ECONOMIC MACRO-INDICATORS AND ENVIRONMENTALLY SUSTAINABLE ECONOMIC DEVELOPMENT

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The context, the arguments and the proposals within the United Nations review of the system of national accounts.

Abstract

Computation procedures of economic macro-indicators produced according to the statistical conventions of the national account system proposed by the Statistical Office of the United Nations, have some problems and are not suitable for the new needs of analysis and planning for environmental sustainable economic development.
The organization of environmental statistics based on physical data is needed to give scientists all data for the correlation analysis between socio-economic phenomena and environmental quality.
In developed countries the use and the creation of supplementary indicators is desirable, net from defense expenses and natural capital variations.

Résumé

Les méthodes de computation des macro-indicateurs économiques produits d'après les conventions statistiques du système de comptabilité national proposé par le bureau Statistique des Nations Unies, ont des limites conceptuels par rapport aux exigences d'analyse et d'aménagement pour le développement économique environnemental soutenable.
L'organisation de statistiques environnementales se basant sur des données physiques pourrait permettre aux savants de formuler les analyses de corrélation entre phénomènes socio-économiques et qualité du milieu.
On devrait créer et utiliser des indicateurs supplémentaires pour les Pays développés, net des frais défensifs et des variations du capital naturel.

1. Introduction

The marked normative nature of Environmental and Natural Resource Economics has strong implications on the determinants for the criteria used to measure both environmentally sustainable development and economic growth. Generally speaking economists are aware of the complexities and ambiguities implicit in the computational procedures for building economic macroindicators according to the System of National Accounts (SNA) as proposed by the United Nations Statistical Office (UNSO).
This paper, after providing a description of the historical and theoretical setting in which the SNA was developed and applied, presents an analysis of both the limits and conceptual inadequacies of the indicators produced with such a system with regard to the emerging needs of policy making (analysis) for environmentally sustainable development. In particular, emphasis is placed on the drawbacks that derive from the conventional use of GNP and NNP, that is, the risks and negative consequences for society resulting from their misuse by economists and politicians in both predicting and planning.
The various proposals put forward for the integration and modification of these indicators are presented, as reported in the literature.
Part of the SNA's inadequacy in signalling the quality of «sustainable» economic performance in the long term is a result of the methodology used and not of the economic concepts on which it is based. In fact, there is always some loss of information in the course of data collection (1); this is particularly true when the recording of data is not systematic which is frequently the case in statistically less developed countries. Although these factors are of interest and merit further consideration in order to present a full picture of the situation, they will not be dealt with in this paper.

2. History and definitions

2.1 The origins of SNA

Although the first attempts to estimate national income were made in seventeenth century England for tax purposes (2), the first empirical studies in national accounting (hereafter N.A.) were developed between the end of the 30's and the beginning of the 40's, under the pressure of the «great depression».
In 1932 the USA Senate requested estimates of national income from the period 1929-31 which were then published under the direction of S. Kuznets (1934). In the U.K. the first official publication was produced by Meade e Stone in 1941, even though Colin Clark had been working on NA throughout the thirties (Backhouse, 1991 p. 276).
During that period keynesianism was particularly influential on the work of British economists and this was strongly reflected in the structure of these studies (Pyatt, 1988). With the spread of keynesian principles overseas, economists were acutely aware of the need to establish macreconomic indicators which would allow the synthetic description and interpretation of the various economic systems operating in different countries. In order to build these indicators, and for other investigative purposes, many States gave themselves a system of national accounts.
The theoretical framework of utilitaristic welfare economics developed by Marshall and Pigou set the conceptual basis for using national income as an economic welfare indicator and at almost the same time the risks involved in the improper use of such an indicator were made clear (Pigou, 1920).
The success of the model proposed by the keynesians encouraged its extension to what is today the conventional SNA commonly recommended to UN state members.
The main economic aggregates do, in fact, reflect the variables used in the simplest of the keynesian macroeconomic models (3).
The Kaldor-Hicks criterion and the introduction of the concept of potential paretian improvement provided more theoretical ground for the use of national income as an indicator of growth of economic welfare (Hicks, 1940; Samuelson, 1950). In the economic literature, there has also been wide discussion of its limitations, both on the merit of that function and as indicator of general economic growth (ex. Boulding K.E. 1952, Kuznets S. 1933, 1948a, 1948b).
Some other, more satisfactory indicators have also been suggested such as «Net Economic Welfare» proposed by Nordhaus W. and Tobin J. (1972) and reapproached by Samuelson (1980).
The first attempt to set international conventions for an SNA goes as far back as 1952 (UNO, 1952) which in turn was based on «The national income measure and the con-

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(1)It is a well established practice to integrate macroeconomic analysis with other indicators which give details about expenditure, divided by sector and for groups of products.

(2) When it was used to investigate how to fund the warfare in the thirty years war.

(3) The so-called «income-expenditure model», where the exogenous variables are government expenditure, investment and exports, while private consumption and imports are the endogenous ones.

struction of social accounting» (League of the Nations, various years) edited by the keynesian Richard Stone. The subsequent and still current revision of the so-called «Blue Book» was carried out in 1968 with great changes in the computational conventions, including the introduction of input-output tables.

