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Towards the Estimation of Final Demand at Total Costs *(Paid Economic Costs Plus Unpaid Ecological Costs)* in an Extended National Accounting Central Framework

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TOWARDS

THE ESTIMATION OF

FINAL DEMAND AT TOTAL COSTS

(paid economic costs ***plus*** unpaid ecological costs**)**

IN AN EXTENDED NATIONAL ACCOUNTING

CENTRAL FRAMEWORK

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Abstract

This paper proposes the estimation of final demand at total costs (paid economic costs *plus* unpaid ecological costs*)* and its inclusion in an extended national accounting central framework. Economy and Nature are treated as two separate entities within the super-entity called Planet. Unpaid ecological costs are the value, in terms of abstention or restoration costs, of the degradation of natural assets in a given period due to economic activities, both production and final use activities. They are finally attributed to resident/national final demand. International flows of ecological costs are taken into account.Economic product and income aggregates being unchanged, saving is reduced by the amount of unpaid ecological costs. A capital transfer of the same amount from Nature to the Economy rebalances the accounts. The paper presents, very tentatively, possible adjusted indicators for productivity changes and GDP volume changes, in order to take into account unpaid ecological costs, if any. A last part deals with the treatment of depletion/extraction of natural resources.

Introduction[1]

In the last decade, the question of sustainable development has led to more and more emphasis on life patterns as seen from the viewpoint of consumption of economic goods and services and their impact on the natural environment. In contrast, in previous decades the main emphasis was put on the producer stage rather than the consumers one. This change of emphasis is very much related to the emergence of the climate change issue and is of crucial importance

It is vital to calculate and record in some way **the costs of the degradation of natural assets that are not included in the market values** so as to estimate the full costs of the final goods and services of the economic circuit. It is both correct and meaningful to say that these **full costs** are the sum of **paid economic costs** and **unpaid ecological costs** by the Economy (or, in equivalent terminology, of **incurred costs** and **non incurred costs**). The ecological costs which have already been internalized are part of paid economic costs and therefore of prices. Internalized costs have partly offset the damage, whether actual or potential, resulting from pressures exerted by economic activities on natural assets. Thus, the expression “unpaid

[1] This text combines and completes two working papers of 2007-2008 and 2009 (see references) which developed a proposition I made in 1995 . I would like to thank Jean-Pierre Berthier, Jacques Magniez and Frederic Nauroy for their comments and suggestions and Jean-François Vacher who translated into English the French working version.

(ecological) costs" means the costs of degradation of natural assets resulting from economic activities that have not been offset by internalized costs. These are non internalized costs.

The present text is organized as follows. Part I presents a possible national accounting central framework with final demand at total costs. Part II compares it with the traditional proposal of measuring a nominal GDP/NDP aggregate adjusted for the environment. Part III cautiously introduces heterodox suggestions for adjusting productivity changes and GDP volume changes in the presence of unpaid ecological costs. Finally Part IV deals with the treatment of depletion/extraction of natural resources.

FOREWORD

What is the purpose of this article?

The present text tries to answer the question: **"How can the national accounting central framework of the SNA / ESA be extended in order to cover certain essential aspects of the relationship between Economy and Nature, while respecting the constraint of conceptual and valuation consistency of this central framework?"**

I draw the attention of those readers who could possibly not be familiar with standardized national accounting to the concept of central framework. A distinction is now well established, if not always well understood, between the central framework of national accounting (some people use to call it "core accounts") and satellite analysis or accounting[2]. The central framework of the SNA / ESA is notably characterized by the requirements for integration and consistency from both conceptual and valuation viewpoints. In particular, the flows and stocks that it describes are observed or estimated in terms of market values, or at

[2] Unfortunately a serious risk of confusion has been introduced in this respect by the SEEA 2012. The first volume of the latter is said to present "the SEEA Central Framework" which could be confused with the SNA / ESA Central framework.

least of transaction values. For lack of actual market values, one, willing to introduce something new in the SNA / ESA central framework, should be able to estimate equivalents to transaction values or prices. This condition is necessary in order to respect the constraint of maintaining coherence in concepts and valuation, and to make it so that the concerned magnitudes become commensurate, and can possibly be aggregated.

In this context, the present paper focuses on the **recording of the degradation of natural assets as a result of economic activities**. Secondarily it discusses certain aspects of the recording of depletion / extraction of (marketed) natural resources as it should have been done for a long time in the traditional central framework itself.

In order to emphasize this objective, the paper makes a distinction between **Economy and Nature as two separate entities within the super - entity called Planet**. This - surprisingly unusual[3] - way of representing the relationship between Economy and Nature is a choice based on a kind of system analysis, perhaps, one could say, a philosophical choice. Nature here is not embodied in the Economy. I must insist on this distinction between Economy and Nature in the context of economic - environmental accounting in order to avoid possible misunderstanding with most economists. Because economics deals with how to behave in the presence of scarcity, economists often consider that trying to apply economic analysis to environmental phenomena - in a context of growing scarcity for natural resources - implies an extension of the economic field itself. Thus for example scarce natural assets are deemed to become economic assets. While the SNA/ESA approach is quite clear in this

[3] Few authors, among those who have worked from an accounting perspective, seem to have adopted a similar approach (notably Henry Peskin in a 1989 text). Most of the others include Nature as part of the Economy.. Adopting a position on this issue is clearly not devoid of meaning. In any event, the stance taken here allows a clearer representation of the relationship between Economy and Nature. In addition, to conceive Economy and Nature as two separate entities (with their many interrelations) allows introducing a Planet super-entity which encompasses them both.

respect by limiting the concept of economic asset to, broadly speaking, market assets, the SEEA position seems a little ambiguous. Nevertheless, in the present paper I follow the SNA tradition. The economy is defined here as it is in the economic accounts of the SNA / ESA. As a consequence I speak of **economic assets** as opposed to **natural assets** (even if certain assets are **dual in nature** (on one hand, they are economic assets and as such they belong to the Economy, on the other hand, they are natural assets and as such they belong to Nature.) and of **economic costs** (paid costs) as opposed to **unpaid ecological costs** resulting from the degradation of natural assets due to economic activities. This type of representation does not prevent from applying economic techniques and analysis to environmental issues.

Because the focus of the article is on the state of the natural assets themselves, the unpaid [by the Economy] ecological costs in question are costs versus Nature. It seems rather logical then to measure the degradation of natural assets due to economic activities by the costs which would have been necessary or are necessary in order to avoid the degradation of natural assets or to restore the degraded ones. These are basically the costs which are called **"imputed maintenance costs"** in the 1993 SEEA.

On the other hand, because of the degradation of natural assets, economic agents may suffer from a loss of ecosystem services due to a reduced capacity of the ecosystems in question to fulfil their functions. This loss of **ecosystem services providing capacity** is very important. Ecosystem services became in recent decades the focal point of many environmental discussions and analysis. A number of projects, like the Millenium Ecosystem assessment (MEA) or The Economics of Ecosystem & Biodiversity (TEEB) undertook the measurement of ecosystem services under the general umbrella terms of "the value of Nature"). However the purpose of the present article is not to deal with the issue of the estimation and the recording of the ecosystem services provided by Nature to the Economy themselves. The estimation in monetary terms of the latter calls for other methods than the

maintenance cost approach. Those methods are diverse. Very often they involve the estimate of the value people give to the ecosystem services of which they benefit or could benefit or could have to renounce (through, among other techniques, contingent valuation surveys). Frequently also the costs of alternative solutions able to provide people with equivalent services are used to estimate the potential loss of ecosystem services due for example to given development projects. A possible evaluation by a general numéraire of all services rendered free of charge by natural assets to economic agents is a very complex issue which is generally considered beyond the scope of what the central framework of the SNA / ESA could ambition to do and is left to satellite environmental accounting. Additionally the possibility of combining market prices / transaction values (those in the SNA/ESA Central framework) with values derived from contingent valuation or similar approaches is still debatable. Similarly trying to assign a monetary value to the stocks of non market natural assets themselves is also left aside. Volume 2 of the SEEA 2012 concerning the ecosystems is in course of preparation. Anyway it is supposed to be experimental at the present stage.

To sum up, measuring unpaid ecological costs representing the degradation of natural assets on one hand and measuring ecosystem services on the other hand are two very different purposes. In order to best illustrate this point, one can consider a situation in which there is no degradation of natural assets by economic activities. In such a case, there are no unpaid ecological costs. Whereas ecosystem services are still provided by Nature to the Economy, both free of charge for the Economy and at no cost for Nature.

Thus the purpose of this paper is much more modest and limited than what (satellite) environmental accounting as a whole possibly can aim at. It is even more modest of course than what economic theory can try to integrate in the context of an extensive wealth concept and the strict perspective of sustainability (hard modelling is at stake there), though the perspective of sustainability is not absent here.

On the other hand, this conceptual paper, presenting an accounting innovation, is very ambitious to the extent that it proposes a solution which could be integrated in a future extended SNA / ESA central framework, while being at the same time heavily data and research demanding**.**

I – A National Accounting Central Framework with final demand at total costs

UNPAID ECOLOGICAL COSTS AND FINAL DEMAND AT TOTAL COSTS

On the basis of an idea presented in 1995[4], I was led to recommend an estimation of unpaid (non incurred) ecological costs by the resident consumers of a given national economy (or to be more precise, by the final demand from resident consumers and resident investors in this economy). Adding these unpaid ecological costs to the final demand at market value

[4] The June 1995 paper in the ROIW , which took place in the context of the discussion about the 1993 SEEA, dealt with various "Reflections on Environmental Accounting Issues" (degradation of natural resources, defensive expenditures, disposal and consumption services, depletion of sub-soil assets and depletion of renewable natural resources). Concerning the degradation of natural assets, the formal presentation in part 4 and Appendix 2 of this paper was partly different from what I do now. Nature and Economy were already presented as two separate entities. However the consumption of natural assets measured by the imputed potential maintenance costs was deemed to be the monetary(exchange) value of the Disposal and Consumption services (following the terminology of the 1993 SEEA) delivered by Nature to the Economy. I speak now in terms of unpaid costs, leaving aside the issue of the measurement of the ecosystem services provided themselves. However the general accounting approach is the same. To quote the conclusion of the 1995 paper : "According to this way of recording, adjusted final consumption is higher than final consumption in the 1993 SNA, whereas disposable income is unchanged and a capital transfer is received from nature".

