GREENSENSE: AN APPLIED INTEGRATED ENVIRONMENTAL IMPACT ASSESSMENT FRAMEWORK FOR THE EUROPEAN UNION

EXECUTIVE SUMMARY

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Introduction

The GREENSENSE project is the latest in a series of projects dealing with 'green accounting', using the impact pathway analysis methodology developed under the ExternE project series. The project aims to make two major contributions to environmental impact assessment and regulatory policy. These are to improve the availability of data on the major impacts of environmental damage caused by economic activity, and to develop and apply an environmental accounting framework that explicitly incorporates sustainability issues. The object is to provide information to policymakers as to whether or not the use of environmental resources is efficient and sustainable[1], if not then what policy action is required, and finally what is likely to be the net effect of this action on wellbeing.

The need for an appropriate framework with which to account for the damage caused to the environment by economic activity is well-known. This project aims to improve current methodology, both by developing an environmental accounting framework that takes forward the most promising aspects of the existing frameworks, and by improving the availability of economic-environmental data with which such frameworks may be applied.

The Project's Objectives

This project aims to address two major problems. The first is a shortage of data on the major impacts to human health, wellbeing[2] and the economy of the environmental damage caused by economic activity. This data shortage limits the ability of policymakers to identify the most urgent environmental policies. The second is related to the framework of economic and environmental reporting that indicates to policymakers and the general public the success of the economy. The existing environmental accounting frameworks have been criticised for a number of reasons, and in particular because they do not place sufficient weight on sustainability concerns. The project's scientific objectives are thus:

(i) <u>To develop a framework of monetary economic and environmental assessment that accounts for both economic efficiency and sustainability.</u>

The first objective is to develop a framework for economic-environmental accounting that addresses the criticisms that have been made of the existing frameworks, while capitalising on their strengths. The welfare-based framework on which current national accounting methodology is based has been criticised, firstly because it

[1] In this project we make a distinction between economic (Pareto) efficiency and sustainability. Efficiency means that a reallocation of resources could not make anyone better off either now or at any other point in time, without making someone else worse off. Sustainability is a use of resources that maintains the ability of the overall capital stock to generate per-capita wellbeing, accounting for unpriced assets and any limits to substitutability between different types of capital stock.

[2] Here and in the rest of the project the term "wellbeing" is used to refer to current utility. This is to avoid confusion with the term "welfare", which is used in the literature to mean the net present value of the path of utility over time.

aggregates the values of environmental and manmade assets, implicitly treating them as substitutes, and secondly because it does not provide a measure of *sustainable* national income. The work done so far to develop an alternative, by Hueting and the GREENSTAMP project, has focussed on the identification of sustainability standards, and the calculation, by means of modelling, of the level of welfare compatible with the attainment of these standards. However, this approach does not reflect the current welfare costs of environmental damage, and the role of economic efficiency in identifying environmental standards. It also uses a macroeconomic modelling approach, which, to describe an actual environmental-economic system, would be prohibitively complex. The project's aim is thus to synthesise these two frameworks by measuring welfare effects as well as costs of satisfying environmental sustainability standards.

A review of the literature on green national accounting has been undertaken. It begins with a brief historical introduction to national accounting, and provided a summary of the reasons for dissatisfaction with the use of GNP as a measure of economic progress. We point out that although GNP was developed as a tool for economic measurement and was never intended for use as a measure of wellbeing, in the absence of a generally accepted alternative, it is used for this purpose. Work done by Weitzman (1976) has been used as the theoretical basis for constructing a "greened" version of NNP, whereby the value of environmental damage and depletion is deducted from the aggregate figure. However, a review of the recent theoretical literature shows that there are considerable problems with measuring such a figure in practice. There are at least three types of income that one might be interested in measuring, namely welfare-equivalent income, wealth-equivalent income and sustainable income. However, Green NNP, even if market prices are undistorted by externalities, bears no systematic relationship to any of them.

Applied work on Green Accounting has also been reviewed. EC-funded projects have included the GARP series of projects, which measure the impacts of environmental damage and their economic values, producing figures that can be used to measure standard Green NNP, and the GREENSTAMP project, which estimates, using economic modelling, the level of income compatible with meeting sustainability standards. We look at the Genuine Savings method, which estimates using market data on the value of natural resource depletion, whether or not individual countries are (weakly) sustainable. We also look at the ISEW, which corrects per-capital consumption for a variety of factors including income distribution, expenditure on durable goods, environmental damage and the depletion of natural resources. We conclude that the measurement problems encountered in producing a reliable single indicator both of the effect of economic activity on current wellbeing, and of the economy's sustainability, may not allow such a measure to be feasibly constructed, and that a more fruitful approach GNP as a measure of economic activity) may be to analyse the two issues separately.