2.2 The concept of environmentally sustainable development

Economic activity makes use of natural capital for many of its functions such as aesthetic-recreational purposes, waste sinks and resource preservation (Pearce & Turner 1989). Natural resources are partly renewable and partly exhaustible, that is, available in finite amounts. Natural capital sustains a variety of biological functions many of which with great potential value in the future (applications in biotechnology inputs, genetic pools etc.). Ethical reasons should induce the present population to consider the right of future ones to inherit a comparable amount of natural resources in both quality and quantity, hence the need to promote models of growth and consumption capable of guaranteeing this intergenerational equity with respect to natural resources ([4]).
Economic development tends to maximise net benefits coming from the functioning of an economic system, in order for it to happen in an environmentally sustainable fashion the economy must operate within constraints that maintain within certain standards, both the quality of natural resources and the services provided by the natural environment.
According to the so-called «theorem of existence», a position of economic optimum does not necessarily correspond to a stable ecological equilibrium: economic and ecological systems may co-exist in a disequilibrium for long periods. In an institutional context where property rights on natural resources with multi-functional characteristics (among which environmental and economic ones), it would appear (Bromley, 1991) that economic forces push the economic system towards equilibria which are not ecologically sustainable. Hence the necessity to specify and impose constraints, identifing by means of technical information those activities which infringe upon, and spring up spontaneously in, an economic system left without adequate institutional policies.
Briefly, the basic rules for sustainable development may be derived from two principles, the first regulating the management of renewable resources, the second that of exhaustible ones:
1) $TU_{rr} \leq TG_{rr}$
2) max IU_{er} subject to TC_t
where in 1) it is imposed that the rate of consumption of renewable natural resources (rr) be less than their rate of production by the natural system; and in 2) that inter-generational utility of exhaustible natural resources (er) be maximized by the introduction of those technologies that are progressively made available by scientific research, so as to maximize productive efficiency here symbolically represented by TC_t. This last constraint should lead towards a decrease in the pressure on natural capital consumption, by means of both an increase of efficiency in its use and the gradual substitution of exhaustible resources with renewable ones. The most difficult step in moving towards a sustainable economic system is defining the activities that violate the environmental sustainability constraints. Such decisions are complex and fraught with uncertainties about the definition and the risks of both the irreversabile effects of certain resource usage and the dynamics of the recovery of the systems involved.
Economic development implies change: one of the most popular uses of macroindicators has been and will remain the comparative analysis of welfare changes in the international scenario. If, from amongst the issues of international policy, environmental sustainability emerges as a priority in development (UN 1973, 1981 e WCED 1987), then these macroindicators, in order to be coherent should incorporate the constraints imposed by this development.

2.3 The concept of income

In economics the Hicks-Lindhall concept of income is generally accepted, which is:

«The purpose of income calculations in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves..... income [is] the maximum value which [one] can consume during a [period], and still expect to be as well off at the end of the [period] as [one] was at the beginning.»

Hicks, 1946

Such a principle is not only inclusive of the income-revenue flow, but also of changes in capital endowment and therefore future productive potential. In practice this principle leads to economically cautious behaviour in the consumer, resulting at least in the conservation of this potential.
This observation has two major implications:
a) income is an economic measure based on the maintenance of the wealth owned;
b) as a consequence, no difference should emerge between long-term and short-term income measures since income itself is conceived as the value of production that can be used up within a period and leaves unchanged the productive potential of the system under observation.
The concept of environmental sustainability is, therefore, implied by the above mentioned definition when the term «wealth» is extended to cover natural resources endowment, which are considered part of the society's wealth and utility function.
Accounting systems incapable of supplying income measures that reflect this principle produce indicators which are unable to sustain economic behaviour and planning decisions which are prudent with respect to consumption. The series of short-term planning decisions, when based on distorted welfare and economic growth indications, will inevitably result in consumption scenarios which are not sustainable in the long-run.
In order to reflect these principles of basic wealth conservation the SNA provides two classes of income indicators: the gross product and the net product. Both of them refer to final production, that is production of goods and services to be consumed or invested, or those which cross the «production frontier» between producers and consumers ([5]).
The difference between gross product and net product is represented by the capital lost by physical obsolescence and depreciation during the period observed. Of course the net product values are the closest to the hicksian concept of income since gross product is inclusive of the capital consumption occurred during the production process.
Paradoxically, gross measures such as GNP are the most commonly used, expecially for designing policy to buffer extreme fluctuations in the economic cycle. Percentage changes in GNP indicate relative positions in recession-expansion cycles and are used for both designing stabilizing policies and managing domestic demand. Furthermore the popularity that GNP enjoys among western democracies makes it an important tool in gaining consensus. At election time, too strong an emphasis is often placed on the behaviour of this indicator compared with the indication that it can plausibly supply with regard to collective economic welfare.
Since soon after the second world war GNP use has tended to prevail as an indicator of short-term productive potential. This emphasis on «short-term» was initially justified by the need to estimate the potential response of economic systems to the impact caused by the war. This stance has been partly justified by the difficulties involved in the estimation of depreciation and the widespread assumption that GNP and NNP in the great majority of economic systems move towards the same direction with the same relative intensity.

3. The traditional criticisms

In the economic literature, there have been frequent and numerous criticisms of the use of product (gross and net) measures as welfare indicators and the accompanying system of statistical and accounting conventions (Studenski, 1958, Kuznets, 1948a, 1948b).

([4]) An exhaustive description of the classic notions of intergenerational equity is provided in writings by Solow, Rawls and Arrow.

([5]) The value of intermediate goods and services is excluded because they would represent double countings.

