How are Green National Accounts Produced in Practice?*

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* This paper has benefited substantially from the comments by Thomas Aronsson and Karl-Gustaf Löfgren.

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Summary in Swedish

Den här rapporten utgör en översikt över hur arbetet med monetära miljöräkenskaper har utvecklats internationellt. Först diskuteras de olika delarna i FN:s handbok för miljöräkenskaper ”System of integrated Economic and Environmental Accounting” (naturresurser, flöden av föroreningar och material, miljöskyddskostnader, och miljöjusterade makroaggregat som till exempel grön NNP och genuint sparande) och hur olika länders miljöräkenskapsprogram relaterar till de olika delarna. Sedan görs en genomgång av olika länders erfarenheter av monetära miljöräkenskapsprojekt i form av grön NNP-beräkningar samt Världsbankens beräkningar av genuint sparande. Därefter presenteras mer detaljerat Norges arbete med att mäta Nationalförmögenheten och Sveriges monetära miljöräkenskaper. Slutligen diskuteras de teoretiska och empiriska svårigheterna med monetära miljöräkenskaper.

BAKGRUND

Konjunkturinstitutet (KI) fick våren 1992 i regeringsuppdrag att utveckla metoder för monetära miljöräkenskaper och att utveckla miljöekonomiska modeller som kan användas för samhällsekonomiska konsekvensanalyser. Uppdraget ingick som en del i det större miljöräkenskapsarbete som också lades ut på Statistiska centralbyrån (SCB) och Naturvårdsverket (NV). SCB fick i uppdrag att utveckla fysiska miljöräkenskaper det vill säga ett statistiskt system som kopplar samman miljöstatistik med ekonomisk statistik. NV skulle utveckla indikatorer och index som kan ge en samlad bild av tillståndet i de svenska ekosystemen och dess förändringar. Bakgrunden till regeringsuppdragen var utredningen (SOU 1991:37-38) ”Räkna med miljön!” som föregicks av en internationell debatt som tog fart när Brundtlandkommissionens rapport om hållbar utveckling kom 1987. FN: s konferens i Rio de Janeiro 1992 rekommenderade att miljöräkenskaper skulle utvecklas som ett komplement till nationalräkenskaperna, för att utvärdera och styra utvecklingen mot ett mer hållbart samhälle.

BERÄKNINGAR AV GRÖN NNP OCH GENUINT SPARANDE

Sedan begreppet hållbar utveckling myntades har många försökt omsätta begreppet i praktiken. Man har bland annat diskuterat huruvida de monetära miljöräkenskaperna skulle kunna användas för att räkna fram en miljöjusterad nettonationalprodukt, även kallad grön NNP. Nettonationalprodukten beräknas som BNP, det vill säga summan av värdet av alla varor och tjänster som produceras för slutlig användning under ett år, minus kapitalförslitning av realkapital (mänskligt producerat kapital) som byggnader och maskiner. Men konsumtion av ”icke-marknadsprissatta” nyttigheter som till exempel miljökvalitet och värdet av förändringar i naturkapitalet såsom biomassa, mark, vatten och luft ingår inte. Tanken med grön NNP var att konstruera ett välfärdsmått som bättre beskrev användningen av ekonomins resursbas, inkluderande varor och tjänster från det ekologiska systemet. Ett välfärdsmått, relaterat till grön NNP, är det genuina sparandet som anger hur mycket ett land egentligen sparar för framtiden i termer av nettoförändringar i alla kapitalstockar.

Den internationella jämförelsen visar att det är få länder som inkluderar monetära miljöräkenskaper i sina miljöräkenskapsprogram. De länder som har försökt räkna ut en grön NNP har gjort det för något specifikt år eller tidsperiod och som en engångsföreteelse. Tyskland, Japan, Mexiko och Sverige har fokuserat på enstaka år, medan Costa Rica, Indonesien, Korea och Filippinerna har beräkningar för en viss tidsperiod. Det råder stora skillnader i analysernas täckning och värderingsmetoder. Vad man väljer att inkludera beror på naturresurstillgång, föroreningsproblem och datatillgång i respektive land. Vissa länder inkluderar bara marknadsprissatta varor och tjänster medan andra länder försöker värdera icke-marknadsprissatta sådana. Sammantaget gör detta att grön NNP-beräkningarna inte blir jämförbara mellan länderna.

För Sveriges del har KI under åren 1992-2004 utvecklat metoder för monetära miljöräkenskaper, bland annat genom ett aktivt deltagande i arbetet med FN:s handbok för miljöräkenskaper. Försök har också gjorts för att räkna ut en partiell grön NNP, även om det inte har varit uppdragets huvudsyfte. Analyserna, som omfattar både teoretiska och empiriska studier, har främst fokuserat på kväve- och svavelutsläppens skadeverkan. De visar att NNP ska justeras ned med 1-2 procent per år om man inkluderar de mest utredda skadeeffekterna av dessa utsläpp som till exempel försurning av mark och vatten och förslitning av vissa material så kallad korrosion. Andra studier fokuserar på hälsoeffekter från luftföroreningar, naturkapitalets avkastning av ekosystemtjänster och hur contingent valuation-metoden ska användas i miljöräkenskaperna. Gemensamt för alla försök att räkna ut grön NNP, såväl i Sverige som internationellt, är att de är partiella och behäftade med stor osäkerhet.

Världsbankens beräkningar av genuint sparande utgår från nationalräkenskapernas sparande (BNP minus konsumtion) som sedan justeras med hänsyn till kapitalförslitning, utbildningsutgifter (som ett mått på värdet på humankapitalinvesteringar), nettoförändringar av naturkapitalstockarna och löpande miljöskador. Dessa beräkningar utförs för ett 200-tal länder men, för jämförbarhetens skull, begränsas det som ingår i beräkningarna. Som exempel kan nämnas att måttet enbart inkluderar ett begränsat urval marknadsprissatta varor och tjänster och att koldioxid är det enda utsläpp som inkluderas. Ett fullständigt välfärdsmått på genuint sparande bör egentligen inkludera värden av alla nettoförändringar i kapitalstockarna.

TEORETISKA OCH EMPIRISKA SVÅRIGHETER

Att praktiskt konstruera monetära miljöräkenskaper möter flera svårigheter. De teoretiska begränsningarna har att göra med förutsättningar, i form av perfekt konkurrens och ingen teknologisk utveckling, som måste gälla för att man ska kunna tolka grön NNP som ett exakt välfärdsmått. Vad gäller de empiriska svårigheterna måste man för varje miljöskada och naturkapital fastställa kvantitativa och kvalitativa förändringar. Här är den naturvetenskapliga datatillgången långt ifrån tillfredsställande. Det finns också stora kunskapsluckor vad gäller orsakssambanden mellan koncentrationen av föroreningar i luft, vatten och jord och deras påverkan på natur och hälsa. Härtill kommer svårigheterna att väga samman och sätta pris på miljöskadorna och förändringar i naturkapitalen. En del av de faktiska skadorna kan kostnadsbestämmas med hjälp av marknadspriser, till exempel korrosionsskador, skador på fisk och växande gröda. Svårare är det med skador såsom påverkan på människors hälsa, förlusten av arter och inverkan på allemansrätten. Kostnaden för sådana skador försöker man uppskatta med betalningsviljestudier. Sådana studier kan till exempel innebära att hushållen tillfrågas hur mycket de är villiga att betala för att en viss aspekt av miljön inte ska försämras. Betalningsviljestudier används annars oftast i kostnadsnyttoanalyser när det gäller specifika objekt (till exempel ett visst skogsområde) eller projekt (till exempel ett visst vägbygge). De är också bäst lämpade att använda i sådana sammanhang. Mycket förenklat innebär beräkningen av en grön NNP utifrån dagens empiriska underlag ett antagande om att betalningsviljestudier, utförda för små geografiska områden i Sverige, är representativa för hela landet, att dessa värderingar appliceras på osäkra naturvetenskapliga samband för varje miljöskada och naturkapitalstock samt att en aggregering sker för att slutligen justera NNP. Det är uppenbart att dessa osäkerheter kraftigt bidrar till att begränsa möjligheterna att komma fram till ett heltäckande och internationellt jämförbart NNP-mått. Att justera NNP med så osäkra uppskattningar leder till ett mycket osäkert resultat som är svårhanterligt ur policysynpunkt. Även under de bästa omständigheterna är det orealistiskt att anta att vi inom överskådlig framtid skulle kunna producera grön NNP som löpande statistik.

Men vi ska därför inte sluta att värdera miljöpåverkan - tvärtom. Det finns idag ett stort behov av samhällsekonomiskt underlag till miljöpolitiken. Här fyller hela miljöräkenskapsarbetet ett viktigt syfte. Arbetet med monetära miljöräkenskaper, som har inneburit en värdering av olika slags miljöpåverkan, kan användas i samhällsekonomiska analyser. De fysiska miljöräkenskaperna där miljödata hänförs till olika typer av verksamheter – privat konsumtion, offentlig förvaltning och näringsliv – gör sambanden mellan ekonomi och miljö synligare. Statistiken utgör också en viktig insatsfaktor till miljöekonomiska modeller som i sin tur kan användas för att utvärdera alternativa sätt att föra miljöpolitik.

KI avslutade arbetet med monetära miljöräkenskaper år 2004 och styrde om verksamheten till förmån för samhällsekonomisk analys för svensk miljöpolitik där fokus ligger på utvärdering av miljöpolitiska styrmedel. Under 2008 fick Statskontoret i uppdrag att utvärdera arbetet med miljöräkenskaper. Den här rapporten är tänkt som ett underlag inför det arbetet och rapporten kommer också att publiceras som ett kapitel i Thomas Aronssons och Karl-Gustaf Löfgrens bok om miljöräkenskaper ”The Handbook of Environmental Accounting” (Edward Elgar Publishing Limited).

Contents

1. Introduction

During the last part of the twentieth century, the effect of human activity upon the environment became an important policy issue. There is now a growing concern about how economic activity affects the environment and it has become more and more recognised that economic growth is dependent upon the provision of environmental services. To be able to combine economic growth with a healthy environment in terms of a sustainable use of natural resources, a better understanding of the relationships between economy and ecology needs to be developed.

The awareness that economic development and environmental aspects cannot be treated separately was the background to the Brundtland Commission, formally the World Commission on Environment and Development set up by the United Nations (UN) in 1983. The commission was created to address the concern about the accelerating deterioration of the environment and its consequences for economic and social development. According to the Brundtland-report, sustainable development is largely about the allocation of resources within and between generations (UN, 1987). One of the most often cited definitions of sustainability was adopted by the commission, that 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.[1] How to measure sustainable development was, however, never conveyed by the commission and has proven to be remarkably difficult. The early discussions on sustainable development departed from the capital stocks and two views on how certain types of capital can replace each other: weak and strong sustainability. The concept of weak sustainability originates from Hartwick's rule, which shows, under certain assumptions, that the rent derived from resource depletion is exactly the level of capital investment needed to achieve constant consumption over time (Hartwick, 1977).[2] In other words, weak sustainability implies that all forms of capital are more or less substitutes for one another. This approach then allows for the depletion and degradation of natural resources, as long as such depletion is offset by increases in the stocks of other forms of capital. Strong sustainability, on the other hand, implies that all forms of capital must be maintained intact independent of each other, implying no substitution between different forms of capital (Daly and Cobb, 1989; Daly, 1990). Several ways of measuring sustainable development have been suggested, involving both theoretical and empirical weaknesses.[3] The welfare measures comprehensive net national product (Weitzman, 1976)[4] and genuine savings (Pearce and Atkinson, 1993), which are firmly founded in neo-classical economic theory and potential indicators of weak sustainability, will be discussed in this paper.