(ii) <u>To extend the methodology by which physical environmental damage is measured in order to improve the availability of economic-environmental data.</u>

The second objective is to improve the availability and coverage of information on the most important environmental impact categories. These impact categories are taken from the EUROSTAT Pressure Indicators Project. With the exception of the analysis of climate change damages and renewable resources, we undertake this work for the three countries of the study's partners, namely the UK, Germany and Spain.

The categories addressed in the project are Air Pollution, Climate Change, Biodiversity Loss, Natural Resource Depletion, Toxic Substances, Urban Environmental Problems (specifically noise), Waste and Water Pollution. These constitute eight of the ten main categories of the EUROSTAT pressure indices; the ninth 'Marine Environment & Coastal Zones' is excluded here, as the focus is on land area of the EU, and the tenth 'Ozone Layer Depletion', is excluded as this problem must be (and is being) addressed at the global level. The general methodology for these estimates is outlined below.

(iii) <u>To estimate the reductions in impacts required in order to satisfy a definition of sustainable development</u>

This objective involves providing an analysis of what is meant by sustainable development, what definitions of sustainability development will be adopted for use in this analysis, and what the implications of this are for each impact category. Chapter 3 went on to examine the issue of sustainability in more detail. First, the chapter outlined some of the factors relevant to sustainability and proposed a system for classifying these under the headings of economic and environmental sustainability, where environmental sustainability is a pre-requisite for economic sustainability. Environmental sustainability encompasses those factors whose contribution is so indirect, and sometimes little understood, that they cannot be given a monetary value and therefore be included in standard economic measures, but whose contribution is essential to the maintenance of human wellbeing. Economic sustainability includes those factors that feed directly into production or human wellbeing, such as natural resources and environmental amenities.

The literature on sustainability was then discussed, in particular the divide in the literature between weak and strong sustainability. The distinction between the two is not so much the aim of sustainability, which may be defined as maintaining some measure of human wellbeing, but rather in the actions required to ensure sustainability. In general terms weak sustainability involves maintaining the value of aggregate capital stocks including natural capital, and the strong sustainability involves maintaining individual types of capital stock, at least up to a certain point. We analysed a model of an economy which displayed the main economy-environment interactions considered in this project, showing how the equivalent of the rule for weak sustainability could be derived for this economy, and then showing the assumptions, and the strength thereof, required for this rule to actually deliver sustainability. We then proposed some additional, qualitative, rules that should be imposed if one accepts that these assumptions may not hold in practice. On the basis of this framework, and of discussion between the project partners, it was agreed that three definitions of sustainability would be analysed in the project, in order to aid comparison among them. The first is weak sustainability, where the value of environmental damage and depletion would be calculated. The second would be "intermediate" or "policy relevant" sustainability, where the current policy aims encompassed in existing EC directives would be taken as the extent of sustainability policy that is currently politically acceptable. Finally, the third would be strong sustainability, which would be targets compatible with bringing a halt to environmental damage and depletion before critical stocks of environmental capital are lost. We identified the appropriate standards for each impact category and these are outlined in the following paragraphs.

Air Pollution: Air pollution impacts are assessed using the impact pathway methodology, estimating impacts and damage costs by applying air quality and exposure response models together with receptor data on risks groups in the population, crops, and building materials. High resolution emission scenarios of SO_2, NO_X, NH_3, NMVOC and CO for 1990 and 1998 are derived using the European emission databases CORINAIR, TNO/CEPMEIP, and EMEP.

Toxic Substances: Air quality modelling together with receptor data and exposure response functions for inhalation were used to analyse the impacts from lead, cadmium, arsenic, chromium, nickel, PCDD/Fs, and PAH. Detailed emission scenarios have been derived for the year 1990. Unit risk factors have been applied to assess the lung cancer cases and corresponding damage costs caused by different toxic substances in air. A water and soil model has also been developed to cover pollution in these media and has been used to estimate damage costs via ingestion.

