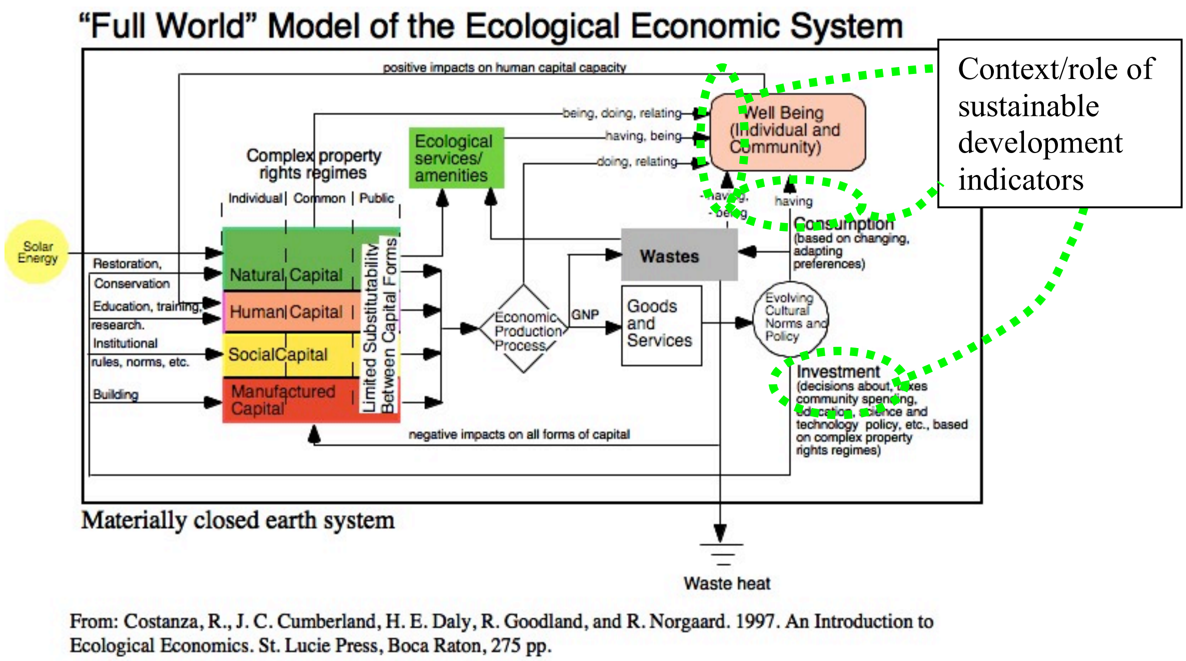

Figure 1: The role of indicators in a four-capital ecological economic model.

In the following pages, two truisms about indicators are helpful in understanding what we observe in modern society. The first is that *we measure what matters*. This statement points to how indicators represent what a community decides to be important to monitor. It is also worth noting how this reflexive relationship works both ways: the aspects of the world that communities decide to measure become more important to the community. For example, the direction of resources towards measuring a particular activity brings increased significance and meaning to that activity. The second relevant truism is that *we manage what we measure*. Thus, one of the primary reasons to establish an indicator is to enable a community to respond to, predict, and manage a particular condition. Keeping in mind these concepts of progress, and indicators, we now turn to the modern fixation with the measurement of economic growth.

CHAPTER 2: GROSS DOMESTIC PRODUCT AND ALTERNATIVE INDICATORS

2.1 History and Misuse of Gross Domestic Product (GDP)

Since the 1940s, the most widely accepted measure of a country's economic progress has been changes in its Gross Domestic Product (GDP). GDP is a measure of market throughout, adding together all final goods and services that are produced and traded for money within a given period of time. It is typically measured using expenditures, by adding together estimates of a nation's C, personal consumption expenditures (payments made by households for goods and services); G, government expenditures (public spending on the provision of goods and services, infrastructure, debt payments, etc.); I, gross investment or net capital formation (the increase in value of a nation's total stock of monetized capital goods); and (X – M), net exports (the value of a country's exports minus the value of imports). Equation (2.1) shows the expenditure method of calculating GDP.

$$GDP = C + G + I + (X - M) \qquad (2.1)$$

It is worth distinguishing between Gross *Domestic* Product and Gross *National* Product (GNP), another frequently mentioned measure of economic progress. GNP measures all final production by domestic companies regardless of where in the world that production takes place; GDP measures the value of final goods and services produced in a country whether by domestic or foreign companies. At the sub-national level, state or regional equivalents such as Gross State Product (GSP) or Gross Value

Added (GVA) may be used to represent an analogous concept (Jackson et al., 2008). At the sub-national scale, however, flows of good, services, and capital across boundaries are much less accurately measured. In this thesis, GDP refers to national measures of economic activity, GSP refers to an equivalent measure for the state of Maryland, and GSP_L refers to more local measures at the city and county levels. GSP_L simply scales down GSP based on population, as local measures of economic flow in and out of a city or county are inaccurate.

A simple picture of a market economy includes a circular flow of income and expenditures between households and businesses (with governments contributing functions such as managing the overall supply of money, and imposing taxes and regulations, for example). Essentially, GDP measures the annual volume of this flow, or throughput, in an economy, similar to the way that an electric meter measures the flow of electricity through a building. GDP can be measured from the perspective of economic production or consumption (as in the expenditures method presented earlier), and the two approaches should theoretically provide equal values. However, GDP measures economic activity only within the market: only goods and services that are publicly traded for money are counted. Some 'nonmarket' production is included in GDP, such as defensive spending by the federal government or nonprofit spending on emergency housing and health care, but on the whole, many significant economic activities are excluded from GDP measurements. As will be shown, this leads to some perverse outcomes.

2.1.1 A Brief History of GDP

The Gross Domestic Product was initially developed in the US and UK in the 1930s and 1940s, when the world was in the midst of major social and economic upheaval from global warfare and the Great Depression. The government under President Roosevelt used the System of National Accounts (of which GDP is a major component) to justify policies and programs aimed at bringing the US out of the depression. As US involvement in World War II became more likely, decision makers used GDP estimates to show that the economy could maintain adequate production and provide supplies for fighting a world war (Marcuss and Kane, 2007). The Bretton Woods Conference in 1944 further influenced the acceptance of GDP as a measure of national economic progress: world leaders agreed that growing the economy was the path to improved well-being, and that GDP was to be the measure of economic growth.

Economists have warned since its introduction, though, that GDP is a *specialized* tool and that treating it as an indicator of general well-being is inaccurate and dangerous. Simon Kuznets, widely accepted as the chief architect of the US national accounting system, cautioned against equating GDP growth with increases in economic or social well-being (Kuznets, 1934; Kuznets et al. 1941). Regardless, economic policy over the last seventy years has, to a significant degree, been designed to achieve economic growth by increasing GDP (Nordhaus and Tobin, 1973). GDP in particular and economic growth in general is regularly referred to by leading economists, politicians, top-level decision makers, and the media as though it represents overall progress or welfare. For example, a report recently released by the World Bank says that nothing besides long-term high rates of GDP growth can solve the world's poverty problem (Commission on Growth and Development, 2008).

2.1.2 Problems with Misusing GDP to Measure Well-Being and Progress

Belief in GDP growth as a panacea has become a problem in itself. As part of the current paradigm in which societies operate, faith in the benefits of GDP growth has gone largely unquestioned. A widespread assumption in development policy is that GDP growth is the best way to develop national economies and to solve humanity's problems. By extension, it is often assumed that GDP growth correlates with increases in human welfare, and that GDP can thus serve as a measure of welfare. This assumption is misguided, as GDP was never intended to measure welfare and its misuse in such a way can lead to perverse outcomes. Consider three examples described by John Talberth (2008):

- Per capita GDP from 2000-2005 rose 23 percent in Sudan despite a devastating drought in 2001 and alleged genocide in the Darfur region beginning around 2003.
- GDP numbers rose unabated in Sri Lanka while the 2004 tsunami claimed over 36,000 lives and destroyed coastal areas.
- The United States increased its GDP from 2003-2005 while spending over $1.4 trillion on defense, enduring huge losses from Hurricane Katrina, and reaching the highest income inequality level since 1928.

Because GDP measures only monetary transactions related to the production of marketed goods and services, it is based on an incomplete picture of the social and natural systems within which the human economy operates. Of particular concern is the way that GDP measurement encourages the depletion of natural resources faster than they can renew themselves, by counting capital depletion as income even when it erodes the capital base from which the value is derived. Another related concern is the way that economic activity bolstered by GDP has degraded ecosystems and thus diminished the services that, until recently, have been provided to humans by nature virtually for free. In 1997, it was estimated that the world's ecosystems provided benefits valued at an average of US $33 trillion per year, significantly larger than the global GDP at that time (Costanza et al. 1997). GDP encourages depletion by placing value upon clear-cutting a forest for timber, for example, while largely ignoring the value of the ecosystem services provided by the forest (including biodiversity habitat, flood protection, air and water purification, and carbon dioxide sequestration).

Despite persistent criticism and well-documented flaws with GDP as a measure of well-being, GDP continues to dominate economic policy discussions. The economists, journalists, teachers, and policy-makers who accept and support the continual focus on GDP are often aware of the shortcomings of this indicator as a measure of human welfare and progress, yet they remain content to allow GDP to guide public policy and development efforts. The illogic in this course of (in)action gives rise to "the GDP paradox," in which people continue to emphasize and focus on GDP even when confronted with clear evidence of the errors in doing so (van den Bergh, 2009).

Economists sometimes justify this flawed position by describing the accomplishments of GDP. They may claim that there is no better way than growing GDP to eliminate poverty and maintain full employment. These claims, which may be true for specific places and time periods, have been called into question by increasing evidence to the contrary. Historical links between GDP growth and poverty or unemployment have not been shown to be causal, meaning that even when GDP has been observed to increase along with reductions in poverty, there is limited evidence that GDP growth caused such a change in living conditions. Peter Victor has further debunked the myth that GDP growth is necessary to meet policy objectives by using systems models to explore ways to maintain employment, low poverty levels, and fiscal balance without growth in economic throughput (Victor, 2008). His work shows that it is possible to achieve human development and public policy goals without relying on economic growth to do it.

Without consensus on a viable alternative, though, GDP is often used to represent welfare by default (Harris, 1997). There are no alternatives to GDP that are measured with the same frequency, reliability, or commitment of resources. The infrastructure for measuring and reporting GDP is already well established, contributing to complacency and acceptance of the status quo. Many institutions and individuals are simply accustomed to managing, reporting, or responding to GDP measurements; in fact, the success of some institutions is actually predicated on increases in GDP (Costanza et al., 2009). This apparent dependence on the current system points towards the possibility of deeper, more systemic forces at work.

The media plays a central role in keeping GDP at the center of policy discussions by constantly reporting on GDP figures and fueling confidence that the information provided by this indicator is of paramount importance. Career politicians primarily interested in re-election may find it too politically risky to adopt a GDP-critical stance, especially in the face of economic recession and widespread misconception that GDP is the only way to maintain full employment. This contributes to a lack of top-down leadership on the issue, stalling national efforts for reform. The situation is reinforced when governments back away from alternative indicators that portray less favorable conditions than GDP figures, as in China's decision to halt their Green GDP program (perhaps for fear that government officials will be held accountable to the negative social or environmental conditions made known by more accurate indicators). Meanwhile, lobbyists and big business aim to sway the economic system in their favor, and this often means sticking with GDP growth as the overarching policy goal, regardless of its problems. GDP growth may not actually be the best way to bring about full employment or eliminate poverty, but it has reliably brought with it increased profits and economic activity such as consumption.

On a macro- scale, collective interests in short-term profits has eclipsed long-term sustainability or environmental quality. Douglas Booth (2004) argues that the world is addicted to growth and that the short-term pleasures from activities such as consumption effectively obscure long-term debilitations such as environmental decline. He describes a dependency on growth so strong that to unhook from it would require modern society to radically restructure major economic and social institutions. The enormity of what may be required to solve the problem of GDP is itself a barrier to action, and a reason for the reluctance to move beyond GDP.

Van den Bergh (2009) exposes the GDP paradox by identifying and refuting two arguments that frequently arise in the face of GDP criticisms: GDP information has a only a modest impact on economic reality (in fact, it is surprisingly easy to see how GDP information has a significant impact on private and public decisions, economic activity, and long-term economic development) and GDP still provides useful information despite its limitations (the article concludes that GDP is a major information failure). Both arguments in favor of GDP represent collective denial on a massive scale, pointing to perhaps the greatest of all reasons for the continual dominance of GDP. Van den Bergh (2009) implicates lock-in, or immersion within a paradigm, as a cause for the denial, concluding that "support for the GDP indicator thus turns out to be rather dogmatic or at best habitual, instead of well reasoned." The breadth and depth of the GDP dogma suggests that a pro-growth paradigm provides overwhelming inertia in favor of the current system. The individuals, institutions, and culture of this pro-growth paradigm may ultimately prove to be maladaptive, but they nevertheless provide support for a seemingly inexorable march toward more GDP growth.

The ways in which conventional economic indicators fail to account for activities and influences that have significant impacts on human well-being was described well in a 1968 speech given by Robert Kennedy: "[GDP] measures everything, in short, except that which makes life worthwhile." This claim gives rise to a major question underlying this thesis: to what extent does an increase in GDP reflect real changes in welfare? While the dominant current paradigm assumes that economic growth always leads to increased welfare, there is evidence that this may not always be the case.

An increasingly large and robust body of research confirms that, beyond a certain threshold, further increases in material well-being have negative side-effects of lowering community cohesion, healthy social relationships, knowledge and wisdom, a sense of purpose, connection with nature, and other dimensions of human happiness (McKibben, 2007). As GDP increases, overall quality of life often increases up to a point, beyond which, benefits from further increases in GDP are offset by the mounting costs associated with increased income inequality, loss of leisure time, and natural capital depletion, for example (Talberth et al. 2007). Manfred Max-Neef (1995) has suggested diminishing and even negative returns on economic growth by claiming that a threshold point exists, beyond which further economic growth ceases to contribute to an increase in welfare and may lead to a reduction in welfare. To test the validity of this threshold hypothesis requires an alternative, more accurate, quantitative measure of welfare.

2.2 Solutions Proposed in the Form of Alternative Indicators

The failure of conventional economic indicators to take into account certain environmental and social factors reinforces the need for improved measures. In particular, Gross Domestic Product (GDP) entirely misses activities that enhance welfare, such as the work of parents and volunteers, as well as activities that diminish welfare, such as pollution and the depletion of natural capital. Indicators used to guide decisions and policies can undermine community values when they disregard positive and negative contributions to welfare in this way (Harris 1997). The situation is made worse by the institutionalized and frequent misuse of GDP as an indicator of overall welfare. GDP was never originally intended to serve as a welfare measure; unsurprisingly, it functions poorly as such. Yet government officials, business leaders, and the media still regularly refer to GDP figures as though they represent welfare.

In response to these issues, a number of alternative ways of measuring progress towards increased human well-being have been developed to supplement or replace the existing system (England, 1998; Parris and Kates, 2003; Wilson et al. 2007; Kerk and Manuel, 2008; Costanza et al. 2009). These proposed alternative indicators have emerged from the growing realization that GDP is a measure of economic *quantity*, not economic *quality* or welfare, let alone social or environmental well-being. Many of the measures also directly address the concern surrounding GDP's emphasis on maximizing quantitative throughput and the subsequent eroding of social and natural capital for future generations. These newer measures are generally categorized as: (1) indexes that do not use GDP and attempt to measure aspects of well-being directly; (2) composite indexes that combine different approaches; and (3) indexes that make 'corrections' to existing GDP and national accounting methods. What follows is a review of some better-known examples of these alternative indicators. Note: this is not intended to be a comprehensive list.

2.2.1 Indexes That Do Not Use GDP

Some alternative indexes do not measure economic activity; rather, they measure environmental or social activities, well-being, impacts, or changes in environmental, social, or human capital. The Ecological Footprint (EF) was developed by Wackernagel and Rees (1996) as a way to account for flows of energy and matter into and out of the human economy, and to convert those flows into a measure of the area of productive land and water required to support those flows. The EF is intended to be used as a resource management tool for assessing whether and to what extent an individual, city, or nation is using available ecological assets faster than the supporting ecosystems can regenerate those assets. Most recent estimates show that humanity's Ecological Footprint is 23 to 40 percent larger than renewable rates, with the vast majority of this overshoot due to carbon emissions (Venetoulis and Talberth, 2006). Over the last 12 years, Ecological Footprints have been calculated for most nations and for numerous sub-national regions.

Another recently developed method takes a different approach and attempts to evaluate human well-being based on self-reporting by individuals and groups. Generally referred to as measures of subjective well-being (SWB), these studies attempt to measure "satisfaction" with quality of life or people's moods and emotions (Diener and Suh, 1999). The intent is to measure the extent to which human needs are actually being met; presumably, environmental or social deterioration would register in people's self-reported levels of well-being. Comparisons of reported well-being and per capita GDP have shown that beyond a certain income level, happiness does not increase significantly with additional income (Inglehart, 1997). Figure 2 illustrates this trend in which there are diminishing marginal happiness returns to increasing GDP (happiness data were obtained form World Values Surveys, GDP per capita data were from the United Nations Statistics Division for National Accounts, and nominal-real GDP adjustments were made with Consumer Price Index annual averages published by the United States Bureau of Labor Statistics).

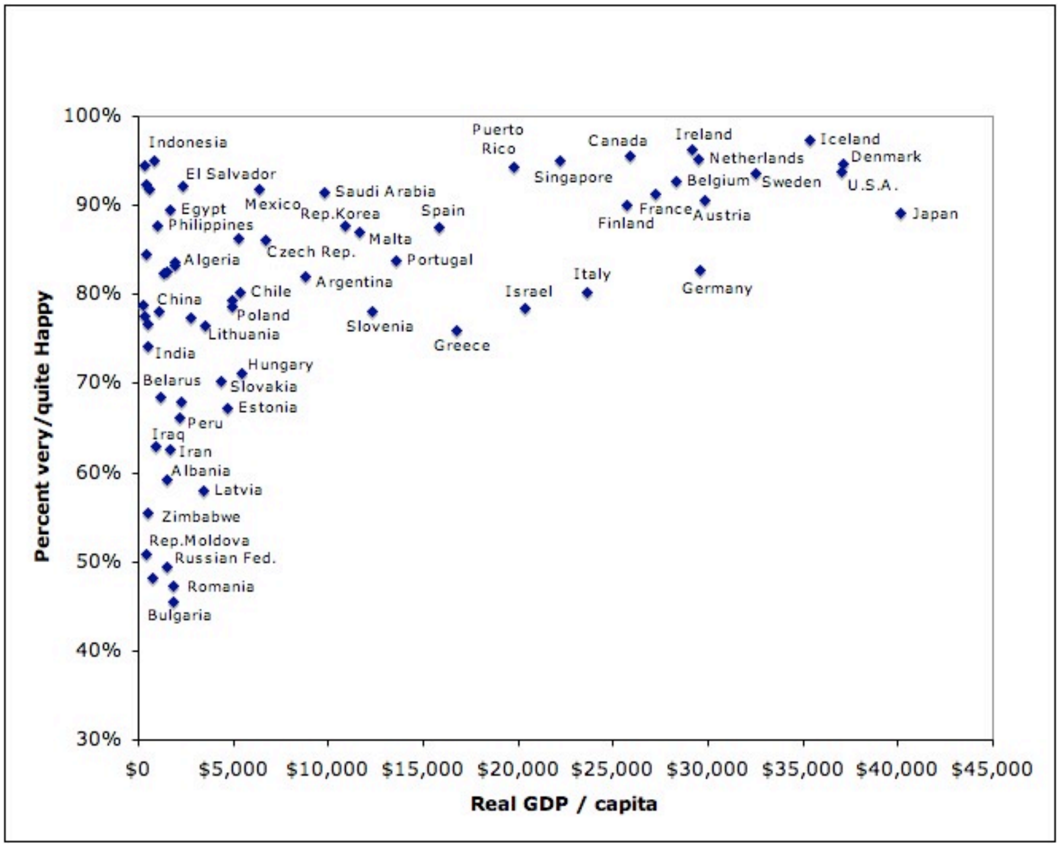

Figure 2: Observed relationship between self-reported happiness and GDP.

Still another approach to welfare with no direct reliance on GDP is Gross National Happiness (GNH). GNH was originally suggested by the King of Bhutan in the early 1980s as a more appropriate measure of progress for the small kingdom than GDP. When it was first proposed, it was not an actual index, but more of a principle for guiding

Bhutanese development in a fashion consistent with the country's culture and spiritual values rather than focusing on increasing economic activity. The government of Bhutan has sponsored over four international conferences on GNH and established a Gross National Happiness Commission to develop a specific methodology for measuring GNH. Survey-based methods include indicators related to nine dimensions of happiness and well-being in Bhutan: psychological well-being, time use, community vitality, culture, health, education, environmental diversity, living standard, and governance. Detailed methods and results of the GNH Index are available at www.grossnationalhappiness.com.

2.2.2 Composite Indexes

Composite indexes deal with the shortcomings of GDP by combining several different measures into a single number that can be used as a more accurate measure of progress. Some indexes combine GDP or GDP variants with other non-GDP environmental/social indexes to describe well-being. For example, since 1990 the United Nations Development Program has published an annual Human Development Report based on the Human Development Index (HDI). The purpose of the report is to show how well the management of economic growth and human development is actually improving human well-being in the nations of the world. The inaugural report defines human development as the "process of enlarging people's choices...to live a long and healthy life, to be educated, have access to resources needed for a decent standard of living,...[to have] political freedom, guaranteed human rights and personal self-respect." However, the authors acknowledge the difficulty of quantifying the last three components, and the index focuses on longevity (measured using life expectancy at birth), knowledge (measured with literacy rate and school enrollment), and decent living standards (measured with GDP adjusted to reflect purchasing power parity) as proxies for people's ability to live long and prosperous lives (UN Development Program, 1990). Initially reported for 14 countries, the UN's 2007 report presented HDI results for 177 countries (UN Development Program, 2007).

The Happy Planet Index (HPI) was developed and published by the New Economics Foundation to measure a country's ecological efficiency in delivering human well-being. The index is a composite of three measures: life expectancy at birth, life satisfaction, and ecological footprint. Interestingly, countries may have similar life satisfaction measures but different overall results. For example, although people in the US and New Zealand report similar levels of life satisfaction, New Zealand's overall HPI is 13 points higher than that of the US, due to the longer life expectancy and lower average resource use rates (as measured by Ecological Footprint) of New Zealanders (Marks et al. 2006).

Comparison of values for the Human Development Index and the Happy Planet Index reveal some differences arising out of methodologies. For example, Honduras and Moldova are two countries with similar Human Development Index values, Ecological Footprints, and life expectancies. But the higher self-reported life satisfaction in Honduras (more than double Moldova's) boosts its Happy Planet Index value 30 points higher than that of Moldova.

2.2.3 Indexes That 'Correct' GDP

Some alternative indicators of economic well-being use the national accounts and GDP as the foundation and then add or subtract quantities in an attempt to address some of the issues already discussed. These measures are based on much of the same economic data as GDP, giving rise to certain limitations including

- A lack of consensus on how to value items that are not regularly reported in monetary terms (e.g., volunteer labor, illegal activities, pollution);
- Unavoidable value-based judgments (subjectivity) in deciding which expenses are beneficial and therefore should be added to the total, and which are detrimental and therefore should be subtracted from the total (i.e., junk food, home security systems);
- Lack of consensus on how to quantify the costs of depleting natural resources.

Despite these hurdles, applications of these modified accounting systems provide compelling evidence of a widening gap between GDP and true economic well-being, indicating that over time, more and more economic activity may be self-canceling from a welfare perspective (Max-Neef, 1995).

Numerous efforts have been undertaken to develop Green GDPs that factor estimates for environmental degredation and depletion of natural resources into the national income accounts to arrive at a single number. Work on a Green GDP for Japan in the 1980s informed the work of Daly and Cobb on an Index of Sustainable Economic Welfare (1989). Green GDP calculations have also been carried out for developed countries such as Australia, Canada, and the United States as well as emerging countries, including China, Costa Rica, Papua New Guinea , and Indonesia. None of the efforts have resulted in regular reporting of the results, and in some cases it has been suggested that potentially unfavorable conditions reported by Green GDP give rise to insurmountable political barriers to acceptance.

Genuine Savings (GS) was developed by the World Bank and defined as “the true level of saving in a country after depreciation of produced capital; investment in human capital (as measured by education expenditures); depletion of minerals, energy, and forests; and damages from local and global air pollutants are taken into account” (Hamliton et al. 2006). This includes the value of global damages from carbon dioxide emissions. Based on national income accounts, the calculation of GS subtracts amounts for environmental degradation and resource depletion and adds in amounts for investments in human capital. Reporting of GS for 120 countries shows that increased national wealth is primarily a result of increased intangible wealth – human capital and the formal and informal institutions that humans create. Low-income countries have a higher percentage of their wealth in the form of natural capital, suggesting that policies designed to maximize short-term profits by liquidating natural capital resources may result in lower welfare in the long-term.

2.3 History and Use of Genuine Progress Indicator (GPI)

The Genuine Progress Indicator (GPI) and the related Index of Sustainable Economic Welfare (ISEW) represent a concerted effort to measure economic well-being and address the failures of GDP by adding or subtracting adjustment terms to GDP. In the following section, the development, usage, and criticisms of this particular indicator approach are explored in more detail.

2.3.1. A Brief History of GPI

As long ago as the 1960s, there have been calls to measure welfare by considering the costs and benefits of changes caused by economic growth (Sametz, 1968). One of the earliest attempts to adjust GDP was by Nordhaus and Tobin (1972), who constructed a Measure of Economic Welfare by making GDP adjustments for typically unaccounted for economic and social factors. The index of the Economic Aspects of Welfare expanded the effort to adjust GDP to include environmental and natural resource elements (Zolotas, 1981). Both of these indicators provided early evidence of a gap between GDP and genuine well-being, quantitatively demonstrating that more and more economic activity may be self-canceling from a welfare perspective.