The Net National Product (NNP) equals the sum of consumption of conventional goods and services and the value of net investment in physical capital. A comprehensive NNP should also include consumption of other utilities, such as leisure and envi-

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[1] The definition originates from the discussion on sustainable income held by Fisher (1906), Lindahl (1933) and Hicks (1939).

[2] These assumptions include a constant population, a closed economy and substitutability between natural resources and produced capital.

[3] These measures can be divided into: 1) Welfare measures, 2) Socio-political indicators: the Index of Social and Economic Welfare (Daly and Cobb, 1989; Cobb et al., 1995) and the Genuine Progress Indicator (UNDP, 1996), 3) Ecological/environmental indicators: Ecological footprints (Rees and Wackernagel, 1994) and Environmental space (Friends of the Earth, 1995) and 4) Single indicators (such as air and water quality, soil erosion etc.). For an analysis of sustainability measures for Scotland during the period 1980-93, see Hanley et al. (1999).

[4] Comprehensive NNP in utility terms is defined using the current value Hamiltonian of the underlying optimal growth problem.

ronmental quality, and changes in natural resource- and human capital stocks. The genuine savings measure equals comprehensive NNP less consumption. Weitzman (1976) shows that comprehensive NNP is an exact indicator of welfare under the restrictive assumptions of an economy with a stationary technology, no externalities and perfect foresight. If the economy also is closed with a constant population and only one capital good, NNP is an exact indicator of sustainability (Asheim, 1994).[5] The welfare significance of genuine savings was first derived by Pearce and Atkinson (1993).

A well-known shortcoming of the System of National Accounts (SNA) is that it does not consider the impact of environmental pollution and depletion of natural resources on welfare.[6] This has been a growing concern ever since the development of the system in the 1940s (Smith, 2007). At the UN Conference on Environment and Development in Rio de Janeiro in 1992, the full text of Agenda 21 was revealed and 179 governments adopted the programme.[7] Agenda 21 included the establishment of systems for integrated environmental and economic accounting. The basis for action stated that a first step towards the integration of sustainability into economic management is better measurement of the role of the environment. The objectives included the expansion of existing systems of national economic accounts with sound theory and practicability, 'in order to integrate environment and social dimensions in the accounting framework, including at least satellite systems of accounts for natural resources in all member states'. One of the stated activities was for the UN statistical office to make the Handbook on Integrated Environmental and Economic Accounting, involving practical guidelines, available to all member countries (UN, 2007). In 1993, the UN published the first handbook on environmental accounting (UN, 1993). It aimed at supplementing existing accounts with environmental and natural resource accounts, employing the same type of accounts, branches and definitions as the SNA. In 2003, a revision of the handbook was released.

Even if the handbook was published as late as in 1993, the development of applied green accounting dates back to the 1970s. Large efforts were, from the beginning, made by individual countries and practitioners developing their own frameworks and methodologies to represent their environmental priorities. Some of the earliest work was undertaken in Norway (Alfsen et al., 1987; Alfsen and Graeker, 2007), followed by France (Theys, 1989), but by the time of the first handbook, Australia, Canada, Denmark, Finland, Germany, Indonesia, Italy, Japan, the Netherlands, the Philippines, Sweden and the United Kingdom had joined the efforts. These experiences on green accounting range from environmental asset and flow accounts to environmentally-adjusted macroeconomic aggregates.

This paper is structured as follows. Section 2 describes the development of the Handbook of Integrated Environmental and Economic Accounting, including the four components of environmental accounts and how the environmental accounting programmes of different countries relate to these four components. Section 3 provides an overview of country experiences of adjusted welfare measures, including comprehensive net domestic product attempts and the genuine savings project carried out by the

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[5] Comprehensive NNP in utility terms can thus be interpreted as the yield from an eternal bond.

[6] Another shortcoming includes the treatment of human and social capital.

[7] Agenda 21 is a 'comprehensive blueprint of action to be taken globally, nationally and locally by UN organisations, governments and major groups in every area in which humans impact on the environment' (http://en.wikipedia.org/wiki/Agenda_21).

World Bank. Sections 4 and 5 include case studies of green accounting projects carried out in Norway and Sweden. Norway was one of the pioneers of green accounting and Sweden is one of the few countries with an environmental accounting programme that includes the calculation of environmentally adjusted macroeconomic aggregates. Section 6 discusses the difficulties encountered in pursuing monetary green national accounts, and Section 7 summarises and concludes the paper.

2. Integrated Environmental and Economic Accounting

2.1 The development of the SEEA 1993 and 2003

In 1993, the UN published its Handbook of National Accounting: Integrated Environmental and Economic Accounting, or SEEA 1993 (UN, 1993). It was the first handbook on environmental accounting, and although it is considered a modest step forward in treating the environment within the national accounts, it was the first time any serious consideration was given to the issue (Smith, 2007). The SEEA 1993 was published as a set of international recommendations rather than as an international standard. As a consequence, countries that had already established environmental accounting programmes did not necessarily adjust their efforts to align with it (Smith, 2007). Other countries, including Columbia, Ghana, Indonesia, Korea and the Philippines, started experimenting with the compilation of the new satellite accounting framework (Hamilton and Lutz, 1996). To exchange experiences among countries and to advance methodologies, the London Group on Environmental Accounting was created in 1994. All of the leading national and international agencies working with environmental accounting joined the group. The UN Statistical Commission (UNSC) formally requested the London Group to collaborate with the UN Statistical Department on the revision of the SEEA 1993 (UNSC, 2007). The revised handbook, the SEEA 2003 was published jointly by the UN, the International Monetary Fund, the Organization of Economic Cooperation and Development, the Statistical Office of the European Commission and the World Bank (UN et al., 2003). It offers guidance to a complete and integrated set of environmental accounts, both in physical and monetary units. The main purpose of the SEEA 2003 is 'to explore how sets of statistical accounts can be compiled which will permit investigation and analysis of the interaction between the economy and the environment' (UN et al., 2003, p. 1). The UN Committee of Experts on Environmental and Economic Accounting has recently decided to make the SEEA 2003 an international standard by 2010. This will increase the pressure to conform to its concepts and methods (Smith, 2007).

2.2 The four components of environmental accounts

The SEEA 2003 comprises four categories of accounts: flow accounts for pollution, energy and materials; environmental protection and resource management expenditure accounts; natural resource asset accounts; and valuation of non-market flow and environmentally adjusted aggregates.

Pollutant and material flow accounts consider purely physical data relating to flows of pollution, materials and energy. The accounts, which follow the SNA accounting structure, provide industry level information about the use of energy and materials as inputs to production and the generation of pollutants and waste. The objective of these accounts is to see the interdependence between the economy and the environment. Since the accounts follow the SNA, links can be made to other economic series. Flow data in physical and monetary terms can be combined to produce so-called 'hybrid' flow accounts, which for example can be used to analyse 'decoupling', i.e. the lessening of correlation or dependency between variables such as economic production and environmental quality. The National Accounting Matrix with Environmental Accounts (NAMEA) is a well-known type of hybrid account developed by Statistics Netherlands in the 1990s, and shows the link between economic indicators and the environment.

Environmental protection and resource management expenditure accounts identify expenditures incurred by industry, the government and households to protect the environment or to manage natural resources. These accounts are consistent with the SNA but summarise all environment-related transactions separately in satellite accounts. The reason behind establishing these type of accounts is 'to identify and measure society's response to environmental concerns through the supply and demand for environment goods and services, through the adoption of production and consumption behaviour aimed at preventing environmental degradation and by managing environmental resources in a sustainable way' (UN et al., 2003, p. 170).

Natural resource asset accounts comprise accounts for environmental assets such as land, fish, forest, water and minerals. An asset account shows opening and closing balances and the related changes over the course of the accounting period. The accounts are measured both in physical and monetary terms. The physical accounts are easier to construct but can not be aggregated and are therefore not very useful in studying tradeoffs among capital stocks. The monetary accounts on the other hand have both practical and conceptual problems related to the limitations and legitimacy of the valuation methods (Smith, 2007). To value natural capital depletion (a quantity reduction in a natural resource), the SEEA 2003 recommends the net present value (NPV), which equals the net return on the extracted resources less the interest gained on the remaining capital (Dietz and Neumayer, 2007). Other methods mentioned are the net price method and the El Serafy method (also called the user cost method).[8] Valuing natural capital degradation (a quality damage of a natural resource) is however more controversial than valuing depletion. Hence, methods to value degradation are discussed among the last types of accounts, which the SEEA 2003 states are more 'hypothetical'. The asset accounts are relevant to the capital-based approaches to sustainable development. The SEEA 2003, however, focuses only on natural capital and does not cover human and social capital, which also need to be included when measuring sustainability. There is a debate on the degree of substitutability of natural capital by other forms of capital, and this has led to two forms of capital-based approaches: weak and strong sustainability (see Section 1). Since strong sustainability implies no substitution between different kinds of capital, there is no need for monetary evaluation. In order to see if weak sustainability is obtained (if the whole capital stock is left intact), the separate stocks need to be valued monetarily.

The valuation section in the SEEA 2003 focuses on valuation techniques for measuring degradation and their applicability in answering policy questions. Cost-based pricing techniques such as structural adjustment costs, abatement costs and restoration costs are described as well as damage- and benefit-based pricing techniques in terms of revealed and stated preference methods. Methodological reservations are made

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[8] The net price method, based on the Hotelling model (Hotelling, 1931), assumes that the value of the resource stock can be calculated simply as the current rent per unit of resource (difference between the price of the resource and the marginal cost of extraction) times the size of the stock. The El Serafy method (El Serafy, 1989) splits the resource rent into an income component that can be consumed and a depletion cost (user cost). The user cost should be reinvested so that its yield will contribute to the generation of income both during extraction and after the resource has been exhausted (El Serafy, 1989).

stating that the valuation techniques are still being developed and the data requirements to implement them are both extensive and resource intensive and thus generally incomplete. The difficulty involved in using these methods 'at the national scale and under the consistency requirements of the national accounts' is also emphasised. The section on environmentally-adjusted aggregates, which is even more tentative, focuses on 'how the conventional national accounts could be adapted to show the interaction between the economy and the environment in monetary terms' and discusses the calculation and (dis)advantages of macroeconomic aggregates.[9] According to the SEEA 2003, 'There is no consensus on how green GDP could be calculated and, in fact, still less consensus on whether it should be attempted at all'. It is clearly stated that the lack of consensus is so large that some of the 'collaborators in the preparation of the handbook would prefer that this chapter were omitted from the book'. Some of these critics are reluctant to incorporate presumed effects of environmental flows into the well-established economic accounts, while others emphasise the data problems involved. At any rate, to complete the picture of integrated environmental and economic accounting, the SEEA 2003 also covers: depletion of natural resources, defensive expenditures (expenditures to combat environmental degradation), and degradation. For each topic there is a discussion of the pros and cons, bringing the issue into the macro aggregate.