(transaction prices) of national accounts (which only cover paid / incurred costs) **would reveal that, - economic GDP, NDP and disposable income remaining unchanged as they are in the central national accounts , whereas saving is reduced - , we consume a part of Nature**. It can be a part of the domestic Nature and/or a part of the Nature from other countries (via imports) and/or a part of the global Nature (notably via our greenhouse gas emissions). One or more flows from Nature to our Economy, **that constitute a kind of involuntary capital transfer from Nature to Economy**, would rebalance the accounts. Of course, in the same way as we can consume a part of natural assets from other economies via our imports, a part of our natural assets can be consumed by other economies through our exports. This kind of analysis involves a complete matrix of exchanges of unpaid ecological costs associated with the international flows in paid economic costs. Involuntary capital transfers from Nature to our Economy are increasing our "**environmental debt**"[5]. If the Economy restores a portion of the previously degraded natural assets, then a capital transfer from the Economy towards Nature reduces this environmental debt. My reflections converge with what the French Ministry in charge of the Environment proposed at the time of the "Grenelle of the Environment" conference (2007) in order to bring to light in market places the "ecological price" of products in addition to their usual price. Unfortunately not much has been actually implemented in this direction.

Focusing on the total cost of national final demand for economic goods and services (in the sense of National accounting) is a considerable task whose feasibility needs to be

[5] The formulation "environmental debt" is pertinent. However, in a framework distinguishing Economy and Nature as two separate entities, it seems better not to treat it as being similar to a financial liability entered in the financial account of the Economy with a financial asset as a counterpart in the accounts of Nature. In a way, the "environmental debt" is much more than a financial debt. Furthermore, the expression "ecological debt" is more relevant than "environmental debt". However the latter being widely in use nowadays, I keep it and use the two expressions as synonyms.

carefully investigated. If it were attainable with an acceptable degree of approximation, **the ratio between this total cost and the paid cost of the final demand (or vice versa)** would give a **very meaningful measurement of the imbalance of the relationship between Economy and Nature**[6]. Actually, in a state of relative equilibrium, i.e. without additional non compensated pressure from Economy on Nature, the unpaid costs would be nil and the concerned ratio equal to 1. This would be **an interesting indicator for sustainable development.** Its interpretation would of course depend on the definition and relevance of the measurement of unpaid costs[7]. Even if a complete implementation were not possible, a partial approach by total costs would bring a wealth of knowledge and many opportunities for inspiring environmental policies.

The referred to above **equilibrium** is however **relative**, to such an extent that the environmental debt does not increase or no longer increases, although there may still be a previous stock of environmental debt. For the latter to decrease, previously degraded natural assets must be restored or compensated for by other equivalent natural assets. Accounting entries may be more complicated in this case than it is in the case of damage to natural assets

[6] As far as the degradation of natural assets is concerned, the (economic) national income is unchanged in the proposed adjusted accounting stucture which treats Economy and Nature as two separated entities. Thus, in this respect, it does not correspond to what economists define as the hicksian measure of income in the extensive wealth approach. Nevertheless the proposed NA central framework clearly shows that, in the presence of unpaid ecological costs, we consume more than our (economic) NI would permit.

[7] The interpretation of such a ratio is more complicated in an open economy than in a closed one. For example, a constant ratio between two periods for a given country may conceal a decrease in the degradation of its domestic Nature and an increase in the degradation of Nature in other countries or of global Nature. In another case, the fact that a ratio greater than 1 (existence of unpaid costs) becomes equal to 1 (no more unpaid costs globally) may conceal a decrease in the stock of environmental debt owed to its domestic Nature (restoration of domestic natural assets) and an increase in the stock of environmental debt owed to the Nature of other countries or to the global Nature.

which generates the environmental debt. Globally, there will be a capital transfer from Economy to Nature. This means that the Economy incurs more than the economic costs in the strict sense. Formally one can say that "paid costs" are then superior to "total costs". However, a comprehensive analysis would raise subtle questions. Depending on the financing mode used for the supplement of "paid costs ", this supplement may appear as a component of NFD/RFD[8] through contributions included in the prices of products, or it may also come from a disinvestment in economic assets, for example of financial assets on foreign countries.

The diversity of financing modes for compensatory capital transfers from Economy to Nature and the time lag between degradation and restoration may make it difficult to trace the relationship between those who have caused ecological costs and those who incur their restoration costs. Thus, there is a complex set of implicit transfers that are difficult to clarify. This question is not theoretical. It was raised about the pollution of sites, notably in Africa, by foreign companies that have since moved away. Strong political implications are involved.

The proposal here is focussed on the degradation of natural assets (ecological degradation) resulting from the **production processes intended to meet the National Final Demand**, as well as from the **consumption/use processes / activities of this Final Demand** (like household car traffic).

This definition excludes of course the damage to natural assets resulting from purely natural processes (volcanic eruption, earthquake, etc.). One should recall that damage to economic assets resulting from natural disasters is in principle recorded by the System of National Accounts as "other changes in volume of assets" within the accumulation accounts.

[8] I use the terms Resident Final Demand (RFD) and National Final Demand (NFD) as synonyms. The resident/national final demand (often called also final expenditure) is the sum of the final consumption and capital formation from the residents of an economy.

More importantly, only the damage to the natural assets themselves is considered. Environmental damage to people and their economic properties is not dealt with in this proposal. Thus the purpose does not cover the measurement of the loss of ecosystem services which can be a consequence of the degradation of natural assets. It does not cover either the other type of damage that may result from this degradation or direcly from the stress factors which are at its origin.

As a consequence **unpaid environmental costs**, **that are not ecological costs**, such as those arising from congestion, noise, emissions affecting human health and other environmental externalities to people and their property, directly or indirectly, are not treated here. This is also true for **other unpaid social costs** (consequences of road accidents, of criminality, of alcoholism for instance). Observation and measurement of these phenomena are important, but belong to different types of exercise.[9]

[9] Many research projects cover both benefits and a wider range of damage costs than the present paper. For instance the Impact Categories of the ExternE project include, in addition to ecosystems, human health - mortality, human health - morbidity, amenity losses, etc..External costs are estimated there in the context of the preparation , generally at the sectoral level, of inter alia internalization policies , comparisons of technologies and more generally cost - benefit analysis. Other similar projects are Exiopol, CREEA, etc. Though the TEEB is focussed on the objective of measuring and valuing the ecosystem services themselves, it is often linked to the preparation of decisions in geographically delimited micro context. In the key messages of its chapter 1 ("Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation") ,we can see that "ecological functioning and economic values are context, space and time specific" and that "both the value of ecosystem services and the costs of actions can be best measured as a function of changes between alternative options." This does not mean however that there is no connection whatsoever between the preparation of micro decisions referred to above and the maintenance cost approach to unpaid ecological costs illustrated in the present paper. In a given micro context , the value of lost ecosystem services providing capacity due to the actual or hypothetical degradation of certain natural assets may have to be confronted, among other elements ,with the costs of avoiding such a degradation or restoring the degraded assets. Doing this in the context of the

The estimate for a given year of unpaid ecological costs is normally intended to measure the unpaid costs of the degradation of Nature occurring between the beginning and the end of a one year period. Therefore, it aims in principle at **physically measuring the state of natural assets at the beginning and at the end of that period, and at assigning a monetary value (maintenance costs, i.e. avoidance or restoration cost or something else)[10] to the physical change (in quality and quantity) of this state**.The use of the maintenance cost approach is closely linked to the purpose itself of measuring the degradation of natural assets from, one could say, the viewpoint of Nature (see above the Foreword). The approach is in broad terms similar to that of insurers who have to estimate damage claims. The physical measurement belongs to the field of observation. However, the list of natural assets that are covered in this exercise may be limited in two ways, either in principle, by adopting a position of indifference regarding the conservation of certain assets, or, for practical purposes, by reducing the range of the effective measurement operation to a part of the natural assets.

What role can possibly play in this context the reference to the levels that are desired by society? These levels are collective choices, nowadays often determined, possibly

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analysis of alternative options, under budget constraints, may help the preparation of decision.Nevertheless, the NA central framework itself must by definition have a macro coverage. It can help in the preparation of macro or sectoral policies, rather than of micro decisions.

[10] The purpose of this paper is not to investigate fully the possible content of the maintenance costs. The latter are commonly referred to as avoidance and restoration costs (remediation costs is also used). However there exist , for instance, various methods that can be used for avoiding the degradation of natural assets in various circumstances. Similarly restoration projects are diverse, including the replacement by equivalent natural assets. On the other hand there can be cases in which neither avoidance nor restoration methods can be used. The irreversible artificialization of agricultural land is a good case in point, which deserves special scrutiny.

in an evolutionary way, by the **objectives and standards which have been set in physical terms by environmental policies.** The interest of these environmental standards (presented as goals to attain) is that they describe **a reference state (from the past)** without going too far back to the origin of the world. They often accept, at least provisionally, a certain level of degradation of Nature. From there it is possible to estimate, by measuring the difference with the state of natural assets at a given time, **a stock of natural assets which have been consumed since the (past) reference state corresponding to the concerned environmental standards**. One can define it as the "**stock of environmental debt**"[11] resulting from the accumulation of the previous annual flows which generated it. Then, from year to year, the changes recorded in the state of natural assets within an accounting period modify this "environmental debt". It increases in case of degradation and decreases in case of restoration (involving in the latter case a capital transfer from Economy to Nature). Stocks and flows of environmental debt are to be broken down into **three components: debt to domestic Nature, to the Nature of other countries and finally to global Nature**. We should emphasize that the observation of annual changes in the state of natural assets is in principle independent from the environmental standards themselves. These are used only to determine a conventional "initial" reference state allowing the estimation of a stock of accumulated environmental debt. If, as is often the case, **environmental standards are modified** (usually in the sense of stricter requirements), the **environmental debt stock** should be reassessed.[12] More specifically, its changes would probably be recorded according to the System of National Accounts (SNA 1993, 2008) formulation as “other changes in volume of assets”.