Many functions and activities for which no regular market exists contribute to the economic welfare of society. Many public sector activities have no such market and their economic valuation remains a problem, the same goes for non-marketed production of goods and services.
Establishing a dividing line between final and intermediate goods and services within the computation of the various sets of economic activities is always, to a certain extent, arbitrary. Most of this discretionary judgement was limited by the conventions on SNA adopted through the standards proposed by UN statistical office (UNSO, 1952, 1968, 1977), but the debate about the conceptual validity of these conventions is still animated.
The methodology employed to compute government expenditure offers many issues to this debate. There exists much dissent about the inclusion of some government expenditure for services in the category of «final products». For example expenditure for police services may be seen as an input in production, instead of a final product of the economic system: without it the government could not enforce the rules of civil order.
The same criticism is often extended to human capital investment in scientific research and education, and to other intangibles such as royalties and know-how. Should they be considered final consumption, investment or intermediate products?

The contribution of public expenditure to final production is computed as the cost of some inputs (labour and intermediate costs) and not on the basis of the market value of the production obtained, as it would be were the service marketed and were the consumers' preferences revealed. That poses serious doubts on the adequacy of these figures to reflect scarcity of resources employed in government expenditure, whose final product is not exposed to the action of market forces which would reflect better the preferences of society.
Other problems make these indicators imperfect for the measurement of economic welfare. Among these there is the difficulty of reflecting equity and distributional effects on income and its variations ([6]); the impossibility of including economic measures of welfare with regard to free time or working and health conditions; the impossibility of including in the final production the contribution of unpaid domestic work ([7]) and of self-consumption of food produce. This last drawback may strongly distort GDP measures of relatively undeveloped economies where these are large components of the final product.
It is worth remarking how, in the analysis of economic performance, the prevailing emphasis is normally placed on measures of flows of resources computed within the SNA, while stock variations are almost systematically overlooked.
Despite these snags, world wide computation of accounting sheets aimed at producing flux measures, supplies data which are so widely used for both planning and economic policies, that changes in relevant methodologies for data gathering and handling would produce, on the one hand serious problems in comparing time series and on the other, costly adjustments to the existing structures. Furthermore the degree of enforcement of the UNSO conventions for the standardisation of SNA statistics are still far from satisfactory (Blades, 1980).
To compensate for the inadequacy of macro-economic indicators as measures of quality of life, it has become common in comparative analyses to use a combination of heterogeneous socio-economic indicators (i.e. the yearly World Development Report by The World Bank) sometimes extended to incorporate indicators of the political and institutional framework (Dasgupta & Weale, 1992).
The current revision of the SNA has been carried out since 1983 by a task force composed by representatives of various international organizations (WB, UNSO, OECD etc.) and should provide an answer to many of these problems. Final results of this revision should be published within 1993.
The following part of this paper focuses on the inadequacies that the current SNA has with regard to the recent issues of eco-compatible and environmentally sustainable development as well as giving a critical description of the major proposals which emerged during the debate([8]).

4. The context of the criticisms of SNA with respect to environmentally sustainable development

The following statement synthetises the critiques on the adequacy of the current SNA in supplying reliable indicators for an economic analysis of «environmentally sustainable» growth:

«A country could exhuast its mineral resources, cut down its forests, erode its soils, pollute its aquifers, and hunt its wildlife and fisheries to extinction, but measured income would not be affected as these assets disappeared.»

(Repetto, 1989)

Natural resource (hereafter N.R.) economists have for a long time been among those who criticise the use of GDP as a welfare indicator in both temporal and spatial terms (Hueting e Bosch, 1990) ([9]) and would like to see the collection of environmental statistics that will integrate these conventional indicators with respect to the concept of welfare.
These criticisms have recently been gaining weight, thanks to the emphasis put on the concept of sustainability celebrated and embraced by the popular «Bruntland Report» (WCED, 1987) which revived the interest of many an International Organization such as the World Bank and the United Nations by means of its Environmental Programme (UNEP) and with the support of many well established environmental economists ([10]).
The international community of economists pays much attention to sustainable development and that has been focused, during meetings and round tables, on the necessity to integrate the existing SNA with information capable of describing the interactions between the economic system and the state of N.R. endowment, with a marked distinction between economic growth and welfare indicators.
To this end El Serafy and Lutz (in Y.J.Ahmad *et al.*, 1989) ([11]) argue that: the concept of welfare is much wider than a monetary measure of income. It covers many dimensions of individual welfare besides those implying market transactions measurable in monetary terms, and is particularly relevant for people whose basic needs have already been satisfied.
Some interesting proposals to improve the measurement of these aggregates are presented in the collection of writings edited by Ahmad *et al.* and published by the World Bank in 1989. This book was intended to clarify the value of certain recommendations to the task force from the U.N. engaged in the revision of the SNA «Blue Book». This book is a position book.
The conceptual drawbacks of an environmental economics perspective in which the current SNA does not account for sustainability may be reduced to two points: on one side the failure to consider capital depreci-

([6]) Two nations, with equal per-head GNP increase, no matter how this increase is spread over the population as a whole, if they were judged only according to the GNP increase would appear to have the same economic welfare improvement. To account for distributional and intersectorial effects it has been proposed (especially in developing countries) that Social Accounting Matrices should be introduced which allow a detailed description of the following: family income sources, income types by firms and geographic areas (Keuning, 1991 e Pyatt, 1988).

([7]) The popular paradox which describes how the GDP of a country would decrease if, *ceteris paribus,* a man married his domestic helper, while real production would remain, in fact, unchanged.

([8]) For a more comprehensive description of these issues references can be found in van Bochove & Bloem (1986), Carbonaro (1991), or in documents by the Inter-Secretariat of the UNSO (1987, 1990).

([9]) These authors point out (pp. 79) that the activity of the Dutch Central Bureau of Statistics was started, set up 21 years before precisely for the collection of environmental statistics.