2.3 Countries with environmental accounting programmes

Several countries are constructing environmental accounts in their statistical offices or in other government departments on an ongoing basis. In addition, there are numerous academic studies. Table 1 lists the countries with on-going programmes and the types of accounts they focus on. Notable is the fact that only six countries have tried to construct environmentally adjusted macroeconomic aggregates. In addition, a closer look at them (see Section 3.2) reveals that these attempts were only made for a certain year or for a short time period.

[9] The SEEA 2003 does not explicitly recommend a specific environmentally adjusted aggregate.

Table 1. Countries with environmental accounting programmes

	Natural resource asset accounts	Flow accounts for pollutants and materials		Environmental protection & resource management expenditures	Environmentally-adjusted macroeconomic aggregates
		Physical	Monetary		
Industrialised countries					
Australia	X	X		X	
Canada	X	X		X	
Denmark	X	X		X	
Finland	X	X		X	
France	X	X		X	
Germany	X	X	X	X	X
Italy	X	X		X	
Japan	X	X	X	X	X
Norway	X	X			
Sweden	X	X	X	X	X
UK	X	X		X	
USA	X			X	
Developing countries					
Botswana	X	X	X		
Chile	X		X	X	
Korea	X	X	X	X	X
Mexico	X	X	X	X	X
Moldova		X			
Namibia	X	X	X		
The Philippines	X	X	X	X	X

Source: Lange (2003).

3. Country experiences of adjusted macroeconomic aggregates

The purpose of most monetary environmental macroeconomic aggregates has been to provide a more relevant welfare measure. One of the most well-known adjusted macroeconomic aggregates is the comprehensive NNP. A related indicator is genuine savings, which measures changes in asset values rather than income. The first section will provide a brief theory of the welfare measurements to illustrate how NNP and genuine savings optimally would be constructed empirically if all information were available, and how these measures relate to each other. Contrary to the theorists, the empiricists often use the measure Net Domestic Product (NDP) instead of NNP.[10] The following sections will give an overview of some of the rather few countries that have tried to derive a comprehensive NDP and of the genuine savings project carried out by the World Bank.

3.1 A brief on the theory of welfare measurement

The conventional NNP includes consumption of goods and services and net investments limited to physical capital. In order to make it a better welfare measure, it needs to be enlarged to a comprehensive NNP and include all aspects of consumption and capital formation (including environmental quality and natural resource stocks) relevant for society. Most studies of a comprehensive NNP are based on a fundamental theorem by Weitzman (1976), where comprehensive NNP is shown to be an exact indicator of welfare under certain conditions. More precisely, he shows that if an economy with a stationary technology follows the first best optimal path, then a comprehensive NNP is directly proportional to the present value of future utility.[11] In other words, along the first best optimal path the value function is proportional to the current value Hamiltonian (in the social planner's optimisation problem), which can be interpreted as the comprehensive NNP in utility terms. With this definition, the comprehensive NNP in utility terms is thus a static equivalent to future welfare.

To derive Weitzman's welfare measure and to illustrate the relation between comprehensive NNP in utility terms and genuine savings, the model from Aronsson et al. (1997, Chapter 4) is applied. A social planner maximises the present value of future utility according to:

$$\underset{c_t, m_t}{Max} \int_0^{\infty} u(c_t, x_t) e^{-\theta t} dt \qquad (1)$$

subject to

$$\begin{aligned} &\text{(i)} && \dot{k}_t = f(k_t, m_t) - c_t \\ &\text{(ii)} && \dot{x}_t = m_t - \zeta x_t \qquad (2) \\ &\text{(iii)} && k(0) = k_0 > 0 \end{aligned}$$

[10] The key difference between NNP and NDP is that NNP measures all output produced by the citizens of a country regardless of where that production takes place, and NDP measures all output produced within the national borders, regardless of the citizenry of those producing.

[11] If these assumptions are violated, the welfare measure will contain unobservable forward-looking terms because technological progress and/or uninternalised externalities make the economic system non-autonomous (Aronsson et al., 2004).

$$
\text{(iv)} \qquad
\begin{aligned}
&x(0) = x_0 \geq 0 \\
&\lim_{t \to \infty} k(t) \geq 0 \\
&\lim_{t \to \infty} x(t) \geq 0 .
\end{aligned}
$$

Consumer utility is assumed to be a function of consumption per unit of labour (per capita) c_t, and a stock of pollution per capita x_t. The production of the consumption good uses capital, labour and emissions (through the use of energy) as inputs. The labour endowment is fixed and normalised to unity. Then k_t and m_t are, respectively, the capital and energy used per unit of labour. Investments equal production less consumption. The stock of pollution x_t develops through the flow of emissions m_t (which depends on production) and the environment's assimilative capacity ($0 \leq \zeta \leq 1$). The present value Hamiltonian can be written as:

$$H_t = u(c_t, x_t)e^{-\theta t} + \lambda_t \dot{k}_t + \mu_t \dot{x}_t . \qquad (3)$$

Let $H_t^c = H_t e^{\theta t}$ be the current value Hamiltonian, which is often used as a measure of comprehensive NNP in utility terms. Then the analogue to Weitzman's welfare measure can be derived as:

$$\theta W(t) = H_t^c = u(c_t, x_t) + \lambda_t^c \dot{k}_t + \mu_t^c \dot{x}_t , \qquad (4)$$

where $$W(t) = \int_t^\infty u(c_z, x_s) e^{-\theta(s-t)} ds$$

is the value function. To transform this measure into what looks like a real NNP concept, the instantaneous utility is approximated with a linear function $u(c, x) \approx \lambda^c c + u_x(c, x)x$.[12] This gives the linearised welfare measure:

$$\theta W(t) \approx \lambda_t^c \left[c_t + \dot{k}_t + \rho_t x_t - \tau_t \dot{x}_t \right], \qquad (5)$$

which measures the comprehensive NNP in real terms times the marginal utility of consumption at time t. The comprehensive NNP consists of the conventional NNP plus two additional terms. The third term measures the value of the stock of pollution at time t, where $\rho = u_x / \lambda^c$ is the marginal consumption value of the stock of pollution. The fourth term is the value of additions to the stock of pollution, and $\tau = -\mu / \lambda^c$. It is also possible to illustrate that genuine savings is a measure of welfare change:

$$\dot{W}(t) = -u(c_t, x_t) + \theta W(t) = \frac{dH_t^c}{dt} = H_t^c - u(c_t, x_t) = \lambda_t^c \dot{k}_t + \mu_t^c \dot{x}_t$$

Thus, genuine savings in utility terms equals NNP less consumption.

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[12] This is a poor approximation if the utility function deviates strongly from linearity. To then make the comprehensive NNP a perfect welfare indicator, the consumer surplus has to be added (Li and Löfgren, 2002).

3.2 Country experiences of comprehensive Net Domestic Product

One of the best-known natural resource accounting studies is Repetto et al.'s (1989) calculation of an Indonesian comprehensive NDP carried out in order to make policy-makers realise the importance of environmental degradation and depletion of natural capital. They construct resource accounts in physical and monetary terms for oil, forests and soil, and use the net price method (see Section 2.2), where rents are determined by the commodity price less all factor costs for extraction, to value depreciation of oil and forests. For soil erosion, the loss of potential future farm income is used. The results from the resource accounts are then aggregated and deducted from the GDP. This results in an incomplete measure of comprehensive NDP since the depreciation of produced assets is not included. The comprehensive NDP figures calculated for the 1971-84 period are generally lower (-2% to -24%) than the GDP, except for 1971 and 1974 when they are higher due to oil discoveries (Hamilton and Lutz, 1996). A similar application was made for Costa Rica (Repetto and Cruz, 1991) focusing on forests, fisheries and soil for the 1970-89 period. There the comprehensive NDP figures are lower than the GDP, ranging from -8% to -13%.

These early attempts were followed by a number of countries. Table 2 shows the countries with ongoing environmental accounting programmes that occasionally produce environmentally adjusted macroeconomic aggregates (Germany, Japan, Korea, Mexico, Sweden and the Philippines). In these projects, the macroeconomic aggregates are affected very differently depending on several factors such as time period studied, type of coverage and valuation method used. This makes it impossible to compare the results among countries. Notable is that the effect on the macroeconomic aggregate for Indonesia and Costa Rica is expressed in percentage of GDP and for the other countries in percentage of NDP.

Some countries, like Germany, Japan and Mexico, have calculated comprehensive NDPs for one specific year, while others, like Costa Rica, Indonesia, Korea and the Philippines, have calculated comprehensive NDPs for an extended time period. The type of coverage varies a lot, depending on the natural resource abundance and the environmental problems in each country, as well as on data availability. Germany, for example, made an attempt to calculate a comprehensive NDP in 1990; it amounted to 97% of the conventional NDP aggregate, implying that the economy generated about DM 59 billion in environmental (degradation and depletion) costs that year. This was mostly due to the large cost associated with an assumed 40% carbon dioxide (CO_2) emission reduction (also Japan included the cost of reducing CO_2 emissions while the other countries did not). The sectors agriculture and energy supply incurred the largest environmental costs per value added, accounting for around 34% of total environmental costs (Bartelmus and Vesper, 2000). The narrow focus of the Swedish project on environmental degradation caused by sulphur and nitrogen emissions is motivated by data availability, since the environmental effects from these emissions are rather well documented. This narrow focus, however, explains the small change compared to conventional NDP (For a broader selection of analyses carried out in Sweden, see Section 5).

Table 2. Comprehensive NDP

Country	Time period	Effect on macroeconomic aggregates	Coverage	Valuation method
Costa Rica	1970-89	GDP reduced 8%-13%	Depletion of forest, fish Degradation of land	Net price method Maintenance cost
Indonesia	1971-84	GDP reduced 2%-24%[a]	Depletion of oil, forest Degradation of land	Net price method Maintenance cost
Germany	1990	NDP reduced 3%	Depletion of minerals Degradation of land, air, water, including CO_2	Economic depreciation Maintenance cost
Japan	1990	NDP reduced 2.4%	Depletion of minerals Degradation of land, air, water, including CO_2 and CFCs	Net price method Maintenance cost
Korea	1985-92	NDP reduced 2.6%-4.1%	Depletion of minerals Degradation of land, air, water	Net price method Maintenance cost
Mexico	1985	NDP reduced 11%-15%	Depletion of oil, forest Degradation of water, air, soil	Net price method and El Serafy's approach Maintenance cost
The Philippines	1988-94	NDP reduced 2%-13%	Depletion of forests, fish, minerals Degradation of soil, air, water	Net price method Maintenance cost
Sweden	1993 and 1997	NDP reduced 1%-2%	Depletion of minerals Environmental damage due to SOx and NOx Environmental protection expenditures	Economic depreciation Damage cost Market cost

Source: Own compilation from Lange (2003) and the country-specific studies: Costa Rica (Repetto and Cruz, 1991); Indonesia (Repetto et al., 1989); Germany (Bartelmus and Vesper, 2000); Japan (Oda et al., 1998); Korea (Korea Environment Institute et al., 1998); Mexico (Van Tongeren et al., 1992); the Philippines (Bartelmus, 1999); Sweden (Skånberg, 2000). Notes: [a] Except for 1971 and 1974, when NDP increased.

