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Integrated Environmental and Economic Accounting – Methods and Applications

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Abstract: The System of integrated Environmental and Economic Accounting (SEEA) aims at incorporating environmental concerns into conventional national accounts. Country projects in Mexico, Papua New Guinea and Thailand confirm the feasibility of integrated accounting and provide an indication of the environmental costs caused by economic production and consumption. Sustainable economic growth can be defined and analysed in terms of environmentally adjusted accounting aggregates.

Key words: Sustainable development; satellite accounting; natural assets; environmental costs; environmentally adjusted net domestic product.

1. Introduction

Since the assessment of the global environment and development situation by the World Commission on Environment and Development (WCED 1987), "sustainable development" has become a widely accepted paradigm. The objective is to address environmental and developmental concerns simultaneously in planning and policy making.[3] The Commission also proposed to shift the focus from reactive to anticipatory policies as the key to a successful implementation of sustainable development. "Getting at the policy sources" is a call for making socioeconomic policies accountable for their environmental effects.

Accounting fully for the costs and benefits of economic activities regarding their effects on the environment can facilitate the integration of environment and development – a goal that has so far eluded quantification and application in national development planning and policies. A number of attempts at correcting macroeconomic indicators have been made, though, deducting environmental costs and other "regrettables" from gross national product, e.g., for the calculation of a measure of economic welfare (Nordhaus and Tobin 1972). More recently, the costs of natural resource depletion were subtracted from gross domestic product in studies of two developing countries (Repetto, Magrath, Wells, Beer, and Rossini 1989 and Solórzano et al. 1991).

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[3] "Sustainable development" has been the leitmotiv of the "Earth Summit", the United Nations Conference on Environment and Development (Rio de Janeiro, 3–14 June 1992).

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Since those estimates were carried out largely outside the national accounting system, they were not able to trace the effects of overall deductions back to causing activities and institutions – probably the most important objective of "accounting for accountability." Moreover, the opportunities of using the accounting identities and balances for validity checks and of embedding the estimations in the established framework of national official statistics are missed in this manner.

The Statistical Division of the United Nations is currently engaged in the revision of the standard System of National Accounts, the SNA (United Nations 1968). The proposed (draft) methodologies, especially for balance sheets of tangible assets (United Nations 1992), already extend the concept of produced assets to include natural (produced and non-produced) assets. This opens the door for further elaboration of changes in those assets in what has been popularly termed "green accounting" within the framework of the internationally approved SNA.

The Statistical Division is also developing the concepts and methods for a System of integrated Environmental and Economic Accounting (SEEA) in an SNA Handbook which will make these methodologies widely available for further testing and refinement in country studies. Already, country projects (as reviewed below) seem to confirm the feasibility and usefulness of integrated accounting. More experience has to be gained, of course, before recommending those methodologies as international standards. In the absence of a general consensus, SEEA is developed as a "satellite" system of the SNA, rather than attempting to change the well-established core SNA itself. In this manner, the users of national accounting data can decide themselves which type of indicators are required to meet their particular information needs.

2. Towards a System of Integrated Environmental-Economic Accounting

Conventional systems of national accounts have been widely criticized for failing to reflect appropriately the transactions related to the non-produced natural environment. Two major drawbacks were stressed in this context, the neglect of scarcities and corresponding depletion of natural resources and the degradation of environmental quality by economic production and consumption activities. In addition, the "inflation" of national income or product by environmental "defensive" expenditure that should be considered as "social costs" has also been criticized (Bartelmus 1992).

To incorporate those concerns in the SEEA, the SNA has been extended in two respects. On one hand, SEEA includes items which are not covered in the traditional, or even the revised version (United Nations 1992) of the SNA. On the other hand, it segregates and identifies some of the elements which are already included in principle, but do not appear separately. Although the SEEA follows as far as possible the principles and rules established in the SNA, it treats some of the items differently. In the SNA, natural assets are only included if they provide direct economic benefits to the owner, while the SEEA includes in principle all natural assets. Mirroring this extended role of the natural assets in the SEEA, costs related to the use of non-produced natural assets by industries are included in their production cost (differently from the SNA, where they are recorded among "other volume changes"). This is illustrated in Table 1 in row 4 by a plus (+) sign in column 1 (cost of produc-