([10]) such as H. Peskin (Resource for the Future, Washington), H. Daly (Lousiana State University, Baton Rouge), C. Leipert (International Institute for Environment and Society, Berlin), R. Goodland (Environment and Scientific Affair, World Bank, Washington, D.C.,), R. Hueting (Central Bureau of Statistics, Voorburg, Netherlands), D. Blades (Economics and Statistics Department, OECD, Paris), R. Repetto (World Resources Institute, Washington, D.C.), R.B. Norgaard (Univeristy of California, Berkeley), to mention here only a few of them.

([11]) Even Pigou, although having inspired and proposed the use of national income as a measure of economic welfare of a country (in *The Economics of Welfare* , 1920), he made a distinction between general welfare and economic welfare, defining the elements of the former as «states of conscience» and the latter as «that part of welfare that can be put, directly or indirectly, in relation to a money measure» (in Pigou 1920 pp. 10-11).

ation and N.R. consumption, a problem which provokes alarming repercussions in the less developed countries; on the other side the «compensating» (Leipert, 1986, 1987, 1988) or «defensive» (Hueting pp. 32-39 in Ahmad Y. J., *et al.*,) expenditures which occur at a growing rate in industrial economies in an attempt to mitigate the negative consequences of economic development. Some theoretical work by Weitzman (1976) shows how, assuming ideal conditions of free-market and efficient competition, it may be demonstrated that by subtracting the defensive expenditures and the economic residual damage due to pollution from measurements of NDP, we can derive an aggregate which adequately represents present and future economic welfare of society.

As usual in accounting we are faced with a dual problem: computing both stock variations and their relative flows. In this paper we approach the problem on the basis of the nature of the computational operations in order to point out two requirements. Firstly accounting for depreciation (loss in value of wealth) due to available N.R. consumption, and secondly computing the costs that society incurs for defensive purposes against negative environmental effects (i.e. pollution) and to try to re-establish desirable environmental quality.

4.1 The failure to account for N.R. consumption

The SNA does not account for new discoveries of N.R., neither does it for their consumption, although, it does so for human capital such as buildings, roads etc.. Despite it being technically possible ([12]), there does not exist a national account for the value of new discoveries due to investments in exploration, neither does there exist one for depreciation of N.R. stocks due to usage (physical depreciation) and price variation (value depreciation).

The SNA includes all the revenues from the sale of these resources in final production, supplying distorted signals about the performances of the economic system under observation, which then appears to produce a national income inflated by the sales of future productive capital.

This treatment involves the assumption of a marginal cost equal to zero for consumption of resources which are considered non-exhaustible, giving incorrect signals to both the market and public decision-makers, neither of whom understand that a temporary and illusory increase of «income» is in fact a loss in the country's wealth. All this provides ground for an inevitable decline in the future potential incomes.

In order to maintain the productive potential of natural capital it is necessary to use part of the revenue for:

a) investment in basic renewable N.R. (forests, ecosystems, rare species, etc.) in order to avoid decline in productivity or, worse, depletion;

b) investment in exploration for new deposits or other human capital stocks capable of maintaining the same flow of consumable production (income) when exhaustible N.R. are depleted.

In the existing SNA net product measures are worked out on the net of the depreciation of human capital which goes into final production, while no provision is taken for depreciation, N.R. consumption, exploration costs and accounting of the value of new discoveries which expand the known stocks. Such an omission is, in itself, grossly illogical and dangerous in its consequences, expecially in developing countries. Let us see why.

The funding of current consumption with revenues from N.R. exploitation, without compensating investments, is to be considered distortive with respect to the sustainability goals in developed countries, but it becomes unacceptable in developing countries where maintaining productive potentials for future generations, should be paramount, given the current rates of population growth.

The direct consequence of this funding is the creation of a feeling of complacency, with regard to the patterns of consumption, in those economic systems most dependent on N.R. exploitation, with scarce or inexistent compensating investments. Furthermore it encourages the establishment of habits of consumption which are as difficult to sustain in the long run as to correct once socially established. Thus the political motive to further a country's international debt.

The extent of the distortion produced by this accounting convention has been the object of some empirical studies: that in Thailand by Repetto (1987,1989,1991) and that on soil erosion carried out by Magrath and Grosh (1985) on the Island of Java.

Data from research on the modes of economic development in Indonesia in the last 20 years, re-arranged to produce an income measure net of depreciation for N.R., have shown how conventional indicators, produced by the SNA, have systematically overestimated economic growth (Repetto *et al.* , 1987).

There exists another reason for changing the accounting treatment of N.R. and non-marketed goods, and that is, improving accounting data equipment. A survey (Blades, 1980) carried out to investigate how many countries were equipped to consider in their national accounts the portion of economic activities taking place outside the regular markets, showed that out of 150 countries, only 65 were equipped to do so. A cautious estimate indicated that out of 49 countries examined there were 19 whose non-market transactions accounted for more than 20% of the countries' GDP. From the same study it emerged how much of the data, on which national accounts computation was made, was supplied by private firms and not, as one would have expected, from government agencies (i.e. copper in Zambia and tin in Malaysia). Only two countries, Japan and Hungary, were capable of supplying estimates on the values of their ore deposits.

4.2 The costs of protection from environmental degradation (defensive or safe-guard expenditure)

This class of expenses is of major interest for highly developed industrial countries, where the combination of high income and material wealth along with marked N.R. degradation makes the environment more valued since it enters, by means of a better perceived scarcity, the articulate utility functions that economically developed societies express.

In the current SNA defensive expenditure is treated in a distorted fashion with respect to the goal of maintaining environmental quality. As a result, the economic system of a country which, ceteris paribus, spends more to defend itself from the effects of production which is noxious to the environment (i.e. pollution abatement), would be considered to be experiencing a higher economic welfare when compared to a country which does not spend as much ([13]). GDP conventionally measured, according to Leipert e Simonis (1988 p. 38) behaves «exactly the opposite to what one would expect from a welfare indicator».