Large methodological variation can also be seen. Most countries estimated industry-specific abatement costs, while Korea, for example, assumed the same abatement costs in all industries in its project for 1985-1992 (Lange, 2003). The Mexico project of the year 1985, carried out jointly by the UN Statistical Office, the World Bank and the National Institute of Statistics, Geography and Informatics of Mexico, used two different methods to value depletion of natural resources (oil and timber): the net price method and the user cost, or El Serafy, approach (see Section 2.2). The net price method resulted in a net rent of 1162 pesos/barrel and an average stumpage value of 21.5 pesos/m^3, while the corresponding figures for the El Serafy approach were much lower: 160 pesos/barrel and 1.6 pesos/m^3 (Heal and Kriström, 2005). The purpose of the Swedish project was to present and evaluate the UN System of Environmental and Economic Accounts in relation to a methodology closer to the theoretically consistent comprehensive NDP. In this project, the issue of double-counting (including degradation already included in conventional NDP measures) was taken into account.

3.3 Genuine savings at the World Bank

As illustrated in Section 3.1, there is a clear relationship between the two welfare measures comprehensive NNP and genuine savings. The comprehensive NNP equals consumption plus the sum of the net changes in all capital stocks valued at their shadow prices, and the genuine savings equals comprehensive NNP less consumption. Negative genuine savings rates are usually interpreted as a decline in wealth, and persistently negative rates as unsustainable development. The World Bank has, in a simplified form, operationalised the genuine savings measure and calls it 'adjusted net savings'. They calculate adjusted net savings for around 200 countries since 1970, using the following expression (Hamilton, 2000):

$$G = GNP - C - \delta K - n(R-g) - \sigma(e-d) + m\,.$$

More specifically, the World Bank adjusted net savings includes four types of adjustments: (1) The capital consumption of fixed assets, δK, is deducted from gross saving to obtain net saving. (2) The education expenditures, m, are added to net domestic savings as a measure of the value of investments in human capital. (3) The depletion of natural resources, $n(R\text{-}g)$, is deducted to reflect the decline in asset values associated with extraction and harvest, where g represents resource stock growth, R depletion and n net marginal resource rents. This includes rents on forest, energy (oil, natural gas, hard coal, brown coal) and mineral (bauxite, copper, iron ore, lead, nickel, zinc, phosphate, tin, gold, silver) depletion, representing the excess returns to these production factors. The forest rent is calculated as the market value of the resources less the average extraction cost for all harvest above sustainable yield. For non-renewable resources there is no sustainable yield (Hecht, 2007). (4) Pollution damages, $\sigma(e\text{-}d)$, are deducted, where e represents pollution emissions, d natural dissipation and σ the marginal cost of pollution. This includes only the estimated damage caused by CO_2 emissions, which is valued at USD 20/metric ton based on Fankhauser (1994). Table 3 displays a comparison of gross domestic savings and genuine savings for the countries included in the World Bank project aggregated into different regions and income levels in 2004. According to Section 3.1, a comprehensive measure of genuine savings should include net changes in all the capital stocks valued at their shadow prices. The World Bank estimate includes a limited amount of market-valued natural resources (for example water, fish and soil are excluded) and only one pollutant, and completely excludes non-market valued resources (biodiversity, nutrient cycling, carbon storage etc.). It could also be questioned whether the USD 20/metric ton of carbon is sufficient to account for the carbon dioxide damage.

Table 3. Adjusted net savings (percent of Gross National Income) 2004.

	Gross domestic savings	Consumption of fixed capital	Net domestic savings	Education expenditure	Energy depletion	Mineral depletion	Net forest depletion	Carbon dioxide damage	Genuine domestic saving
Income									
Low income	22.7	9.2	13.5	3.4	6.7	0.4	0.7	1.1	8.0
Middle income	28.3	11.1	17.2	3.6	8.4	0.5	0.0	1.0	10.7
High income	19.4	13.2	6.2	4.6	1.4	0.0	0.0	0.3	9.1
Region									
East Asia & Pacific	39.1	10.5	28.6	2.3	4.1	0.4	0.0	1.2	25.1
Europe & Central Asia	23.4	10.7	12.7	4.1	12.0	0.3	0.0	1.4	3.0
Latin America & Carib.	22.7	12.1	10.6	4.4	7.2	1.1	0.0	0.5	6.3
Middle East & N. Africa	30.0	11.2	18.8	4.5	27.3	0.1	0.1	1.2	-5.3
South Asia	23.6	9.1	14.4	3.6	2.7	0.3	0.7	1.2	13.2
Sub-Saharan Africa	17.1	10.9	6.2	3.9	9.8	0.4	0.6	0.7	-1.5
World	20.8	12.7	8.1	4.4	2.8	0.1	0.0	0.4	9.2

Source: Own compilation from World Bank (2007).

The adjusted net savings vary considerably and are less than gross domestic savings for all regions. It is obvious that resource depletion is generally lower in high-income countries. Education expenditure is higher in high-income countries than in middle- and low-income countries. CO_2 damage is higher in low- and middle-income countries compared to high-income countries. The East Asia and Pacific region exhibits high gross and genuine savings and low resource depletion. Notable is that adjusted net savings are actually negative for two regions (the Middle East and North Africa, and Sub-Saharan Africa), indicating that these economies are living off their assets rather than creating new wealth. The region of the Middle East and North Africa depletes an exhaustible resource, violating Hartwick's (1977) rule, which requires the sum of the value of the net changes of stocks to be zero in order for welfare not to decrease. A World Bank report compares the adjusted net savings rates of different countries in 1970-1993, and concludes that the Sub-Saharan African average genuine savings rates rarely exceeded 5 percent of GNP during the 1970s and then started a sharp negative trend at the end of that decade, from which the region has never recovered. The Middle East and North Africa region consistently had negative genuine savings rates as a percentage of GNP throughout the period, varying from -5 to -35 percent (World Bank, 1997).

However, the adjusted net savings rate project at the World Bank has been criticised. Neumayer (2000) for example argues that the conclusions of the World Bank depend on their method of computing user costs from resource exploitation. He takes Saudi Arabia as an example, which according to the World Bank calculations has had negative rates since 1976 (varying from -3 to -48%), leading to the, according to him, counter-factual conclusion that the country has depleted its capital to an extent that implies that its inhabitants should be severely impoverished. As an alternative, Neumayer (2000) employs the El Serafy method (see Section 2.2) which he argues is superior since it does not depend on efficient resource pricing. A calculation of adjusted net savings using the El Serafy method changes the results: Sub-Saharan Africa does not exhibit persistent negative rates and the region of North Africa and the Middle East turns out to be a strong genuine saver. The sensitivity of the results leads the author to warn policy-makers not to draw the wrong policy conclusions for the wrong countries based on the World Bank rates (Neumayer, 2000). Dietz and Neumayer (2004) also argue that the adjusted net savings rates are sensitive to the method of calculating rents from resource extraction, and claim that the World Bank estimates are at the high end and probably overestimate the unsustainability of certain resource-dependent regions. Also Pillarisetti (2005) argues that the measure is empirically imperfect and that policy implications based on this measure are erroneous. For example, investment in human capital measured by education expenses strongly influences the numerical values of genuine savings.[13] Genuine savings (without education expenses) are almost identical to unadjusted net savings for a majority of countries (Pillarisetti, 2005).

[13] A measure of the value of investments in human capital in terms of education expenditures lacks information about the societal value of education (Aronsson et al., 1997). As a better alternative, Jorgenson and Fraumeni (1992) suggest a method for valuing education where the investment character of education is recognised: education increases the productivity of an individual, which increases future earnings.

4. Norway – one of the first constructors of green accounts

4.1 Natural resource accounting

One example of an early national effort in constructing natural resource accounts is Norway (Alfsen et al., 1987; Alfsen and Greaker, 2007).[14] The task, which was introduced before the development of the SEEA, was given to Statistics Norway by the Norwegian Ministry of Environment in 1978 with the aim to ensure better long-term natural resource management.[15] The accounting system was initially very ambitious, covering a large number of natural resources and environmental issues (such as energy, minerals, sand and gravel, forests, fish, land use, freshwater, air pollution and waste). The resource accounts were divided into material and environmental accounts and expressed in physical terms, but were complemented with market prices when available.[16] The material accounts included three parts: (1) reserves accounts (the in- and out-going resource base including adjustments, i.e. discoveries, reappraisals, new technology etc.); (2) extraction, conversion and trade accounts by sector; and (3) end use accounts by sector. Almost ten years after implementation, the accounting experience was evaluated (Alfsen et al., 1987). The results were disappointing, indicating that most of the accounts were under-utilised by policy-makers. In fact, the only account that was regularly used was the energy account. This led to a more narrow coverage of the natural resource accounting with a stronger focus on energy resources and air pollutants. Presently, the macroeconomic models employed by the Ministry of Finance for medium- and long-term economic projections include energy and air pollution variables as well as waste.

4.2 National wealth

Although the idea of constructing a comprehensive NDP in Norway was considered in the early 1990s, it was immediately abandoned. It was not considered correct for the statistical accountants to take decisions about the value of environmental assets and to incorporate such decisions in apparently neutral information about the trend in an environment-adjusted GDP (Alfsen and Greaker, 2007). Instead, Statistics Norway has occasionally calculated the changes in national wealth defined in Table 4. As recognised, the national wealth measure also has several shortcomings. First, quite a number of renewable resources are not included since market prices of their services do not exist. Second, future prices are too uncertain. Third, human capital is calculated residually.[17]

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[14] Another early effort was made by France (for information on that project see Theys, 1989).

[15] The text in this section draws heavily on the article by Alfsen and Greaker (2007).

[16] Methods used to value goods not traded in any market were not applied.

[17] Return on human capital=net national income-resource rents-net return on fixed capital.

Table 4. Definition of national wealth

i)	+Present value of future resource rents from renewable natural resources.
ii)	+Present value of future resource rents from non-renewable natural resources.
iii)	+Present value of future contribution from human capital.
iv)	+Current value of fixed capital as given by the national accounts.
v)	+Net financial wealth.

Source: Alfsen and Greaker, 2007.

4.3 Indicators of sustainable wealth

In order to try to solve the problem of how to measure sustainability, an official commission was asked to develop a core set of indicators for sustainable development. The strategy of the commission was 'to choose indicators that best reflect the value, defined as the welfare effects, of the various components of national wealth' (Ministry of Finance of Norway, 2005). This resulted in the 16 indicators shown in Table 5.

Table 5. Indicators of sustainable wealth.

Issues that the indicators shall cover	Indicators
1. Climate change	Emissions of greenhouse gases compared to the Kyoto Protocol target
2. Acidification	Percentage of land area where the critical load for acidification has been exceeded
3. Terrestrial ecosystems	Population trends of nesting wild birds
4. Freshwater ecosystems	Percentage of rivers and lakes with clearly good ecological status
5. Coastal ecosystems	Percentage of coastal waters with clearly good ecological status
6. Efficiency of resource use	Energy use per unit GDP
7. Management of renewable resources	Recommended quota, total allowable catch actually set and catches of Northeast Arctic cod
8. Hazardous substances	Household consumption of hazardous substances
9. Sources of income	Net national income per capita, by sources of income: • Resource rent from renewable natural resources • Resource rent from non-renewable natural resources • Return on produced assets • Return on human and environmental capital • Return net income from abroad
10. Sustainable consumption	Petroleum adjusted savings
11. Level of education	Population by highest level of education completed
12. Sustainable public finances	Generational accounts: Need for tightening of public finances as a share of GDP
13. Health and welfare	Life expectancy at birth
14. Exclusion from the labour market	Long-term unemployed persons and disability pensioners as percentage of population
15. Global poverty reduction	Trade with Africa, by LDC countries and other African countries
16. Global poverty reduction	Norwegian development assistance as percentage of gross national income

Source: Ministry of Finance of Norway, 2005.