Urban environmental problems (noise): The most important issue for urban areas not covered in other sections of the project is the human health effects from traffic noise. Impacts from noise have been assessed for Germany, Spain, and the UK, according to quantifiable stress-related health effects. Of the costs, the majority are accounted for by amenity losses. Other effects are heart disease, subjective sleep quality and hypertension. Standards defined for **noise** do not correspond to sustainability issues, since noise does not have long-term implications, but reflect the minimal level of environmental quality that is acceptable for the population. The WHO has defined guideline values for this purpose, which can be taken as efficiency-based environmental standards.

Waste: intermediate standards are those required to comply with EU legislation relating to recycling.

Climate change: This is considered here as a sustainability issue, which does not measurably affect current wellbeing. The present value of the impacts of climate change is estimated using the *FUND* model, an economic growth model, driven by scenarios of population and technology, where greenhouse gas emissions feed into models of carbon cycle and climate. Climate change impacts include agriculture, water, energy, coastal zone, health and ecosystems. Calculated costs include heating, cooling and. coastal protection costs, forced migration, loss of land and wetlands, mortality and morbidity

The model runs from 1950 to 2200, in time steps of one year. Marginal discounted damage costs per tonne of greenhouse gas emissions represent the weak sustainability criterion. The intermediate sustainability target is based on the EU's policy target, while the strong sustainability target is based on a target concentration at the lower end of those discussed in the literature.

Biodiversity: Intermediate Standards for biodiversity are those required for compliance with the EC's 4^{th} Environmental Action Plan.

Natural resources: For natural resources, the value of extraction of energy resources in the UK, Spain and Germany has been calculated as a weak sustainability criterion; this will be extended with an analysis of the potential implications of energy price changes under different scenarios. The intermediate and strong sustainability targets for energy take account of the climate change implications of energy use; this rather than availability is thought to be the factor limiting energy use. The strong sustainability target has been identified by analysing the output of energy use and economic growth scenarios by the SRES used in the IMAGE 2.2 Climate Model. For forestry, we have looked at the extent to which the EU imports timber from countries where the harvesting is at a higher rate than its replenishment. We then calculate the reductions in imports required to bring harvesting rates in line with replenishment rates, and estimate the resulting price increases faced by EU consumers in order to calculate a capital loss that exporters make at present compared to a sustainable harvesting scenario.

Water pollution: strong sustainability requires that pollution should not exceed assimilative capacity, or endanger life support services. There is considerable uncertainty regarding threshold levels, therefore arguably a precautionary approach is required. The Water Framework Directive (2000) stipulates that EU countries must prevent further deterioration of their waters, and protect, enhance and restore them in order to achieve “good” or “high” status in all of their water bodies by the end of 2015. The requirements of this policy are taken here to satisfy the definition of strong, as well as intermediate, sustainability.

The sustainability standards used in the analysis are summarised in Table 1.

Table 1: Sustainability targets analysed under the GREENSENSE project

Environmental Impact	Weak Sustainability	Intermediate sustainability target	Strong sustainability target
Air pollution	Invest the value of damage to capital stocks due to air pollution.	Current legislation with Emission Ceilings	Medium Ambition GAP Closure + Emission Ceilings / Maximum Technical Feasible Solution
Climate Change	Invest the NPV of the cost of current carbon emissions ($4/tonne current estimate)	550 ppmv by 2120	450 ppmv by 2120
Biodiversity	Invest the value of damage to capital stocks due to biodiversity loss	Natura 2000 network to be preserved No further wetland loss or degradation 15% of agricultural area under management contracts No further deterioration of natural and semi-natural forests	20% of all land to be preserved in natural condition
Natural resources	Energy: Invest % of resource rents Invest value of future price Increases Forestry: Invest value of future price increases	12% energy from renewables by 2010	16-19% energy from renewables by 2010 (current estimate)
Toxic Substances	Invest the value of damage to capital stocks due to Toxic substances	Concentration levels of lead and cadmium given in EU Directives	Future steady-state concentrations of lead and cadmium
Urban Environmental Problems (Noise)	Not applicable since only current welfare impacts	Not applicable since only current welfare impacts	Not applicable since only current welfare impacts
Waste	Invest the value of damage (e.g. land converted for landfill) due to waste	Landfill max. 35% of household waste; Recycle 25%	Land space availability
Water Pollution	Invest the value of any decline in water resource stocks.	Satisfaction of the EC Water Framework Directive	Satisfaction of the EC Water Framework Directive