The conventional criticism tries to point out that the inclusion of defensive expenditure in the final expenditure is incorrect, since it is money spent to maintain or recuperate a satisfactory environmental standard, that is, a natural capital existing prior to the negative actions brought about by the economic system. This type of expenditure would be better treated as a real cost for intermediate goods necessary to correct the spontaneous actions of the productive system in order not to decrease the N.R. endowment and the quality (hence the utility) of their relative economic functions: notably an investment in natural capital.

5. The proposals

The treatment of both the above mentioned classes of expenditure has been the subject of many studies which have resulted in proposals for correction (or integration) of the current SNA. In particular there exists a difference of opinion with respect to the following:

— the consistency of the corrections to be introduced with existing conventions and definitions of the accounts sheets;

— whether or not these corrections for environmental expenditure should lead to the

([12]) Ferran (1981) points out how, after the compulsory introduction by the Security Exchange Commission, in 1978, of new accounting procedures for enterprises extracting N.R., the USA were potentially capable of both making an inventory, and accounting in SNA for the known reserves of fossil fuel.

([13]) This does not take into account that among those who spend less there are countries whose economies do not pay for defensive expenditures simply because they do not need any.

creation of additional indicators or to the change of the traditional ones.
Various positions exist even on these issues. The main ones are described in the following.

5.1 The correction of SNA with respect to the consideration of N.R. consumption

The accounting criteria for the treatment of physical and value depreciation of natural capital are the object of controversial proposals.
The prevailing one is that of accounting for them separately from the conventional SNA sheets, in satellite accounts and to use them to derive, along with the conventional income measures, some modified «environmentally sustainable» macro-indicators ([14]).
Those who claim that these concerns should be part of the SNA (Harrison in Ahmad *et al.*, 1989), would like to see the inclusion of N.R. consumption and defensive expenditure in the amortisation or (Leipert, 1987, Leipert e Simonis, 1988, El Serafy in Ahmad *et al.*, 1989) directly detracted from the GDP, so as to indicate clearly that they represent unsustainable outlays.
Other authors (Hueting, Peskin, Daly etc.) argue for the creation of additional macro-indicators, modified so that the depreciation would be subtracted from gross aggregates and give «environmentally sustainable» measures.
The point made in § 4.1 poses two problems: how to calculate the value of an exhaustible resource stock in a fashion compatible with both economic theory and accounting conventions, and how to calculate the changes in value of such a stock.
Harrison, El Serafy and Daly proposed some corrective methods for this problem (Ahmad *et al.*, 1989). Daly observes that neither gross nor net income measures adequately represent the hicksian concept of income because both imply unsustainable long run consumption. Gross measures, in fact, are inclusive of human and natural capital consumption while net ones are bio-physically unsustainable.
As an alternative indicator he proposes the Net Social Sustainable Product, obtained by detracting capital amortisation (CA) and defensive (DE) expenditure from conventional net product (NP).
Which gives
$NSSP = NP - SD - ACN$
The construction of these aggregates would be a result of the construction of satellite accounts, which would not interfere with conventional SNA sheets. In particular natural capital depreciation should be linked to the revenues coming from both renewable and exhaustible N.R. consumption. Daly argues that this depreciation could be valued either on willingness-to-pay (WTP) measures or on the substitution cost, neither choice implying a higher degree of arbitraryness than that currently implied by computational conventions for man made capital depreciation.
Regarding WTP measures, applied to economic evaluations in N.A., Hueting (Ahmad *et al.*, 1989) claims that they would produce estimates tending to infinitity due to the infra-marginal units which include the high values of the initial doses of benefits resulting from environmental improvements. Furthermore WTP measures would be inclusive of income differences because high income individuals show higher consumer surpluses. Thirdly, WTP measures of environmental benefits, despite being sufficiently accurate to be included in N.A. procedures would still be inconsistent with other economic measures used in this context since the former are inclusive of consumer surplus while the latter are marginal measures: average price multiplied by quantity.
Once adopted, Daly's proposal would not modify the current SNA framework and environmental statistics would be the basis of information to reconcile conventional gross and net product measures with an environmentally sustainable measure of income.
On the other hand El Serafy claims that if an innovation on SNA has to be made it must change gross product measures (GDP and GNP) because they are the indicators most frequently used and it is ethically wrong to account as current production (by including it in gross measures) that which also belongs to future generations, even though the possession of N.R. does give a real advantage in income terms which cannot be ignored by net indicators after depreciation.
He therefore proposes a formula to calculate natural capital conversion into a permanent flow of income. Annual revenues from that resource must be shared out into two components: a portion of income to be included in the gross product measure (X), and one of capital to be put on one side and possibly invested so that global capital endowment to be inherited by future generations is not eroded. In order to do this, at the end of each year, a simple computation should be carried out, which requires the knowledge of two entities:
— the number of periods (years n) in which the particular N.R. is capable of producing the physical flow of goods supplied during the period under observation (obtained by simple division of the known deposit stock by the flow experienced in that period);
— the discount rate r.
Assuming that it is possible to invest that capital for $n+1$ periods we have