A central question is how these indicators are interpreted. For example, can a decrease in one wealth component be offset by growth in other wealth components, i.e. is there substitutability? The Ministry of Finance argues that since there are different opinions on this point, the question of 'weak' versus 'strong' sustainability needs to be determined by political authorities (Ministry of Finance of Norway, 2005). Strong sustainability does, however, not appear to be practically applicable.

Physical indicators to measure sustainability have also been developed by the UN, the OECD and the EU as well as by individual countries. Most indicators follow the DPSIR model introduced by the OECD in the 1970s and further developed by the EU. The DPSIR abbreviation implies that the indicators should measure: Driving forces of environmental change (e.g. industrial production); Pressures on the environment (e.g. emissions of air pollutants); State of the environment (e.g. urban air quality); Impact on the population, economy and ecosystems; and Response of the society (pollutant taxes). Although the indicators are useful for following the development within certain areas of importance for sustainability, they can not provide any guidance as to whether the development is sustainable or not. The indicator approach departs from the view that certain resources are especially important for sustainable development and have to be held intact. This is not unproblematic since it is very difficult to determine which resources are important for future generations. Furthermore, since the indicators are not weighed together, the approach implies that all indicators have to move in the right direction in order for the development to be sustainable; i.e. strong sustainability (see Section 1). Generally, it is not realistic to assume that deterioration in one indicator can not be compensated by an improvement in another. When interpreting the indicators one therefore needs to be careful not to judge the negative direction of one indicator as the overall development not being sustainable.

5. Sweden – one of the few constructors of comprehensive NDP

The Commission for Environmental Accounting was appointed in 1990 to investigate the possibilities of supplementing Sweden's national accounts with accounts of national resources and the environment. In June 1992, the commission's recommendations resulted in three new government commissions: Statistics Sweden was made responsible for resource accounting in physical terms, the Environmental Protection Agency was made responsible for compiling environmental indices of the state of the environment, and the National Institute of Economic Research (NIER) was made responsible for pursuing monetary green accounting.

The initial work at Statistics Sweden included the linkage between economic statistics and the following types of energy and environmental data: energy accounts in physical and monetary terms; accounts of emissions of sulphur dioxide, carbon dioxide, nitrogen oxide and volatile organic compounds; accounts for nitrogen and phosphorus flows; and environmental protection statistics for the nation, local authorities and industry (NIER and Statistics Sweden, 1998). Since 1992, the green accounting work at Statistics Sweden has developed in several dimensions.[18] One of the most recent projects is the derivation of the economic structures and environmental pressure in the Swedish river basin districts in 1995-2005 (Statistics Sweden, 2007).

More specifically, the NIER assignment consisted of investigating the possibilities of evaluating the environmental accounts in monetary terms, i.e. developing methods to pursue monetary green accounting. The monetary accounts obtained in this way could then be used as a basis for environmental adjustment of different macro-economic measures. The assignment also included the development of environmental economic models for economic impact analysis. The analyses that were carried out had different focuses. Common for the approaches is that they start off in a theoretically consistent framework and that an empirical example is then applied to the framework. A transparent, consistent framework is important in order to identify sectors of the economy that are affected, to separate different types of externalities and to avoid double counting. The remainder of this section will present a selection of the analyses carried out at NIER.

5.1 Correcting NDP for emissions: Implementing theory in practice

The empirical work on green accounting is usually separated from the theoretical work. The theorists develop advanced models with interesting theoretical aspects but do not consider what data is available and possible to measure. Empirics, on the other hand, are more focused on data and are not as interested and knowledgeable in theoretical aspects. The purpose of Ahlroth's (2003) analysis was to combine theoretical and empirical work in order to provide a structure for damage valuation. The approach, which builds on the SEEA, was one of the first attempts to bridge a gap between two traditions in the green accounting literature (Heal and Kriström, 2005).

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[18] For more information about the green accounting projects carried out at Statistics Sweden, see http://www.scb.se/templates/Product____38161.asp

Ahlroth developed an optimal control theory model for adjusting NDP for the effects of sulphur and nitrogen emissions and inserted empirically estimated values into the model. The utility function includes consumption of an aggregate consumption good, a vector of emissions (sulphur dioxide, nitrogen oxide and ammonia) and a vector of the stocks of these pollutants. The production uses labour, capital, and flows of natural resources and emissions/energy, and can be used for consumption of market goods, emission abatement and investments. The stock of capital depreciates by a constant depreciation rate and an additional depreciation that depends on current emissions (corrosion due to acidification). Pollution affects labour supply through the increase in sick leaves and early retirements. Growth in natural resource stocks is affected by the stock of pollution which in turn is assumed to increase by the emitted amount less the dissipation rate (buffering ability). The derived NDP includes adjustments to labour supply and the natural resource stock, and corrections in terms of consumer disutility from the flow and level of the pollution stock, and environmental degradation. In the empirical part, the damages are mainly stock effects, but some flow effects from emissions are included. Specifically, the depreciation of real capital, natural capital and labour stock (health) is accounted for. Table 6 lists the figures which should be included in an adjustment of NDP. The results show that the total effect amounts to US$2331 million, or approximately 1.6 percent of NDP.

Table 6. Components of adjustment of NDP; 1991 price level.

	Million US$	Valuation method
Timber	94	Dose-response function
Fishing, professional	11	Dose-response function
Labour supply	49	Dose-response function
Fishing, households	106	CV study
Recreation, Baltic	294	CV study
Recreation, Lakes	882	CV study
Recreation, Forest	271	CV study
Nitrate in groundwater	235	CV study
Health	388	CV study
Total adjustment	2331	

Source: Ahlroth, 2003.

5.2 Applying the contingent valuation method in resource accounting

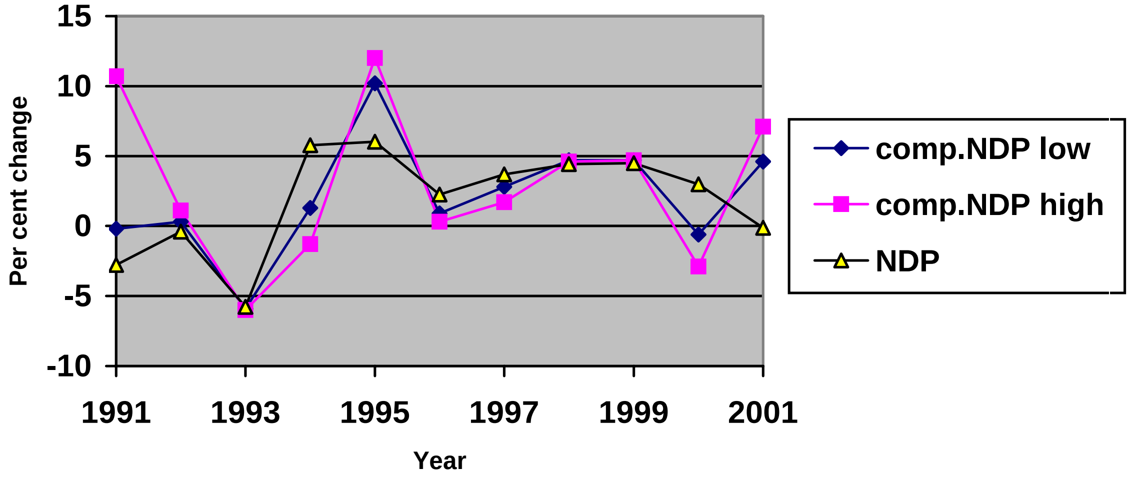
Although the Contingent Valuation Method (CVM) is the dominating method for valuation of non-market goods, there is no established agenda for its application in green accounting (see Section 2.2 above). A CVM project intended to extend the existing empirical research on green accounting was started in 2000 at NIER. Until then, the research had been focused primarily on market data (avoidance costs, damage costs, etc.). Boman et al. (2003) developed a model for environmental accounting that can be applied in an empirical contingent valuation experiment. Their work focused particularly on five of the sixteen environmental goals that the Swedish society has decided upon: reduced climate impact; natural acidification only; clean air; zero eutrophication; and a rich diversity of plant and animal life. It is assumed that these targets can be viewed as a type of quantity index for environmental quality, such that the consumption decision is first made with respect to total environmental quality and then with respect to the specific environmental goals. Boman et al. (2003) specify a theoretical framework in which the consumer derives utility from consumption and environmental quality (measured as disutility from emissions and concentrations of pollutants, utility from biodiversity preservation, and utility from the remaining natural resource goods and services). The derived NDP should be adjusted positively with respect to the value of increases in environmental and natural resources, and negatively with respect to the value of harmful pollution flows. To adjust the NDP in monetary terms, the CVM is suggested in order to derive marginal willingness to pay for approaching the environmental goals. Boman et al. (2003) outline fifteen survey versions in which three levels of change for each of the five environmental goals are stipulated. All versions include both a question about willingness-to-pay (WTP) to avoid one level of change for one environmental goal, and a question about WTP to achieve all sixteen environmental goals. The CVM has an advantage in that it typically includes the consumer surplus, but since the approach is not able to capture the preferences of future generations, it does not provide sufficient information for resource accounting (Aronsson et al., 2004).

5.3 Monetary green accounting and ecosystem services

In the theoretical literature, the environment is usually described in terms of flows and stocks of pollutants. The purpose of Gren's (2003) analysis was to derive a monetary green accounting system where the value of changes in natural capital is derived from the capital stocks' production of ecosystem services. She developed a theoretical model in which the economy produces a composite good and non-marketed goods in terms of ecosystem services. Both types of goods use natural capital and emit pollutants, and the marketed goods additionally need man-made capital. The change in the stock of natural capital is determined by its own growth, ecosystem management and pollutant deposition. Utility in society is determined by consumption of marketed and non-marketed goods and services. In addition, pollutants affect utility directly through their impacts on health. Adjustments to the NDP should be made with regard to non-marketed ecosystem services. These adjustments include current utility from pollutants and ecosystem services, and change in future utility from ecosystem services caused by the period's change in the stock of natural capital. Gren (2003) also makes an empirical demonstration of the accounting system that focuses on the natural capital assets (forests, agricultural landscape, wetlands, air quality, and coastal and marine ecosystems) and the ecosystem services (recreation, health impacts and pollutant sink). The correction of NDP implies an increase of between 0.9 and 3.3 % mainly due to the value of recreation, forest carbon sequestration and wetland nitrogen cleaning.[19] The analysis was later extended to the ten year period from 1991 to 2001 (Gren and Svensson, 2004). Figure 1 shows the annual growth in NDP and the comprehensive NDP for two assumptions regarding the values of environmental services (low and high values). The differences in growth between comprehensive NDP and NDP were small in 1992, 1993 and 1996-1999, and large in the other years.

[19] The interval is due to different assumptions regarding the abilities of forest carbon sequestration and wetland nitrogen cleaning.

Figure 1 Annual growth in NDP and comprehensive NDP, 1991-2001.