(iv) <u>To attach economic costs to the environmental impacts and the actions required to meet sustainability standards, and to use this data to apply the framework developed in (i).</u>

This objective involves using the latest data available in the literature to attach economic values to the welfare effects of current environmental damage and to the action required to reduce environmental impacts to within environmentally sustainable levels. We took the results from the green national accounting literature review and the discussion of the issues of sustainability, and proposed a framework for integrated economic and environmental reporting. Having argued that it may not be possible to provide a single indicator of both current wellbeing and sustainability, we propose that these factors be described separately, namely by a disaggregated set of (weak, strong and intermediate) sustainability indicators, and by an Index of Consumption Corrected for Environmental Damage (ICCED). The results have been compiled into an integrated framework for economic and environmental reporting. This involved firstly gathering data on consumption and GDP for the UK, Germany and Spain. This data was obtained from the OECD (2003), and the data for the UK was converted into Euros using exchange rates obtained from the Bank of England (2003).

The values of the total environmental impacts were entered into the tables for the three countries, and these are shown in Tables 2 to 4. These values are simple means of those presented in ranges in the individual impact chapters.

Table 2: Total Environmental Impacts: UK

Total environmental Impacts	Billions of (2000) Euros		Intermediate Sust. Target	Strong Sust. Target
	1990	1998	2006	2006
Air Pollution	24	13	6.6	5.5
Biodiversity		-0.174	-0.044	
Resource Extraction				
Toxic Substances - dioxins		1.8		
Toxic Substances - heavy metals	0.3	0.06	0.04	
Noise		2	2.6	2.6
Waste	(.19)	(.18)	(.23)	
Water Pollution	0.5	0.4	0.2	0.2
Total	**25**	**17**	**9**	**8**

Table 3: Total Environmental Impacts: Germany

Total environmental Impacts	Billions of (2000) Euros		Intermediate Target	Strong Target
	1990	1998	2006	2006
Air Pollution	70	31	17	16
Biodiversity		-0.024	0.057	
Resource Extraction				
Toxic Substances - dioxins		0.2		
Toxic Substances - heavy metals		0.7	0.1	0.1
Noise		5.1	6.4	6.4
Waste	(0.3)	(0.26)	(0.26)	
Water Pollution				
Total	**70**	**37**	**24**	**23**

Table 4: Total Environmental Impacts: Spain

Total environmental Impacts	Billions of (2000) Euros		Intermediate Target	Strong Target
Year	1990	1998	2006	2006
Air Pollution	12	11	6.2	4.6
Biodiversity		-0.06	-0.52	
Resource Extraction				
Toxic Substances - dioxins		3.9		
Toxic Substances - heavy metals	0.2	0.02	0.01	
Noise		1.4		
Waste	(.08)	(.14)	(.15)	
Water Pollution				
Total	**12**	**16**	**6**	**5**

Air pollution damages dominate: their dominance is exacerbated by the incompleteness of a number of the other impact categories - most notable water pollution in Spain and Germany - following from the lack of data available (or robust exposure-response functions in the case of toxic substances).

Nevertheless the importance of air pollution is a key finding, which also appears in other studies for Europe. Second, we note the fall in damages between 1990 and 1998, especially in the UK and Germany, where they have fallen by 50 and 56 percent respectively. It is also notable that a similar fall has not taken place in Spain [3].

Third, the reduction in damages if the current emissions ceilings were to be met would be another 50 percent or so, but the additional fall in damages compared to 1998 in going to the maximum technical feasible solution would be relatively small (58 percent instead of 50 percent in the case of the UK, 48 percent instead of 45 percent in the case of Germany and 58 percent instead of 44 percent in the case of Spain).

The sustainability side of the reporting framework that shows the estimated avoidance cost of meeting the sustainability standards in 2006 for the three countries, shown in Tables 5 - 7.

[3] The negative numbers for biodiversity reflects the fact that, in 1998, biodiversity resources generated environmental benefits and under the intermediate sustainability criteria these benefi ts will fall (less use of conservation areas will be possible). Here is a case, however, where the benefits of conservation cannot be valued adequately, resulting in an incomplete picture for this category in money terms.