[11] When environmental standards are missing, conventional reference states have to be decided upon, based on the knowledge and wisdom of the scientific community..

[12] The stock of environmental debt may have to be reassessed for other reasons. For instance changes in available technologies have to be taken into consideration.

The observation of changes in the state of natural assets is independent from the options that societies may have chosen: strong, weak or intermediate variants for **substitutability** between natural assets and produced assets. Substitutability considerations may however play a role, explicitly or implicitly, in the definition of a reference state through the adopted environmental standards or at the time amendments are made to these standards.

The estimates must be made as close as possible to **market price/transaction price values**, in order to render (imputed) unpaid costs commensurable with (actual) paid costs.

Estimating the degraded part of the stock of natural assets and its changes requires a lot of information, primarily in physical terms. As natural assets of other countries and public goods at World level are also at stake in the estimate of the "unpaid costs", these procedures ideally require **a close international collaboration of great magnitude**.

Though the purpose is to bring to light unpaid costs at the stage of final demand, this does not command what approach to follow in practice in order to estimate these costs and break them down by product (type of goods or services) used or consumed.

Implementation methods can be very different. In general terms, one can make a distinction between an analytical approach and a tentatively more systematic one though in practice both types of procedure will probably be used jointly.

In an analytical approach one will successively investigate the various type of natural assets, their state of health, the sources of their degradation, the methods (including their costs) that could have been used in order to limit or avoid this degradation, the restoration projects which could be contemplated and their costs. Various geographical scales have to be considered.

A very interesting proposal for a systematic approach can be found in Jean - Louis Weber 2011 publication “An experimental framework for ecosystem capital accounting in

Europe" (EEA Technical report | No 13 / 2011). This framework is being implemented experimentally in 2012 by the European Environment Agency. It consists in a sequential combination of physical and monetary accounting.

The physical part of the sequence ends up with the building of a "Total Ecosystem Capital Potential Account"and an "Account of Territorial Ecosystem Capital Degradation by Stress Factors". Stress factors are land - cover change, restructuring / de - structuring of landscapes and rivers, over - exploitation of biological resources, waste disposal and pollution (including GHGs). The Report does not enter into the details of the intended calculation. However it is easy to perceive that the methodology is both promising and complex. The crucial objective of the physical accounts is to imagine and implement a general equivalent measurement unit for the whole of the ecosystem capital potential (the ability of the natural assets to continue to deliver their services is taken as a by - pass route avoiding the estimate of the full range of ecosystem services). This physical measurement unit is called, at least provisionally, "Ecosystem Potential Unit Equivalent (EPUE)". As an illustration of the intermediary steps in this calculation, one can look at the proposed "Ecosystem Capital Biodiversity Account" where the aim is to assess ecosystem health regarding biodiversity, not biodiversity per se.

Then the linkage to the much shorter monetary part of the sequence is achieved through an "Estimation of unit costs of ecosystem capital restoration by stress factors". The product of the degradation in EPUE by the unitary remediation costs by ecosystem types / issues / regions then gives the Territorial Consumption of Ecosystem Capital. One should note that, whereas the physical part of these accounts covers ecosystem capital stocks exhaustively, the monetary part of the sequence relates only to the degradation (consumption) of ecosystem capital. No monetary valuation of the full stocks themselves is contemplated. Such an approach presumably raises a number of complex issues and variants are probable.

One can note that this “Consumption of Ecosystem Capital” is conceptually similar to the “Unpaid ecological costs” which are defined in the present article (international flows are to be taken into account in both approaches).

However the unpaid ecological costs on RFD are not intended to be measured only globally. They should be measured, in a crossed analysis, both by type of natural assets concerned and by type of goods and services composing RFD. Once they are estimated by type of goods and services, it would be easy to allocate them between various categories of the population.

Ideally, the general matrix of unpaid ecological costs would look as follows (with n types of natural assets and m types of goods & services in Resident Final Demand) :

Unpaid ecological costs by RFD

Degradation of natural assets by type of assets

	Domestic	Foreign	Global	All assets
Degradation of nat. assets by type of G. & S in Resid. Fin. Dem	1 n	1 n	1 n	1 n
1				
.				

.				
m				
All RFD				Total

Ideally again, the general matrix of unpaid ecological costs is derived from a number of sub-matrices . Of central importance, and most presumably the starting point of the actual estimate of unpaid ecological costs, is the degradation of domestic natural assets. This one is to be estimated by type of assets and industry and RFD use activity at the origin of the degradation; then by type of assets, industry/activity and direct destination of their output (making use of supply and use tables) ; then by type of assets, industry/activity and final destination of their output (making use of analytical input - output tables) ; finally by type of assets and type of goods and services in RFD.

Subsequently unpaid ecological costs that are embedded in the relations with the rest of the world have to be taken into account.

For the sake of clarification, the following point must be stressed. I-O tables and external trade in G. & S. matrices, duly adjusted if necessary, are indispensable tools in this undertaking. However their role is purely auxiliary in nature in the approach followed in this paper. That is, they serve to convert, for instance, estimates of unpaid ecological costs by type of natural assets which result from productive activities of industries and RFD use activities into unpaid costs finally attributable to Exports and RFD by type of G. & S. respectively. In contrast, here, I-O Tables are not used at all in order to simulate what could happen if the unpaid ecological costs were internalized. The purpose is to uncover the hidden ecological costs that are not taken into account by the economic values which are recorded in national accounting. These unpaid ecological costs are of course possible candidates to internalization policies. However matrices of unpaid costs, in the perspective of the present paper, are

juxtaposed with matrices of paid costs, not combined with them. The value of the output of industries and their economic value added are not changed. The counterpart of each box in the matrices of unpaid costs is a capital transfer from Nature finally conveyed to the relevant part of final demand at total cost.

AN EXTENDED SNA/ESA CENTRAL FRAMEWORK

Leaving aside the matrix of unpaid costs itself, a general accounting scheme is presented in the Tables which follow. In order not to overly complicate the presentation, I have not treated the case of restoration of natural assets by the Economy in these tables.

Table A is a synthetic presentation of the conceptual approach as a whole.

TABLE A - Paid and unpaid costs

Paid costs of economic Goods and Services	= produced (GDP)	+ imported	- exported	= Paid costs of National Final Demand (NFD)
+				
Unpaid costs (to Nature) of Goods and Services	= produced[13]	+ imported	- exported	= Unpaid costs of NFD
=				
Total costs of goods and Services	**= produced**	**+ imported**	**- exported**	**= Total costs of NFD**

National Disposable Income (National accounts)	= Final consumption at paid costs	+ Capital formation at paid costs	+ Net Lending or Borrowing (vis à vis the Rest of the World)
National Disposable Income (National accounts)	= Final consumption at total costs	+ Capital formation at total costs	+ Net Lending or Borrowing (vis à vis the Rest of the World) - Capital transfer from Nature (Negative Saving of the Economy)

Total costs of NFD	= Paid costs + unpaid costs
Total costs - paid costs	= Negative Saving of the Economy = Capital Transfer from Nature = Change in environmental debt (excluding revaluation)
Paid / incurred costs ——————— Total costs	**= Indicator of the imbalance in the relationship between Economy and Nature (ratio equal to 1 at equilibrium)**

[13] Unpaid costs recorded in the column "produced" cover both unpaid costs resulting from the production process (domestic production in the sense of GDP) and those resulting from the consumption/use processes of the National Final Demand, whether it relates to domestically produced or imported goods and services. Table A is simplified. A more comprehensive scheme would in principle include a separate row for unpaid costs resulting from the consumption/use processes of NFD

TABLE B presents in a very simplified way the accounting scheme which results from the above considerations. Let us assume a closed economy (no import or export) where GDP, GNI (Gross National Income) and GNE (Gross National [final] Expenditure) have a nominal monetary value of 1,000 in a given period of time, with a FC of 900 and a GFCF (Gross Fixed Capital Formation) of 100. Let us also assume the absence of cross-border pollution flows. Finally, let us assume that non-compensated (unpaid) damage to domestic natural assets by economic activity in this country are 50, of which 45 are attributed to final consumption and 5 to GFCF (the figures have been selected here in a purely arbitrary manner). The resulting accounting scheme (TABLE B) would be as follows:

TABLE B

Extremely simplified accounts of a closed economy and of Nature

	Economy		Nature	
	Uses	**Resources**	**Uses**	**Resources**
Present accounts				
GNI		1,000		
Use of income:				
FC at paid costs	900			
Gross saving	100			
Use of saving:				
Gross saving		100		
GFCF at paid costs	100			
Total costs accounts				
GNI		1,000		
Use of income:				
FC at total costs (paid and unpaid)	945			
Adjusted gross saving 1	55			
Use of saving:				
Adjusted gross saving 1		55		
GFCF at total costs (paid and unpaid)	105			
Adjusted gross saving 2 (negative saving of the economy)	- 50			
Capital transfer from Nature		50	50	
Degradation of natural assets (Unpaid costs)				50

The last two rows (in the column "Nature") of TABLE B represent a partial "Changes in balance sheet account" for Nature. This one hinges upon a very partial Balance sheet for Nature. It is very partial because it holds only two items, which are both on the Asset side. The first one is registered as a negative item and records the accumulated degradation of natural assets due to economic activities. The second one records the corresponding amount of the accumulated environmental/ecological debt to Nature. Let us assume that these two figures amounted to - 1,650/+ 1,650 at the end of the previous year. They then move to - 1,700/+ 1,700 at the end of the current year.