Table 1. SEEA matrix based on SNA concepts (summary table)

		Domestic production of industries (1)	Final consumption		Non-financial assets			Export (7)	Total uses	
			Individual (2)	Collective (3)	Produced assets of industries		Non-produced natural (6)		Domestic origin (8)	Foreign origin (9)
					Man-made (4)	Natural (5)				
1	Opening stocks				(+)	(+)	(+)			
	Use of products of industries									
2	Domestic production	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)	
3	Import	(+)	(+)	(+)	(+)			(+)		(+)
4	Use of non-produced natural assets	(+)				(−)				
5	Use of produced fixed assets	(+)			(−)	(−)				
6	Contribution to EDP	(+)								
7	Gross output of industries (7 = 2 + 3 + 4 + 5 + 6)	(+)								
8	Other volume changes				(+,−)	(+,−)	(+,−)			
9	Revaluation due to market price changes				(+,−)	(+,−)	(+,−)			
10	Closing stocks (10 = 1 + 2 + 3 + 8 + 9)				(+)	(+)	(+)			

Source: SNA Draft Handbook on Integrated Environmental and Economic Accounting (Statistical Division of the United Nations, Provisional Version, New York, March 1992)

tion) and a minus (−) sign in column 6 (change in non-produced natural assets). A further basic difference between the two systems is that, in addition to market valuation as the main accounting principle, the SEEA recommends the use of other valuation principles as well.

From a narrow point of view, the main objective of the SEEA is to identify economic costs and benefits related to the environment. However, from an environmental point of view, further ecological or "social" values can also be introduced in the SEEA. Such values refer to the maintenance (damage avoidance or restoration) costs of environmental systems or to other contingent valuations of revealed preferences for environmental services.

The SEEA is structured in a modular way which permits to establish the system in parts or steps according to particular environmental conditions, statistical capabilities and information needs. The first module segregates environment-related flows and stocks of the traditional accounts, identifying (a) actual expenditures for the protection or enhancement of different fields of the environment, (b) environment-related categories of the SNA non-financial asset flows and stocks and (c) the income generated by non-produced natural assets such as land and biological resources (in agriculture or fisheries) that are "economically controlled" by production units.

The second module creates links between physical data bases and the corresponding monetary information of the SNA. The Handbook thus discusses not only the monetary aspects of integrated accounting but describes also their underlying physical counterpart. Physical natural resource accounts and the measurement of "residuals" affecting environmental quality are thus an integral part of the SEEA.

On the basis of the information compiled in the first two modules, the third module calculates the cost related to the use of non-produced natural assets and capital accumulation, including changes in the quantity and quality of natural assets.

As already indicated, SEEA is derived from the SNA by introducing the use of non-produced natural assets by domestic industries (in row 4 of Table 1). For the sake of simplicity, the use of the natural assets by the non-productive (final consumption) sector is shown together with that of the production sector in the first column of the table. As indicated in row 6, the inclusion of environmental costs and their deduction, together with intermediate consumption and depreciation from gross output permits the calculation of an Environmentally adjusted net Domestic Product, or EDP (in column 1).

3. Testing the SEEA: Country Case Studies

The SEEA is still in an experimental stage. The feasibility of the concepts has to be tested by implementing the SEEA in countries at different stages of development. The United Nations Statistical Division, in close collaboration with the World Bank and national statistical offices, has conducted two country projects and intends to promote the implementation of SEEA through further country projects.

The following describes some of the experiences gained in Mexico (van Tongeren, Schweinfest, and Lutz 1991), Papua New Guinea (Bartelmus, Lutz, and Schweinfest 1992) and Thailand.[4]

[4] An assessment of the feasibility of integrated environmental and economic accounting in Thailand was carried out by the authors in January 1992 as part of a World Bank mission on sustainable development. However, due to the restricted nature of this feasibility study no data can be shown for Thailand at the present stage of the project.

3.1. Identification of environmental information in conventional accounts

In general, only some data on environmental expenditures by the central government were available. However, such data were lacking for the private (production) sector and households, indicating an important area for further statistical development.