Daly and Cobb (1989) built upon this previous work measuring economic welfare and proposed an Index of Sustainable Economic Welfare (ISEW) as "a way of measuring the economy that will give better guidance than the GNP to those interested in promoting economic welfare" (Daly and Cobb, 1989, pg. 401). The ISEW featured a series of adjustments to GDP to account for social factors that affect welfare as well as environmental issues and long-term sustainable use of natural resources. In 1995, an organization called Redefining Progress revised the ISEW methodology and published the renamed Genuine Progress Indicator (GPI). The ISEW and GPI are essentially the same thing, with slight differences in adjustment terms and valuation methods. To avoid confusion, in the remainder of this thesis the term GPI will be used to refer to studies that make use of this indicator approach.

2.3.1. How GPI Measures Progress

The GPI uses monetary valuation to assess the impacts of economic growth on sustainable welfare. As a full-cost accounting tool, the GPI goes beyond measuring the quantity of economic activity and includes details about quality by incorporating changes in environmental conditions, resource stocks, social capital, income distribution, and other non-marketed economic activity. It is one of the first alternatives to GDP that has been debated within the scientific community and used by governments and non-governmental organizations to more closely measure sustainable economic welfare (Talberth et al. 2007).

Computation of the GPI begins in the same manner as GDP, with a measure of personal consumption expenditures. While some critics consider this a questionable reference point from which to begin a calculation of sustainable economic welfare, many recognize personal consumption expenditures as a ‘necessary evil’ – necessary in order to enjoy the benefits that goods and services have to offer (Lawn, 2003). The GPI then weights personal consumption for income distribution, in order to reflect the welfare implications of social equity (i.e. the marginal benefit uses of the rich are less than those of the poor).

Next, monetized valuations are added or subtracted to account for the aspects of economic activity that enhance or diminish welfare. There are typically about six positive adjustments and seventeen negative adjustments, but the details can differ depending on case-specific conditions or data availability (see the methods section for a description of adjustment terms for the proposed study). The focus of these adjustments has been summarized by grouping them into the following categories: a weighting for income distribution followed by adjustments related to household expenditures and work, mobility, social capital, pollution, land loss, natural capital, and net investment (Costanza et al. 2004). The equation for calculating GPI then looks like

$$GPI = C_{adj} + G_{n\text{-}d} + W - D - E - N \qquad (2.2)$$

where C_{adj} is personal consumption expenditures adjusted for income inequality, $G_{n\text{-}d}$ is non-defensive government expenditures, W is non-monetarized contributions to welfare, D is defensive private expenditures, E is the costs of environmental degradation, and N is the depreciation of natural capital base.

The GPI emphasizes the point that the quantity of economic activity alone matters little without additional information about the quality of that activity (Venetoulis and Cobb, 2004). The additional information included in the adjustments accounts for 1.) items that GDP counts as benefits but that are really costs (i.e. money spent repairing damage from pollution), 2.) items that GDP ignores but that are really costs (i.e. nonrenewable resource depletion), and 3.) items that GDP ignores but that are really benefits (i.e. the value of household labor). Despite their significant contributions to economic welfare, these finer points are overlooked when all economic activity is simply added together as benefits, as in the calculation of GDP. The GPI represents a more thorough approach to national income accounting if the goal is to provide accurate information about the genuine well-being of the nation as a whole.

2.3.2 Criticisms of GPI

Many criticisms of the Genuine Progress Indicator have emerged over the years. Neumayer (1999) criticizes the conceptual underpinnings of GPI by claiming that it lacks a theoretical basis and incorrectly combines the measurement of current welfare and sustainability (two concepts that he argues are best kept separate). He rightly points out how the GPI combines the measurement of current welfare and sustainability, and claims that the items involved in assessing welfare are not necessarily relevant to sustainability (and vice versa). For example, providing for a more equitable income distribution may have profound implications for current welfare, but it has less to do with long-term sustainability. Lawn (2005) justifies the GPI's measurement of sustainable economic welfare by describing how current welfare can affect longer-term sustainability if it erodes the capital base upon which future welfare depends. I agree with Neumayer's (1999) claim that current welfare and sustainability are best measured separately, despite Lawn's defense of the GPI's approach to measuring both welfare and sustainability (most recently, in Lawn and Clarke, 2008). In addressing this issue, I think that a separate natural capital account (with biophysical assessments of resource stocks and flows) can supplement GPI to better portray the dynamic relationships between economic welfare and ecological sustainability. Two complementary welfare and sustainability indicators would help maintain a focus on the biophysical basis for economies (Niccolucci et al. 2007).

Other criticisms point to the controversial and often arbitrary nature of which methods are used to make the monetary adjustments, with some evidence that the subjective choice of method could be partly responsible for results that agree with the threshold hypothesis (Neumayer, 2000; Bleys, 2006). In response, Philip Lawn and others have described a theoretical foundation for the most controversial terms used to construct the GPI and shown how the GPI is consistent with Fisher's definition of income and capital (Lawn, 2003; Lawn, 2005; Lawn et al. 2009). Lawn also emphasizes the way in which human-made capital stock maintenance should be calculated as a cost, as is done with the GPI in the form of lost natural capital. In his latest defenses of GPI, he has openly acknowledged the need for a more consistent set of valuation methods in order to further validate the results of GPI studies and facilitate wider use of GPI methods (Lawn, 2005; Lawn et al. 2009).

Those who doubt the scientific integrity of GPI level a more serious charge at this indicator. For example some feel that failure "to fulfill fundamental scientific requirements [make GPI] rather useless if not misleading with respect to policy advise" (Bohringer et al. 2007). Specifically, the normalization, aggregation, and weighting of underlying variables in GPI measurement are claimed to be 'tainted' with subjective judgments. Lawn refutes this criticism and has theoretically justified GPI's methodological approach. In my opinion, Bohringer et al.'s (2007) argument warrants consideration. It is undeniably true that GPI requires subjective value judgments on the part of the researcher. However, it is worth noting that GPI is not a unique indicator in this sense. Any and all indicators are ultimately based on subjective interpretations of which information is worth paying attention to, and how to properly pay attention to it. For example, GDP, the Human Development Index, and other indicators are based on people choosing to measure, weight, and aggregate certain information. And when we choose, we invariably use our values to do so. Rather than being a shortcoming, I believe the subjective nature of the GPI to be an inherent element in all indicators. I also think that, in comparison with other indicators in use today, the GPI does a better job of openly acknowledging the assumptions and subjective values upon which it is based.

One final criticism of GPI is considered here: the assumption that progress (or sustainable economic welfare) is proportionate to the consumption of produced goods and services. It is without question that GPI is a consumption-based indicator. GPI is directly proportional to consumption, meaning that increases in consumption will lead to increases in GPI. This implies that more consumption is better, as more consumption drives up the measure of genuine progress. In fact, two sub-national GPI studies confirmed that within the GPI framework, it is possible to deplete natural and social capital while increasing consumption to produce a rising GPI per capita. Venetoulis and Cobb (2004) found that counties in the San Francisco Bay Area with the highest and lowest personal consumption per capita also had the highest and lowest GPI per capita, respectively. In a more recent study of several Ohio counties and cities, Bagstad and Shammin (unpublished) found that external social and environmental costs were offset in wealthy suburban counties by increases in consumption (Bagstad and Shammin attempt to deal with the fact that not all consumption spending necessarily improves well-being by including detailed personal consumption expenditure data in their treatment of the costs of climate change).

Lawn (2003) argues that "using consumption expenditure as the initial reference point does not imply that consumption is itself good … it is necessary to consume goods to gain the services that they yield." This points to the way in which consumption is not an end, but it is only one means to improving human well-being (Daly and Farley, 2004). Ever-increasing consumption as a goal is unreasonable and unrealistic. Consumption is inextricably linked to resource use and waste generation, and so it cannot increase without limit on a finite planet.

Measures of economic welfare based upon consumption (which implies the insatiability of human wants) may continue to misguide collective human behaviors towards the exhaustion of resources and economies that exceed ecological carrying capacities. Ever-increasing consumption is not only unreasonable and unrealistic; it distracts from more beneficial human development goals and from dealing directly with pressing problems that face modern society. The GPI framework could be improved by more explicit consideration of how consumption contributes to human welfare (for more on this subject, see the section on Recommendations for Future Work at the end of this thesis). The psychic enjoyment of life upon which economic welfare depends is not determined by the rate at which goods and services are consumed (Daly, 1979). For the time being, though, psychic income and welfare are difficult to quantify, while consumption is relatively easy to measure and can serve as a proxy for welfare.

2.3.3 GPI Applications at Different Scales

The Index of Sustainable Economic Welfare and the variant Genuine Progress Indicator have been applied at the national level to over 20 different countries. These studies are summarized in Table 2.

The availability of data and authors' preferences for certain valuation methods have led to differences within each study's methodology, making it a challenge to draw meaningful comparisons among the studies. Nevertheless, the results of each study show the same general trend of an overall rise in GDP despite either a leveling off, falling, or more slowly rising GPI. In some cases, GPI may be positively correlated with GDP up to a certain point in time, beyond which the two indicators diverge. This observation implies that when GDP grows beyond a certain scale, additional economic growth as measured by GDP does not always lead to increased genuine welfare. In other words, as an economy grows larger in GDP terms, the costs of economic growth eventually begin to outweigh the benefits from a welfare perspective. Many of the studies offer compelling evidence in support of the threshold hypothesis and reveal a clear point in time when GPI begins to diverge from GDP, usually around 1970-1980. This body of work at the national level calls into question the welfare impacts of policies designed to grow GDP and suggests that GPI may be a more useful tool for gauging welfare.

Table 2: Thirty-seven national GPI studies for twenty-one different countries.

Study	Country	Study period
Hamilton, 1997	Australia	1950-1996
Hamilton, 1999	Australia	1950-1996
Hamilton and Denniss, 2000	Australia	1950-2000
Lawn 2008	Australia	1967-2006
Stockhammer et al., 1997	Austria	1955-1992
Bleys, 2006	Belgium	1970-2000
Bleys, 2008	Belgium	1970-2004
Castaneda, 1999	Chile	1965-1995
Wen et al., 2008	China	1970-2005
Scasny, 2002	Czech Republic	
Nourry, 2008	France	1990-2002
Diefenbacher, 1994	Germany	1950-1990
Lawn, 2008	India	1987-2003
Guenno and Tiezzi, 1998	Italy	1960-1991
Makino et al., 2003	Japan	1955-2000
Makino, 2008	Japan	1970-2003
Rosenberg and Oegema, 1995	Netherlands	1950-1992
Bleys, 2007	Netherlands	1971-2004
Forgie et al. 2008	New Zealand	1970-2005
Forgie et al. 2007	New Zealand	1970-2005
Gil and Slezynski, 2003	Poland	1980-1997
Moffatt and Wilson, 1994	Scotland	1980-1991
Hanley et al. 1999	Scotland	1980-1993
Jackson and Stymne, 1996	Scotland	1970-2005
Jackson and Stymne, 1996	Sweden	1950-1992
Clarke and Islam, 2004	Thailand	1975-1999
Clarke and Shaw, 2008	Thailand	1975-2004
Jackson et al. 2002	UK	1950-1996
Jackson and Marks, 1994	UK	1950-1990
Jackson, 2004	UK	1950-2002
Anielski and Rowe, 1999	US	1950-1997
Venetoulis and Cobb, 2004	US	1950-2002
Talberth et al. 2007	US	1950-2004
Hong et al. 2008	Vietnam	1992-2004
Midmore et al. 2000	Wales	1970-1996
Matthews et al. 2003	Wales	1990-2000
Jones et al. 2007	Wales	1990-2005

Recently, studies at the local scale have also found GPI to be useful in understanding the full range of welfare impacts resulting from marketed economic activity. These studies are summarized in Table 3.

Table 3: Fourteen sub-national GPI studies for fifty-nine different regions.

Study	Region and country	Country	Study period
Lawn and Clarke, 2008	State of Victoria	Australia	1986-2003
Anielski et al., 2001	Province of Alberta	Canada	1961-1999
Gustavson and Lonergan, 1994	Province of British Columbia	Canada	
Pannozzo et al., 2009	Province of Nova Scotia	Canada	Approx. 1980-2005
Wen et al., 2007	Cities of Suzhou, Yangzhou, Ningbo, and Guangzhou	China	1991-2001
Jackson et al., 2008	All English regions	England	1994-2005
Pulselli et al., 2006	Province of Siena	Italy	1999
Pulselli et al., 2008	Province of Modena	Italy	1971-2003
Pulselli et al., 2008	Province of Rimini	Italy	1971-2003
Bagstad and Ceroni, 2007	7 northeast Vermont counties, State of Vermont	US	1950-2000
Bagstad and Shammin, unpublished	Cities of Akron and Cleveland, 17 northeast Ohio counties, State of Ohio	US	1950-2005
Bay Area Genuine Progress Indicator Analysis, 2006	City of San Francisco, 8 California counties	US	2000
Costanza et al., 2004	City of Burlington, Chittenden County, State of Vermont	US	1950-2000
Environmental Quality Board, 2000	State of Minnesota	US	1960-1995
Reportedly in preparation by multiple organizations	States of Maryland, Massachusetts, Michigan, and Utah	US	varies

GPI has been especially valuable at the local scales in informing debate and stimulating questions about the nature of the economic development process (Jackson et al. 2008). The GPI can provide a time-series measure of elements that contribute significantly to quality of life and can draw attention to critical development issues such as the distribution of resources, the benefits and costs of production and consumption, and the value of non-market goods and services.

Table 3 shows published studies of the Genuine Progress Indicator, or some comparable measure, at the sub-national level in only 6 different countries. Bagstad and Ceroni (2007) point out how local and regional differences lead to an uneven distribution of the costs and benefits of economic growth across a country (see later section on bias and transboundary costs). Local GPI estimates would be expected to reflect differences in income distribution, environmental impact, or social capital between areas. For instance, two studies for Vermont found GPI to be higher than the national average, perhaps due to environmental quality and relatively low costs of pollution (Costanza et al. 2004; Bagstad and Ceroni, 2007). The sub-national GPI studies do not reveal as sharp a divergence between GPI and the regional GDP-equivalent (GSP, GVA, or GSP_L) as national GPI studies do. While a clear threshold does not always emerge in these local studies, regional estimates of a GDP-equivalent consistently overstate the welfare of regions when measured with GPI, and GDP-equivalent growth rates are consistently found to be higher than GPI growth rates in the years since 1980.

2.4 Barriers to Measuring Real Progress

Although problems with GDP as a measure of economic progress have been known since its inception and numerous alternative measures have been proposed, there are still significant barriers to developing, implementing, and using better measures of progress. These can be generally categorized as data, methodology, and social/institutional barriers. The data and methodology barriers are common to all indicators, including GDP, and can be dealt with technically. The social/institutional barriers may ultimately be more difficult to overcome. This section is based extensively on the published report by Costanza et al. (2009), which also presents more detailed ideas for moving forward in the adoption of better measures of progress.

2.4.1 Data Barriers

Indicators are intended to provide information about a system – its current condition, how that condition has changed or will change over time, and the condition of and changes in the forces affecting the system. The choice of particular indicators defines goals and what is important to a community. To be useful, an indicator needs to be reliable, the underlying data need to be available in a timely fashion, and data must be at an appropriate scale and scope. These key qualities ensure that an indicator is effective in informing decisions or measuring progress towards desired goals. Critics of alternative or complementary measures argue that data issues hinder wider adoption of new measures in place of GDP (Parris and Kates, 2003).

Indicator reliability has to do with whether or not a change in an indicator is an accurate signal of change in the system it is supposed to measure. To the extent that they are based on GDP and national accounts data, alternative measures meet the same standard of accuracy. Alternative measures based on environmental or social data may be less accurate, but this situation can be improved by investment in the right kinds of data as well as methods for reporting and collecting data. Rather than dwelling on natural variation in data quality both within and between indicators, managers could assess, "grade," and communicate data quality for all indicators and their components (as proposed in Costanza et al. 1992).

Another potential barrier is the frequency with which underlying data were available. GDP is currently reported annually for all countries of the world and quarterly for many developed nations. However, the infrastructure does not currently exist to gather and report many environmental or social data as frequently as economic data, especially in developing countries. In order for alternative measures to be accepted on the same level as indicators like GDP, support from governments, nonprofits and foundations is needed to continue building the infrastructure required to gather and report relevant data on a regular basis.

In particular, local-scale and developing nations' indicator work could benefit from improved capacity to calculate and report on alternative measures. Nations with less developed governmental and financial accounting institutions have improved their efforts to track GDP with assistance from international standardization institutions, but much work remains to be done to make reporting on measures such as GPI more accessible to all countries.

2.4.1 Methodology Barriers

Methodology barriers involve issues of standardization and the role of value-based judgments inherent in alternative indicators. GDP methods originally developed by the US and UK treasuries are now standardized by a statistical division of the United Nations that also oversees standardization of Green GDP (Costanza et al. 2009). Efforts to standardize the methods for GPI and other alternative indicators have been underway for a comparatively short period of time and still lack broad consensus on the standards.

A number of choices underlie the construction of an indicator, including which items to incorporate, how to measure or valuate items, and how to weight or aggregate different items when they are combined. Societal values and goals are an unavoidable element in any indicator, GDP included. Communities measure what they think is important and their choice of indicators will naturally reflect their collective values and goals. Alternative measures that include ecosystem health or stocks and flows of natural resources are often called into question due to the lack of standardized valuation methodologies (England, 1998; Neumayer, 1999; Neumayer, 2000; Lawn, 2003; Lawn, 2005). Other alternative measures that are based on surveys of individuals' perceptions of well-being are often criticized for being too 'subjective.' These issues could be addressed through a multi-stakeholder consensus-building process to determine which methods and indicators to employ, something that was notably absent in the process of creating GDP. In addition, it is important to recognize that today's predominant indicators suffer from the same problem of subjectivity. While designing GDP and the system of national accounts 70 years ago, Simon Kuznets observed that "for those not intimately acquainted with [systems of national accounts], it is difficult to realize the degree to which estimates of national income have been and must be affected by explicit or implicit value judgments" (Kuznets et al. 1941).

2.4.2 Institutional and Social Barriers

The social, institutional, and political inertia of the current system represents perhaps the greatest of all barriers to new indicators of progress. The relatively well-developed system in favor of GDP, the current dominance of the "growth paradigm," and the power of those with a vested interest in maintaining the status quo all provide significant resistance to change.

Over its seventy-year history, the evolution of the system of national accounts has included the necessary informational infrastructure and intellectual know-how to collect, manage, analyze, and report GDP in an accurate and timely manner in developed nations. Efforts to collect and manage data for alternative measures have been under way for much less time and with much less funding. As a result, institutional obstacles related to informational infrastructure and expertise for new data sources continue to impede widespread use of new indicators of progress.

The deep-seated belief that growing GDP will solve all the world's problems presents an enormous challenge to developing better measures of progress. Across the world, the growth of economic activity as measured by GDP is heralded as a universal remedy. Most reports by economists, politicians, and media sources equate GDP growth with improvements in human well-being. Business leaders, economists, media, and governments claim that there is no better way to measure economic progress, eradicate poverty, or maintain employment than tracking and increasing GDP. As a result, the general public also tends to believe that GDP is the correct measure and that growth will solve the world's problems. The considerable force of the current GDP-based growth paradigm must not be overlooked as a principal barrier to shifting the focus to include environmental and social elements of progress.

Finally, organizations and institutions with a vested interested in maintaining the status quo effectively prevent wide-scale use of alternative indicators, including industries and businesses whose financial success is predicated on continually increasing economic activity as well as those institutions that are charged with collecting, managing, and reporting on current indicators. Many top-level political and business leaders are fixated on throughput-increasing technological advancements and openly reject goals that are inconsistent with GDP growth (Lawn, 2001). Organizations working on better measures of progress would benefit from presenting a united front on the pressing need for better measures.

CHAPTER 3: ESTIMATING THE BALTIMORE GENUINE PROGRESS INDICATOR

This chapter presents estimates of the Genuine Progress Indicator to Baltimore City, Baltimore County, and Maryland 1950-2005. Study of the GPI for this region contributes to the Baltimore Ecosystem Study (BES) project by providing information about how changes in environmental, social, and economic conditions have impacted welfare since 1950. Specifically, the Baltimore GPI addresses the BES central question number three: "How can urban residents develop and use an understanding of the metropolis as an ecological system to improve the quality of their environment and their daily lives?" The research goals and corresponding objectives are summarized in Table 4.

Table 4: Summary of research goals and objectives for the Baltimore GPI study

Goals	Objectives
Assess the need for better measures of progress	Examine the misuse of GDP and review alternative indicators of progress (see Chapter 2 and Costanza et al. 2009)
Investigate how sustainable economic welfare in the Baltimore region has changed over the last 60 years	Compute a revised regional Genuine Progress Indicator for Baltimore City and County for the years 1950, '60, '70, '80, '90, 2000, and 2005, using the best available current data and methods
Explore the extent to which GDP accurately reflects changes in the Baltimore region's welfare, 1950-2005	Compare time trends in per capita GPI with per capita GDP (or its regional equivalent) for the different scales
Build the case for a more standardized approach to measuring regional economic welfare	Maintain consistency with previous regional GPI studies (when possible) and compare with their results
Introduce applied ecological economic concepts to an urban Long Term Ecological Research site	Communicate findings at the annual BES meeting in October 2009

3.1 Study Area

The study area includes the city and county of Baltimore in the state of Maryland. In 1950, the eastern seaboard city of Baltimore was the sixth-largest city in the United States and provided an economic foundation for the Maryland area, with thriving steel, manufacturing, and shipping industries (Levine, 2000). By 2000, the region had undergone significant changes: the decline of the manufacturing sector and deindustrialization gave rise to a service-providing economy; the racial makeup of Baltimore's urban population changed with the phenomenon of "white flight" and a more than doubled African-American population; and migration out of the city contributed to intense suburbanization of the central Maryland region (Caplow et al. 1994; Levine, 2000). While nearly one-third of the people in Baltimore City left during that time period, Baltimore County's population almost tripled (see Figure 3).

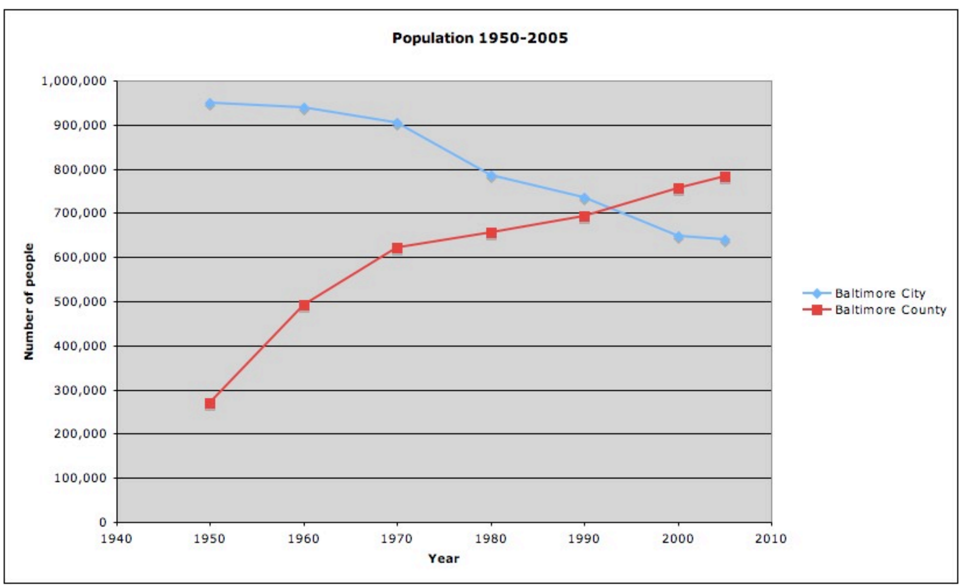

Figure 3: Population trends in Baltimore City and Baltimore County.

Baltimore County surrounds Baltimore City on all sides except to the South. The region is located on the transition line between the Piedmont Plateau and the Atlantic Coastal Plain, in the deciduous forest biome (Pickett et al. 2008). Baltimore City is drained by three major streams and a direct harbor watershed into the Chesapeake Bay, considered the largest and most productive estuarine system in the world (Brush, 1994). The Baltimore Ecosystem Study, part of the Long Term Ecological Research Network, makes use of watershed boundaries in its socioeconomic and biogeophysical studies, but the data involved in the calculation of a GPI make political boundaries more appropriate for the proposed study. Figure 4 shows the geographical location of Baltimore City, Baltimore County, and Maryland (Source: Maryland Department of Business and Economic Development).

Figure 4: Geographical context for Baltimore City.

3.2 Methods

The Baltimore GPI further investigates the challenges and advantages of applying GPI at a local scale explored by Bagstad and Ceroni (2007). As in past local GPI studies, data limitations at the local scale require assumptions, extrapolations, and/or the use of proxy data. In order to maintain consistency across studies and provide for meaningful comparisons with other county/city estimates, the methods of earlier local studies in the US are followed to the extent possible, specifically Costanza et al. (2004) for Vermont, Bagstad and Ceroni (2007) for Vermont, and Bagstad and Shammin (in preparation) for Ohio.

The idea of a standardized method or different regions gives rise to a difficult question. While using a standardized tool offers comparability across studies of other regions, it also restricts what elements are included/excluded from the progress indicator. On one hand, quality of life indicators based on community input can capture unique elements of a place and result in a more meaningful product calibrated to the core values of a community. On the other hand, such an approach, while desirable from a community visioning perspective, misses out on the opportunity to directly compare welfare with other areas. In order to build upon and allow direct comparisons with previous work, the Baltimore GPI study aims to maintain consistency with past studies when possible. Table 5 summarizes the items and valuation methods used in the Baltimore GPI calculations, many of which follow directly from previous local and national studies in the United

States including Bagstad and Ceroni (2007), Costanza et al (2004), and Talberth et al (2007). In addition, detailed GPI methods are presented in Appendix II.