$$(1) \qquad X/R = 1 - \frac{1}{(1+r)^{n+1}}$$

which gives

$$(2) \qquad X = R \cdot \frac{1}{(1+r)^{n+1}}$$

where X is the (real) income component to be included in the GDP, R the returns from the sale of the resource in that period net of the extraction costs, r is the rate of discount and n the number of periods during which the resource can produce that flow on the basis of the known stock. The component of real income X is obtained by subtracting from the value of the returns from the resource in that period an amount of capital that if invested at the interest rate $+r$ for $n+1$ periods, that is, for a period equal to the duration of the known stock of reserve plus one, it would build up to reach a value equal to R (the value of the extraction obtained in the period under observation).
The simple operation:

$$(3) \qquad UC = R - X$$

provides the user's cost (UC) which needs to be put aside (and possibly actually invested with an interest rate of r) ([15]) and subtracted from the GDP as alien to current consumption, but destined to future use.
To support this approach the author claims that the arbitrariness involved in choosing the interest rate to apply is no greater than that already involved elsewhere in the existing SNA (see § 3), whereas both the formula and the assumption made are metaphors to make economic analysts aware that only a portion of N.R. revenues is really income. Even the interest rate definition could be meant as a minimum threshold for the returns below which the portion to be invested should not be employed.
New discoveries of N.R., which at first may seem a problem with such an approach, would simply be incorporated by increasing the known stock of the resource in the ratio which defines n thereby making the left side of (2) increase so that (X) would increase and (UC) diminish. This proposal would provide a neat and immediate solution for treating exhaustible resources on the basis of financial (discount rate) and physical (known reserve) entities which incorporate effects of technological innovation, trends of prices, etc. The crucial point made by El Serafy's proposal is that it should not only be included in satellite accounts and reconciliation sheets but *also* in flow accounts in the SNA to change GDP measures.

5.2 SNA correction for expenses for environmental protection (defensive expenditures)

Defensive expenditures include the following arbitrarily chosen groups:
— costs for environmental protection and environmental damage compensation;
— additional costs for spatial concentration of production: commuting (pollution, car

([14]) For an extensive description of the various possible indicators see Peskin (in Ahmad *et al.* 1989) e Leipert (1987).

([15]) Ward (1982) claims that the amount put aside should actually be invested so as to continue to generate an income flow even after the exhaustion of the N.R.. Conversely El Serafy allows the investment to be simply «hypothetical» (El Serafy & Lutz in Ahmad *et al.*, 1989).

accidents etc.), lodgings and recreational costs;
— defense costs against sabotage risk, crime, technical difficulties;
— costs due to disturbances of physical and mental health (smoking, drug addiction, stress, etc.);
Harrison defines as defensive expenditures those for permanent maintainance of N.R. and her approach is analogous to the existing treatment of man-made capital in SNA.
Two categories of expenditures are accounted for on a yearly basis in SNA: one to allow for replacement of the capital asset at the end of its economic life (depreciation), the second to repair and maintain the fixed capital over such a period or to extend the useful life of capital assets over a longer one.
So defensive expenditures for natural capital may be made to prevent it from degradation or to «redress degradation that has already occurred» (Harrison in Ahmad Y. J., *et al.*, 1989 page 21).
The first type parallels ordinary maintanance costs of man-made capital, while the second type becomes necessary when the first does not take place or has proved insufficient to recreate initial conditions.
Anne Harrison proposes to incorporate depreciation for natural assets coherently with existing accounting conventions.
Their treatment would vary according to who pays and how these expenses are incurred. The public sector may pay for it by raising the necessary funds from taxation of private polluting agents. The latter would pay taxes proportionally to their N.R. consumption and the revenue would cover the defensive service produced by the government. In this case defensive expenditures would be treated as an intermediate cost because they are part of the input for the production of a service.
If polluting agents were not made to pay and government used global revenues to fund this service, defensive expenditures would be treated as final production.
Finally, in the case in which polluting agents met these expenses, either to abide by the law or out of their own initiative, then again they would be treated as intermediate expenditures and would not be part of the national income.
This Author does not agree with the total exclusion of these amounts from GDP (as proposed by Leipert) because that would countervene both the accounting definitions of final demand ([16]) and the necessity to maintain for GDP the function of indicating general economic activity as derived from final expenditure.
Harrison's proposal results in GDP reflecting both defensive expenditures necessary to avoid degradation, and a consumption of natural capital equal to this when the expenditure does not take place. Both these entities should, anyway, be present in the reconciliation sheets.
When the defensive expenditure incurred is only one part of the amount needed, the balance should be computed as natural capital consumption (**table 1**).

Table 1 ***Harrison's proposal: effect on GDP of defensive expenditures resulting from an environmental protection program.***

	Present SNA		Harrison's Proposal	
	Without program	With program	Without program	With program
GDP	100	105	105	105
Consumption of COU	10	10	10	10
Consumption of NRC	—	—	5	0
GDP	90	95	90	95

Source: Harrison in Ahmad *et al.*, 1989 pag. 21.
MMC=man-made capital
NRC=natural capital