Very partial Balance sheet of Nature

	Assets
Accumulated degradation of natural assets	- 1,700
Accumulated environmental debt of the Economy	1,700

Within those partial Changes in balance sheet account and Balance sheet of Nature, the possible restoration of previously degraded natural assets leads to opposite entries. We assume in the present paper and its tables that entries are "net", i.e. that they are the balance between the new non compensated degradations of the year under consideration and the possible restoration of previously degraded assets. As a result, unpaid costs are also recorded in "net" value.

Let us now introduce in a simplified way the relations with the rest of the world. We suppose that imports (used only for FC) and exports are of the same amount. GDP, GNI and GNE are still 1,000. We also suppose that unpaid costs on imports (unpaid damage resulting from the production by the rest of the world of our imports) are 10 and that unpaid costs on exports are 5. The lower part of TABLE B becomes:

TABLE C – An open economy

Total costs accounts		
	Economy	
	Uses	**Resources**
GNI		1,000
FC (at total costs)	950	
(945 + 10 - 5)		
Adjusted gross saving 1	50	
Use of saving:		
Adjusted gross saving 1		50
GFCF (at total costs)	105	
Adjusted gross saving 2 (negative saving of the economy)	- 55	

What follows gets a bit more complex. We need to introduce two Economies (national Economy and Economy of the rest of the world) and two Natures (domestic Nature and Nature of the rest of the world).

	Economies				**Natures**			
	National		**Rest of the world**		**Domestic**		**Rest of the world**	
Capital transfer from Nature		55		5	50		10	
Degradation of natural assets						50		10[14]

In this example, the National Economy has a consumption of unpaid natural assets (non compensated damage) of 55, of which 45 come from the domestic Nature and 10 from the Nature of the rest of the world. Degradation of domestic natural assets is 50, of which 45 are related to the GNE and 5 to exports to the rest of the world.

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[14] Flows from the rest of the world (ROW) Nature are partial. They only concern here unpaid costs on exports of ROW to the concerned national economy.

II – Final demand at total costs or nominal GDP/NDP adjusted for the environment?

Let us compare now the treatment presented in part I, which increases the nominal value of Final Demand by the amount of unpaid ecological costs, corresponding to the degradation of natural assets, with the solution which has been so often proposed of reducing the nominal value of GDP and/or NDP by this amount.

Let us start again from TABLE B (Extremely simplified accounts of a closed economy and of Nature). I suppose that this economy does not extract non-renewable market resources (no mining or oil extraction) from nature (see part IV below).

In this closed economy, GDP and GNI (Gross National Income) are equal according to the SNA /ESA:

GDP = GNI = 1,000

If we assume that the consumption of economic fixed capital (CFC) in the sense of the SNA / ESA amounts to 70, then we obtain the following net aggregates:

Net Domestic Product = Net National Income = 930

Final Consumption (at paid costs) = 900

Net Saving = 30

Net Fixed Capital Formation (at paid costs) = 30 (i.e. 100 - 70)

Net Final Demand (at paid costs) = 930

We now take into account the cost of the degradation of Nature (total unpaid ecological costs).

The SEEA (System of integrated Environmental and Economic Accounting) of 1993,[15] like almost all proposals to take into account the degradation of nature due to economic activities, subtracts the total of unpaid costs (50 to be specific in the present paper) from the NDP in National Accounts in order to obtain an environmentally adjusted NDP (often called in an entirely inappropriate way "Green GDP")[16]. If one does this, the result is an adjusted NDP reduced by 50, i.e.:

"Adjusted" NDP = 930 - 50 = 880

The tables of SEEA 93 show effectively that these 50 represent the estimated value of the degradation of nature resulting from economic activities. However, the SEEA 93 did not try to be more precise and to complete the set of accounts so as to see how it is balanced. In particular, it is unclear if GDP itself is modified (and not only NDP), nor how incomes are changed. Moreover, no notion of final demand at total costs appears anywhere.

It was largely in reaction to the SEEA 1993 that the article I published in 1995 in the Review of Income and Wealth proposed to record an additional amount of final demand value and an equivalent (and involuntary) capital transfer from Nature to the Economy. This proposal has been pursued and detailed in the **lower part of TABLE B** from Part I. TABLE B is completely balanced; the GDP (or NDP) of the Economy is not changed in nominal value. However, it is important to perceive that **the balancing equation of GDP is different** in the lower part of **TABLE** B from the one in its upper part.

[15] I refer here to the 1993 SEEA because it was more directly oriented towards the adjustment of aggregates than the SEEA 2003 which mostly discussed methodological valuation alternatives.

[16] The set of accounting matrices in SEEA 93 is fairly complex. For those who would like to spend some time on them, I recommend looking at table 4.6 (p. 111 from the English original edition) entitled "SEEA matrix: environmental costs at maintenance values (version IV.2) - numerical example". It is reproduced in pages 346-347 from "A History of National Accounting" (Vanoli 2005).

Instead of the classical formula (in a closed economy):

GDP = GFD (gross final demand) at paid costs, or 1,000 = 1,000

we now have:

GDP + Unpaid ecological costs (Capital transfer from Nature)

= GFD at total costs

i.e. 1,000 + 50 = 1,050 (945 + 105)

or GDP = GNI = GFD at total costs - Unpaid ecological costs

(Capital transfer from Nature)

i.e. 1,000 = 1,000 = 1,050 - 50

If TABLE B (which leaves the economic CFC unchanged) were presented in net value**,** we would have:

NDP + Unpaid ecological costs (Capital transfer from Nature)

= Net FD at total costs

i.e. 930 + 50 = 980 (945 + 35)[17]

Whether we compute the aggregates in gross or net value, in the sense of NA, these transformed equations show explicitly that the Economy consumes a part of Nature. I remind the reader that in the accounting framework of TABLE B, Nature is treated as a separate entity from the Economy, not as a part of it.

In contrast, the accounting principles of the SEEA 93 treat the natural assets as a part of the Economy. The economic assets of SNA/ESA are thus extended and include as well, in the SEEA, at least in principle all non-produced natural assets. How does appear, in this context, the balance of goods and services?

The tables of the SEEA 93 are focused on the highlighting of environmental costs and on the transition from the NDP of the SNA to the environmentally adjusted NDP ("Eco

[17] To be specific: 35 = 105 (GFCF at total costs) - 70 (economic CFC).

Domestic Product"). Thus, they leave open the question of whether, according to the SEEA 93, GDP is modified or not when taking into account the degradation of non-produced natural assets generated by economic activities, bearing in mind that the value of the production of the economy in the sense of NA is not changed by the SEEA[18]. The answer depends on the accounting treatment which may be used for recording the counterpart of this degradation: additional consumption of fixed capital, or additional intermediate consumption, or a combination of both (I leave aside the mixed solution).

Let us first study the effect of recording an additional CFC. Given the same hypotheses for the economy as in TABLE B, the implicit balance of goods and services is then[19]:

Adjusted NDP = Final Consumption + Adjusted Net Fixed Capital Formation (NFCF)

i.e. 880 [1,000 - 70 - 50] = 900 - 20 [100 - 70 - 50][20]

We can observe that FC is unchanged and remains that of NA at paid costs (900). GFCF is also valued at paid costs (100) and the adjustment for the environment is made on one hand to the Net Domestic Product and on the other hand to the CFC.

From the income side, we have:

Adjusted NDP = Adjusted NNI = 880

Implicitly, in the SEEA 93, the labour income (notably compensation of employees) is unchanged and the total adjustment of 50 concerns only the net capital income.

It should be noted that GDP itself is not modified in this hypothesis[21]. The same applies to GNI[22].

[18] Except in variants introducing the production of household domestic services, but this is another issue.

[19] As the CFC is not an observable flow of goods and services, there cannot be here a true balance of flows of goods and services as it is presented in the SNA /ESA

[20] The adjusted NFCF is calculated as follows: 100 (GFCF of NA) - 120 (extended CFC which includes the 50 of consumption of natural assets) = - 20.

Thus, in the hypothesis of a treatment by additional CFC, it appears that, the total value of production being unchanged, the Final Gross Expenditure in current value of the economy is not modified. It remains valued at paid costs. In a coherent framework of national accounting, and this consistency constraint applies even in the case of an environmental satellite account, it is not possible in this approach to bring to light the final demand, and particularly the final consumption at total costs including unpaid ecological costs. However, in recent years, the latter have received increasing attention from analysis and environmental policy.

Let us suppose now that instead of an additional CFC we choose to record **an additional intermediate consumption** (IC) for the same amount, which still represents a counterpart of the degradation of non-produced natural assets generated by economic activities. As the value of production is unchanged, it follows that the GDP is reduced by the same amount by which the IC is increased.

The implicit balance of goods and services, still based on the same data of TABLE B, is then:

Adjusted GDP = Initial GDP - Additional IC [or ΔIC]

i.e. 950 = 1 000-50

The general balance of goods and services, still based on the same data of TABLE B, must therefore be changed on the use side:

Adjusted GDP = [Initial FC – α ΔIC] + [Initial GFCF - (1 – α) ΔIC]

The downward adjustment of GDP which has been performed ex-post by the introduction of an additional IC does imply that its **counterparts** (on the use side) are **valued**

[21] We must keep in mind that the SEEA reasons on the hypothesis that net aggregates replace gross ones in current use. This is a highly discussed issue (see notably footnote 19).

[22] But its structure is different. CFC is larger and net capital income smaller.

for lower amounts than those for paid costs. On the income side, assuming that labour income is unchanged, the adjustment of 50 concerns first the gross capital income, then the net one.

These static balancing exercises, within the assumptions that have been looked at so far, lead to results we can see as unrealistic and/or of little interest. It is so because certain significant aggregates of transactions (intermediate consumption, consumption of fixed capital) are modified ex post without changing other key variables (price and quantity systems for supply and use of products, labour income). Thus, in the debates about the SEEA 93, many national accountants underlined the fact that **this kind of ex post internalization of environmental costs** made little sense in a static accounting approach. They promoted an alternative approach which consists of modeling economies that would be subjected to the constraints of environmental standards and then observing the result. Incidentally, it is only in such a context that the concept of green GDP can make sense.