Table 5: Components and calculation methods for the Baltimore GPI

GPI component	Welfare impact	Description	Calculation method
A. Personal consumption expenditure	+, base value	Initial starting point for GPI and basis for evaluating welfare associated with consumption of goods and services.	Per capita income × national ratio of consumption expenditure to income
B. Income distribution	+ or -	The Gini index is the difference between actual distribution and equal distribution by income quintiles, ranging from 0 (all households have same income) to 1 (one household has all income).	(Gini coefficient in year / Gini coefficient at lowest value) × 100
C. Consumption adjusted for inequality		This weighted personal consumption becomes the base number from which other components are added or subtracted.	Column A / Column B
D. Value of household labor	+	Household labor includes work like meal preparation, cleaning, repairs, and parenting. It is valuable economic activity, but goes unaccounted for in the national income accounts.	Net opportunity cost method = total hours of housework performed × wage one would pay to hire someone else to do equivalent work in their home
E. Value of volunteer work	+	Volunteer work is an important contribution to community well-being, yet is omitted from GDP.	Net opportunity cost method = total hours of volunteer work performed × average hourly wage rate

F. Services of household capital	+	Takes into account the annual services provided by household appliances and equipment, which is a better measure of value than just the money spent on such durable items.	Cost of consumer durables (item L) × depreciation rate of 12.5%
G. Services of highways and streets	+	These government-provided services could be sold in theory but are difficult to price for individuals. 7.5% assumes 10% of net stock is annual value and 75% of miles driven are for pleasure.	Net stock of highways and streets × 7.5% annual value
H. Cost of crime	-	Crime diminishes welfare through direct costs such as medical expenses and lost property, as well as indirect costs of preventing or avoiding crime.	Direct costs of property crimes + defensive expenditures to avoid crime
I. Cost of family breakdown	-	Divorces and excessive television watching take an economic toll on society, despite the ways they can cause GDP to go up.	Cost of divorce + social cost of television viewing
J. Loss of Leisure Time	-	GPI considers the loss of leisure that comes with overworking to increase economic output.	Employment level × lost leisure hours × average hourly wage rate
K. Cost of underemploy ment	-	People who are chronically unemployed, discouraged (gave up looking for work), or involuntary part-time (prefer full-time work but unable to find it) represent reduced community welfare, as limited work opportunities may lead to crime, mental illness, or substance abuse.	Number of underemployed persons × unprovided hours per constrained worker × average hourly wage rate

L. Cost of consumer durables	-	Actual expenditures on consumer durables are subtracted from GPI to avoid double counting the value of their services (item F).	Per capita personal income (item A) × national percentage of spending on consumer durables
M. Cost of commuting	-	Commuting incurs direct cost of money spent on a vehicle or public transit, plus indirect cost of time lost that might have been spent on more enjoyable or productive activities.	Cost of vehicle × percent vehicle use for commuting + cost of public transit + cost of commuting time using local wage rate
N. Cost of household pollution abatement	-	Expenditures made for air filter equipment and waste treatment do not improve welfare, but rather compensate for pollution externalities imposed by economic activity. They attempt to restore environmental quality to a baseline level.	Cost of automotive air filters and catalytic converters + cost of sewage and septic systems + cost of solid waste disposal
O. Cost of car accidents	-	GPI accounts for the impacts of car crashes on welfare by considering direct costs (property damage and healthcare expenditures) and indirect costs (lost wages).	Number of accidents × cost per accident
P. Cost of water pollution	-	Damage to water quality represents a clear welfare loss yet is ignored by GDP. The estimates are understated because of a lack of data on nonpoint sources of pollution.	Percentage of impaired water quality × benefit of unimpaired waters
Q. Cost of air pollution	-	The cost of air pollution to households, infrastructure, the environment, and human health is omitted from GDP despite its clear implications for well-being.	Pollution data × cost per unit of air pollution damage

R. Cost of noise pollution	-	The US has noise pollution regulations but no official inventories of its extent or severity. The World Health Organization (WHO) has estimated damage caused by noise pollution in the U.S.	Urbanization index values × WHO estimate of noise pollution costs
S. Loss of wetlands	-	The value of ecosystem services provided to humans by wetlands is uncounted in GDP, but societal benefits include regulated and purified water and wildlife habitat.	Total ha wetland lost × estimated wetland value per ha
T. Loss of farmland	-	Urbanization that destroys farmland results in costs such as reduced sustainable local food supply; lost scenic, aesthetic, and historic values; decreased water quality and flood control; and degraded wildlife habitat.	Farmland ha lost to urbanization × estimated farmland value per ha
U. Depletion of non-renewable resources	-	Depleting nonrenewable resources prevents future use of these resources and is unsustainable. GPI approximates the cost by using renewable energy replacement costs.	Consumption of nonrenewable resources × cost to replace with renewable resources
V. Long-term environmental damage	-	GPI attempts to account for the costs associated with long-term environmental degradation by focusing on climate disruption.	Energy consumption × marginal social cost of CO_2 emissions in a given year
W. Cost of ozone depletion	-	Loss of ozone threatens the welfare of all on the planet by increased exposure to harmful solar radiation. GPI estimates expected economic costs of this long-term environmental problem.	Release of ozone depleting chemicals × cost per kg

X. Loss of forest cover	-	Loss of forests means loss of the many goods and services provided by forests, including flood control, air and water purification, maintenance of biodiversity, wildlife habitat, non-timber forest products, and scenic, recreational, and aesthetic values.	Area of forest lost × forest ecosystem service value per ha
Y. Net capital investment	+ or -	In order for a society to avoid consuming its capital as income, it must maintain and increase the supply of capital to meet the demands of increased population. This calculation aims to estimate changes in the stock of built capital available per worker.	Scaled down national figures based on population.
Z. Net foreign borrowing / lending	+ or -	Economic sustainability is affected by the extent to which an economy relies on foreign funding to finance its current consumption.	This item is omitted due to difficulty acquiring relevant data at local scales

The methods employed in this study were designed to complement earlier GPI research. It is still worth noting certain differences between the research presented in this thesis and previous GPI studies. These differences are material. However, care has been taken to ensure that underlying differences do not influence final GPI results in ways that prevent meaningful comparisons between this thesis and other studies. Table 6 summarizes significant contributions to an evolving GPI methodology.

Table 6: Contributions and changes to prevailing GPI methodologies.

Contribution or methodological improvement	Justification for diverging from earlier studies
1940s baselines were used for the costs of wetland, forest, and farmland loss categories as opposed to pre-settlement baselines	Pre-settlement land cover baselines are inappropriate starting points for these calculations, as pre-settlement conditions are not possible or desirable in modern society
A distinction is made between nonrenewable energy resources that are consumed for electricity generation or for transportation and related sectors	Biofuels are not a suitable replacement for nonrenewable resources used in generating electricity, and should thus not be used in calculating replacement costs (as has been done in many previous studies)
The value of education is omitted	Despite the significance of education to sustainable economic welfare, it is omitted here to avoid the likelihood of double-counting – other categories such as personal consumption, value of volunteer work, and cost of crime already capture many elements of the value of education
Local analogs to GDP are more specifically classified as GSP or GSP_L	An important distinction, as GSP and more local measures of economic activity are inherently different than national measures of GDP, mostly due to transboundary accounting (or the absence thereof)
Indicator bias is acknowledged and investigated	The tendencies of any indicator system to lead toward particular social outcomes needs to be admitted and further explored
A conceptual approach to incorporating uncertainty in GPI research is presented	Uncertainty and error are largely ignored in the prevailing GPI methods, which could benefit from more accurate, quantitative descriptions of confidence in results

3.3 Results and Analysis

The analysis of the Baltimore GPI results begins with a presentation of the final GPI results and the largest positive and negative contributions to the indicator. A comparison is made between estimates of GPI and GDP-equivalent (GSP or GSP_L) for all three scales, 1950-2005, and trends in per capita GPI and GDP-equivalent are described. Further comparisons are made between GPI estimates for the states of Vermont, Ohio, and Maryland, as well as between GPI estimates for the cities of Burlington, VT; Cleveland and Akron, OH; Baltimore, MD; and the four Chinese cities of Suzhou, Yangzhou, Ningbo, and Zhejiang. Uncertainty analysis is used to determine how the final GPI results vary according to finite changes in the underlying adjustment terms.

3.3.1 Comparison of GPI with GDP-equivalents

The results of the Baltimore GPI analysis are shown in Figure 5: Baltimore City GPI per capita results compared with GSP_L per capita.; Figure 6: Baltimore County GPI per capita results compared with GSP_L per capita.; and Figure 7: Maryland GPI per capita results compared with GSP per capita.

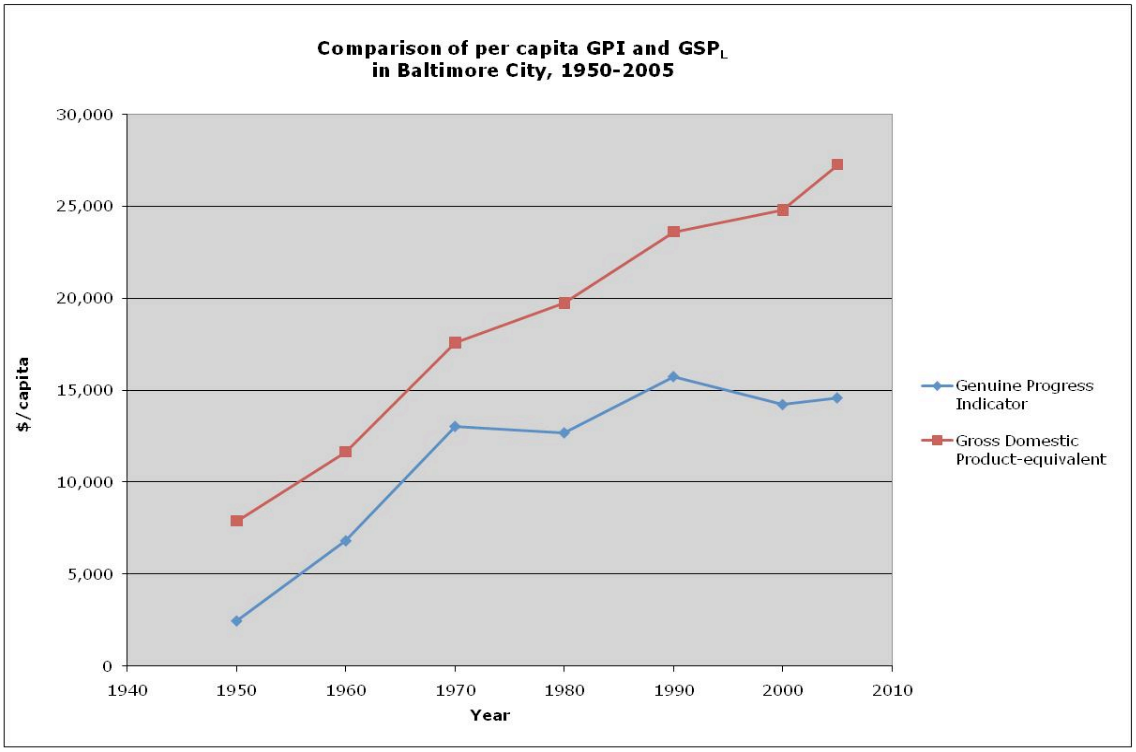

Figure 5: Baltimore City GPI per capita results compared with GSP_L per capita.

It can be seen that GPI per capita rises in Baltimore City over the study period (at an average annual growth rate of 3.2% per year for 1950-2005), but the GPI per capita rises at a slower rate in the later part of the study period. GSP_L per capita, on the other hand, shows a steadier rise throughout the entire study period. The pattern of divergence between GSP_L per capita and GPI per capita occurs most notably between 2000-2005, but the average growth rates from 1970-2005 are 1.3% per year for GSP_L, and 0.4% per year for GPI.

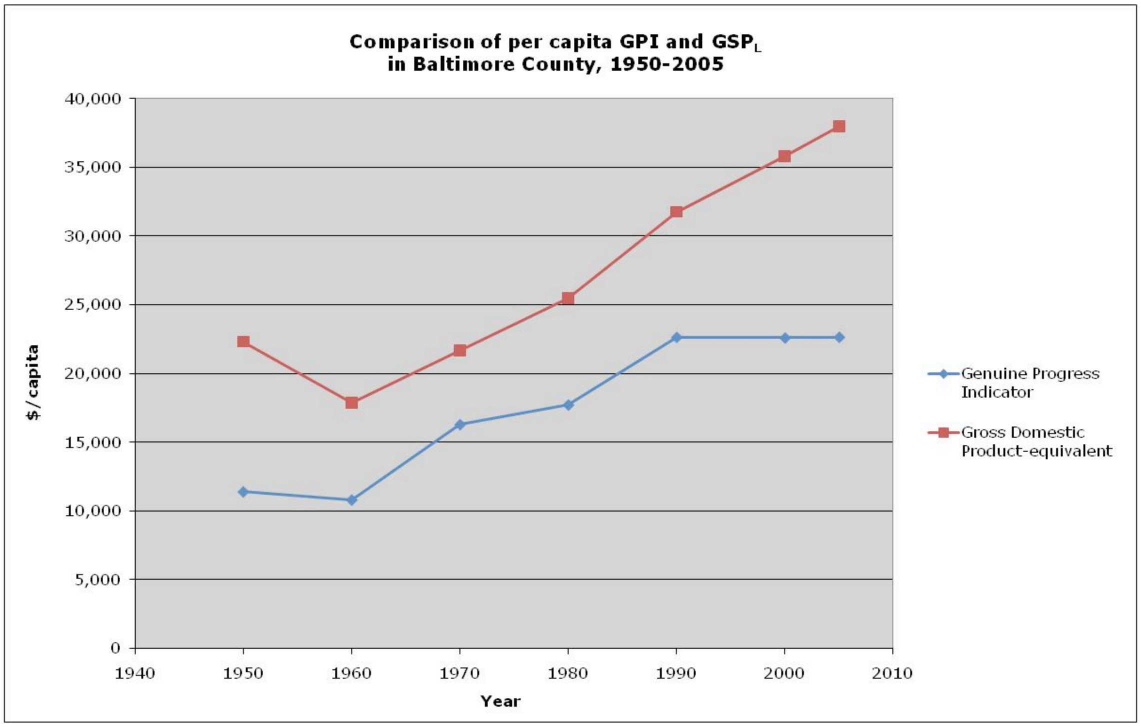

Figure 6: Baltimore County GPI per capita results compared with GSP_L per capita.

It can be seen that GPI per capita rises steadily in Baltimore County over the study period (at an average annual growth rate of 1.2% per year). In the period from 1970-2005, GPI per capita rises at 0.8% per year, which is half the GSP_L per capita growth rate in this time period of 1.6% per year. Again, the pattern of divergence between GSP_L per capita and GPI per capita in Baltimore County occurs most notably in more recent years, since 1990.

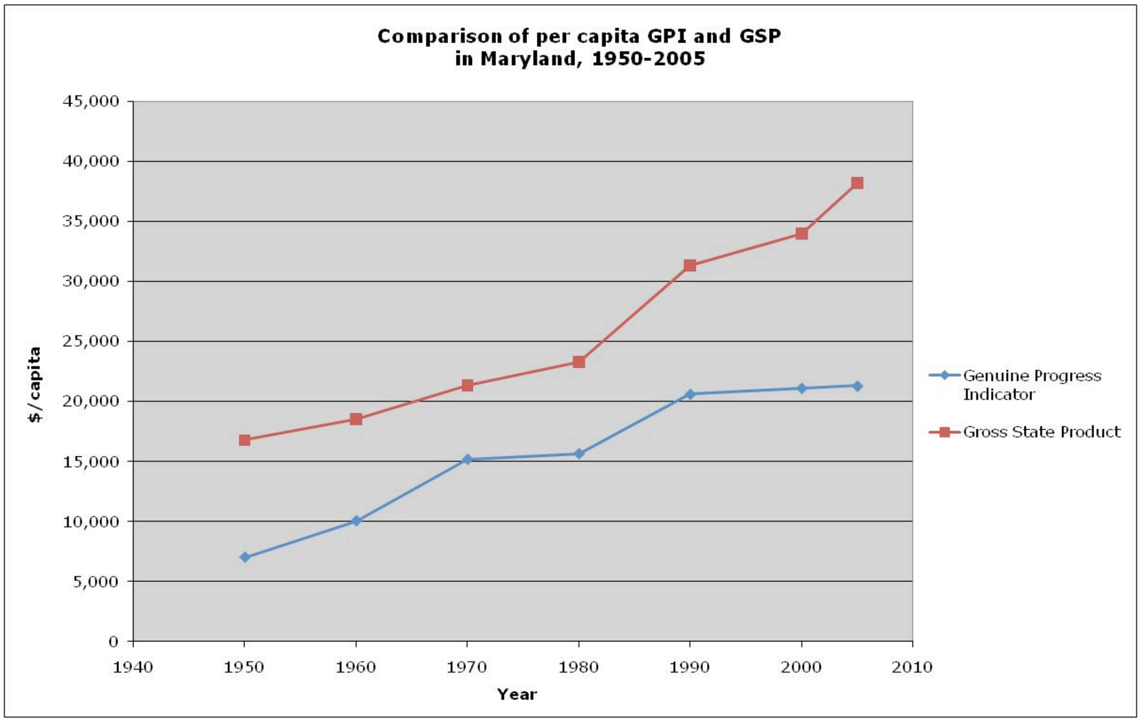

Figure 7: Maryland GPI per capita results compared with GSP per capita.

It can be seen that GPI per capita rises in Maryland over the study period (at an average annual growth rate of 1.9% per year). GSP per capita also grows at a faster rate than GPI per capita at the state scale. The divergence between GSP per capita and GPI per capita occurs since 1980, and more clearly since 1990.

The observed decadal growth trends in per capita GPI and GDP-equivalents are presented in Table 7 for Baltimore City, Baltimore County, and Maryland. At all three scales, a higher level of growth in per capita GPI marked the period of 1950-1970, while since 1970, growth rates of per capita GDP-equivalent are typically higher than per capita GPI.

Table 7: Average annual growth rates of GPI per capita and GDP-equivalent per capita in % per year for each decade.

Decade	GPI per capita average annual growth rate in %	GSP or GSP_L per capita average annual growth rate in %
Baltimore City		
1951-1960	10.8	4.0
1961-1970	6.7	4.2
1971-1980	-0.3	1.2
1981-1990	2.2	1.8
1991-2000	-1.0	0.5
2001-2005	0.5	1.9
Baltimore County		
1951-1960	-0.5	-2.2
1961-1970	4.2	1.9
1971-1980	0.8	1.6
1981-1990	2.5	2.2
1991-2000	0.0	1.2
2001-2005	0.0	1.2
Maryland		
1951-1960	3.7	1.0
1961-1970	4.2	1.4
1971-1980	0.3	0.9
1981-1990	2.8	3.0
1991-2000	0.2	0.8
2001-2005	0.2	2.4

These findings provide weak support for Max-Neef's Threshold Hypothesis, which states that economic growth as measured by GDP contributes to economic welfare only up to a point (the threshold), and that beyond this point further economic growth has a diminishing return, and sometimes negative impact, on economic welfare (Max-Neef, 1995). While GPI per capita increases across the study period for all three scales (except for 1951-1960 in Baltimore County), the trends at all scales indicate that the rate of growth of GPI is slower in more recent decades. GDP-equivalent per capita, on the other hand, does appear to grow faster in more recent decades, but not in a significant way.

3.3.2 GPI Contributions

Table 8 presents genuine progress accounts for Baltimore City in the year 2000. The figures in this table are estimates of total adjustments, not per capita estimates.

Table 8: Genuine progress accounts for Baltimore City in year 2000.

Contributions		Amount (Billions)
Value of household work and parenting	+	5.67
Value of volunteer work	+	0.94
Services of consumer durables	+	1.44
Services of streets and highways	+	0.53
Net capital investment	+	1.10
Total positive contributions to the GPI		9.67

Deductions		Amount (Billions)
Cost of inequality	−	1.73
Cost of crime	−	0.66
Cost of family breakdown	−	0.15
Loss of leisure time	−	0.33
Cost of underemployment	−	0.73
Cost of consumer durable purchases	−	1.65
Cost of commuting	−	1.25
Cost of household pollution abatement	−	0.10
Cost of auto accidents	−	0.41
Cost of water pollution	−	0.01
Cost of air pollution	−	0.18
Cost of noise pollution	−	0.06
Loss of wetlands	−	0.00
Loss of farmlands	−	0.00
Loss of forest cover	−	0.00
Depletion of non-renewable resources	−	3.71
Long-term environmental damage (carbon emissions damage)	−	1.02
Cost of ozone depletion	−	0.01
Total negative deductions to the GPI		12.00

Genuine Progress Indicator (year 2000)	9,222.24
Gross Domestic Product-equivalent (year 2000)	16,076.87

In the most recent year of the study, 2005, the most significant positive and negative adjustment items in the Baltimore GPI are similar to the results of previous GPI studies. Significance here is represented by the absolute amount by which the item adjusts GSP_L (the percentage change in GSP_L per capita due to the item). The five most significant positive and negative contributions to the Baltimore GPI are presented for the year 2005 in Table 9.

Table 9: Five most significant positive and negative contributions to the Baltimore City GPI in year 2005.

Top 5 Positive Contributions	Per capita value	% of GSP_L per capita
1.) Value of household work	$ 8,515	31.2 %
2.) Services of household capital	$ 2,375	8.7 %
3.) Net capital investment	$ 1,374	5.0 %
4.) Value of volunteer work	$ 158	0.6 %
5.) Services of highways and streets	$ 102	0.4 %

Top 5 Negative Contributions	Per capita value	% of GSP_L per capita
1.) Depletion of non-renewable resources	$ 5,934	21.8 %
2.) Income inequality adjustment	$ 4,501	16.5 %
3.) Cost of consumer durables	$ 2,714	10.0 %
4.) Long-term environmental damage	$ 1,860	6.8 %
5.) Cost of commuting	$ 1,775	6.5 %

The positive contribution of the value of household work represents the single largest adjustment to GSP_L per capita in Baltimore: more than a 30% addition to GSP_L per capita in 2005. Other city-level studies in the U.S. have similar findings: the value of household work was among the most significant adjustments to GDP-equivalent per capita in the most recent years of the studies (Costanza et al 2004; Bagstad and Ceroni, 2007; Bagstad and Shammin, unpublished). Meanwhile, the negative contribution of non-renewable resource depletion was a 21.8% subtraction from GSP_L per capita in 2005. The adjustments for income inequality and long-term environmental damage amounted to

16.5% and 6.8% subtractions from GSP_L per capita in 2005, respectively. These three items are also among the most significant negative adjustments in other city-level GPI studies in the U.S.

In 2005, the Baltimore GSP_L per capita was $27,278 and the Baltimore GPI per capita was $14,585. In 2004, the U.S. GDP per capita was $37,572 and the U.S. GPI per capita was $13,807 (all in 2000 US Dollars). While the individual items made larger adjustments to GDP in the Baltimore study than the U.S. study, the final GPI results were opposite: the Baltimore GPI per capita in 2005 was 53.5% of total GSP_L per capita and the U.S. GPI per capita in 2004 was only 36.7% of total GDP per capita. This illustrates that the absolute larger positive and negative adjustments in the Baltimore GPI more completely cancel each other. At the national scale, the negative adjustments end up deducting more from GDP than the positive adjustments add.

The trends for individual contributions to the Baltimore GPI are presented for the more recent time period of 1980-2005 in Table 10. A facial icon combined with 'traffic light colors' is used to qualitatively evaluate the trend of each indicator:

 A positive trend, indicating movement toward target

 A somewhat positive trend, indicating slight movement toward target or a mixed trend

 A negative trend, indicating unfavorable movement away from target

The economic variables show an overall positive trend, with increases in income inequality representing the only movement away from the target of increased economic welfare. The social variables show an overall negative trend due to increases in items such as the cost of crime, the cost of underemployment, and the loss of leisure time. Still, favorable trends can be seen in the decreasing costs of family breakdown and automobile accidents. The environmental variables are largely mixed, showing improvement in some conditions and decline in others. Both the final GPI per capita and GSP_L per capita trends are overall positive in that they both increase. However, it can be seen how GSP_L's growth rate outpaces growth in GPI. In this assessment of the trends of Baltimore GPI items, only the absolute growth rates in each individual item are considered. A more complete picture of Baltimore's development trends can be attained by combining these results with the previously described relative significance of each contribution (presented earlier in Table 9).

Table 10: Baltimore GPI contributions assessment 1980-2005

🙂 Positive trend 🙁 Negative trend 😐 Somewhat positive trend

Indicator (per capita estimates used)	1980	1990	2000	2005	Trend assessment
Economic Variables					
Personal consumption expenditures	100	123.7	131.8	153.8	🙂
Income distribution index	100	102.2	109.6	115.5	🙁
Consumption adjusted for income inequality	100	115.3	116.6	126.6	🙂
Value of household labor	100	124.6	107.1	104.3	😐
Value of volunteer work	100	113.4	129.8	141.1	🙂
Services of household capital	100	125.3	138.5	148.2	🙂
Services of highways and streets	100	103.5	146.7	185.0	🙂
Net capital investment	100	91.3	386.0	313.9	🙂
Net foreign lending and borrowing	100	NA	NA	NA	
Social Variables					
Cost of crime	100	148.3	143.1	127.4	🙁
Cost of family breakdown	100	95.1	98.4	91.4	🙂
Loss of leisure time	100	202.9	467.4	595.8	🙁
Cost of underemployment	100	159.2	257.6	307.0	🙁
Cost of consumer durables	100	125.3	138.5	148.2	🙁
Cost of commuting	100	120.1	141.7	130.5	😐
Cost of household pollution abatement	100	99.4	100.4	102.2	😐
Cost of automobile accidents	100	100	100	96.6	🙂
Environmental Variables					
Cost of water pollution	100	100	82.0	74.2	🙂
Cost of air pollution	100	93.3	88.4	97.0	😐
Cost of noise pollution	100	98.3	91.7	91.7	🙂
Loss of wetlands	100	119.1	148.5	159.4	🙁
Loss of farmland	100	156.8	194.8	197.1	🙁
Cost of nonrenewable resource depletion	100	94.2	99.6	103.2	😐
Cost of long-term environmental damage	100	171.3	222.4	262.9	🙁
Cost of ozone depletion	100	99.2	13.6	5.7	🙂
Loss of forest cover	100	121.0	152.6	117.7	😐
Final Results					
GPI	100	117.1	124.7	128.4	🙂
GSP_L	100	119.6	125.5	138.2	🙂

3.3.3 Comparison of Maryland GPI with other States

Figure 8 presents the estimate of the Maryland GPI per capita compared with results from Vermont (Bagstad and Ceroni, 2007) and Ohio (Bagstad and Shammin, unpublished).