Source: Gren and Svensson, 2004.

5.4 Air pollution, ill health and welfare

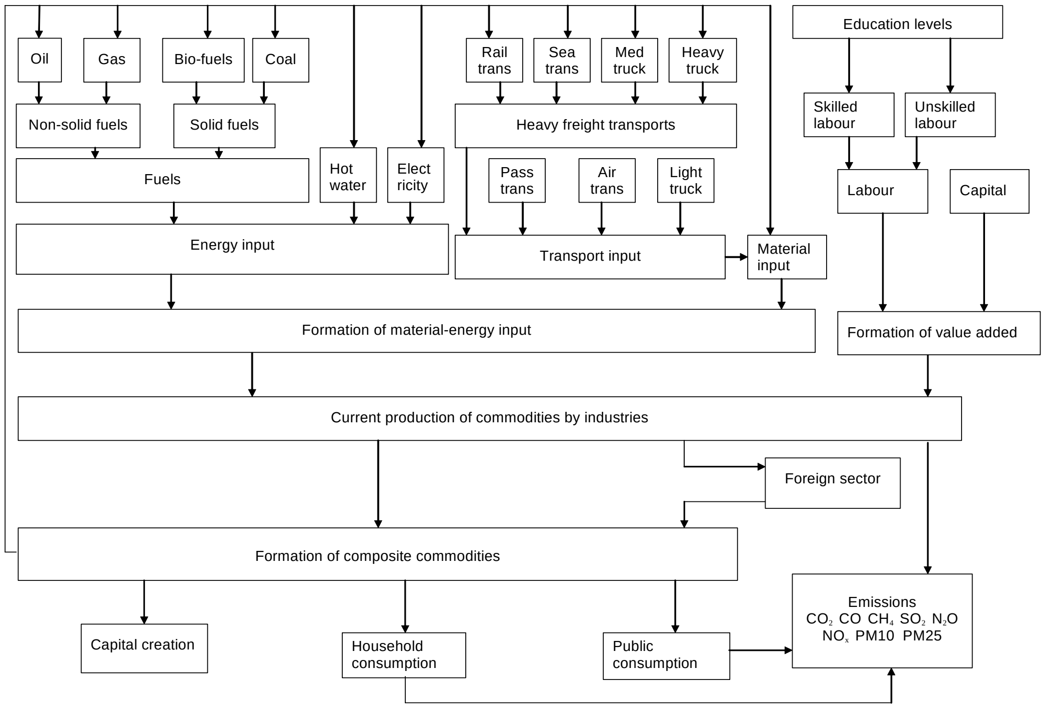
When investigating analytically the measurement of welfare and health effects induced by pollution, health usually enters the utility function as a capital stock (see for example Johansson and Löfgren, 1995, and Aronsson et al.,1994). As the problems of measuring a positive value for 'normal' health status in accounting terms are well-known, Huhtala and Samakovlis' (2007) analysis opts for valuation methods that are suitable for estimating negative impacts, or damage to health, to show how monetary valuation of the health effects of air pollution can be carried out in practice. They present a theoretical framework for comprehensive national accounting that considers health effects of air pollution. A production externality is included, which causes both direct disutility and an indirect welfare effect by negatively affecting labour productivity. The usefulness of the framework is demonstrated by applying it to data from a dose-response analysis between respiratory-restricted activity days and nitrogen oxide as an indicator of urban air pollution (Samakovlis et al., 2005) and a contingent valuation study valuing disutility from respiratory ill health episodes (Samakovlis and Svensson, 2004). In the theoretical framework a simple dynamic model is used to illustrate how an accounting system that incorporates health effects of air pollution can be developed. The accounting framework is modelled as a social planner's optimisation problem where a fixed amount of labour is allocated between production of a composite commodity and a healthcare sector. The healthcare sector corresponds to the defensive expenditures undertaken to improve health. Capital and a polluting input are used in addition to labour to produce the composite commodity. Utility is derived from consumption of the composite commodity whereas air pollutants cause disutility, which can be alleviated with inputs for healthcare and mitigation. The theoretical framework indicates that the NDP adjusted for health impacts from air pollution involves two extra terms: One is a negative term that reflects the welfare effects of pollution. It captures the direct perceived disutility of symptoms related to air pollutants. The other term is positive and measures the avoidance of disutility by mitigating problems and symptoms associated with pollution-related illnesses through defensive expenditures. However, defensive expenditures should not be subtracted from the NDP. The logic is that while it may be negative from a social point of view that the output of the healthcare sector increases due to pollution, the increase nevertheless contributes to the NDP. Certain social costs, such as defensive expenditures, are thus implicit in the level of NDP. To have NDP indicate the negative effects not captured in market transactions, it should be adjusted only with the disutility from pollution. In total, the negative health effects of nitrogen dioxide emissions amount to 0.6% of the Swedish GDP.

5.5 EMEC – An environmental medium-term economic model

Determination of the overall economic impact of taxes and regulations in the environmental area often involves using a general equilibrium model that reflects relationships both within the economy and between the economy and the environment. As a response to the task provided by the governmental commission, NIER developed the EMEC[20] model based on the physical environmental accounts of Statistics Sweden (Östblom, 1999; Östblom and Berg, 2006). The model has been used in a number of government studies mostly related to the medium-term survey at the Ministry of Finance or to different formulations of climate policy (NIER 2002 and 2003, SOU 2005:10; SOU 2004:19; SOU 2003:60; SOU 2001:2; SOU 2000:45; SOU 2000:23, SOU 2000:7), and in scientific studies (Östblom and Samakovlis, 2007; Nilsson, 2004; Östblom, 2003; Nilsson and Huhtala, 2000). The model has 26 business sectors and one general government sector. Firms and households demand a mix of 33 goods and services as manufacturing inputs, for investment and for household consumption. The total labour supply is determined exogenously, and capital is offered according to an exogenously determined rate of interest. All production factors are freely mobile among sectors. Free competition prevails in all markets, and there are no economies of scale in production. It is assumed in the model that firms and households fully adjust to price changes. Household consumption and the activities of the business sector give rise to environmental pollution. Combustion is the primary source of carbon dioxide, sulphur dioxide and oxides of nitrogen. Energy and environmental taxes are imposed on the use of energy by households and firms. Any existing exceptions in the taxation of manufacturing firms are considered in the tax rates used. The principal limitations on economic growth are the availability of production factors and the state of technological development. The model is continuously under development and recent extensions of the model include a more detailed representation of transport demand and a disaggregation of the electricity and district heating sector (Östblom and Berg, 2006; Berg, 2007). Currently, the waste sector is being incorporated into the model. Figure 2 presents the flows of commodities, factors and emissions in the model.

[20] Environmental medium term economic model.

Figure 2 Flows of commodities, factors and emissions in the EMEC*.



Note: * The arrows indicate the direction of flows. Source: Östblom and Berg, 2006.

General equilibrium models can be used to construct macro-economic indicators for an 'environmentally adjusted economy', or in other words, a greened economy GDP (geGDP).[21,22] In this approach, the key variables of the conventional national accounts are modelled into the future showing the economic and environmental consequences of scenarios for a more sustainable economic development. The purpose is to permit quantification of economy-environment policy trade-offs at the macroeconomic level – i.e. to estimate output losses or economic opportunity costs associated with environmental standards (O'Connor, 2001). Similar analyses, focusing specifically on CO_2 emissions, have been carried out with the EMEC model in order to inform politicians about the likely macro-economic impacts of achieving different formulations of climate policy.[23]

[21] For applications and a more detailed explanation of geGDP, see O'Connor (2001).

[22] Another modelling approach is the Hueting's sustainable national income (SNI), which estimates the level of national income that would occur if the economy met certain environmental standards using available technology (World Bank, 2006).

[23] One example is the governmental commission on a system and regulatory framework for the flexible mechanisms of the Kyoto Protocol, where the model analysis led to the recommendation that it is the quantity of emission allowances allocated to the Swedish trading sector that should be compared with the national target and not the actual emissions (SOU 2003:60).

6. Difficulties encountered in constructing welfare measures

There are several difficulties involved in pursuing green accounting in practice. The most substantial ones relate to the monetary valuation of degradation and to the environmentally adjusted macroeconomic aggregates. This is why the chapters in the SEEA handbook that include these issues have been subject to so much controversy among the collaborators of the handbook. This section discusses some of the theoretical weaknesses and empirical difficulties encountered when constructing welfare measures.

6.1 The theoretical weaknesses of the welfare measures

Weitzman (1976) shows that the comprehensive NNP measured in utility terms is proportional to the optimal value function, defined as the maximised objective function in a dynamic economy with stationary technology and perfect competition.[24] This implies that the comprehensive NNP can be interpreted as a static equivalent to future utility (Aronsson et al., 2004). The most severe weakness of this measure is the strong assumptions needed to justify a welfare interpretation. The restrictive assumptions of a stationary technology and perfect competition imply no disembodied technological change and a first best allocation, both circumstances that do not hold in reality. When these assumptions are relaxed, welfare depends on time itself, meaning that the derived welfare measure will be biased (Aronsson and Löfgren, 1995). In addition, Dasgupta and Mäler (1998) show that a comprehensive NNP is not suitable for making intertemporal and cross-country comparisons of social well-being, unless the analysed economies are in stationary states. Assuming that the economy is on an optimal path corresponds rather poorly to the starting point of the debate on sustainability, namely the concern about the accelerating deterioration of the environment, which implies that the resource allocation is not optimal (Aaheim and Nyborg, 1995). Asheim (1994) also shows that with multiple capital stocks, it is generally not possible to construct an exact indicator of sustainability based solely on comprehensive NNP.

The genuine savings rate constitutes the net changes in all the capital stocks valued at their shadow prices. As indicated in Section 3.3, negative genuine savings rates are usually interpreted as a decline in wealth and persistently negative rates as unsustainable development. However, it has been shown that a positive value for genuine savings is a necessary but not sufficient condition for achieving sustainability, implying that non-negative rates cannot rule out unsustainable development (Asheim, 1994; Pezzey and Withagen, 1995). The most significant weaknesses of the measure are that genuine savings is based on a model of an inter-temporally efficient economy; that the genuine savings model is vulnerable to exogenous shocks (technological progress, terms-of-trade effects, non-constant discount rates), implying that existing prices are no longer optimal and need to be re-estimated; that the population is assumed to be constant; and that genuine savings rates are sensitive to the calculation of natural capi-

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[24] Weitzman (1976) also assumed a linearly homogeneous utility function which implies that the consumer surplus equals zero and that the comprehensive NNP constitutes an exact welfare measure.

tal depreciation and to how environmental pollution is accounted for (Dietz and Neumayer, 2004).[25]

6.2 Lack of data and scientific knowledge

The calculation of a comprehensive NDP requires that we determine in physical terms how the flow of environmental services is affected and how the stocks of natural capitals have changed during the year. Determining physical changes in natural capital involves both quantitative and qualitative changes from one year to the next. The genuine savings measure has essentially the same data needs. The flow of environmental services can be affected through noise, other health effects or damage to crop harvests, which in turn affects the value of private and public consumption.[26] Almost all other environmental damage can either entirely or partly be assigned to changes in the natural capital stocks that try to capture the change in the value of the natural capital stock that is passed on from one period to the next. This includes for example all the effects from acidification (except the health related ones) and most of the consequences from the emissions of nutrients. The effects from sulphur dioxide, nitrogen oxide, ammonia, hydrocarbons and persistent organic compounds give rise to both health effects and changes in the stocks of natural capital. The emission of nitrogen and phosphorous to water and chlorinated organic compounds and biochemical oxygen demand mainly affect the stocks of natural capital. In practice, however, it is very difficult and in certain cases impossible to separate flow effects from effects on capital assets, since a certain emission (or interference) often gives rise to both.