Estimates of the stocks of produced assets by type of activity were based on statistics of gross fixed capital formation, and input-output data in Mexico. The corresponding data of Papua New Guinea were estimated from the results of a survey of a limited number of enterprises. Thailand is currently estimating the stock of gross fixed capital by means of the perpetual inventory method.

3.2. Non-produced natural resources: market valuation

In the absence of market prices for mineral reserves, the valuation of those reserves was based on the income generated by mineral production, that is, the so called "net rent" calculation.[5] The "net rent" values were applied to the physical quantities of proven reserves, annual extraction and new finds in order to assess their monetary values.

The depletion of mineral reserves was estimated in two ways. On one hand, the total net rent was treated as the cost of depletion (Repetto et al. 1989). The other approach used in the studies was the calculation of the so called "user cost" (El Serafy 1989), according to which the "net rent" is subdivided into sustainable and non-sustainable parts. This is based on the assumed future income flow of the asset, and the non-sustainable part of the income is interpreted as the "user cost" of the owner.

[5] Net rent is defined as gross value added minus annual depreciation minus a total labour cost minus a "normal return" on invested assets.

Table 2. Value added, net rent and user cost of the mining sector, 1985 (% of GDP)

	Mexico	Papua New Guinea
Value added	3.1	9.8
Net rent	3.0	3.0
User cost	0.4	0.3

In the case of Mexico, oil is the only mineral which is included in the case study. In Papua New Guinea, the estimates were based on data of the five largest mines which represent 95% of the production of the mining sector. In Thailand, estimates for the "net rent" of the mining sector were made only while data on reserves still need to be compiled. Table 2 provides a summary comparison of these estimates in Mexico and Papua New Guinea.

The net rent and user cost approaches were also applied to estimate the depletion (beyond natural regeneration) cost of commercial and own-consumption logging as shown in Table 3. In Papua New Guinea, the current cut level was found to be sustainable, since exploitation does not exceed the regeneration of the forests, and consequently no depletion allowance was estimated. In Thailand where logging was almost completely banned in 1989, the environmental services provided by the forests were considered to be far more important than its potential income generating capability.

Table 3. Value added and cost of depletion due to logging, 1985 (% of GDP)

	Mexico	Papua New Guinea
Value added	0.4	5.4 (1989)
Net rent	0.3	0.0
User cost	0.02	0.0

3.3. *Non-produced natural resources: ecological valuations*

The limits of market valuation become apparent in the case of forest which provide significant non-economic benefits in the form of environmental services (e.g., of soil formation, climate control or flood regulation). A much broader set of natural assets and environmental functions of those assets is thus covered by valuation methods other than market valuation in the SEEA.

In the case of forests, environmental functions were assessed in different ways in the studies. The Mexican study imputed costs for the lost wood content due to transfer of forest land to agriculture, livestock holdings and urbanization. The imputation was based on the same net rent approach already used in the estimation of the economic depletion cost of the forestry sector. In Papua New Guinea, the socio-cultural and environmental costs of forest depletion were addressed in two ways. On one hand, those costs were based on negotiations between the traditional users of the forests and the logging companies, reflecting a willingness-to-pay approach. An "avoidance cost" approach was also used, estimating the revenue foregone due to a hypothetical avoidance of annual cut. In Thailand, besides the imputed "net rent" calculation, the cost of reforestation was used as an alternative.

Agricultural land and soil erosion were evaluated only in the Mexican study. The assumed cost of substituting the annual loss of productivity was calculated in this case. Water resources were also included in the Mexican case study, but only the cost of ground water depletion was estimated.

The physical flows of air pollutants, waste water and solid waste disposal were estimated by sector of origin, but costed in selected cases only. Avoidance cost estimates were used as the main valuation principle in this part of the studies. The overall environmental cost due to losses in environmental functions are shown in Table 4.