Table 5: Costs of meeting Sustainability Standards: UK

	Euro (2000) billion	
Sustainability: Pressures	Annual Total Avoidance Cost Intermediate	Annual Total Avoidance Cost Strong
Air Pollution		
SO2	1.5	3.2
NOX/NMVOC	6.2	8.8
NH3	0.06	1
PM10	N/A	N/A
Biodiversity		
Resource Extraction	N/A	N/A
Toxic Substances		
Waste	1.03	
Water Pollution	0.1	0.1
Total	**8.89**	**13.1**

Table 6: Costs of meeting Sustainability Standards: Germany

	Euro (2000) billion	
Sustainability: Pressures	Annual Total Avoidance Cost Intermediate	Annual Total Avoidance Cost Strong
Air Pollution		
SO2	4	4.1
NOX/NMVOC	11	13
NH3	1.3	2.5
PM10	N/A	N/A
Biodiversity		
Resource Extraction	N/A	N/A
Toxic Substances		
Waste	1.16	
Water Pollution		
Total	**17.46**	**19.6**

Table 7: Costs of meeting Sustainability Standards: Spain

	Euro (2000) billion	
	Annual Total Avoidance Cost	Annual Total Avoidance Cost
Sustainability: Pressures	Intermediate	Strong
Air Pollution		
SO2	0.9	1.5
NOX/NMVOC	4.2	5.4
NH3	0.03	0.03
PM10	N/A	N/A
Biodiversity	N/A	N/A
Resource Extraction		
Toxic Substances		
Waste	0.7	
Water Pollution		
Total	**5.83**	**6.93**

Again the data are most complete for air where robust technical cost data were supplied by IIASA. (however no information is available for the PM_{10} reduction). Data for the avoidance costs are also not available for biodiversity, and partially available for waste (only for the intermediate standard) and water pollution (only available for the UK). The long time period before toxic substances are judged to reach their sustainability constraints also disallows meaningful calculations of avoidance costs. Since noise is not treated as a sustainability issue in our analysis, cost estimates for noise reductions are not made.

The two sets of information - on environmental damage costs and costs of meeting sustainability targets are then combined in the ICCED tables on a per-capita basis. The first and second columns in the table show consumption corrected for environmental damage for the years 1990 and 1998. The third and fourth columns show consumption corrected for environmental damage for projected economic growth and environmental damage, under two separate environmental policy assumptions. These are; intermediate sustainability, that is meeting the standards envisaged in current EU legislation, and strong sustainability, that is of putting the economic-environmental system onto a path that involves bringing the damage and depletion of the environment to within the assimilative and regenerative capacity of the environment before damage is done to critical natural capital.

Future data are estimated as follows. Projected default future GDP has been estimated by assuming that GDP grows at 2% annually from measured 2001 levels. Estimated avoidance costs for the year 2006 are then deducted from this figure to yield an estimated “realised” GDP. Realised consumption levels are then estimated by assuming that consumption will be the same proportion of “realised GDP” as the consumption share of 2001 GDP. The value of the environmental damage implied by meeting these standards is illustrated in the third and fourth columns of table. The cost of meeting these standards has been deducted from the projected GDP and consumption figures. The ICCED tables for the three countries are presented in Tables 8 - 10.

Table 8: The ICCED for the UK

	Per capita (2000) Euros UK		Intermediate Target	Strong Target
	1990	1998	2006	2006
GDP	13238	22398	29523	29523
Final Consumption Expenditure	10910	18563	25313	25313
Env. Damage	426	294	161	143
Env Damage as % Consumption	3.91	1.58	0.64	0.56
Env Damage as % GDP	3.22	1.31	0.55	0.48
Avoidance cost			0.2	0.2
ICCED			25151	25170

Table 9: The ICCED for Germany

	Billions of (2000) Euros		Intermediate Target	Strong Target
	1990	1998	2006	2006
GDP	17025	23791	28198	28198
Final Consumption Expenditure	13030	18258	22132	22132
Env. Damage	863	456	290	277
Env Damage as % Consumption	6.62	2.50	1.31	1.25
Env Damage as % GDP	5.07	1.92	1.03	0.98
Avoidance cost			0.22	0.24
ICCED			21841	21854

Table 10: ICCED for Spain

	Billions of (2000) Euros		Intermediate Target	Strong Target
	1990	1998	2006	2006
GDP	7994	13509	18409	18409
Final Consumption Expenditure	6144	10365	13961	13961
Env. Damage	312	416	146	118
Env Damage as % Consumption	5.08	4.01	1.04	0.84
Env Damage as % GDP	3.90	3.08	0.79	0.64
Avoidance cost			0.1	0.2
ICCED			13815	13843

Tables 8 to 10 above, show:

a. The difference in per capita consumption expenditure between the intermediate and strong targets is minimal – it does not even register to one decimal place.
b. The additional reductions in damages in going for the intermediate target are much greater than the additional costs.
c. The same holds in going from the intermediate to the strong targets -- the fall in damages exceeds the costs by a large margin.
d. Measured ICCED is higher in the strong sustainability case, but only by about 0.1 percent.