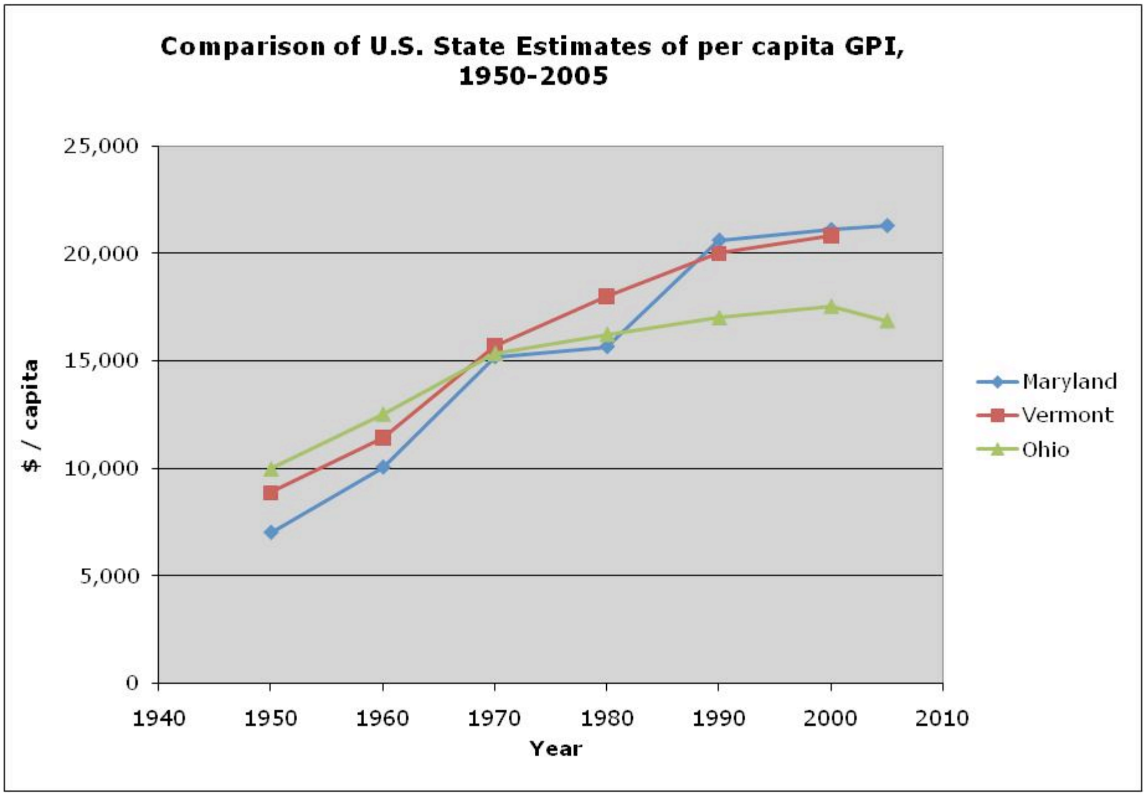

Figure 8: Maryland GPI per capita results compared with Vermont and Ohio.

All three states follow the same trend of an overall increasing GPI per capita, with Maryland's GPI per capita increasing the most at an average rate of 1.9% per year between 1950-2005. In comparison, Vermont's GPI per capita average annual growth rate is 1.7% per year between 1950-2000, and Ohio's GPI per capita average annual growth rate is 1.0% per year between 1950-2005.

3.3.4 Comparison of Baltimore GPI with other Cities

Figure 9 presents the Baltimore City GPI per capita results compared with results from Burlington, VT (Costanza et al. 2004), and the cities of Cleveland and Akron, OH (Bagstad and Shammin, unpublished).

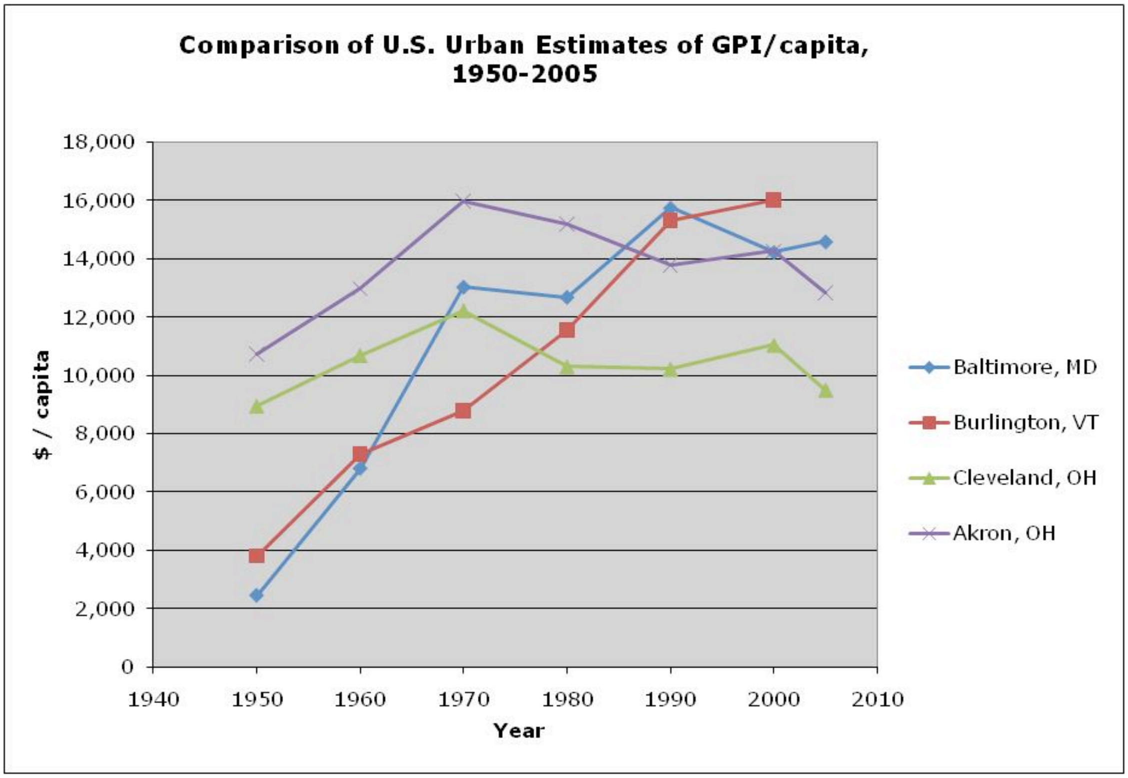

Figure 9: Baltimore City GPI per capita results compared with other U.S. cities.

The Baltimore City and Burlington GPI per capita trends both generally increase across the study periods, at average annual growth rates of 3.2% per year and 2.9% per year, respectively. Meanwhile, GPI per capita results for Cleveland and Akron both follow a different pattern, with average annual growth rates of 0.11% per year and 0.32% per year, respectively.

When the Baltimore City GPI per capita trends are compared with results for four cities in China (see Figure 10), the differences between development in the U.S. and in China can be seen clearly in comparisons of growth rates and in the absolute values of GPI per capita estimates. The absolute differences in GPI per capita estimates reflect the differences in consumption. However, even while the GPI data are only available for the study period 1991-2001, GPI per capita average annual growth rates are significantly higher in Chinese cities than in Baltimore City (Wen et al. 2007). Baltimore City's GPI per capita grew at an average rate of 3.2% per year, while in China, Suzhou grew at an average rate of 21.4% per year, Ningbo at 18.6% per year, Guangzhou at 13.1% per year, and Yangzhou at 14.4% per year. Looking only at the decade of the 1990s, all Chinese cities exhibit GPI growth, while Baltimore City shows a decline in GPI.

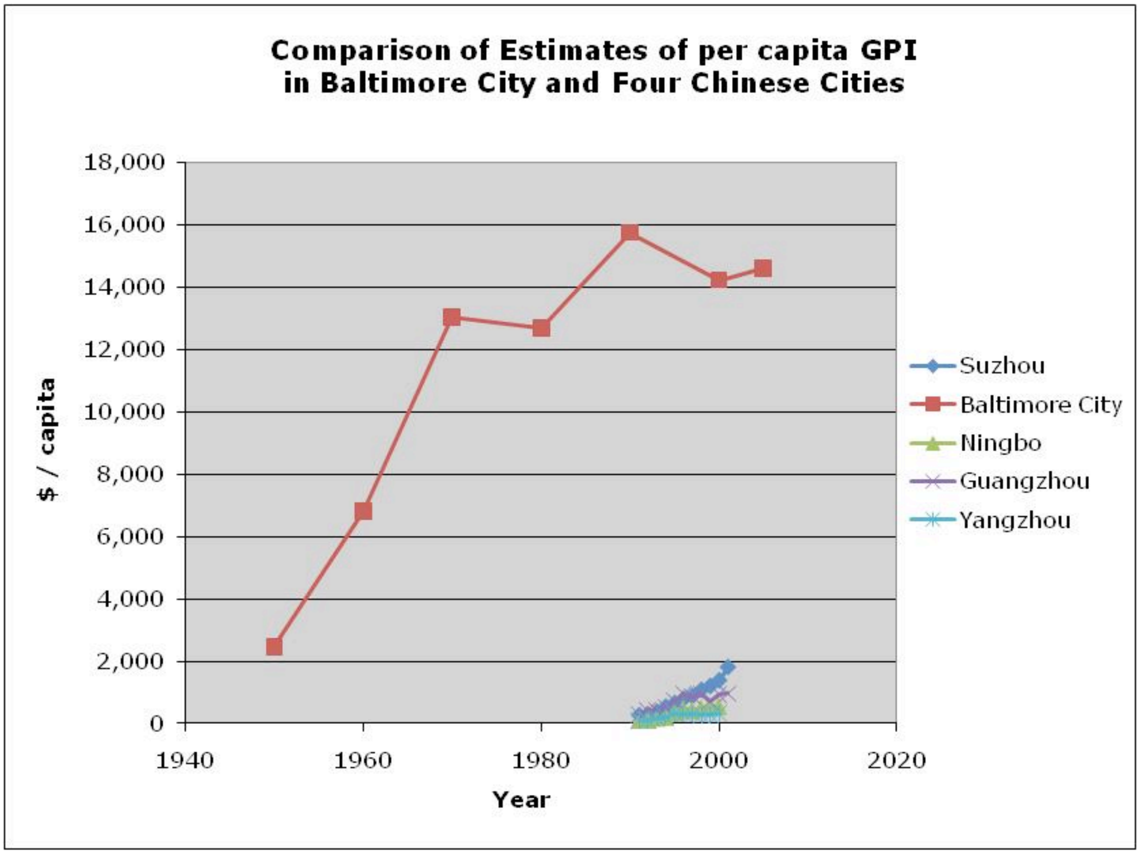

Figure 10: Baltimore City GPI per capita results compared with other Chinese cities.

3.3.5 Comparison of Two Independent GPI Studies in Maryland

Hans Haake, visiting scholar at the Center for Integrative Environmental Research at the University of Maryland, recently completed a GPI study for the state of Maryland in cooperation with the Office of Governor O'Malley and numerous state agencies, including the Maryland Department of Natural Resources, Department of Transportation, Department of the Environment, Department of Planning, and Department of Housing and Community Development. Figure 11 presents a comparison of the preliminary results from Haake's study with the Maryland GPI calculated in this thesis. The two Maryland GPI estimates were obtained independently, with careful attention given to ensuring separate models and calculations.

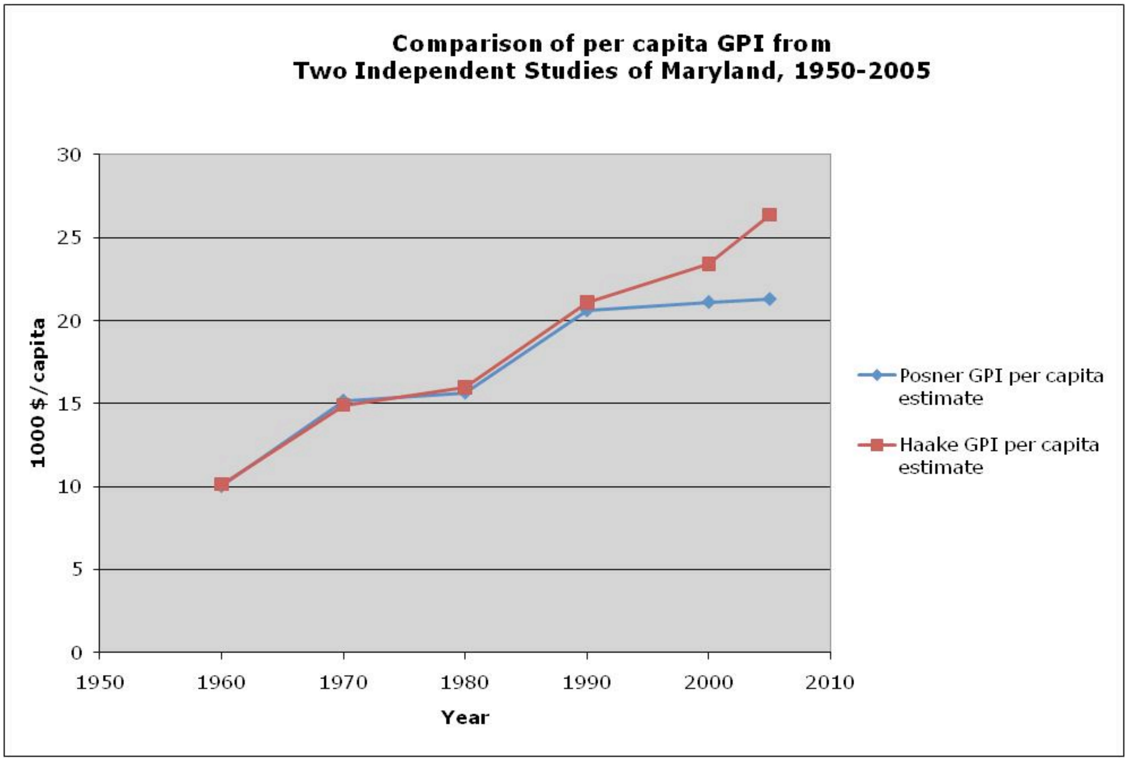

Figure 11: Comparison of Maryland GPI per capita results from two independent studies conducted simultaneously.

As can be seen, the two estimates of the Maryland GPI are in close agreement, providing compelling evidence for the stability and reliability of the GPI methods used. The GPI per capita trends diverge most in the year 2005, probably as a result of different methodologies. For example, Haake includes a positive adjustment term for the value of education, which is a significant contribution in the state of Maryland. The value of education is omitted from the Maryland GPI study presented in this thesis. Further analysis of the detailed methods of these two independent studies is planned and will likely reveal other differences that could account for the divergence toward the end of the study period.

3.3.6 Uncertainty Analysis

Herendeen (1998) defines uncertainty analysis as "the determination of how something changes (or is uncertain) with finite changes (or uncertainty) in one or more inuputs" (pg. 300). Uncertainty analysis is used to understand how changes in the underlying adjustment terms affect the final GPI result. The most significant positive and negative adjustment terms are tested for how much they can influence the GPI in Baltimore, and the results are presented in Table 11. Not surprisingly, the most significant adjustment items also had the largest influence on the final GPI when they were increased by 10%. In the section on bias, an analysis is presented for how changes in the underlying data for each adjustment term can influence final GPI trends.

Table 11: Sensitivity of the Baltimore GPI to changes in the underlying adjustment terms.

Positive adjustment terms	Change in GPI resulting from 10% increase in term	Negative adjustment term	Change in GPI resulting from 10% increase in term
Value of Household Labor	5.4%	Cost of Depletion of Nonrenewable Resources	-3.5%
Services of Household Capital	1.4%	Cost of Income Inequality	-2.6%
Services of Highways and Streets	0.06%	Cost of Consumer Durables	-1.6%
Value of Volunteer Work	0.09%	Cost of Long-Term Environmental Damage	-0.07%
Net Capital Investment	0.81%	Cost of Commuting	-1.04%

3.4 Discussion

In this section, a more in-depth analysis is presented for three adjustment terms in the Baltimore GPI: the costs of crime, the costs of long-term environmental damage, and the costs of non-renewable resource depletion. The choice of these terms for discussion is motivated by the relevance of these particular adjustment terms to Baltimore, as well as their strong influences on the final GPI results.

3.4.1 Assessment of the Cost of Crime

The cost of crime is a significant issue in Baltimore City, where crime rates are consistently much higher than the national average. Beyond the total amount of crime, the types of crimes that occur in Baltimore also reveal unfavorable social conditions: in the year 2000, violent crime accounted for 12.3% of total recorded crimes in the U.S. and 24% of reported crimes in Baltimore City (Uniform Crime Reports, 2000). Figure 12 illustrates how the estimated per capita cost of crime in Baltimore City is as high as 5 times the national estimate at the 1990 peak. Even with the recent success of crime reduction initiatives in Baltimore City, the city still struggles with crime rates well above those of the surrounding region and the United States as a whole.

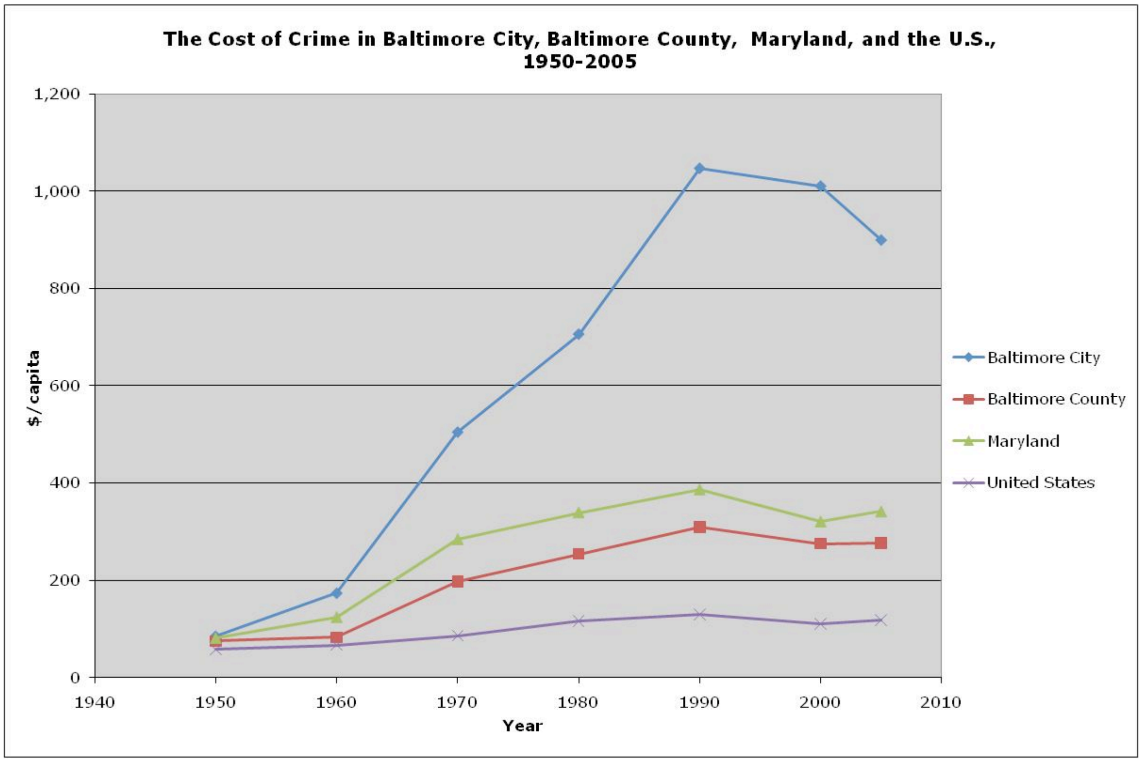

Figure 12: Comparison of the cost of crime in Baltimore City, Baltimore County, Maryland, and the U.S., 1950-2005.

The GPI's approach to the cost of crime attempts to account for the damages to human and social capital that result from crime, and to subtract these amounts from the indicator. These damages are valuated and subtracted from the indicator with the reasoning that expenditures that are a direct or indirect result of crime should not contribute positively to an indicator of well-being. Traditionally, the GPI method subtracts direct costs in the form of tangible victim injury costs, and indirect costs in the form of household defensive expenditures on security systems, locks, and safe deposit boxes.

Victim injury costs can include tangible costs such as medical costs and day of work missed, as well as intangible cost estimates, such as lost quality of life. Future GPI studies may have access to more reliable data on intangible victim costs of crime, but the Baltimore GPI study presented here uses only tangible victim costs. Another possibility for future studies is the use of locally-specific multipliers. These involve matching anonymous survey results with reported data on the incidents of crime. In actuality, more crimes happen than are reported, and the use of an empirically-based multiplier can correct for this effect, though significant uncertainty could remain around estimates of the numbers of sex crimes (Dubourg and Hamed, 2005).

Violent crimes typically account for a larger proportion of estimates of the total cost of crime, even while the number of incidents for violent crimes may be lower than the number of non-violent crimes (as is the case in Australia – see Mayhew, 2003). There is considerable uncertainty in assessing the lost community capital that results from crime (i.e. in the form of lost sense of trust, safety, and comfort), but attempts to do so have still been made. For example, Lawn and Clarke (2008) presents a study of the Thai GPI that includes an estimated cost of corruption of bureaucrats and politicians (based on a % of annual GDP growth).

Public expenditures on law enforcement could contribute positively or negatively to an indicator of welfare, though they are largely omitted from GPI methods. On the one hand, the conditions that require large law enforcement expenditures are detrimental to well-being. On the other hand, spending on law enforcement plays an important role in keeping crime to tolerable levels and could be viewed as contributing to economic welfare by creating safer communities. Expenditures on criminal justice systems and on the regulation and litigation associated with corporate crime could also be included in future GPI studies.

3.4.2 Assessment of the Cost of Long-Term Environmental Damage

The valuation of long-term environmental damage relies upon greenhouse gas (GHG) emissions and related costs of climate change. Several issues arise surrounding the quantifying of CO_2 impacts to natural and built capital, as well as the cost of climate change damages. The questions of cumulative costs, marginal social costs, and marginal abatement costs are thought through in this section.

Daly and Cobb (1989) approached the costs of long-term environmental damage by proposing a tax on the consumption of non-renewable energy resources. The amount of the tax is admittedly arbitrary, and defended on the grounds that ignoring climate change because of uncertainty and disagreement about methods has been a mistake. GPI studies for the U.S. and Vermont also apply a tax to non-renewable energy resource consumption in order to estimate the cost of long-tern environmental damage (Talberth et al. 2007; Costanza et al. 2003; Bagstad and Ceroni, 2007). The arbitrariness of the amount of the tax has drawn considerable criticism, leading to the development of alternative valuation methods for the cost of climate change (Bleys, 2007).

Jackson et al. (1997) proposed one such different method in their ISEW study for the United Kingdom: their approach assigns a marginal social cost to each tonne of GHG emissions that “reflects the total (discounted) value of all future damage arising from that tonne of emissions." The costs of climate change are calculated by multiplying the carbon emissions in a given year by the marginal social cost for that year (which varies over time to reflect how the damage estimate depends on the total stock of atmospheric carbon). Total costs of climate change in each year are determined by accumulating annual costs since 1900. This 'marginal social cost' method is an improvement over the 'arbitrary tax' method in that it makes use of more recently available data and is based on carbon emissions directly rather than nonrenewable resource consumption. The 'marginal social cost' method also goes beyond present-day annual damages to include the discounted value of welfare loss incurred by future generations (Bleys, 2007).

Neumayer (2000) takes issue with the accumulation of the cost of climate change. He argues that accumulation leads to multiple counting because valuing GHG emissions with a marginal social cost in a given year already includes the discounted future costs of the emissions over all time. Lawn (2005) defends the accumulation, arguing that GPI measures sustainable economic welfare at the time it is experienced, and past GHG emissions affect this experience. The decision to accumulate the costs of climate change or not has been determined by the researchers conducting the GPI study. For example, in Vermont, Costanza et al. (2004) choose to accumulate costs while Bagstad and Ceroni (2007) choose not to accumulate. This inconsistency in methods has also drawn criticism, as a researcher's subjective choice of method leads to different outcomes.

I agree with Lawn that the total cost of climate change in any given year should include the cumulative impact of climate change damage of the past and present economic activity, but Neumayer's argument is more theoretically sound in pointing out how the marginal social cost captures the discounted costs of GHG emissions over time. For these reasons, the Baltimore GPI methods follow Bagstad and Ceroni (2007) and Shammin and Bagstad (unpublished), and do not accumulate the costs of climate change. The later section on indicator bias includes some more consideration of how accumulation of the costs of climate change affects the final GPI results.

Estimates of regional impacts of climate change would improve sub-national GPI studies by providing more accurate data on the costs of climate change. In particular, regional assessments could reveal unequal distribution of costs and benefits related to climate change (i.e. some areas may benefit from the consumption of fossil fuels while other areas may incur climate change costs disproportionate to their consumption of fossil fuels). Regional variation in climate change impacts is an example of the inherent uncertainty and imprecision that needs to be explicitly addressed when estimating the impacts of climate change (Borsuk and Tomassini, 2005). The Baltimore GPI study acknowledges the uncertainty in the costs of climate change by examining the range of estimates that can be found using different methods (see following section on bias in the Baltimore GPI).

Estimates for the total cost of long-term environmental damage in Baltimore City, Baltimore County, and Maryland are presented in Figure 13.