The main reason for the difficulties encountered by the proposals for downward adjusting GDP or NDP in nominal value seems to be that these proposals are based on **the idea that the market (or transaction) values,** that constitute the FD (FC and GFCF), **represent the "true" values of goods and services as measured by National Accounting.**

In fact, this idea is false for at least two reasons. First, a (usually unconscious) **confusion** is made **between physical phenomena and phenomena in monetary value**. Damage incurred by natural assets as a result of economic activities is partly the counterpart of the many services rendered by Nature to producers.From this point of view these intermediate services are actually entries (physical ones) in the economic production processes. Without them, those processes would be either impossible or only possible on a smaller scale.

Nevertheless, since they are by definition imputed ecological costs beyond the costs actually paid, these intermediate services are rendered free of charge to the economy, at the expense of the degradation of a part of natural assets. They do not play any role in the determination of relative prices. They are in no way incorporated in the costing of their products by economic producers. For the latter, they are nonexistent in monetary value. In some presentations of the standard economic theory, the sum of producer selling prices is, under certain assumptions, equal to the sum of their costs. These costs do not include free environmental services. The producers' economic estimates do not take them into account; in fact, they only consider the economic costs of labour and economic capital[23]. It is precisely this conception that the environmental policy and, in a broader sense, the sustainable development policy, want to change.

We can summarize the previous paragraphs by saying that absolute or relative market (or transaction) prices/values may represent the "actual economic values" but not the "true values per se". This fundamental difference is the basis of the distinction between paid costs (= prices) and total costs (paid and unpaid ≠ from prices). Taking into account unpaid costs, and incorporating them, is precisely a central objective and an essential means of environmental policy, which implies estimating unpaid costs for the different kind of products.

The second reason which may seem to legitimize the idea that market values are the "true" values of goods and services, for final consumers this time, is probably a rigid

[23]. Everything written above applies to **non-internalized ecological costs**. When damage to natural assets has been prevented or corrected by economic actions of various types, the costs of these actions constitute effective economic costs. **These costs are said to be internalized**. They enter paid costs, are involved in the costing of their products by producers and in the determination of prices. They are included in labour and economic capital costs. In practice, it is often difficult to distinguish, among paid costs, those which result from the internalization of environmental costs from the others.

interpretation of the consumer preference theory. According to this interpretation, the results of the consumer's choices supposedly reflect, through price ratios, a **notion of utility in itself, regardless of the costs that have been taken into account in the price system**. But the choices made are contingent upon a system of costs through supply-demand interactions. Once again, the internalization of unpaid costs in the process of making them payable would modify the system of prices and quantities, which is precisely what we are looking for.

III – Adjusting productivity changes and GDP volume changes in the presence of unpaid costs : some heterodox suggestions

An objection to the proposal in part I and II can be formulated as follows: "If GDP is not adjusted, the **measurement of the change in productivity of economic activities that degrade Nature continues to give misleading results". The case of agriculture** is often cited in this context.

It seems possible to try to address this concern in an accounting framework showing paid, unpaid and total costs. This part of the paper is obviously tentative and maybe a little provocative. It presents a possible analytical extension of the general approach of the paper in terms of adjusted indicators. It calls for critical reactions and possible alternative suggestions in a similar line of reasoning.

ADJUSTED PRODUCTIVITY VOLUME CHANGES ?

As for the measurement of the change in productivity, the analysis should be placed in the context of accounts in volume ("at constant prices") that can be interpreted as a comparison in time (which is what I am doing here) or in space between two different situations. In the simplified presentation of TABLE D, I keep the same data as in TABLE B for the accounts of year 1. I suppose that prices and incomes do not vary between year 1 and year 2 and that the only change between year 1 and year 2 is that the unpaid costs rise from 50 to 100. The same production in volume and in value (at paid costs) is obtained with the same paid costs (factors) in volume and in value, but through an increased pressure on Nature (for example, a threshold has been reached, damage has increased, and non incurred maintenance/restoration costs have become higher). TABLE D, which corresponds to the lower part of TABLE B, with the inclusion of a column for the Planet, presents the accounts of year 2 (at prices of year 1).

TABLE D

Accounts in volume of year 2 at prices of year 1 with FD at total costs

	Economy		Nature		Planet	
	U	**R**	**U**	**R**	**U**	**R**
GNI		1,000				1,000
Use of income:						
FC at total costs (paid and unpaid)	990				990	
Adjusted gross saving 1	10				10	
Use of saving:						
Adjusted gross saving 1		10				10
GFCF at total costs (paid and unpaid)	110				110	
Adjusted gross saving 2 (negative saving of the economy)	- 100				- 100	
Capital transfer from Nature		100	100		100	100
Degradation of natural assets (unpaid costs)				100		100

The output of our hypothetical economy (in TABLE B and consequently in table C we assume it is a closed economy and GDP = GNI) has not changed between periods 1 and 2. In an alternative formulation "it is the same in the two different situations". It still amounts to 1,000. And the economic costs have not changed either. However, from the Planet perspective (as a super-entity encompassing Economy and Nature), the amount and the structure of the necessary costs to obtain this production have evolved. Unpaid costs to Nature have increased. At time t_1, paid costs were 1,000, unpaid costs 50 and the total costs amounted to 1,050. At time t_2, paid costs are still 1,000, unpaid costs have become 100 and the total costs reached 1,100.

Starting from this point, we could define two notions of productivity: economic productivity (at paid costs) and productivity at total costs.

Economic productivity is the ratio between output in volume (at constant prices) and paid costs in volume (at constant prices):

economic productivity EP = *output P / paid costs PC*

It is the productivity concept derived from classical national accounts.

Productivity at total costs is the ratio between output in volume (at constant prices) and total costs (paid economic costs *plus* unpaid ecological costs) in volume (at constant prices):

productivity at total costs PTC = *output P / total costs TC*

It follows:

$$PTC/EP = \left(P/TC\right)/\left(P/PC\right) = PC/TC$$

and:

$$PTC = EP \times \left(PC/TC\right)$$

Productivity at total costs PTC is thus equal to economic productivity EP multiplied by the ratio between paid costs PC and total costs TC.

In the presence of unpaid ecological costs (PC < TC), productivity at total costs is lower than economic productivity (at paid costs).

If unpaid ecological costs are non-existent (PC = TC), both productivities are equal.

If paid costs are greater than total costs (PC > TC), which means that the Economy has restored previously degraded natural assets, productivity at total costs is greater than economic productivity.

In the example of TABLE D (rounded off):

at t1 $\quad PTC1 \quad = \quad EP1 \times 1{,}000/1{,}050 \quad = \quad 0.95EP1$

at t2 $\quad PTC2 \quad = \quad EP2 \times 1{,}000/1{,}100 \quad = \quad 0.91EP2$

In terms of annual productivity changes, in the same example:

$$\frac{PTC2}{PTC1} \quad = \quad EP2 \times \frac{1{,}000}{1{,}100} \Big/ EP1 \times \frac{1{,}000}{1{,}050} \quad = \quad \frac{0.91\ EP2}{0.95\ EP1} \quad = \quad 0.95 \times \frac{EP2}{EP1}$$

And since here EP2 = EP1, we have: $PTC2/PTC1 = 0.95$

From t1 to t2, economic productivity (at paid costs) hasn't changed, whereas productivity at total costs decreased by 5 % (output in volume remained stable while total costs in volume increased by 4.8 %).

More generally,

$$\frac{PTC2}{PTC1} \quad = \quad EP2 \times \frac{PC2}{TC2} \Big/ EP1 \times \frac{PC1}{TC1}$$

Which could also be written:

$$PTC2/PTC1 \quad = \quad \left(EP2 \diagup EP1\right) \quad \times \quad \left(PC2 \diagup PC1\right) \quad \times \quad \left(TC1 \diagup TC2\right)$$

From which we deduct:

$$\text{if} \quad TC2/TC1 > PC2/PC1 \quad \text{then} \quad PTC2/PTC1 < EP2/EP1$$

$$\text{if} \quad TC2/TC1 < PC2/PC1 \quad \text{then} \quad PTC2/PTC1 > EP2/EP1$$

$$\text{if} \quad TC2/TC1 = PC2/PC1 \quad \text{then} \quad PTC2/PTC1 = EP2/EP1$$

The changes in productivity at total costs are lower than the ones in economic productivity if total costs increase faster than paid costs, i.e. if unpaid ecological costs increase faster than paid economic costs.

They are greater if total costs increase slower than paid costs, i.e. if unpaid ecological costs increase at a slower pace than paid economic costs.

When the two types of costs rise in parallel, the two measures of changes in productivity are equal. However, in all these cases, the degradation of natural assets due to economic activities persists. It stops only when unpaid ecological costs disappear. Then the relationship between Economy and Nature reaches equilibrium, in the sense that there is no further degradation of natural assets. Nevertheless, as noted inpart I, it is only a relative balance since the environmental debt that may have been accumulated up until then did not fade away. In order to make it decrease, or even disappear completely, paid economic costs must progressively include the restoration costs of previously degraded natural assets. If restoration costs consist of actual costs for reconstituting natural assets (or creating equivalent natural assets) through gross capital formation in the sense of NA, these internalized costs would thus have actual additional outputs as their counterpart. Then, in the accumulation accounts, capital transfers from Economy to Nature would be recorded. One should pay particular attention to the **case when the restoration of degraded renewable natural assets** (such as stocks of fish resources in Nature) **is the result of total or partial abstention from extraction activities regarding these resources**. Abstention costs cannot for the most part be

observed. They have to be estimated and imputed. They somehow represent implicit *negative* ecological costs. They should be recorded *in a positive way* as an output of the concerned economy (therefore at the numerator of calculation formulas for changes in productivity). This will then lead to capital transfers from Economy to Nature in accumulation accounts [see part IV below].