We should note that these conclusions are provisional, and could be influenced by the lack of data on some avoidance costs (e.g.) for some air pollutants.

Table 11 shows the estimates of the indicator of weak sustainability for the capital stocks for which this was possible.

Table 11: Weak Sustainability measures

Value of change in Capital Stocks (bn Euro) 1998

	UK	Germany	Spain
Manmade capital	3807	4044	2296
Ecosystems (biodiversity)	0.174	0.02	0.06
Natural Resources	3.2	1.3	0.03
Waste Stocks			
Total	**3810**	**4045**	**2296**

The data show how dominant the figures for man-made capital are in these three countries. Valuation of ecosystems hardly register on the scale of values, although this is partly due to problems in valuing these resources in a credible manner. The calculations made here come up with values that are intuitively too low. Further work is needed on this, although it is unlikely that it will change the overall picture completely. For natural resources, the valuations include only mineral resources relevant to energy, which now make up a very small part of the capital stock in these countries.

Given the difficulties in calculating measures of natural capital, even in advanced countries such as these, the prospects for a credible weak sustainability measure must be considered as poor. The same applies for the genuine savings measure, for which differences in these stocks are needed. Subtracting two large, uncertain numbers does not give a more accurate smaller number.

Climate change impacts were treated separately, because the estimates of damages associated with them are made on a global - rather than an individual country - basis. Levels of greenhouse gases in the atmosphere are treated as a natural capital stock so that monetarised impacts are considered as a change in the value of that stock.

Table 12 summarises the results for climate change which the FUND model has generated for the three sustainability criteria.

Table 12: Costs associated with Climate Change impacts and mitigation (3% d.r)

Name	**Description**	**Monetary value (Euro/tC)**
Weak sustainability	Marginal damages of climate change	8/tC
Intermediate sustainability	Limit CO2 concentrations to 550 ppm	49/tC
Strong sustainability	Limit CO2 concentrations to 450 ppm; zero emissions by 2200	495/tC

Sensitivity analyses that use different assumptions regarding, e.g. discount rate regimes, values of mortality and morbidity effects, show the NPV of damages to 2200 to vary between zero and EURO 18 per tonne of carbon. The figures are quite startling. Damage estimates are very much smaller than the costs of meeting either intermediate or strong sustainability targets and the costs of the strong sustainability target is an order of magnitude greater than that for the intermediate target. What does this imply for policy? Unfortunately, given the great uncertainty in the damage estimates, the conclusions are weaker than the numbers might suggest. Tentatively one might say that an intermediate target is justified on precautionary grounds but that aiming for the strong sustainability target would be difficult to justify. What is clear, however, is that there will be significant returns in policy making terms to getting more **information** on the damages.

Looking at non-renewable resources from a climate change perspective one can conclude that the use of these resources would be limited by climate change sustainability criteria rather than by availability. In other words, it is not that the planet will run out of non-renewable fossil fuel resources but rather that the climate change targets will limit the use of these resources over the next 100 years. The analysis also showed, under a number of energy use scenarios, that the present renewable targets set by the EU are in line with those required under the most environmentally-friendly socio-economic scenarios to meet the intermediate climate change objectives.

Initial Conclusions

This is the first attempt to bring together both the ‘economic’ approach and the ‘sustainability’ approach to national accounting of the environment. The lack of data availability somewhat limits the empirical results for policy purposes at present, though the magnitude of the estimates made indicate that welfare and sustainability issues associated with the environment should remain high on the policy agenda. The central estimates provided above also hide the considerable uncertainties involved in the estimation procedures - both physical and monetary. Nevertheless, the exercise serves to demonstrate the information requirement entailed in compiling more complete accounting frameworks for the environment, well-being and sustainability.

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