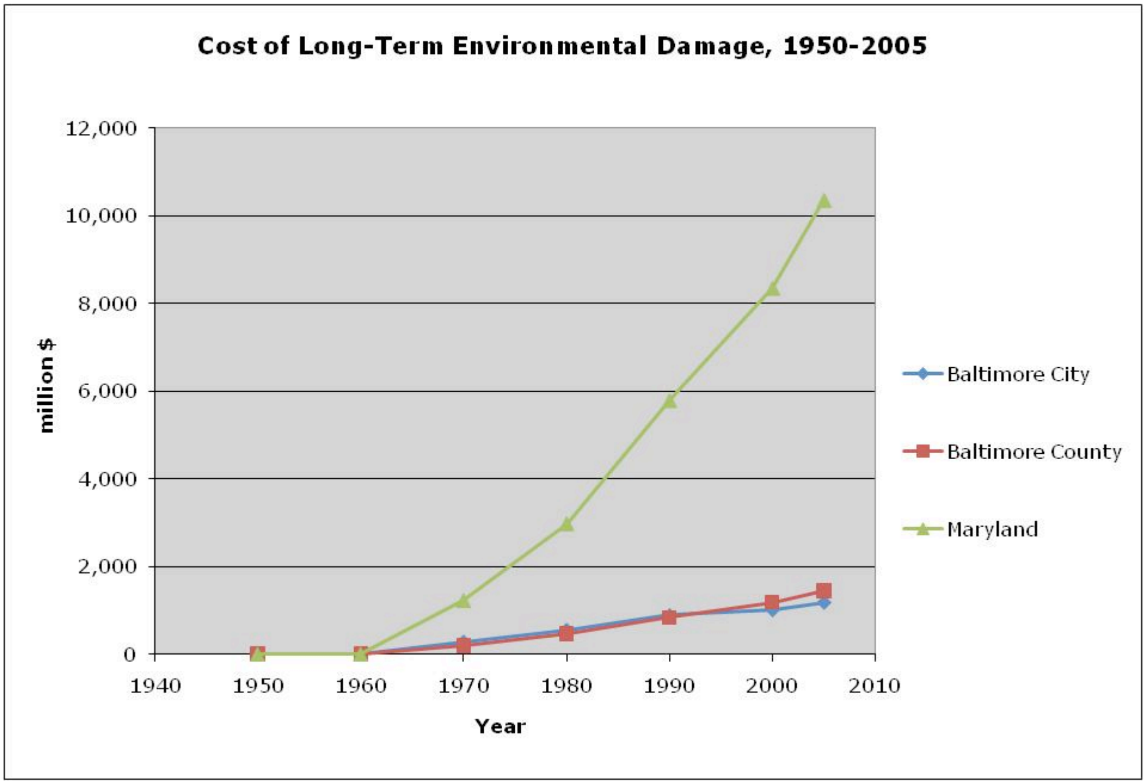

Figure 13: Total cost of long-term environmental damage in Baltimore City, Baltimore County, and Maryland.

The per capita estimates are the same for Baltimore City, Baltimore County, and Maryland, as all three sub-national estimates were scaled based on population. These estimates do not include accumulating costs of carbon dioxide emissions – they count only the estimated damage of emissions in that year. Figure 14 shows two estimates of per capita cost of long-term environmental damage in Baltimore City: one with accumulating costs from carbon dioxide emissions, and one with non-accumulating costs.

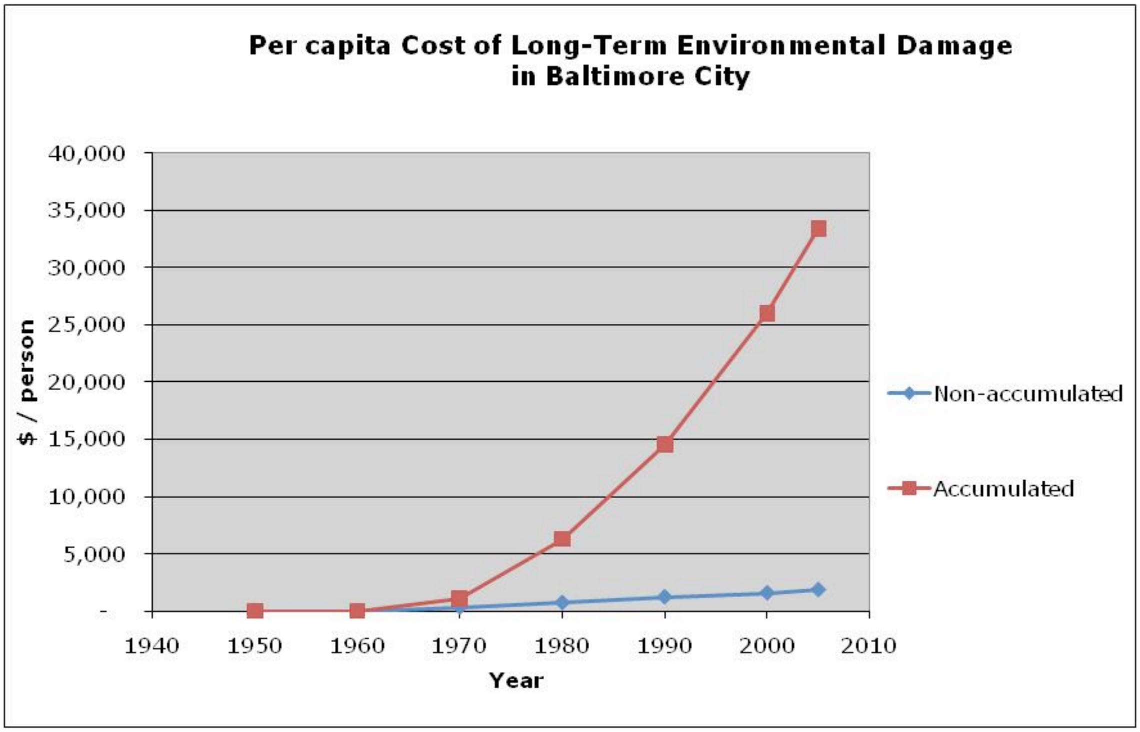

Figure 14: The effect of accumulating the cost of carbon dioxide emissions in Baltimore.

3.4.3 Assessment of the Cost of Non-renewable Resource Depletion

In estimating the costs of non-renewable natural resource depletion, GPI methods rely upon energy resource consumption data and renewable energy replacement costs. By estimating the cost of substituting nonrenewable energy resources with renewable energy resources, the GPI treats the depletion of nonrenewable resources as a cost rather than a benefit. Figure 15 shows the per capita cost of nonrenewable resource depletion for all three scales for the entire study period (the graphs are the same because of scaling down to local levels based on population).

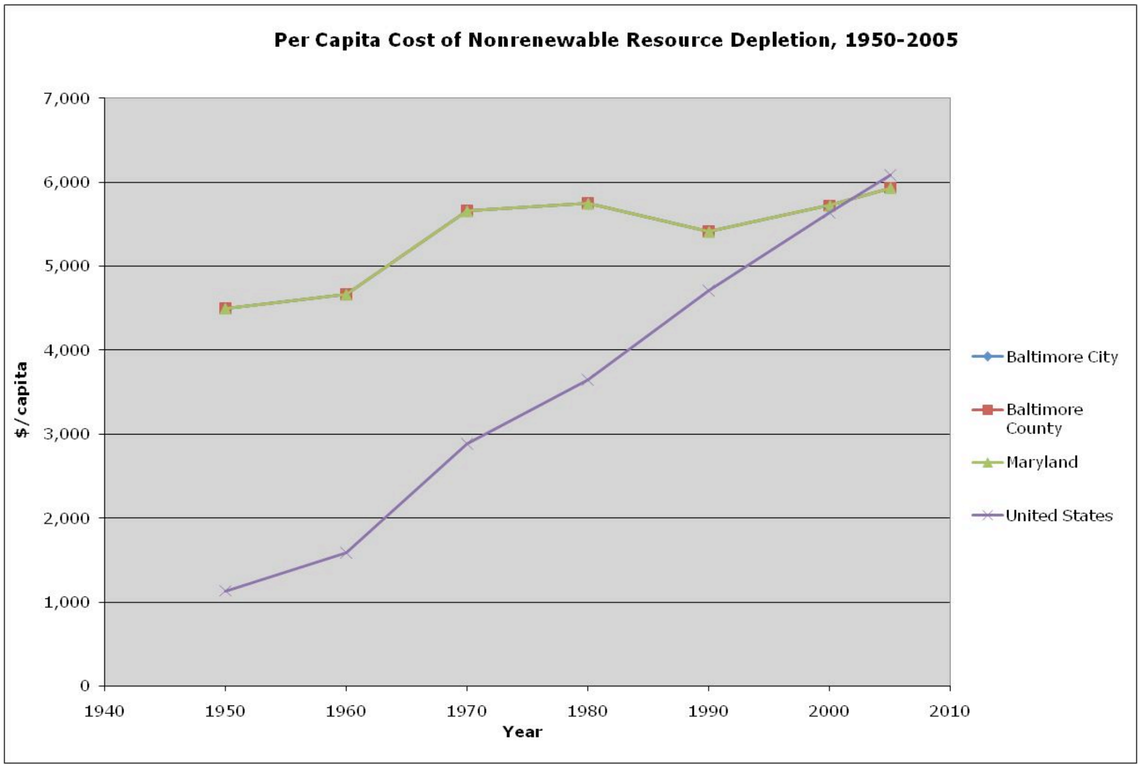

Figure 15: Estimates of the per capita cost of nonrenewable resource depletion.

Daly and Cobb (1981) originally employed the El Serafy method in accounting for the way that depletion of nonrenewable resources diminishes income possibilities for future generations. El Serafy's method involves estimating a 'true' income (different that the total income) that does not compromise the ability of future generations to generate income from an intact natural capital base (El Serafy, 1991). The method uses an estimate of the number of years to depletion (based on the static lifetime and depletion rate of a depletable resource) and an interest rate on alternative investments in order to determine the fraction of total revenue that should be subtracted. Cobb and Cobb (1994) responded to criticism of this method by introducing a different valuation method based on the amount of money needed to compensate future generations for the loss of natural capital. Their replacement cost method estimates the amount that future generations will have to pay in order to replace depleted nonrenewable resources with renewable substitutes.

Neumayer (2000) disagrees with the way replacement cost methods used in GPI studies imply that nonrenewable resources must be substituted right away (the GPI approach subtracts replacement costs in the same year when the depletion takes place), even though there are still plenty of reserves available. Lawn (2005) defends the GPI approach on the grounds that regardless of when renewable substitutes will be needed, the cost of developing a renewable substitute must be incurred when the depletion takes place. The Baltimore GPI accepts Lawn's theoretical basis and employs the replacement cost approach to valuing the depletion of nonrenewable resources.

Another controversial issue arises in considering whether to base nonrenewable resource depletion on resource production or consumption. Past GPI studies differ in their use of energy resource production or energy resource consumption approaches to the cost of nonrenewable resource depletion. Deducting nonrenewable energy resource *production* essentially removes a non-sustainable source of income from national accounts (Shammin and Bagstad, unpublished). Estimating the cost of nonrenewable energy resource *consumption*, on the other hand, incorporates the costs of replacing nonrenewable energy resources with renewable substitutes. GPI studies should consider whether the production or the consumption of nonrenewable resources is a more appropriate approach. If a region is a net energy consumer, then consumption data should be used; if it is a net producer, then production data are more appropriate. In this way, the

GPI results will reflect the larger estimated impact between nonrenewable resource production or consumption.

In several GPI studies, the renewable resource replacement cost was based upon ethanol (Anielski and Rowe, 1999; Costanza et al. 2004; Venetoulis and Cobb, 2004; Talberth et al. 2007). However, as pointed out by Shammin and Bagstad (unpublished), biofuels are not suitable replacements for all nonrenewable energy resources. As a result, the Baltimore GPI distinguishes between nonrenewable resources used for transportation and related sectors (which can be replaced by biofuels), and nonrenewable resources used to generate electricity (which can be replaced by wind or solar). The separation of these two categories of nonrenewable energy resources provides a more accurate estimate of replacement costs.

Yet another method exists that avoids incorporating the depletion of nonrenewable resources into a single, final indicator. This promising approach does not account for depletion by adjusting to an aggregated, summary indicator (i.e. GDP, GPI, or income). Rather, it develops a separate satellite account for the monitoring and reporting of natural capital. Satellite accounts can capture a level of detail that is lost by summary indicators that attempt to aggregate disparate information into a single metric. However, while satellite accounts provide more details about the depletion of natural capital, they do not consider the anticipated interaction between stocks of natural resources and prices (Herendeen, 1998). Future models of the dynamics of natural resource stocks and prices could provide better grounding for the development of satellite accounts. Nevertheless, the more comprehensive description of natural capital provided by satellite accounts may be the best way to inform decision-makers and the public about nonrenewable resource depletion.

CHAPTER 4: CONCLUSIONS

Despite the widespread recognition that GDP fails as a true measure of sustainable economic welfare, alternative indicators have yet to be fully developed, regularly published, or integrated into economic policy and decision-making. The estimate of the Baltimore Genuine Progress Indicator contributes to the efforts to develop better measures of progress. This study highlights the importance of investing in collection of the right kinds of data and helps point the way towards which aspects of economic activity, social conditions, and environmental conditions are worth tracking. This chapter presents some policy implications stemming from the Baltimore GPI, some indicator bias inherent in the GPI methodology, and ideas for moving forward in the development and application of the GPI.

4.1 Policy Implications

The Baltimore GPI further establishes the GPI as a tool for realigning policy goals with increased genuine quality of life for all. A more thorough re-examination of the GPI impacts of past policies, as well as analysis of predicted GPI impacts from future development scenarios could provide insight into the effects of policy changes on true economic welfare. Infusing debate with concepts from the GPI and ecological economics could persuade local government to predict the effects of land use or transportation policies on a region’s GPI, rather than focusing solely on the effects on GDP. What if economic development decisions were made by considering the impacts of projects on economic welfare rather than GDP? Development decisions could involve estimates of how a project might have a return on economic welfare for each dollar invested, similar to current assessments of 'jobs per dollar invested.' When making trade-offs about how to allocate scarce resources to alternative desirable ends, decision-makers could pay attention to expected benefits in the form of GPI growth.

Regular reporting of a city's GPI could have important consequences for city officials. The use of GPI in local government decisions could represent a wider effort for public organizations to become environmentally responsible, economically profitable, and socially fair at the same time. Achieving environmental, social, and economic progress is a political challenge, as these goals are often perceived as competing for limited resources, with many still believing that environmental responsibility must come at the expense of economic profit (Zeemering, 2009). In some instances, trade-offs must be made between competing aims, but environmental, economic, and social goals do not have to be mutually exclusive. The GPI is a useful framework for understanding how certain environmental and social conditions are related to economic welfare. More widespread adoption of a better indicator such as GPI has potential to inform local government officials about the true nature of economic development in their communities. Those who help shape government policy can then champion the sustainable economic welfare goals of GPI, and share information with citizens and the business community.

From a policy perspective, local GPI studies point to policy recommendations that are in the domain of national governments (Clarke and Lawn, 2008). This makes it difficult for sub-national authorities to significantly influence GPI trends in their communities, as larger impacts to economic welfare and GPI would result from national policies. For example, the Baltimore GPI study has resulted in the following policy recommendations, all of which are most effectively implemented at the national level.

- Incentives to foster research and development into green technologies
- Policies to promote resource-conservation and the reduction of industrial material and energy throughput
- Accounting policies to internalize the external and non-market costs of economic growth
- Ecological tax reform to "reward 'welfare-increasing' business behavior … encourage the development and uptake of resource-saving technologies … and penalize environmentally-destructive behavior" (Clarke and Lawn, 2008, pg. 580).

Still, informing political leaders can change the context in which other decisions are made (Arbuthnott, 2008). A more developed indicator system such as GPI would bring sustainability to the attention of multiple levels of government, with implications for planning, economic development, civic engagement, and environmental initiatives (Zeemering, 2009). If decisions at the local level are made based on the GPI, then there is potential for others to follow. Reports on GPI trends could answer the call for performance measures more closely aligned with sustainable economic welfare and progress towards sustainability goals.

4.2 Quantitative Bias Inherent in GPI

Within any indicator framework, value judgments are made about the desirability of particular indicator trends (i.e. it is good if indicator X goes up). The GPI framework is no different and contains assumptions about how changes in the underlying adjustment terms affect economic welfare. In the sub-national GPI study presented in this thesis, the methods inevitably lead toward certain results, giving rise to an indicator framework that implicitly favors particular policy and development outcomes. This 'indicator bias' can lead to undesirable outcomes if it reinforces conditions or behaviors that are not necessarily beneficial for sustainable welfare. In this section, I test key assumptions that contribute to indicator bias in order to explore how they influence the final GPI results. The analysis, which is summarized in Table 12, reveals some of the inherent tendencies built in to the GPI framework.

Table 12: Summary of indicator bias in the Baltimore GPI.

Aspect of GPI Affected	Indicator Bias	Underlying Assumptions
Cost of household pollution abatement	Toward more sewers and less septic systems	Cost of sewer installation is $0
Costs of wetlands, forest cover, and farmland loss	Toward baseline conditions, with varying strength depending on choice of baseline	Choice of baseline to represent desirable land cover conditions
Cost of income inequality	Toward less inequality in distribution of incomes, with varying strength depending on choice of optimal level of inequality	Choice of desirable level of income inequality; choice of whether to weight final GPI or personal consumption expenditures
Cost of family breakdown	Toward no divorces	All divorces are universally bad for sustainable economic welfare
Cost of long-term environmental damage	Toward less consumption of nonrenewable energy resources (and thus lower CO_2 emissions), with varying strength depending on accumulation and value of marginal social cost	Choice of whether to accumulate costs over time; choice of marginal social cost and whether it increases over time
Transboundary costs and benefits	Toward externalizing environmental, economic, and social costs	Ignores the distribution of costs and benefits from economic growth
Treatment of costs that are miscounted as benefits	Toward a higher GPI	Costs that GDP miscounts as benefits are subtracted only once

Household Pollution Abatement

Development and land use debates sometimes contest whether centralized water treatment systems are more beneficial than decentralized, local septic systems. The cost of household pollution abatement term in the GPI accounts for two options for the treatment of household wastewater: sewer or septic. In making a distinction between the economic welfare benefits of these two options, the GPI makes a value judgment about which of these options is more optimal than the other.

The total cost of household pollution abatement considers water, air, and solid wastes. The wastewater part (which accounts for an average of 60% of the total cost of household pollution abatement in Maryland over the entire study period) adds together the cost of septic and the cost of sewer. In 2005, the total cost of sewer treatment was over 20 times higher than the total cost of septic systems. If a community adheres to the GPI as a measure of progress, then this number will likely increase as indicator feedback pushes toward more sewers. An increase in the ratio of sewer to septic systems leads to a higher GPI. A decrease in the ratio of sewer to septic systems leads to a lower GPI.

Assume that the total number of households needing wastewater treatment remains constant, but the ratio of septics to sewers does not. Starting from the Maryland 2005 figures, the effects are observed for a 10% increase and decrease in the number of households using sewer (and the corresponding decrease and increase in the number of households using septic). A 10% increase in the number of households with sewer causes the cost of sewers to increase by 10%, and the cost of septic to decrease by 80%. The total cost of wastewater treatment increases by 12%. On the other hand, a 10% decrease in the number of households with sewer causes the cost of septic to increase by a factor of 37, and the total cost of wastewater treatment to increase by a factor of 2.4.

This means that, since the GPI calculates the cost of septic systems as considerably higher than the cost of sewers, the GPI will guide development toward more sewers and less septics for household wastewater treatment. Minimizing the cost of this negative adjustment term will produce a more favorable GPI outcome, and this can be achieved through a shift toward centralized wastewater treatment.

There is no one correct method for treating residential wastewater. In some cases, sewer systems may make more sense; in other situations, septic systems are the ideal situation from a sustainable economic welfare perspective. The GPI's preference for sewer systems is a product of the underlying valuation methods. In calculating the cost of septic, the GPI methods include a cost of $4000 per septic installation. In the GPI's valuation of the cost of sewer, however, there is no cost of installation (only the average usage of 3000 gallons per person and the utility rate are accounted for). Thus, the GPI assumes the cost of installing a sewer system is $0. In reality, the actual cost is greater than $0 and is related to sewer system infrastructure, including pipes, plumbing, and water treatment plants, much of which could come about from public expenditures. A more appropriate valuation method for estimating the cost of household pollution abatement would include the costs of sewer infrastructure. This would lessen the GPI's indicator bias toward more sewer and less septic systems.

Cost of Wetlands Loss, Cost of Forest Cover Loss, Cost of Farmland Loss

A major assumption used in these three adjustment terms has to do with the baseline that is chosen for land cover figures. Earlier GPI studies use estimates of pre-settlement land cover acreage to calculate the costs of lost wetlands and forest cover. Later studies have recognized that pre-settlement forest cover and wetland conditions are likely unattainable in modern society, and may not even be desirable. Thus, more recent GPI studies use some year before the study period as the baseline from which changes to land use are measured and valued in terms of the effects on economic welfare. The selection of a particular year as the optimal land use condition can have a significant impact on the final GPI results.

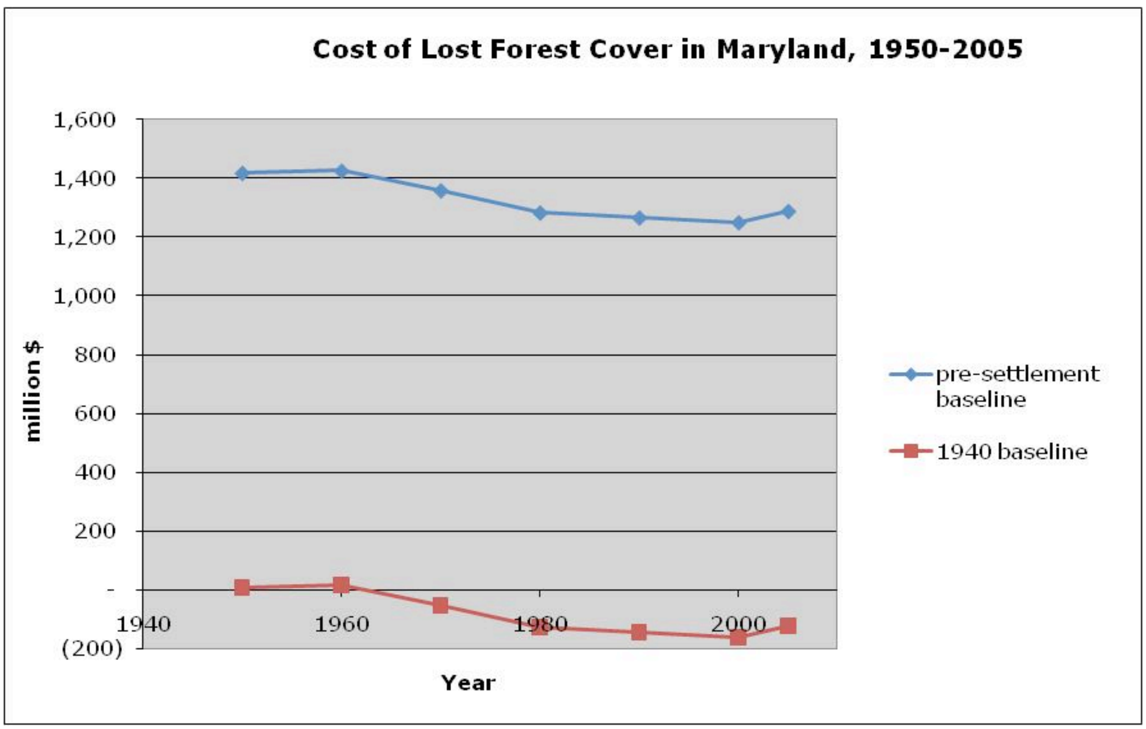

Figure 16: Cost of lost forest cover in Maryland with different land cover baselines.

Figure 16 shows the difference in cost of lost forest cover in the Maryland GPI when using either a pre-settlement baseline or a year-1940 baseline. Using a pre-settlement baseline increases the cost of lost forest cover significantly. In fact, using a 1940s baseline actually leads to several years with a negative cost, or a benefit (due to forest cover conditions that have improved over the 1940 baseline). The bias in GPI toward increased wetland, forest cover, or farmland acreage occurs regardless of the baseline used, but the choice of baseline influences the strength of the bias in this term.

Cost of Income Inequality

One measure of inequality uses an Atkinson income that indicates "the proportion of the present total income that would be required to achieve the same level of social welfare as at present if incomes were equally distributed" (Atkinson, 1983, pg. 57). This approach explicitly states a society's aversion to inequality in income distribution. GPI, on the other hand, uses a measure called the Gini coefficient and makes an assumption about the optimal level of income inequality in society. GPI does this by choosing the year in the study period with the lowest level of inequality as measured by the Gini coefficient. The percent change of any deviation from this low point is then used to weight personal consumption expenditures before making subsequent adjustments. This method implicitly assumes that the lowest level of inequality is the optimal condition from an economic welfare perspective.

The justification for this adjustment in GPI comes from evidence that inequality in the distribution of income can diminish a nation's economic welfare (Easterlin, 1974; Abramowitz, 1979). But, how much inequality is too much? More research is needed to better understand how changes in the distribution of income impact economic welfare, and sustainability. The GPI methods require a choice of a historical condition as a baseline (the lowest level inequality over the study period) and the GPI then either goes up with less inequality, or down with more inequality. Along with using different baselines for the optimal level of inequality, GPI studies have used different methods for weighting. For example, Stockhammer et al. (1997) use their inequality index to weight the final GPI value as opposed to personal consumption expenditures. The choice of an optimal level of inequality (i.e. a particular year when inequality is assumed to be at its "best"), as well as whether to weight personal consumption only or the entire final GPI figure, can lead toward stronger or weaker bias in the GPI toward less inequality in the distribution of incomes.