With this treatment when this type of expenditure is in excess of natural capital consumption, the latter becomes negative hence increasing NDP and reducing the distance from GDP, in accordance with economic and accounting conceptions of net and gross measures.
Harrison claims that rather than presenting natural capital consumption as a decrease in NDP, which should remain an indicator of general economic activity of a country, it would be preferable to attract the economist's attention to the real meaning of GDP and NDP, the latter being the adequate income (sustainable consumption) measure.
Hueting (1980,1987) proposes a static analysis.
The environment provides functions which sustain economic activities; when one of these functions prevents present or future performances of a function, a loss is incurred. This gives the environment an economic utility, loss of function means incurring a cost.
The supply curve of environmental quality may be built on the basis of costs observed in the market place which are required to reach certain levels of quality, that is «the supply curve is the cost curve for diminishing pressure on the environment. According to Hueting, to build this curve we would have technical problems in the calculations, but the theory is sound.
The demand curve, however, is unknown since we are unable to observe the relative shadow-prices. WTP methods would not be applicable in SNA contexts since they do not allow the building of a complete demand curve (see Hueting in Ahmad *et al.*, 1989) ([17]). We cannot derive a demand curve from the market, but we can substitute this information with a «technically» determined demand curve ([18]) built on standards derived from physical or health considerations capable of representing the constraints of environmentally sustainable economic development. The deviation of an economic system from these would be calculated on the basis of the costs necessary to return to those standards.
According to Hueting, the economic measure of environmental degradation which takes place in a certain period should not be limited to costs for compensation and repairs, since there is a risk that these do not represent real degradation as, in reality, repairs and compensation rarely take place, and when they do they rarely match the whole value of degradation.
Consumers' revealed preferences could be substituted for with the political will to move development along a sustainable path in operational terms.
A comparison between a scenario produced by a transition towards a sustainable economic system and one based upon decisions made using only conventional SNA indicators has been described for the Netherlands and another is under way for Taiwan (Hueting, 1987).
Apart from the complexity and the heavy labour input involved, the Author feels that there are two two conceptual difficulties with this kind of research:
1) it is not built on individual preferences;
2) irreversible losses are not computable;
Whereas its advantages would be:
1) it provides an acceptable integration of SNA with measures of environmental functions expressed in monetary terms;
2) it implies an operational definition of the term «environmentally sustainable economic development»;
3) it is based upon environmental statistics which must be available if any steps forward are to be made in effective environmental policy.

([16]) Which is not concerned with the nature of the product, but the destiny of goods after exchange: consumption, capital investment or processing into other products.

([17]) According to Hueting, WTP measures may be justified to measure environmental losses for population, but they become useless in measuring the damage due to a slow process of degradation of the production conditions potentially useful to the life of future generations. In these cases levels of uncertainty are far too high to let results have any significance.

([18]) The unknown demand curve is substituted for by a line parallel to the x axis, built on the operational translation of the sustainability concept. The volume of activity necessary to obtain that amount of reduction of environmental degradation may be obtained by a combination of technical measures to reduce polluting activities. In practice that means that no degradating activity must be allowed to have a higher rate than that of natural generation (volume of soil erosion per unit of time lower than the rate of soil formation, volume of emission lower than that of their degradation etc.)

Leipert's proposal is limited to the treatment of «social and ecological costs» in industrial societies. He looks at the problem from the angle of one pursuing the goal of «remodernising the industrial society in an ecological sense». This Author observes that the current tendency to react to environmental degradation is based upon additional technological corrections (such as catalytic converters, waste treatment plants, chemical pollution abatement etc.) instead of a systematic prevention of noxious emissions by means of clean and integrated technologies. If production were organised on this basis, energy that is currently used for pollution abatement processes would be saved.
The future outlook for the present tendency is an unsustainable scenario for economic growth because spatial concentration and current organization of production would lead to ecological costs which are higher than prospective benefits from growth.
Complex as it may be, Leipert claims that economic evaluation of environmental damage should be encouraged, even at a simple empirical level. Encouragement should be given as well to formation of satellite accounts capable of providing information about the physical consumption and production of each economic sector along with their respective defensive costs.
Leipert proposes the identification of ecological costs and associated social costs in the phase of production and he groups them into the following classes:
— compensating economic activities (for past and future environmental damages);
— income, property or production losses;
— environmental damage (to human health, flora, fauna, buildings, works of art and materials).
Not all of these components may be adequately monetarised, but even in this case the arbitrariness implicit in the computation would not be significantly distortive.
Research based on these settings indicates that West Germany's environmental protection expenditures in 1984 approached 24,1 billion DM. If this amount is compared with a (very approximate) estimate of environmental damage sustained in the same year (Wicke, 1986) amounting to 103,5 billion DM (around 6% of Germany's GDP that year), it becomes apparent that defensive expenditures of an industrial system such as Germany's amount to nearly a quarter of environmental damage due to production, as it is currently organised.
Leipert proposes the creation of accounts which reflect ecological costs of each productive activity, at both national and local level.
In Italy some attempts have also been made to estimate «sustainable GDP» (Carlucci, 1990), although with slightly different criteria to those which Leipert used. This Italian estimate shows that this indicator is some 1% less than the GDP conventionally measured, a difference on the same scale as Leipert's results in West Germany.
The team reviewing SNA firmly opposes the inclusion in the SNA, at least at this stage, of this type of expenditure (Blades, 1989, Bartelmus *et al.*, 1991). The reason put forward is the following: if a country accepts a low level of environmental quality for its population, economic accounts should not make this fact explicit. Including recommendations in this sense within accounting conventions would perform a normative function in terms of environmental policy, a role which is alien to national accountants, but more properly belonging to politicians.
Similar opposition concerns the extension of national accounts to cover variations in N.R. endowment and known stocks, since this accounting practice is fraught with uncertainty and would cause further distortion with respect to macro-economic indicators defined in the SNA.