If one attempted to adopt the approach cautiously proposed in this part of the article, implementation at various levels would require additional specifications. In particular, it would be necessary to know if it concerns an open economy, the macro level or only a particular industry.

In a **specific industry,** the unpaid ecological costs to take into account in the calculation of productivity at total costs and its changes are those which result from its productive activity in the territory, i.e. the sum of unpaid costs on the output from its process of production and of unpaid costs on its intermediate and capital inputs. In other words, these are the unpaid direct and indirect costs of the demand directed to this industry's products. Matrices with unpaid costs by industry and by product are then necessary

At the **macro level**, in a **closed economy**, the total costs of national final demand can be interpreted as the total production costs **for the Planet** of the products that constitute this NFD (paid costs plus unpaid ecological costs).

In an ***open economy, still at the macro level,*** foreign trade is brought into play. We must use input-output tables and foreign trade matrices. The National production (GDP) should then be related to the total production costs **for the planet** of the products that constitute the demand for this economy's GDP (paid economic costs plus unpaid ecological costs on the output from its process of production and on its intermediate and capital inputs).

ADJUSTED GDP VOLUME CHANGES ?

In the same vein as the approach suggested above for measuring productivity and productivity changes, we could also try to propose an additional notion for the volume of GDP and its changes.

Intuitively, one might define an "adjusted[24]" GDP volume (value at constant prices) in the following way (using the notation AGDP = adjusted GDP and EGDP = economic GDP):

- **Volume (value at constant prices)**

$$\boldsymbol{AGDP1} = \boldsymbol{EGDP1} \times {PC1}/{TC1}$$

$$AGDP2 = EGDP2 \times {PC2}/{TC2}$$

Thus:

if	*PC1 < TC1*	*then*	*AGDP1 < EGDP1*
if	*PC1 = TC1*	*then*	*AGDP1 = EGDP1*
if	*PC1 > TC1*	*then*	*AGDP1 > EGDP1*

- **Volume changes (value changes at constant prices)**

$$AGDP2/AGDP1 = EGDP2 \times \frac{PC2}{TC2} \Big/ EGDP1 \times \frac{PC1}{TC1}$$

From which we deduct:

$$\boldsymbol{AGDP2/AGDP1} = \left({EGDP2}/{EGDP1}\right) \times \left({PC2}/{TC2}\right) \times \left({TC1}/{PC1}\right)$$

By reasoning on the basis of this last formula, we may scrutinize **three extreme cases** of PC / TC relationship:

[24] I chose to use, at least at this stage, a "technical" term so as to avoid a possible misinterpretation.

1. there are no unpaid costs, either at t1, or at t2:

then:

$$AGDP2/AGDP1 = EGDP2/EGDP1$$

since

$$PC1 = TC1 \quad and \quad PC2 = TC2$$

2. there are no unpaid costs at t1, but there are some at t2:

then:

$$AGDP2/AGDP1 = \left(EGDP2 \diagup EGDP1\right) \times \left(PC2 \diagup TC2\right)$$

and $AGDP2/AGDP1 < EGDP2/EGDP1$

since we assumed that PC2 / TC2 is lower than 1 and also that TC1 and PC1 are equal

3. there are unpaid costs at t1, but there are no more at t2:

then:

$$AGDP2/AGDP1 = \left(EGDP2 \diagup EGDP1\right) \times \left(TC1 \diagup PC1\right)$$

and $AGDP2/AGDP1 > EGDP2/EGDP1$

since we assumed that PC2 and TC2 are equal and also that TC1 > PC1

In **intermediary cases**, the result depends on the relative weights of

$$PC2 / TC2 \quad and \ of \quad TC1 / PC1$$

To sum up, as TC1 / PC1 is the inverse of the PC1 / TC1 ratio, we deduct from the volume change formula:

if *(PC2/TC2) > (PC1/TC1)* then *(AGDP2/AGDP1) > (EGDP2/EGDP1)*

[pressure on Nature decreases]

if *(PC2/TC2) = (PC1/TC1)* then *(AGDP2/AGDP1) = (EGDP2/EGDP1)*

[pressure on Nature is stable]

if *(PC2/TC2) < (PC1/TC1)* then *(AGDP2/AGDP1) < (EGDP2/EGDP1)*

[pressure on Nature increases]

We can observe that the volume change formula is valid whether the EGDP is growing, stagnant or decreasing.

Which name could be given to this "adjusted" volume and its changes? We could call it perhaps "**volume and volume changes of GDP at total costs for the Planet**."

This view points to a fuzzy idea which had been presented during the discussions around the SEEA 1993. According to this idea, taking into account the degradation of natural assets due to economic activities in a national accounting context should not be dealt with through a decrease in nominal value of GDP, but through an adjustment of its volume changes.

The interpretation of the suggestion presented above is somewhat delicate. In the presence of unpaid ecological costs, the adjusted formula for the volume of GDP shows that its economic volume is attributed to Economy and Nature according to the relative proportions of paid and unpaid costs. However, this solution does not measure the relative contributions of Economy and Nature to the economic output[25]. Actually, when there are no

[25] There are some attempts to measure the actual contribution of Nature to the output of various economic activities. For instance, one can try to give a monetary value to the pollination services provided by bee populations. This can be done either at the margin for the loss of services due to the regression of these populations, or in totality for the whole of the pollination services, whether or not they are endangered. In such a context it is often proposed to "disentangle" the market value of certain goods and services between an economic

unpaid ecological costs, the economic volume of GDP is entirely attributed to the Economy. However, this does not mean that the Economy operates then without certain services provided by Nature, which are both free of charge and without costs for Nature.

Globally, GDP is, **in physical terms**, produced jointly by the Economy and Nature. However, when the relationship between Economy and Nature is at equilibrium, the services rendered by Nature to the Economy are without cost for Nature. Paid economic costs are then the total costs since they are the only ones. One should not forget though that nowadays in our economies paid economic costs include avoidance or restoration costs for degradation of natural assets which have been already internalized, i.e. incorporated into paid costs.

It is only when the economic production generates non-compensated damage to natural assets that its volume is partly considered as "extra" ("undue"). This "extra" part is then deducted from the economic volume of GDP in order to calculate the adjusted volume of GDP that is proposed here.

component and a natural component, a complex issue indeed.This purpose is totally different from what is aimed at in part III of this article. Here the issue is to possibly find an adjusted indicator for GDP volume change by taking into account unpaid ecological costs when such costs exist.

IV – Depletion/extraction of natural resources (renewable or non - renewable) and adjustment of GDP and NDP

NON – RENEWABLE NATURAL RESOURCES

So far in this text, which is centered on the issue of the degradation of natural assets, I implicitly assumed that the economy under review was not extracting market resources from Nature. Thus, there was no mining, no oil extraction, no fishing. We must now abandon this hypothesis. I first assume that this **economy owns non-renewable natural resources and extracts a part of them**, which is sold and enters into market economic relations. I will then refer to the case of renewable natural resources.

Until now, the national accounting central framework takes the total value of the extracted quantities measured at well head prices as the value of the output of the extractive industries and leaves the rent, for instance the oil rent, included in GDP. NDP, GNI and NNI are not adjusted either.

This treatment is unanimously considered unsatisfactory. It has however been maintained in the new version of SNA/ESA (2008 SNA) through lack of consensus on a more satisfactory alternative treatment[26]. Among the main points of divergence, one of the proposed solutions reduces the value of GDP by the amount of the rent (I seem to be the only one, or almost the only one, amongst national accountants who explicitly supports this proposal, which is slightly disturbing, I confess). Another solution reduces only the NDP, not the GDP, by an amount equivalent to an economic CFC. There has also been a debate on the

[26] For a synthetic presentation of the calculation method for the rent, on which agreement is quite general, see box 61, pp. 336-338 in "A History of National Accounting". For a presentation of the main methods proposed to record the extraction of non-renewable resources, on which views differ, see box 62, p. 339-341.On the estimation of the value of deposits, see Box 61 of "A History of National Accounting".

possible inclusion of the resources discovered in the output and the GFCF of the Economy (a minority view, mostly by the US, is in favour of including them).

Whatever be the solution, this issue should have been resolved in the NA Central framework itself. It is only a secondary concern for environmental satellite accounting. The fact that the SEEA 1993, as well as the SEEA 2003, had to rest on an unsatisfactory NA Central framework regarding this point has been a source of confusion. Finally, the SEEA 2012 decided to depart from the SNA 2008. However it adopted a solution which, in my view, is not fully satisfactory. On one hand, a new accounting entry for depletion is introduced, which is a significant step ahead. On the other hand, it is treated as a kind of extension of the SNA's Consumption of fixed capital, leading to a Depletion Adjusted Net Value added and a Depletion Adjusted NDP, but leaving GDP unchanged.

I maintain that extracted quantities of a market non-renewable resource must be regarded as the **disposal** (by the owner in favour of the extractor, who possibly can be the same economic unit) **of a fraction of the stock of the relevant resource**. These quantities must be recorded for the amount of the rent (the intrinsic value of the resource) which is included in their market value. The value of the rent is equal to the well head price minus all costs - including the normal profit – for exploration, development and exploitation attributable to the extracted quantities. If we take this position, the decrease of the stock of the resource will appear as a disposal of assets to be recorded in the same way as the disposal of other assets in the capital account of the Economy.

To avoid frequent misinterpretations,the **accounting treatment** that I **propose** should be explained in detail. In the supply and use accounts for goods and services, two different types of goods must be distinguished: on one hand the natural resource in the ground before extraction, and on the other hand the product after extraction. A supply and use account is created for the resource prior to extraction. This account receives two entries. On one hand,

the fraction of the natural resource "to be extracted" during the period appears as a negative change in stock / inventories (or any similar term), which is equivalent to a "supply". On the other hand, an intermediate consumption (by the extractor) of the same amount balances the account. The supply and use account of the product after extraction is the same as the present one in national accounts. On the other hand, in the industry account of the mining activity, the value added of the extractor is reduced by the amount of this new intermediate consumption of "natural resource in the ground before extraction". The GDP is thus reduced by the same amount.