Cost of Family Breakdown

Within the cost of family breakdown adjustment, GPI uses estimates of the direct cost of divorce and the cost of divorce to children. By subtracting expenditures on divorce-related goods and services, the GPI methods assume that divorce is universally bad. GPI thus fails to account for the ways that divorce can benefit individuals and communities. It is unrealistic to assume that every divorce results in a negative contribution to welfare, when some divorces undoubtedly lead to improvements in quality of life for those directly involved and others. Figure 17 shows how the estimated cost of family breakdown is affected by the assumptions that all or half of divorces are bad (where "bad" in this context means it is a cost that warrants being subtracted within GPI). The effect is slight, but in counting all divorces as universally bad, GPI is biased toward a society with no divorces despite the ways in which divorce can actually contribute to economic welfare.

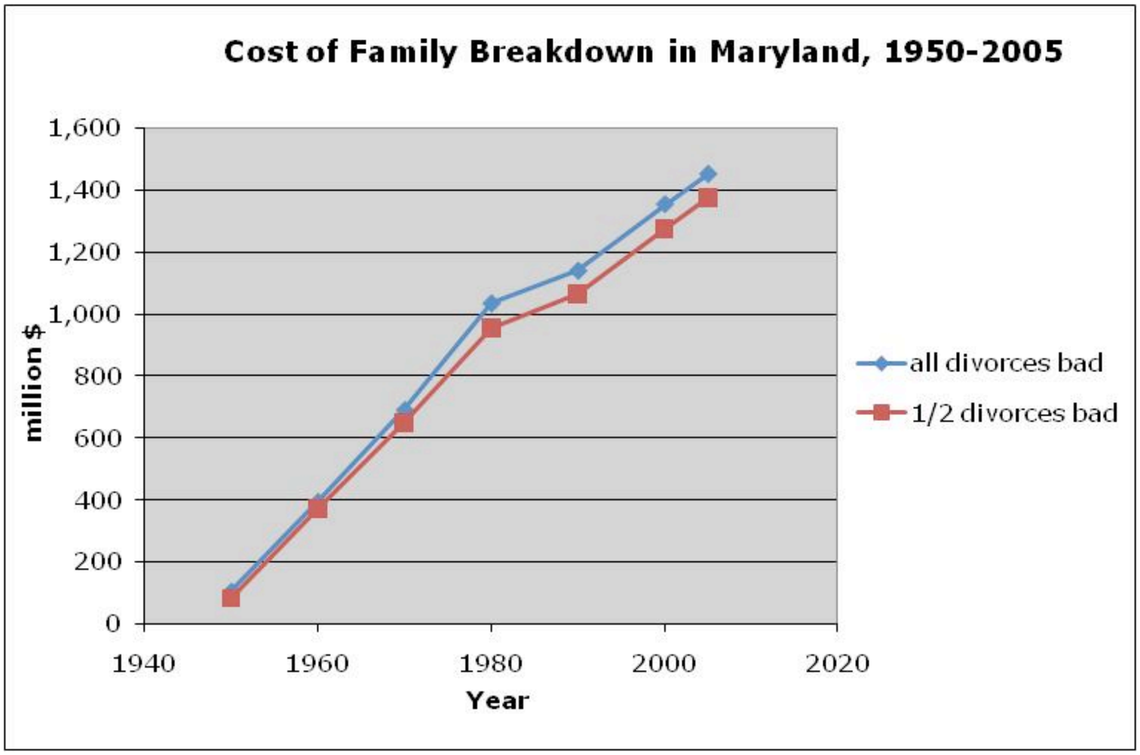

Figure 17 : Cost of family breakdown in Maryland with all and with half of all divorces bad.

Cost of Long-Term Environmental Damage

The GPI framework is rightfully biased toward lower CO_2 emissions. However, the degree to which GPI can lead society toward lower carbon emissions is a consequence of i.) whether the costs of climate change are accumulated over time (as described earlier), and ii.) the choice of a particular marginal social cost per ton of CO_{2e} emitted, and whether this cost increases over time. As noted in the detailed GPI methods in Appendix II, there are many widely varying estimates for the marginal social cost of carbon dioxide emissions. Tol (2005) reviews 103 estimates from 28 published studies that range from -6.6 to 1,667 dollars per ton CO_{2e} emitted. The range and distribution of marginal social cost estimates suggests a high level of uncertainty in estimates of the marginal social cost of carbon dioxide emissions. Tol (2005) claims that "the marginal damage costs of carbon dioxide emissions are unlikely to exceed $50/tC, and probably much smaller." The strength of GPI's bias toward reduced CO_2 emission is largely determined by the selection of this marginal damage cost value. The GPI study presented in this thesis uses a marginal social cost of CO_2 emissions that escalates from $1 to $104 per ton CO_{2e} emitted. The uncertainty and controversy in choosing "the right" marginal social cost makes it impossible to avoid this indicator bias in GPI.

Transboundary Costs and the Distribution of Costs and Benefits from Economic Growth

Overall, the GPI ignores the distribution of costs and benefits among various regions. GPI focuses on the location where the consumption of goods or services occurs, but the costs associated with economic growth can be born far from the place of consumption. For example, one region may enjoy the benefits of natural resource consumption (and have an inflated GPI) while another region may bear the costs of depleted natural capital stocks (and have a lowered GPI) (Lawn and Clarke, 2008). This can lead to one region's economic welfare being artificially supported by externalizing costs to another region. The failure to properly account for resource and waste imports and exports creates indicator bias in GPI toward exporting the costs of economic growth to other locations.

Treatment of Costs that are Miscounted as Benefits

Subtracting a cost that is miscounted as a benefit is one of the ways that GPI purports to 'correct' GDP (for example, in many instances GDP counts pollution as a benefit when it is actually a cost). If indeed GDP counts something as a benefit and it is really a cost, then proper accounting would mean this item should be subtracted once so that it is not counted as a benefit, and once more so that it is appropriately counted as a cost. Thus proper accounting for these items in GPI would involve subtracting them twice. But, these terms are only subtracted once, creating indicator bias within GPI methods toward more conservative estimates of economic welfare.

4.3 Recommendations for Future Work Developing Genuine Progress Accounts

The results of this GPI study will enrich the flux of information in the Baltimore urban ecosystem by providing citizens with integrated indicators of environmental and social well-being. This scientific research in the Baltimore region cannot exist independently from the knowledge and behaviors within the community (Picket et al. 2008). An interesting approach to future work with sub-national applications of the GPI would be to study the impact that GPI information has on public and private decision-making. The environmental and economic information provided by GPI is understood to inform collective decision-making, but more research is needed to understand how tracking and reporting on GPI can influence individual behaviors. One promising approach to these issues is to consider the interactions among determinants of behavior, and the interdependence of complex ecological and economic systems. For example, social and environmental conditions affect GPI, while at the same time, the information provided by GPI influences social and environmental conditions.

This study of the Baltimore GPI will provide a stronger foundation for future studies of economic welfare at the local level. As a more consistent set of adjustment terms and methods are developed, GPI may become more widely accepted as a policy and planning tool. There is a growing consensus that the world needs to move beyond GDP to develop more accurate, meaningful measures of welfare and sustainability. For example, the Beyond GDP international initiative states that

> "GDP is not meant to be an accurate gauge of longer term economic and social progress and notably the ability of a society to tackle issues such as climate change, resource efficiency or social inclusion. There is a clear case for complementing GDP with statistics covering the other economic, social and environmental issues, on which people's well-being critically depends."
>
> - August 20, 2009 Communication from the European Commission

Similar findings have been released by the Commission on the Measurement of Economic Performance and Social Progress organized by President Sarkozy of France. The case for GPI as a better method of measuring national progress than GDP is weakened by the way in which each GPI study uses a different approach based on the preferences of self-appointed experts. A more standardized and improved GPI methodology could inspire more consistent national and sub-national applications of GPI, with more meaningful comparisons among results.

GPI is fundamentally flawed in its dependence on consumption and "having" as a proxy for progress. In relying so heavily upon consumption, GPI implicitly assumes that human wants are insatiable and that more is always better. In truth, there is more to well-being than can be portrayed by a measurement of consumption that fails to recognize a limit to the desirability or benefits of consumption.

GPI measures value by multiplying marginal price by total quantity, and thus does not function well when considering goods and services that are essential and non-substitutable (goods and services for which there is inelasticity of demand, such as food, water, or ecosystem life support functions). In these cases, a small decrease in quantity so that there is not enough for everybody could result in a huge increase in price. As an example, people could spend more money on food during a food shortage that causes prices to skyrocket, but this does not necessarily mean anyone is better off. Yet personal consumption, and thus GPI, would rise with the increased spending in such a situation. GPI is a significant improvement on GDP, but it falls short of providing a theoretically and empirically sound measure of human welfare by failing to i.) explicitly acknowledge a limit to human wants, ii.) appropriately consider the benefits and costs of increased consumption in ecological and economic systems, and iii.) properly account for total values when it comes to essential and non-substitutable goods or services.

One way to improve the GPI's reliance on consumption would be to include some mechanism for ensuring sustainable scale. For instance, a GPI model could reflect diminishing marginal utility for the personal consumption expenditures upon which GPI is based. Choosing a threshold for optimal per capita consumption and a rate of diminishing marginal benefits derived from further consumption, one could set GPI to increase less with each marginal increase in personal consumption. Consumption could even be assigned to have a negative contribution to GPI once it reaches beyond a certain level (once consumption becomes "too excessive"). Choosing a consumption threshold could be based on empirical data (i.e., the GDP per capita level where GPI begins to diverge in the numerous GPI studies to date – see Bleys, 2007), but it would be a challenge to avoid controversy in the subjective distinction between beneficial and harmful consumption.

Another improvement to the current GPI methodology would be to entirely do away with the personal consumption basis for an indicator of progress, or to include additional indicators that are not consumption-based and that could provide additional valuable information on the whole system. The inclusion of additional indicators that are not based on consumption rather than an overhaul of the GPI framework (as described above) is a more promising and flexible approach, and one that could more easily incorporate future advances in thinking about human needs and well-being. Ecological Footprint, for instance, is an indicator that is not based on consumption, but rather on biophysical assessments of resource use and waste generation. An indicator to track and report on natural capital stocks and the sustainability of a system needs to be grounded in biophysical assessments.

Any measurement made of the natural world includes an inherent level of uncertainty that cannot be avoided. This is true for empirical data obtained for both ecological and economic systems. Currently, there has been little, if any, treatment of uncertainty in GPI-related research. Addressing uncertainty in GPI studies is important, though, for several reasons. First, GPI is wrought with uncertainty. Some adjustment terms used in constructing a GPI are subject to considerable uncertainty (i.e. the cost of climate change), while others are based on relatively certain data (i.e. measures of expenditures on public transportation). All terms include some uncertainty, though, and thus the GPI should incorporate and aggregate the uncertainty in its underlying terms.

Second, presenting GPI with error bars would make the final results more accurate and meaningful. By acknowledging the range of values that an estimate of socio-economic inequality might have, for example, a study could carry this uncertainty through the GPI calculations to provide a more realistic and honest final result. Finally, an effective treatment of the uncertainty in GPI would allow for appropriate levels of confidence when stating results. Confidence intervals could enhance the scientific and political relevance of GPI by quantifying and comparing the degrees of certainty assumed and allowed for in measuring economic and social progress. Attention to these statistical issues could strengthen the case for using GPI to make important political, business, and individual decisions.

The design and planning of cities is one such important area of decision-making that could be enhanced by greater use of GPI and complementary indicators. GPI-based urban design could result in self-reliant local communities closely linked to supporting ecosystems, or it could lead toward denser, more compact, greener, and less auto-dependent urban cores. The GPI could be infused into community design approaches such as New Urbanism (Thomas and Furuseth, 1997), conservation planning, and smart growth. The emergence of the field of green buildings could be monitored explicitly in GPI with an adjustment term that accounts for changes in the number of LEED-certified buildings (Leadership in Energy and Environmental Design), which impact sustainable economic welfare by investing in more efficient and high-performance buildings. GPI could thus be used to reinforce society's shift towards cleaner energy and greener buildings. An additional measure related to land use and development could estimate the "cost of impervious surface," with deductions for the money spent paving parking lots and constructing stormwater management systems to replace disturbed natural ecosystems. An improvement to the estimates of the cost of pollution abatement in community design and planning could include expenditures required to clean up toxic materials such as asbestos in insulation, lead in the paint of older houses, and PCBs in electronics and older buildings materials.

A key part of realizing sustainability is to create a network of people that develop performance indicators and engage in a dialogue and a process for moving toward sustainability goals (Innes and Booher, 1999). Rethinking resource use, progress, and development patterns requires an evolved set of policy tools. GPI could be up to the task, but only if it can become a publicly vetted, politically viable, and easily available tool. It needs to have the same level of recognition, faith, and reliability that GDP holds with top-level managers as well as everyday citizens.

Wide-spread recognition of an indicator by large, trusted organizations is required if it is to be accepted as a new welfare index (Lawn, 2005). The methodological bias and inconsistencies within and between GPI studies hinder this acceptance. A critical challenge facing the effort to create new ways of measuring progress is to deal with the lurking indicator bias that can unintentionally favor particular policy and development outcomes. GPI is found to be an imperfect measure of true progress, but it is believed to be an improvement over GDP for guiding modern society towards a more sustainable and desirable future. Incorporating human needs, livelihoods, and capabilities; developing a complementary, systems-based biophysical assessment of capital stocks; and engaging in a new consensus-building process to determine better measures of progress would make GPI a stronger candidate for guiding human economies toward genuine progress.

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APPENDIX I: GENUINE PROGRESS INDICATOR RESULTS

	Year	Personal Consumption A	gini coefficient	Income Distribution Index B	Adjusted Personal Consumption C	Value of Household Work D
Baltimore City	**1950**	$4,622,851,521	0.458	106.64	$4,335,011,618	$5,151,925,258
	1960	$6,860,517,148	0.439	102.11	$6,718,572,349	$6,683,077,559
	1970	$12,322,504,945	0.430	100.00	$12,322,504,945	$7,601,928,837
	1980	$11,821,119,227	0.439	102.18	$11,569,453,253	$6,423,199,252
	1990	$13,678,043,562	0.471	109.62	$12,477,334,948	$7,488,117,945
	2000	$12,845,418,331	0.496	115.53	$11,118,219,345	$5,669,451,539
	2005	$14,793,913,345	0.534	124.18	$11,912,957,446	$5,450,286,737
Baltimore County	**1950**	$3,899,621,093	0.388	106.64	$3,656,812,829	$1,493,232,737
	1960	$5,787,211,064	0.371	102.11	$5,667,473,077	$3,569,340,101
	1970	$10,394,688,184	0.364	100.00	$10,394,688,184	$5,311,975,430
	1980	$12,705,202,323	0.364	100.11	$12,690,828,690	$5,462,128,377
	1990	$17,295,873,167	0.400	109.88	$15,741,114,874	$7,187,926,570
	2000	$21,639,384,116	0.428	117.63	$18,395,662,193	$6,745,589,912
	2005	$25,153,234,039	0.452	124.18	$20,254,911,582	$6,804,884,664
Maryland	**1950**	$23,103,513,532	0.372	106.64	$21,664,982,995	$12,434,766,337
	1960	$34,286,641,079	0.356	102.11	$33,577,246,981	$21,589,556,195
	1970	$61,583,885,646	0.349	100.00	$61,583,885,646	$33,877,814,559
	1980	$75,216,844,007	0.352	100.86	$74,575,791,359	$34,865,728,745
	1990	$113,730,354,523	0.384	110.03	$103,364,306,585	$47,799,214,675
	2000	$145,383,808,393	0.407	116.62	$124,665,722,676	$45,613,815,181
	2005	$173,377,426,235	0.433	124.18	$139,614,032,663	$46,630,556,832
United States	**1950**	$1,152,800,000,000	0.421	107.97	$1,067,703,991,850	$749,480,000,000
Talberth et al 2007	**1960**	$1,597,400,000,000	0.403	104.24	$1,532,425,172,678	$996,150,000,000
	1970	$2,451,900,000,000	0.394	101.55	$2,414,475,627,770	$1,324,000,000,000
	1980	$3,374,100,000,000	0.403	103.87	$3,248,387,407,336	$1,759,760,000,000
	1990	$4,770,300,000,000	0.428	110.31	$4,324,449,279,304	$2,067,690,000,000
	2000	$6,739,400,000,000	0.462	119.07	$5,660,031,914,000	$2,396,460,000,000
	2004	$7,588,600,000,000	0.469	120.10	$6,318,567,860,117	$2,542,160,000,000

Figure 18: GPI calculation results in Year 2000 US Dollars.

Value of Volunteer Work E	Services of Household Capital F	Services of Highways and Streets G	Cost of Crime H	Cost of Family Breakdown I	Loss of Leisure Time J
$70,321,577	$646,104,833	$10,533,812	$80,839,820	$41,817,778	$719,501,911
$78,263,613	$783,623,284	$16,151,912	$162,854,350	$99,530,971	$342,922,384
$84,981,700	$1,413,240,255	$35,758,687	$456,918,513	$154,101,310	$0
$87,808,549	$1,260,926,112	$43,532,624	$555,303,384	$182,963,738	$84,778,615
$93,188,255	$1,477,997,402	$42,137,070	$770,306,837	$162,727,496	$160,884,994
$93,981,028	$1,439,782,242	$52,660,874	$655,138,228	$148,440,510	$326,680,900
$100,828,807	$1,519,872,488	$65,534,093	$575,545,585	$135,992,202	$410,924,599
$20,012,447	$545,023,786	$15,187,863	$20,203,090	$12,075,645	$214,747,994
$43,787,286	$661,027,914	$22,679,978	$40,582,038	$62,192,494	$188,602,081
$66,326,784	$1,192,143,306	$47,101,419	$122,615,509	$110,196,753	$0
$90,480,106	$1,355,228,812	$60,114,678	$166,559,364	$167,725,814	$84,831,204
$112,625,057	$1,868,926,319	$62,085,915	$214,242,081	$171,209,119	$176,593,351
$141,108,383	$2,425,456,312	$80,980,769	$208,013,007	$202,862,696	$451,522,220
$154,911,091	$2,584,151,165	$103,188,638	$216,213,249	$209,797,354	$599,219,595
$186,759,250	$3,229,022,540	$152,980,162	$189,614,828	$104,671,399	$1,818,359,554
$271,168,830	$3,916,295,188	$234,570,565	$384,772,395	$394,041,675	$1,159,959,387
$385,727,964	$7,062,916,723	$462,330,123	$1,115,140,035	$689,890,055	$0
$548,218,499	$8,023,172,835	$601,461,147	$1,429,118,161	$1,033,775,090	$518,106,388
$767,630,604	$12,289,269,864	$624,670,781	$1,846,785,434	$1,139,051,654	$1,221,887,817
$966,546,830	$16,295,384,094	$818,647,082	$1,700,672,214	$1,353,460,502	$3,150,696,720
$1,080,950,331	$17,812,161,939	$1,043,824,096	$1,901,539,225	$1,450,814,952	$4,205,865,697
$30,720,000,000	$133,830,000,000	$32,010,000,000	$8,820,000,000	$17,560,000,000	$12,070,000,000
$31,780,000,000	$186,350,000,000	$40,400,000,000	$12,200,000,000	$31,830,000,000	$6,310,000,000
$65,200,000,000	$280,820,000,000	$68,890,000,000	$17,440,000,000	$47,190,000,000	$0
$116,630,000,000	$393,250,000,000	$83,460,000,000	$26,180,000,000	$62,560,000,000	$146,340,000,000
$118,560,000,000	$530,850,000,000	$84,470,000,000	$32,210,000,000	$64,750,000,000	$220,280,000,000
$125,100,000,000	$678,350,000,000	$107,800,000,000	$31,040,000,000	$69,140,000,000	$363,300,000,000
$131,300,000,000	$743,720,000,000	$111,550,000,000	$34,220,000,000	$71,890,000,000	$401,920,000,000

Cost of Underemployment	Cost of Consumer Durables	Cost of Commuting	Cost of Household Pollution Abatement	Cost of Automobile Accidents	Cost of Water Pollution
K	L	M	N	O	P
$98,617,023	$738,405,524	$872,683,121	$133,257,722	$598,188,302	$4,533,830
$162,082,922	$895,569,468	$789,944,974	$122,811,755	$591,458,819	$6,079,033
$246,198,546	$1,615,131,720	$981,459,739	$125,101,620	$570,506,344	$7,951,574
$345,465,728	$1,441,058,414	$1,069,730,346	$114,998,855	$495,562,427	$7,567,908
$514,494,602	$1,689,139,888	$1,202,168,805	$106,884,240	$463,589,825	$7,079,643
$733,655,711	$1,645,465,419	$1,249,921,323	$95,162,596	$408,540,210	$5,118,121
$862,931,230	$1,736,997,129	$1,135,854,148	$95,607,864	$389,361,614	$4,565,384
$16,994,386	$622,884,327	$244,485,937	$38,751,814	$141,456,083	$1,290,262
$51,487,298	$755,460,474	$684,483,263	$70,812,363	$257,728,061	$3,187,870
$102,587,868	$1,362,449,492	$915,990,357	$86,415,724	$325,060,660	$5,452,377
$162,919,578	$1,548,832,928	$1,166,849,472	$96,204,504	$343,137,235	$6,306,293
$332,213,396	$2,135,915,794	$1,139,432,577	$96,280,492	$362,250,631	$6,657,566
$640,363,752	$2,771,950,071	$1,357,871,902	$106,269,252	$395,692,661	$5,965,716
$790,582,568	$2,953,315,617	$1,513,810,380	$111,164,972	$403,117,946	$5,584,083
$143,726,043	$3,690,311,475	$2,220,019,439	$308,660,165	$1,371,672,209	$11,185,300
$316,283,103	$4,475,765,929	$3,696,195,220	$406,053,566	$1,815,248,448	$20,073,173
$631,128,600	$8,071,904,826	$6,083,380,934	$572,985,302	$2,296,305,336	$34,434,378
$1,151,353,068	$9,169,340,383	$7,944,422,979	$653,942,427	$2,468,760,112	$40,562,647
$2,150,800,704	$14,044,879,845	$9,340,437,646	$755,015,825	$2,799,233,450	$45,992,447
$4,349,084,597	$18,623,296,107	$10,431,910,101	$775,256,877	$2,899,233,151	$41,907,618
$5,294,331,687	$20,356,756,502	$11,498,959,619	$828,778,134	$2,853,690,124	$39,751,697
$15,880,000,000	$77,080,000,000	$141,840,000,000	$20,000,000	$135,370,000,000	$45,820,000,000
$30,860,000,000	$95,280,000,000	$158,310,000,000	$830,000,000	$160,620,000,000	$52,900,000,000
$59,730,000,000	$169,500,000,000	$198,850,000,000	$4,050,000,000	$182,290,000,000	$62,130,000,000
$111,360,000,000	$257,210,000,000	$255,240,000,000	$12,780,000,000	$213,420,000,000	$74,170,000,000
$189,230,000,000	$453,520,000,000	$372,450,000,000	$11,590,000,000	$191,670,000,000	$89,700,000,000
$124,480,000,000	$863,300,000,000	$495,190,000,000	$16,260,000,000	$193,140,000,000	$109,090,000,000
$176,960,000,000	$1,089,910,000,000	$522,610,000,000	$21,260,000,000	$175,180,000,000	$119,720,000,000

Cost of Air Pollution Q	Cost of Noise Pollution R	Loss of Wetlands S	Loss of Farmlands T	Depletion of Nonrenewable Resources U	Long-term Environmental Damage V
$311,992,289	$84,333,992	$88,059	$4,363	$4,272,367,468	$0
$287,653,192	$86,637,124	$102,531	$225,976	$4,379,454,806	$0
$312,017,989	$94,013,054	$122,253	$390,082	$5,124,850,798	$283,874,182
$241,711,471	$84,038,804	$144,801	$470,910	$4,522,250,268	$556,758,955
$210,905,896	$77,256,628	$161,328	$690,767	$3,983,990,709	$891,960,625
$176,250,176	$63,510,363	$177,206	$756,087	$3,712,256,513	$1,020,915,825
$190,815,668	$62,719,027	$187,796	$754,906	$3,798,322,104	$1,190,641,960
$115,424,587	$19,720,981	$2,195,346	$520,702	$1,215,853,265	$0
$193,788,419	$38,696,373	$2,570,562	$18,051,959	$2,296,603,890	$0
$273,858,711	$57,079,966	$3,051,138	$30,783,366	$3,514,099,180	$194,651,917
$198,809,661	$64,529,923	$3,602,623	$37,054,059	$3,768,364,665	$463,943,977
$181,565,199	$66,248,713	$4,016,814	$54,110,667	$3,746,471,433	$838,783,332
$184,808,318	$69,257,986	$4,447,847	$59,178,164	$4,327,031,123	$1,189,986,342
$213,513,384	$71,770,687	$4,667,799	$59,086,590	$4,645,862,602	$1,456,316,448
$654,391,729	$143,491,964	$214,623,044	$10,017,521	$10,540,251,583	$0
$800,524,562	$207,945,189	$251,283,943	$202,060,021	$14,461,107,855	$0
$1,129,233,521	$311,792,766	$298,268,350	$472,941,021	$22,193,220,985	$1,229,320,172
$1,082,149,769	$361,732,427	$352,182,204	$606,360,021	$24,238,462,485	$2,984,129,638
$1,139,443,979	$408,153,804	$392,958,084	$808,510,021	$25,881,741,501	$5,794,565,299
$1,216,890,283	$446,370,587	$434,925,435	$854,864,431	$30,396,279,015	$8,359,347,517
$1,361,714,639	$468,755,294	$456,570,489	$883,429,641	$33,072,736,811	$10,367,153,472
$71,470,000,000	$6,780,000,000	$38,560,000,000	$25,800,000,000	$174,820,000,000	$0
$79,030,000,000	$9,190,000,000	$42,790,000,000	$64,590,000,000	$290,300,000,000	$0
$99,340,000,000	$12,460,000,000	$47,010,000,000	$108,210,000,000	$586,680,000,000	$9,660,000,000
$68,650,000,000	$14,340,000,000	$50,620,000,000	$155,680,000,000	$826,660,000,000	$134,220,000,000
$52,290,000,000	$15,840,000,000	$52,470,000,000	$200,460,000,000	$1,171,290,000,000	$412,340,000,000
$40,580,000,000	$17,500,000,000	$53,040,000,000	$251,690,000,000	$1,585,890,000,000	$960,070,000,000
$40,050,000,000	$18,210,000,000	$53,260,000,000	$263,860,000,000	$1,761,270,000,000	$1,182,820,000,000