6. Present experiences and functional approaches

Environmental accounting is not starting from scratch. Some countries have gathered significant experience and, using various approaches, have built and run accounting systems capable of supplying, in a systematic and comparable fashion, relevant information on the use of N.R. in time series. Pierce (Cfr. Pierce *et al.*, 1989) reminds us that the first attempts to build environmental accounting can be traced back to the work of Nordhaus e Tobin (1972) in the USA and to the initiative taken by the Norweigian government around 1974. The former attempt was based on the incorporation of environmental statistics, in monetary terms, in the SNA (the approach currently followed by Japan and Indonesia), while the latter case involved N.R. accounting in physical terms and distinct from SNA (the approach currently followed by France and Canada).
Following Norgaard's (1989) plea for the development and use of multi-disciplinary approaches towards environmental evaluation and accounting, some research has been carried out to use non-monetary indicators for national accounts (Kummel, Shussler, 1991). Norgaard claims that such an approach is particularly needed because of the following unsolved problems:
a) aggregation problem in unit of currency;
b) inconsistency of economic theory in support of SNA derivation of aggregate measures;
c) «bounded knowledge» problem, that is, the lack of a single model to explain economic-environmental system interactions.
Whatever solution is adopted the first step towards N.R. accounting remains the creation of an inventory of the baseline stock endowment. In accordance with this simple principle a set of countries have either already committed themselves or are moving towards historical, cultural and environmental inventories (Nicolo, 1986; Repetto, 1989). This set includes Canada, France, The Netherlands, Australia e Norway along with many developing countries such as Costa Rica, Indonesia, China, Argentina, The Ivory Coast and Thailand. In some cases, such as France, an attempt has been made to represent three dimensions: social, environmental and economic.
The statistical representation of environmental quality presents various problems which are different from those encountered in economic statistics (Elvers, 1989), while the techniques for the statistical representation of energy and material balances are already well established. In order to pave the way for the integration of these functions into the SNA the United Nations Statistical Office has produced guidelines for organising environmental statistics according to the existing SNA categories (domestic consumption, domestic production, imports and exports etc.) (Bartelmus in Ahmad *et al.*, 1989; Bartelmus *et al.*, 1991). The material balance approach can in fact, with some adjustment, be framed within I-O tables (Ayres and Kneese, 1969), from which we can derive energy and material inputs, processing and final waste for each productive activity. There are two drawbacks as regards the input-output approach: the first concerns the lack of satisfactory geographical information supplied by I-O tables, which is often the most relevant when it comes to local environmental policy; the second is that I-O analyses barely discriminate between noxious or beneficial effects of the flows of material that they represent, neither do they describe their modes of generation and disposal. In order to overcome this basic limitation it is necessary to rely on practical conventions based on scientific information. Since 1955 Japan has presented a new aggregate in its national accounts sheets, the so called «Net National Welfare» NNW. This is obtained by subtracting from NDP the value of expenditures that should be met to guarantee certain quality standards for certain «systems» such as water, air, waste disposal etc.. These standards are arbitrarily fixed on a technical and scientific basis and the costs of regenerating those standards for the system is worked out according to available technologies. Pierce (et al., 1989) notes how this arbitrariness may cause diversity in procedures and, therefore in corrections from GDP values. This approach does not identify defensive expenditures which remain included in GDP and NNW. Some degradation does inevitably occur even within this set of standards and it cumulates over time. Despite its «imperfections» this attempt at monetarization has given rise to the systematic construction of time series upon which politicians have been able to base planning choices.

7. Conclusions

The objective of this paper was to analyse the context in which the institution of SNA has been developed, the concepts upon which the complaints of inadequacy of the current N.A. conventions have been built,

based upon the quest for macro-indicators which would be useful in planning environmentally sustainable economic growth, and, finally, the major proposals for correction put forward to this end.

This problem represents but one of the many facets of the SNA revision currently under way at the UN statistical office. National Account Systems will probably never be a finished product.

It is highly probable that, at this stage, environmental accounting will not be included as part of SNA conventions. The complexities and constraints mentioned in this paper, along with the diversity of problems between developing and developed countries, mean that this field must still be considered to be in an embryonic stage of study and research. Much more theoretical and empirical work is needed before a decision can be made about which conventions to adopt at an international level for the SNA framework.

The pitfalls mentioned in § 4.1 and 4.2 cause systematic suboptimal allocation of N.R. and therefore social costs and injustice between generations. It is possible to avoid these problems by means of income indicators which incorporate cautionary constraints for environmentally sustainable economic growth.

The organization of environmental statistics based on physical data appears to be the first step necessary to supply economic analysts with data on which to base comparative analysis between socio-economic data and environmental quality. A monetary measure of the flow of services that the environment supplies to the economic system, which is both theoretically and operationally satisfactory, seems to be a long way off yet.

Economically and statistically developed countries ought to make an effort to create and use, even transitorily, environmentally sustainable income measures in addition to the conventional ones produced by the SNA. The meaning of these supplementary measures should also be made adequately known to analysts so they can highlight the conceptual differences between these, GDP (indicator of general economic activity of an economy) and NDP (income measure net of capital consumption).

It is unlikely that developing countries, without proper aid from international cooperation, will create adequate conditions to allow to gather proper data for environmental statistics. Without the availability of such data, only simple proposals such as El Serafy's may be immediately applied.

The position of the «task force» for SNA revision seems to be, so far, the wisest even if it may seem non-committal: on one side it encourages the creation of satellite accounts which supplement the economic statistics with physical data supplied by environmental statistics; on the other side, changes in the construction of conventional income aggregates are ruled out, these aggregates seem to be destined, for the time being, to remain the «central core» of national economic statistics. In doing so it reinforces the position that it is by the combination of the two that more adequate and additional income measures are to be built (Bartelmus *et al.*, 1991).

There is no doubt that if «environmentally sustainable» economic development is to change from a mere statement of intentions into an objective of international economic policy, it will be with the help of the results obtained from better applied research in this field. ●

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The author is grateful to Lorenzo Venzi, Alessandro Sorrentino, Donato Romano, Margherita Carlucci and Paolo Quirino for useful suggestions supplied during the various layouts of this contribution. The usual disclaimer applies.