A **simple numerical example** can help.

Suppose the value of the extracted quantities at well head price (output of the extracting industry) is 1000 (of which 600 are exported and 400 delivered to the refining industry). Inside the value of 1000, 700 are costs (including the normal profit) and 300 are the resource rent (intrinsic value of the resource in the ground). The owner of the resource in the ground is supposed to be also the extractor.

Supply and Use (Goods & Services) Accts			Asset Accts
	Uses	Resources	Change in Assets
Natural resource before extraction			
Changes in stock / inventories	-300		-300
Intermed. cons. by the extractor	300		
Product after extraction (no change)			
Output		1,000	
Intermed. cons. by the refin. ind	400		
Exports	600		
Industry Accounts			

Extracting industry

Output (no change)		1,000	
Intermed. cons. of natur. res. before extract	+300		
Gross value added, gross operating surplus	-300		

Refining industry

no change			

Aggregates

GDP, NDP	-300		

In the above solution, a deposit of non-renewable natural resources is treated by analogy with a stock of inventories.

Those who support the analogy with fixed assets and the CFC are, in my opinion, departing from the National Accounting concept of fixed capital. According to NA (see for instance SNA 93, paragraph 10.7, SNA 2008, paragraph 10.11), a fixed asset is characterized by the fact that it can be used repeatedly or continuously in processes of production for more than one year. This definition can be applied without any problem to the accumulation of exploration expenses, as intangible assets, or to development assets which are necessary to carry out mining operations. Proponents of the theory discussed here extend the notion of fixed assets to the deposit itself consisting of non-renewable (proven) resources. But it seems difficult to argue that this "package" of resources is used durably in a production process. It is clear that it is not a production process of the (non-produced) resource itself. It cannot be the extraction process either. The latter changes the location of the extracted part of the resource (i.e. from a sub-soil resource to a well head resource), but the resource deposit as such does not take part in the extraction process.

The crux of the matter is the participation in a production process. In fact, those who support the position presented above replace the criterion of repetitive or continuous

participation in a production process by the one of pure and simple durability, from which they then tend to draw two consequences. On one hand, the difference between fixed assets and inventories becomes a simple matter of difference in durability. On the other hand, the concept of capital consumption is extended to all forms of (non-financial) capital and the terminology is changed. The expression "capital consumption" is used instead of the term "consumption of fixed capital" and can be applied to inventories and their changes (entries / withdrawals from inventories).

Two conceptions of NA seem at stake behind differences that may superficially look negligible. The first one focuses, in the wake of economic theory, on more abstract notions than the traditional NA ones. The other conception holds that NA is a representation of economic life which must be more concrete than economic theory, while being more abstract than the perceptions of phenomena and the representations, including accounting, by economic agents themselves. The treatment to be used in NA for recording the quantities of non-renewable resources extracted during a given period is a good example of the implementation of these two views and of the differences to which they can lead.

Three more points should be specified on the issue of non- renewable ressources.

Firstly, if Nature and Economy have been distinguished as two separate entities, a capital transfer from Nature to Economy will be recorded either as the extraction process progresses or at the time when discovered resources are proven (this flow would replace the present SNA/ESA recording under “Other changes in volume of assets”)

Secondly, the calculation of the rent mentioned earlier uses current well head market prices, such as they are. It does not raise the issue of determining whether these prices correspond or not to what they should be from the strict point of view of sustainability quantification. This question belongs to the field of forecasting exercises which is situated on the outside of the current NA framework. If the whole rent is deducted from GDP/NDP as I

propose, the calculation of current GDP/NDP does not even involve the calculation of future rents. On the other hand, if the deduction from GDP/NDP is limited to the difference between the current rent and a net income which is calculated by applying a discount rate to the total value of the deposits (rV_t), then the adjustment to GDP/NDP depends on the present value of future rents which is used to estimate the value (V_t) of deposits.

Thirdly, the extraction of non-renewable resources may lead to the uncompensated degradation of non-market natural assets. The value of this degradation is not included in the well head market prices. It constitutes unpaid ecological costs and pertains to the global treatment which is proposed in part I of the present paper.

RENEWABLE NATURAL RESOURCES

The case of extraction of **renewable natural resources** (more precisely non-cultivated renewable natural resources) is slightly more complex. As long as extractions do not exceed the regeneration capacity of the resource, the total value of extracted quantities is rightfully incorporated into the output value of the Economy. There is no capital transfer to record from Nature to Economy (the intrinsic monetary value of the resource is nil). Beyond its regeneration capacity, the natural asset starts to become depleted and the removed quantities beyond the bio-capacity equilibrium constitute a capital transfer (in kind) from Nature to Economy. If we assume that the equilibrium level of reference and the extracted quantities in excess have been estimated (which is no obvious matter), the main difficulty consists in determining the monetary value to attribute to this capital transfer. If the overexploitation is accompanied by the existence of rent phenomena, in the sense mentioned earlier for non-renewable resources, we might consider applying a treatment which is similar to the one for non-renewable resources. But it is not so simple. Should we deal with the rent only on quantities extracted beyond the point of equilibrium? Though this stance might seem logical in order to match up the excess of removed physical quantities and the value of the rent on

these quantities, several difficulties still arise. It is probably impossible, except in specific circumstances, to determine, i.e. to locate and single out, the quantities that are "accountable" for the extraction beyond the equilibrium and their value. Even if it could be done, there would still be a doubt on the general relevance of such a distinction between "virtuous" extracted quantities and "non-virtuous" ones. It is all the more so since market prices tend to get closer when considering all the extracted quantities from relevant business areas. Besides, there may be on one hand some kind of rent, in the current sense of economic rent, without any over-extraction exceeding the bio-capacity equilibrium, for instance when the increase in demand for a given resource (fish for example) tends to precede that of the supply because of changes in consumer preferences. On the other hand, there may be no rent at all or simply one that can decline and ultimately disappear, if the depletion of the stock of resources leads to an increase in their extraction costs. Then, the economic factors of production may not even receive a "normal" remuneration (this may also be the case for some non-renewable resources).

In such circumstances, what should be done? It would be advisable to first consider the potential cost of preserving or restoring the resource to the equilibrium level of its stocks. The value of this preservation or restoration cost to the equilibrium level can rightly be regarded as an estimate of the value of the consumption, whether potential or effective, of the fraction of the natural resource that is endangered, and then depleted, when getting close to the equilibrium/disequilibrium point and finally crossing this limit. We can easily see that this question is of the same nature as the (imputed) potential maintenance costs issue which was extensively discussed in part I of this text. This estimate determines then the amount in monetary value of the capital transfer from Nature to Economy resulting from an overexploitation (first potential, then actual) of the concerned renewable resource.

We are then led to propose the following treatment when we go beyond the equilibrium point.

- The possible rents resulting from **the whole of the extractions** of this renewable resource are one of the counterparts of the capital transfer from Nature to Economy. They have to be deducted from the value of the output of the concerned extractive activities. They represent the market part of the intrinsic value of the resource, and lead to a double entry of the same amount for increase in stocks /decrease in stocks (inventories) of the economy in relation to the concerned resource.

  Let'suppose the deliveries by the extracting industry of a currently extracted renewable ressource are 1000 (800 go to Final Consumption and 200 to the Intermediate Consumption by the food industry) of which 300 come from the intrinsic value of the natural resource (resource rent) . According to the present SNA, the output of the extracting industry is 1000. With the treatment that I propose, the output would be only 700 (1000 - 300). The recording is as follows :

Supply and Use (Goods & Services) Accts			Asset Accts
	Uses	Resources	Change in Assets
(Cap transfer from Nature)			+300

Renewable natural resource (extracted)

Changes in stock / inventories	-300		-300
Output		700	
Final consumption	800		
Intermed. cons.	200		
Total	700	700	

As a consequence, the Gross Value Added and Gross Operating Surplus of the extracting industry, as well as GDP and NDP, are 300 less than in the present SNA.

(NB : the total deliveries 1000 are balanced by the sum of the output of the extracted industry 700 and the 300 entry under changes in stock/inventories corresponding to the capital transfer from Nature)

- The remainder of the potential costs for preserving/restoring the resource to its equilibrium level, after the above deduction of any possible rent, represents the unpaid ecological costs to be added to the paid costs of National Final Demand so as to obtain the estimate of NFD at total costs (including possibly foreign trade).
- When the preservation/restoration costs of the resource are, totally or partially, internalized (through various forms of imposing extraction limitations), unpaid costs are gradually transformed into paid costs, the capital transfer from Nature to Economy decreases and then becomes nil, before finally turning into a capital transfer from Economy to Nature corresponding to the restoration of the stock of the renewable resource **within Nature**, accompanied by a symmetric decrease in the environmental debt of the Economy.

Estimating the preservation/restoration costs of the resource is thus vital. It depends on the analysis of all conceivable forms of environmental policy instruments (total temporary bans, regulatory quotas, tradable or non-tradable extraction permits ...), of their costs (estimating the costs of total abstention from extraction is the most sensitive issue) and of their effectiveness.

Once the amount of abstention costs has been estimated, their recording deserves some careful attention. Abstention, total or partial, from extraction activities results in the restoration of the stock of degraded renewable natural resources, like wild fish. The amount of their costs should be treated as an output of the concerned economy. This is not an obvious

solution as there are no actual inputs in the process of production in question (one could say that there is no actual process of production either). In addition, a wild renewable natural resource like fish is considered, in national accounting, a non-produced asset. So, quite unusually in national accounting, both inputs and output are imputed. Apparently everything is invented in this case. What is real then ? Two things are real. Firstly the stock of the renewable resource in question is moving toward its equilibrium regeneration capacity. Secondly this movement is due to the abstention from extraction activities.