Cost of Ozone Depletion W	Loss of Forest Cover X	Net Capital Investment Y	Net Foreign Lending and Borrowing Z	Total GPI	Population	Personal Consumption per capita
$5,399,256	-$26,750	$70,164,955	$0	$2,322,058,342	949,708	$4,868
$14,805,306	-$53,745	$54,054,542	$0	$6,391,663,394	939,024	$7,306
$47,623,221	$201,395	$364,243,540	$0	$11,802,195,622	905,759	$13,605
$48,261,260	$487,980	$344,436,089	$0	$9,977,802,016	786,775	$15,025
$44,772,391	$552,208	$294,243,355	$0	$11,585,452,092	736,014	$18,584
$5,409,207	$613,720	$1,096,152,387	$0	$9,222,235,300	648,615	$19,804
$2,250,340	$467,380	$879,664,075	$0	$9,335,204,706	640,064	$23,113
$1,536,549	-$358,348	$19,967,919	$0	$3,082,454,959	270,273	$14,428
$7,763,963	-$718,682	$28,346,421	$0	$5,321,362,352	492,428	$11,752
$32,655,140	$2,686,916	$249,761,013	$0	$10,122,361,061	621,077	$16,737
$40,215,825	$6,512,237	$287,016,575	$0	$11,619,397,876	655,615	$19,379
$42,103,131	$7,369,550	$276,701,027	$0	$15,673,915,918	692,134	$24,989
$6,305,008	$833,092	$1,277,682,584	$0	$17,084,120,996	756,030	$28,622
$2,752,471	-$11,636,833	$1,075,948,357	$0	$17,732,856,582	782,885	$32,129
$13,320,371	-$7,481,474	$173,102,216	$0	$16,414,778,352	2,343,001	$9,861
$48,887,622	-$15,002,871	$178,489,924	$0	$31,142,128,467	3,100,689	$11,058
$206,232,866	$51,984,075	$1,577,360,531	$0	$59,561,872,325	3,922,399	$15,701
$258,671,827	$127,820,700	$1,846,116,583	$0	$66,039,598,840	4,216,975	$17,837
$290,860,981	$144,647,811	$1,911,533,183	$0	$98,551,659,393	4,781,468	$23,786
$44,291,059	$160,872,855	$8,975,391,026	$0	$112,096,147,820	5,310,916	$27,375
$19,594,156	$122,590,065	$7,659,407,923	$0	$118,657,901,579	5,573,163	$31,109
$681,905,701	$35,100,000,000	$11,250,000,000	$10,000,000	$1,217,332,086,149	154,233,234	$7,474
$2,469,244,666	$39,350,000,000	$10,400,000,000	$1,320,000,000	$1,721,965,928,012	183,285,009	$8,715
$9,258,881,072	$42,390,000,000	$82,460,000,000	-$3,450,000,000	$2,576,206,746,698	203,210,158	$12,066
$12,712,631,543	$45,850,000,000	$99,480,000,000	$2,570,000,000	$3,235,544,775,793	226,545,805	$14,894
$10,899,448,142	$49,160,000,000	$99,720,000,000	-$68,100,000,000	$3,567,489,831,162	248,709,873	$19,180
$598,080,985	$50,480,000,000	$475,600,000,000	-$249,800,000,000	$3,968,753,833,015	281,421,906	$23,948
$103,266,818	$50,640,000,000	$388,800,000,000	-$254,020,000,000	$3,998,194,593,299	289,567,789	$26,207

GPI per capita	Total GDP	GDP per capita
$2,445	$7,493,943,161	$7,891
$6,807	$10,935,754,077	$11,646
$13,030	$15,941,304,050	$17,600
$12,682	$15,533,708,510	$19,744
$15,741	$17,380,260,000	$23,614
$14,218	$16,076,869,000	$24,786
$14,585	$17,459,830,000	$27,278
$11,405	$6,030,679,042	$22,313
$10,806	$8,800,443,439	$17,872
$16,298	$13,447,337,660	$21,652
$17,723	$16,695,450,380	$25,465
$22,646	$21,977,320,000	$31,753
$22,597	$27,083,084,000	$35,823
$22,651	$29,718,390,000	$37,960
$7,006	$39,297,027,590	$16,772
$10,044	$57,345,328,146	$18,494
$15,185	$83,596,890,000	$21,313
$15,660	$98,185,350,000	$23,283
$20,611	$149,832,450,000	$31,336
$21,107	$180,367,000,000	$33,962
$21,291	$212,901,100,000	$38,201
$7,893	$2,098,550,000,000	$13,606
$9,395	$3,062,370,000,000	$16,708
$12,678	$4,491,251,160,000	$22,102
$14,282	$5,682,462,070,000	$25,083
$14,344	$7,475,631,510,000	$30,058
$14,103	$9,951,100,000,000	$35,360
$13,807	$10,879,548,400,000	$37,572

APPENDIX II: DETAILED METHODS FOR THE BALTIMORE GPI

This section includes more detailed methods and results for each column used in the construction of the Baltimore Genuine Progress Indicator. Online data sources are also included at the end.

Column A: Personal consumption expenditures

The values for personal consumption expenditures since 1970 were obtained from the US Bureau of Economic Analysis Regional Economic Accounts. Earlier values (for 1950 and 1960) were extrapolated using the 1970 ratio of county or city to state personal income. The percentage of income that went towards personal consumption was then estimated using the National Income and Product Accounts table 2.1, Personal Income and its Disposition. This method assumes that the rate of consumption in Baltimore city and county is the same as the national rate, an assumption that is required due to insufficient local scale data. (Note: Throughout the calculation of the Baltimore GPI, applications of national-level figures to the population of Baltimore have been made in order to account for the absence of specific detailed economic or social data at the city, county, and/or state levels).

Column B: Income distribution

One of the most popular summary measures of inequality is the Gini coefficient. In this case, it is used to provide a single figure that represents the properties of a given income distribution. The Gini coefficient ranges from 0, where there is perfect equality and everyone receives an equal share, to 1, where there is perfect inequality and one person or group received all of the income (a higher Gini coefficient value indicates more inequality). Technically, the Gini coefficient is based on the difference between the Lorenz curve describing observed cumulative income distribution and an ideal curve describing perfectly equal income distribution. Another summary measure of income inequality is the Atkinson measure, which allows specification of the social welfare function underlying the research. Since reliable information was unavailable about the sensitivity to changes in different portions of the income distribution (aversion to income inequality) in Baltimore or Maryland, the Gini coefficient was used in this study.

Living conditions in the United States have changed over the last 50 years. Today, a smaller percentage of people live in families than was the case in the 1940s, when the US Census began using the Gini coefficient to measure family income inequality (US Census Current Population Survey 2000). Since 1967, the US Census has begun collecting and reporting on households, an increasingly important demographic unit of study. Previous GPI studies in Vermont and Ohio use the Gini coefficient based on family incomes. Since the household has been the more popular unit of study recently, and since Gini coefficients for Maryland, Baltimore County, and Baltimore City were calculated by the Maryland Department of Planning for 1980, 1990, and 2000 based on household income, the Gini coefficient based on household income is used in this study.

National Gini coefficients were obtained from the U.S. Census and used to estimate figures for Maryland for 1950 and 1960. The average percentage difference between the Maryland and the national Gini coefficients from 1970-2000 (0.8844 +/-

0.01%) was used to estimate Maryland figures for 1950 and 1960 based on national data. Similarly, the Baltimore City and County Gini coefficients for 1950, 1960, 1970, and 2005 were based on the average difference with Maryland Gini coefficients in known years.

Using the Gini coefficient, an index of income distribution was derived following Costanza et al. (2004) and Bagstad and Ceroni (2007). The year 1970, the decennial year in the study period with the lowest income inequality for the United States, was set as the base year and given an income distribution index value of 100. Other years were given values based on their Gini coefficients relative to the Gini coefficient in the year 1970 (for instance, the income distribution index for year 2000 would equal Gini2000/Gini1970 x 100).

Column C: Personal consumption adjusted for income inequality

Personal consumption is adjusted for income inequality by simply dividing personal consumption (column A) by the income distribution index (column B) and multiplying by 100.

Column D: Value of household labor

The valuation of household work follows the methods of Northern Vermont (Bagstad and Ceroni, 2007), Burlington Chittenden and Vermont (Costanza et al., 2004), and the Redefining Progress 2006 update (Talberth et al., 2007), which use Robert Eisner's national-level work as the starting point. This valuation is based upon methods described in Eisner's book The Total Incomes System of Accounts (1989) and a definition of household labor that includes meal preparation, cleaning, laundry, repairs, gardening, shopping, banking, traveling to obtain goods and services, and care of family members.

Studies conducted by the Michigan Survey Research Center in 1965, 1975, and 1981 provide estimates of the time spent doing housework for employed and unemployed males and females. This time spent doing housework is then valued using a replacement cost method: by determining how much a family would have to pay to hire another person to do equivalent work, using the average wage rate for maids, housekeepers, and cleaners.

For 1990, 2000, and 2005, I used the Eisner's 1981 estimates of the amount of time spent doing housework in each of the 4 categories (both genders, employed and unemployed). The Labor Force Statistics from the Current Population Survey of the US Census contained the population data in each of the 4 categories for the year 2005. Earlier years were estimated based on each category's percentage of total population in 2005. Then I multiplied the total time spent doing housework by the Maryland mean wage rate for maids and housekeepers (obtained form the 2000 and 2005 Bureau of Labor Statistics Occupational Employment Statistics) or the national mean wage rate for laundry, cleaning, and garment services (obtained from 1990 Bureau of Labor Statistics online data) to obtain the value of the housework. Since household labor data are based on the national averages, the sub-national values differ based only on discrepancies among employment characteristics.

The methods employed are based on the following assumptions:

• The national time use estimates from the Michigan Survey Research Center were assumed to be representative of the populations of Baltimore City, Baltimore County, and Maryland.

• The growth rates Eisner used in his calculations, based on national level data, were assumed to be appropriate at the other three scales.

• The hourly wage rates used for 1950-1990 are based on national figures assumed to be representative of the other three scales.

• The 1981 estimates of time spent doing housework represented the estimates for 1990, 2000, and 2000.

Column E: Value of volunteer work

In reports by the US Bureau of Labor Statistics, education levels have been shown to be a key predictor for likelihood to volunteer and hours spent volunteering (Boraas 2003). On average, individuals with higher levels of education are more likely to volunteer and volunteer more hours than individuals with lower levels of education. For instance, college graduates were shown to be over 4 times more likely to volunteer than people without a high school diploma (Boraas 2003). The median number of hours college graduates spent volunteering each year was also 25% higher than the amount donated by people with less than a high school diploma. This makes the estimation of volunteer work based on education levels a useful approach when reliable local scale volunteering data are unavailable.

The number of people in each education attainment category (less than high school diploma, high school graduate with no college, less than a bachelor's degree, college graduate) was multiplied by the proportion of people likely to do volunteer work in each category. The number of volunteer hours was estimated by multiplying this figure (number of people who volunteered) by the median number of hours volunteered in each education attainment category. To calculate the value of volunteer work, the annual number of volunteer hours was then summed across education attainment categories and multiplied by the dollar value of a volunteer hour. This approach recognizes the variation in likelihood and amount of volunteering for different education attainment categories. It does not account for volunteer work done by individuals under the age of 25, as well as informal volunteer, neighborly, or other unreported volunteer work and so represents a conservative estimate.

Education attainment and population data for individuals over 25 years of age were obtained from the US Census and the National Center for Educational Statistics, except for the years 1960-1980 where values were interpolated. Likelihood to volunteer and median number of volunteer hours per education attainment category was obtained from the Bureau of Labor Statistics. Independent Sector provides a national-level dollar value of volunteer work from 1980-2008, as well as a 2007 state-level dollar value for volunteer work. Using the percentage difference between the 2007 Maryland and national values, estimates of the dollar value of volunteer work in Maryland were calculated for 1980-2005. There was an insignificant difference between the inflation-adjusted values of volunteer work in 1980 and 2005, so the 1980 value was used for prior years (rather than extrapolated values).

These methods assume that the national-level correlation between education attainment and volunteering holds true across time (i.e. it stayed the same through previous decades) and space (i.e. it holds true at local scales). In reality, education attainment figures have changed considerably since 1950; it is unlikely that volunteer rates and volunteer amounts by education attainment categories haven't changed as well. The difference between Maryland and national values of volunteer work in 2007 is also assumed to stay the same for other years.

Column F: Services of household capital

The GPI views the original purchase price of consumer durables as a cost, and the services a consumer received from the product over its lifetime as a benefit. The cost of consumer durables calculated in column L is used to estimate the services derived from these goods. As in previous GPI studies, it is assumed that the average household capital item lasts 8 years and thus has a fixed depreciation rate of 12.5%. This percentage of the cost of consumer durables is added back in to the GPI to account for the services they provide.

Column G: Services of highways and streets

The services of highways and streets was calculated based on the US Bureau of Economic Analysis' figures for the net value of stocks of highways and streets at the national level (tables 7.1A and 7.1B, net stock of government fixed assets). The total national stock value of streets and highways is multiplied by 7.5% in order to estimate the annual flow of social benefits from the stock value. This assumes that 10% of the net stock value is the annual flow of value, and that 25% of this should be subtracted as defensive expenditures for commuting (25% of 10% equals 7.5%).

This national level figure is scaled down based on the relative mileage of roads and highways found in Baltimore City, County, and Maryland. The total mileage of roads and highways at all three scales for 1960-2005 was available from the Maryland Department of Transportation Highway Information Services Division annual reports. Road and highway mileage for Maryland and the U.S. in 1950 was obtained from the Statistical Abstract of the United States. To estimate the city and county level mileages in 1950, the average percentage of Maryland roads in the county or city for the other known decades was used.

Column H: Cost of crime

The cost of crime was calculated with methods similar to Costanza et al (2004), which in turn followed the methods of Anielski and Rowe (1999). Two categories were considered: the direct costs of crime based on the number of different types of crimes and the tangible costs associated with each type, and the indirect costs of crime based on defensive expenditures to prevent crime.

It is widely known that Baltimore City has suffered from high crime rates relative to other urban areas in the U.S. In the year 2000, violent crime accounted for 12.3% of all recorded crimes at the national level. In Baltimore City, 24% of reported crimes were considered violent. For this reason, it was considered important to capture as much detail about the types of crime as possible in this study.

For the direct costs of crime, detailed crime data for Baltimore City, Baltimore County, and Maryland 1990-2005 was obtained from the uniform crime reporting office of the Maryland State Police. The FBI Uniform Crime Reports also provided crime data for the state of Maryland 1950-2005. To estimate detailed local crime data for 1950-1980, extrapolation was used based on the proportion of city or county crimes to state crimes in known decades. The costs per crime were available from two US Department of Justice research reports, Miller et al (1993) and Miller et al (1996). The figures used included tangible victim costs per crime such as medical care expenses, emergency services, property loss/damage, and productivity loss. Intangible costs such as pain, suffering, and impacts on quality of life were excluded due to the difficulty quantifying such costs. This means that the direct costs of crime included in this study may be considered conservative estimates. For each type of crime, the number of reported cases was multiplied by the associated victim cost per crime. These figures were summed to provide the total direct costs of crime for Baltimore City, County, and Maryland.

For the indirect costs of crime, the absence of local scale data meant that national estimates had to be used and scaled down to the local levels based on the numbers of households (which were available from the US Census). Following Costanza et al (2004) and Anielski and Rowe (1999), the indirect costs include expenditures on household security systems, locks, and safe deposit boxes.

These methods assume that national level figures are representative of defensive expenditures at the more local levels. They also assume that the costs of each type of crime are applicable at different levels and remained the same over prior decades. Also, since this valuation of the costs of crime does not include unreported crimes or arson (for lack of reliable data), they are certainly conservative estimates.

Column I: Cost of family breakdown

Following the methods of early GPI studies in the United States, two proxies are used in calculating the cost of family breakdown: the cost of divorce and its effect on children, and the amount of time spent watching television.

In estimating the cost of divorce, the direct cost to adults was based on out-of-pocket expenses for legal fees, counseling, and establishing separate residences. The Anielski and Rowe (1999) estimate of $8,922 per divorce (2000 dollars) was multiplied by the number of divorces. Maryland state vital statistics reports provided the numbers of divorces at all scales for 2000 and 2005, and the number of divorces in Maryland for 1950-2005. The Maryland state divorce rate was used to scale down figures for Baltimore County and City 1950-1990 based on population.

The cost of divorce to children was also taken from the Anielski and Rowe (1999) estimate of $13,380 (2000 dollars) per child affected by divorce. The National Center for Health Statistics reports on the vital statistics of the US provided data on the number of children per divorce for Maryland 1990-2005 and for the entire US 1950-2005. Maryland figures for 1950-1980 were estimated based on the difference between known Maryland

and national children per divorce data. The state figures were then scaled down to provide Baltimore County and City estimates of the number of children affected by divorce.

The costs of excessive television watching were estimated with methods similar to Costanza et al (2004) and Bagstad and Ceroni (2007), which follow Anielski and Rowe (1999). The social cost of television viewing is estimated as \$0.54 per hour (2000 dollars). The numbers of family households with children were obtained from the US Census for all scales 1980-2005, and were estimated for 1950-1970 based on the percentage of households that are families with children for the known years. The percent of households with television sets was taken from national figures 1950-2005 provided by the Television Bureau of Advertising and Nielsen Media Research. The average hours a household spends watching television daily was also provided by the Television Bureau of Advertising. This assumes that the national data for television ownership and television viewing are applicable at the state, county, and city scales. The costs of excessive television watching were then calculated as

= (number of family households with children) x (% households owning televisions) x (annual hours of TV watched per household) x (\$0.54/hour)

The total costs of family breakdown were calculated by adding together the direct cost of divorce, the cost of divorce to children, and the cost of excessive television watching.

Column J: Loss of leisure time

The value of lost leisure time is estimated in relation to 1969, the year with the greatest leisure since 1950. The number of leisure hours per year per worker is provided by a study by Leete-Guy and Schor (1992) that estimated the annual working hours (including housework) of labor force participants. These figures were used to derive figures for 1970, 1980, and 1990. Following the national GPI methods, it was estimated that the annual hours of work declined by 0.3 percent per year for prior years (since 1950). From 1990-2005, data points were extrapolated based on the trend data provided by Mishel et al (1996), who estimated that annual hours of work increased an average 5.2 hours per year between 1989-1994.

Assuming that in 1969, a typical worker had 10 hours per day of discretionary time (3,650 annual hours), 3,650 minus the annual hours of work equals the total discretionary hours of leisure per person per year. This refers to time away from work minus time spent sleeping and doing maintenance activities. The resulting figure for each year is subtracted from the 1969 value – this change in amount of leisure time from 1969 is the basis for estimating the loss of leisure time.

Bureau of Labor Statistics estimates for the number of employed workers is multiplied by annual lost leisure hours per worker. Finally, these total annual hours are valued at $13.36 per hour in 2000 dollars (which is approximately the average real wage rate for the period 1950-2005, following the national GPI studies). In the absence of local data on average number of hours worked each year, these methods rely on national scale data that misses local work patterns. Local characteristics are captured somewhat in the numbers of employed workers data.

Column K: Cost of underemployment

Following Costanza et al's (2004) methods, unemployment data were used to determine underemployment figures. Unemployment data for Maryland were obtained from the US Census for the years 1950-1980 and from the Bureau of Labor Statistics 1990-2005. For Baltimore County and City, unemployment data for 1990-2005 came from the BLS Local Area Unemployment Statistics, unemployment data for 1980 came from the Census USA Counties, and unemployment data for 1950-1970 were estimated based on comparisons with state and national level rates.

Using national level unemployment data combined with 'employment underutilization' data from the Bureau of Labor Statistics, a quadratic regression equation was developed to describe the relationship between unemployment and underemployment (similar to Costanza et al's methods). This equation enabled estimates of underemployment based on unemployment.

The methods from Talberth et al (2007) were used to estimate the number of "unprovided hours" of work by constrained workers at a national level. These unprovided hours include all unemployed and underemployed workers – those without work all year, working only part-time for part or all of the year, and working full-time only part of the year. The figures from Leete-Guy and Schor (1992) were extrapolated to obtain figures for all years of interest. The total unprovided hours of work were divided by the number of underemployed and unemployed people to get a national-level estimate of unprovided work hours per constrained worker. This rate was applied to labor force figures for the state, county, and city to obtain the total unprovided hours of work at these scales. The total cost of underemployment was calculated as

= (number of underemployed people) x (hours of unprovided work per constrained worker) x (average real wage rate of $13.36/hr, the same as used in the cost of lost leisure time)

Column L: Cost of consumer durables

Detailed consumer spending data were not available at the local scales, so national level figures were used to provide estimates. Total personal consumption expenditures and total spending on durable goods were available for the United States for all years from the Bureau of Economic Analysis. The percentage of consumer spending that went to durable goods at the national level was assumed to apply at the smaller scales as well. This ratio was then multiplied by personal consumption expenditures for Maryland, Baltimore County, and Baltimore City to determine the cost of consumer durables for each year.

Column M: Cost of commuting

The cost of commuting includes both direct and indirect costs. The direct costs include money spent to pay for a vehicle for commuting, or for public transportation fare. Direct costs are calculated as follows:

= 0.3 (cost of user-owned transport) + 0.3 (price of purchased local transportation)

The cost of user-owned transport is multiplied by 0.3 because this is the estimated portion of total non-commercial vehicle miles used in commuting, from Anielski and Rowe (1999) (who based this estimate on figures from the Statistical Abstract). The cost of user-owned transport is calculated by multiplying the number of new registered vehicles in a year by the average price per vehicle. The numbers of cars, trucks, and motorcycles registered in the US was obtained from the US DOT Bureau of Transportation Statistics (BTS). Vehicle registration totals for Maryland were available from BTS for 1980-2000, and by vehicle type from highway statistics reports for 2000-2005. The proportion of Maryland to US vehicle registrations was used to extrapolate back to 1950. Baltimore City and County figures are scaled down from Maryland based on population. The average purchase price was derived from data provided by the Maryland Motor Vehicle Administration on used and new car sales, 2000-2008. A weighted average price was calculated based on numbers of new and used cars, and this number was extrapolated back to 1950 based on national average purchase price trends. The estimated depreciation of private cars is excluded to avoid double counting (services of household capital).

The price of purchased local transportation is multiplied by 0.3 because this is the estimated portion of passenger miles on local public transportation used for commuting. The Maryland Department of Budget and Management provided the operating budget for the Maryland Transit Administration (MTA), 2004-2009. The MTA provides bus and rail services at the local and state levels. The data were extrapolated backwards based on a trend for purchased local transportation (American Automobile Manufacturers Association 1996). This study observed a 25% increase over the decade 1984-1994. It is difficult to assess the amount of money spent on local transportation prior to the 1970s, as historical public transportation records become less reliable (in Baltimore, the change of the Baltimore Transit Company into the MTA around 1970 created an historical data gap for prior years).

The indirect costs include time lost to commuting that might have been spent on other, more enjoyable or productive activities. The indirect cost of commuting is calculated as the estimated daily commute time, times 2 (to calculate for round trip), times 250 (estimated number of work days per year), times the number of employed people, times a reduced average hourly wage rate. The wage rate was reduced in the same way as in Anielski and Rowe (1999), to account for how some people regard commuting as part nuisance and part leisure. The US Census provided figures for average daily commute at all three scales for the years 1990-2005. 1980 figures were extrapolated based on a DOT study estimate of 13.7% increase in commuting time 1983-1995, referenced by Anielski and Rowe (1999). Earlier decades were extrapolated based on the 30% increase per decade used by Costanza et al (2004) which is based on a national trend for total miles traveled. The same assumptions apply: a correlation between US, Maryland, Baltimore City, and Baltimore County commuting time trends, and a direct correlation between total miles traveled and number of miles commuted. The direct and indirect costs are summed to provide estimates of the total costs of commuting.

Column N: Cost of household pollution abatement

The cost of household pollution abatement is comprised of air pollution (automobile emissions abatement expenditures), water pollution (sewage and septic systems), and solid waste.

Automobile emissions abatements were calculated in the same way as Costanza et al (2004) and Bagstad and Ceroni (2007). Using the registration data for cars and trucks from column M (cost of commuting), the number of new cars + trucks each year was determined. Motorcycles are not part of the calculation because they do not have emission abatement devices. The cost of automobile emissions abatement expenditures was estimated as the costs of catalytic converters ($100 per car) and air filters ($8.50 per car) multiplied by the number of new registered cars. Regarding the cost of air filter replacements: total vehicle miles was available for Maryland 1990, 2000, 2005, but for no other years or scales. Because of the high uncertainty extrapolating these figures, the cost of air filter replacements was not included.

The estimated cost of water pollution abatement makes use of Census data for 1970-1990 on the number of houses with public sewer connections and with septic tanks in Maryland. The percentages of houses with sewer and septic in 1990 and 1970 were multiplied by the total number of housing units 2000-2005 and 1950-1960 to extrapolate the data to Baltimore County and unknown years. It was assumed that Baltimore City's household water pollution abatement is entirely based on sewer. Current sewer rates were obtained from Baltimore Department of Public Works ($3.39 per 100 cubic feet) and

Baltimore County Public Works ($34.18 per 1000 cubic feet), and were assumed to represent the costs of household water pollution abatement with sewers for all years. The average rate was used as the sewer rate for Maryland. Following Costanza et al (2004), the cost of sewer abatement is

= average person per unit x number of units using sewer x average annual output per person (3,000 cubic feet) x cost per cubic foot

The cost of septic abatement was calculated following Costanza et al (2004), with an installation cost of $4,000 and a $200 maintenance cost every 5 years. The total cost of household water pollution abatement is the sum of the expenditures on sewer and septic services.