3.4. *Environmentally adjusted net domestic product*

A step-wise deduction of environmental costs of natural resources depletion, first, and of a more controversial allowance for environmental quality degradation, in a second step, permitted the calculation of two types of EDP. EDP1, costing oil depletion, deforestation and land use effects in Mexico and the exploitation of mineral resources in Papua New Guinea, amounted to about 94% of NDP in Mexico (1985) and between 92% and 99% in Papua New Guinea (1986–1990). Allowing for further costs of environmental quality degradation (defined, however, somewhat differently in Mexico and Papua New Guinea), decreased the percentages (of EDP2 over NDP) to 87% in Mexico (1985) and between 90% and 97% in Papua New Guinea (1986–1990).

4. Policy Use: Accounting for Sustainable Economic Growth

4.1. *Concepts and definitions*

Sustainability in production and income generation is not a new concept. At least for one factor of production, i.e., fixed assets, an allowance is made in both micro- and macro- (national) accounts for its "depreciation" in order to maintain the capital stock, "consumed" overtime. Such allowance is common practice: it is accounted for as a cost item, entering the gross value of production but is excluded from the contribution of a production unit to national income, i.e., net value added.

Recent or recently "discovered" scarcities

Table 4. Imputed environmental costs (ecological valuation), 1985 (% of GDP)

	Mexico	Papua New Guinea
Forests: Compensation costs of logging		0.4
Transfer losses (conversion of forest to agricultural land)	1.6	0.4
Land – soil erosion	0.9	
Ground water use	0.4	
Cost of pollution: Air	3.4	
Water	0.4	1.6
Solid wastes	0.4	

in natural resource supply and environmental services of waste absorption have prompted the extension of the sustainability criterion from produced capital maintenance to the maintenance of natural capital. The measurement of this extension and its implications for key accounting indicators has been the main objective of the above-described integrated accounting system. Natural assets can be viewed as providing material (resource) and non-material (waste disposal services) inputs into economic production. An allowance for their depletion and depreciation can, therefore, be justified in analogy to the use of produced capital. As described above, deducting these environmental costs from NDP obtains the environmentally modified indicator of EDP.

Focusing thus on the maintenance of produced and natural capital for ensuring continuing generation of output and value added and bearing in mind possibilities of extending the use of natural capital through (resource saving and environmentally sound) technological progress, resource discovery or substitution of primary (produced, natural or human) inputs, sustainable economic growth can be defined in operational terms as "increase in EDP (which accounts for the consumption of produced capital and the depletion and degradation of natural capital), taking into account that past trends of depletion and degradation can be offset or mitigated by technological progress, substitution, discovery of natural resources and changes in consumption patterns" (Bartelmus forthcoming).

The definition refers explicitly to the environmentally adjusted indicator of EDP. The concept of sustainable economic growth differs, however, from the definition of this indicator as an essentially analytical (*ex-ante*) concept that anticipates the occurrence of resource discovery, improvement in the efficiency of resource use, technological progress or changes in lifestyles.

In addition to the maintenance of produced and natural capital, the maintenance of "human capital" of labour, skill and knowledge, and of "institutional capital," providing the social, legal and organizational infrastructure for economic activities and conflict resolution, could also be introduced in a comprehensive discussion of the sustainability of economic production. However, both conceptual and statistical problems have generally prevented the full incorporation of human and institutional capital in national accounts. Further effects of natural or man-made disasters, high

inflation, indebtedness, and changes in the "institutional environment" and in the productivity of human capital may of course also affect the sustainability of economic growth as defined above. The allowance for produced and natural capital consumption in the above definition represents therefore only a "more sustainable" growth concept that needs further refinement through more comprehensive models of sustainable growth.

4.2. *Modified ("green") indicators in economic analysis*

As illustrated in the above definition of sustainable economic growth, the use of rigorously defined – modified – accounting indicators as variables in economic analysis (modelling) would also modify key economic concepts such as capital, income, cost (intermediate consumption, depreciation) or profit. The comparison of conventional economic analysis with alternative "green" modelling would permit to trace the consequences of merging environmental concerns into macro- and microeconomic strategies – the key objective of sustainable growth and, to a certain extent, development (see Section 4.3 below).