Under such circumstances, the proposed recording is necessarily conventional, though not arbitrary.The restoration of the stock of natural resources is attributed notionally, not physically, to the Economy as an output of a new (imputed) economic activity which can be called "Restoration of renewable natural resource". The account of this industry is balanced by an amount of value added equal to the one of the output. A new supply and use account is also introduced, called "Renewable natural resource (restored)". The counterpart of the output is a positive change in stock/inventories. Then in the change in assets accounts, there is a negative change in stock/inventories balancing an equivalent capital transfer from the Economy to Nature. The ecological debt of the Economy towards Nature is reduced accordingly.

Let'suppose the abstention costs have been estimated at 300. The recording is as follows :

Supply and Use (Goods & Services) Accts			Asset Accts
	Uses	Resources	Change in Assets
(Cap transfer to Nature)			-300

Renewable natural resource (restored)

Changes in stock	+300		+300
Output		+300	

Industry Accounts

Restoration of renewable natural resource

Output		+300	
Value added	+300		

GDP and NDP are 300 more than in the present SNA. The ecological debt of the Economy is reduced by 300.

CONCLUSION

I do not underestimate the practical difficulties involved in implementing the unpaid ecological costs approach, both globally, by type of assets and by type of goods and services composing Resident Final Demand . It is not possible at this stage to predict how far this implementation could effectively be developed and therefore if it could be comprehensively achieved. In any case, it is not unrealistic.

However, we must be aware that an important part of the necessary estimates are the same as those that were required by the proposals for definition and calculation of an environmentally adjusted Net Domestic Product in a closed economy.

The proposals in this text are more demanding because their content is much richer. Environmentally adjusted GDP/NDP was centered on the production and the extraction of natural assets of a given country or their degradation. In contrast, the proposals in this text are centered on National/Resident Final Demand and thus, through foreign transactions, also on international flows (at world scale) of unpaid ecological costs linked to the degradation of natural assets wherever they might be located. Environmentally adjusted GDP/NDP was focusing on productive industries. In contrast, the proposals in this text are centered on the products, by type of goods and services resulting from the process of production of these industries, and which are part of the World Final Demand. They ideally require the use of input-output tables and matrices of international trade at a world scale so as to estimate the unpaid ecological costs that can be allocated to the National Final Demand of each country.

Apart from a richer content, the proposals in the text are also richer in potentialities. This is primarily true on a conceptual level. They offer a possible extension of the NA central framework itself, even though in practice this extension could stand for a rather long time as a

complement to this central framework. In fact, they are fully compatible with the rules and concepts of the central framework, once we have introduced the necessary adjustment for the handling of the extraction of natural resources, especially the non-renewable, market ones and for treating Nature as a separate entity from Economy. The proposed accounting scheme, thanks notably to the separation of Economy and Nature, does not claim to artificially internalize imputed (unpaid) ecological costs. It merely observes that, the Economy being what it is, economic agents have consumed a part of Nature, which is measured by the degradation of natural assets. The Economy has thus consumed something that it did not produce. A negative saving corresponds to this "something", and has for counterpart a capital transfer from Nature to Economy. In my opinion, this form of statistical representation appears to be more meaningful.

It is based on an integrated accounting framework and avoids the arbitrary decrease in nominal value of GDP/NDP resulting from the possible calculation of an environmentally adjusted GDP/NDP. In fact, this ex post statistical adjustment has raised major objections on the ground of principle and led to unsolvable problems of interpretation. This proposal was well-intentioned but inadequate and has caused, in my opinion, a blockage and a long stagnation until the focus moved in the last period towards the estimation of unpaid ecological costs of National Final Demand.

This decisive step[27] resulted from the development of environmental policies, particularly those related to the climate change issue. From the perspective of these policies, the potential reward of the approach by unpaid environmental costs assigned to Final Demand is considerable, even in case the implementation is partial.

[27] I am not taking the credit for it because my suggestion of 1995 fell flat for various reasons. The main one was, I believe, that the pressure in favour of an adjustment through the decrease in nominal value of GDP/NDP was so strong that it prevented those interested in these questions to perceive the relevance of another approach.

By comparison, the notion of environmentally adjusted GDP/NDP, often called "green GDP", was basically aiming at raising the awareness of environmental problems. In the mind of its proponents, it was supposed to provide a communication tool, but it underwent a failure which stopped its development.

In contrast, the ecological footprint approach has proved to be a very efficient communication tool. Therefore, at this final stage, it may be useful to outline some comparison between the approach advocated in this text, which focuses on unpaid ecological costs, and the ecological footprint approach. Such a suggestion may look surprising since the latter calls for an entirely physical accounting which is completely different from the environmental economic accounting based on estimates in monetary terms. All the more reason however, we could say, to see what there may be in common with the two approaches.

From a certain perspective, the final objective is the same. The ecological footprint method compares, in terms of surface (i.e. in global hectares), the “ecological footprint” itself (which can be interpreted as a "need of Nature" corresponding to its economic consumption of all kind) for a given entity with the “bio-capacity” (which represents various forms of the "availability of Nature") of the same entity. This method seeks then to provide for the relevant entity, and for the whole planet in particular, a global measure of the imbalance of its relationship between Economy and Nature. On the other hand, the accounting of Final Demand at total costs (i.e. paid economic costs plus unpaid ecological costs) also seeks to provide ultimately a comprehensive measure of this imbalance (the ratio between total costs and paid costs). We might even be tempted to say that the aggregate of unpaid ecological costs could be used as a monetary measure of the ecological deficit (footprint less bio-capacity), considering that in both cases the purpose is to provide a measure, in different numeraires, of the consumption of natural assets over a given period of time. However, the two approaches are so different that it would be risky to accept this interpretation. In

particular, the consumption of natural assets is central in the estimate of NFD at total costs, it still remains an implicit background in the ecological footprint approach.

Each one of the two approaches aims at clarifying the question of development sustainability for a specific entity in a given period. Neither one will tell us how long this non-sustainable development can be pursued before a great catastrophe happens (in contrast to estimates and analyses on climate change which deal directly with this issue). In fact, the approach by unpaid ecological costs does not seek to give a value to all natural assets, but only to the fraction of those assets which has been deteriorated over a given period, without knowing to which part of the total this fraction corresponds[28]. Similarly, and maybe in contradiction with appearances, the ecological footprint approach does not tell which fraction of total natural assets the ecological deficit corresponds to.

On a very important point the two approaches have close methodological concerns. As they stand in the perspective of consumption or final demand for an entity, they must give a great importance to international flows. For the ecological footprint, it is necessary to estimate the indirect imports and exports flows of carbon (grey energy) which will be combined with emissions resulting from productive activities of an entity so as to end up at the carbon consumption included in its total final consumption/demand. The estimation of unpaid ecological costs related to the resident final demand of an entity calls for an approach of the same type, although more ambitious in principle (with larger concerned matters and measures in monetary terms).

[28] This assertion needs to be qualified perhaps. It is true as far as unpaid ecological costs in monetary terms are concerned. However the implicit ambition of a project like the ecosystem capital accounting experimental framework (J.L.Weber and the E.E.A.), referred to in part I of this article, seems wider. The physical measurement that is proposed of both total ecosystem capital potential and ecosystem capital degradation (which is in correspondence with unpaid ecolgical costs) points to a possible combination of those potential estimates.

From a political perspective, the objectives that are pursued by the two approaches are significantly different. The main objective of ecological footprint is to raise public awareness and influence the opinion on strategic policies in favor of sustainable development. It may however not be used in an efficient way to clarify specific choices for economic policy. This is shown by the conversion of carbon emissions due to consumption of fossil fuels into the forest surfaces needed for carbon sequestration. The part of the partial energy footprint in the total footprint is so important that potential surfaces of forests resulting from the conversion of carbon emissions cannot be regarded as an objective assigned to the actual extension of forests. This point gave rise to some ambiguity in the discussions about the ecological footprint.

On the other hand, the unpaid ecological costs approach is a focusing point of many environmental debates and can become a foundation stone for policies related to the ecological pole of sustainable development[29].

[29] This does not mean that things are that simple. A key objective of environmental policy is the internalization of unpaid environmental costs, which leads to replace them by economic paid costs. There is much discussion on the subject of the possible redistributive effects of this internalization. However the question is not always properly presented. We must distinguish between two issues. The first one concerns the equity. It consists of determining whether, for a given category of economic agents, the costs incurred by reason of internalization are equal, lower or higher than the ecological costs caused by its Final Demand. If, for each category of agents, its incurred costs are equal to the costs that it has caused, it can be said that the internalization is fair, i.e. it does not have redistributive effect in the sense that it does not make some agents endure environmental costs caused by others. In contrast, if for various categories of agents the costs they bear as a result of internalization are not equal to the ecological costs that they have caused, internalization is not then fair, since it does make some agents endure the costs caused by others, and it has in this sense redistributive effect.

It is however another matter to consider the differences in the capacity that various categories of economic agents may have, when taking into account their respective incomes, for withstanding the internalization weight of caused environmental costs, even if the internalization policy is fair in the sense defined above. For purpose of

In practice, the unpaid ecological costs approach may include and actually already includes steps that focus on estimates in physical terms. Thus, much work has been for some time devoted to estimating, through input-output tables, flows of international trade, emissions and various data statistics, the CO_2 content or its CO_2 equivalent for NFD in several countries[30]. This work aimed notably at comparing national emissions of pollutants from production processes and emissions due to NFD after taking into account the international trade. Similar work is underway in France[31]. This type of research can be extended to other pollutants, and maybe, with more difficulty, to phenomena such as damage to biodiversity. In some cases, it seems possible to move directly from a physical content, for instance quantities of CO_2, to the corresponding unpaid ecological cost in monetary terms[32].

social policy, it can then be decided to help in various ways the disadvantaged social groups to bear this burden. But there is a strong interest in not confusing the internalization processes for which the costs caused/costs incurred relationship is essential with the possible accompanying social measures for certain categories of the population.

[30] Wiedmann 2009

[31] Lenglart, Lesieur, Pasquier 2010

[32] Nauroy 2010

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