To be able to make correct deductions from (or additions to) the NDP, one must define what is considered a harmful (or beneficial) environmental effect and how it has changed during the year. If critical loads have been derived, then emissions exceeding these levels can be considered harmful. Another question relates to the curvature of the so-called dose-response or exposure-response functions. Are relationships linear or do we need to determine non-linearities for certain substances (for example in the form of threshold effects) when making assumptions about the marginal effects of different pollutant levels? The lack of scientific knowledge regarding environmental damage is obviously a problem when trying to construct a comprehensive NDP. Additional knowledge will probably lead to the discovery of new problems. The discovery of the Antarctic ozone hole, for example, changed the view of chlorofluorocarbons. Additional knowledge makes it necessary to revise assumptions about relationships and effects. These discoveries imply, in the calculation of a yearly comprehensive NDP, an immediate capital loss even though the change might have been going on for a long time. Methods to measure changes in natural capital stocks can also change, affecting the size of the stock and the comprehensive NDP even if the actual stock has not changed. This obviously renders it more difficult to make meaningful comparisons over time. One difficulty also lies in the fact that it is not always possible to establish the relationship between emission and damage. In some cases the relationships can be incompletely known, and in other cases the damage occurs as a response to the interaction of several factors (i.e. most of the individuals who develop lung cancer from radon are smokers).

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[25] Genuine savings can, however, be extended to take into account technological development and market imperfections.

[26] Most of the discussion in this section is based on the report from the Swedish Commission for Environmental Accounting (SOU 1991:37).

A prerequisite for making these types of calculations is of course that data regarding physical changes and damages (or improvements) is available. Data on the use of non-renewable resources and the emission of air pollutants such as carbon dioxide, sulphur dioxide and nitrogen oxide is usually well documented, while data on emissions of chemicals and waste is usually weaker and characterised by large uncertainties.

6.3 The valuation of non-market goods

Valuations in the national accounts are usually based on market prices. Valuation of goods not traded in any market is more problematic, although necessary if we want to adjust the NDP for changes in the state of the environment. Both the changes in the flow of environmental services and the changes in the stock of the natural capital assets need to be valued.

There are two main methods for valuing environmental changes in monetary terms: through damage cost estimations and through individuals' WTP to avoid the damage or negative changes. Although some of the actual damage can in principal be valued at market prices (for example corrosion and damage to crops and fish), it is more difficult to value for example health effects and loss of species. As exemplified in Section 5.4, the costs of health effects from air pollution consist of not only medical care and production losses, but also of disutility from the disease. This disutility value cannot be determined by market prices. A more appropriate method is to use the Contingent Valuation (CV) method. The application of CV in a green accounting context is surrounded by several difficulties. Although the number of CV applications has increased immensely over the last decades, not all environmental aspects have been valued. Even if most aspects had been valued, there would have been several problems involved in transferring the results since every study only determines the willingness to pay for the object in the study.[27] Furthermore, one cannot add the results of several studies to determine the population's total WTP, since the resulting sum can become larger than the individuals' budget constraints. Large-scale multiple goods valuation is required in order to avoid the problem of adding valuation studies. A proposed method to overcome the difficulty with exceeding the budget constraint – asking individuals how much money they would be prepared to spend totally on measures to improve the environment which then could be allocated on the different environmental targets – was discussed in Section 5.2. Another aspect is that the WTP studies reflect the preferences of present generations, while we also need to know the preferences of future generations.

The comprehensive NDP measure has been criticised for combining actual market transactions with hypothetical WTP values. The criticism relates to the fact that the use of WTP values does not consider the economic adjustments that would occur in the economy. Had the WTP values actually been paid, then relative prices throughout the economy would change and thereby affect economic behaviour and, ultimately, the NDP. It is in other words not enough to find the value of the environmental change in order to adjust the NDP; the traditional NDP measure must also be ad-

[27] Ready et al. (2004) show in a European study, which estimated the value of avoiding disutility episodes from respiratory ill health caused by air pollution through national CV surveys for five countries, that transferring results from one country to another on average leads to an over- or underestimation of 38%.

justed, which requires a model of the economy that analyses its interrelationships (Alfsen and Greaker, 2007).

Other critics argue that one should not try to measure non-market goods and services in monetary terms at all. This objection does not consider that some kind of implicit valuation is always made. In practice, the political decisions often serve as an implicit valuation of the environment. It appears therefore better that the decision is made based on a more complete analysis where environmental resources have been made more visible. Some critics argue that the methods erroneously use money as a superior value. However, using money to value environmental benefits is practical, since it makes it easier to compare the benefits with the costs which are measured in monetary terms. Others argue that the comprehensive data demands make valuation impossible. Environmental valuations can in some cases overestimate and in others underestimate the value of the environment. The reason can be that there are uncertainties regarding ecological relationships (see Section 6.2), but there can also be uncertainties regarding substitution possibilities and changing preferences. Even if there are practical problems surrounding the valuation of environmental changes it is reasonable to use the existing methods (Ministry of Finance of Sweden, 2000).

7. Conclusions

Green accounting in practice comprises natural resource asset accounts, flow accounts for pollutants and materials, environmental protection expenditures as well as environmentally adjusted macroeconomic aggregates. In this paper we have focused on the last type of accounts and more specifically on the welfare measures comprehensive net national product (NNP) and genuine savings. These measures have both theoretical and empirical weaknesses. Theoretical flaws include the strong assumptions needed for the measures to be exact indicators of welfare or to justify an interpretation of sustainable development. Empirical difficulties include data availability and valuation of non-market goods. The data requirements are gigantic, there are several uncertainties and often a plain lack of knowledge regarding environmental effects. Valuation of non-market goods has to address the various issues of aggregation, market versus shadow prices, discounting and benefit transfer etc., associated with the use of the different methods. As the review of country experiences of creating comprehensive NDPs indicates, the attempts are either focused on the most urgent environmental problems or where the data availability is satisfactory in each specific country. Although this might seem wise, it is not enough to base welfare comparisons on. The genuine savings project at the World Bank totally excludes non-market valued resources and only includes a limited amount of market-valued natural resources. Due to these weaknesses and difficulties there is reason to be sceptical of the derived welfare measures. It is actually useless to partially adjust the NNP or other macroeconomic aggregate with the information that is available. An incomplete or wrongly measured adjusted NNP is generally not a better measure of welfare than the conventional measure, and could in fact be even worse (Aronsson, 1998). Regardless of how interesting it would be (especially from a political point of view) to measure sustainable development, at this date there are no theoretically consistent and empirically feasible measures that are able to indicate whether development is sustainable.

What should be done instead depends on the issue at stake. If we are interested in analysing the effects of environmental policy proposals on the overall economy, then e.g. general equilibrium models are more flexible and better suited than national accounts. These models, which can be run several times varying different formulations of the policy measures, try to give a consistent and comprehensive picture of economic development capturing repercussions among different sectors in the economy. A case in point is the greened economy GDP which estimates national income looking into a hypothetical future in which economic development must meet certain environmental standards. The impact on the economy is estimated by internalising the costs of reducing environmental degradation. The purpose is to provide policy-makers with guidance about the likely impacts of alternative development paths and the instruments for achieving them (World Bank, 2006). On the other hand, if we are interested in measuring environmental changes, the environmental accounts are better suited for this purpose.

The environmental statistics derived in the environmental accounts are necessary in the models to evaluate environmental policy. General equilibrium models make extensive use of the input- output tables created by the national and green accounts. Other types of models use other parts of the green accounts. Thus, even though the calculation of environmentally adjusted macroeconomic aggregates cannot be the ultimate goal of compiling environmental accounts, the potential for environmental statistics to increase the understanding of the relation between economy and the environment is unlimited.

References

Aaheim, A. and K. Nyborg (1995), 'On the interpretation and applicability of a "Green national product"', *Review of Income and Wealth* 41(2), 57-71.

Ahlroth, S. (2003) 'Correcting NDP for SO2 and NOx Emissions: Implementation of a Theoretical Model in Practice', *Review of Income and Wealth* 49 (3), 425-440.

Alfsen, K. H. , T. Bye, and L. Lorentsen (1987) 'Natural resource accounting and analysis. The Norwegian experience 1978-1986'. Sosiale og Økonomiske Studier, vol. 65. Central Bureau of Statistics of Norway, Oslo.

Alfsen, K. and M. Greaker (2007) 'From natural resources and environmental accounting to construction of indicators for sustainable development', *Ecological Economics* 61, 600-610.

Aronsson, T. (1998), 'Bör vi försöka utvidga nettonationalprodukten till en välfärdsindikator' (in Swedish), *Ekonomisk Debatt* No 4.

Aronsson, T. and K.-G. Löfgren (1995), 'National Product Related Welfare Measure in the Presence of Technological Change, Externalities and Uncertainty'. *Environmental and Resource Economics* 6, 321-32.

Aronsson, T., P.-O. Johansson and K.-G. Löfgren (1994), 'Welfare Measurement and the Health Environment', *Annals of Operation Research* 54(1), 203-315.

Aronsson, T., P.-O. Johansson and K.-G. Löfgren (1997), *Welfare Measurement, Sustainability and Green National Accounting*, Cheltenham, UK and Lyme, USA: Edward Elgar.

Aronsson, T., K.-G. Löfgren and K. Backlund (2004), *Welfare Measurement in Imperfect Markets – A Growth Theoretical Approach*. Cheltenham, UK and Northampton, USA: Edward Elgar.

Asheim, G. (1994), 'Net national product as an indicator of sustainability', *Scandinavian Journal of Economics* 96, 257-265.

Bartelmus, P. (1999), 'Green accounting for a sustainable economy: Policy use and analysis of environmental accounts in the Philippines', *Ecological Economics* 29, 155-170.

Bartelmus, P and A. Vesper (2000), 'Green Accounting and Material Flow Analysis: Alternatives or Complements?', Wuppertal Papers No. 106, Wuppertal Institute.

Berg, C. (2007), 'Household Transport Demand in a CGE-framework', *Environmental and Resource Economics,* 37(3).

Boman, M., A. Huhtala, C. Nilsson, S. Ahlroth, G. Bostedt, L. Mattsson, P. Gong (2003), 'Applying the Contingent Valuation Method in Resource Accounting: A Bold Proposal', Working paper No. 85, National Institute of Economic Research.

Cobb, C., E. Halstead, and J. Rowe (1995), *The Genuine Progess Indicator – Summary of Data and Methodology. Redefining Progress,* Washington DC.

Daly, H. E. (1990) 'Toward Some Operational Principles of Sustainable Development', *Ecological Economics* 2 (1):1-6.

Daly, H. E. and J. B. Cobb (1989) *For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future*. Boston, MA: Beacon.

Dasgupta, P. and K.-G. Mäler (1998) 'Decentralization Schemes, Cost-Benefit Analysis, and Net National Product as a Measure of Social Well-Being', Beijer discussion paper Series No. 116, Beijer International Institute of Ecological Economics, Stockholm.