Solid waste data were obtained from Baltimore City Department of Public Works Bureau of Solid Waste, Baltimore County Department of Pubic Works Bureau of Solid Waste Management, and the Maryland Department of Environment, for the years 2000 and 2005. A report by the EPA provided national solid waste data back to 1960. The percent decrease per capita was calculated at a national scale and used to extrapolate to earlier years for Maryland, Baltimore City, and Baltimore County. Since earlier numbers were not available, the 1960 estimate per capita was also used for 1950. Waste per capita values were applied to populations to determine total solid waste disposed. Following Costanza et al (2004), residential waste was assumed to be 60% of municipal waste. An estimate of $100 per ton was used to calculate the total expenditures on solid waste based on a study by Franklin and Associates (1997). The costs for air, water, and solid waste pollution abatement were summed to provide the total cost of household pollution abatement. As in previous local-scale GPI studies in the US, the air pollution component comprises a very small portion of the total costs of household pollution abatement (in 2005, less than 6% of total costs at each scale).

Column O: Cost of automobile crashes

Data for automobile crashes were available by type of crash for 2000-2005 at all three scales from Maryland Department of Transportation State Highway Administration. Data were also available on fatalities and total crashes for the three scales since 1994. The missing data were extrapolated based on these known figures, in the same way as Bagstad and Ceroni (2007). An average crash rate based on population was used to calculate crash estimates for earlier decades. Multiplying the crash rate times known populations provided the numbers of fatalities, injury crashes, and property damage crashes for each scale, 1950-1990.

The National Safety Council publishes estimates of the costs of unintentional injuries. Their 2007 figures are measures of the dollars spent and income not received due to accidents. For motor vehicle accidents, this includes wage and productivity losses, medical expenses, administrative expenses, and motor vehicle damage. The average 2007 rate (in 2000 dollars) is $928,500 per death, $51,160 per injury crash, and $6230 per property damage crash. These figures were applied to the numbers of each type of crash to estimate the total cost of automobile crashes at each scale.

The issue noted by Costanza et al (2004) and Bagstad and Ceroni (2007), where the National Safety Council cautions against applying the cost estimates to cases of fewer than 10 fatalities per year, did not arise in this study. The methods for determining historical crash numbers rely on the assumption that recent crash rates based on population apply to earlier decades. This assumption is likely to break down for the earliest decades, when automobile use per capita was not as widespread and thus crash rate estimates based on population are likely to be too high.

Column P: Cost of water pollution

Following Costanza et al (2004) and Bagstad and Ceroni (2007), the first step in calculating the cost of water pollution was to estimate the benefits of clean water. This method is based on Freeman's (1982) "most likely point" values for the same five relevant categories used in Vermont's GPI studies: fresh water recreational fishing, boating, swimming, drinking water, and non-user benefits (ecology, aesthetics, and property value). The estimates were summed, converted to 2000 dollars, and divided by the US population to determine the per capita benefit of water quality. This figure was applied to the populations at each scale and for each decade.

This method of calculating the benefits of water quality assumes that the benefits to people in Maryland are the same per capita as at the national level. Since Maryland is a coastal state with a unique estuary system and water-based recreation opportunities, this assumption likely underestimates the benefits of water quality in the state. For instance, the Freeman national study estimates the benefit of freshwater recreational fishing at $1 billion (1978 dollars), which amounts to $9.38 per capita (2000 dollars). A 2000 Maryland Department of Natural Resources report estimated that Maryland anglers spent

$475 million on fishing in 1996. In 2000 dollars, this amounts to a benefit of $98 per capita, which is a full order of magnitude greater than the national average for this benefit category. The conclusion is that Maryland people benefit from water quality at a higher per capita rate than the national average – the estimate of benefits based on Freeman's study provides a conservative figure for this study.

Water quality impairment data by category were available from the 2000 Maryland 305(b) report to the EPA on water quality. Percentage impairment was determined for streams and rivers, estuary, and lakes and reservoirs based on the total miles, square miles, and acres, respectively. These data are from assessments of 98% of non-tidal rivers and streams, 98% of estuary waters, and 68% of lakes and reservoirs. Since estuary waters constitute 95% of Maryland surface water, the error introduced by partial assessments is minimized. Using 2000 as the base year, figures for other years were determined from the same trends used in Costanza et al (2004): a 3% per year decline in water quality 1950-1972, a stable level of water quality 1973-1990, and a 2% per year improvement in water quality 1991-2005. These trends were applied to the percentage impairments figures, so that a decline in water quality meant an increase in percent impaired.

Unfortunately, Baltimore City and Baltimore County data were not available for use in this calculation, so the cost estimates for these areas are simply scaled down based on population. This introduces uncertainty in the county and city estimates, especially because the estuary is a dominant portion of the state's water quality figures, but the estuary does not lie within Baltimore County at all and borders along Baltimore City (which introduces the question of how much of the Chesapeake Bay is in Baltimore City). Scaling down to the local levels based on population ignores the water issues unique to Baltimore County and Baltimore City. Local estimates could be improved significantly by local scale water quality data, perhaps indirectly available through other Baltimore Ecosystem Study projects. For instance, Groffman et al. (2004) find that Nitrogen concentrations (a key nutrient affecting water quality) are higher in streams draining suburban lands than in streams draining urban lands. Incorporating more of this sort of information could present a more accurate picture of the costs of water pollution at the local scales in Maryland.

Column Q: Cost of air pollution

The cost of air pollution is based on county-level air pollutants data provided by the EPA and damage cost estimates based on the work published in Freeman (1982). The EPA has recently replaced the Pollution Standard Index (PSI) and started using the Air Quality Index (AQI) instead in order to monitor more pollutants in a slightly different way. PSI and AQI data are similar but are not directly comparable. However, following Bagstad and Shammin (unpublished), they can be used to develop temporal and cross-county trends for air quality for the years 1973-2005. For 2000 and 2005, the median of the year's daily AQI values was calculated for Baltimore City and Baltimore County. For 1980 and 1990, the median of the year's daily PSI values was calculated for Baltimore City and County. Historical PSI data were obtained through the Internet URL-editing process described by Costanza et al (2004). AQI and historical PSI values were unavailable for the state of Maryland, so the average of the fourteen Maryland counties' median AQI values was used for 2000 and 2005. For earlier years, the Maryland figures are extrapolated based on the differences with Baltimore City in known years. For figures prior to 1973, Aneilski and Rowe's (1999) assumptions were used: air quality declined 1% per year in the 1950s, 2.4% per year in the 1960s, and improved 3% per year 1970-1977.

Freeman's (1982) national level damage costs estimates from air pollution were obtained for several categories and adjusted in the following ways. The damage to agricultural vegetation figure was scaled down based on farmland acreage data from the US Census of Agriculture and the National Agricultural Statistics Service (see loss of farmland for more details on data). The acid rain damage category was scaled down based on water and forest acreage data obtained from the USDA Forest Resource Inventory, the National Resources Inventory, and urban tree canopy data from the Baltimore Ecosystem Study (see loss of forest for more details on data). The other four damage cost categories were scaled down based on population: materials damage, costs of cleaning soiled goods, urban disamenities, and aesthetics. Table 13 summarizes these estimates.

Table 13: Scaling of national damage estimates as reported in Freeman (1982).

Damage cost category	**National estimate from Freeman (1982)**	**Basis for scaling to local levels**	**Maryland estimate for year 2000**
Damage to agricultural vegetation	$14.74 billion	Farmland acreage	$33.30 million
Materials damage (paint, metals, rubber)	$22.04 billion	Population	$415.93 million
Costs of cleaning soiled goods	$18.15 billion	Population	$342.52 million
Acid rain damage (aquatic and forest)	$5.48 billion	Forest acreage and water coverage	$25.58 million
Urban disamenities (reduced property values and wage differentials)	$32.76 billion	Population	$618.24 million
Aesthetics	$16.44 billion	Population	$310.25 million
Total	*$109.61 billion*		*$1,745.83 million*

The use of locally-relevant and more current damage cost estimates would have improved the calculations for the cost of air pollution, but the data available do provide a useful estimate for using in the Genuine Progress Indicator. The same sort of regionally-specific issues noted in Bagstad and Ceroni (2007) apply here, in that Maryland's unique agricultural landscape and the Chesapeake Bay may be more vulnerable to certain air pollution damage than other landscapes. Without accurate, local-scale data, the use of national level damage cost estimates scaled down based on appropriate factors provides a starting point for future efforts.

Column R: Cost of noise pollution

The calculation of the cost of noise pollution relied on an urbanization index described in Costanza et al (2004). Data for urban populations were available online from the US Census website at all scales for 1990 and 2000. Urban populations for earlier years were obtained from the Census of Population, Number of Inhabitants reports. For 2005, urban population figures were estimated based on the 2000 percentage of the population considered urban at each scale. The urbanization index was then determined by dividing the state, county, or city urban population by the US urban population for each year.

Following the national United States GPI estimates and Bagstad and Ceroni (2007), a cost estimate from a 1972 World Health Organization study was extrapolated based on estimated rates of increase and mitigation of noise pollution (the cost of noise pollution increases 3% per year 1950-1971, equals $4 billion in 1972, and increases 1% per year 1973-2005). The same assumptions and problems with this method noted in earlier studies apply here as well: this method assumes noise pollution results from urbanization and relies upon an old study. Some of the elements that could be used in a more updated estimate of the cost of noise pollution are the impact of lower property values, health care costs (related to loss of sleep, damage to hearing, and stress), and work income (stemming from difficulty concentrating or communicating, fatigue, and annoyance). In another sense, one could estimate the cost of noise pollution from expenditures on abatement. The Noise Pollution Clearinghouse (www.nonoise.org) has an online library of studies by the Environmental Protection Agency that estimate the regulatory costs of programs to control noise from traffic, trucks, motorcycles, airports, lawn mowers, jetskis, trains, and more. This resource could serve as a starting point for future damage estimates resulting from noise pollution.

Column S: Loss of wetlands

The same challenges noted in Costanza et al (2004) and Bagstad and Ceroni (2007) for wetland loss estimates arose in this study. Differences in wetlands classification methods means careful attention must be paid to historical data on wetland acreage figures. Fortunately, one detailed wetland study for the state of Maryland provides the majority of data for the calculations. Other National Wetland Inventory data that were used included similar methods and definitions.

Tiner and Burke presented a comprehensive study title Wetlands of Maryland (1995) in cooperation with the Fish and Wildlife Service and the Maryland Department of Natural Resources. They estimate about 600,000 acres of wetlands in the state in 1995, and provide figures for Baltimore City and County for the year 1981. This study also provides data on wetland trends in the state. Pre-settlement wetland acreage and cumulative losses were determined using a US Fish and Wildlife Service report to Congress (Dahl 1990), maps of hydric soils, and the assumption that the inclusion of somewhat poorly drained soils within the hydric soil map units creates a slight overestimation bias. From this information, it was estimated that Maryland once contained 1.2 million acres of wetlands. Tiner and Burke (1995) estimate 45-65 % of Maryland’s wetlands have been lost. These state-level trends were the basis for estimating the pre-settlement wetland acreage for Baltimore County and City as well. Since presettlment wetland conditions are an unrealistic baseline, 1940 wetland figures were ultimately used to estimate the costs of wetland loss in following years.

Based on Tiner and Burke (1995), it was estimated that between 1955 and 1978, 76 % of wetland losses can be directly attributed to human impacts, including impacts from agriculture, roads and highways, housing, commercial and industrial development, and public facilities. Their annual net loss estimates for different types of wetlands were weighted by the amounts of each type of wetland relative to the total wetland acreage. This produced a statewide loss estimate of 7.4% 1955-1978. This trend was extrapolated to 1982, at which point Tiner and Burke (1995) estimate about 6000 wetland acres were lost between 1982-1989. A slightly lower loss rate of 800 acres/year was assumed for 1989-1995. The rate of loss 1985-1995 then was 1.4%. For 1995-2005, it was assumed this is lessened to 1%. This slowing rate of wetland loss is based on the Maryland Tidal Wetlands Act in 1989 and the increasing federal regulation of wetlands since 1975. Baltimore County and City trends were assumed to mirror state trends (which slightly overestimates wetland loss in these areas because of the significance of tidal wetland trends at the state level).

Following Bagstad and Ceroni (2007), wetland losses were valued at $396 per acre per year prior to 1950. 1950 losses were valued at $1,973 per acre per year, and the value was assumed to increase by 2.5% per year to account for the increasing scarcity of wetlands. In agreement with Bagstad and Ceroni (2007), this estimate of 2.5 % per year seemed to be a more reasonable number than the 5% per year used by Costanza et al

(2004). The economic costs from wetland loss were assumed to be cumulative. While this approach makes certain assumptions about quantitative loss of wetlands, it entirely neglects qualitative changes in wetlands (for example, changes in hydrological flows or vegetation). These can be more subtle and difficult to detect but can still impair the ecosystem service functioning of wetlands and thus the cost estimates for losses.

As noted in the cost of water pollution category, water-based resources have above average value in Maryland. In 1997, the EPA reported on the economic value of wetlands in Maryland within the Chesapeake Bay watershed. In 1993, it was estimated that sport fishing expenditures were $275 million, retail sales from wetland-dependent migratory bird hunting were $20 million, and commercial fish and crab harvests provided about $5 billion. The total Chesapeake Bay wetland acreage of 31,001 acres means that recreational fish and bird hunting alone provide a value of over $9,515 per acre per year, a figure considerably higher than the 1993 figure used in the calculation (about $5,700 per acre per year).

Column T: Loss of farmland

The Census of Agriculture provided data on amount of land in farms for Maryland counties in the years 1987, 1992, 1997, 2002, and 2007. 1950 data were also obtained for Maryland, Baltimore City, and Baltimore County. The missing data points were interpolated or estimated based on the percentage of Maryland farm land in Baltimore County for known years (for county estimates) or the loss rate at the county scale (for city estimates). The National Agricultural Statistics Service provided farm land acreage for Maryland 1950-2005.

The next task was to determine how much farmland was lost to development as opposed to abandonment (reverting to forest) or conservation of agricultural land. The American Farmland Trust estimated that in Maryland 1992-1997, 37,800 acres of prime agricultural land were converted to development. This translates to a rate of 7,560 acres per year, which was then compared with the total farmland loss rate for that decade of 11,465 acres per year to estimate that 65% of the farmland lost in the decade 1990-2000 was due to urbanization. This figure was used for Baltimore County and the state of Maryland; it was assumed that 100% of the farmland lost in Baltimore City can be attributed to conversion for development. The cumulative cost of urbanization up to 1950 was taken from the national GPI figure ($2.85 billion) and scaled down based on total amounts of farmland.

The dollar value per acre per year figures used to estimate the cost of farmland lost to urbanization in prior studies varies. The most recent national level GPI study uses a much higher value than other studies, based on specific farmland in Kentucky that is highly valued and not representative of other areas in the US. The 1999 GPI report uses a value of $404 per acre per year (2000 dollars). However, data from the Agricultural Census suggest Maryland farm land values are slightly higher than this national average – approximately $625 per acre per year in 1997 and $622 per acre per year in 2002. It was assumed that this value was consistent over all years. The value of $622 per acre per year was multiplied by the acres converted to development and added to previous costs (the costs are considered cumulative, as in prior GPI studies).

The costs associated with damage to soils (for instance, soil erosion and compaction) are difficult to estimate due to a lack of accurate data at the smaller scales. The GPI studies in Vermont avoid including this value, and the Ohio study found that the costs associated with soil erosion, which they based on Natural Resource Inventory data, were “extremely small in the scheme of the GPI” (Bagstand and Shammin, unpublished). As such, the costs of farmland lost in Maryland, Baltimore City, and Baltimore County were based entirely on the land lost to urbanization and do not include damages resulting from soil fertility loss.

Column U: Depletion of nonrenewable resources

The cost of depleting nonrenewable resources was estimated using the cost of replacing those resources with renewable ones. Energy consumption values provide a more appropriate basis for the calculation than do production values, as Maryland does not produce a considerable amount of energy. Detailed energy consumption data for Maryland 1960-2005 were available from the Energy Information Administration’s state energy data system. Figures for 1950 were extrapolated based on the known 45-year trend. Consumption data were not available at smaller scales, so Baltimore City and County data were scaled down from Maryland data based on population. The assumption that local energy consumption can be scaled down based on population leads to Baltimore City’s energy consumption decreasing at times, along with the population.

Following Bagstad and Shammin (unpublished), a distinction was made between consumption of nonrenewable energy resources for electricity generation (assumed in this study to be energy derived from coal and nuclear) and for transportation and related sectors (assumed in this study to be the rest of the nonrenewable resources consumed). This was because even though earlier studies assume replacement costs with biofuels for all energy, biofuels would not be suitable for replacing all nonrenewable energy sources. Biofuels were used for replacement costs of transportation and related sectors energy sources (mostly petroleum) and wind and solar were used for replacement costs of electricity generation energy sources.

The total Btu's of nonrenewable energy resources consumed for electricity generation were converted to kWh and multiplied by a replacement cost for a 50/50 mix of wind and solar power. A study by Makhijani (2007) provides estimates of the cost of replacing nonrenewable energy resources with wind power ($0.055/kWh) and solar ($0.12/kWh). The average cost of $0.0875/kWh was used to provide a replacement cost with an even mix of the two renewable energy sources. The same study also estimates the cost to replace petroleum with biofuels at a large scale as $116/barrel. The total Btu's of nonrenewable energy resources consumed for transportation and related sectors was converted to barrels of oil equivalent and multiplied by this cost. The two components (electricity generation and transportation) were then summed to obtain an estimate of the total cost of depleting nonrenewable resources.

The Governor of Maryland has recently launched the "EmPower Maryland" initiative aimed at reducing total state energy consumption 15% by 2015. Data from the

Energy Information Administration for 2006 already reflect a decrease in total energy consumption from the previous year, though this can be seen several times over the past 45 years. Meanwhile, a very small portion of the total energy consumed in Maryland comes from renewable sources, and this percentage has actually decreased in recent years: about 3% in 2005 compared with 4% back in 1990.

The uncertainty inherent in transitioning to new energy resources and consumption patterns needs to be acknowledged, especially at large scales. The transition to renewable energy resources, though eventually inevitable, will be influenced by things like technological increases in efficiency, demand-side management, alternative energy sources, and social adaptation challenges. Impending governmental regulation of certain types of energy resources and support of renewable resources (financial incentives, subsidies, funding for research and development, etc.) injects still more uncertainty into studies of the costs of replacing nonrenewable energy resources.

Column V: Long-term environmental damage

The cost of long-term environmental damage was calculated based on the consumption of energy resources, as in previous GPI studies. Energy consumption makes a good proxy for long-term environmental damage because the impacts associated with the consumption of energy are significant and are largely missed by standard national accounting practices. The major impact included in the GPI calculation is from climate change associated with the combustion of fossil fuels. The energy information administration provided detailed data for Maryland's energy consumption since 1960.

1950 consumption estimates were extrapolated from the known trend. Baltimore City and County figures were based on these state-level consumption data and scaled down by population.

Energy consumption in trillion Btus was converted to barrels of oil equivalent. Costanza et al (2004) use a $2.56 per barrel (2000 dollars) tax on all forms of energy use to estimate the costs of energy consumption. The same value was used for Maryland, Baltimore City, and Baltimore County to calculate the costs of consuming only the energy generated from fossil fuels, nuclear, hydroelectric (due to ecological costs), and biomass (due to associated CO_2 impact). Energy from "other" (wind, geothermal, solar electric, and solar thermal) was not included. Rather than accumulate the costs over time (as in Costanza et al., 2004), a one time cost for the damage from energy consumption was used (as in Bagstad and Ceroni, 2007).

A separate method carried out involved using the carbon emissions coefficient to determine the amount of carbon dioxide emitted per Btu of different kinds of energy consumed. Carbon coefficients were obtained from the US Department of Energy and used to calculate the metric tons of CO_2 emitted for Maryland's coal and oil consumption. These physical amounts of CO_2 were then assigned a marginal social damage cost similar to the US GPI methods (Talberth et al., 2007). Assuming that the Earth's CO_2 sequestration capacity became exceeded in 1964, marginal damage costs increase from $1 per metric ton CO_2 in 1964 up to $89.57 per metric ton CO_2 in the year 2000. This is consistent with Talberth et al.'s (2006) values, which were derived from a survey of studies.

The economics of climate change is an expanding field of research, especially given the recent interest in policies aimed at reducing greenhouse gas emissions. One meta-analysis of climate change costs studies reviewed one hundred and three estimates of the marginal damage costs of carbon dioxide emissions (Tol 2005). Issues and uncertainties related to discount rates, aggregation, and weighting affect the results of these studies, sometimes even changing the sign of the cost (indicating the impacts of carbon dioxide can be evaluated as a cost in one scenario but a benefit in another). These studies rely upon global models and estimate the impacts at large scales, in the interest of informing policy-based decisions about the trade-off between avoided impacts and the costs of emission reduction. In the case of Baltimore City, County and Maryland, the $2.56 per barrel tax is a reasonable figure for estimating the long-term environmental damage resulting from the consumption of energy.

Column W: Cost of ozone depletion

Since regulation and data collection on the release of ozone-depleting chemicals occurs at the national scale, estimates must be made at the national level and then scaled down to the state, county, and city level based on population. Data on the emissions of the ozone-depleting chemicals CFC-11, 12, 113, 114, and 115 since the 1930s were available from the Alternative Fluorocarbons Environmental Acceptability Study (AFEAS). The amounts released of each chemical were summed to obtain a total amount of ozone-depleting chemicals released. The figures for world emissions were multiplied by 0.4 to estimate the contributions of the United States (while the Vermont GPI studies estimate the US share as 1/3 of the world total, 0.4 is more in agreement with recent national-level GPI estimates for the US that include data from the EPA and US Congress on the US contribution).

The cost estimate figure from Talberth et al (2007) was used to calculate the cost of ozone depletion. This value, $49,669 per metric ton (in 2000 dollars), was multiplied by the amount of ozone-depleting chemicals released by the United States. As in the calculation of long-term environmental damage, the question of whether or not to accumulate damage costs arose. Both the annual costs and cumulative costs were calculated for comparison. A significant disparity occurs as a result of the sharp drop in CFC emissions between 1990 and 2000 (due to the Montreal Protocol and subsequent phase-out of CFCs in the US). In the final GPI, only the annual costs were included to provide a conservative estimate.

Column X: Loss of forest cover

The methods used to value forest cover loss were similar to Costanza et al (2004) and Bagstad and Ceroni (2007). Forest acreage for Maryland for the years 1938, 1953, 1963, 1977, 1987, and 1997 was obtained from a USDA Forest Service report (Smith et al 1997). Values were interpolated to obtain the necessary estimates of forest cover. Baltimore County figures were obtained for the years 1914, 1997, and 2007 from the Baltimore County Forest Sustainability Program. The trends in forest cover at the state level were used to estimate county trends for earlier years.

Trees in cities may not be thought of as a typical “forest,” but they still provide valued services to our daily lives. In the urban setting, these may include reducing the urban heat island effect, improving water quality, saving energy, reducing air pollution, increasing neighborhood desirability and quality of life, enhancing property values, providing wildlife habitat, and providing aesthetic benefits. A report on Baltimore City’s urban tree canopy provided acreage of tree cover for 2007, and prior years were estimated based on state level trends (O’Neil-Dunne, 2009).

Pre-settlement forest cover was assumed to be 94% of land area. As with the loss of wetlands, it is unrealistic to assume a baseline of presettlement forest cover, as returning to 94% forest cover is highly unlikely and may not even be desirable. Calculations were carried out using a presettlement baseline and a 1940 forest cover baseline, for comparison. It was decided that while the presttlement baseline may provide a more accurate (higher) cost estimate, it is more realistic to use 1940 as the baseline conditions from which the costs are estimated. The final GPI calculation used the 1940 baseline figures, which accumulate to reflect how the lost ecosystem services from a lost acre of forest one year are still lost in subsequent years.

Column Y: Net capital investment

As population increases, so does the demand for capital. In order to avoid consuming capital as income, capital stocks must be maintained or increased to meet increased demand. The GPI corrects for net capital investment by focusing on the quantity of capital available for each worker. Changes in the stock of capital are calculated by taking the amount of new capital stock and subtracting capital requirement (equal to the percent change in the labor force multiplied by the previous year's capital stock). Recent GPI studies for the United States calculate net capital investment from capital stock and labor force data available from the US Bureau of Economic Analysis. Comparable data were unavailable at the more local scales, as in the Vermont and Ohio GPI studies. For this reason, national estimates were calculated and were scaled down based on population for all three scales and all years.

Column Z: Net foreign lending and borrowing

The extent to which Maryland, Baltimore County, or Baltimore City depend on "foreign" funding to maintain levels of consumption was difficult to determine, given data limitations at the local scales. What's more, the definition of what constitutes "foreign" investment becomes vague at local scales. One possible method was used in the GPI estimates for the San Francisco Bay Area (Venetoulis and Cobb 2004). In order to include in their GPI estimates the welfare loss of local citizens due to holding debt at the national level, national debt or surplus was simply scaled down based on population. This method fails to accurately represent the strengths and weaknesses of the local economies of Maryland, Baltimore City, and Baltimore County, though. Following the GPI studies for Vermont and Ohio, this item is not included in the final GPI calculation.

Online Data Sources

US Census
USA Counties
US Census of Agriculture
USDA, National Agricultural Statistics Service
American Farmland Trust
Television Bureau of Advertising and Nielsen Media Research
National Center for Health Statistics vital statistics reports
Statistical Abstract of the United States
National Center for Educational Statistics
US Bureau Labor Statistics
US Department of Transportation, Bureau of Transit Statistics
Maryland Department of Transportation, Highway Information Services Division
Maryland Department of Transportation, State Highway Administration
Maryland Department of Business and Economic Development
Independent Sector
Maryland State Police FBI Uniform Crime Reports
Maryland Motor Vehicle Administration
Maryland Department of Budget and Management
Baltimore City Dept. of Public Works Bureau of Solid Waste
Baltimore County Dept. of Pubic Works Bureau of Solid Waste Management
Maryland Department of Environment
Maryland Department of Natural Resources
2000 Maryland 305(b) report to the EPA on water quality
Noise Pollution Clearinghouse
Energy Information Administration
Baltimore County Forest Sustainability Program
Baltimore Greenhouse Gas Inventory
Baltimore Sustainability Plan