As far as overall economic growth is concerned, it has been suggested that limits in the availability of natural (resource) capital and the absorptive capacity of environmental media pose absolute limits on the level of economic growth. Consequently, economic policies would have to shift the focus from the "efficiency" of resource allocation to the "sufficiency" or limitation of the scale of economic growth (Daly forthcoming). Replacing conventional growth indicators such as GDP or NDP by EDP and expanding the scope of key variables such as capital and capital formation to include natural capital (use) in dynamic growth modelling could provide early-warning signals about the trends and limits of sustainable economic growth.

Arguments that enormous costs of environmental protection generate unemployment are typically met with counter-arguments referring to positive employment effects of the creation of new environmental industries. Positive employment effects of environmental clean-up have to be judged, however, as to their actual contribution to social welfare. Increased employment in environmental protection has been considered as social "defense" costs against deteriorating environmental conditions. The separate identification of environmental protection activities in the SEEA is to assess labour and other costs devoted to such defensive activities.

Resource limitations inherent in the notion of sustainability can in principle be circumvented at national and sub-national levels by substituting nationally and locally wasting resources through trade (imports). It is of course another question, as discussed above, to what extent there is enough room for substitution at the global level where the ultimate resource limits would be revealed. Full-cost accounting of the total scarcity cost in natural resource exports should alert to under-pricing and wasteful exportation of resources, especially from developing countries.

The debt overhang of many developing countries might be an accelerating factor in resource exploitation. This is the case when "mining" the resource presents the only means of fetching hard currency for debt servicing. "Debt-for-nature-swaps" have already been applied, though on a very limited scale, to address simultaneously issues of indebtedness and environmental conservation. Transfers of financial resources from debt servicing are already reflected in national income. The combined effects of

debt service and environmental deterioration could be assessed summarily by environmentally adjusted national income indicators. The full incorporation of financial and distributionary accounts into the proposed system of integrated accounting constitutes a further challenge to national accounting and accounting analysis.

If indeed a large portion of economic activity is devoted to dealing with environmental effects rather than to the generation of "true" (welfare-creating) income (Leipert 1984), a considerable distortion of the economic structure is the consequence of such policies. The above-described integrated accounting system has been designed to reveal such distortion in production and consumption by accounting for the costs created to society from lack of maintenance of natural capital and from "defending" society against a decline in environment-related quality of life.

Policies of economic (dis)incentives aim at the internalization of environmental costs into the accounts and budgets of micro-economic agents of enterprises and households. The objective is to make those who cause environmental problems accountable for their environmental effects. In environmental accounting, this incorporation would be reflected by turning imputed environmental costs into regular costs of capital consumption or intermediate consumption.

4.3. From growth to development

Economic policies are typically integrative, focusing on variables that use the *numéraire* of the monetary unit for aggregation and disaggregation across sectors and institutions in accounting, modelling and policy/programme evaluation. As already indicated, certain aspects of sustainability, such as the maintenance of natural capital in production, lend themselves to such monetary aggregation. Other aspects of sustainability, notably of "human capital" or of the objective of "equity," are hardly possible to assess in monetary terms. The policy focus on monetary measures of economic growth has therefore been criticized by advocates of multi-objective development, addressing a variety of social concerns or human needs and aspirations as part of the overall goal of improving the quality of human life.

There is now growing recognition that long-term planning and policies are needed at the national level to take into account non-economic social, demographic and environmental variables for achieving sustained development. Systems of (environment) statistics and indicators aim at measuring these variables in an integrative, or at least comparable, fashion, providing a synthetic picture of the state and trend of the environment and its links to human socio-economic activities.[6]

The desire to obtain more aggregated indices of "development" that do not only focus on economic aggregates but also on other "human" values has prompted the estimation of a "Human Development Index" (UNDP 1991). The index accounts, apart from per-capita GDP, for literacy and life expectancy and can be adjusted for distributionary aspects. It remains to be seen if these efforts of assessing integrated and sustainable development in non-monetary terms can prompt decision makers to formulate and implement consistent sustainable development policies, programmes and projects.

[6] For example, the Statistical Division of the United Nations is actively promoting the application of methodologies of environment statistics, organized in a Framework for the Development of Environment Statistics (FDES). The framework links social, demographic and economic statistics of human activities with data on environmental impacts and social responses (United Nations 1984, 1988 and 1991).

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