Dietz, S. and E. Neumayer (2004), 'Genuine savings: a critical analysis of its policy-guiding Value', *International Journal of Environment and Sustainable Development*', Vol. 3, Nos. 3/4.

Dietz, S. and E. Neumayer (2007), 'Weak and strong sustainability in the SEEA: Concepts and measurement', *Ecological Economics* 61, 617-626.

El Serafy, S. (1989), 'The Proper Calculation of Income from Depletable Natural Resource', in Y. J, Ahmad, S. El Serafy and E. Lutz, eds., *Environmental Accounting for Sustainable Development: a UNDP – World Bank symposium*. Washington D. C.: The World Bank.

Fankhauser, S. (1994), 'Evaluating the Social Costs of Greenhouse Gas Emissions', *The Energy Journal*, Vol. 15 No. 2, 157-184.

Fisher, I. (1906), 'The Nature of Capital and Income, New York: Macmillan.

Friends of the Earth (FoE) Europe (1995*), Towards a Sustainable Europe*. FoE, Brussels.

Gren, I. M. (2003) 'Monetary Green Accounting and Ecosystem Services', Working paper No. 86, National Institute of Economic Research.

Gren, I. M. and L. Svensson (2004), 'Ecosystems, Sustainability and Growth for Sweden during 1991-2001', Occasional Studies No. 4, National Institute for Economic Research.

Hamilton, K. and E. Lutz (1996), 'Green National Accounts: Policy Uses and Empirical Experience', Environment department papers No. 39, The World Bank.

Hamilton, K. (2000), 'Genuine Saving as a Sustainability Indicator', Environmental Economic Series No. 77, The World Bank.

Hanley, N., I. Moffatt, R. Faichney, M. Wilson (1999), 'Measuring sustainability: A time series of alternative indicators for Scotland', *Ecological Economics* 28, 55-73.

Hartwick, J. M. (1977), 'Intergenerational Equity and the Investing of Rents from Exhaustible Resources', *The American Economic Review*, Vol. 67, No. 5.

Heal, G. and B. Kriström (2005) 'National income and the environment', in: K. G. Mäler and J. R. Vincent (ed.), *Handbook of Environmental Economics*, edition 1, volume 3, chapter 22, 1147-1217, Elsevier.

Hecht, J. E. (2007) 'National Environmental Accounting: A Practical Introduction', *International Review of Environmental and Resource Economics*, 1, 3-66.

Hicks, J. R (1939), *Value and Capital* (2nd ed.), Oxford: Clarendon Press.

Hotelling, H. (1931), 'The Economics of Exhaustible Resources', *Journal of Political Economy* 39(2), 137-175.

Huhtala, A. and E. Samakovlis (2007), 'Air pollution, ill health and welfare', *Environmental and Resource Economics*, 37, 445-463.

Johansson, P.-O. and K.-G. Löfgren (1995), 'Wealth from Optimal Health', *Journal of Health Economics* 14, 65-79.

Jorgenson, D.W. and B.M. Fraumeni (1992), 'Investment in Education and U.S. Economic Growth', *The Scandinavian Journal of Economics*, 94, supplement, 51-70.

Korea Environment Institute, UNDP, and UNSD (1998), 'Pilot compilation of environmental-economic accounts'. Korea Environmental Institute: Seoul.

Lange, G.-M. (2003), 'Policy Applications of Environmental Accounting', Environmental Economics Series Paper No. 88, The World Bank Environment Department.

Li, C.H. and Löfgren, K.G. (2002), On the Choice of Money Metrics in Dynamic Welfare Analysis: Utility versus Money Measures. Umeå Economic Studies No. 590.

Lindahl, E. (1933), 'The Concept of Income', in G. Bagge (ed.), *Economic Essays in Honor of Gustaf Cassel*, London: George Allen & Unwin.

Ministry of Finance of Norway (2005), 'Indicators for Policies to Enhance Sustainable Development', Ministry of Finance of Norway, Oslo.

Ministry of Finance of Sweden (2000), 'Vad är hållbar utveckling?' (in Swedish), Bilaga 7 till LU1999/2000.

National Institute of Economic Research (2002), 'Economic Effects of Restrictions on Carbon Dioxide Emissions. Scenarios for Sweden to 2010' (in Swedish), Report 2002:1, Environmental accounts.

National Institute of Economic Research (2003), 'Economic Effects for Sweden of Limited Carbon Dioxide Emission Trade within EU' (in Swedish), Report 2003:1, Environmental accounts.

National Institute of Economic Research and Statistics Sweden (1998), 'SWEEA Swedish Economic and Environmental Accounts', Environmental Accounts Report 1998:2.

Neumayer, E. (2000), 'Resource Accounting in Measures of Unsustainability', *Environmental and Resource Economics* 15: 257-278.

Nilsson, C. (2004), *Studies in Environmental Economics: Numerical Analysis of Greenhouse Gas Policies*, Ph.D. Dissertation, Stockholm School of Economics, Stockholm.

Nilsson, C. and A. Huhtala (2000), 'Is CO2 Trading Always Beneficial? A CGE-Model Analysis on Secondary Environmental Benefits', Working Paper No. 75, National Institute of Economic Research, Sweden.

O'Connor, M. (2001), 'Towards a Typology of Environmentally Adjusted National Sustainability Indicators', Eurostat Working Papers 2/2001/B/4.

Oda, K., K. Arahara, N. Hirai, and H. Kubo (1998), 'Japan: The system of integrated environmental and economic accounting (SEEA) – trial estimates and remaining issues', In K. Uno and P. Bartelmus, eds., *Environmental Accounting in Theory and Practice*. Dordrecht: Kluwer Publishers.

Pearce, D., and G. Atkinson (1993), 'Capital theory and the measurement of sustainable development: an indicator of weak sustainability', *Ecological Economics* 8(2), 103-108.

Pezzey, J. and C. Withagen (1995), 'The rise, fall, and sustainability of capital-resource Economies', *Scandinavian Journal of Economics* 100, pp. 513-527.

Pillarisetti, J. R. (2005), 'The World Bank's genuine savings measure and sustainability', *Ecological Economics* 55, 599-609.

Ready, R., S. Navrud, B. Day, R. Dubourg, F. Machado, S. Mourato, F. Spanninks and M. X. Vazquez Rodriquez (2004), 'Benefit Transfers in Europe: How Reliable are Transfers between Countires?', *Environmental and Resource Economics* 29.

Rees, W., M. Wackernagel (1994) 'Ecological footprints and appropriated carrying capacity: measuring the natural capital requirements of the human economy' in A. M. Jansson, M. Hammer, C. Folke, R. Costanza (Eds.), *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*. Island Press, Washington, DC.

Repetto, R., W. Magrath, M. Wells, C. Beer, and F. Rossini (1989). *Wasting Assets: Natural Resources in the National Accounts*. World Resources Institute, Washington D.C.

Repetto, R. and W. Cruz (1991), *Accounts overdue: Natural Resource Depreciation in Costa Rica*. World Resources Institute, Washington D.C.

Samakovlis, E., A. Huhtala, T. Bellander, M. Svartengren (2005), 'Valuing health effects of air pollution–focus on concentration-response functions', *Journal of Urban Economics*, 58(2).

Samakovlis, E. and L. Svensson (2004), 'Valuing morbidity effects of air pollution in Sweden' (in Swedish), Environmental accounts, Report 2004: 2, National Institute of Economic Research, Stockholm.

Skånberg, K. (2000), 'A partially environmentally adjusted net domestic product for Sweden 1993 and 1997', Working Paper No 76, National Institute for Economic Research, Stockholm.

Smith, R. (2007), 'Development of the SEEA 2003 and its implementation', *Ecological Economics*, 61.

SOU 1991:37, 'Räkna med miljön! Förslag till natur- och miljöräkenskaper' (in Swedish), Betänkande av miljöräkenskapsutredningen.

SOU 2000:7, 'Medium term survey', Ministry of Finance, Sweden.

SOU 2000:23, 'Förslag till Svensk Klimatstrategi – Klimatkommitténs betänkande' (in Swedish).

SOU 2000:45, 'Handla för att uppnå klimatmål! – Kostnadseffektiva lösningar med flexibla mekanismer inom klimatområdet' (in Swedish).

SOU 2001:2, 'Effektiv hushållning med naturresurser' (in Swedish).

SOU 2003:60, 'Handla för bättre klimat' (in Swedish).

SOU 2004:19 'Medium term survey', Ministry of Finance, Sweden.

SOU 2005:10 'Handla för bättre klimat – Från införande till utförande' (in Swedish).

Statistics Sweden (2007), 'The economic structures and environmental pressure in the Swedish river basin districts 1995-2005' (in Swedish), Environmental Accounts Report 2007:1.

Theys, J. (1989), 'Environmental accounting in development policy: the French experience'. In : Ahmad, Y. El Serafy, S. Lutz, E. (Eds.), *Environmental Accounting for Sustainable Development*. The World Bank, Washington, D. C.

United Nations (1987), 'Report of the World Commission on Environment and Development', General Assembly Resolution 42/187, 11 December 1987.

United Nations (1993), *Handbook of National Accounting – Integrated Environment and Economic Accounting*. Series: F, No. 61, Sales number: 93.XVII.12, New York.

United Nations, Commission of the European Communities, International Monetary Fund, Organisation for Economic Cooperation and Development, World Bank (2003), *Handbook for Integrated Environmental and Economic Accounting*. United Nations, New York. Draft available from the website of the UN Statistical Division, www.un.org..

United Nations (2007) Agenda 21 Chapter 8 (website) http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter8.htm.

United Nations Development Program (1996), *Human Development Report 1996*, Oxford University Press, Oxford.

United Nations Statistical Commission (2007) Environmental-Economic Accounting (website) http://unstats.un.org/unsd/envaccounting/EnvAcc_Brochure_FINAL1.pdf

Van Tongeren, J., S. Schweinfest, E. Lutz, M. Gomez Luna and G. Martin (1992) 'Integrated Environmental and Economic Accounting – the Case of Mexico', CIDIE Workshop on Environmental Economics and Natural resource Management in Developing Countries, World Bank, Washington D.C., 22-24 January 1992.

Weitzman, M. L. (1976), 'On the Welfare Significance of National Product in a Dynamic Economy', *The Quarterly Journal of Economics* 90, 156-62

World Bank (1997), *Expanding the Measure of Wealth: Indicators of Environmentally Sustainable Development*. Washington D.C.: World Bank.

World Bank (2006), *Where is the wealth of nations?*, Washington D.C.: World Bank.

World Bank (2007) website: www.web.worldbank.org.

Östblom, G. (1999),'An Environmental Medium Term Economic Model EMEC' Working Paper No 69, National Institute for Economic Research.

Östblom, G. (2003), 'Vinner Sverige på att delta i utsläppshandel?' (in Swedish), *Ekonomisk Debatt* 31, No 8.

Östblom, G. & C. Berg (2006), 'The EMEC model: Version 2.0', Working Paper No 96, National Institute for Economic Research.

Östblom, G. and E. Samakovlis (2007), 'Costs of Climate Policy when Pollution Affects Health and Labour Productivity – A General Equilibrium Analysis Applied to Sweden', *Climate Policy*, 7 (5).

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